Molluscs from Arctic Region at the National Museum of Natural Sciences collections (MNCN-CSIC, Madrid, Spain)

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Abstract

The Mollusca Collection of the National Museum of Natural Sciences (MNCN, CSIC, Madrid) contains some specimens from the Arctic Circle, exactly 38 lots including historical collections, which may provide insights to climate change research. Some of these collections refer to those of the Head of the Scientific Commission of the Pacific**,** the mariner and naturalist Patricio Paz y Membiela (accessioned in 1873), and the malacologists Joaquín González Hidalgo and Florentino Azpeitia (accessioned in 1913 and 1934 respectively). Recently there has been a donation from the collector and diplomat Javier Conde de Saro which was accessioned in the MNCN in 2011 and a collection of the curator of the Mollusca Collection, Rafael Araujo, of 2010. These specimens belong to 26 species (15 marine and three freshwater gastropods; six marine and one freshwater bivalves; and one polyplacophoran) from places such as Kola Peninsula, Greenland and Novaya Zembla; and Russian Arctic waters. All of these specimens have been databased and are an important contribution to global research as mollusc are heavily affected by temperature changes and ocean acidification.

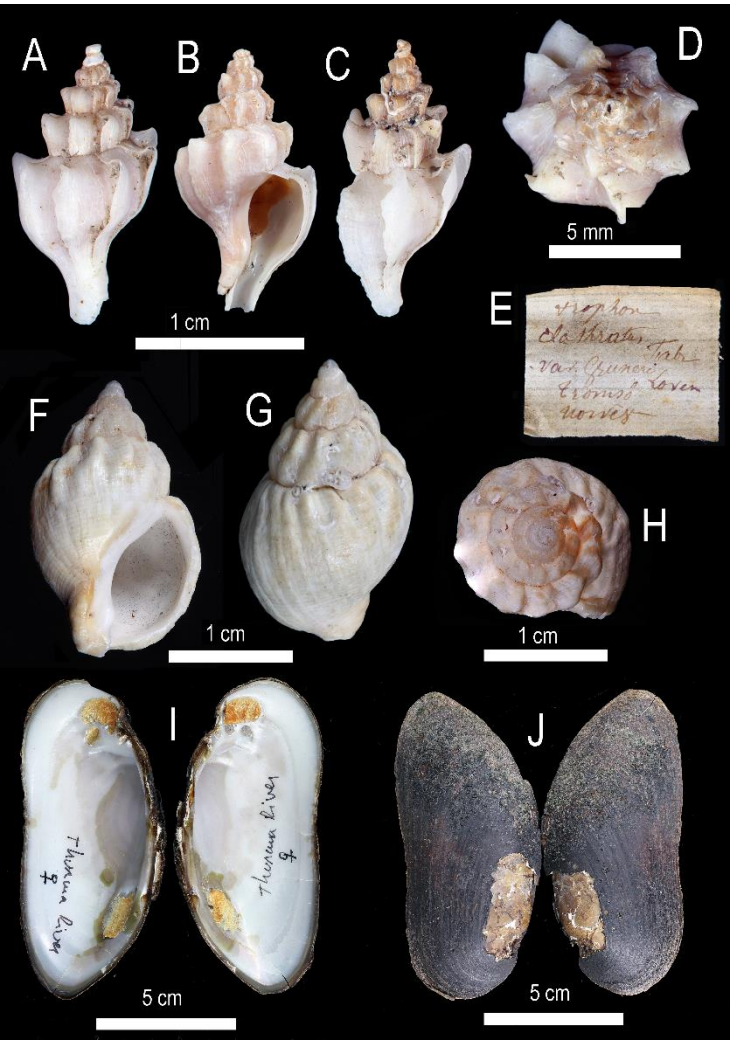
Key words: Extant Mollusca, Arctic, National Museum of Natural Sciences (CSIC, Madrid), marine, freshwater, climate change.

Introduction

Mollusca is one of the most diverse groups of animals and the second largest animal phylum after the Arthropoda. Estimates of all living molluscs range from near 50,000 to 200,000 species (Groombridge & Jenkins, 2002; Chapman, 2009: Rosenberg, 2014; Matoo & Neiman, 2021). Besides their diversity in body form, molluscs also exhibit a wide range of physiological, behavioural and ecological adaptations, and they have evolved very diverse lifestyles enabling them to live in almost every habitat (marine, terrestrial and freshwater) except free flying in the atmosphere. They are often one of the more conspicuous groups, sometimes predominant in some biological assemblages, and display an extremely diverse feeding habits (Ponder et al. 2020). Therefore, they play an important role in all levels of the food webs, being ecologically important, providing essential ecosystem services such as habitat structure for benthic species, water purification and a food source for other organisms (Gazeau et al., 2013). Because their shells preserve well, shell-bearing molluscs have an extensive fossil record and some putative

molluscs first appeared in the fossil record of the early Cambrian (about 520 million years ago). Besides their economic importance (as a source of food and other human resources), molluscs have provided valuable scientific insights into very biological disciplines, including climate change research. Global climate change is progressing at an unprecedented rate, with important consequences for all ecosystems.

