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BRYOZOA OF THE RUSSIAN SEA SHORE OF THE BALTIC SEA.

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Abstract

The Bryozoan fauna of the Russian sea shores of the Baltic Sea is very poor. In the south-western part of the Baltic Sea were found five species only: Einhornia crustulenta baltica, Electra pilosa dentata, Callopora aurita, Alcyonidium polyoum, Victorella pavida. The first one is registered in the Gulf of Riga, the Gulf of Finland and the Gulf of Bothnia only. Decrease in the number of Bryozoa species having taken place in the sea from west to east is due to a gradual decrease in the salinity in the same direction.

Key words: *Bryozoa, fauna, ecology, barrier salinity, endemic*

1. INTRODUCTION

«It is necessary to notice that nowadays there is reappraisal of present views on biodiversity of brackish and freshwater seas and lakes of our planet. Conception of native and xeno biodiversity of the Baltic Sea, the Black Sea and the Sea of Azov, the Caspian and the Aral seas is continuously expanding and supplemented.

Earlier suppositions that the indicated water bodies cannot be regarded as poor are being justified. Their native and xeno biodiversity are considerably higher than earlier was supposed, but trying to revise obsolescent views one must not carry to an absurdity. Both original native and xeno biodiversity are under pressure of not only changing natural factors (temperature, salinity, etc.) but also anthropogenic ones.

The Baltic Sea is young and being a cold lake in glacial times. It still retains many features of a lake. It is a semi-closed, shallow, brackish water body with a smooth salinity gradient, and unique fauna and flora. The biodiversity of Baltic Sea is relatively low but is also unique.

Rivers play an important role in the water balance of the Baltic Sea. There are oligohaline and mesohaline water zones in the Baltic Sea, each with its own specific flora and fauna. The areas with the most freshwater characteristics are the Gulf of Finland and Gulf of Bothnia. The central water zone of the Baltic Sea has a pronounced mesohaline character. Polyhaline conditions can only be found in

the Kattegat and the Sound. The biodiversity of this young sea was formed in postglacial times.

All the Baltic Sea biodiversity is extremely heterogeneous. The western corner of Baltic, Kattegat, etc. is sharply different from the eastern corner of the Neva Bay. Full–saline marine waters coming from the Northern Sea and their biodiversity have nothing in common with biodiversity of practically fresh water discharged by the Neva River, the Luga and Narova rivers. The central Baltic with its saline conditions and biodiversity also is unlike aforementioned the Kattegat and the Neva Bay. In the boundaries of one sea having arisen only recently on a glacial shield that then became a glacial lake, there are clearly distinguishable three associated microcosms (marine, brackish and freshwater), each one with unique biodiversity» (Aladin, Plotnikov, 2011).

Peculiarities of geographical distribution of different marine invertebrates groups depend on their common organization giving them of more or less possibilities for adaptive changes to appropriate biotopes. Naturally, a mode of distribution, for instance, of mobile animals such as fishes or cephalopods which has capabilities of keen reaction to environmental changes and which can move active to avoid negative influences, is significantly different from distributional pattern, for instance, Bryozoa, adult colonies of which have not a capability to active changing of biotope and they are closely connected to bottom of the sea.

Differences in osmoregulatory capabilities of some groups of invertebrates and in particular of Bryozoa, have influence on a potential in a distribution of different invertebrates groups.

2. MATERIAL

Two Russian papers have described Bryozoa of the Russian sea shores of the Baltic Sea: Knipovich N.M.(1909)–Bryozoa has determined by Kluge G.A. who identified three species for whole sea and E.A. Androsova (1962). The Bryozoan fauna of the Baltic Sea have had not enough description in Russian scientific literature untill Androsova paper (1962) was published.

An abundant collection was gathered by Knipovitch in the Gulf of Finland and near the Aland Islands, Saaremaa and Hiiumaa (the Moonsund or the West Estonian Archipelago), near Liepāja (Libau), along southern marine coast of Sweden and in an entrance of the Sound. The Kurshsky Bay and adjacent regions were unexplored.

