Proc. Estonian Acad. Sci. Biol. Ecol., 2004, **53**, 4, 236–250

Historical review of the literature on phytobenthic investigations in the Gulf of Riga

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Received 28 March 2001, in revised form 22 March 2004

Abstract. Phytobenthic investigations in the area of the Gulf of Riga date back as far as the end of the 18th century. Since then a large number of investigations have been carried out in the area resulting in numerous publications in various local and wide-spread European languages. The aim of the present paper is to give a detailed review of the knowledge concerning the species composition and quantitative distribution of phytobenthos in the area. For historical reasons, a great part of the scientific literature from the area is in the Russian, Estonian, or Latvian language. These works contain valuable information useful now that investigations have become truly international and large-scale around the Baltic Sea. The present paper gives a review of 85 papers or other published materials and presents the most important conclusions and facts. A comparative list of species of macroalgae and phanerogams ever identified from the area is given with references to the authors.

Key words: macrophytobenthos, Gulf of Riga.

INTRODUCTION

The Gulf of Riga is considered to be one of the most eutrophied basins in the Baltic Sea. Therefore it was recently placed under close investigation in terms of description and modelling of biogeochemical processes and biodiversity. As 20% of the total area of the Gulf is shallower than 10 m the role of benthic littoral communities in this ecosystem should be of great importance and possible large-scale and long-term developments in the functioning of the Gulf of Riga ecosystem are expected to have a strong effect on the littoral biota.

The aim of the present paper is to give a detailed review of the knowledge concerning the species composition and quantitative distribution of phytobenthos in the area. Due to the history of the area a large part of the scientific literature concerning it is written in Russian, Estonian, or Latvian, and is so not available

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for direct reading to a great majority of scientific public around the Baltic Sea. However, these works contain valuable scientific information useful at the present time when scientific investigations have become truly international and large-scale around the Baltic Sea.

The publications dealing with the algae of the Baltic Sea, including the Gulf of Riga, may be conventionally divided into two groups covering also two different periods. The first will cover the floristic lists and taxonomic studies mainly until World War II, and the second the research done since the end of the 1950s in the field of bioproduction and algal communities. The location of the study area is shown in Fig. 1.

