The bilateral project “Environmental monitoring of Arctic coastal ecosystems: Sensitivity to petroleum pollution (Arctic EcoSens)” is supported by the Russian Foundation for Basic Research (18-54-20001) and the Research Council of Norway (280724).

EcoSense 2018 meeting. Organizing committee:

Head: Prof. Dr. Andrei I. Granovitch, St-Petersburg State University, Russia. E-mail: granovitch@mail.ru
Paul E. Renaud, Akvaplan-Niva, Norway
Arina L. Maltseva, St-Petersburg State University, Russia
### ECOSENS_2018 MEETING. PROGRAMM

#### 3 October 2018. Wednesday
Volkhovsky per., 3, 4 floor, room 408 (the Graduate School of Management, SPbSU, look at the map below)

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>09:30</td>
<td>Registration of participants</td>
</tr>
<tr>
<td>10:00</td>
<td>Andrei Granovitch, St Petersburg State University: “Greetings and opening words”</td>
</tr>
<tr>
<td>10:10</td>
<td>Dag Malmer, the Royal Norwegian Consulate General in St. Petersburg: “Russia – Norway cooperation in Arctic Region”</td>
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<tr>
<td>10:20</td>
<td>Official greetings from St Petersburg State University</td>
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<tr>
<td>10:30</td>
<td>Paul Renaud, Akvaplan-Niva AS: “EMAP and the path to Arctic EcoSens”</td>
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<tr>
<td>10:50</td>
<td>Arina Maltseva, St Petersburg State University: “Introduction into Russian part of EcoSens_2018: main topics, participants, summer expedition, expected results”</td>
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<tr>
<td>11:10</td>
<td>Paul Renaud, Akvaplan-Niva AS: “Arctic EcoSens, Norwegian part: objectives and work plan”</td>
</tr>
<tr>
<td>11:35</td>
<td>Nina Jørgensen, Norwegian Polar Institute: “Arctic EcoSens and the Russian-Norwegian bilateral monitoring program” (via Skype)</td>
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<tr>
<td>12:00</td>
<td>LUNCH</td>
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<tr>
<td>13:30</td>
<td>Jasmine Nahrgang, Arctic University of Norway &amp; Marianne Frantzen, Akvaplan-Niva AS: “Petroleum effects on early life histories of arctic fish” (via Skype)</td>
</tr>
<tr>
<td>14:00</td>
<td>Mal'tseva Arina, St Petersburg State University: “Littorina snails as indicators for ecological monitoring”;</td>
</tr>
<tr>
<td>14:25</td>
<td>Inna Morgunova &amp; Anna Kursheva, VNIOkeangeologia: “Preliminary results of the aromatic HCs study in soils and sediments collected in and around the city of Tromsø from the shallow water - land transects with different levels of technogenic pollution &amp; plans for further research”</td>
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<tr>
<td>14:50</td>
<td>Elizaveta Gafarova, St Petersburg State University: “Symbiotic microorganisms: compositions, variability and principal constructing factors”</td>
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<td>15:10</td>
<td>COFFEE BREAK and DISCUSSIONS</td>
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#### 4 October 2018. Thursday
Volkhovsky per., 3, 4 floor, room 410 (the Graduate School of Management, SPbSU, look at the map below)

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>10:00</td>
<td>Alexei Bambulyak, Akvaplan-Niva AS: “Aquaculture, oil drilling and shipping: possible risks to marine coastal areas”</td>
</tr>
<tr>
<td>10:30</td>
<td>Frank Beuchel &amp; Sabine Cochrane, Akvaplan-Niva AS: “Modelling the sensitivity of Barents Sea coastal habitats to petroleum pollution”</td>
</tr>
<tr>
<td>11:20</td>
<td>Liudmila Sergienko, Petrozavodsk State University: “Plant coastal biocoenoses of the Norwegian Arctic”</td>
</tr>
<tr>
<td>11:45</td>
<td>Sergei Korsun, St Petersburg State University: “Recent advances in foraminiferal biomonitoring”</td>
</tr>
<tr>
<td>12:00</td>
<td>LUNCH</td>
</tr>
<tr>
<td>13:30</td>
<td>Andrei Sikorski, Akvaplan-Niva AS and Vasily Radashevsky, Institute of Marine Biology: “Cross-border collaboration on polychaete taxonomy” (via Skype)</td>
</tr>
<tr>
<td>14:00</td>
<td>Marina Varfolomeeva, St Petersburg State University “Modelling pollution impacts on populations and organisms”</td>
</tr>
<tr>
<td>14:20</td>
<td>Elena Golikova, St Petersburg State University: “Salt marsh foraminifera next to the polar circle: a baseline study”</td>
</tr>
<tr>
<td>14:40</td>
<td>Dmitry Mikhailov, St Petersburg State University: “Molecular analyses reveal a hidden diversity of salt marsh foraminifera”</td>
</tr>
<tr>
<td>15:00</td>
<td>Roman Ayanka, Egor Repkin, Ekaterina Laskova, St Petersburg State University: “Parasitic systems related to the Arctic coastal area”;</td>
</tr>
<tr>
<td>15:20</td>
<td>COFFEE BREAK and DISCUSSIONS</td>
</tr>
</tbody>
</table>
The meeting place: Volkhovsky per., 3, the Graduate School of Management, SPbSU
SOCIAL EVENTS DETAILS:

