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LONG-TERM DYNAMICS OF THE PHYTOBENTHOS IN PÄRNU BAY, THE BALTIC SEA

Abstract. The species composition of bottom vegetation in Pärnu Bay, the Baltic Sea, has considerably changed as compared to the situation prevailing thirty years ago. This is due to increasing pollution which has exerted the greatest influence on the macrophytes in the northern part of the bay. Several species, such as the red alga *Phyllophora truncata* f. *angustissima,* the brown alga *Stictyosiphon tortilis*, the green algae *Cladophora rupestris*, *Enteromorpha ahlneriana*, and *Zygnema* sp., the charophytes *Tolypella nidifica*, *Chara canescens*, *Ch. aspera*, *Ch. tomentosa*, *Ch. connivens*, and the phanerogam *Ruppia maritima*, which in the late 1950s were found north of the Liu — Tahkuna line, no longer occur there. The distribution area of the green alga *Cladophora glomerata* has considerably expanded.

Key words: Pärnu Bay, macrophytobenthos, long-term changes.

Introduction

Research into the species composition of the phytobenthos in Pärnu Bay was started in 1959 when Trei-Pullisaar took phytobenthos samples at 71 stations in Pärnu Bay and in the surroundings of Kihnu Island (Pullisaar, 1961; Трей, 1976). The material was collected by means of mechanical equipment. Sampling was repeated in 1979, 1980, and 1982 at 120 stations (Трей, 1985, 1986). The results obtained were generalized and presented in a book (Trei, 1991). Pärnu Bay, especially its northern part, is strongly polluted. First of all, it is the Pärnu River which carries into the bay sewage and industrial waste water produced by a tannery and the textile, woodworking, and food-processing industries. A good deal of municipal sewage reaches this part of the bay through the collecting main every day. Prior to 1991 the town of Pärnu had no sewage purification plant, and several toxic substances found their way directly into the bay together with eutrophication-causing nutrients (N, P).

On the basis of ecological conditions the bay may be divided into two parts along the Liu—Tahkuna line. The area north of the line is dominated by soft bottoms (sand, clay, sandy clay, mud) with occasional stone accumulations. This part of the bay is characterized by poor light conditions — the Secchi disc transparency of the water is often less than 1 m. The shading effect is caused by a high content of seston, mainly of bottom particles. After storms the transparency of the water decreases abruptly. The salinity of the water is 4.5—5.4‰.

The water is much cleaner in the southern part of the bay, where its transparency reaches 3 m. Extensive areas of the bottom are covered with sand and stones, which creates favourable conditions for the development of bottom vegetation. The salinity is higher, reaching 6‰.

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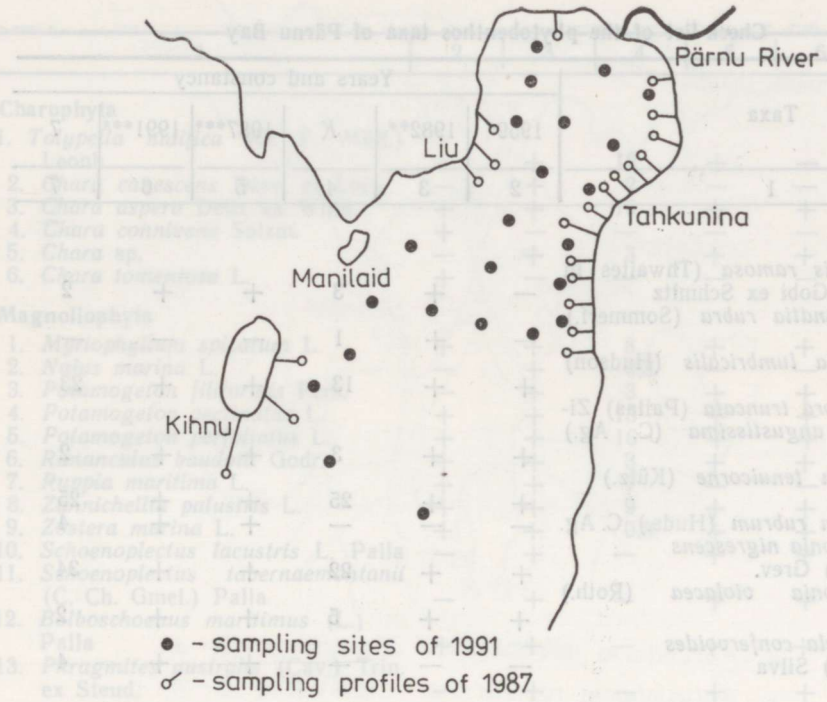


Fig. 1. Sampling stations in Pärnu Bay.