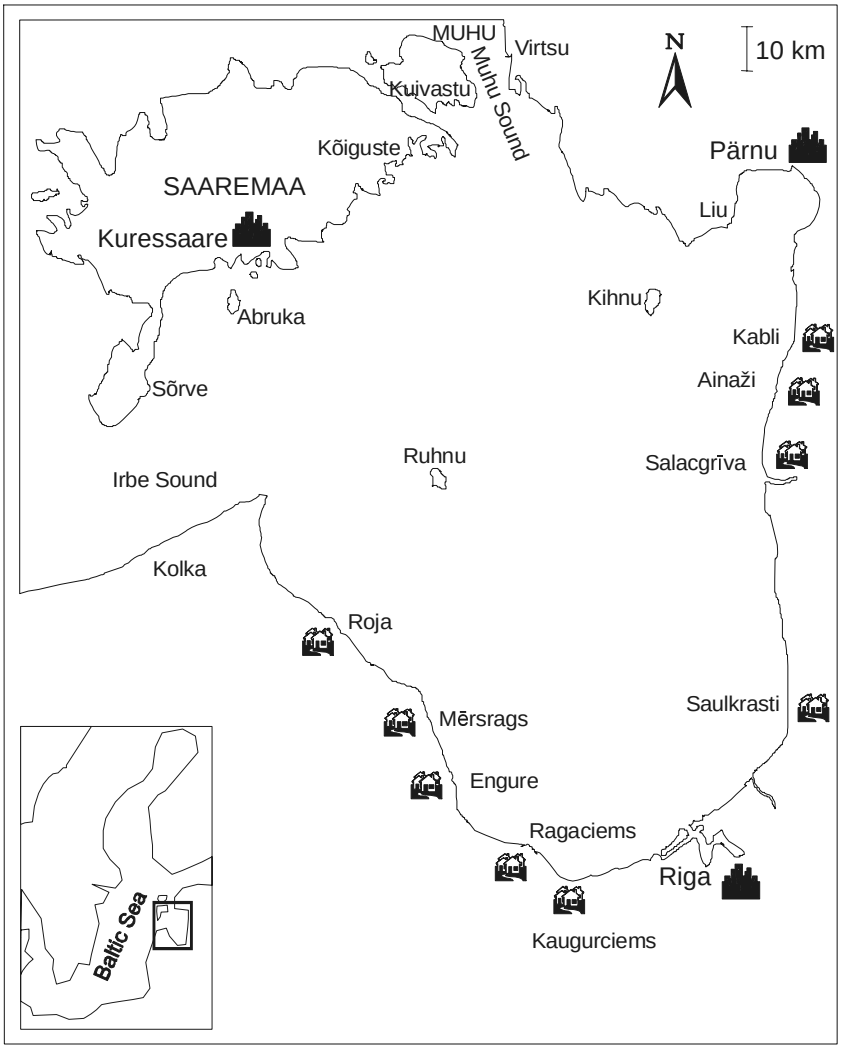

Fig. 1. Location of the study area.

HISTORICAL STUDIES WITH FLORISTIC ORIENTATION

The first written record about the macroalgae of the Eastern Baltic, including evidently also the Gulf of Riga, can be found in *Versuch einer Naturgeschichte von Livland* (1778) by Jacob Benjamin Fischer, a pupil of C. Linné. The initials of the author on the title page of the first edition are J. L., but in the second edition (1791) these are already J. B., although both works have been written by one and the same researcher. In both works the bladder wrack (*Fucus vesiculosus*) is mentioned without any concrete data on the finds; in the second work also the species *Furcellaria lumbricalis* (= *Fucus lumbricalis*) and *Enteromorpha* (= *Ulva) intestinalis* are named. Between these two monographs the author published (1784) *Zusätze zu seinem Versuch einer Naturgeschichte von Livland*, in which he named *Ulva intestinalis* and three species of *Conferva*. In Grindel's *Botanisches Taschenbuch für Liv-, Kur- und Ehstlands* (1803) again the bladder wrack and agar-agar, two species of *Enteromorpha* (= *Ulva*), and some species of *Chara* are mentioned; unfortunately, without showing where exactly the last were found. In 1805 *Oeconomisch-technische Flora für Liv-, Ehst- und Kurlands* by Friebe was published, where the bladder wrack is again mentioned. Von Luce (1823) in his *Topographische Nachrichten von der Insel Oesel in mediczinischer und ökonomischer Hinsicht* describes accumulations of bladder wrack (*Fucus vesiculosus*) cast ashore, which coast dwellers used as a fertilizer. He also mentions the coastal water species *Chara hispida*.

The above-mentioned publications are followed by Eichwald's (1847, 1849, 1852) three works entitled "Erster..., Zweiter..., Dritten Nachtrag zum Infusorienkunde Russlands", respectively. These works deal mainly with planktonic microorganisms. However, in the third work Eichwald mentions also the occurrence of *Chara* in the vicinity of bathing places at Kuressaare. Besides, he also calls attention to the "blooming" of water in the Gulf of Riga, caused evidently by *Anaebaena* species. In the area of Kaugern in the Gulf of Riga the author identified *Fucus vesiculosus*, *Chorda filum*, *Ectocarpus* sp., *Furcellaria lumbricalis*, *Polysiphonia nigrescens*, and *Ceramium* sp. as the most frequent species of macroalgae. Currently, basing on this work, some conclusions can be drawn as to the changes in the distribution of algal vegetation in the area.

A similar three-part work was published by two friends C. A. Heugel and C. J. G. Müller (Heugel & Müller, 1847; Heugel, 1851–1852, Müller, 1852–1853). In the first paper attention is paid to the abundance of the bladder wrack cast ashore from the Baltic Sea. In the second work the occurrence of the species *Chara aspera* Willd. in the sea near Kuressaare, and *Ch. crinita*, *Ch. hispida* L., and *Ch. tomentosa* L. at Kura beach was mentioned. The third work describes bladder wrack accumulations on the sandy sea floor below the Mustjala cliff.

