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Tiiu TREI

PHYTOBENTHOS IN THE WATERS OF THE VILSANDI STATE NATURE RESERVE

Study area

The Vilsandi State Nature Reserve is situated in the open Baltic, near the western coast of Saaremaa Island. The study area can be divided into two quite different parts. The first includes the northern, the western and the south-western open coastal regions of Vilsandi Island and the small islands (Nootama and others) located south-west of Vilsandi. The second comprises the sheltered areas south of Vilsandi Island and Kuusnõmme and Kihelkonna Bays.

The former area is characterized by a relatively high water salinity (>7‰) and with good light conditions (Secchi disc transparency is usually 6—8 m, quite often it reaches 10—11 m). Hard bottoms — the Silurian rocks, boulders and stones — prevail. Sandy bottoms with boulders and pebbles also occur. The area is exposed to the wave action, especially the small islands (Nootama and others located SW of Vilsandi Island) are entirely under the influence of the motion of the sea.

The areas with hard bottoms, with high water salinity and with good aeration are favourable places for the fastening of green, brown and red algae.

The latter is a relatively sheltered and shallow sea area with an indented coast-line and numerous islets. The depth of the water does not exceed 2.5—3 m; its salinity is usually over 7‰. Sediment bottoms, mainly muddy sand, clay and loam with scattered stones or gravel prevail. In places mud containing H_2S occurs. The low transparency of the water (<1 m) caused by fine-grain sediments during storms and after them is characteristic of this aquatory.

This area is suitable for charophytes and phanerogams, the dwarf forms of *Fucus* were also encountered in some stations. The surface of scattered boulders and stones is covered with a light-green jellied coat of blue-green algae, *Rivularia haematites* being the dominating species among them. In deeper areas the *Fucus*-communities are spread.

The influence of human activity is of little significance in the whole study area. The numerous bird fauna causes the enrichment of the water with nutrients, but its intensive exchange with the water from the deeper open sea does not enable a high nutrient level in the water of the study area.

Material and methods

The material was collected from 84 sampling stations in 1981, 1983 and 1984. In addition the material gathered earlier (in 1964, 1966 and 1967) from 42 stations was used.

The sampling stations were located in the area from the water-line down to a depth of 14 m. The material was gathered by SCUBA-divers according to the methods generally used. The aim of the research was to

establish the floristic composition, environmental conditions and distribution of species and to elucidate plant communities.

Samples of plants from the frame with a surface of 0.25 or 0.01 sqm (in some communities) were collected. The wet biomass (i.e. phytomass) per 1 sqm was calculated taking into consideration the coverage at the stations.

Floristic composition of phytobenthos

The phytobenthos in the coastal waters of the Vilsandi State Nature Reserve is characterized by a relatively great number of taxa, the important role of halophilous species and the existence of several rare species.

The floristic list contains 50 taxa, among them 7 phanerogams, 19 green, 12 brown and 12 red algae. The blue-green algae, requiring a special research are omitted. The taxa of algae are ranged on the basis of the system presented by H. Pankow (1971). The abundance of species is estimated according to a 5-point scale, 5 denoting the maximum and 1 the minimum abundance (Table 1).

Notes considering the taxonomy and distribution of some species

Under the taxon *Ulvopsis grevillei* (Table 1) the alga, named earlier as *Monostroma balticum* (Aresch.) Wittr. is presented.

In the present paper the standpoint of Nienhuis (1975, cited from Blair, 1983) is favoured and the taxa *Rhizoclonium riparium* (Roth) Harvey and *Rhizoclonium implexum* (Dillw.) Kütz. are used as synonyms. The delimitation of these two species is often complicated because in the Estonian material the rhizoidal proliferations occur seldom and the dimensions of these two species overlap. According to Nienhuis (Blair, 1983) the filament diameter and the degree and size of rhizoidal proliferations are influenced by environmental conditions and do not have any taxonomical value.

Some rare and interesting species were encountered, among them green algae *Cladophora albida* and *Cladophora oblitterata* are notable. Hitherto these species were not recorded in the northern Baltic proper.