Androsova collected Bryozoa in the Kurshsky Bay in the summer of 1961. The collection and her more early bryozoan collection near Tallinn and Narva-Jõesuu of the Gulf of Finland and collections of Pavlovich S.A. (1907 near the Aland Islands), Sadokova A.P. (1909 near Liepāja), Butakova A.I. (Moonsund strait), Kluge G.A. (1955, the Pärnu Bay) have permitted to describe the Bryozoan fauna of these regions. Androsova has described four bryozoan species of coastal waters of above mentioned regions and especially near Rybachy, Zelenogradsk, Svetlogorsk in the Kurshsky Bay and one species in the Gulf of Finland. There are three cheilostomate species and one ctenostomate species between them.

The Kurshsky Bay has water with low salinity which does not exceed 8 ‰. The Bay has shallow depths with average depth approximately 3,7m. The most narrow and shallow part of the Bay is northern one where depths do not exceed 2 м. The deepest part is a region near southern–eastern coast of Rybachy, where depths are 5,5–6,0m. Many rivers flow to the Bay and the largest of them is Neman. An input of fresh water exceeds volume of the bay in four times yearly and a level of the bay is higher than the Baltic Sea level on 12–15cm. A difference of water volumes comes through a strait to the Baltic Sea.

Salinity distribution in the Gulf of Finland is determined by an interaction between river flow (for the most part due to rivers Neva, Narova, Luga) and deep brackish waters of the Bay. General characteristics of salinity regime in the eastern part of the Gulf of Finland are the following (Nekrasov et al., 1997):

– an existence of vertical gradient of water saltiness everywhere except the Neva Bay;

– an increase of salinity from eastern region to western part (especially at upper layers);

– an increase of salinity from northern region to southern part of the bay

Water salinity during a year has noticeable seasonal changes. Spring salinity has minimal value because of ice-melting input. Surface salinity in this period increases from the eastern part toward western one from 0,5–1,8 ‰ near Kroonstad until 4,5–4,7 ‰ in Gogland region. Bottom salinity grows in same direction from 3,5 until 5–6 ‰ (even 7,2–7,6 ‰ in the depth region of 40–50m). In summer a surface salinity increases until 0,5–1,0 ‰, although it is the same value of a salinity as in spring at deeper layers. Vertical mixing equalizes vertical salinity gradient and a salinity increases until 4,9–5,1‰ in surface water of western parts in the Gulf of Finland with respective salinity increase in bottom water layers until 6,7–6,85‰.


Figure 1. To the left–the Koporsky Bay; to the right–underwater landscape in the Saaristomeri

Our samples were collected near Saint Petersburg region in the Koporsky Bay of the Gulf of Finland and represented by only *Enhornia crustulenta baltica*. Other new findings of the same species were collected by finnish researcher in Saaristomeri near Finland.

Androsova has found three cheilostomate species and one ctenostomate species in the Kurshsky Bay: *Einhornia (Electra) crustulenta baltica*, *Electra pilosa dentata*, *Callopora aurita* и *Alcyonidium polyoum*. She has met *Einhornia* (*Electra*) *crustulenta baltica* in the Gulf of Finland only.

Species number decrease has taken place together with decrease from oceanic water salinity to brackish one. Especially interesting are marginal zones. Here is an interosculation of marine and brackish water faunas on the one hand and freshwater on the other hand is pronounced (Remane, 1934, 1969; Remane, Schlieper, 1971; Khlebovich, 1974; Kinne, 1971).

Androsova has divided the Baltic Sea into three parts, which is based on bryozoan distribution: the first is the Great Belt (33 bryozoan species).

Recent German researchers informed of 46 species cheilostomate, cyclostomate and ctenostomate Bryozoa in the western part of the Baltic Sea and of four freshwater species. Nikulina (2008) was described new species *Electra moskvikvendi* for western part of the Baltic Sea and later described new genus *Einhornia* for species with one horn.