Schmidt's "Flora des silurischen Bodens von Ehstland, Nord-Livland und Ösel" (1855) mentions five species of *Chara* occurring in the sea. Two parts of "Blicke in die Cryptogamenwelt der Ostseeprovinzen" by Dietrich (1856, 1859) belong to the same period. In these papers five species of macroalgae are mentioned and the works by Grindel (1803) and Fischer (1791) are cited. In his article "Algen des

Rigaschen Meerbusens" (1866) Bushe names 12 species of macroalgae collected on the beach in the vicinity of Dubultu (Dubbeln), the Gulf of Riga. These species are *Cladophora crystallina* Kütz., *C. seriacea* Kütz., *Enteromorpha intestinalis* Link, a *capillaris* and b *crispa, Ectocarpus litoralis* Ag., *Chorda filum* Lam., *Fucus vesiculosus* L., *Furcellaria fastigiata* Lam., *Gymnogongrus plicatus* Kütz., *Ceramium diaphanum* (Lightf.) Roth, and *Polysiphonia nigrescens* Grev.

About ten years later (1877) Winkler's review "Literatur und Pflanzen-verzeichnis der Flora Baltica" was published. Unfortunately, it does not mention the exact places where one or another species of algae was found. The list of references contains publications covering a wide time span, starting with Fischer (1791); however, not all the works published by that time are included. Of the 70 species of algae listed, more than 40 were evidently found growing in the sea. The next work by the same author "Über einige für die Ostseeprovinzen neue Characeen" (Winkler, 1878) is the first to cite the finds by other researchers in the Gulf of Riga (and elsewhere). The species mentioned include *Ch. aspera* Willd. in Kuressaare Bay; *Ch. crinita* Wallr. in Kurland, *Ch. vulgaris*, *Ch. hispida*, and *Ch. baltica* are mentioned as occurring "... in Oesel...", and it is not clear where these species were exactly found. *Ch. baltica* Fr. var. *fasciculata* Fr. was found in the sea. He mentions the abundant occurrence of *Nitella nidifica* Ag. in the coastal waters of Saaremaa and Hiiumaa islands, the frequent occurrence of *Ch. hispida* in Haapsalu and Kuressare bays, and the finds of *Ch. nolteana* Al. Br. (= *Ch. baltica* Fr. var *concinna*) in the vicinity of the islands of Abruka and Vilsandi.

Gobi in his papers on the Gulf of Finland (1874, 1877) presents some data on the algae in Kuressaare Bay. He names the species *Ectocarpus siliculosus* (Dillw.) Lyngbye, *Lithoderma fatiscens* Aresch., *Gobia baltica* (Gobi) Reinke, *Dictyosiphon foeniculaceus* Grev., *Stictyosiphon tortilis* (Rupr.) Reinke, *Chorda filum* Lam., *Fucus vesiculosus* L. + var. *nanus* C. Ag., *Furcellaria fastigiata* Lam., *Phyllophora brodiaei* (Turn.) J. Ag., *Polysiphonia nigrescens* Grev. a *fucoides* Harv., and *Hildenbrandia prototypus* Nardo.

Artzichovskij's series of papers on the dwarf forms of *Fucus vesiculosus* was published in the early 20th century (1902–1903, 1905, 1907). The algae were studied in Kuressaare Bay, where the author considered the dwarf specimens of bladder wrack as degenerated forms. His standpoint was criticized by Elenkin (1906), who maintained that morphological changes in plants had been caused by low salinity and unfavourable environmental conditions. The problem has not been convincingly solved in the world literature as yet.

