Arctic marine fauna: data accumulated in Russia

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Summary.

The Arctic contains the poorest known of the major Oceans, despite a relatively long sampling history. With current observations suggesting that climate change effects are magnified in polar systems, there is a critical need to organize all current and historical data collected in the Arctic to access the impact of such changes on marine life. The project aims to compile into the form of databases all information on marine benthic biota accumulated by Russian scientists over the last two centuries. It is expected to generate the following three databases: 1) Geo-referenced lists of species of Arctic marine free-living invertebrates; 2) Russian expeditions and stations taken in the Arctic (from 1800 to date); and 3) Russian publications on marine Arctic fauna (ca. 500). The project will be executed by three leading institutions in Russia: the Zoological Institute (St.-Petersburg), Russian Academy of Sciences (i), the P.P. Shirshov Institute of Oceanology (Moscow), Russian Academy of Sciences (ii) and the Zoological Museum, Moscow State University (iii). These databases will contribute to collaborative work with scientists studying patterns of marine biodiversity in the Arctic on a larger scale (the *Arctic Census of Marine Life* initiative). From the *Census of Marine Life* perspective of "*Known, Unknown and Unknowable*," the project will contribute to the components "*Arctic benthos: The known*" and "*Arctic pelagic: The known*."

Background. The Arctic Ocean plays a crucial role in the global climate system and biogeochemical cycling (e.g. Gramberg, Romankevitch, 1982; Thiede, 1992). In recent years, attention to the Arctic has grown considerably owing to observed and predicted changes in global climate that appear to be amplified compared to lower latitudes (see *International Arctic Scientific Committee* Project Catalogues, www.iasc.no). Recent global warming in the Arctic Ocean results in shifting of ice-edge to the north, decreasing of sea-ice thickness and surface, and increasing of ice-open areas.

Recent investigations have estimated a decadal loss in Arctic sea ice of 2-3% (Parkinson et al., 1999) and a reduction in sea ice thickness of an average of 1m in the Chukchi and Beaufort Seas (Rothrock, Maykut, 1999). Measurable temperature shifts have been recorded for the Arctic shelf shallow water bodies, the transition zones from sub-Arctic to high Arctic conditions (Hunt, Stabeno, 2002). The dramatic magnitude of these ongoing changes underscores the pressing

urgency for obtaining baseline information on the composition, diversity and functioning of Arctic marine biological systems.

The effects of Arctic climate change are expected to be most pronounced on the shelves but will extend into the deep Arctic Ocean that receives a considerable portion of its carbon from the shelves (Aagaard et al., 1981, Schauer et al., 2002) and from sea ice algal production (Gosselin et al., 1997). Changes in hydrographic conditions (e.g. warming of sea surface temperature, changes of the mixed layer, and reduction in sea ice extent), will have dramatic effects on the timing and spatial distribution of ice-associated and pelagic primary production, and subsequently on the deposition of carbon to the benthos. Changes in carbon supply to the benthos, in turn, will have cascading effects into higher trophic levels, such as marine mammals and sea birds, and, hence, impact the functioning and bio-complexity of the entire system (Moore, 2003). While processes are immensely important, it has been documented repeatedly that they are critically impacted by the composition of biota involved . Consequently, species level information is essential to discussions of climate change, its expressions and effects.

The international scientific community has realized an urgent need for better understanding of processes and increased knowledge of biodiversity of the Arctic Ocean, not only for ecosystem modelling, but because even the baseline information about this part of the world ocean is in a very poor state (e.g. the *Arctic CoML* initiative).

Data on marine Arctic fauna accumulated in Russia over the last two centuries has a tremendous value for establishing the species richness and biodiversity of the Arctic, and examining problems related to global climate modeling.

In Russia, the history of Arctic fauna exploration began more than 200 years ago. As early as the late 17th century, the Zoological Museum in St. Petersburg acquired its first collections from the Barents, Kara and White Seas. Since then, Russian scientists have collected samples from more than 14,000 stations in the Arctic seas, predominately from the Barents and White Seas. The number of samples collected from these stations is several times higher than the number of stations. The majority of the material obtained has been deposited in the scientific collections of the Zoological Institute, Russian Academy of Sciences (ZIN). In total, this collection holds more than 90,000 samples of benthic organisms from the Arctic Seas.

