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**Vertical distribution and diurnal fluctuations of zooplankton
in the Gotland Deep, June 1969, a Baltic Year study**

Preliminary report

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Abstract

The study describes the results of zooplankton sampling during a short period of the International Baltic Year at station F 81 (BY 15 A) in the Gotland Deep. An analysis has been made of the abundance at different depths of the commonest species belonging to the groups: Copepoda, Cladocera, Rotifera, and "others". A clear diurnal pattern could be distinguished mainly for the copepods, which were strongly dominant. Their vertical distribution showed both interspecific differences and intraspecific differences between developmental stages. The cladocerans were still very rare at that time of the summer, their numbers being too low for any definite conclusions.

Zusammenfassung

Vertikalverteilung und tageszeitliche Fluktuationen des Zooplanktons im Gotlandtief im Juni 1969. Eine Studie im Rahmen des Baltischen Jahres

Die Studie beschreibt die Ergebnisse von Zooplanktonfängen während einer kurzen Periode des Internationalen Baltischen Jahres bei Station F 81 (BY 15 A) im Gotlandtief. Die Abundanz der häufigsten Arten aus den Gruppen Copepoden, Cladoceren, Rotatorien und "andere" aus verschiedenen Tiefen wurde analysiert. Ein klares tägliches Verteilungsmuster konnte hauptsächlich bei den Copepoden erkannt werden, die deutlich dominant waren. Ihre Vertikalverteilung zeigte sowohl zwischenartliche als auch innerartliche Unterschiede zwischen den Entwicklungsstadien. Cladoceren waren noch selten in dieser Zeit des Sommers, ihre Anzahl war zu gering für bestimmte Aussagen.

Material and methods

The samples were taken during a cruise of the RV Aranda, in the Gotland Deep at station F 81 (BY 15) (Fig. 1). Sampling was carried out on 7, 8, and 11 June, 1969. For this preliminary presentation only part of the material has been used as an example. The samples were taken with a 150 μ m Nansen closing net, according to the Baltic Year 1969–70 Program Manual (The Baltic Oceanographers 1968), from 25–0, 50–25, 100–50, and 150–100 m (vertical hauls).

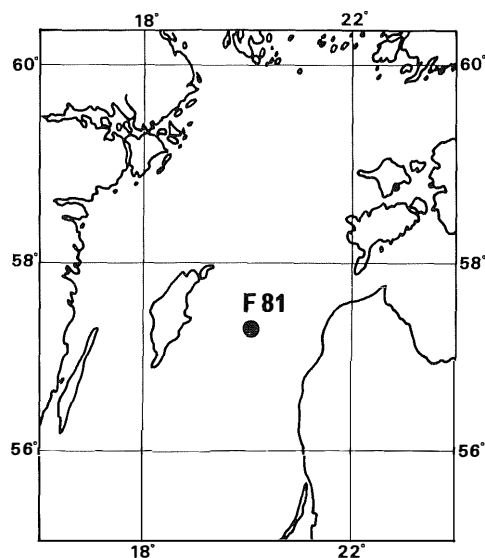


Figure 1
The sampling station

Weather and hydrography

The days of sampling were bright, cloudiness being 1/8 or less. The state of the sea varied from calm to moderate. The temperature was still low at that time of the summer, about 7°C in the surface layer. The thermocline was situated between 15 and 20 m, and the permanent halocline lay in the region of 50 to 70 m. The values for oxygen saturation were 100 to 90% in the uppermost layer, 50% at about 60 m, and ca. 10% below the halocline, which corresponds to an oxygen content below 1 mg/l (Fig. 2).

