The seasonal succession of hyaline *Helicostomella subulata* and agglutinated *Tintinnopsis lobiancoi* – dominants of the Baltic Tintinnina (Ciliophora)

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Baltic Sea
Helicostomella subulata
Tintinnids
Tintinnopsis lobiancoi

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Abstract

Tintinnid species composition and abundance were determined in surface water samples taken from four sites in the Gulf of Gdańsk, and along four cruise tracks from the Gulf of Gdańsk to Helsinki.
The seasonal succession of two dominants – the hyaline *Helicostomella subulata* and the agglutinated *Tintinnopsis lobiancoi* – was evident. The former coincided with the beginning of summer and was replaced early in the season by the latter. Other Tintinnina species were found only occasionally and did not significantly affect the total tintinnid abundance.

1. Introduction

Loricated ciliates of the suborder Tintinnina are important components of the marine community, constituting a link between micro- and macrozooplankton (Heinbokel and Beers, 1979; Stoecker *et al.*, 1981; Verity, 1986, 1987; Fenchel, 1987; Middlebrook *et al.*, 1987; Leakey *et al.*, 1992; Pierce and Turner, 1992). The aim of this paper is to follow the annual changes in the tintinnid community while paying particular attention to the seasonal interchangeability of *Helicostomella subulata* and *T. lobiancoi* groups

(Halme and Lukkarinen, 1960; Bakker and Phaff, 1976), which we recorded as being among the most numerous tintinnids.

2. Materials and methods

Samples were taken by the Centre of Marine Biology, Gdynia, generally at weekly intervals between 24.06.1991 and 12.05.1992 at four stations along the Gulf of Gdańsk coast: Oksywie, Gdynia, Orłowo, and Sopot (Fig. 1). These were supplemented by samples taken during four cruises from the Gulf of Gdańsk to Helsinki: 9–10.09.1991, 4–6.10.1991, 14–16.10.1991, and 18–24.05.1992.

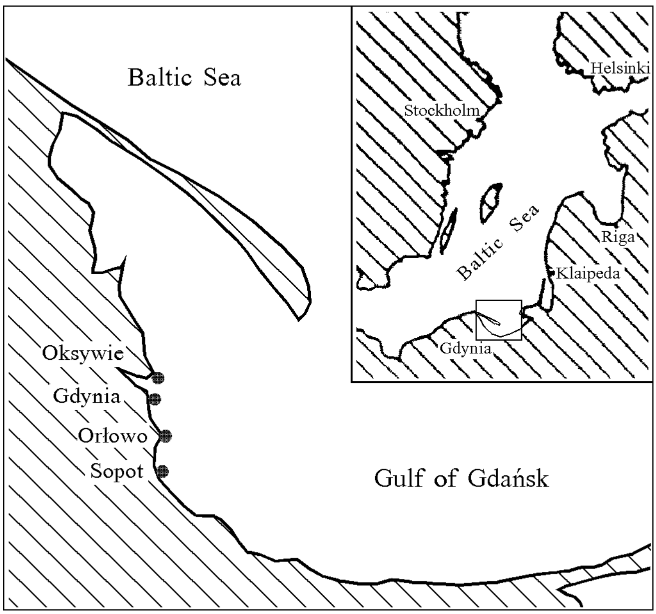


Fig. 1. Location of the sampling stations in the Gulf of Gdańsk

Samples were taken from surface waters using a 9-litre bathometer combined with a thermometer. The ciliates in the sample were concentrated on a 35 μm nylon mesh, fixed with 4% formalin buffered with calcium carbonate and transported to the Nencki Institute of Experimental Biology, Warsaw, for examination. All tintinnids in each sample were identified (according to Kofoid and Campbell 1929; Halme and Lukkarinen 1960; Bakker and Phaff, 1976), and counted using a light inverted microscope. A JEM 120 EX scanning electron microscope operating at 40 kV was used to identify the morphological details of the loricae of the dominant tintinnids. Cells of the latter were prepared as described by Wasik and Mikołajczyk (1990).