First investigators of marine Arctic fauna used mainly qualitative tools (dredges, trawls, etc.), but since the beginning of the 20th century, researchers have started collecting quantitative samples. The real revolution in quantitative sampling occurred in the 1960s when SCUBA methods were introduced. ZIN applied the first SCUBA methods in the Far East seas, the Sea of Japan, and the Sea of Okhotsk. From 1970 to 1989, ZIN organized several expeditions to different parts of the Arctic: Franz Josef Land (1970, 1981, 1982); the Laptev Sea (1973); Wrangel Island and De Long Strait of the Chikchi Sea (1976); the White Sea (1977-1985); Chauna Bay of the East-Siberian Sea (1986); Jarnyshnaya Inlet of the Barents Sea (1987-1988); the south of Chukchi Sea (1988); the Chukchi Sea and the east of the East Siberian Sea (1989). The SCUBA method allowed study of the previously unknown coastal zone of the Arctic seas down to a depth 20-30 m. As a result of these expeditions, about ten collective monographs on the composition and distribution of Arctic invertebrates and ecosystems have been published (Golikov (ed), 1977; 1985; 1988; 1990; 1994; 1994a; 1994b; Sirenko (ed), 2001).

In the early 1990s, the possibility of closer cooperation of Russian scientists with foreign colleagues appeared. The falling of the "iron curtain" allowed the organizing of several expeditions financed mainly by western countries (Germany, Norway, USA and others). Scientists from ZIN took part in 14 expeditions aboard Russian, German and U.S. vessels. About 1,000 samples at 470 stations were collected during these expeditions.

Rich material, collected during the last years allowed scientists to considerably increase the knowledge on species diversity of poorly studied Siberian seas, such as the East Siberian, Chukchi and Laptev Seas. As a result of seven expeditions onboard the German RV *Polarstern* (1993, 1995, 1998) and the Russian RVs *Ivan Kireev* (1993), *Professor Multanovsky* (1994), *Capitan Dranitzin* (1995) and *Jakov Smirnitsky* (1995), the list of species found in the Laptev Sea alone increased by 400 names. Some of the mentioned and several other expeditions have also worked in other Arctic seas and in adjacent deep waters of the Arctic Basin, which resulted in the addition of many more species to regional species lists.

Extensive studies of the Eurasian (Russian) Arctic seas in the past years has revealed that benthic communities in this region display a depth-related belt pattern. The estuarine communities are dominated by the bivalves *Portlandia aestuariorum* and *Cyrtodaria curriana*. There is a very broad belt of biocenoses in more open waters, dominated by different species of bivalves, such as *Astarte borealis*, *Macoma calcarea*, *Portlandia arctica*, *Leionucula tenuis*, *Nuculana pernula*, *N. radiata* and others. The depth layer between 60 and 700 m is characterized by the dominance

of ophiuroids, *Ophiocten sericeum, Ophiopleura borealis* and *Ophiocantha bidentata*. Depths between 700 and 2000 m are dominated by polychaetes of the families Maldanidae, Chaetopteridae and others. Still deeper, from 2000-2500 m, there is a pronounced dominance of echinoderms: holothurians *Kolga hyalina* and *Elpidia glacialis* and echinoids *Pourtalesia jeffreys,i* with bivalves (*Ciclopecten frigidus*) also present (Sirenko, Piepenburg, 1994; Sirenko, 1998). Further studies are required to examine if this pattern prevails throughout the entire Arctic Basin, and also to complete the full spectrum of the benthic community data by including studies of the meiofauna-sized organisms.

Despite a long history of Arctic sampling, the knowledge of Arctic biota is very preliminary and restricted to certain geographic areas, gear types and size classes. Regular and extensive sampling using modern techniques and approaches is required. The most pronounced gaps exists in terms of the knowledge of deep-water fauna, and the role of organisms of smaller size classes (meiofauna and microbes – if anything, macro- and megabenthos are best studied as described above).

The main aim of the Arctic project is to build into the form of publicly accessible databases information on marine invertebrate species diversity, and the stations sampled by Russian expeditions, to facilitate the efforts undertaken by the international scientific community aimed at understanding patterns of marine biodiversity in the Arctic on a larger scale.

Proposed databases will contribute to collaborative work with scientists studying patterns of marine biodiversity in the Arctic on a larger scale (the *Arctic Census of Marine Life* initiative). From the *Census of Marine Life* perspective of "*Known, Unknown and Unknowable,"* the project will contribute to the components "*Arctic benthos: The known*" and "*Arctic pelagic: The known*."

Most of the Russian data remains unknown and inaccessible to the wider scientific audience in the west, because it was published only in Russian, often in grey literature, and part of the material still remains unprocessed in the collections. There is also a real danger of the loss of taxonomic expertise and information collected by retiring scientists. There is an urgent need in archiving these data, especially under the present general conditions for a science in Russia with an extremely low budget and 'aging' of scientists.

