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INFLUENCE OF EUTROPHICATION ON SEASONAL VARIATIONS OF ZOOPLANKTON BIOMASS IN SHALLOW COASTAL LAGOONS OF THE SOUTHERN BALTIC

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Seasonal zooplankton dynamics in two coastal lagoons differing in degree of their eutrophication are compared. The two water bodies show no clear difference with respect to calanoid copepods. Rotifers in the more eutrophic lagoon show a pronounced peak of abundance in early summer, not observed in the less eutrophic lagoon. It is concluded that grazing of bacteriodetritivorous rotifer species is an important regulator of primary production.

INTRODUCTION

Semi-enclosed shallow brackish water lagoons (boddens) are ecosystems typical of the coastal area of the Southern Baltic. These nontidal horohaline waters exhibit stronf variations in the seasonal dynamics of biotic components due to their shallowness and hydrographic variability. In this paper, an attempt is made to correlate differences in the degree of eutrophication with seasonal variation of a biotic component, i.e., metazooplankton biovolume, in two lagoons differing in the extent of their eutrophication: the highly eutropic chain of boddens south of the Darss-Zingst peninsula (Darss-Zingst Boddens) and the Polish part of the Vistula Lagoon (Fig. 1). The Vistula Lagoon is only slightly influenced by freshwater run-off from rivers and is therefore less eutrophic (Table 1). The aim of this work is to find out whether the difference in extent of eutrophication can lead to major differences in the zooplankton dynamics.