The green algae *Capsosiphon fulvescens*, *Percursaria percursa*, *Prasiola stipitata*, *Rosenvingiella polyrhiza* and charophyte *Chara connivens* are also worth mentioning. In the northern Baltic these species have been found only in separate habitats so far.

In 1927 the Latvian algologist H. Skuja (1928) visiting the group of Vaika Islands (near the west coast of Vilsandi) found there abundantly two rare and interesting algal species — the red alga *Rhodochorton rothii* (= *R. purpureum*) and the brown alga *Leptonema lucifugum* Kuck. (= *Waerniella lucifuga* (Kuck.) Kylin). The first species occurred as a carmine red felt-like cover in rock fissures and cavities near the waterline up to 1.5 metres above it. The second species reminded yellowish-brown velvet.

There could be detected only single specimens of the former species under the microscope in the material collected from one station only. The latter species was not noticed at all.

It is interesting to note that usually common and in Estonian waters widely spread brown alga *Sphacelaria arctica* is rare in the surroundings of Vilsandi Island. In spite of the high salinity of the water and plenty of suitable places for fastening, the species was observed as single specimens at two stations only.

It seems necessary to point out some specific features of *Ruppia* species concerning their fertility. In July 1966 in all stations there were individuals of *R. maritima* bearing fruits. It enabled the author of the present paper to identify this species confidently. The fertile *R. cirrhosa* was then observed only at one station.

On the contrary, in July 1981 and 1983 there were fertile specimens of *R. cirrhosa* at many stations, the fruits of *R. maritima* were never found. For that reason many vegetative plants remained unidentified.

According to H. Luther (1947) the different dimensions of leaves and the different forms of the leaf tips make it possible to identify sterile *Ruppia* individuals in the Finnish waters. The dark green leaves of *R. cirrhosa* have rounded tips and their breadth is about 1 mm.

Unfortunately, the examination of *Ruppia* collected from the Vilsandi surroundings did not confirm the position mentioned above. The leaves of both fertile *R. cirrhosa* and *R. maritima* have quite often pointed tips. The breadth of fertile *R. cirrhosa* leaves was only seldom above 1 mm, mostly it was 0.4—0.7 mm only. It means that the dimensions and forms of vegetative organs vary and overlap, therefore the identification of sterile plants is problematic.

Phytobenthic communities

On the ground of the dominating species, the floristic composition and environmental requirements 13 associations (ass.) were differentiated in the study area. 7 associations are distributed on hard bottoms, 6 of them are characteristic of sediment bottoms. They all belong to the sublittoral belt. The numerical data concerning the above-named associations are given in Table 2. The constant species of the associations (K) are presented only in the case when there are more than 5 analyses per association.

In the highly exposed areas in shallow coastal waters on hard bottoms the vegetation is mosaic. The species occur here in small, more or less pure separate alternating patches, forming a heterogeneous cover on rocks, boulders and stones. The dominating species are not prominent and it is difficult to distinguish plant communities. In such a case it seems expedient to use H. Schwenke's (1966) conception about the quasi-littoral zone. Owing to the tearing and crushing effect of waves and ice, permanent and distinct plant communities cannot form in this area. The main components in this mosaic vegetation are species of green algae *Enteromorpha* and *Cladophora*, brown algae *Dictyosiphon foeniculaceus*, *Stictyosiphon tortilis*, *Pilayella litoralis*, *Chorda filum*, *Fucus vesiculosus*, red algae *Ceramium rubrum* and *Ceramium tenuicorne*.

In the Vilsandi area the quasi-littoral belt extends from the water-line to a depth of 0.5—1.5 metres.

In places *Pilayella litoralis* can form a distinct association already from the water surface down to a depth of 2—3 m. It is a uniform low brownish or beige belt, covering large areas. In most cases the role of other species in this community is unimportant, although here and there specimens of *F. vesiculosus*, *C. filum* and *C. tenuicorne* overlap *Pilayella*.