03 October, Wednesday.
18:00 Meeting in the vestibule of the “Gostiny dvor” metro-station and moving by bus to the Mariinsky Concert Hall (Dekabristov, 37 / Pisareva, 20);

04 October, Thursday.
18:00 Meeting near the St. Petersburg University main building (Universitetskaya 7/9) and walking to the restaurant (Tamozhenny per., 2);
ABSTRACTS in alphabetical order

Aianka Roman, Repkin Egor and Laskova Ekaterina
Parasitic systems related to the Arctic coastal area
Saint-Petersburg State University, Russia. E-mail: r.ayanka@mail.ru

Analysis of paraxeny is an important issue for understanding of parasitic systems functioning. The ability to infect several hosts’ species in parallel at the certain stage of a parasite life cycle is, on the one hand, a stabilizing factor for a parasitic system, allowing a parasite to use effectively a variety of ecological niches. On the other hand, this contributes to the differentiation of a parasite population due to habitat heterogeneity caused by inequality of paraxenic hosts. Noteworthy, at the populational level, not only host’s physiological specifics affects the structure of a parasite population, but also ecological characteristics: density of populations of paraxenic hosts, age structure, distribution of parasite eggs and larvae, etc. Thus, the presence of paraxenic hosts contributes to the formation of typical structure and dynamics of a parasitic system. Complex approaches are needed to study such systems, invoking analysis of populations, morphology and genetics of parasites.

Another important issue is the impact of anthropogenic pollution on the parasitofauna. Well known that parasites often do not excrete the ultimate metabolic products, avoiding host’s intoxication. For example, during trematodes cercaria stage formation, metabolic products are stored within the bladder as granules. In this way, if pollutants are present in environment, these will be accumulated by parasites, and their presence can significantly affect development of infection, which finally will change structure of parasite population.

In this study, we analyzed parasitic system of trematodes, parasitizing as a first intermediate host intertidal snails of closely related species of the genus Littorina, subgenus Neritrema. This includes two complexes of cryptic species: “saxatilis” (L. saxatilis, L. arcana, L. compressa) and “obtusata” (L. obtusata, L. fabalis). More than 15 species of trematodes are associated with Littorina species.

The study was aimed, firstly, to elucidate the structure of trematodes’ hemipopulations connected with populations of Littorina snails; secondly, to estimate a degree of intraspecific genetic variability within the parahemipopulations of the trematodes Microphallus similis, M. pygmaeus and Podocotyle atomon; thirdly, to assess possible correlations between morphological and genetic variability in example of M. piriformes from different species of host mollusks collected in different geographic locations.

During the expedition 2018 to Tromsø, Norway the snails were collected using standard samples (1/40 m²) from various substrates (stones, gravel, macrophytes) in the different tidal levels of littoral zone. Molluscs were dissected for identification of species, sex and the presence of trematodes infection. The data obtained were statistically processed by a distance based redundancy analysis (dbRDA) to find out environmental factors, affecting the abundance of analyzed species and frequency of occurrence of different parasites in different ecotopes.

Several trematodes species (M. similis, M. pygmaeus and P. atomon) were chosen for analysis of intraspecific genetic variability. Clonal samples of partenites and (meta)cercaria were collected from infected mollusks of different species. To estimate a degree of parasites populations at the genetic level we analyzed a set of molecular markers:
mitochondrial (subunit I of cytochrome oxidase C (COI), subunit I of NADH dehydrogenase complex (NADH)) and nuclear (internal transcribed spacers (ITS1, ITS2) and the arginine kinase sequence (AKin)).

Trematodes *M. piriformes* display a significant degree of polymorphism at the stage of metacercaria, which might be a mark of coexistence of several cryptic species. Trematodes were collected from *Littorina* snails in several geographic locations of the White Sea (Sredny Island, Kandalaksha Bay, Russia) and the Barents Sea (Dalnie Zelentsy, Russia; Kiberg, Norway; Tromsø, Norway) coasts in 2017-2018. The flattened metacercariae were pictures with a digital camera for analysis of body shape variability; washed partenites and metacercaria were fixed in ethanol for further molecular studies. Morphological comparison of the samples was carried out by the method of geometric morphometry using the software tpsUtil and tpsDig (Stony Brook Morphometrics). Samples also were compared on molecular markers, such as the subunit I of cytochrome oxidase C (COI) and the internal transcribed spacers ITS1 and ITS2.