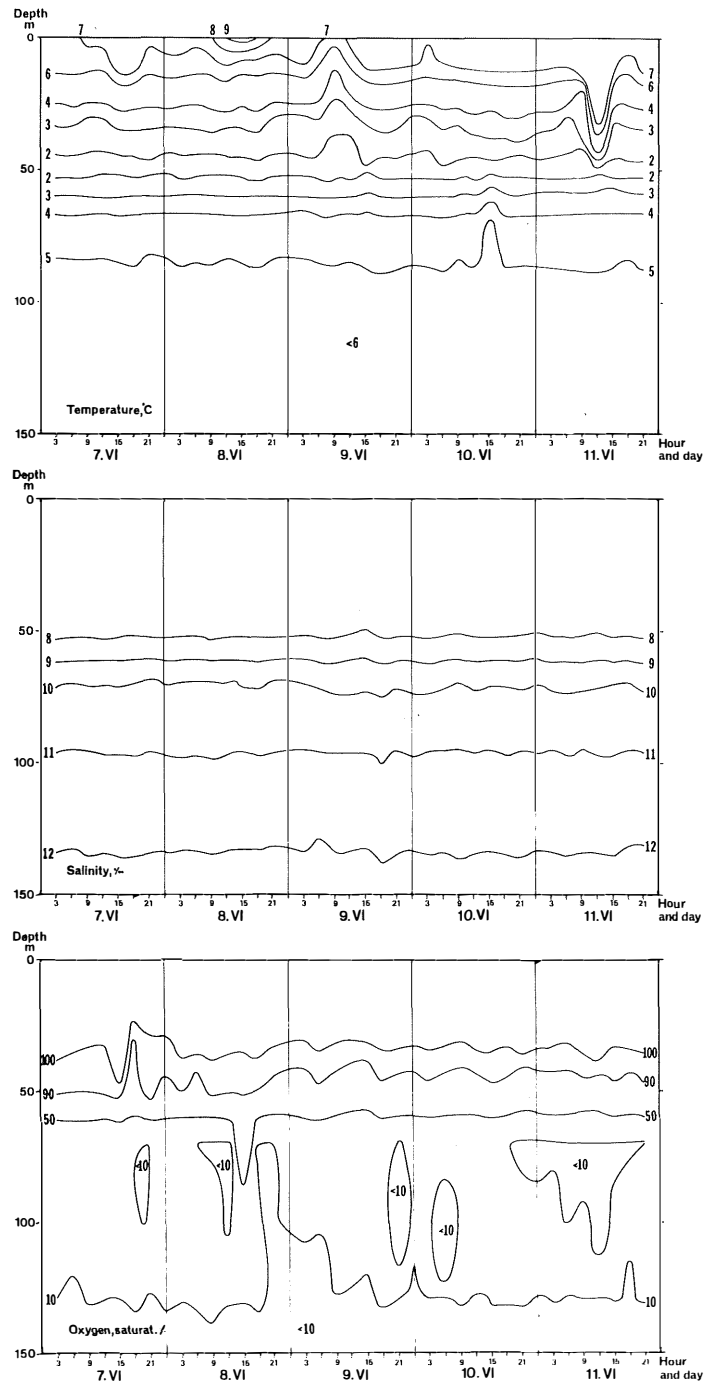
The samples were taken about a fortnight before midsummer, i.e. at that time of the year when the contrast between day and night is at its minimum. On 8 June the sun rose at the sampling site at 01.45 GMT, and set at 19.32 GMT.

Results

Copepoda

Copepods were strongly dominant in the zooplankton community, the genera *Pseudocalanus*, *Acartia*, *Temora*, *Centropages*, *Eurytemora*, and *Oithona* being represented. Of these, *Pseudocalanus minutus elongatus* (BOECK) and *Acartia* sp. occurred in such quantities that conclusions regarding their vertical distribution and fluctuations can safely be drawn. When the sexes and different developmental stages had been separated (Figs. 3 and 4), a clear difference in behaviour could be discerned between *Pseudocalanus* and *Acartia*.