The association *Fucus vesiculosus* has the most extensive area of distribution, occurring at the depth of (1)1.5—(3)5 m. In deeper areas it is replaced by communities of several red algae. The ass. *Fucus vesiculosus — Furcellaria lumbricalis — Polysiphonia nigrescens* can be understood as a transition community between *Fucus* and red algae associations. There are different red algal species dominating in various variants. Up to the present in the Vilsandi surroundings the ass. *Furcellaria lumbrica-*

Table 1
Таблица 1

Floristic list of phytobenthos in surroundings of Vilsandi
Флористический состав фитобентоса в окрестностях о-ва Вилсанди

Taxon Таксон	Number of habitats Число местонахождений	Abundance Обилие	Depth, m Глубина, м	Salinity, ‰ Соленость, ‰
1	2	3	4	5
Chlorophyta				
1. *Ulothrix* sp.	5	1	0.1—2.8	6.83—7.02
2. *Geminella* sp.	1	1	2.2	7.73
3. *Chlorchormidium flaccidum* Kütz.	1	1	0.1	7.52
4. *Ulvopsis grevillei* (Thuret) Gayral	6	1—5	1.0—2.2	6.74—7.73
5. *Percursaria percursa* (C. A. Ag.) Bory	2	1	0.2—2.8	7.02
6. *Capsosiphon fulvescens* (C. A. Ag.) Setchell et Gardner	3	1	0.1—0.5	7.26
7. *Enteromorpha intestinalis* (L.) Link.	13	3—4	0.1—0.5	7.58—7.68
8. *Enteromorpha* spp.	8	2—4	0.1—1.5	7.43—7.58
9. *Prasiola stipitata* Suhr	5	2—3	up to 1—2 m above the water surface	6.97
10. *Rosenvingiella polyrhiza* (Rosenv.) Silva	2	2	up to 0.5 m on overwashed rocks	6.97
11. *Rhizoclonium riparium* (Roth) Harvey	16	1—5	0.5 m above the water surface down to 3.4 m	6.74—7.70
12. *Cladophora rupestris* (L.) Kütz.	16	1—4	1.5—6	6.90—7.27
13. *Cladophora oblitterata* Söderstr.	2	1—2	near the water surface	7.52—7.93
14. *Cladophora glomerata* (L.) Kütz.	13	1—2	0.1—2	6.74—7.63
15. *Cladophora sericea* (Huds.) Kütz. sensu van Hoek	13	3—4	0.1—0.5(1.9)	7.52—7.70
16. *Cladophora albida*	5	1—4	0.1—0.8	7.58
17. *Urospora penicilliformis* (Roth.) Aresch.	6	1—5	near the water surface and 0.5 m above it	7.58
18. *Spirogyra* sp.	23	1—4	0.1—14	6.74—7.73
19. *Zygnema* sp.	16	1—4	1.0—2.2	6.74—7.73
Charophyta				
1. *Tolypella nidifica* (O. F. Müll.) Leonh.	1 +5	1	1.9	7.70
2. *Chara canescens* Desv. et Lois.	4 +5	1—5	1.5—2.8	7.24
3. *Chara tomentosa* L.	1	1	3	7.73
4. *Chara baltica* Bruz.	1 +5	1	1.3	7.24
5. *Chara aspera* Deth. ex Willd.	8	5	0.2—2.8	7.02—7.73
6. *Chara connivens* Salzm. ex A. Br.	1	1	1.7	6.74

Table 1 (continued)