In the first years of the independent Baltic States (and even before that), Finnish, Swedish, and Danish researchers used to make short field trips to the Gulf of Riga and the area of the West Estonian islands. Svedelius (1902) identified 17 species and forms of algae at the coast of Hiiumaa; Eklund (1927–1928, 1929) made his research at the coasts of Hiiumaa and Vormsi; Häyrén (1929–1930) in the vicinity of Tallinn, Pakri Islands, Ragöarna, Vormsi, Vilsandi, and (1936–1937) at the coast of Saaremaa; Åberg (1933) on the Paldiski Peninsula and the Pakri Islands.

Skuja's (1924) research on the algae at the south and west coasts of the Gulf of Riga was published in *Acta Universitatis Latviensis*. He mentions 7 taxa of *Enteromorpha*, 10 species of Cladophoraceae, 8 species or forms of *Chara*, 3 taxa of *Pilayella*, 3 taxa of *Ectocarpus*, *Sphacelaria racemosa* var. *arctica* Harv., *Stictyosiphon tortilis* (Rupr.) Reinke, 3 taxa of *Dictyosiphon*, *Gobia baltica* (Gobi) Reinke, *Elachista fucicola* (Velley) Fr., *Castagnea virescens* (Carm.) Thur., *Chorda filum* (L.) Stackh., *Lithoderma fatiscens* Aresch., *Fucus vesiculosus* f. *angustifolia* C. A. Ag., *Anfeltia plicata* (Huds.) Fries, 2 taxa of *Polysiphonia*, *Rhodomela subfusca* (Woodw.) Ag., *Callithamnum byssoideum* Arnott., 2 species of *Ceramium*, *Furcellaria fastigiata* + f. *aegagropila* Reinke, and *Hildenbrandia prototypus* Nardo, altogether more than 50 species.

A detailed survey of the bladder wrack and its economic importance was published by Lepik (1925). The distribution of the bladder wrack at the west and north coasts of the Gulf of Riga was mapped. A list of 18 species found in the algae cast ashore was also presented. Two years later Dannenberg (1927) in "Vorarbeiten zu einer Algenflora des Ostbaltischen Gebietes" presented a floristic list that includes the following species: *Enteromorpha intestinalis*, *E. clathrata*, *Cladophora rupestris*, *Tolypella nidifica* a *condensata*, *Chara crinita*, *Ch. aspera*, *Ch. ceratophulla*, *Pilayella littoralis*, *Ectocarpus siliculosus*, *Sphacelaria racemosa* + var. *arctica*, *Chorda filum* f. *pumila*, *Fucus vesiculosus* + var. *angustifolia* + f. *baltica*, *Phyllophora parvula* + f. *angustifrons*, *Polysiphonia violacea* var. *tenuissima*, *P. nigrescens*, *Rhodomela subfusca*, 3 species of *Ceramium*, *Furcellaria fastigiata* + f. *aegagropila*.

Lippmaa (1935) mentions the massive occurrence of *Monostroma balticum* in Kuressaare Bay, where the species occurs partly as a loose sea-floor organism.

A paper by Hasslow (1939) names two algal species in the Gulf of Riga: *Tolypella nidifica* and *Chara tomentosa* L. (= *Ch. ceratophylla* Wallroth).

As already mentioned, in the above publications the authors mostly gave various lists of species, but usually the precise locations of findings and information about the environmental conditions are lacking.

QUANTITATIVE STUDIES

After World War II there was a 15-year period of standstill. On the one hand, it was due to the lack of researchers. On the other hand, under the Soviet occupation access to the seaside was strictly restricted. It was not until the end of the 1950s and the beginning of the 1960s that the first young specialists became engaged in the research on algae. In 1961 T. Pullisaar-Trei published her paper on the bottom vegetation of Pärnu Bay in the *Proceedings of the Estonian Academy of Sciences*. This marks the beginning of the second period of phytobenthos investigations in the Gulf of Riga. The particular studies were started as early as 1959 and they lasted for three years. Since then besides Pärnu Bay the whole northern part of the Gulf of Riga was studied in detail, first by means of dredges