3. Results

Two Tintinnina species, the hyaline *Helicostomella subulata* (Fig. 2) and the agglutinated *Tintinnopsis lobiancoi* (Fig. 3) were dominant at the four stations in the Gulf of Gdańsk (Fig. 1), and elsewhere in the Baltic Sea (Figs. 5a, 6a, 7a, 8a). Other species – *Leprotintinnus botnicus*, and five *Tintinnopsis* species: *T. beroidea*, *T. baltica*, *T. campanula*, *T. cylindrica* and *T. fimbriata* – were found only occasionally and did not significantly affect the total tintinnid abundance.

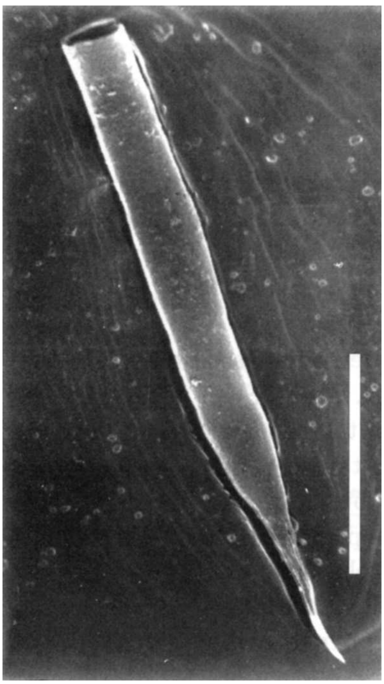


Fig. 2. Scanning electron micrograph of *Helicostomella subulata*. Bar = 100 μm

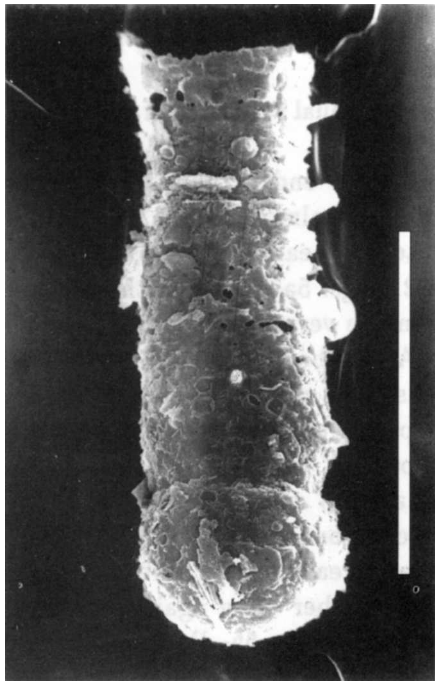


Fig. 3. Scanning electron micrograph of *Tintinnopsis lobiancoi*. Bar = 100 μm

3.1. Gulf of Gdańsk

At the end of June, when the water temperature varied around 15°C (Fig. 4), a few cells of *T. lobiancoi* were noted at all the stations in the Gulf. At the beginning of July cell numbers usually increased to 10 cells dm^{-3} (Figs. 5a–c), although 50 cells dm^{-3} were attained at Sopot (Fig. 5d). In mid-July, a second peak of 85 cells dm^{-3} was recorded at Oksywie (Fig. 5a) and of 35 cells dm^{-3} at Sopot (Fig. 5d).