The material for the present paper was collected in Pärnu Bay and in the surroundings of Kihnu Island at 55 stations in 1987, and at 48 stations in 1991 (Fig. 1). All the samples were collected by SCUBA divers within a frame with a surface area of 0.25 m². Samples were taken from the water edge to a depth of 15 m. The sampling was performed from aboard a ship, or in shallow water from a rubber boat.

Results and Discussion

The authors identified 8 taxa of red algae, 6 species of brown algae, 12 species of green algae, 2 species of charophytes, and 11 species of phanerogams in the samples collected in Pärnu Bay in 1991 (Table, Figs. 2—5 *a*, *b*, *c*, and *e*).

Unfortunately, the data for 1959 (the first column of the Table) are not representative enough to allow a comparison with the later data. Some suspicion arises as to the absence of some species in Pullisaar's study (1961); the more so since these species are mentioned in his later publications. In view of this, we shall compare the check-list of species of the early 1980s (Трей, 1986) with the results obtained by the present authors in 1991.

As to the red algae recorded by Trei at the beginning of the 1980s we failed to find only the species *Hildenbrandtia rubra* = *H. prototypus*, the other species have preserved up to the present. *Rhodomela confervoides* and *Ceramium tenuicorne* have appeared. In most cases, the constancy of species has remained at the level recorded in the early 1980s. The constancy of *Furcellaria lumbricalis* and *Polysiphonia nigrescens* has considerably increased.

Taxa	Years and constancy					
	1959*	1982**	*K*	1987***	1991***	7
1	2	3	4	5	6	7
Rhodophyta						
1. *Asterocytis ramosa* (Thwaites in Harvey) Gobi ex Schmitz	—	+	3	+	+	2
2. *Hildenbrandtia rubra* (Sommerf.) Menegh.	—	+	1	—	—	—
3. *Furcellaria lumbricalis* (Hudson) Lamour.	+	+	13	+	+	23
4. *Phyllophora truncata* (Pallas) Zinova f. *angustissima* (C. Ag.) Sjöst.	+	+	3	+	+	2
5. *Ceramium tenuicorne* (Kütz.) Waern	+	+	25	+	+	25
6. *Ceramium rubrum* (Huds.) C. Ag.	—	—	—	+	+	4
7. *Polysiphonia nigrescens* (Hudson) Grev.	+	+	22	+	+	34
8. *Polysiphonia violacea* (Roth.) Grev.	+	+	5	+	+	2
9. *Rhodomela confervoides* (Hudson) Silva	—	—	—	+	+	4
Phaeophyta						
1. *Pilayella littoralis* (L.) Kjellm.	+	+	8	+	+	27
2. *Ectocarpus siliculosus* (Dillw.) Lyngb.	—	+	1	+	+	21
3. *Pseudolithoderma subextensum* (Waern) Lund	—	+	17	+	+	19
4. *Sphacelaria* arctica Harvey	+	+	14	+	+	10
5. *Fucus vesiculosus* L.	+	+	18	+	+	10
6. *Stictyosiphon tortilis* (Rupr.) Reinke	+	—	—	+	+	2
Chlorophyta						
1. *Ulothrix subflaccida* Wille	—	—	—	+	+	17
2. *Ulothrix tenerrima* (Kütz.) Kütz.	—	—	—	+	+	4
3. *Geminella* sp.	—	+	7	—	—	—
4. *Capsosiphon fulvescens* (C. Ag.) Setch. et Gardn.	—	+	4	—	—	—
5. *Percursaria percursa* (C. Ag.) Bory	—	+	4	—	—	—
6. *Enteromorpha intestinalis* (L.) Link	+	+	11	+	+	19
7. *Enteromorpha clathrata* (Roth) J. Ag.	+	—	—	+	+	4
8. *Enteromorpha prolifera* (O. F. Müll.) J. Ag.	—	+	4	+	+	17
9. *Enteromorpha pilifera* Kütz.	—	+	2	—	—	—
10. *Enteromorpha ahlneriana* Bliding	—	—	—	+	+	4
11. *Chaetomorpha linum* (O. F. Müll.) Kütz.	—	+	0.8	+	+	4
12. *Cladophora fracta* (O. F. Müll. ex Vahl) Kütz.	—	—	—	+	+	10
13. *Cladophora glomerata* (L.) Kütz.	+	+	34	+	+	45
14. *Cladophora rupestris* (L.) Kütz.	—	+	3	+	+	6
15. *Rhizoclonium riparium* (Roth) Harvey	—	+	11	+	+	21
16. *Urospora penicilliformis* (Roth) Aresch.	—	+	0.8	—	—	—
17. *Oedogonium* sp.	—	+	9	—	—	—
18. *Spirogyra* sp.	+	+	16	+	+	38
19. *Zygnema* sp.	—	+	10	+	+	17