and other technical devices. Since 1961 SCUBA divers have been used, which enabled to initiate quantitative studies, but also to determine algal communities and the biomass of species. These studies resulted in a number of scientific works. Two main publications, based on 15 years of phytobenthos studies, were a book on brown and red algae in the coastal waters of western Estonia (Trei, 1976) and an article on green algae and charophytes in the coastal waters of western Estonia (Trei, 1977), both in Russian. These two works give complete lists of phytobenthos species with distribution maps. Quantitative data and a classification of phytobenthos communities were presented in a dissertation defended in 1973 (Trei, 1973a) as well as in other publications (Trei, 1973b, 1975). The species composition of phytobenthos in western Estonia, including the northern part of the Gulf of Riga, is described also in some other papers (Trei & Kukk, 1974), which in fact repeat the results presented in previous publications.

At the same time some Latvian investigators started to describe the littoral vegetation on the southern coast of the Gulf of Riga. A list of 59 species of different varieties and forms of benthic algae found in the southern part of the Gulf of Riga in 1965–1966 and 1969–1970 is given by Kumsare et al. (1974). Of these 12 forms were blue-green algae (Cyanophyta), 12 diatom algae (Bacillariophyta), 18 green algae (Chlorophyta), 8 brown algae (Phaeophyta), and 9 rhodophyll algae (Rhodophyta). A brief review of the algological investigations in the period starting from World War I carried out in the territorial waters of the Soviet Union, including also the Gulf of Riga, is given by Rudzroga (1974). A bibliography of 72 works is attached including also some works published in the 19th century.

The works dealing with marine benthic vegetation as a commercial raw material may be regarded as a new direction in the phytobenthic investigations in this area. In fact, the first real quantitative estimations of phytobenthos biomass in the region were made for the assessment of potential economic resources (Kireeva, 1960). In 1961 Kireeva published a paper on the reserves of *Furcellaria fastigiata* in the area of Saaremaa and Hiiumaa in the Russian language. A year later, Pullisaar-Trei's paper on the possibilities of using Estonian marine vegetation in the Estonian language appeared in the scientific-technical journal *Kalatööstus* (Fishing Industry) (Pullisaar, 1962). In both these works the main stress was laid on the possibility of commercial exploitation of various species of red algae, mainly *Furcellaria lumbricalis* for agar production. The discovery of vast amounts of loose, unattached red alga *F. lumbricalis* in the area between Saaremaa and Hiiumaa islands was published by Kireeva (1964, 1965a,b). The agar production based on local raw material started in the region in 1967.

Three papers dealing with the peculiarities of the growth of *Furcellaria* spp. in the Gulf of Riga and neighbouring sea areas were published in the 1970s (Blinova, 1971, 1977; Blinova & Tolstikova, 1972).

Of great interest in terms of quantitative assessment of algal communities in the Gulf of Riga is the annual report of the Baltic Department of the All-Union Institute of Fisheries Research and Oceanology from the year 1973 (Kalnozols, 1973). In the chapter on the distribution and ecology of benthic algae in the Gulf

of Riga a detailed description of the habitats on the western and eastern coasts, altogether at a length of 230 km, is given with quantitative estimations of the total biomass of the algal communities (Tables 1 and 2). According to this material, 93.4% of the total macroalgal biomass in this area is formed by *Fucus vesiculosus*. The share of all other species was described as very small.

The most recent data about the distribution of commercially usable red algae communities are presented in a series of publications by a group of Latvian researchers (Korolev et al., 1983, 1991a, 1993; Muravsky et al., 1988; Kuznetsova et al., 1989). These works link the tremendous decline of *Furcellaria* communities in the whole eastern Baltic to the increased oil pollution. Some modern techniques of underwater research such as underwater TV and aerophotography were used during these investigations. In these works also some rough biomass estimations are given. The same group of researchers has published a number of works dealing with the construction and cultivation of artificial reefs in the coastal areas of the NE Baltic Sea (Korolev et al., 1989, 1990, 1991b; Korolev, 1991).