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**Bambulyak Alexei**

**Aquaculture, oil drilling and shipping: possible risks to marine coastal areas**

Akvaplan-niva AS, Fram Centre, 9296 Tromsø, Norway. E-mail: Alexei.Bambulyak@akvaplan.niva.no

Arctic regions, and thus ice-covered waters, are continuously getting higher in the national and international political agenda. The world demand in energy resources and the need in development of new transportation routes are pushing industrial activities up North where we see prospects and expectations on one side, and gaps and challenges on the other. The hydrocarbon resources of the Barents Sea have long been noted as promising and prospective. Now, two fields were put in production in the Norwegian part of the Barents Sea – Snøhvit and Goliat, and one in the Russian – Prirazlomnoye, however, several fields have been discovered and more discoveries expected with implementation of geological studies and exploration drilling. The Barents Sea can be seen as the region of possible conflicts of interests of petroleum industry, fisheries and nature protection. The coastal areas are also prospective for aquaculture (cage farming) development in both Norway and Russia. Increased Arctic shipping, including transportation of liquid hydrocarbons, development of port infrastructure also put a pressure on coastal ecosystems. Environmental management of petroleum, shipping and aquaculture industries in Norway and Russia have similar basic principles, however, there are significant changes in assessing environmental risk and defining environmental damage liability.

The paper will present the status and development prospects of petroleum, aquaculture and shipping business in Norwegian and Russian parts of the Barents Sea, possible risks associated with these developments focusing on oil-spill risks to marine coastal areas, oil spill prevention and response systems, and oil pollution damage assessment approaches applied in Norway and Russia.
The sensitivity of a coastal habitat to any biotic or abiotic stressor is dependent on the interaction among underlying geomorphological aspects of the coast, e.g. depth, wave exposure, and the structural and functional characteristics of the communities present. In the case of petroleum pollution, physical factors determine delivery, accumulation, and persistence of the pollutants in different habitats. Benthic faunal communities are often reliable indicators of organic pollution (Pearson and Rosenberg 1978, Crowe et al. 2004, Johnston & Roberts 2009), and diversity, abundance, and taxonomic structure of the community have been shown to respond in similar, predictable manners to a variety of stressors (Vitousek et al. 1997, Piola & Johnston 2008). Functional traits of community members (motility, feeding type, reproductive strategy, size) can also be useful in predicting recovery post-stress: communities dominated by short-lived, rapidly reproducing and motile species will likely recover from a pollution event more rapidly than communities dominated by sessile, long-lived organisms with a longer reproduction cycle (Pearson & Rosenberg 1978). Thus, biotic characteristics used in conjunction with physical features of the coastal habitat can be predictive of habitat-specific sensitivity to petroleum pollution.

An outline about how we plan to produce a model for a benthic sensitivity index (BSI) for soft- and hard-bottom habitats on coastal areas in Northern Norway and North-west Russia will be presented. The model will be based on earlier work done for Svalbard coastal habitats (Beuchel et al. 2011, Beuchel et al. 2014), which have been used by the Governor of Svalbard to delineate sensitive and valuable marine areas around the archipelago, and in the management plans for east and west Svalbard. We will use biological and physical data obtained from a network of more than 400 soft-bottom stations from across northern Norway and northwestern Russia (Fig 2) collected over a range of spatial and temporal scales. We will also use photographic time-series data from four hard-bottom habitats (Figure 2) that have been sampled annually for up to 40 years, and the results have provided insight into the environmental factors that govern the variations in benthic communities (Beuchel et al. 2006). Both taxonomic and functional traits data from these two data sets will be analysed for trends in community structure and function (Cochrane et al. 2012), and the BSI model will characterize habitats in terms of their sensitivity to disturbance, and in particular to petroleum pollution. For this model, physical parameters provided by NGU and the Coastal Authority, such as substrate composition, shoreline characteristics, grain size, depth, and organic carbon levels will be classified and then ranked according to their sensitivity to oil spills. In combination with the biological data, these data will result in a sensitivity index for each location taking ecological (e.g. areas with high biodiversity or high productivity) and economical (e.g. importance of food resources) as well as taking scientific criteria (areas important for scientific research) into account.

We will assess these results together with our Russian colleagues and adjust the parameters as appropriate. Once we agree on a common strategy, we will together perform the same analyses for the Russian Barents region based on available marine data as well as coastal vegetation data from the project partners. In addition to at last one scientific article, WP1 will produce GIS-based maps indicating relative sensitivity of habitats across the region, suitable for both local and national management purposes.
References


Gafarova Elizaveta

“Symbiotic microorganisms: compositions, variability and principal constructing factors”

Saint-Petersburg State University, Russia. E-mail: orhidea-palma@yandex.ru

Bacterial symbionts are found to be connected with almost any multicellular organisms of any taxon in nature. The co-evolution of such communities lasts for many years. The composition of intestinal symbiotic communities affects many aspects of the normal body functioning. It is already no more considered animals as autonomous creatures, but as a biological system connecting the host’s and its inherent microbes by molecular network called "holobiont", the collective genome of which is the "holologenome". Providing metabolites, that possibly are not coded by host genome, the microflora certainly affects ontogenesis and all the aspects of host physiology.

The importance of bacteria in energy metabolism is profound. Some herbivores, such as termites, do not get enough nitrogen with food, so they maintain nitrogen fixing symbionts. Enzymatic digestion also cannot be done without bacteria, which in addition to increasing the bioavailability of “inedible” food provide proteins neutralizing poisons that reached the gut. Some populations of desert woodrats, for example, eat highly toxic creosote bush. It is mediated by gut microbes: a disruption of the gut microbiota with antibiotics results in their inability to consume creosote toxins.