A critical question in this scenario is whether and how natural populations will respond to global climate change, and whether these responses will be fast enough and adequate for species persistence (Waldvogel et al., 2020). Natural history collections, present in worldwide museums and research institutions, provide a valuable resource for climate change research (Pyke & Ehrlich, 2010). They can provide information such as the extinction rates of different species and shifts in their geographical distribution in response to climate change. These collections contain billions of specimens collected over the last two centuries, each of which bears potential witness to past ecological conditions and irrefutable evidence of historical biogeographical distributions (Krishtalka & Humphrey, 2000). In cases of endangered fauna, the role of natural history collections is essential, being the last repositories where scientists can study extinct or endangered species (Shaffer, Fisher & Davidson, 1998). A specimen belonging to a natural history collection with associated data (locality, collection date, context, etc.) is an unequivocal record of the presence of a taxon in a specific place at a specific time. The fact that the Arctic Circle is beginning to thaw will make it navigable, which will speed up the thaw and the loss of diversity with even more migrations of Pacific and Atlantic species into the Polar Circle than the current already present there. It is therefore essential to study its Arctic fauna and climatic conditions to help to foresee possible consequences and try to mitigate them. As molluscs form one of the most abundant and diverse group of organisms and their major component of the shell composition is calcium carbonate, the ocean acidification, which depends on CO2 capture from the atmosphere, may impact in ocean chemistry and on the shell production of marine shelled molluscs (Parker *et al*., 2013).



The MNCN has Arctic specimens (Figure 1) of at least 26 species including the classes Bivalvia, Gastropoda and Polyplacophora from marine and freshwater

environments never published previously. The first specimens collected date from the end of the 19th century, making them valuable for climate change studies. Most of the latest specimens collected in the last 20 years have been preserved in ethanol and some frozen for DNA studies. Their data are on GBIF with all MNCN Mollusca data and also easily discovered on Zenodo (https://zenodo.org/) as Arctic specimens housed at the MNCN-Madrid.

Figure 1. A-D different views of *Boreotrophon clathratus* (Linnaeus, 1767), MNCN 15.05/93882, from Tromsø, Norway. E. Original label of 1913 with previous identification of A-D. F-H different views of *Buccinum ciliatum* (Fabricius, 1780), MNCN 15.05/33692, from Greenland, Denmark. I-J. Internal and external views of left and right valves of *Margaritifera margaritifera* (Linnaeus, 1758), MNCN 15.07/7108, from Thurma River, Umba, Kola Peninsula, Russia. CC BY-NC 2.0.

Only two species of those present in the MNCN collections have a restricted polar distribution and the rest have a worldwide distribution in temperate coasts. The polar subspecies *Ladislavella catascopium vahlii* is endemic of west Greenlad (Vinarski et al., 2017). The specimens in the MNCN belong to the historical collections, collected before 1873. The boreal Arctic species *Neptunea communis* is typical from Chukchi Peninsula (Herman, 1989), also found in west Novaya Zembla as the MNCN specimen.

Finally, the other species present in this Collection are of temperate climate and one of them, assuming the identification of the specimen is correct, the hydrobiid *Peringia ulvae*, can be also found in tropical areas such as Senegal, and it is considered an invasive species in northern waters, and it is tolerant high salinity.

Collection history and temporal coverage

The first 13 specimens from Arctic were accessioned in the MNCN in 1873, given by the Head of the Pacific Scientific Commission (the latest large Spanish scientific expedition, 1862-1865, during the reign of Isabel II Queen of Spain), the mariner and zoologist Patricio Paz y Membiela (1808-1874). His comprehensive collection was bequeathed to the MNCN (Figure 1 A-E with some specimens and original label) for a symbolical fee. Paz y Membiela was awarded the Grand Cross of Elizabeth the Catholic in 1867, in recognition of his work in the Navy and the Pacific Scientific Commission. From that date he devoted to the study of molluscs and to increase his collection, many times by exchange with other naturalists. In 1871 he was a founding member of the Spanish Society of Natural History. His Arctic specimens (almost 13% of the Arctic MNCN molluscs, Figure 2) are mainly marine and freshwater gastropods, which were probably exchanged with other naturalists as it is not recorded he travelled to the Arctic.