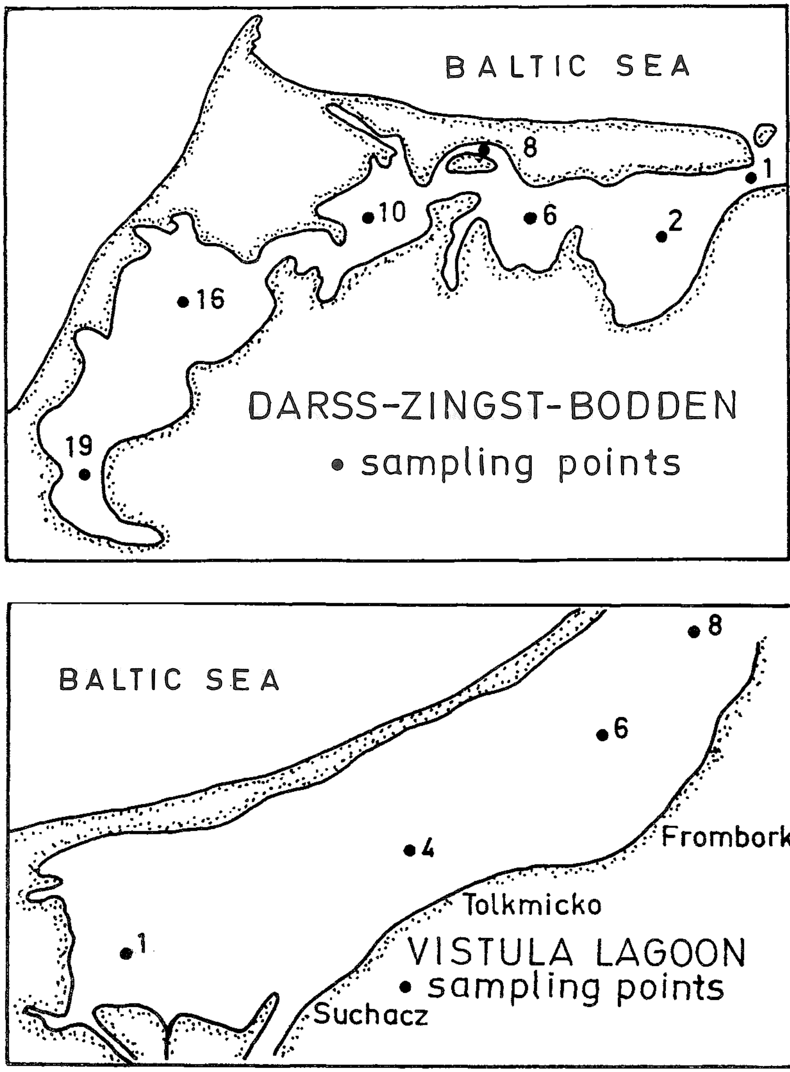

Fig. 1. Map of sampling sites

MATERIALS AND METHODS

Sampling locations are shown in Fig. 1. Samples were taken with a Ruttner sampler form several depths of the water column, except for the very shallow Stations 6, 8, 10, 16, and 19 of the Darss-Zingst Boddens where only one sample from the depth of

Table 1

Parameters characterizing morphometry, hydrography and degree of eutrophication of the two water bodies studied. Data from Adamkiewicz-Chojnacka and Więcławski (unpubl. manuscript), Heerkloss et al. (1985), and Schlungbaum (unpubl.).
n = number of records; x = arithmetic mean; C.L. = 99% confidence level;
DIN = dissolved inorganic nitrogen (μmole/dm^3)

Parameters	Darss-Zingst boddens	Vistula lagoon (Polish part)	Significance level
area	197 km^2	328 km^2	–
length	55 km	35 km	–
mean depth	2.0 m	2.4 m	–
salinity	1.5–8.5 ‰	0.7–4.5 ‰	–
pH-value x ± C.L.	9.07 ±0.41[1] n = 360	8.51± 0.14[2] n = 29	$p < 0.01$
DIN $\bar{x}$ ± C.L.	3.93 ± 0.99[3] n = 55	1.44 ± 0.23[3] n = 8	$p < 0.01$
Secchi depth	20–50 cm	30–100 cm	–

[1] 1985–1988, station 8
[2] 1981–1982, station 1–8
[3] July – August 1985, Darss-Zingst Boddens station 1–8 (eastern part), Vistula lagoon station 1–8.

about 1 m was collected at each site. Samples were fixed with 4% formaldehyde. Abundance and developmental stage of the species present in the samples were determined under a microscope. Volume standards for abundance-biomass conversion are given in Table 2 (as modified from Schnese unpubl. manuscript). Only the species shown in the table are considered in the study, the species being the most common ones in both water bodies. The egg biomasses were not included.

Data obtained during several years were pooled and ordered to form diagrams which relate the sampling date to biovolume (Figs 2–6). The diagrams are divided into fields defined by half-month on the time axis and biovolume on the ordinate. The number of records in a given field is denoted by symbols defined as follows: 1 ... 9: record numbers between 1 and 9; A ... Z: record numbers between 10 and 36; a star represents more than 36 records. The bottom row of symbols represents numbers of those records that are lower than one fine scale step on the biovolume axis including zero values. A line is drawn above the fields which have the highest biovolume by half-month. In drawings showing more than one curve, record numbers are denoted with symbols only for that curve drawn as solid line.

Table 2

Assumed volume standards (10^6 μm^3 per ind.)

Taxon	Species	Volume
Copepoda	*Eurytemora affinis*, adults, May-Sept.	13.900
Copepoda	*E. affinis*, copepodites, May-Sept.	6.000
Copepoda	E. affinis, adults, Okt.-April	37.000
Copepoda	E. affinis, copepodites. Okt.-April	8.600
Copepoda	*Acartia* tonsa, adults	14.700
Copepoda	A. tonsa, copepodites	6.300
Copepoda	adults, May – Sept.	14.300
Copepoda	copepodites, May – Sept.	6.100
Copepoda	naupli, May – Sept.	0.970
Copepoda	adults, Okt. – April	37.000
Copepoda	copepodites, Okt. – April	8.600
Copepoda	naupli, Okt. – April	1.230
Rotatoria	Brachionus quadridentatus	1.100
Rotatoria	B. calyciflorus	0.800
Rotatoria	B. angularis	0.230
Rotatoria	B. urceolaris	0.800
Rotatoria	Filinia longiseta	0.440
Rotatoria	Keratella cochlearis	0.100
Rotatoria	K. quadrata	0.250
Rotatoria	Euchlanis dilatata	0.400
Rotatoria	Asplanchna sp.	5.000
Rotatoria	Synchaeta littoralis	0.300
Rotatoria	S. baltica	0.800
Rotatoria	S. pectinata	0.800
Rotatoria	Synchaeta spp. > 0.12 mm	1.100
Rotatoria	Synchaeta spp. 0.08–0.12 mm	0.450
Rotatoria	Synchaeta spp. < 0.08 mm	0.180
Rotatoria	Trichocerca spp.	0.100
Rotatoria	Polyarthra dolichoptera	0.380
Rotatoria	P. vulgaris	0.380

