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Seasonal fluctuations in macrobenthic fauna of the *Fucus* belt in Kiel Fjord (western Baltic Sea)

K. Anders & H. Möller

Institut für Meereskunde; Düsternbrooker Weg 20, D-2300 Kiel, Federal Republic of Germany

ABSTRACT: The macrobenthic fauna associated with *Fucus* at a station in the Kiel Fjord was investigated from June 1978 until June 1979. The predominant group in number as well as in biomass were gammarids. They formed, together with the isopods *Idotea* spp., approximately 95 % of the total average annual biomass. The total dry weight of all macrobenthic animals (excl. *Littorina* spp.) increased from 1.9 g per kg *Fucus* in May to about 16 g in June–August, and dropped to 8.3 g in September. Winter average dry weight values were only about 6 % of the summer values.

INTRODUCTION

The brown alga *Fucus vesiculosus* forms a substantial part of the seaweed community from the midwater line down to about 2 m depth in the Baltic Sea. Due to the lack of major rock soils in Kiel Bight, mainly individual stones lying on sandy and muddy bottom and hard substrate are colonized.

Hoffmann (1952) estimated the *Fucus* stocks (*F. vesiculosus* and *F. serratus*) of Kiel Bight from depths of 0 to 6 m to be about 1.8 kg wet weight per m^2. This corresponds to a yearly production of 0.6 kg per m^2, assuming a regeneration period of 3 years. Seasonal and annual fluctuations of the stock are mainly determined by drift ice, wave action and water temperature.

Quantitative data on the colonization of *Fucus* by micro- and macrofauna were given by Boaden et al. (1975), Hagerman (1966), Knight & Parke (1950), Ohm (1964), Segerstråle (1928, 1944), Haage & Jansson (1970), Oertzen (1968), and Skult (1977). Haage (1975, 1976) conducted extensive studies near Askö in the northwestern Baltic Sea on the population development of the predominant species.

The present study focusses on the quantification of that zoobenthic biomass in the *Fucus* belt, which serves as food for fishes, rather than on taxonomic aspects.

METHODS

Twenty-four samples were taken between June 1978 and June 1979. Weekly sampling periods were interrupted by coastal ice layers in winter and early spring (Table 1). Sampling took place at a depth of 0.5 m within the outlet of Kiel Fjord (Fig. 1). The area was well protected against major wave action, produced by the predominating west winds. The bottom was a mixture of sand and mud with many single stones colonized by *Fucus* plants. Salinity usually ranges from 12 to 16 $\times 10^{-3}$ S.

Table 1. Basic data on samples

Date Day/Month	Water temperature (°C)	Sample volume (g *Fucus* dry weight)
1978		
11. 6.	13.8	254
18. 6.	12.0	256
25. 6.	12.0	338
2. 7.	13.8	329
9. 7.	14.2	310
16. 7.	15.8	234
23. 7.	16.6	211
30. 7.	21.5	214
6. 8.	18.3	154
13. 8.	18.2	218
20. 8.	21.3	263
29. 8.	16.3	207
3. 9.	16.0	211
17. 9.	14.4	270
8. 10.	13.0	183
28. 10.	11.5	235
22. 11.	6.9	226
9. 12.	2.5	155
1979		
7. 1.	0.9	236
4. 2.	0.5	173
10. 5.		185
19. 5.		204
26. 5.		284
2. 6.		175

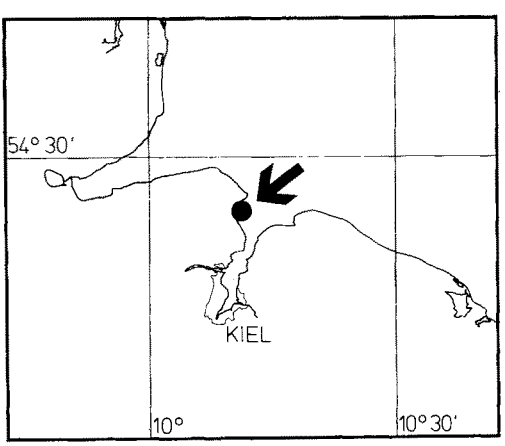

Fig. 1. Station map (in western Baltic Sea)

Samples were taken by placing a hand net of 300 µm mesh size over individual *Fucus* plants, closing it at the bottom and cutting off the rhizoids. Only fish and larger shore crabs were observed to escape. The samples were washed in water from the sampling place and filtered through a 300 µm net. Animals clinging to the plants were loosened by short suspension in 4 % formaldehyde.