In terms of long-term changes of the structure of phytobenthic communities related to the eutrophication of coastal waters, Pärnu Bay is the best studied area in the Gulf of Riga. Research into the species composition of the phytobenthos in Pärnu Bay was started in 1959 when Pullisaar-Trei took phytobenthos samples at

Table 1. Total biomass of the algal communities in the southern Gulf of Riga (wet weight) according to Kalnozols (1973)

Location	Area, km^2	Mean coverage, %	Biomass, kg/m^2	Total biomass, t
Roja	0.23	60	1.284	295.3
Kaltene	1.65	70	1.820	3 003.0
Upesgrīva	2.76	40	0.720	1 987.1
Mērsrags	4.56	40	1.672	7 624.3
Engure	14.95	50	1.252	18 717.4
Ragaciems	0.38	60	1.584	598.8
Bigaunciems	1.05	50	1.030	1 081.5
Kaugurciems	4.18	60	1.154	4 825.4
Ainaži	3.15	30	0.918	2 891.7
Kuiviži	17.50	15	0.111	1 942.5
Salacgrīva	19.20	50	1.200	22 980.0
Vitrupe	3.20	30	0.780	2 496.0
Kutkajurags	1.44	15	0.201	289.4
Kurmpags	7.20	50	1.780	12 816.0
Latchi	2.34	30	0.738	1 726.9
Sculte	2.10	50	1.070	2 247.0
Saulkrasti	1.20	30	0.624	748.8
Total	87.09			86 271.1

Table 2. Biomass of some species of bottom vegetation in the southern Gulf of Riga according to Kalnozols (1973)

Location	Species						Total
	Fucus vesiculous	*Furcellaria lumbricalis*	*Cladophora* sp.	*Ceramium* sp.	*Polysiphonia* sp.	Other	
Roja	276.0	2.8	11.0	5.5			295.3
Kaltene	2 772.0	46.2	115.5	69.3			3 003.0
Upesgrīva	1 766.4	66.2	88.3	66.2			1 987.1
Mērsrags	7 296.0	73.0	109.4	145.9			7 624.3
Engure	17 940.0	149.5	299.0	299.0	14.9	15.0	18 717.4
Ragaciems	544.3		9.1	45.4			598.8
Bigaunciems	1 050.0		10.5	21.0			1 081.5
Kaugurciems	4 012.8	200.6	301.0	301.0	10.0		4 825.4
Ainaži	2 646.0	189.0	18.9	37.8			2 891.7
Kuiviži	1 575.0	210.0	52.5	105.0			1 942.5
Salacgrīva	19 200.0	1 920.0	708.0	1 152.0			22 980.0
Vitrupe	2 304.0		115.2	76.8			2 496.0
Kutkajurags	259.2		25.9	4.3			289.4
Kurmpags	11 520.0	1 008.0	144.0	144.0			12 816.0
Latchi	1 684.8		28.1	14.0			1 726.9
Sculte	2 100.0	8.4	42.0	84.0	4.2	8.4	2 247.0
Saulkrasti	720.0	7.2	7.2	14.4			748.8
Total, t	77 666.5	3 880.9	2 085.6	2 585.6	29.1	23.4	86 271.1
%	90.01	4.50	2.43	3.00	0.03	0.03	100.00

71 stations in Pärnu Bay and in the surroundings of Kihnu Island (Pullisaar, 1961; Trei, 1976). Sampling was repeated in 1979, 1980, and 1982 at 120 stations (Trei, 1984, 1986). The results obtained were generalized and presented in a book (Trei, 1991). The most recent data are available from the sampling in 1991 made by Kukk and Martin (Kukk & Martin, 1992) at 48 stations.

A useful source of information about algal investigations in the area is a literature review concerning hydrobotanical investigations in the coastal waters of the Soviet Union published by Trei (1982). This work includes 161 references covering both benthic and pelagic investigations, including those in the Gulf of Riga. In the works published during the 1990s, the focus is mostly on the following of long-term changes in the phytobenthic zone of the Gulf of Riga. The drastic changes in the species composition of the whole Gulf of Riga during the last 60–70 years were described by Kukk (1993, 1995, 1996) based on sampling in 1984, 1987, and 1990 and data available from the literature.