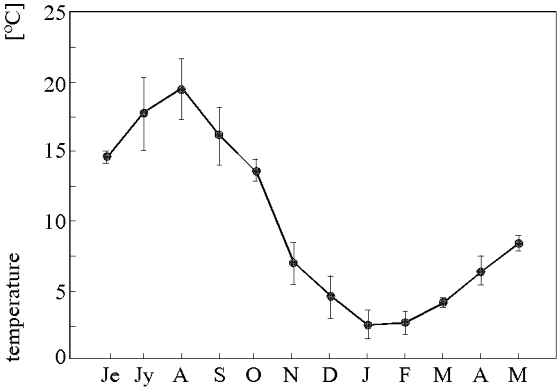
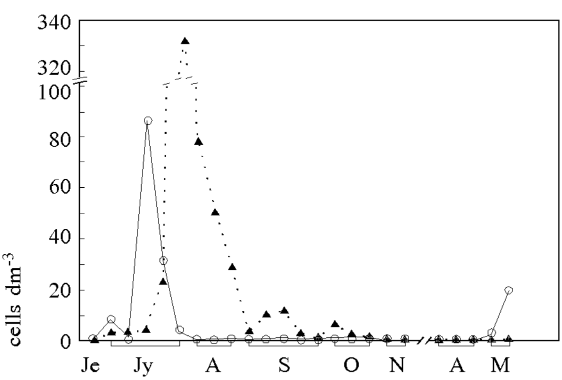


Fig. 4. Annual variations in water temperature in the Gulf of Gdańsk

At the end of July *T. lobiancoi* numbers dropped abruptly at most stations to almost zero, a level that was maintained throughout the autumn, winter and early spring. They recovered slightly at the beginning of May 1992 (Figs. 5a–d), when the water temperature exceeded 8°C (Fig. 4) and when the vernal growth period commenced.

At the beginning of July *H. subulata* numbers increased so rapidly that this species replaced *T. lobiancoi* entirely (Figs. 5a–d). Such a rapid change in species composition was particularly evident at Oksywie (Fig. 5a) and Sopot (Fig. 5d), where *H. subulata* numbers attained respective maxima of 340 and 93 cells dm^{-3}. After this time cell abundance declined and fluctuated around zero during the first week of September. Numbers did once more increase briefly, but never exceeded 25 cells dm^{-3}, and from the end of September were again near zero, a situation that held to the end of sampling (Figs. 5a–d). From the end of November to early April the water temperature was no higher than 7°C (Fig. 4).

a



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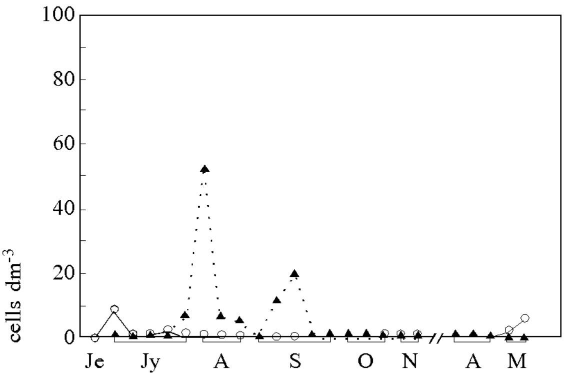

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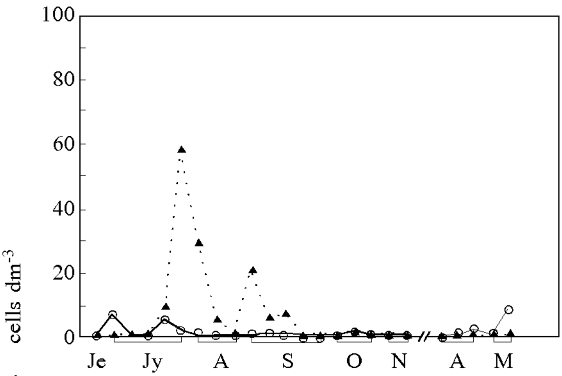