In *Pseudocalanus* the nauplii occurred mainly in the uppermost layer; most of the younger copepodids (I–III) occurred in the same layer, but considerable numbers were also found between 50 and 25 m. The older copepodids (IV–V) occurred mainly in the 50–25 m fraction, though some were found in the 100–50 m and 25–0 m layers. The older copepodids showed a slight tendency towards downward migration

**Figure 2**

Hydrography at station F 81 for the period 7 to 11 June, 1969

8.VI		Depth							
		0	3	6	9	12	15	18	21 hr.
	m	0	3	6	9	12	15	18	21
	0	10237	13663	10369	6413	1630	850	6328	1630
	50	130	261	261	130	33	-	424	261
	100	106	90	489	41	82	261	701	147
	150	2	12	17	4	10	4	38	7
	0	130	-	65	130	-	-	-	-
	50	1043	2739	326	654	261	522	652	669
	100	497	245	489	269	424	84	68	522
	150	69	98	91	109	116	120	114	113
	0	261	261	130	196	-	163	65	328
	50	652	-	-	-	-	130	33	-
	100	-	-	-	-	-	-	-	-
	150	2	-	-	-	1	-	-	-
	0	6649	6402	6732	4962	4115	7676	7114	7109
	50	20638	28495	33450	31691	21453	41536	18560	16270
	100	3056	2274	4189	3473	5118	5511	4581	5233
	150	802	242	209	199	291	164	438	278
	0	4238	4173	4499	3125	2606	7141	7104	3064
	50	163	522	2021	619	391	1434	685	143
	100	48	40	33	49	130	114	195	131
	150	77	36	8	6	14	8	22	18
	0	7499	10433	6161	3978	9259	10596	11215	9977
	50	8472	652	456	228	815	3521	4597	1532
	100	1516	228	440	122	1809	1598	1565	701
	150	283	186	141	55	115	109	109	7

Figure 3

Vertical distribution and diel fluctuation of some plankters typical of Baltic zooplankton. The amounts of the species in each haul are shown as percentages of their occurrence in the entire water column sampled. Numbers represent individuals/10 m³

in the daytime. Adult individuals of both sexes had their main occurrence in the 100–50 m fraction and showed clear vertical migration, descending in the daytime.

The unit *Acartia* sp. comprises *A. bifilosa* and *A. longiremis*. The results for the two species are combined in the diagrams, since it was not possible to separate their nauplii and copepodids IV–V.

The vertical distribution of *Acartia* differed clearly from that of *Pseudocalanus*. *Acartia* is mainly confined to the surface layer; all its developmental stages, including adults, occurred in greatest numbers between 25 and 0 m. Only adult females were found in noteworthy quantity in the 50–24 m layer, as well. They also migrated downwards in the daytime.

Centropages and *Temora* were so sparse that no detailed conclusions can be drawn. However, the results indicate that the nauplii and copepods of *Temora* are in general bound to the uppermost layer (25–0 m), and that diel migration occurs among the adults.

Cladocera

The cladocerans were still very rare at that time of the summer, their numbers being too low for any definite conclusions. The most abundant species was *Evadne nordmanni* LOVÉN, which mainly occurred in the uppermost layer (Fig. 3).