1	2	3	4	5
Phaeophyta				
1. *Pilayella litoralis* (Lyngb.) Kjellm.	47	1—5	0.1—12	6.74—8.08
2. *Ectocarpus confervoides* (Roth) Le Jolis s. lat.	33	1—4	0.1—14	7.43—8.08
3. *Sphacelaria arctica* Harvey f. *artica*	2	1	1—14	7.24
4. *Pseudolithoderma subextensum* (Waern) Lund	11	2—5	0.1—14	7.24—7.70
5. *Stictyosiphon tortilis* (Rupr.) Reinke	15	1—3	0.1—14	7.68—7.70
6. *Dictyosiphon foeniculaceus* (Huds.) Grev.	20	1—5	0.1—5	6.83—7.68
7. *Chorda filum* (L.) Stackh.	23	1—5	0.3—12	7.10—7.68
8. *Fucus vesiculosus* L. f. *vesiculosus*	33	5	0.3—7	6.90—7.63
9. *Fucus vesiculosus* L. f. *nana* C. A. Ag.	2	4—5	1—2.1	7.68
10. *Fucus vesiculosus* L. f. *filiformis* C. A. Ag.	9	2—5	1—2.9	6.83—7.68
11. *Leathesia difformis* (L.) Aresch.	4	1—2	1.5—2.7	7.52—7.70
12. *Elachista fucicola* (Velley) Aresch.	14	4	0.5—5	7.52—7.68
Rhodophyta				
1. *Asterocytis ornata* (C. A. Ag.) Hamel	5	1	0.5—2.9	7.24—7.73
2. *Rhodochorton purpureum* (Lightf.) Rosenv.	1	1	2 m above the water surface	
3. *Hildenbrandtia prototypus* Nardo	1	2	near the water surface	6.90
4. *Furcellaria lumbricalis* (Huds.) Lamour.	29	3—5	(1.0) 2.0—14	6.90—8.08
5. *Phyllophora truncata* (Pallas) Newroth et Taylor f. *truncata*	5	2	1.9—14	6.90—7.70
6. *Phyllophora truncata* (Pallas) Newroth f. *elongata*	1	1	4.5	7.18
7. *Phyllophora truncata* (Pallas) Newroth et Taylor f. *angustissima* (C. A. Ag.) Sjöstedt	1	1	2.1	7.11
8. *Ceramium rubrum* (Huds.) C. A. Ag.	41	3—5	0.1—14	6.83—7.93
9. *Ceramium tenuicorne* (Kütz.) Waern	37	1—5	0.1—14	6.83—7.70
10. *Polysiphonia nigrescens* (Smith) Grev.	34	1—5	1—14	6.83—8.08
11. *Polysiphonia violacea* (Roth) Grev.	2	1	1.5—1.7	7.68
12. *Rhodomela confervoides* (Huds.) Silva f. *tenuior* (C. A. Ag.) Pankow	13	1—4	1—14	7.27—8.08
Angiospermae				
1. *Myriophyllum spicatum* L.	7	2	1—2.8	6.83—7.24
2. *Zostera marina* L.	11	3—5	1.5—5.4	7.02—7.63
3. *Potamogeton filiformis* Pers.	2	2	0.5—2.5	7.52—7.68
4. *Potamogeton pectinatus* L.	18	3—5	1—3.4	6.74—7.73
5. *Zannichellia palustris* L.	4 +6	2	0.3—2.2	7.43—7.68
6. *Ruppia cirrhosa* (Petagna) Grande	9 +1	3—5	1.0—1.7	6.83—7.68
7. *Ruppia maritima* L.	1 +8	2—3	0.3—0.5	7.10—7.68
Ruppia (vegetat.)	8	3	0.5—2.2	7.68—7.70

* The sign + denotes the number of habitats of charophytes and phanerogams according to the data collected in 1966 and 1967 when there were more sampling stations in the shallow coastal water.

Знак «+» обозначает число местонахождений харовых водорослей и фанерогамов по данным 1966—1967 гг., когда большинство исследований проводили в мелководных районах заповедника.

Table 2
Таблица 2

Phytobenthic communities of sublittoral in surroundings of Vilsandi
Растительные сообщества сублиторали в окрестностях о-ва Вилсанди