In 1913, a few Arctic marine and freshwater gastropods of the collection of the MNCN curator Joaquín González Hidalgo (1839-1923) were accessioned in the MNCN (almost 7% of the Arctic molluscs). González Hidalgo was Director of MNCN between 1900 and 1901 and a Member of the Royal Academy of Exact, Physical and Natural Sciences. In 1931 and 1934, a few more marine gastropods (3%) of the Francisco Prieto Caules (1841-1889) and Florentino Azpeitia (1859-1934) collections were donated to the MNCN. The specimen given by the Civil engineer Francisco Prieto Caules in the 19th century (donated in the 20th century) is the muricid *Nucella lamellose*, typical of northeastern Pacific and Arctic. The specimens donated by Azpeitia are not identified.

The rest of the collection (> 77%) has been recently collected in the last quarter of the 20th century and incorporated into the Mollusca Collection in the last 13 years (Figure 2). Collectors of these recent acquisitions have been the MNCN mollusc curator Rafael Araujo (1960-2021), the diplomat and naturalist Javier Conde de Saro and Rafael Muñiz Solís. Conde se Saro collected and bought molluscs from 1970s to 2000s. He lived in the north of Africa, and South America where he sampled molluscs. In the case of Muñiz Solís, his collection was made in the south of the Iberian Peninsula and north of Africa between 1950s and 1970s. Therefore, their Arctic specimens were bought or received in exchange.

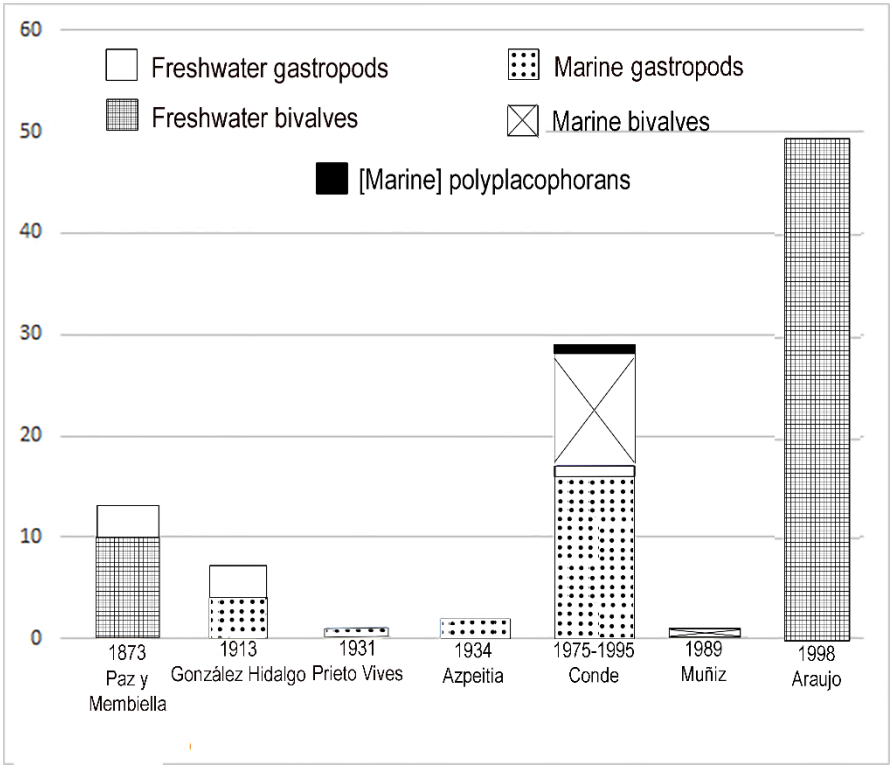


Figure 2. Distribution of the different Arctic mollusc collections by collector and year of collection.

Taxonomic coverage

A total of 102 specimens, of 38 lots, represents 19 families (Figure 3) of gastropods, bivalves and polyplacophorans from freshwater and marine environments. Most of them, 94%, are identified to species level with updated taxonomic identifications following WoRMS (World Register of Marine Species) and MolluscaBase classification and taxonomy and some specific publications.

Almost half of the MNCN Arctic specimens (49%) are freshwater mussels, which were collected by Araujo (Figure 4) in 1998 during a European sampling campaign led by the Russian zoologist Valerij Zyuganov (Araujo, 2000). Some of them were preserved in ethanol and others frozen in order to study their DNA.