RESULTS

Analysis of the zooplankton samples in this study was restricted to calanoid copepods and rotifers. The taxa were dominants in both water bodies (Adamkiewicz-Chojnacka and Fait 1987; Adamkiewicz-Chojnacka and Leśniak 1985; Heerklosa et al. 1984). Other taxa such as cyclopoid copepods, cladocerans, larvae of gastropods, bivalves, cirripeds, and polychaetes occurred only sporadically or were dominant only during periods of special environmental conditions.

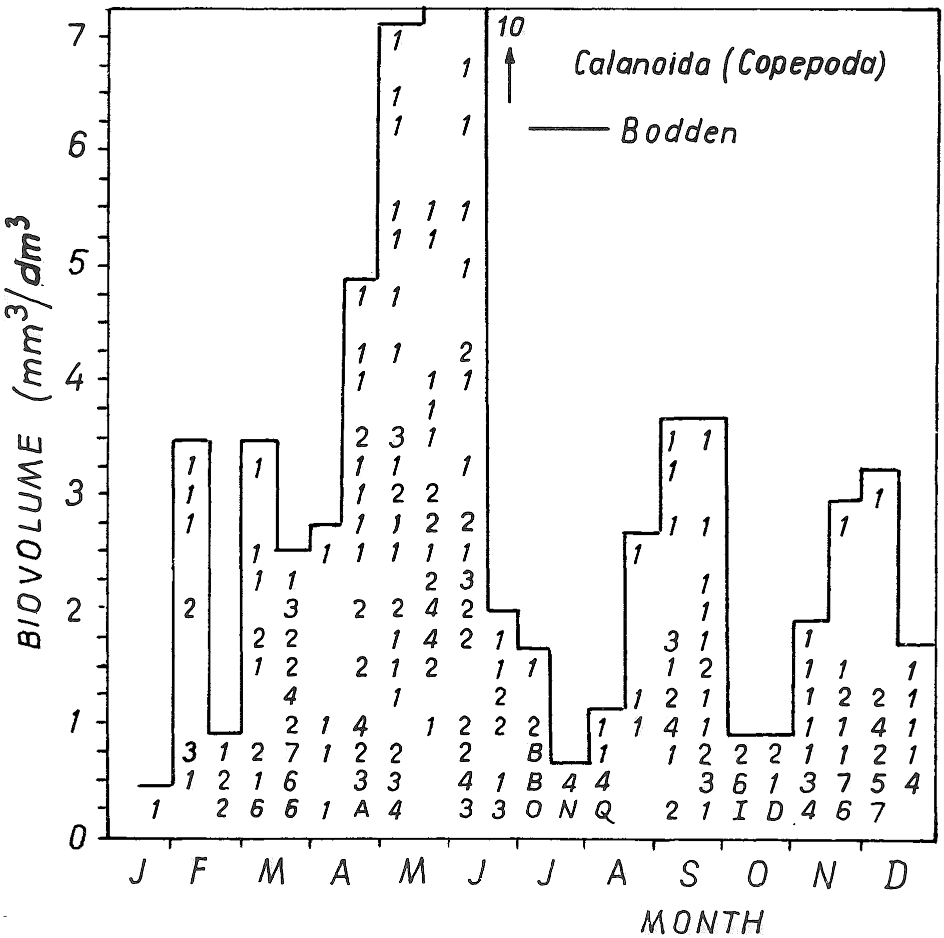

Fig. 2. Diagram of calanoid biovolume values for Stations 1–19 of the Darss-Zingst Boddens for a period of 8 years (1974–1985 except for 1976, 1979, 1980, 1984)