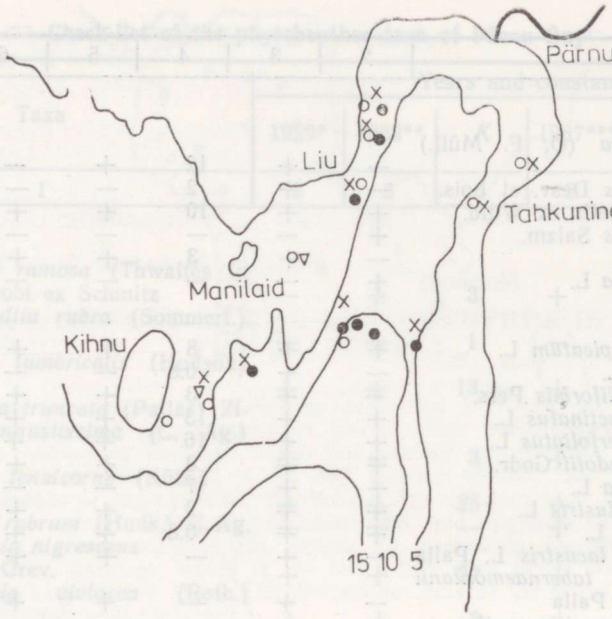
1	2	3	4	5	6	7
Charophyta						
1. *Tolypella nidifica* (O. F. Müll.) Leonh.	—	+	12	+	—	—
2. *Chara canescens* Desv. et Lois.	—	+	2	—	—	—
3. *Chara aspera* Deth. ex Willd.	+	+	10	+	+	6
4. *Chara connivens* Salzm.	+	—	—	—	—	—
5. *Chara* sp.	—	+	3	+	+	2
6. *Chara tomentosa* L.	+	—	—	—	—	—
Magnoliophyta						
1. *Myriophyllum spicatum* L.	+	+	8	+	+	4
2. *Najas marina* L.	—	+	0.8	—	—	—
3. *Potamogeton filiformis* Pers.	—	+	3	+	+	27
4. *Potamogeton pectinatus* L.	+	+	13	+	+	10
5. *Potamogeton perfoliatus* L.	+	+	16	+	+	6
6. *Ranunculus baudotii* Godr.	+	+	3	+	+	2
7. *Ruppia maritima* L.	+	+	7	—	—	—
8. *Zannichellia palustris* L.	+	+	9	+	+	10
9. *Zostera marina* L.	+	+	0.8	+	+	4
10. *Schoenoplectus lacustris* L. Palla	—	+	—	+	+	6
11. *Schoenoplectus tabernaemontanii* (C. Ch. Gmel.) Palla	—	+	—	+	+	10
12. *Bolboschoenus maritimus* (L.) Palla	+	+	—	+	+	2
13. *Phragmites australis* (Cav.) Trin. ex Steud.	—	+	—	+	+	10

* Samples collected in 1959 (Pullisaar, 1961).
** Samples collected in 1979, 1980, and 1982 (Трей, 1986).
*** Samples collected by Kukk.