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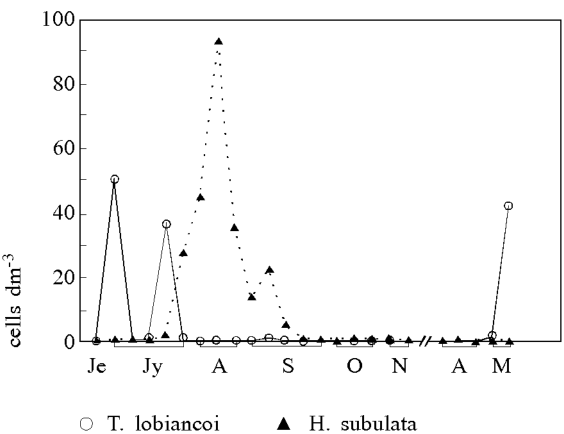


Fig. 5. Seasonal occurrence of *T. lobiancoi* and *H. subulata* at Oksywie (a), Gdynia (b), Orłowo (c), Sopot (d) from June 1991 to May 1992

3.2. Baltic Sea

During the first cruise in September 1991 (Fig. 6a) the mean water temperature at the 6 stations off the Swedish coast and the 2 in the Gulf of Finland was 14.9°C (Tab. 1). At all stations *H. subulata* was the exclusive dominant species, with cell numbers ranging from *ca* 200 dm^{-3} (stn. 3) to 1200 dm^{-3} (stn. 8). *T. lobiancoi* was only noted at stn. 8 (off Helsinki), where 20 cells dm^{-3} were recorded (Fig. 6b).

Table 1. Water temperature variations during the cruises to Helsinki

Number of stations	Temperature [°C] 9–10.09.1991	4–6.10.1991	14–16.10.1991	18–24.05.1992
1	14.2	11.9	13.1	–
2	14.2	12.4	–	7.5
3	14.8	12.4	13.9	7.2
4	–	11.9	13.1	7.5
5	14.5	10.2	13.1	8.0
6	14.4	11.8	13.2	7.0
7	16.4	11.7	13.2	8.0
8	15.6	10.5	13.1	8.5
9		11.2	11.2	9.0
10		12.2	11.9	9.9
11		13.2	11.2	10.7
12		12.8	10.0	10.0
13		13.2	11.2	10.0
14				10.0
15				10.5
16				10.0
17				11.0
18				10.0
19				13.5
20				15.0
Mean	14.9	12.0	12.4	9.2

The two cruises in early and mid-October provided an opportunity to study the autumn decrease in *H. subulata* numbers. Of the 13 stations (Fig. 7a) in the first cruise, the first six were located in the western Baltic, the seventh in the northern Baltic, numbers 8 and 9 in the Gulf of Finland, and 11 to 13 in the southern Baltic. *H. subulata* abundance depended on the location (Fig. 7b). Off Sweden, cell numbers were very high, varying from 100 to 200 dm^{-3}, except at stn. 5 where only 25 cells dm^{-3} were recorded. High numbers, however, were also noted at stn. 7. In the Gulf of Finland