Salinity near Lolland and Falster and Møn is 8 ‰ in August only. Five species of Bryozoa inhabit the second south–western region which is characterized by a decreasing of salinity (7–8‰ in August). Two of them are typical brackish water species, i.e. *Einhornia* (*Electra*) *crustulenta baltica* and *Victorella pavida*, the last of them has had an origination in Ponto–Caspian region and later has invaded in the Baltic Sea.

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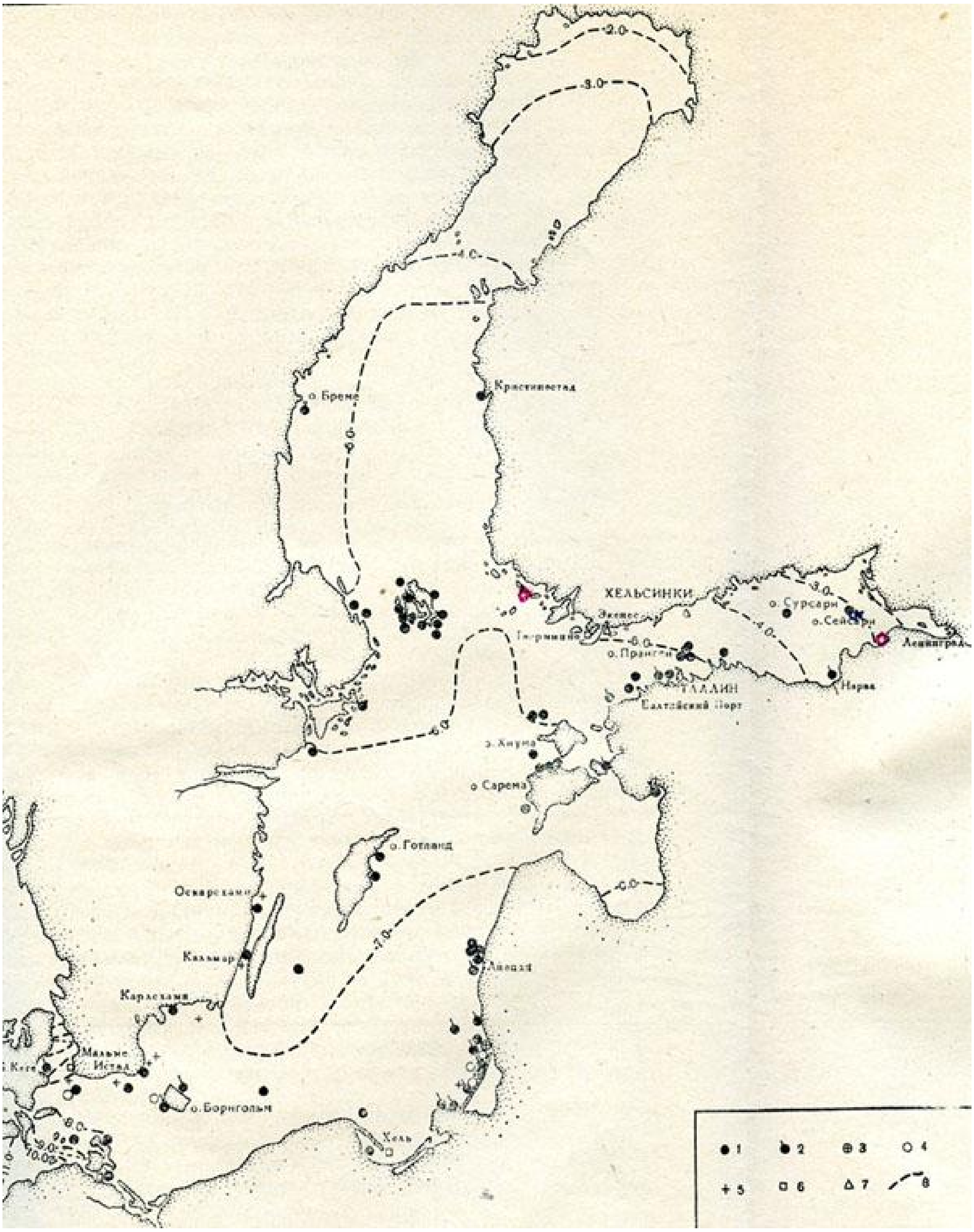