From brown algae we managed to identify *Stictyosiphon tortilis*, which was recorded in the late 1950s, but was not found in the samples of the early 1980s. Most likely, it did not get into the samples due to its low constancy in the bay. The constancy of *Pilayella littoralis* and *Ectocarpus siliculosus* = *E. confervoides* has increased markedly as compared to that in the early 1980s. The constancy of *Fucus vesiculosus* has considerably decreased.

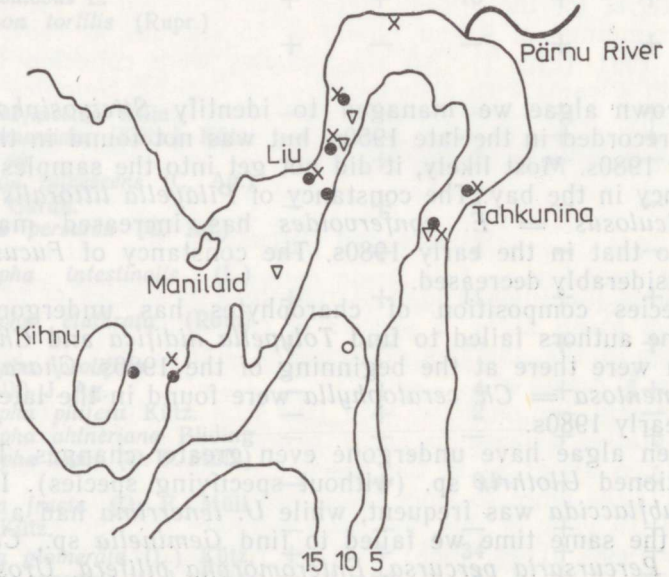
The species composition of charophytes has undergone notable changes. The authors failed to find *Tolypella nidifica* and *Chara canescens*, which were there at the beginning of the 1980s. *Chara connivens* and *Ch. tomentosa* = *Ch. ceratophylla* were found in the late 1950s but not in the early 1980s.

The green algae have undergone even greater changes. Trei (Трей, 1986) mentioned *Ulothrix* sp. (without specifying species). In our material *U. subflaccida* was frequent, while *U. tenerrima* had a lower constancy. At the same time we failed to find *Geminella* sp., *Capsosiphon fulvescens*, *Percursaria percursa*, *Enteromorpha pilifera*, *Urospora penicilliformis*, and *Oedogonium* sp.; however, this may be due to their low constancy in the bay as a whole. The constancy of the remaining species has considerably increased in the course of the last 8—10 years. This concerns, first of all, *Cladophora glomerata*, *Enteromorpha intestinalis*, *E. prolifera*, *Rhizoclonium riparium*, and *Spirogyra* sp. Massive occurrence of *Spirogyra* sp. was registered at one station in the vicinity of Liu at a depth of 0.5 m where the other species had a low constancy. Evidently, this area is heavily polluted.



● - *Furcellaria lumbricalis*
x - *Polysiphonia nigrescens*
▽ - *Ceramium rubrum*
o - *C. tenuicorne*

Fig. 2. Main habitats of red algae in Pärnu Bay.



x - *Ectocarpus siliculosus*
o - *Pseudolithoderma subextensum*
● - *Pilayella littoralis*
▽ - *Fucus vesiculosus*

Fig. 3. Main habitats of brown algae in Pärnu Bay.