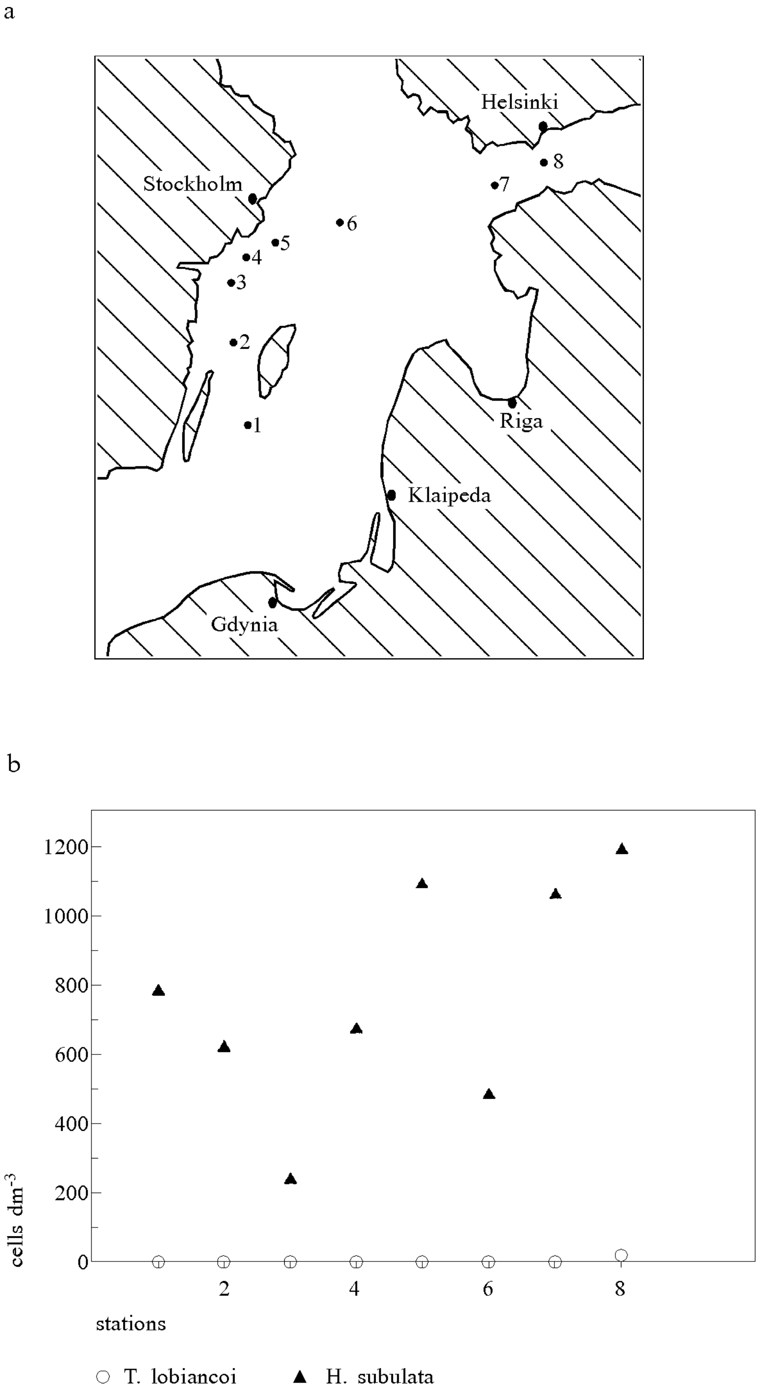


Fig. 6. Sampling points (a) and distribution of *T. lobiancoi* and *H. subulata* (b) during the cruise to Helsinki from 9 to 10 September 1991