Figure 2. Distribution of Bryozoa in the Baltic Sea (according to Androsova, 1962). Red points show our new findings. 1. *Einhornia crustulenta baltica* (Borg) (in scientific literature); 2. *Einhornia crusrulenta baltica* according to Androsova; 3. *Electra pilosa dentata*; 4. *Callopora aurita*; 5. *Alcyonidium polyoum*; 6. *Victorella pavida*; 7. *Plumatella fungosa*; 8. Salinity in August in upper surfaces layers of Baltic waters.

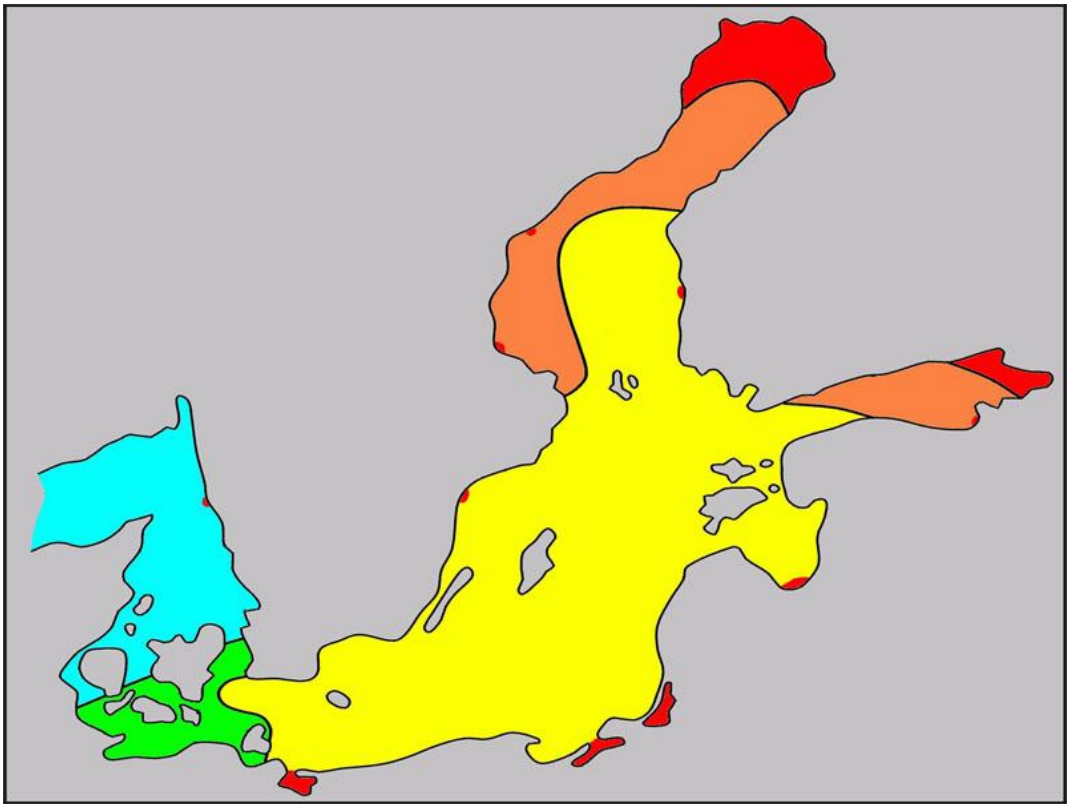

Figure 3. Salinity zones in the Baltic Sea (Aladin, Plotnikov, 2009). 1. Blue color – basic marine (26–40‰); 2. Green color – transitional brackish water–marine (8–26‰); 3. Yellow–basic brackish water (5–8‰); 4. Red color – basic freshwater (0–2‰); 5. Biscuit color – transitional freshwater–brackishwater (2–5‰) (cited by Aladin, Plotnikov, 2011).