Association Ассоциация	Number of samples Количество проб	Depth, m Глубина, м	Coverage, % Покрытие, %	Biomass, g/m² Биомасса, г/м²	Average biomass, g/m² Средняя биомасса, г/м²	Number of taxa Количество таксонов		Average number of taxa per sample Среднее количество таксонов в пробе	Constancy, % Константность, %
						total всего	per sample в одной пробе		
1	2	3	4	5	6	7	8	9	10
A. On hard bottoms									
a) brown algae									
1. *Pilayella litoralis*-ass.	5	0—2.1	60—100	189—223	206	11	3—5	5.0	*Cer. tenuic.* 80
2. *Fucus vesiculosus*-ass.	7	1—5	50—100	276—8400	2523	24	8—11	9.6	*Pil. lit.* 85.7 *Ch. filum* 71.4 *Ectoc. conf.* 71.4 *Spirogyra sp.* 71.4 *Cer. rubr.* 71.4
b) red algae									
3. *Fuc. vesiculosus-Furcellaria lumbricalis-Polysiphonia nigrescens*-ass.	2	4.2—4.5	70—80	406—1230	818	13	6—11	8.5	
4. *Furc. lumbric.*-ass.	3	8.5—14	20—80	9—919	315	12	4—11	6.7	
5. *Furc. lumbric.-Ceramium rubrum*-ass.	6	4.5—10.6	50—95	90—1146	777	12	2—8	6.0	
6. *Ceramium rubrum*-ass.	7	3.0—9.5	40—90	56—1080	431	13	3—10	5.3	*Pol. nigr.* 83.3
7. *Polysiphonia nigrescens*-ass.	3	4.2—5.4	60—90	184—360	292	10	4—6	5.3	*Furc. lumbric.* 71.4

Table 2 (continued)

1	2	3	4	5	6	7	8	9	10
B. On sediment bottoms									
a) phanerogams									
8. *Zostera marina*-ass.	6	1.5—5.4	45—100	177—1000 (3200)	1023	20	5—10	8.0	*Pil. litor.* 83.3, *Furc. lumbr.*, *Pol. nigr.*, *Cer. tenuic.* } 66.7
9. *Potamogeton pectinatus*-ass.	8	1.7—2.8	50—100	280—4200	1317	28	3—14	8.4	*Pil. litor.* 87.5; *Pol. nigr.* 75
10. *Ruppia cirrhosa*-ass.	7	0.2—1.6	80—100	808—2646	1824	27	6—13	10.0	*Pil. litor.* 85.7; *Zygnema* sp. 71.4
b) charophytes									
11. *Chara canescens*-ass.	2	1.5—1.9	30—75	182—435	309	12	5—9	7.0	
12. *Chara aspera*-ass.	3	2.1—2.2	2—70	14—1316	450	15	7—12	8.7	
c) dwarf forms of *Fucus*									
13. dwarf *Fucus*-ass.	2	2.1—2.9	50—70	116—784	537	20	9—14	11.5	

lis, the ass. *Furcellaria lumbricalis — Ceramium rubrum*, the ass. *Ceramium rubrum* and the ass. *Polysiphonia nigrescens* were distinguished, all occurring in the open sea.

From the associations characteristic of sediment bottoms the ass. *Zostera marina* and the ass. *Ruppia cirrhosa* survive the wave action quite well. They were observed frequently, but in smaller patches in the whole area.

The communities of the dwarf forms of *Fucus* and of charophytes are limited to sheltered bays. The distribution area of the ass. *Potamogeton pectinatus* is somewhere between them. In addition to Kuusnõmme and Kihelkonna Bays this association is spread also in the bays located on the southern and northern coast of Vilsandi Island. Some of these bays are relatively more exposed to waves.

From the associations, recorded in the study area, the ass. *Chara canescens* and the ass. *Ruppia cirrhosa* are worth mentioning. Elsewhere in Estonian coastal waters the named species occur only as single individuals without forming separate communities.

The ass. *Chara canescens* was registered in the relatively sheltered southern part of Kuusnõmme Bay, where it was bordering on the association *Chara aspera*. In all phytobenthic communities of Kuusnõmme Bay loose-lying green alga *Ulvopsis grevillei* was observed in large quantities.

Nearly in all the samples, collected from Kuusnõmme Bay and partly also from Kihelkonna Bay the charophytes and phanerogams were wrapped into brownish-grey or pale-red algal filaments. In these filaments several species were observed. The most frequent among them were *Ceramium tenuicorne*, *Zygnema* spp and *Spirogyra* spp.