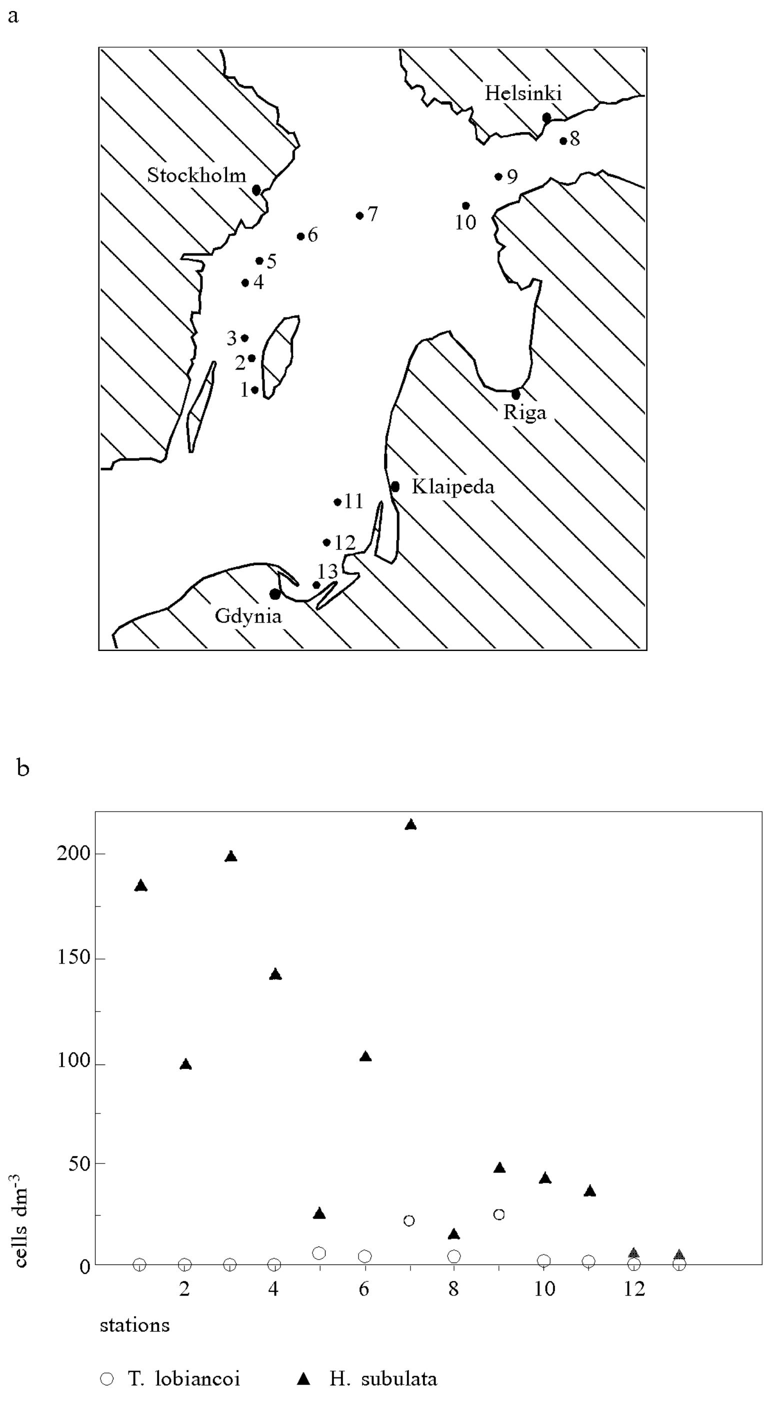
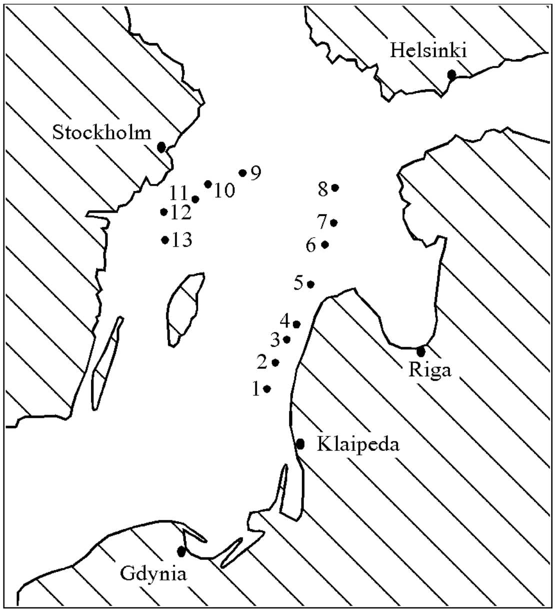