The third central region (according to Androsova) of the Baltic Sea with the Gulf of Riga, the Gulf of Finland and the Gulf of Bothnia is characterized by only bryozoan species *Einhornia* (*Electra*) *crustulenta baltica*. The central region of the sea has substantial desalination in comparison with western region. Substantial desalination of this part of the Baltic Sea is confirmed by a penetration to these bays of freshwater bryozoan species *Plumatella fungosa*.

Well–known scientist Segerstråle (1953) has explained a distribution of marine species in the Baltic Sea by gradual increase of water salinity during the last thirty years before 1953. The salinity was extremely high during the 1950s. It then dropped to an all-time minimum in 1992–1993, but is now back at the same level as at the beginning of the century.

«Water salinity is one of major environmental factors influencing on hydrobionts. Finding-out of peculiarities of relation of aquatic animals and plants to this factor is important for understanding both autoecological and synecological laws.

The Concept of relativity and plurality of barrier salinity zones has been formulated more 20 years ago within the school of V.V. Khlebovich (Aladin, 1986). Its substantive theses have been published in «Journal of General Biology» (Aladin, 1988).

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Two main statements have been stated: zones of barrier salinities are relative, on the one hand, to the degree of hydrobionts osmoregulatory capacities perfection and, on the other hand, to the water chemical composition.

All hydrosphere could be divided into freshwater brackish water, marine and hyperhaline salinity zones. Marine zone covers more than 95% of hydrosphere. Portion of freshwater zone is less then 3%.

Portion of brackish water and hyperhaline zones is less then 0.5%. Between these four basic zones there are transitional ones and the portion each of them is less then 0.5%. Approximate boundaries and corresponding barrier salinities for all of these zones are defined.

There are several zones of barrier salinities and they are unequal in their importance.