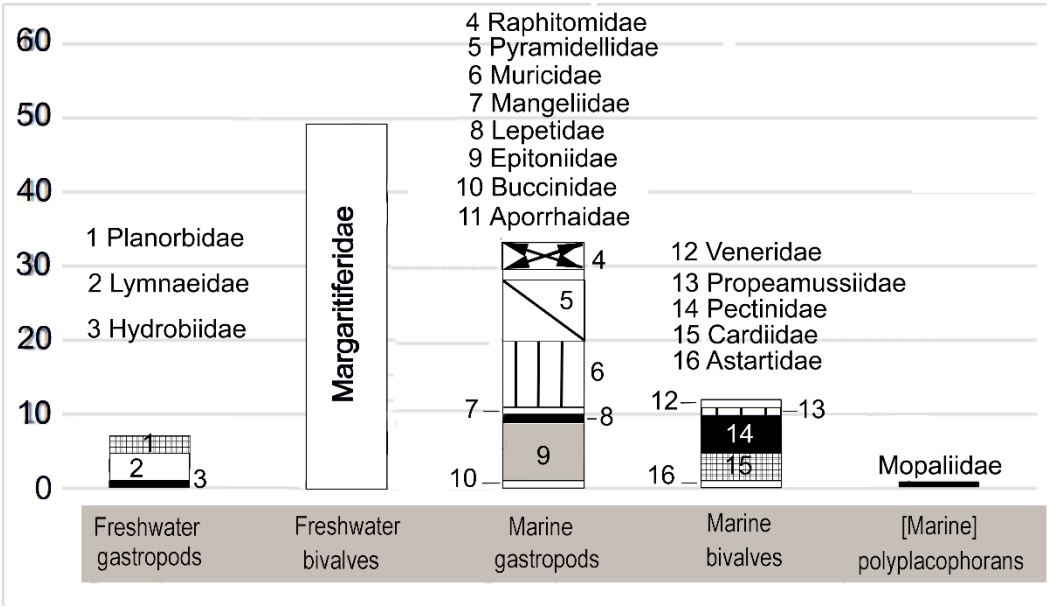


Figure 3. Distributions of the MNCN molluscs by families and group and habitat. Freshwater mussels margaritiferids are the most common, followed by marine gastropods belonging to the families Mangeliidae, Muricidae and Buccinidae as the most abundant. Legend of each family on the column graph where there is representation. CC BY-NC 2.0.

Figure 4. Rafael Araujo during the zoological sampling campaign of 1998 collecting in Kola Peninsula. CC BY-NC 2.0.

Collection preservation

There are 49 specimens which their soft parts are preserved in ethanol (mostly 70% ethanol, 30% water or with absolute ethanol) and the rest (53) are dry specimens. Some buccinids are accompanied by their corresponding opercula. One fifth of these specimens are preserved frozen.

Geographic coverage

Regarding the geographical information (Figures 5-6), half of them come from Kola Peninsula, Russia. They are margaritiferids collected by Araujo in 1998, containing samples with DNA. The following site with more specimens is Tromsø, Norway, with 17% of the specimens between marine bivalves (Cardiidae

[22.2%]) and marine gastropods (Mangeliidae [50 %], Muricidae [16.6%], Pyramidellidae [11.1 %]) from the Conde de Saro Collection is their majority. In the case of Greenland (over 14% of the Arctic molluscs) are gastropods (freshwater 60%, marine 40%) from historical collection, mainly from the 19th century.

The rest of the localities are represented in less proportion. Lofoten archipielago, Norway, with almost 7% of the specimens are distributed between marine bivalves (8 specimens) and a polyplacophoran, mainly of the Conde de Saro Collection. There are three marine gastropods (almost 3% of the collection) from Barents Sea of the Conde de Saro Collection. two marine gastropods have been collected from White Sea, Russia, another two from Davis Strait (between Greenland and Baffin Island, Canada); and two marine bivalves from Svalbard, Norway.

Individual specimens are those from Lodingen, Norway (freshwater gastropod); Novaya Zembla, Russia (marine gastropod); Bering Sea (Buccinidae); and from an unknown Arctic locality from the Prieto Caules historical collection (Muricidae).

None of the Arctic specimens have geographic coordinates recorded. Although the exact place where the specimens have been collected is not known, the MNCN digitisation team will geo-reference all the MNCN specimens automatically, in the next Museum digitisation step, allowing it to acquire point and extent data from Google Maps.