Fig. 2 shows an average seasonal calanoid copepod cycle in the Darss-Zingst Boddens for the period of 1974–1985. More than 800 records are included. The dominant calanoid species was *Eurytemora affinis* (Poppe).m It occurred throughout the year and developed a pronounced spring peak in April and May. In late summer and autumn, the *Acartia* species (mainly *A. tonsa* Dana) occured as well. A biomass minimum in early summer was typical of all the years of study. Rotifers attained their

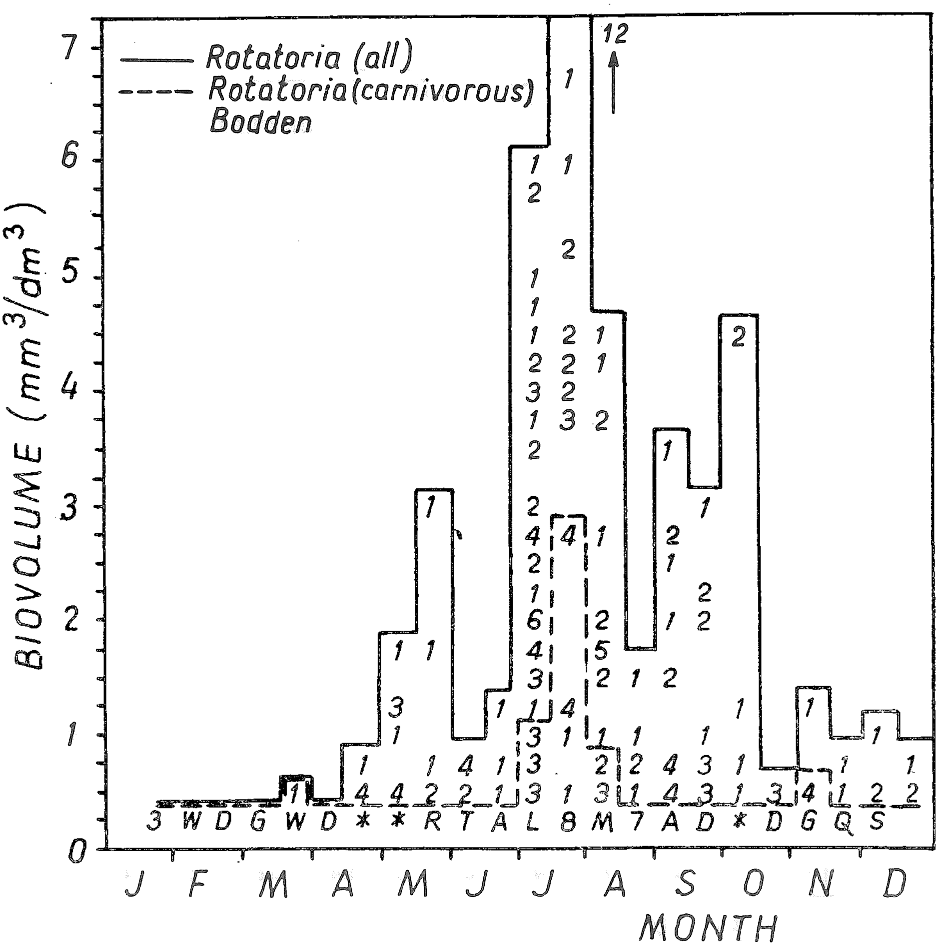

Fig. 3. Diagram of rotifer biovolume values for Stations 1—19 of the Darse-Zingst Boddens for a period of 8 years (1974—1985 except for 1976, 1979, 1980, 1984)

largest biovolume peaks during this period (Fig. 3), *Filinia longiseta* (Ehrenberg), *Keratella cochlearis* (Gosse), and *Brachionus quadridentatus* (Hermann) being the dominant species (Fig. 4). In summer, carnivorous species (mainly *Trichocerca* spp.) became rather important (Fig. 3).