Some data about the abundance of various species of benthic algae in the ecosystem of the Gulf of Riga can be found in the work by Laganovska & Kachalova (1990). According to them the total number of species of benthic algae in the Gulf of Riga is 39, which makes it the poorest region in the Baltic in terms of benthic algae. According to the most recent check-list of macroalgae in the Baltic Sea region, published in 1995, the number of species for the area is 49 (Nielsen et al., 1995).

The "Gulf of Riga Project" initiated by the Nordic Council of Ministers in 1993 resulted in two papers describing the quantitative distribution of phytobenthos in the Gulf of Riga (Kautsky et al., 1999; Martin, 1999). The results of these investigations together with data from other national and international projects were used in the PhD dissertation by Martin (2000). In this work the present distribution of phytobenthos is given together with the historical background and analyses of the environmental forcing of phytobenthos communities in the area.

Short-term changes of the phytobenthic communities on the southern coast of Saaremaa Island and in Pärnu Bay are described in the review on the results of the monitoring of phytobenthos communities as a part of the Estonian National Marine Monitoring Programme (Martin et al., 2003). The decline of the bladder wrack community in Kõiguste Bay in the middle of the 1990s is covered by the Fourth Periodic Assessment of the state of the Baltic Sea issued by HELCOM (Martin, 2002). Data on the quantitative distribution of phytobenthic communities in Kõiguste Bay have been published also in a series of ecological investigations carried out in this area (Kotta et al., 2000; Orav et al., 2000; Reitalu et al., 2002). Long-term changes in the distribution of several charophyte species in enclosed sea bays of the northeastern part of the Gulf of Riga are described by Torn & Martin (2003). Series of ecological *in situ* experiments have been carried out in the northern part of the Gulf of Riga (Kõiguste Bay) to study the grazing effect on phytobenthic communities (Orav-Kotta & Kotta, 2003, 2004; Orav-Kotta, 2004).

A comparative list of species of macrophytobenthos ever found in the waters of the Gulf of Riga, based on historical publications and recent findings, is given in Table 3.

Table 3. Comparative list of the species identified from the phytobenthos of the Gulf of Riga by different authors

Taxa	According to			
	Skuja, 1924	Kumsare et al., 1974	Trei, 1976, 1977, 1986	Kukk, 1993
1	2	3	4	5
Rhodophyta				
Anfeltia plicata (Huds.) Fries	+	–	–	–
Asterocytis ramosa (Thwaites in Harvey) Gobi ex Schmitz	–	–	+	+
Polyides rotundus (Huds.) Grev.	–	–	+	+
Callithamnion roseum (Roth.) Lungb.	+	–	+	+
Ceramium tenuicorne (Kütz.) Waern	+	+	+	+
C. rubrum (Huds.) C. Ag.	–	–	+	+
Furcellaria lumbricalis (Huds.) Lamour.	+	+	+	+
Hildenbrandia rubra (Sommerf.) Menegh.	+	+	+	+
Phyllophora truncata (Pallas) Zinova	–	–	+	+
Polysiphonia nigrescens (Huds.) Grev.	+	+	+	+
P. violacea (Roth.) Spreng.	+	+	+	+
Rhodomela confervoides (Huds.) Silva	+	+	+	+
Phaeophyta				
Pilayella littoralis (L.) Kjellm.	+	+	+	+
Ectocarpus siliculosus (Dillw.) Lyngb.	+	+	+	+
Sphacelaria arctica Harvey	+	–	+	+
Sph. plumigera Holmes	–	–	+	+
Pseudolithoderma subextensum (Waern) Lund	+	+	+	+
Elachista lubrica Rupr.	+	–	+	+
Stictyosiphon tortilis (Rupr.) Reinke	+	+	+	+
Dictyosiphon foeniculaceus (Huds.) Grev.	+	+	+	+
D. chordaria Aresch.	+	–	–	–
Eudesme virescens (Carm.) J. Ag.	+		+	
Chorda filum (L.) Stackh.	+	+	–	–
Fucus vesiculosus L.	+	+	+	+
Chlorophyta				
Ulothrix tenerrima Kütz.	+	+	–	+
U. subflaccida Wille	+	–	–	+
U. zonata (Weber et Mohr.) Kütz.	–	+	–	–
Capsosiphon fulvescens (C. Ag.) Setch. et Gardn.	–	–	+	–
Enteromorpha ahlneriana Bliding	+	+	+	+
E. intestinalis (L.) Link	+	+	+	+
E. prolifera (O. F. Müll.) I. Ag.	+	+	+	+
E. pilifera Kütz.	–	–	+	+
Percusaria percursa (C. Ag.) Bory in Dupperrey	+	–	+	–
Chaetomorpha linum (O. F. Müll.) Kütz.	+	+	–	+
Cladophora fracta (Dillw.) Kütz.	+	+	–	+
C. glomerata (L.) Kütz.	+	+	+	+
C. rupestis (L.) Kütz.	+	+	+	+