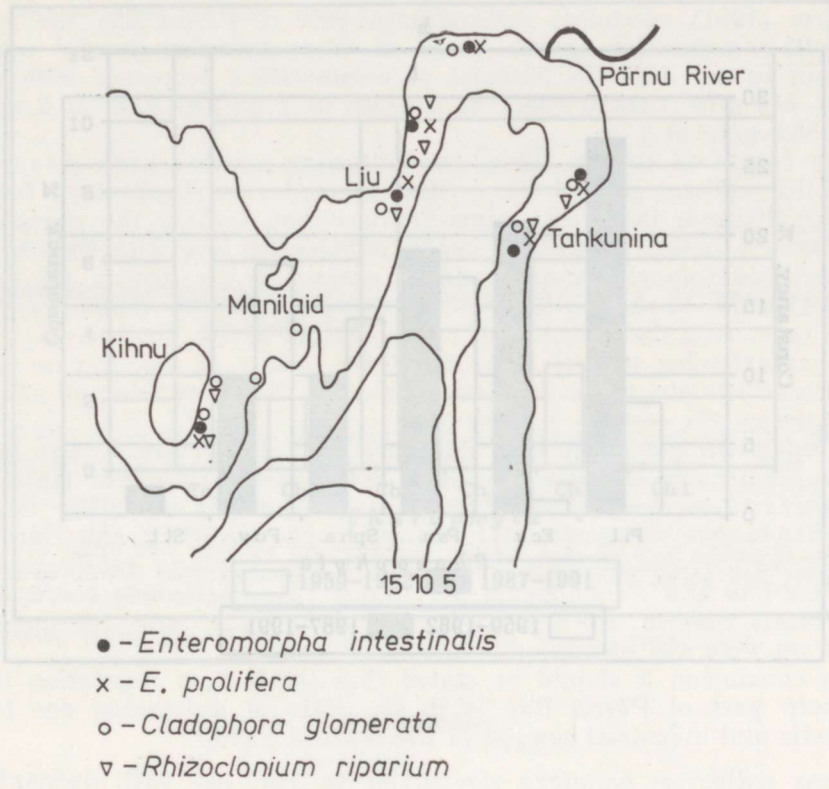


Fig. 4. Main habitats of green algae in Pärnu Bay.

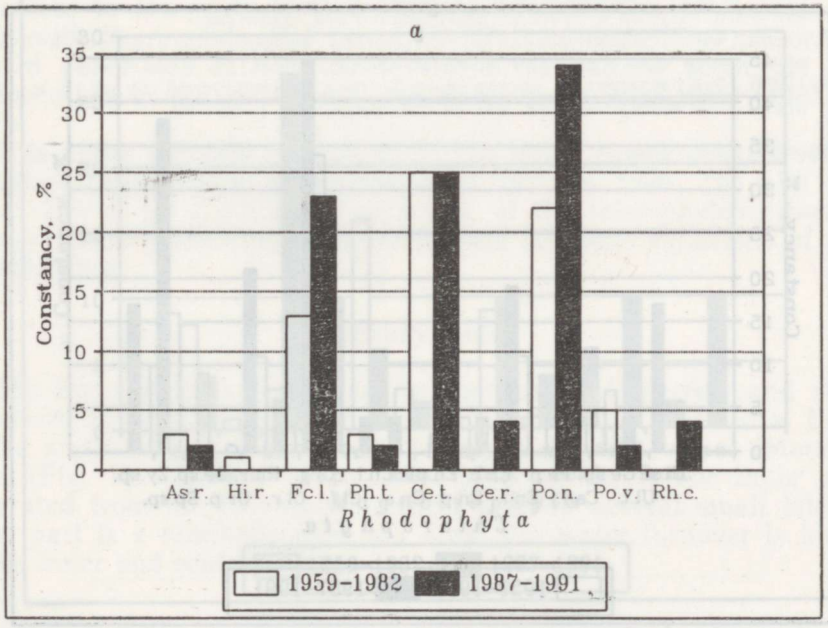
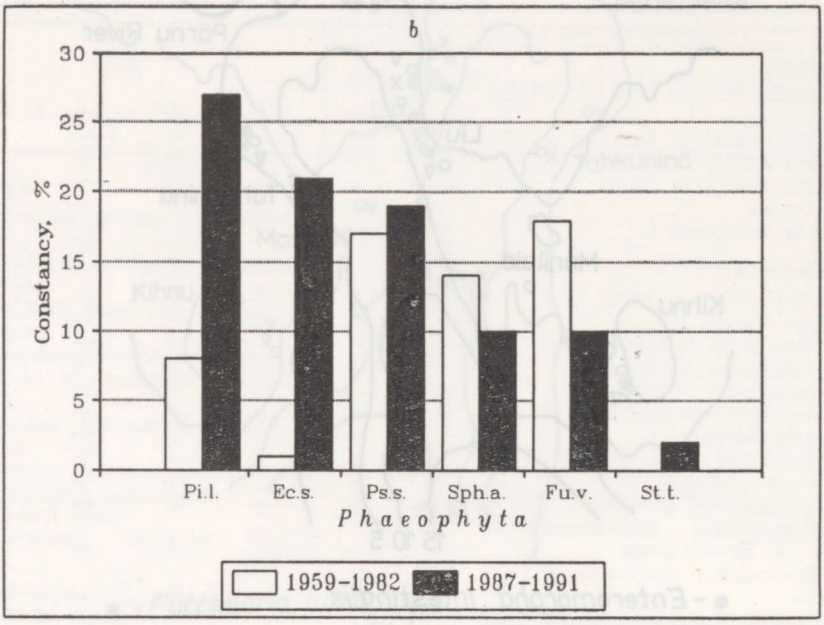


Fig. 5. Constancy of phytobenthos taxa in Pärnu Bay.