Data obtained in 1975, 1977, and 1978 were selected to compare the Darss-Zingst Boddens with the Vistula Lagoon. The analysis include 450 (Darss-Zingst Boddens) vs. 103 (Vistula Lagoon) records. No clear difference could be observed for calanoid

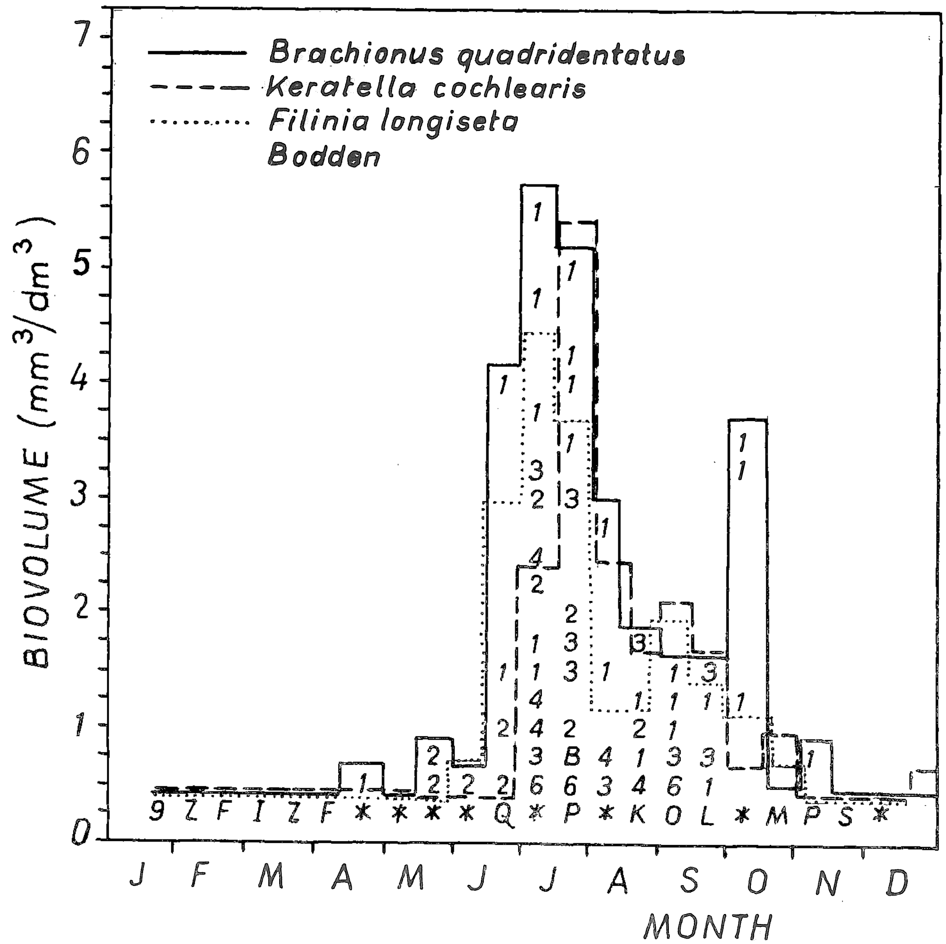

Fig. 4. Diagram of rotifer biovolume values for Stations 1—19 of the Darss-Zingst Boddens for a period of 8 years (1974—1985 except for 1976, 1979, 1980, 1984)

copepods (Fig. 5), the spring peak of *E. affinis* being slightly less pronounced in the Vistula Lagoon. As opposed to calanoid copepods, rotifers exhibited a clear difference (Fig. 6). The Vistula Lagoon had no rotifer peak in early summer when the copepods were at a minimum. One of the three dominant rotifer species of the Darss-Zingst Boddens, *B. quadridentatus,* was almost completely absent in the Vistula Lagoon. The other two species were present, but did not develop such peaks of abundance as in the Darss-Zingst Boddens.