Bacteria assist a normal embryonic development of both invertebrate and vertebrate species, affecting directly the proliferation of epithelial stem cells and indirectly on the immune system, being a part of developmental bias effect, and thus, evolutionary important.

In vertebrates, the gut microbiota communicates with the central nervous system – through neural, endocrine and immune pathways – and thereby influence brain function and behavior. Germ-free mice demonstrate more aggressive behavior than their “healthy” relatives. Invertebrates are also not devoid of bacterial “zombing”. Nutrients, received be drosophila from food, can be modified by symbionts, and the individuals, feeding in a similar way, have pheromones more accessible to each other and their mating is easier than among groups that fed differently. This affects the behavior of individuals and the structure of the whole population at the same time.
The spread of certain bacteria is different from community to community. The social context also shapes the establishment of mammalian gut microbiota, like in Chimpanzees, in which individuals from the same community have more similar microbiota than with individuals from different communities. The microbiome is heterogeneous: some bacteria are directly transferred from the maternal organism, most are recruited from the environment, and some sustain throughout the host lifetime, and some do not. The multi-component system includes resident bacteria, which necessity may be reflected in the genome, and the environmental bacteria that are temporarily present in the body, and allows symbionts rapidly responding the changes in the host's diet; this implies that the composition of the system can be modified by the environment. Such changes may allow the animal to adapt better or contrariwise to worsen survival in a particular ecological niche.

Gut microbiota thus represents an important source of metabolic flexibility that can allow its host to rapidly acquire an adaptive phenotype under current environmental conditions illustrated by e.g. the bean bug, which has developed insecticide resistance through the acquisition of insecticide-degrading bacteria from the soil. Similarly, in the western rootworm gut microbiota mediates adaptation to human-driven landscape changes. Individuals who are accustomed to feeding in agricultural areas cannot survive in the conditions of wild meadows.

Although molluscs represent one of the most abundant animal taxons, the importance and roles of microbiota for their physiology is still poorly known. On the coasts of the North Atlantic seas there are represented 6 species of the genus *Littorina*, including phylogenetically related species of the subgenus *Neritrema* (*L. saxatilis, L. arcana, L. compressa, L. obtusata, L. fabalis*) which became a model system for ecological, evolutionary, physiological, parasitological studies over the last 30 years. The isolation of some may be associated with ecological speciation.

The qualitative composition of the communities of intestinal microorganisms is expected to reflect the ecological differences of phylogenetically related species of this genus. Our study assumes the analysis of the influence on these microbes such factors as host type, geographical region, season, tidal level at the collection point, sex, age or parasitic infestation as well as presence on some stressors related to anthropogenic pollutions.

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**Golikova Elena**

**Salt marsh foraminifera next to the polar circle: a baseline study**

Saint-Petersburg State University, Russia. E-mail: quinqueloquina@gmail.com

Tidal salt marshes are coastal wetlands that develop in the upper intertidal zone along the wave-sheltered coasts in temperate and high latitudes (e.g., Adam, 1990; Scott et al, 2014). These highly-productive vegetated areas support various habitats and provide shelter, breeding sites and food for multiple invertebrates, fish, birds and mammals. Salt marshes produce large amount of organic matter for the food web. Being prosperous in mid latitudes, coastal salt marshes become scattered and less diverse in subarctic and Arctic regions (Scott et al. 2014). They may shrink to a narrow belt of a few meters across in high latitudes (e.g., Funk et al. 2004). Nevertheless, salt marshes remain very important in ecosystem functioning in high latitudes (for instance, as breeding sites and food for many migratory waterfowls). Due to their costal location salt marshes are very susceptible to various anthropogenic impacts, especially those associated with oil exploration and
transportation. Their location puts them at risk as the petroleum industry develops in the high latitudes.

The White Sea is a subarctic shelf sea situated in the northern European part of Russia. Extensive salt marshes do exist in Onega and Kandalaksha Bay of the White Sea. The present levels of chemical contamination in the Kandalaksha Bay is still very low (Savinov et al., 2000; Berger et al., 2001; Dahle et al., 2006) that allow us to establish a reference site in pristine environments, which can be used later in environmental monitoring studies.

Foraminifera are meiofaunal protists well suited for environmental monitoring due to their diversity, abundance, reproduction rate, and presence of stress-tolerant taxa (e.g., Schönfeld et al, 2012). Being one of the most abundant inhabitants of salt marshes, they can be used in monitoring studies. While in mid-latitudes living assemblages of salt marsh foraminifera have been scrutinized, in higher latitudes they have received little attention.

The aims of the present study were to describe two pristine salt marshes of the Kandalaksha Bay of the White Sea and to characterize pre-impacted assemblages of salt marsh foraminifera. Firstly, we described halophytic vegetation of salt marshes, measured the elevations of salt marshes above sea level and related it to the tidal datums for studied area. Thereafter, we characterized the assemblage structure and spatial distribution of salt marsh foraminifera. This study has documented the pre-impacted state of subarctic salt marshes of the White Sea, thus establishing the reference point. Our data contribute to the further development of salt marsh foraminifera as a tool for future biomonitoring studies in high latitudes.