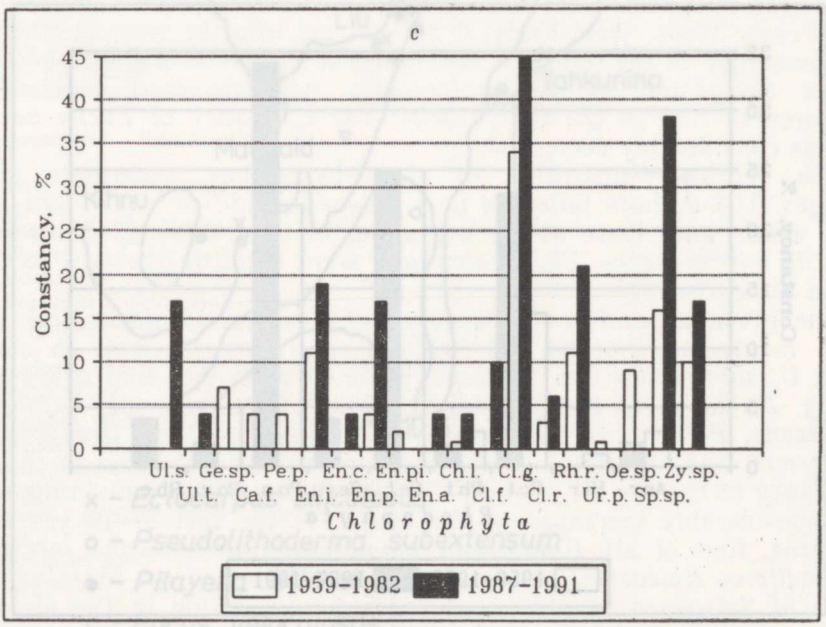
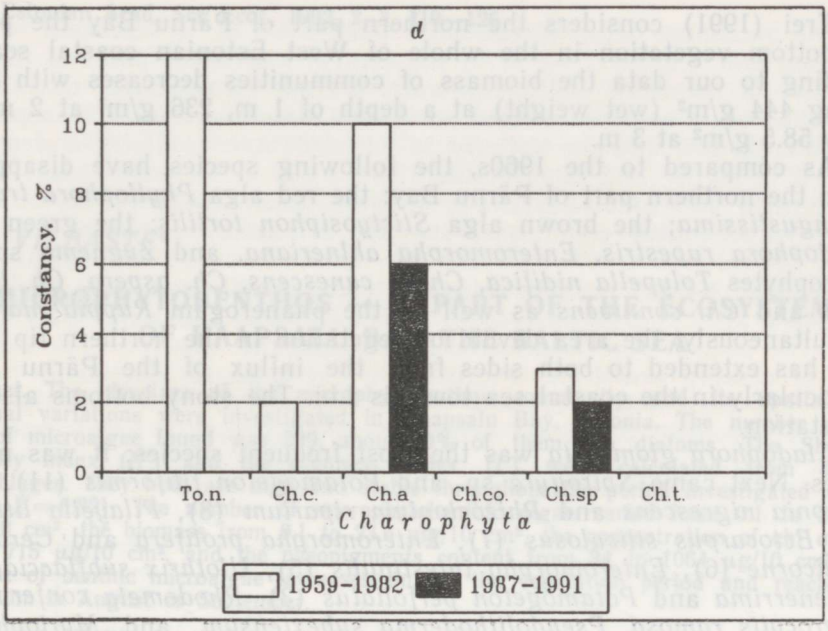


Fig. 5 continued.



