A DNA analysis of ballast water detects invasive species

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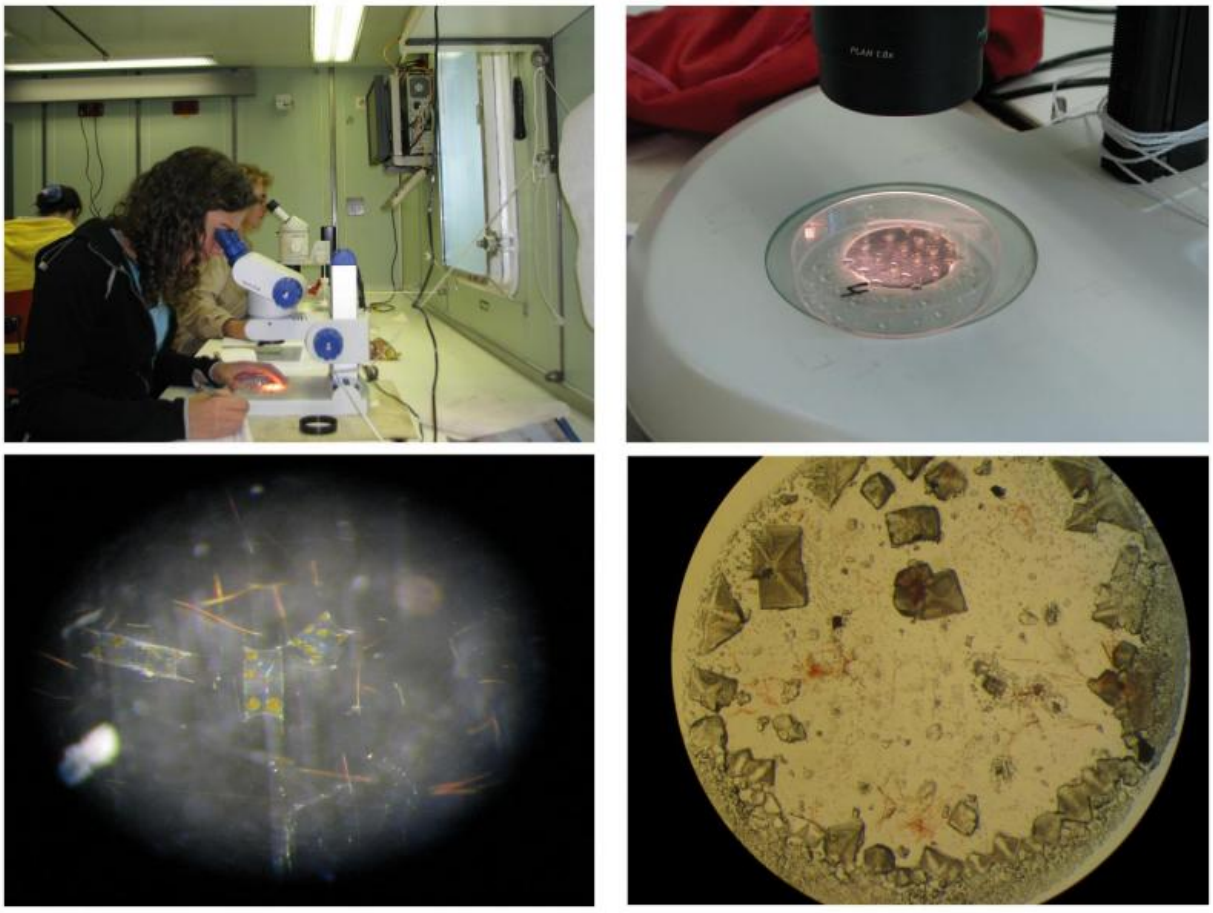

Analysis of DNA samples collected in the ballast water. Credit: Deni Ribicic

The German research vessel Polarstern covers thousands of kilometres

between the northern and southern hemispheres in search of samples of biological material. This ship, however, has some other onboard passengers: organisms that can adapt to extreme water temperatures and could potentially invade the new waters where this ice breaker takes them. Upon analysing the DNA present in this vessel's ballast water, a team of scientists showed the first molecular evidence of the persistence of DNA belonging to a tiny sea snail which is capable of tolerating adverse conditions.

Maritime transport is considered one of the most important ways that native species are moved between marine regions. The trip can be especially successful if these species latch on to the vessel's anchors or chains, or even if they travel in the ship's ballast water tanks. Each year, between 2.2 and 12 billion tons of water are transported around the oceans of the world in these ballast water tanks which also serve as a means of transport for about 7,000 species per day.

In a European report that analysed 15 samples of ballast water, live specimens of more than one thousand species were discovered in ship tanks that arrived to European ports. These taxa, however, must face very harsh conditions upon arrival: darkness, temperature changes, salinity, murky waters, turbulence and a lack of oxygen. Not all of the species will survive, and the ones that do become potential invasive species.

In order to identify which organisms are most capable of tolerating non-native waters and are thus the most invasive, a team of researchers led by the University of Oviedo (UO) analysed the environmental DNA present in the 70 m3 of ballast water in the tank -filled with water from the North Sea- of the scientific research vessel Polarstern. This ship travelled between Bremerhaven (Germany) and Cape Town (South Africa) between October and December of 2012.

The German research vessel Polarstern during its trip between Bremerhaven (Germany) and Cap Town (South Africa) in 2012. Credit: Anastasija Zaiko

"Seeing as this ballast water has travelled from the north to the south and has even crossed the tropics, it has thus been subjected to extreme temperature variations in addition to anoxic conditions [a total lack of oxygen]," explains Alba Ardura to SINC, the main author of the study published in the 'Journal of Molluscan Studies' and a researcher at the University of Perpignan (France) at present.

Is this snail a potential invasive species?

While filling up the ballast water tank, the organisms that were alive upon entry into the tank in Bremenhaven could have been subjected to conditions of stress which could result in their death, thus meaning that "the number of DNA molecules would decrease over the course of the trip," points out Ardura. Nonetheless, this is not what happened to the laver spire shell, also called the mudsnail (Peringia ulvae): "The number of one of the haplotypes (variations in DNA within the same species) increased during the trip," affirms the scientist.

Animals like this invertebrate leave behind traces of their presence in the waters where they live such as dead cells that have sloughed off or fluids.. In this case, the mudsnail left behind traces in the ballast water. It is possible to extract DNA from a sample of water in order to determine what species are living there. "We can thus have a wide range of information about the species which are present in the environment we are analysing without having to carry out individual sampling one by one," observes the expert.

Nonetheless, finding evidence of the mollusc does not confirm that it is alive, "but it does confirm the resistance of its DNA to adverse conditions," indicates Ardura. Up until now there has not been any evidence of the presence of this small snail outside of its natural habitat, although some studies have indeed described its ability to tolerate diverse ecological conditions.

For researchers, environmental DNA and its massive sequencing are a "very promising" tool for rapid biodiversity analysis and the detection of potentially invasive species that are present in ships' ballast waters. Though we should also point out that "the tool has its limitations which need to be remedied in order to develop an effective and robust method for applications in this field," concludes the scientist.

More information: Alba Ardura et al. Environmental DNA evidence of transfer of North Sea molluscs across tropical waters through ballast water, *Journal of Molluscan Studies* (2015). DOI: 10.1093/mollus/eyv022