8.VI		Depth m								hr.							
		0		3		6		9		12		15		18		21	
Pseudocalanus minutus elongatus	♀	0	98	130	85	98	33	130	33	0	98	130	85	98	33	130	33
		50	263	212	391	575	1157	1208	704	1060	0	0	0	0	0	0	0
		100	35	44	29	30	31	32	33	29	0	0	0	0	0	0	0
	♂	0	65	391	391	33	0	0	0	65	0	0	0	0	0	0	0
		50	196	318	456	310	1141	688	799	212	0	0	0	0	0	0	0
		100	49	46	21	28	49	10	14	4	0	0	0	0	0	0	0
	C ^{IV-V}	0	2804	1435	913	1630	1109	825	869	13054	0	0	0	0	0	0	0
		50	3195	10828	13889	7929	7401	14039	8292	5217	0	0	0	0	0	0	0
		100	1948	1100	2413	1981	1956	2527	1956	2771	0	0	0	0	0	0	0
	C ^{I-III}	0	86	49	45	40	57	53	99	53	0	0	0	0	0	0	0
		50	17832	21809	22105	19171	17149	21875	24402	31855	0	0	0	0	0	0	0
		100	12911	13237	17875	20896	12128	2305	5118	7923	0	0	0	0	0	0	0
N	0	236	383	766	448	652	760	636	587	0	0	0	0	0	0	0	
	50	153	54	62	47	82	98	147	54	0	0	0	0	0	0	0	
	100	3680	4088	34384	28821	22887	48883	40887	25238	0	0	0	0	0	0	0	
♀	0	4238	3652	1630	2641	1924	3912	3912	2771	0	0	0	0	0	0	0	
	50	350	261	163	155	212	261	424	603	0	0	0	0	0	0	0	
	100	479	49	52	54	72	98	145	138	0	0	0	0	0	0	0	
♂	0	782	591	448	717	591	585	1425	1680	0	0	0	0	0	0	0	
	50	0	24	33	49	114	98	179	0	0	0	0	0	0	0	0	
	100	6	9	2	4	5	5	5	2	0	0	0	0	0	0	0	
♀	0	281	1043	781	328	188	488	1174	68	0	0	0	0	0	0	0	
	50	16	8	0	0	0	0	0	0	0	0	0	0	0	0	0	
	100	4	0	0	0	0	0	0	2	0	0	0	0	0	0	0	
C ^{IV-V}	0	1108	1668	678	913	1043	1438	1668	678	0	0	0	0	0	0	0	
	50	0	0	65	65	0	16	0	82	0	0	0	0	0	0	0	
	100	26	8	0	0	3	0	5	8	0	0	0	0	0	0	0	
C ^{I-III}	0	782	622	717	717	261	3183	1832	180	0	0	0	0	0	0	0	
	50	130	0	587	33	0	196	33	33	0	0	0	0	0	0	0	
	100	8	8	0	0	16	0	16	16	0	0	0	0	0	0	0	
N	0	35	3	1	1	2	0	1	3	0	0	0	0	0	0	0	
	50	1304	652	1178	458	717	1368	1304	326	0	0	0	0	0	0	0	
	100	33	0	281	0	0	130	0	33	0	0	0	0	0	0	0	
N	0	24	0	0	0	0	0	0	33	0	0	0	0	0	0	0	
	50	6	16	5	1	4	0	11	3	0	0	0	0	0	0	0	
	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Figure 4

Vertical distribution and diel fluctuation of *Pseudocalanus minutus elongatus* BOECK and *Acartia* sp. shown separately for females, males, and different developmental stages. Percentage distribution and figures as in Figure 3.

Rotifera

The rotifers occurred chiefly in the uppermost layer (25–0 m). The dominant group was the genus *Synchaeta*. Other rotifers, as *Keratella cochlearis* (GOSSE) and *Keratella quadrata* (MÜLL.), were occasionally found in some of the samples. An aggregation of rotifers, evident for instance in *Synchaeta* sp., was often observed

in the 100–50 m fraction, and was presumably caused by accumulation of sinking animals in the halocline region (Figs. 1 and 3). The mesh size of the net used was presumably too large to give quantitative samples. No diel migration could be observed.

Others

Polychaeta larvae, most probably representing only *Harmothoe sarsi* (KINB.), generally preferred the layer between 100 and 50 m, but also occurred in noteworthy numbers in the 50–25 m and 150–100 m fractions, sometimes also in the uppermost layer (25–0 m) (Fig. 3). The appendicularian *Fritillaria borealis* LOHM. occurred mainly in the uppermost layer. It did not show any marked migratory trend.

Conclusion

Although the study was not planned to give a detailed picture of the vertical distribution of zooplankton, or to provide data especially for studying diel fluctuations, it showed evident interspecific differences in both respects. Differences were also apparent between the developmental stages of the same species, and in some cases (copepods) between adult females and males. This shows the importance of detailed analysis.

The results also show that zooplankton investigations, e. g. for monitoring purposes, should be thoroughly planned as regards, for instance, sampling design and statistical treatment of data. Factors such as patchiness should be considered in interpreting the results. In the present study the abundance values often fluctuated strikingly between the samples, presumably mainly because of patchiness and horizontal currents.

References

THE BALTIC OCEANOGRAPHERS: The Baltic Year 1969–70. Program manual. 60 pp. Göteborg (1968)