Jørgensen Nina Mari

Russian Norwegian bilateral environmental work – its relevance for Arctic EcoSens and vice versa

Norwegian Polar Institute, Framsenteret NO-9296 Tromsø, Norway

Norway and Russian have a long joint history related to marine ecosystems, first through harvesting and trade, fisheries and hunting. Scientific bilateral cooperation in the Barents Sea on fishery has been ongoing for over 60 years and scientific bilateral cooperation environment for over 25 years. This collaboration is valuable to both countries, and generates knowledge on our joint sea, the Barents Sea. Both countries value ecosystem based management of marine areas, and see benefits in shared knowledge on important ecosystem components, and the factors influencing these, such as human activities (shipping, petroleum industry).

The last 10 years, the Joint Russian Norwegian Environmental Commission has focused on ocean management as a priority, and Norway has shared experiences with the development and effectuation of the Management plan for the Barents Sea with Russia, see link in Russian here: (http://www.npolar.no/npcms/export/sites/nz/no/arktis/barentshavet/forvaltningsplan/filer/FPB-russ.pdf).

Partners are the Ministry of Climate and Environment of Norway (https://www.regjeringen.no/en/dep/kld/id668/) and Ministry of natural resources and ecology of Russia (http://www.mnr.gov.ru/en/). Monitoring of marine ecosystems is a vital part of the management of these ecosystems, and Russia and Norway decided to work on joint indicators for monitoring of the environment. In 2015 the Environmental Commission
approved the 22 indicators (English and Russian version here: https://brage.bibsys.no/xmlui/handle/11250/280544). Indicators include oil pollution of the marine environment. The Environmental Commission also works on joint valuable areas in the Barents Sea and on overview of human influence on the marine environment. These issues correspond well to issues relevant to Arctic EcoSens as do the effort to involve young scientists, to establish and encourage networks. Arctic EcoSens will produce new knowledge relevant to the commission and should provide targeted outreach on these issues to the Russian and Norwegian partners in the Environmental Collaboration.

Kursheva Anna and Morgunova Inna

Preliminary results on the aromatic hydrocarbons distribution in soils and sediments collected from the shallow water - land transects around the city of Tromsø

Federal State Budgetary Institution “Academician I.S. Gramberg All-Russian Scientific Research Institute for Geology and Mineral Resources of the Ocean” FSBI “VNIIOkeangeologia”, St.-Petersburg, Russia. E-mail: a.kursheva@mail.ru

Information on the aromatic hydrocarbons (HCs) content and distribution in components of geologic environment allows to define an input from both nature and technogenic sources, and to reveal the level of contamination. Considering the wide spread of HCs in geologic environment and the steady geochemical background they form in the lithosphere, the variations in their distribution may be associated with specifics of initial organic matter (OM), conditions of its accumulation and transformation.

In this study we used samples of soils and sediments (4 sites, 12 cores), collected in and around the city of Tromsø from the shallow water – land transects during the scientific-research expedition in July, 2018. The total content of aromatic HCs in the lipid fraction of soil and sedimentary OM were analyzed by spectrofluorimetry using the «FLUORAT-Panorama-02». The resulting spectra and the position of the fluorescence maximum allow indicate significant variations in aromatic HCs distribution and allocate the main two groups of samples with different spectral characteristics.

Thus, the spectral profiles with the position of the fluorescence maximum at 380 nm are usually associated with the polycyclic aromatic HCs in the fuel polluted areas [1]. Such types of spectra were identified in samples collected near the oil loading terminal and in the central part of the city and is likely related with the one-time ejection of pollutants to the environment as a result of human activity. This agrees with the significant increase of the aromatic HCs in the surface sediments and may testify to the input of fresh unoxidized petroleum products (e.g. spent fuels, engine oils etc.).

The study of the conditionally unpolluted sites of the Kvaløya and Tromsø shores that were expected to have background characteristics of HCs distribution has shown the different type of fluorescence spectra. The maximum associated with the light aromatic compounds was detected at 280 nm, the second order peak testify to the three- and pentacyclic aromatic HCs input which may be related with both natural and technogenic sources and should be studied in detail at the molecular level for more precise conclusions. The total content of aromatic HCs here is an order of magnitude lower than in the conditionally polluted areas and is comparable with the recently detected background values of the Barents Sea region [2].
In our future work we plan to focus our attention on study of the molecular composition of HCs in these two types of samples. The detailed information on the molecular markers and biomarkers distribution (n-alkanes, isoprenoids, cyclizes, terpanes, aromatic HCs) will provide us the knowledge about the transformation processes of the OM, reveal the its main sources and estimate the level of human impact on the environment of the region.

**Acknowledgements**

We would like to thank Andrey Granovich and St.-Petersburg State University for the support in organizing the expedition. We also express our special gratitude to Paul E. Renaud and Akvaplan Niva for assistance during the field work. This work is supported by the Russian Foundation for Basic Research and Research Council of Norway (NFR) in the frames of the joint project “Environmental monitoring of Arctic coastal ecosystems: Sensitivity to petroleum pollution (Arctic EcoSens)” (RFBR № 18-54-20001; PETROMAKS2 NFR #280724).