Fig. 7. Sampling points (a) and distribution of *T. lobiancoi* and *H. subulata* (b) during the cruise to Helsinki from 4 to 6 October 1991

a



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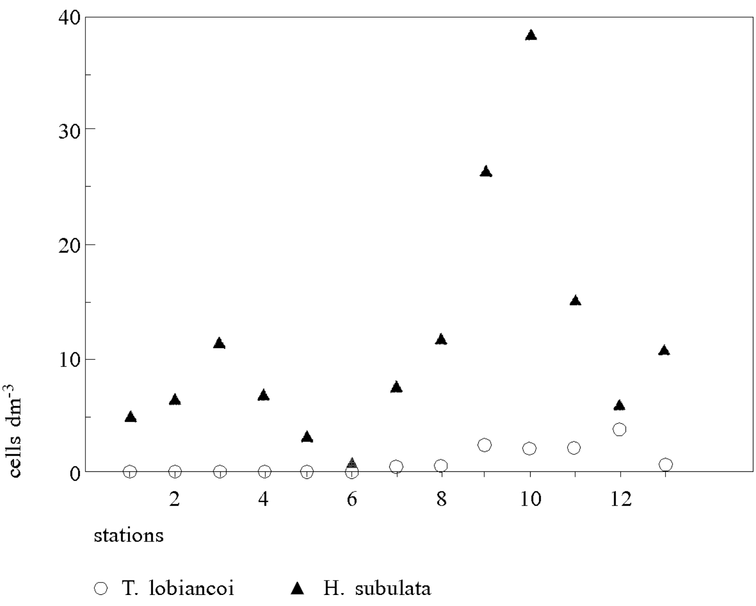
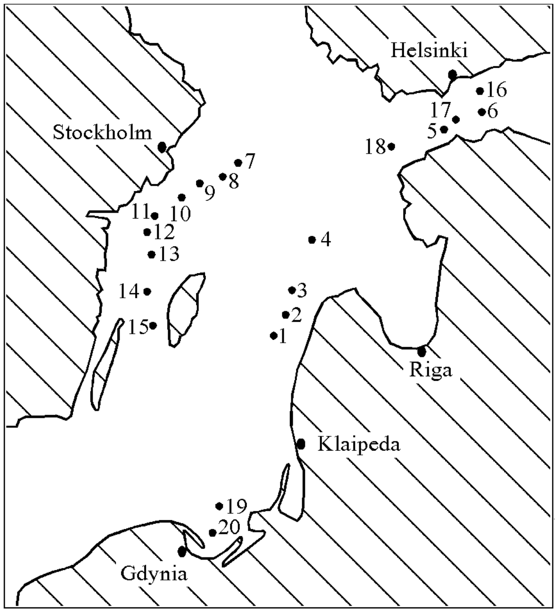


Fig. 8. Sampling points (a) and distribution of *T. lobiancoi* and *H. subulata* (b) during the cruise to Helsinki from 14 to 16 October 1991

a



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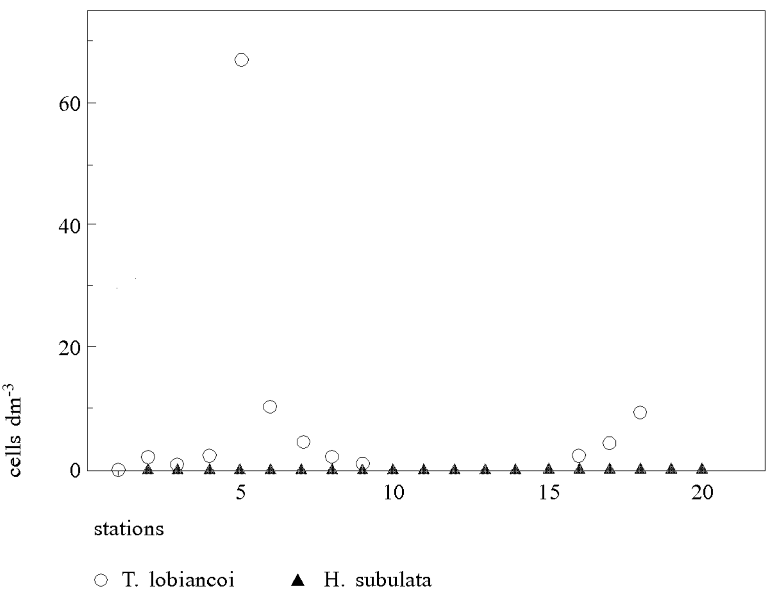