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Comparing the material collected in the study area in recent years with the material collected in the 1960s there are no essential changes or trends of changes in the floristic composition and distribution of the phytobenthos. The quantitative biomass data are hardly comparable because of their scantiness in the 1960s. There was no remarkable intensive development of green alga *Cladophora glomerata* indicating the eutrophication of the sea area.

As a result of the investigation the sea area of the Vilsandi State Nature Reserve is considered to be relatively clean so far.

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Tiiu TREI

FÜTOBENTOS VILSANDI RIIKLIKU LOODUSKAITSEALA VETES

1981., 1983. ja 1984. a. juulikuus 84 uurimispunktist kogutud materjali põhjal on esitatud fütobentose süstemaatiline nimestik (tab. 1). Andmed 13 sublitoraalis esineva fütobentose assotsiatsiooni kohta on koondatud tabelisse 2. Vilsandi ümbruse fütobentost iseloomustab suhteliselt suur liikide arv, halofiilsete liikide suur osatähtsus ja mitmete haruldaste liikide olemasolu.

Kogu Läänemere kirdeosale uued liigid on *Cladophora albida* ja *Cladophora oblitterata*. Läänemere kirdeosas seni harva leitud liikidest kasvasid uuritud alal *Percursaria percursa*, *Capsosiphon fulvescens*, *Prasiola stipitata*, *Rosenvingiella polyrhiza*, *Chara connivens* ja *Rhodochorton purpureum*.

Тийу ТРЕЙ

ФИТОБЕНТОС МОРСКИХ ВОД ВИЛСАНДИСКОГО ГОСУДАРСТВЕННОГО ЗАПОВЕДНИКА

Вилсандиский государственный заповедник находится в открытой части Балтийского моря недалеко от западного побережья о-ва Сааремаа.

Материал собран в июле 1981, 1983 и 1984 гг. на 84 станциях, находящихся на глубине до 14 м от уреза воды. Материал собран аквалангистами по общепринятой методике.

Исследованный район можно условно разделить на два различные участка. Первый из них открыт к волнению и охватывает северное, западное и юго-западное прибрежье о-ва Вилсанди. Этот участок характеризуется относительно высокой соленостью (>7‰) и большой прозрачностью воды (обычно 6—8 м, часто до 10—11 м). Грунт твердый (в частности доломиты), подходящий для прикрепления зеленых, бурых и красных водорослей.

Другой участок охватывает более защищенное от действия волнения извилистое южное прибрежье о-ва Вилсанди со множеством маленьких островков, а также Куусныммескую и Кихелконнаскую бухты. Этому участку характерны мелководность (<2,5—3 м), мягкий мелкозернистый грунт и малая прозрачность воды (редко превышает 1 м). Здесь в основном преобладают харовые водоросли и фанерогамы.

Фитобентос относительно богат таксонами — всего 50 (табл. 1). Обилие таксонов определено по пятибалльной шкале.

В составе фитобентоса много халофильных и редких видов. Впервые из северо-восточной части Балтики обнаружены зеленые водоросли *Cladophora albida* и *Cladophora oblitterata*. Из редких для северо-восточной части Балтийского моря видов найдены *Percursaria percursa*, *Capsosiphon fulvescens*, *Prasiola stipitata* и *Rosenvingiella polyrhiza*, *Chara connivens*, *Rhodochorton purpureum*.

Выявлено 13 ассоциаций фитобентоса, относящихся к сублиторали (табл. 2). Заслуживают внимания ассоциации *Ruppia cirrhosa* и *Chara canescens*, так как в иных прибрежных районах Эстонии эти виды встречаются только единичными экземплярами.

При сравнении данных 1981—1983 гг. с данными 1964, 1966 и 1967 гг., заметных изменений в флористическом составе и в распространении фитобентоса не обнаружено. В исследованном районе до сих пор также не наблюдается интенсивного развития зеленой водоросли *Cladophora glomerata*, индикатора эвтрофирования воды.

На основе изучения фитобентоса исследованный участок моря можно считать относительно чистым.