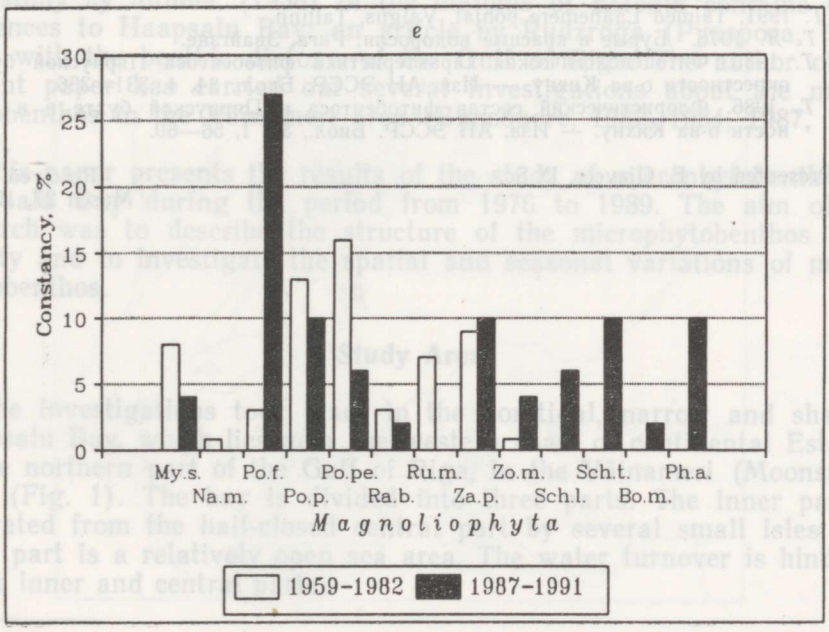


Fig. 5 continued.

Trei (1991) considers the northern part of Pärnu Bay the poorest in bottom vegetation in the whole of West Estonian coastal sea. According to our data the biomass of communities decreases with depth, being 444 g/m² (wet weight) at a depth of 1 m, 236 g/m² at 2 m, and only 58.5 g/m² at 3 m.

As compared to the 1960s, the following species have disappeared from the northern part of Pärnu Bay: the red alga *Phyllophora truncata* f. *angustissima*; the brown alga *Stictyosiphon tortilis*; the green algae *Cladophora rupestris*, *Enteromorpha ahlneriana*, and *Zygnema* sp.; the charophytes *Tolypella nidifica*, *Chara canescens*, *Ch. aspera*, *Ch. tomentosa*, and *Ch. connivens* as well as the phanerogam *Ruppia maritima*. Simultaneously, the area devoid of vegetation in the northern tip of the bay has extended to both sides from the influx of the Pärnu River, particularly in the coastal sea towards Liu. The stony bottoms also lack vegetation.

Cladophora glomerata was the most frequent species; it was met 14 times. Next came *Spirogyra* sp. and *Potamogeton filiformis* (11), *Polysiphonia nigrescens* and *Rhizoclonium riparium* (8), *Pilayella littoralis* and *Ectocarpus siliculosus* (7), *Enteromorpha prolifera* and *Ceramium tenuicorne* (6), *Enteromorpha intestinalis* (5), *Ulothrix subflaccida* (4), *U. tenerrima* and *Potamogeton perfoliatus* (3). *Rhodomela confervoides*, *Asterocytis ramosa*, *Pseudolithoderma subextensum*, and *Myriophyllum spicatum* were met once.

In conclusion it should be stated that the bottom vegetation in the northern part of Pärnu Bay is in the state of depression due to the domestic and industrial sewage of the town of Pärnu.

REFERENCES

Pullisaar, T. 1961. Pärnu lahe põhjataimestikust. — Eesti NSV TA Toim. Biol., **X**, 4, 340—345.

Trei, T. 1991. Taimed Läänemere põhjal. Valgus, Tallinn.

Трей Т. Я. 1976. Бурые и красные водоросли. Рига, Звайгзне.

Трей Т. 1985. Фитоценологическая характеристика фитобентоса Пярнуской бухты и окрестности о-ва Кихну. — Изв. АН ЭССР. Биол., **34**, 4, 331—336.

Трей Т. 1986. Флористический состав фитобентоса в Пярнуской бухте и в окрестности о-ва Кихну. — Изв. АН ЭССР. Биол., **35**, 1, 56—60.

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