Fig. 9. Sampling points (a) and distribution of *T. lobiancoi* and *H. subulata* (b) during the cruise to Helsinki from 18 to 24 May 1992

and at stn. 11, *H. subulata* numbered around 50 cells dm^{-3}. In spite of the close proximity of the last two stations to stn. 11, cell numbers at the former approached zero. *T. lobiancoi* was found at only 5 stations (5–9) and numbers were very low. The water temperature during this first cruise averaged 12°C (Tab. 1).

A seasonal reduction in *H. subulata* abundance was noted (Fig. 8b) during the second October cruise (Fig. 8a) (stations 1–8 in the eastern Baltic, 9–13 in the western Baltic). Over the entire cruise track only one distinct peak (almost 40 cells dm^{-3}) was noted (stn. 10). Single cells of *T. lobiancoi* appeared at stations 8–12. The mean water temperature during this cruise was 12.4°C (Tab. 1).

Studies of the tintinnids collected during the May 1992 cruise (Fig. 9a) confirmed the previous year's observation that *T. lobiancoi* signals the start of the summer period of enhanced biological activity (Fig. 9b). Four sectors of the Baltic were examined during this cruise: eastern (stations 1–4), Gulf of Finland (5–6, and 16–18), western (7–15), and southern (19–20). Moderate numbers of tintinnids (67 cells dm^{-3}) were recorded only in the Gulf of Finland (stn. 5), with only a few cells of *T. lobiancoi* noted outside this region. *H. subulata* was not found during this cruise. The mean seawater temperature during the May 1992 cruise was 9.2°C (Tab. 1).

4. Discussion

The abundance and species composition of the ciliate community is known to change during the course of the year in response to fluctuations in temperature, food availability (mainly phytoplankton) and grazing pressure from metazooplankton (Boikova, 1984; Arndt, 1991; Pierce and Turner, 1992; Witek, 1993). Our study of inshore and offshore sites in the Baltic Sea demonstrated the seasonal succession of *Tintinnopsis lobiancoi* and *Helicostomella subulata*. The former coincided with the beginning of summer and was replaced early in the season by the latter. The seasonal succession of tintinnid species in the Gulf of Gdańsk was reported many years ago by Biernacka (1948). According to her, some species are present throughout the year while others can be found only during the warmer period. *Helicostomella* was not, however, included among the tintinnid genera discovered by Biernacka (1948). This absence of *H. subulata* is somewhat surprising, since this species was present in the summer samples taken in the same region by Kirchner (1937).

Biernacka (1948) found *T. campanula*, now classified in the *T. lobiancoi* group, to be the most abundant species in August. This concurs neither with our own observations nor with those made by other authors (Kivi, 1986;

Leppänen and Bruun, 1986), who found *T. lobiancoi* dominating the tintinnid population at the beginning of summer.

We found that in late autumn and winter the cell numbers of each of the dominant species oscillated around zero. The influence of low temperature became clear in the context of the work of Verity (1987), who noted that temperate zone tintinnids start multiplying when the water temperature exceeds 6°C. The increase in water temperature to 8°C in May 1992 coincided with the reappearance of *T. lobiancoi*. However, the most important factor regulating the tintinnid population seems to be food supply, since ciliates respond rapidly to phytoplankton blooms even at low temperatures (Leppänen and Bruun, 1988).

Almost fifty years ago, Biernacka (1948) noted a large variation in tintinnid numbers at closely located stations in the open Baltic waters. We also observed sharp differences in cell abundance between some neighbouring Baltic stations. This phenomenon could be have caused by the local presence of a large amount of food. Taniguchi and Kawakami (1985) found that when some tintinnids 'encounter a patch of dense food, they can immediately feed and grow at their maximum potential rate', thereby increasing their abundance and biomass.

Acknowledgements

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