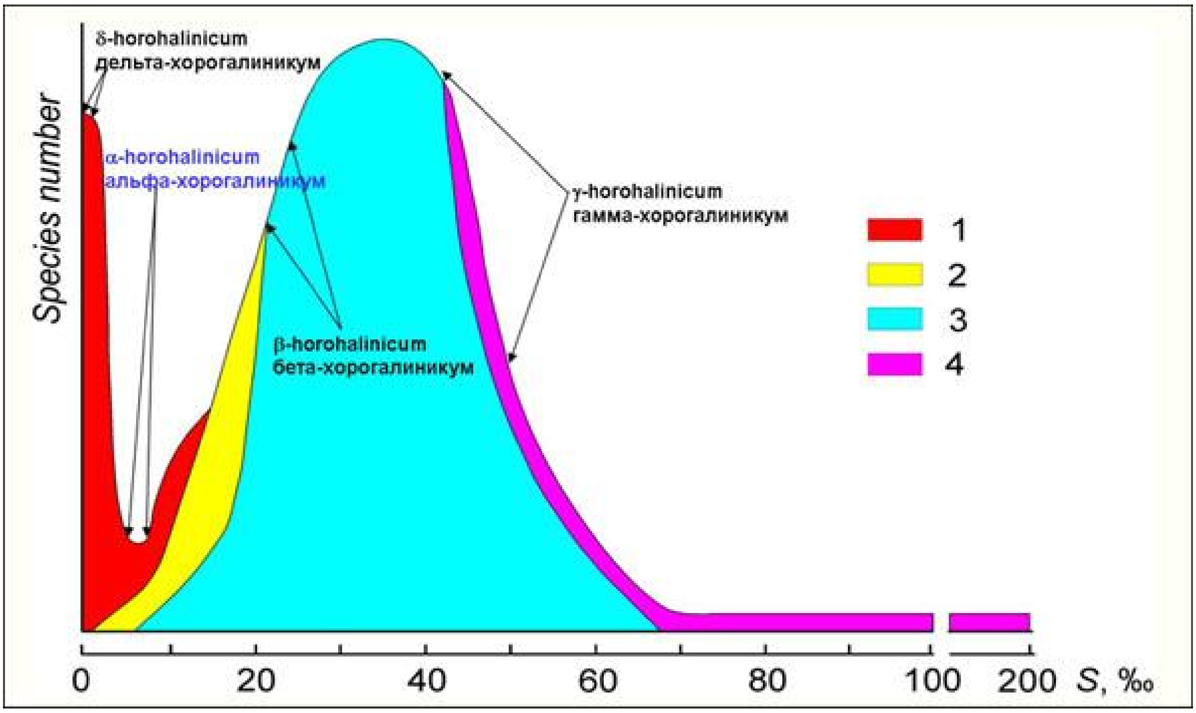

Figure 4. Connection of species number of aquatic organisms with position of barrier salinity zones (cited by Aladin, Plotnikov, 2011) 1 – freshwater, 2 – brackish-water, 3 – marine, 4 – hyperhaline and ultrahaline species

Position and wide of barrier salinities cannot depend only on physicochemical characteristics of aquatic environment. Values of barrier salinities can change with evolution of salinity adaptations and osmoregulatory capacities of hydrobionts (Aladin, Plotnikov, 2011).

«We distinguish between four barrier salinities or horohalinicums for marine and continental waters: α–(5–8‰), β–(22–26‰), γ–(45–50‰) and ™(0.5–2‰). In metamorphized continental waters, barrier salinities are shifted to higher concentrations» (Aladin, Plotnikov, 2009). It is possible to distinguish all three basic and two intermediate zones in the Baltic Sea (Fig. 3). The basic zones are fresh water, brackish water, and marine. The intermediate zones are the following: (5) transitional between fresh water and brackish water; (2) transitional between brackish water and (Legend as Fig.2 and 3).

Table 1. Values for salinity zones of oceanic, Caspian and Aral waters according to basic concept of barrier salinities (Aladin, Plotnikov, 2009)

Zones	Ocean	Caspian	Aral
Basic freshwater	0-2 ‰	0-2.5 ‰	0-3 ‰
Transitional freshwater-brackishwater	2-5 ‰	2.5-7 ‰	3-8 ‰
Basic brackishwater	5-8 ‰	7-11 ‰	8-13 ‰
Transitional brackishwater-marine	8-26 ‰	11-28 ‰	13-29 ‰
Basic marine	26-40 ‰	28-41 ‰	29-42 ‰
Transitional marine-hyperhaline	40-50 ‰	41-50.5 ‰	42-51 ‰
Basic hyperhaline	> 50 ‰	> 50.5 ‰	> 51 ‰

Einhornia crustulenta baltica is extremely interesting species in this point of view.

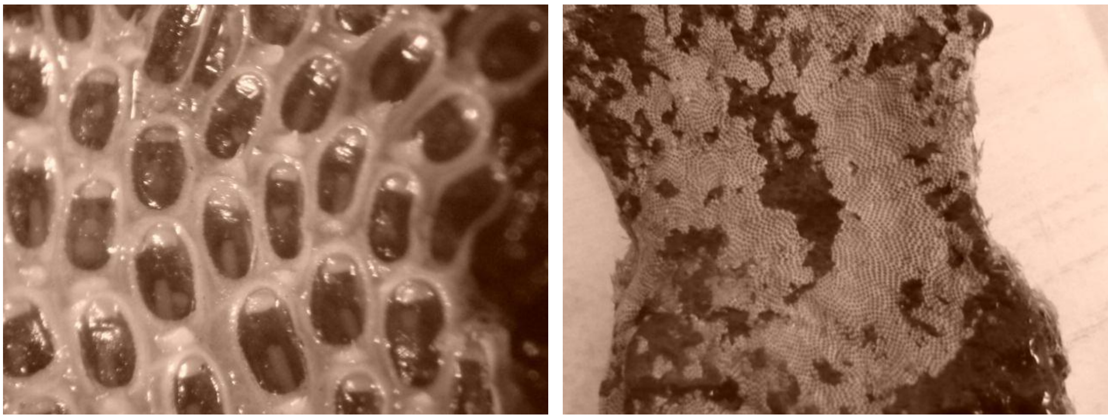

Figure 4. *Einhornia crustulenta baltica.* The Gulf of Finland, the Koporsky Bay (on stone in 2007)

There is only species, which can overcome a α–horohalinicum barrier and can live at salinity lower than 5‰. Perhaps, it is unique species among cheilostomate bryozoa because they are predominant marine group and prefer typically marine conditions of life. Origination of *Einhornia crustulenta baltica* is a question for separate research because it was found in the Arctic Chuckchee Sea and in the Bering Sea in the Far East.