**References**


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**Maltseva Arina**

**Littorina snails as indicators for ecological monitoring**

St-Petersburg State University, Russia. E-mail: arina.maltseva@spbu.ru

Intertidal communities are an integral part of the complex marine ecosystem. Intertidal species are important indicators of ecosystem health, especially in areas subject to environmental threats from municipal and industrial pollution. Periwinkles as common inhabitants of intertidal zones could be used as model organisms for monitoring possible stress-induced shifts in community state. In 2016 we tested a method for assessing the effect of complex anthropogenic pollution on the littoral fauna using proteomic and metabolomic approach. The species composition of littorinid assemblages was described in contaminated and uncontaminated regions. Additionally, *Littorina saxatilis* were collected from upper and lower tidal levels for molecular analyses. GC-MS analysis was performed to evaluate the composition of metabolites and 2D DIGE to detect changes in the proteins profiles. (1) Only *L. saxatilis* was present in the polluted location, while 4-6 species occurred in unpolluted sites. (2) Molluscs under complex pollution significantly differed from the ones of uncontaminated regions at the physiological level (both proteome and metabolome, qualitatively and quantitatively). For example, differences in the expression of immune response proteins, enzymes energy and lipid metabolic and antioxidant response were detected between molluscs from the contaminated and uncontaminated sites. (3) Snails collected from the lower and upper levels of clean locations showed significant physiological differences (both proteomic and metabolomics). On the contrary in a contaminated region, the differences between mollusks inhabiting different levels were almost completely smeared. Probably, physiological changes caused by pollution exceed the adaptive changes associated with habitat at a specific level of the littoral. Moreover, these changes are common for all individuals, regardless of level. Finally, this leads to the disappearance of the difference between individuals living in different levels, as well as intrapopulation physiological diversity. (4) Although the total fecundity of females was not affected in population from polluted locations compared to clean ones; the rate of developmental abnormalities was significantly increased in such populations. This reflects that pollution impacts on coastal area are detectable at the level of whole
community (species composition), particular species populations (efficacy of replenishment) and single individuals (physiology).

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**Mikhailov Dmitrii**

**Molecular analyses reveal a hidden diversity of salt marsh foraminifera**

St-Petersburg State University, Russia. E-mail: Streptocid-mx@yandex.ru

There are several foraminiferal species on salt marshes worldwide. Some of them – *Trochammina inflata*, *Balisticammina pseudomacrescens* and *Entzia macrescens* are described from geographically remote areas. Since the presence of molecular methods in foraminiferal diversity assessment it is clear that at least in some cases species with vast ranges are a complex of several genetically isolated cryptic species (e.g. Hayward, 2004). We investigated phylogenetic relationships for 3 species of mentioned above trochamminid salt marsh foraminiferans, for which we obtained 41 partial SSU rDNA sequences. *Trochammina* is divided in two species, one containing *T. inflata* from the Baltic Sea and the other one consisting of a new, yet undescribed species present in the White Sea. Specimens of *Entzia macrescens* from marshes of the North Sea, White Sea and salt pools of southern Europe are also belong to genetically distinct populations. A combination of overall test morphology and molecular data is necessary for the diversity assessment of this group.

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**Nahrgang Jasmine¹ and Frantzen Marianne²**

**Petroleum effects on early life histories of arctic fish**

¹ Arctic University of Norway, 6050 Langnes, 9037 Tromsø, Norway. E-mail: jasmine.m.nahrgang@uit.no
² Akvaplan-niva AS, Fram Centre, 9296 Tromsø, Norway. E-mail: marianne.frantzen@akvaplan.niva.no

Capelin (*Mallotus villosus*) is a key species in the Barents Sea ecosystem, representing a major food source for several predators in the ecosystem, including cod (*Gadus morhua*), marine mammals, and sea birds. The Barents Sea capelin undertake an aggregated spawning migration to nearshore spawning sites within an area stretching from northwestern Norway to Kola Bay in northern Russia in the period from February to April. Spawning takes place at the seabed in coastal areas (Gjøsæter 1998). Oil spills close to the coast during capelin spawning can be critical for the recruitment as crude oils and petroleum products are toxic to fish, and, in particular, to early life-stages such as embryos and larvae (e.g. Incardona et al., 2004; Sørhus et al., 2015). Previous studies on Barents Sea capelin has shown that the capelin embryo survival and hatching success is significantly affected when chronically exposed to environmentally realistic oil concentrations (40 μg L-1 SUM 26 PAHs) leaking from contaminated gravel (Frantzen et al., 2012), or when acutely exposed to dispersed oil for 48 h just after fertilization (Frantzen et al in prep). Recent studies on polar cod (*Boreogadus saida*) early life stages have revealed that even extremely low concentrations (ng L-1 SUM 44 PAHs) of crude oil water soluble fraction (WSF) affects survival, development and growth in this species (Nahrgang et al., 2016; sens2change: Ongoing project lead by J. Nahrgang). By taking advantage of the experience build up through our previous studies, we will conduct a laboratory experiment at the Barents Ecotox Laboratory (Tromsø, Norway) whereby fertilized capelin eggs will be collected from the field. In order to investigate whether capelin is more or less sensitive to crude oil WSF than polar cod, the same exposure protocol will be utilized, and the same
Endpoints will be studied in capelin larvae as previously studied in polar cod larvae. Embryos will be exposed to ng L⁻¹ concentrations of crude oil WSF and treatment water and subsamples of larvae will be analysed for total hydrocarbon content and PAHs. Hatched larvae size (body length, yolk sac volume) and potential developmental deformities (e.g. pericardial oedema, spinal curvature, craniofacial and body shape abnormalities) will be studied through picture analysis as well as histology (Frantzen et al. 2012; Nahrgang et al. 2016). Cardiac function will be studied according to Incardona et al. (2009). Immunofluorescence and confocal microscopy techniques will be used to detect CYP1A on hatched larvae (Incardona et al 2005). In addition, we will assess swimming activity (speed, turning ability, pattern, etc.) in newly hatched fish (Di-Poi et al 2014).