The dry weights of single *Fucus* samples are given in Table 1. Its average value throughout the period of investigation was 230 g. All data in the text on frequencies of benthic animals refer to 1 kg algae dry weight and are calculated as monthly average values.

RESULTS AND DISCUSSION

The predominant group in number as well as in weight were the gammarids, representing in summer, as well as over the whole year, an average of 60 % of the total biomass (excl. *Littorina* spp., Table 2). Among these, *Gammarus zaddachi* and *G. salinus* were identified as the main species. In July, *Gammarus spp.* reached a maximum of 25 400 individuals and in June a maximum biomass of 9.5 g dry weight (Tables 2, 3). Apparently, there is only one main reproduction phase (Fig. 3). During winter months, the population density of gammarids dropped to less than 1 % of summer values. Haage (1975) observed the lowest number of individuals at a site near Askö (Swedish Baltic Sea coast) and at a depth of 0.5 m, during winter and spring too. The density of the animals increased during the following months.

The isopods *Idotea baltica* and *I. chelipes* composed an average 36 % of the total biomass for the year with a maximum value of 54 % in August. The month of highest abundance of *Idotea* individuals (2350 in July) is, as it is for the gammarids, one month before the largest biomass was observed (8.2 g in August). In winter, the isopods disappeared completely from the *Fucus* belt. Data from Figure 4 indicate that probably

Table 2. Composition of fauna among *Fucus* plants (g dry weight of animals per kg *Fucus* dry weight) in Kiel Fjord 1978/79

Month	*Littorina* spp. (incl. shells)	*Mytilus edulis* (excl. shells)	Gammarids	*Jaera albifrons*	*Idotea* spp.	Chironomids	Total (excl. *Littorina*)
Jan	0.1	0.3	1.1	<0.1	0.0	0.0	1.4
Feb	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar							
Apr							
May	0.0	<0.1	1.9	0.0	<0.1	0.0	1.9
Jun	11.1	<0.1	9.5	<0.1	6.1	0.2	15.8
Jul	22.2	0.3	9.1	0.3	5.1	2.1	16.9
Aug	43.2	0.2	6.8	<0.1	8.2	0.1	15.3
Sep	1.5	<0.1	3.8	<0.1	4.5	<0.1	8.3
Oct	8.5	<0.1	3.0	0.0	1.0	0.0	4.0
Nov	0.3	<0.1	2.9	0.0	0.0	0.0	2.9
Dec	0.0	<0.1	1.5	0.0	0.0	0.0	1.5
Percentage		1.4	58.2	0.5	36.2	3.7	100.0

two reproduction periods exist – one in June and the other in late August. In comparison, Haage (1975) found an increase in stock size of *I. chelipes* in summer and autumn, up to 2400 individuals per kg *Fucus* dry weight, while in winter he observed a big decrease.

Table 3. Composition of fauna around *Fucus* plants (individuals per kg *Fucus* dry weight) in Kiel Fjord 1978/79

Month	*Littorina* spp.	*Mytilus edulis*	Polychaetes	*Corophium* spp.	Gammarids	*Jaera albifrons*	*Idotea* spp.	Chironomids
Jan	4	34	0	0	153	25	0	0
Feb	0	0	0	0	12	46	0	0
Mar								
Apr								
May	1	5	26	0	469	1	12	0
Jun	42	41	61	53	15239	505	1355	1097
Jul	535	151	36	66	25409	5816	2347	18739
Aug	227	130	15	3	9065	698	2103	474
Sep	65	20	0	0	1447	53	598	23
Oct	62	39	0	0	441	17	102	0
Nov	18	49	0	0	358	22	4	0
Dec	0	45	0	0	245	13	0	0