Objectives. The project focuses on compiling various data on marine Arctic fauna into databases. The following three components/databases are expected:

1. Geo-referenced list of species of Arctic marine free-living invertebrates.
2. Russian expeditions and stations taken in the Arctic (from 1800 to date).
3. Russian publications on marine Arctic fauna (ca. 500).

Partners, roles and material. The project is being implemented by three institutions in Russia:

1) Zoological Institute (ZIN), Russian Academy of Sciences (St.-Petersburg) (Group leader Dr. B.I. Sirenko, a group of 9 in total)
2) P.P. Shirshov Institute of Oceanology (IORAS), Russian Academy of Sciences (Moscow) (Group leader Dr. A.V. Gebruk, a group of 6 in total), and
3) Zoological Museum (ZM), Moscow State University (Moscow) (the only participant is Dr. D.L. Ivanov).

ZIN has long-standing experience working in the Arctic seas. It has accumulated a tremendous amount of information on Arctic biota, with records dating as far back as the early 18th century. It is expected that the database will include all information from 50 Russian expeditions to the Arctic, 5,000 stations and 4,700 species of marine free-living invertebrates. ZIN will mainly undertake computing components of work, but some taxonomy is expected.

IORAS, traditionally working in deep waters, has accumulated substantial data and material on the benthic fauna of the Norwegian and Greenland Seas, and in part data on the biota of the central Arctic basin. This information will be included in the common database, including information on about 550 stations plus lists of species of selected benthic taxa (echinoderms and bivalves). IORAS will undertake both taxonomical work and computing activities.

Substantial information has also been accumulated in the ZM, mainly due to the presence of taxonomical collections and expertise in certain groups. For the purpose of this project, it is expected to focus just on just one taxon, the Scaphopoda, which has about 720 records in the Arctic. ZM will undertake mainly computing components of project.

Dr. Andrey Gebruk (IORAS) will coordinate the project.

Database format and content. The ZIN group has published the taxonomical part of their database in a species list (Sirenko, 2001). In the new database, species names will be related to station data (coordinates, depth) and a specimen number. Some species identifications will be clarified and a portion of a new material also will be processed. At present, available information exists in the form Data Base Files (DBF) linked with Information Retrieval System (IRS) in FoxPro for Windows. Station database will include the vessel name, expedition number, station number, date, depth, coordinates and gear used. The final format of databases will be compatible with the ArcCoML database group and linked to OBIS. The IORAS and ZM components of databases will be generated new in accordance with agreed format.

Arctic Census of Marine Life Initiative (ArcCoML). The project compleiments the *Arctic Census of Marine Life Initiative* (PIs B. Bluhm, R. Gradinger and R. Hopcroft). Results of the project also will be of interest to other CoML projects, e.g. HMAP, FMAP and MAR-ECO.

Main scientific questions. An extensive database on Arctic benthic fauna will be a powerful tool for modeling the Arctic marine ecosystem and addressing a variety of biogeographical and biodiversity problems, such as 1) species richness in the Arctic (compared to neighboring regions), 2) areas of low/high biodiversity, 3) species composition along the depth gradient, 4) level of endemicity of Arctic fauna, 5) biogeographic barriers, 6) biogeographical history of the Arctic fauna, and a variety of other questions. It is expected that the databases will be used for an analytical analysis jointly with the ArcCoML community after completion of the data entry phase.

Implementation and work plan. The project is expected to last 15 months (beginning in September-October 2004). For the ZM group, the project will comprise one major phase with main activities including data compilation and computing (Table 1). For the ZIN and IORAS groups, two phases of work are planned: i) taxonomical work (processing of existing material, species identification and clarification) and ii) computing. At the end of the project, a web page with a list of species of Arctic free-living invertebrates (Database 1) will be prepared (presumably at the web site of ZIN and on the ArcCoML portal).

Table 1. Main activities during the project and a timeline (A - data compilation and computing; B- taxonomical work (processing of existing material, species identification and clarification); C- preparation of the web page).

Months	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
ZM	A														C
ZIN/IORAS	B						A								C

The project will start with a short meeting at ZIN of the three group leaders to discuss a work plan, existing sets of data, to avoid overlaps and maximize a combined effect. A short meeting of PIs is also scheduled at the end of the project to check and polish combined results.

Report on progress will be prepared after 7 months to show the results of the taxonomical work and the agreed format of the database.

Outreach. The list of species of Arctic free-living invertebrates (Database 1) will be made available on the web at the web site of ZIN.. Other outreach activities will be carried out in collaboration with the ArcCoML office.

Communication with CoML and ArcCoML. Activities within the project will be reported to the CoML secretariat, results will be discussed with the ArcCoML group and presented at the CoML and ArcCoML workshops and meetings. The generated databases will be used jointly with the CoML scientists.

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