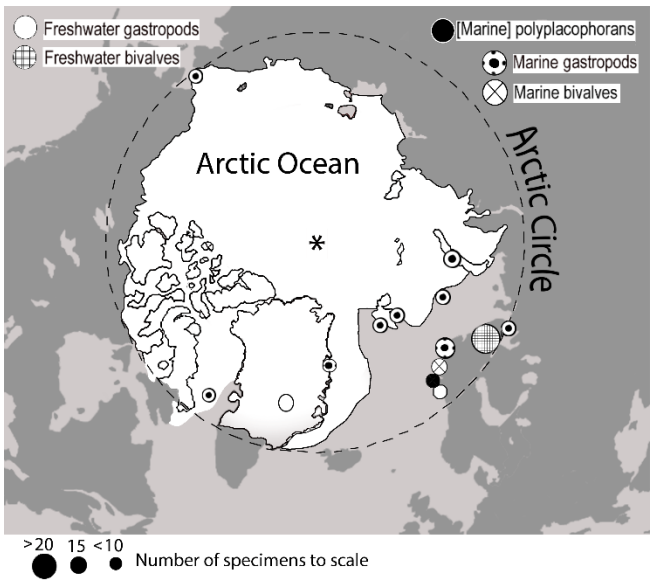


Figure 5. Bubble map with sampling localities and mollusc abundance.

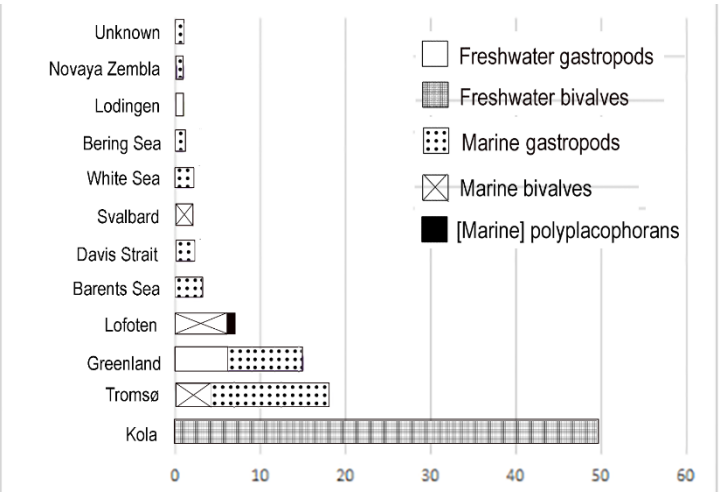


Figure 6. Bar chart showing abundance by localities and habitat of each class.

Discussion

The fact this Collection keeps historical specimens, which are only from the Arctic Circle, make it useful for comparison of the Arctic present-day representatives to the historical ones of the same species, in order to study their shell chemical composition, morphology and DNA. Differences between both representatives, historical and present-day ones, may help with understanding how their habitat has changed. It is possible that these species have adapted to their environment over time. Then their shells will display differences and their DNA will be also affected.

The rest of the specimens are representatives of species that are also present elsewhere. In the case of some historical specimens this may mean that some specimens were already adapted to live in colder climates than the ones they used to live or they could be native to the Arctic as well. They could have migrated with marine currents or more rarely through the anthropocenic action. One of these species is the freshwater pearl mussel *Margaritifera margaritifera,* which is very sensitive to pollution, habitat modification or disturbance, and considered an environmental indicator (Santos *et al*. 2015). This was probably the most abundant bivalve in ancient rivers all around the world. It was already present at the middle of the 19th century in Kola Peninsula. This species exclusively inhabits cold running waters with low mineralization (Bolotov et al, 2019). Nowadays, it is threatened and recorded in the IUCN Red List of Threatened Species. As the MNCN Collection keeps the soft body of some *M. margaritifera* specimens frozen, which were collected more than two decades ago, makes them a good resource for DNA research. On the other hand, their shells make another important resource as their morphology convexity has changed over time.

Conclusions

The MNCN Arctic Mollusca Collection contains more than one hundred specimens belonging to at least 26 species. Only two species of those present in the MNCN collections have polar distribution and the

rest have a worldwide distribution mainly in temperate areas. One of these species, *Peringia ulvae*, is also found in tropical climate, which may reflects the warming of northern waters already in 1975. There are also 49 specimens of the *Margaritifera margaritifera*, an environmental indicator, which was sampled several decades ago with the most recent preservation techniques, such soft body preservation for DNA studies. Therefore, this collection may contribute to a better knowledge of the Arctic mollusc fauna, its evolution and species replacement.

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