Subsamples from each treatment and from both the embryo and larvae stage will be analysed by project partners at SPbSU for metabolomics to assess the biochemical pathways that might be linked with the observed effects.

References
Sens2change: https://www.facebook.com/Sens2change/

Sergienko Liudmila
“Plant coastal biocoenoses of the Norwegian Arctic”

Petrozavodsk State University, 33, Lenin Str., 185910, Petrozavodsk, Republic of Karelia, Russia. E-mail: saltmarsh@mail.ru

The exceptional biodiversity of coastal ecosystems presents them like the local sources of sustainability for ecosystems and ecosystem services in Norwegian Arctic. The purpose of the investigation - using an ecosystem approach to identify the specific drivers of pollution and their impact on coastal communities with different types of substrate – silt and rocky-pebble-sand substrate, to establish the “Essential” and “Recommended” species of coastal plants and their communities as bioindicators.

Based on the previously developed classification (Minaeva, Sergienko, etc. 2017) for the coastal zone of the North-Eastern Europe, the following type of habitats (=ecological communities) are highlighted: kelp-vegetated intertidal areas on gravel-pebble substrate, sparsely vegetated intertidal areas on gravel-pebble, salt middle marshes on gravel-pebble substrate, saline sedge-grasses meadows on the mud-clay substrate with organic layer, salt high marshes on gravel-pebble substrate, sandy-pebble-gravel ridges with brackish vegetation, brackish middle marshes on gravel-pebble substrate. Coastal biocoenoses composed of pioneer groupings, single-species communities, few-species and more complex communities, with a distinct mosaic structure.

*Plantago maritima* is an obligate halophyte, hypoarctic Eurasian species, abundant on the coast of the North-eastern Europe have been choosing like a key species. The measurements of structural and functional characteristics of populations of the *Plantago maritima* were done along the tidal gradient on the supralittoral and littoral zones on special plots (transects). Within the transects, the three zones were distinguished, according to the type of substrate and vegetation. Zone I started from the lowest limit of zonal vegetation (from the native coast to the edge of water), which prevailed on the slightly overgrown coastal terraces with turf soils. The lower level of zone I is determined by a stripe of storm sediments. Zone II was situated in 3-6 m from a stripe of storm sediments. The substrate was represented by a turf-covered loam with gravel. Zone III was located in 6-10 m from a stripe of storm sediments. The main substrate was represented by medium loam with silt on the surface of the spots. In each zone, the plant species composition and full geobotanical descriptions on the experimental plots were done.

The preliminary obtained results on the populations of *P. maritima* showed the significant changes in their structural parameters along a tidal gradient from the low supralittoral up to low littoral zones. In fact, the *P. maritima* plants from the zone I in comparison with plants from zones II and III were characterized by the highest values of leaves length, the largest size of the generative organs – the length of floriferous stem, and the inflorescence. In other words, decreased size of plants was observed closely to the minimum level of the low tide. Among the investigated plants within the population of *P. maritima*, the largest differences were found for the plants grown in supralittoral zone, outside the area with the daily floods.

Higher biological variability of *P. maritima* grown in splashing zone without flooding can show that the plants have a well-defined capacity for responses to the changes of abiotic factors and in this zone the plants have the optimal habitat conditions (turf layer in soil, higher cover of codominant species, compared to the another two zones, lower duration under tidal water column).

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*Sikorski Andrey¹ and Radashevsky Vasily²*

**Cross-border collaboration on polychaete systematics**

¹ Akvaplan-niva AS, Fram Centre, 9396 Tromsø, Norway. E-mail: avs@akvaplan.niva.no

² Institute of Marine Biology, A.V. Zhirmunsky National Scientific Center of Marine Biology, Far Eastern Branch of the Russian Academy of Sciences, 17 Palchevsky Street, Vladivostok 690041, Russia. E-mail: radashevsky@gmail.com