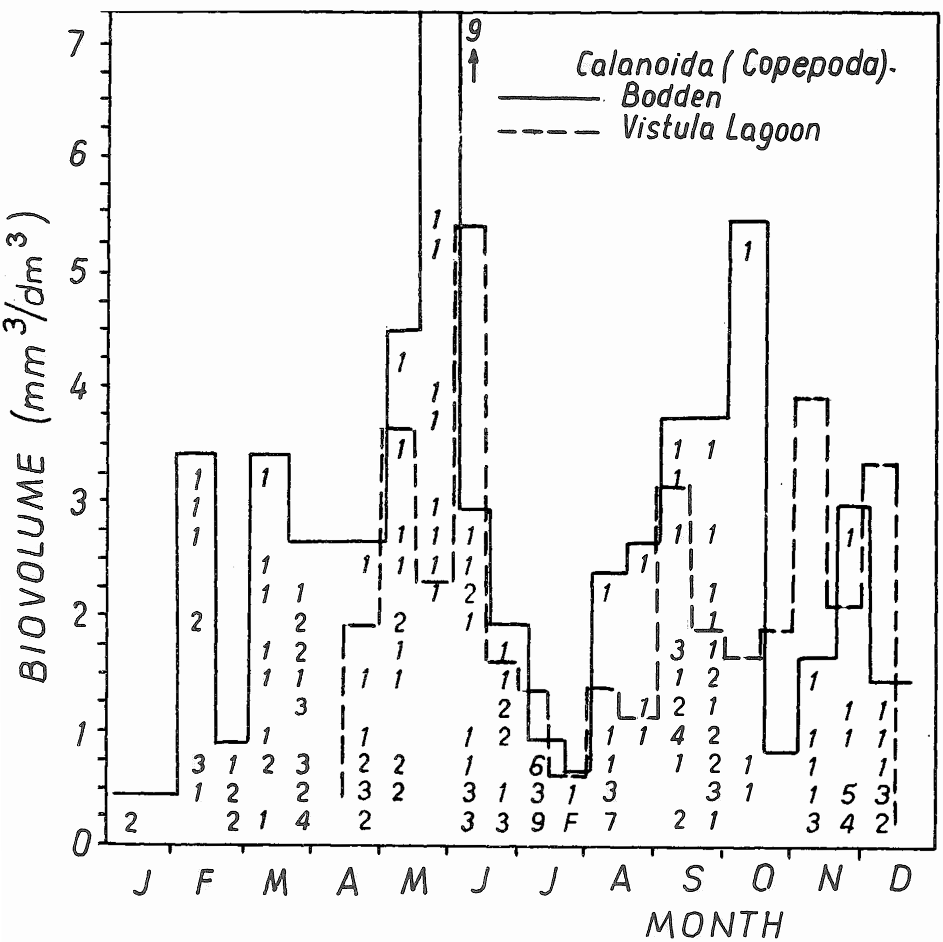

Fig. 5. Diagram of calanoid biovolume values for Stations 1—19 (Darss-Zingst Boddens) and Stations 1—8 (Vistula Lagoon) for a period of 3 years (1975, 1977, 1978). No line could be drawn for January — March for the Vistula Lagoon due to lack of data

DISCUSSION

It can be concluded that an increase in rotifer biomass during early summer reflects an effect of eutrophication in the water bodies studied. Most of these rotifers are bacterio-detritivores. Pourriot (1977) has experimentally shown this feeding preference in *K. cochlearis* and *F. longiseta*. Our finding that the behaviour of *B. quadri-*