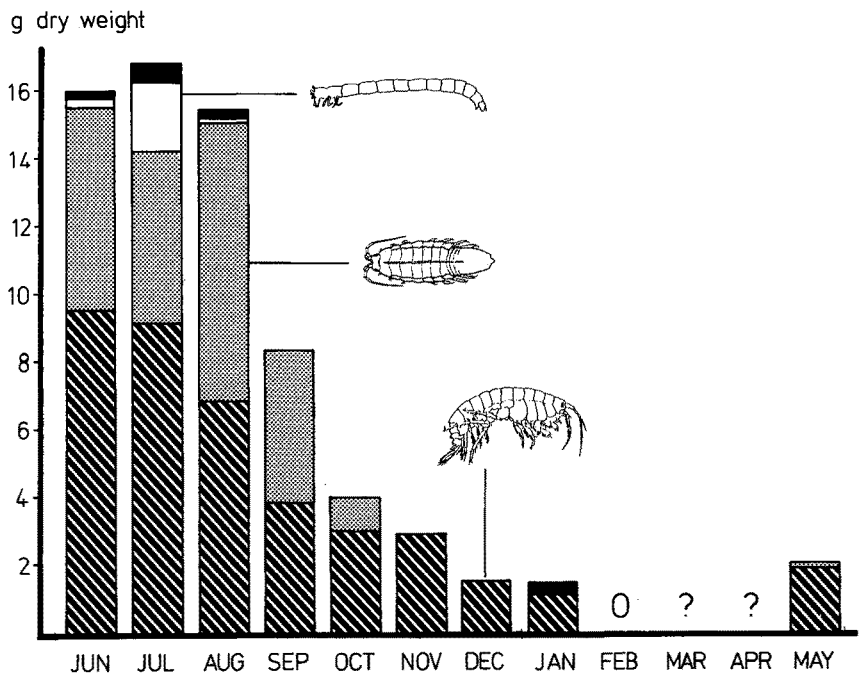

Fig. 2. Seasonal fluctuations in macrobenthos among *Fucus* plants (per kg dry weight) in Kiel Fjord (western Baltic Sea): gammarids, *Idotea* spp., chironomids, and others (black bars) *Littorina* spp. not considered. The low value in May is attributable to the harsh conditions in the winter of 1978/79

Besides gammarids and *Idotea*, all other inhabitants contributed, on an average, only 5.6 % to the total annual biomass (Table 2, Fig. 2). The gastropod genus *Littorina* has been excluded from these calculations, as it usually does not serve as fish food, due to its thick shell. For *Littorina*, one single spatfall in late July was observed (Fig. 4).

Chironomid larvae were common during summer. Their maximum occurrence, 18 700 individuals and 2.1 g biomass, was found in July. This represented 12 % of the total biomass (Table 2). From October to May they were missing.

Up to 5800 individuals of the isopod *Jaera albifrons* were present in July. This period of maximum production is in accordance with the findings of Schütz (1969) in the mesohaline area of the Kiel Canal. There seemed to be only one reproduction period in 1978, the "spring generation". Due to their small size, their contribution to the total biomass was negligible.