Other typical brackish water species *Victorella pavida* of Ponto–Caspian origin had not overcome the α–horohalinicum barrier as it can see above. Ponto-Caspian fauna evolved over millions of years in a series of large lakes and seas with widely varying salinities and water levels and alternating periods of isolation and open connections between the Caspian Sea and Black Sea depressions and between these basins and the Mediterranean Basin and the World Ocean. These conditions probably resulted in selection of Ponto–Caspian endemic species for the broad environmental tolerances and euryhalinity many exhibit. The Baltic Sea is geologically young and presents much lower levels of endemism. The high tolerance of Ponto–Caspian fauna to changeable environmental conditions, their ability to survive exposure to a range of salinities, and the similarity in environmental conditions available in the Baltic Sea probably contribute to the invasion success of the bryozoan species.

Ecological conditions of life in the Gulf of Finland play a key role in ecological conditions of the central part of the Baltic Sea. Marine Bryozoa can serve as bioindicator species of pure and aerated water.

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TOURISM INFRASTRUCTURE, A PREREQUISITE FOR SUSTAINABLE DEVELOPMENT: CASE STUDY OF THE NATIONAL PARKS OF EVROS, GREECE

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Abstract

The establishment and improvement of infrastructure can result in increasing the efficiency of economic activities in the countryside. In addition, it is an important factor for sustainable tourism around National Parks. Therefore, the visitors' assessment of the local facilities and services can lead us to very useful conclusions about the quality of the experience they receive, and also define the future of the area. The present study was conducted at the National Parks of Evros Prefecture, namely Dadia and the Evros Delta, where the visitors stated their views about the existing infrastructure. A structured questionnaire was used and the cluster sampling method was applied in both cases.The statistical package SPSS was used for the data analysis The results of the study indicate that visitors are quite satisfied with their experience at the National Parks, although the public transport and recreation facilities to proven be insufficient in both cases.

Key words*: Tourism infrastructure, National Parks, sustainable development, Evros, problems and improvement of infrastructure*

1. INTRODUCTION

National Parks offer various types of recreation and sightseeing activities and are a catalyst in attracting large numbers of visitors (Boyd and Hall 2005; Saarinen, 2001). According to Rigall-Torrent and Fluvia (2007, 2011), cultural legacy, public safety, and public infrastructure are some of the social benefits that arise through sustainable tourism development. Intrinsically, tourism development is closely affiliated with environmental (Gerberich 2005; Zeppel 2006), economic (Lemelin & Bennett 2010), social, cultural, political and psychological benefits (Scheyvens, 2002; Zeppel 2006; Butler & Hinch 2007) which are delivered to gateway communities. For this reason, the development and improvement of infrastructure is an essential pre-requisite, in order to address the competition imposed by other equally famous destinations with high visitor numbers (Sheykhi 2009).

The establishment and improvement of infrastructure is one of the most important factors that can contribute to local and regional development. The implementation of development plans and infrastructure improvements can result in reducing production costs and increase the effectiveness and efficiency of economic activities in a rural environment (Shen et al 2012). However, as Elliot (1997) notes, governmental plans and actions are the ones that are able to provide the basic infrastructure for rural development. Moreover, as Reihanian et al. (2012) complement, infrastructure deficiencies are connected with a lack of interest on the part of the local government.

It should also be noted that visitors' views on the local facilities, services and infrastructure provide crucial information about the quality of the experience they receive. The latter leads us to the conclusion, that information data about visitors can contribute to the effective management of National Parks and Protected Areas (Lindberg & Veisten 2012).