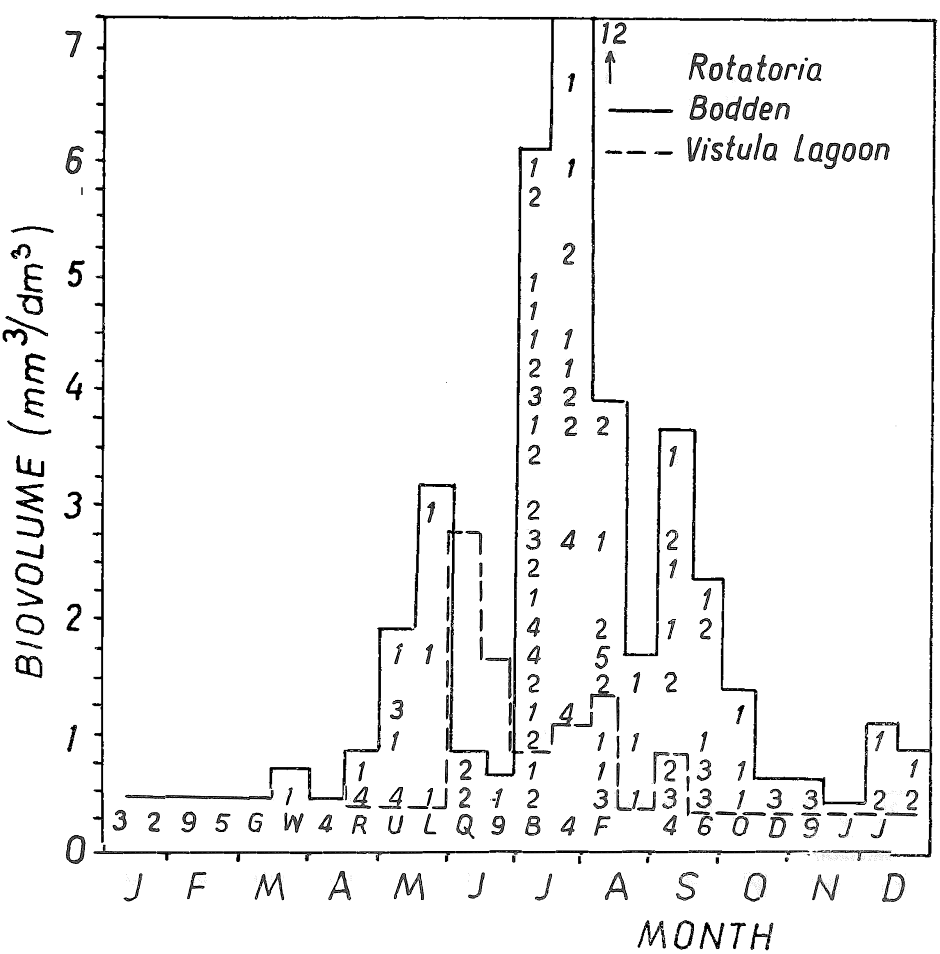

Fig. 6. Diagram of rotifer biovolume values for Stations 1—19 (Darsz-Zingst Boddens) and Stations 1—8 (Vistula Lagoon) for a period of 3 years (1975, 1977, 1978). No line could be drawn for January — March for the Vistula Lagoon due to lack of data

dentatus is similar to the other two species in both their seasonal dynamics and response to eutrophication possibly indicates a similar feeding biology. However, this has to be verified experimentally.

Increased abundances of bactorio-detritivorous rotifers which possibly takes place when eutrophication advances may be a consequence of an intensified microbial activity. The rotifers thus regulate the increased primary productivity by intensified grazing. When the average rotifer biomass during July is taken into account (2 mm^3/ /dm^3) and a specific feeding rate of 100% of the body mass per day is assumed (Arndt and Heerkloss 1989; Cushing 1976), the rotifer grazing rate amounts to 20% of the primary production (see Heerkloss et al. 1984 for data on primary production). Thus, rotifers may contribute significantly to the decomposition capacity of the pelagic system in the Darss-Zingst Boddens during mid-summer.

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