Table 3. *Continued*

Taxa	According to			
	Skuja, 1924	Kumsare et al., 1974	Trei, 1976, 1977, 1986	Kukk, 1993
1	2	3	4	5
Rhizoclonium riparium (Roth) Harvey	+	+	+	+
Urospora penicilliformis (Roth) Aresch.	+	–	+	+
Oedegonium sp.	–	–	+	+
Spirogyra sp.	+	–	+	+
Zygnema sp.	+	–	+	+
Charophyta				
Chara aspera Willd.	+	–	+	+
Ch. baltica Bruz. em Wahist.	+	–	+	–
Ch. canescens Desv. et Lois.	+	–	+	+
Ch. connivens Salzm.	+	–	–	–
Ch. tomentosa L.	+	–	–	–
Tolypella nidifica Braun.	+	–	+	+
Magnoliophyta				
Myriophyllum spicatum L.			+	+
Najas marina L.			+	+
Potamogeton filiformis Pers.			+	+
P. pectinatus L.			+	+
P. perfoliatus L.			+	+
Ranunculus baudotii Godr.			+	+
Ruppia maritima L.			+	+
Zannichellia palustris L.			+	+
Zostera marina L.			+	+
Schoenoplectus lacustris (L.) Palla			+	+
Sch. tabernaemontanii (C. C. Gmel.) Palla			+	+
Bolboschoenus maritimus (L.) Palla			+	+
Phragmites australis (Cav.) Trin. ex Steud.			+	+

ACKNOWLEDGEMENTS

The present study was initiated and funded as part of the “Littoral” subproject in the framework of the “Gulf of Riga Project” carried out during the years 1992–1997. The authors appreciate the valuable comments made by the project group, including the leader of the subproject Dr. Daniel Conley, and also by Pentti Kangas, Anita Mäkinen, and Hans Kautsky. The work on the updating of the manuscript after a long delay with the publication was carried out in the framework of Estonian governmental programme No. 0182578s03 and publication was made possible with support from grants Nos. 5927 and 5103 of the Estonian Science Foundation. The authors wish to thank an anonymous referee for valuable comments and suggestions.

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Liivi lahe põhjataimestiku uuringute ajalooline ülevaade

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Põhjataimestiku uuringute ajalugu Liivi lahe piirkonnas ulatub juba 18. sajandisse. Kahe ja poole sajandi jooksul on teaduslikus kirjanduses avaldatud suur hulk teoseid nii kohalikes kui Euroopas enam levinud keeltes. Käesoleva artikli eesmärgiks on anda ülevaade põhjataimestiku uuringutest Liivi lahes ja teha inglis-keelsele lugejale kättesaadavaks uuringute põhilised tulemused. Artiklis on refereeritud 85 teaduslikku publikatsiooni, mille põhjal on koostatud ka Liivi lahe põhjataimestiku liikide võrdlev nimekiri.