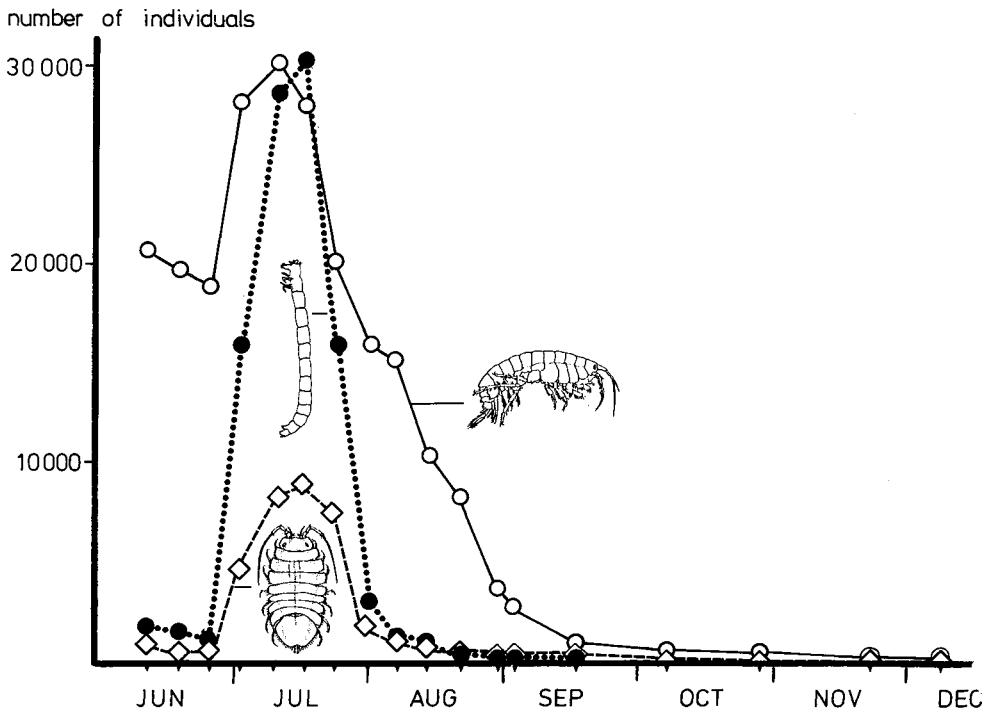

Fig. 3. Seasonal fluctuations in the abundance of the three most numerous macrobenthic species among *Fucus* plants (per kg dry weight) in Kiel Fjord (1978): gammarids, chironomids, and *Jaera albifrons*

Occasional species found in the samples were *Lucernaria quadricornis*, *Hydrobia* sp., *Mytilus edulis*, *Cardium edule*, various polychaete species, *Gastrosaccus spinifer*, *Mysis mixta*, *Corophium* sp., *Crangon crangon*, and *Carcinus maenas*.

For all groups listed in Table 3, July was the month of greatest density of individuals. Accordingly, one single period of reproduction seems to exist. The genus *Idotea* may be an exception, probably due to the existence of two species which were not separated during this survey.

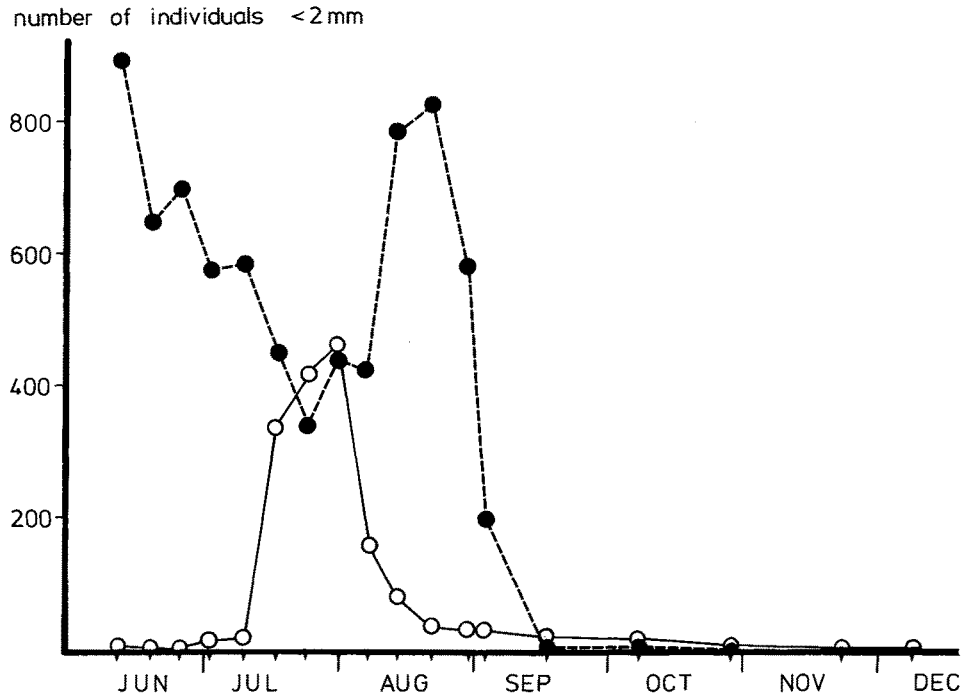

Fig. 4. Spatfall of *Littorina* spp. (unbroken line) and *Idotea* spp. (broken line) among *Fucus* plants (per kg dry weight) in Kiel Fjord (1978)

The maximum biomass of all groups occurred between June and August. The total biomass increased from 1.9 g in May to 15.8 g in June and reached a peak of 16.9 g in July. A 50 % reduction in weight occurred from August to September and again in October. The average weight from December to February was only 1 g. These seasonal fluctuations of zoobenthos in the *Fucus* belt correspond largely to the seasonal fluctuations of the fish fauna in the same area, which will be the subject of an additional study.

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