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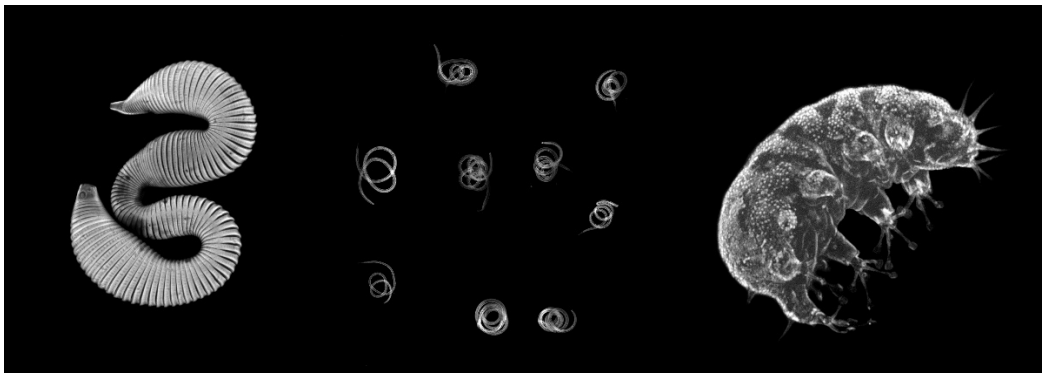
Up to 200 new species hidden in marine sediments soon to be described thanks to AI and 3D imaging



Meiofauna organisms including Epsilonema (left) several Nematodes (center) and Tardigrada (right) observed under fluorescence microscope © Ifremer / Roscoff Biological Station

Through the Meiodyssea project, scientists from IFREMER, in collaboration with teams from JAMSTEC in Japan, Naturalis Biodiversity Center in the Netherland and Senckenberg Natural History Museum in Germany, are taking on the challenge of describing 125 to 200 new species of meiofauna, small organisms measuring less than a millimeter that nest in sediments, in the 5 oceans. Combining high-resolution 3D imaging and artificial intelligence, this ambitious project, funded by the Sasakawa Peace Foundation, aims to fill our knowledge gap on the diversity, ecology and evolutionary history of invisible marine fauna, to facilitate the conservation of vulnerable marine ecosystems.

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This project, coordinated by Ifremer, stands out for the method developed and the number of sediment samples that will be analysed: already existing or to be collected during future oceanographic campaigns, these samples will come from 1,437 sites around the world. This new database will cover all marine environments, from the coast to the open sea, including abyssal plains and hadal trenches, from depths of a few centimetres to over 6,000 meters, in the heart of polar waters and tropical seas.

A WORLD TOUR OF SEAS AND OCEANS TO UNDERSTAND THE ECOLOGY OF SMALL ORGANISMS

Of the 2 million species described, only 250,000 are marine animals. Even on the best-known beaches, an average of 50% of the species sampled are new. And in some ecosystems that are still relatively unexplored, such as the deep sea, 90% of the meiofauna observed has not been described.

> **"With the 125 to 200 new species that will be described over the course of the project, we will increase by around 1/5 the number of new meiofauna species described each year around the world**. This will help us to better understand the role of these species, invisible to the eye, in the dynamics of marine ecosystems," explains **Daniela Zeppilli, head of the Meiodyssea project and head of the deep environment laboratory at Ifremer.**

Unlike bacteria and viruses, these small animals possess complex organs and play a part in the food chain of much larger organisms. Some meiofauna are "sentinel species": the presence of certain nematodes, small worms, is an indicator of chemical contamination of the environment. A better understanding of meiofauna and its role in ecosystems will allow us to better assess the impact of human activities on the ocean. Not forgetting that these species, which are capable of living in extreme conditions, are a source of inspiration for biotechnologies.

A DATABASE SHARED WITH THE GLOBAL COMMUNITY OF TAXONOMISTS SERVING BIODIVERSITY

From these thousands of samples, millions of organisms will be extracted, sorted and selected in order to detect hitherto unknown. These last will be described from every angle, identified, annotated, measured and imaged in 3D to visualize all their external and internal morphological structures with unprecedented precision. Their genetic, proteomic and functional characteristics will also be examined using sequencers.

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All this information will be compiled in a database of high-resolution 3D images. To increase efficiency, scientists will train artificial intelligence software to detect, measure and describe the morphological and morphometric characteristics of new species.

> "Thanks to cutting-edge instruments and the development of this new methodology, we will be able to identify any new species present in a sample in 15 minutes instead of several weeks, says the scientist. Their complete description should take a few days instead of several months. We'll be working better and faster".

From 2025 onwards, the massive image and data bank will be freely accessible on a virtual platform. Taxonomists from all over the world will be able to consult all the information on the species they are interested in, without having to travel.

> **"The Meiodyssea project is the first step towards what is known as "cybertaxonomy", thanks to the evolution of new technologies. We hope to initiate a movement towards more secure data storage and towards a worldwide standardization of taxonomy methods and protocols to accelerate our knowledge of the world's marine biodiversity",** concludes Daniela Zeppilli.

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