The polychaetous annelids (Annelida, Polychaeta) is one of the largest, ubiquitous and dominant (both by biomass, species diversity, and individual numbers) groups in marine macrobenthic communities. This is also one of the oldest groups of marine invertebrates greatly evolved in the Precambrian period. The species composition and systematics of polychaetes from European waters have been studying since early 18th century. From that time, the polychaetes have traditionally been considered as polymorphic, highly adaptive and cosmopolitan organisms. Many species were originally described by European authors who gave an impression of complete knowledge about this group in this region, and led to a great reduction (or complete stop in many countries) of financial support for systematic studies on polychaetes in last decades. At the same time, new sampling techniques, better microscopy and especially use of molecular data gave new insights into the biodiversity on the planet. Careful modern studies repeatedly demonstrate that polymorphic widely
distributed “species” in fact comprise groups of species appearing similar to one another and differing by little features that were neglected in previous studies. For example, molecular analysis of *Terebellides*, a genus of sedentary polychaetes mainly inhabiting continental shelf and slope sediments in North East Atlantic, discovered the presence of more than 25 species of which only seven were formally described. Increasing demand for ecological expertise resulted in a great increase in environmental agencies conducting numerous monitoring surveys all over around Europe. These surveys brought enormous amount of samples and organisms to be analyzed and identified. And one of the most numerous groups are the polychaetes. In our study, we concentrate on one of the largest groups of polychaetous annelids, the family Spionidae Grube, 1850, which comprises over 600 species, currently grouped into about 40 genera. Members of this family are very common in marine and estuarine communities all over the world. Most spionids live on soft bottoms but some bore into sponges, mollusc and barnacle shells, corals and other biogenic calcareous structures, or into non-biogenic hard substrata such as lime-, mud- and sandstones. The population density of tube-dwellers may reach hundreds of thousands of individuals per square meter. Morphological examination of samples collected from Scandinavian waters by the Akvaplan-niva AS, Tromsø, discovered a great diversity of spionids that was not described before. More than 50 species were distinguished based on morphological characteristics. Complexes of similar species and the presence of cryptic species are suggested within the genera *Dipolydora*, *Laonice*, *Malacoceros*, *Scolelepis*, *Polydora*, *Prionospio* and *Spio*. The original 19th century descriptions of spionids from Scandinavian waters were very brief and fit several species recognized nowadays. The main purpose of our study is to re-describe the Norwegian spionids using modern sets of morphological characters and identify them based on morphological and molecular data.

Varfolomeeva Marina

**Modelling pollution impacts on populations and organisms**

St-Petersburg State University, Russia. E-mail: marina.nikolaeva@gmail.com

Measuring pollution effect can be performed at several levels from the biological perspective: community (or even ecosystem), population, and organism. Each level of observation would supply the data with specific statistical properties.

Univariate methods imply analyzing one property of interest at a time. The univariate comparisons of discrete groups (e.g. at different pollution levels) can be done using the methods similar to a simple t-test, or more elaborate like moderated t-test (Ritchie et al. 2015, Smith, 2005, Student, 1908). However, the application of t-test-like methods is limited to the cases when there are distinct groups, balanced on other “nuisance” variables. When it is necessary to account for many covariates, linear models (general, generalized, additive etc.) are more suitable, because they allow to model dependence of a parameter from a set of predictor variables, categorical or continuous (Fox, 2015, Buja et al., 1989, Nelder, Wedderburn, 1972). Linear models may include many different predictors, such as concentration of different kinds of PAH and heavy metals (or their linear combinations derived from Principal Component Analysis). Necessary covariates that must be accounted for are abiotic factors at community or population levels or properties of individuals at the organism level.

Multivariate methods deal with the data in all its complexity: each observation is described by several properties, which are analyzed together. Indirect ordination is a family of
multidimensional methods, which order objects based only on their “internal” properties (Legendre, Legendre, 2012). The methods such as Non-Metric Multidimensional Scaling (nMDS), Principal Component Analysis (PCA) or Correspondence analysis (CA) (Kruskal, 1964, Hirschfeld, 1935, Pearson, 1901) are usually applied for a primary description of the complex multidimensional data in fewer dimensions. Ordination may be followed up by a test of grouping defined according to an external criterion. One possible test is Permutational Multivariate Analysis of Variance (perMANOVA, Anderson 2005). Direct ordination methods order objects according to their multivariate dissimilarity as a function of environmental conditions. Such methods as Canonical Correspondence Analysis (CCA), simple or distance-based Redundancy Analysis (RDA, db-RDA) (Borcard et al., 2011, Legendre, Anderson, 1999, Ter Braak, 1986, Van Den Wollenberg, 1977) serve not only for dimension reduction, but also for building explanatory models and testing hypotheses. They can be used for linking data from different levels of study. Hierarchical classification methods allow to represent multivariate data as dendrograms, based on object dissimilarity (Gan et al., 2007). Reliability of branching pattern can be estimated with multiscale bootstrap (Shimodaria, 2004). Classification methods are used on their own or in combination with ordination techniques to combine the data from different levels. Discrimination methods allow to identify properties that distinguish categories of samples. A combination of ordination and discrimination methods (e.g. sparse Principal Least Squares – Discriminant Analysis, sPLS-DA; Le Cao et al. 2011) can be used to identify proteins or metabolites as potential biomarkers. Geometric morphometrics is a landmark-based approach to studying shape of living organisms. Ordination methods applied to such data allow to study shape variation (PCA; Adams, Otarola-Castillo, 2013, Legendre, Legendre, 2012), and in relation to external (e.g. geochemical, ecological or physiological) data (Adams, Otarola-Castillo, 2013).

The collection of statistical methods allows to perform almost any analysis: from description to inference and visualization. The suitable method can be chosen based on data properties.