Terms of reference for the ISA-Ifremer Meioscool postdoctoral fellowship

Project title

Meioscool mentorship in cybertaxonomy and automatic approaches for the assessment of anthropogenic stressors in areas of exploration for deep-sea minerals.

Background

The ocean is the largest living habitat on the Earth, covering more than 70 per cent of the planet's surface.[1,2] Latest estimations suggest that 60-80 per cent of Earth's biodiversity is found beneath the surface of the oceans, with at least one million species identified. Nonetheless, the vast majority of the sea floor outside the contract areas managed by the International Seabed Authority (ISA) remains to be explored.[2] Meanwhile, the growing need for marine resources, including seabed minerals, and increasing anthropogenic pressures call for the development of fast and accurate impact assessments on marine ecosystems and life therein.[3,4] Reliable species identification forms the basis for all ecological, evolutionary and environmental impact assessments. The scientific community must build baseline data sets and catalogues of marine life essential for assessing potential changes in marine biodiversity.

Meiofauna is a collective term for a diverse assemblage of eukaryotic organisms that dominate the benthic environment, including small animals and protists, operationally defined based on the standardized mesh size of sieves with 1,000 µm and 32 µm as upper and lower limits, respectively.[5-7] Meiofauna vitally contributes to ecosystem processes and functions and studies showed their potential as indicators and sentinels for ecosystem health.[5] Meiofauna dominates abyssal plains and has a fundamental role in polymetallic nodule ecosystems.[8,9] It has also been recently demonstrated that nematodes, the most abundant metazoan group in deep-sea meiofauna, are essential, even dominant, players in the peripheral or so-called inactive zones of hydrothermal fields.[10] Increasing our knowledge of meiofauna communities from ecosystems that would be impacted by deep-sea mining is pivotal.

All meiofauna characteristics considered (small organisms requiring expert skills not available, too many species still undescribed considering the limited number of taxonomists, accessible and easy-to-use identification guides/tools for the non-taxonomists rare), the taxonomic impediment is especially severe for this important marine compartment. Even with technology pushing a revolution in taxonomy, the major current problem related to applying fingerprinting techniques is the lack of meiofauna data in gene or image repositories, making it impossible to associate sequences with species and their functional roles in the ecosystem.[11,12] Another important aspect is the lack of active meiobenthologists. In response to this gap, Ifremer initiated the Meioscool initiative in 2013. Meioscool workshops and summer schools aim to bring together experts in meiofauna, increase awareness of their role in marine ecosystems, train students and researchers and stimulate the emergence of a new generation of meiobenthologists.

Project objectives

This project will focus on mentoring a Meioscool trainer in cybertaxonomy and automatic approaches for the assessment of anthropogenic stressors in areas of interest for deep-sea mining.

In particular, this project aims to achieve three distinct objectives:

1. Describe the nematode community structure, identifying key bioindicator species and functional traits for the detection of environmental changes in the context of deep-sea mining
2. Apply integrative cybertaxonomy and automatic approaches for the assessment of anthropogenic stressors in areas of interest for deep-sea mining
3. Establish a Meioscool mentor trained in ISA-standardized approaches and integrative tools, including the ISA-Ifremer Meioscool "Training Kit"

To achieve these objectives, samples from the French exploration contract concerning polymetallic sulphides in the Mid-Atlantic Ridge, North Atlantic Ocean (cruise BICOSE2023) and polymetallic nodules, Pacific Ocean (cruise EDEN2024) will be investigated. The research carried out by the postdoctoral fellow on the samples shall not be intended to replace any activity that Ifremer personnel carry out to comply with the plans of work for exploration signed between ISA and Ifremer.

The postdoctoral fellowship position will be developed under the framework of the "Blue Revolution" and "MEIODYSSEA" projects, applying cybertaxonomy using 2D and 3D imaging techniques and building a reference training data set based on processed images combined with visual and manual image analysis for machine learning method development.

The Meioscool mentorship will include training on ISA-standardized approaches and integrative tools for investigating meiofauna. During this project, the postdoc will participate in the development of the ISA-Ifremer Meioscool "Training Kit." This comprehensive package will include a benthic imaging device, digital materials and technological tools, such as a web-based platform for image analysis. The kit will enable post-event interactions and sustained collaborations among the Meioscool team, the mentor and Meioscool participants. The postdoc will also participate in the organization of a one-week Meioscool workshop at Ifremer in the summer of 2025. The development of these organizational skills, together with post-event interactions, will allow the postdoc to conduct future training in schools in their country of origin, therefore contributing to ISA's capacity development strategy.

Expected outputs

A draft report will be provided for review and feedback by the ISA Secretariat at least one month prior to finalization. A final draft report incorporating comments from the Secretariat will be submitted at the end of the project. The final report will include the

- quantitative biodiversity and functional data of benthic communities
- taxonomic checklist of infauna species found in SMS/polymetallic nodules sites sampled
- list of key species associated with detected environmental changes
- image and genetic reference library of benthic species
- the ISA-Ifremer Meioscool "Training Kit"
- outline of one or two draft manuscripts, with a time frame for submission in an open-access journal (see provisional schedule below).

Project implementation

The project will be conducted at Ifremer (Brest, France) with support provided for a 12-month postdoctoral fellowship. The postdoc, selected in consultation between ISA and Ifremer, will be assisted by the "Blue Revolution" and "MEIODYSSEA" networks of taxonomic experts for species identification and by a broader team for various technological developments. Furthermore, the postdoc will be integrated into the Meioscool training programme, which includes dedicated workshops, special training modules and a dedicated e-learning teaching unit.

Methodologies

Image-based semi-automated analyses using various devices (digital scanners, ZooSCAN, flow cytometers and microscopes) have been used for plankton research for more than two decades. A few

years ago, the TARA team developed a 3D-fluorescence imaging and classification tool for rapid quantitative analysis of microbial organisms in environmental samples. This method entails high-content feature extraction and derivation of quantitative data from images that enables accurate automated taxonomic classification.[13]

Some flow cytometry systems can also sort single individuals after imaging acquisition. Microscopic infauna semi-automated identification is still in its infancy. The FlowCAM system allows the identification and classification of specimens at high taxonomic levels, obtaining numbers of individuals comparable to traditional methods.[14] 3D fluorescence imaging techniques have been used in a few meiofauna taxonomical studies, but they have not yet been tested for automated species identification.[15,16]

In this project, the "Quantitative 3D-imaging" method[13] will be adapted for infaunal microscopic benthic communities. Before imaging, faunal samples will be identified at the species level and prepared following a multiple-step procedure in order to adequately stain the target organisms. Light-Sheet, Axiozoom and/or Confocal laser scanning microscopes will be used for high throughput sample imaging. Complementary genetic sequence data will be obtained for representative specimens of identified morphological species. Key species associated with detected environmental changes will be identified both morphologically and genetically.

The Curiosity Microscope will be adapted to meiofauna scopes for the ISA-Ifremer Meioscool "Training Kit." The Curiosity Microscope will provide images directly connected to a web-based platform for image analysis, such as EcoTaxa.

Eligibility criteria

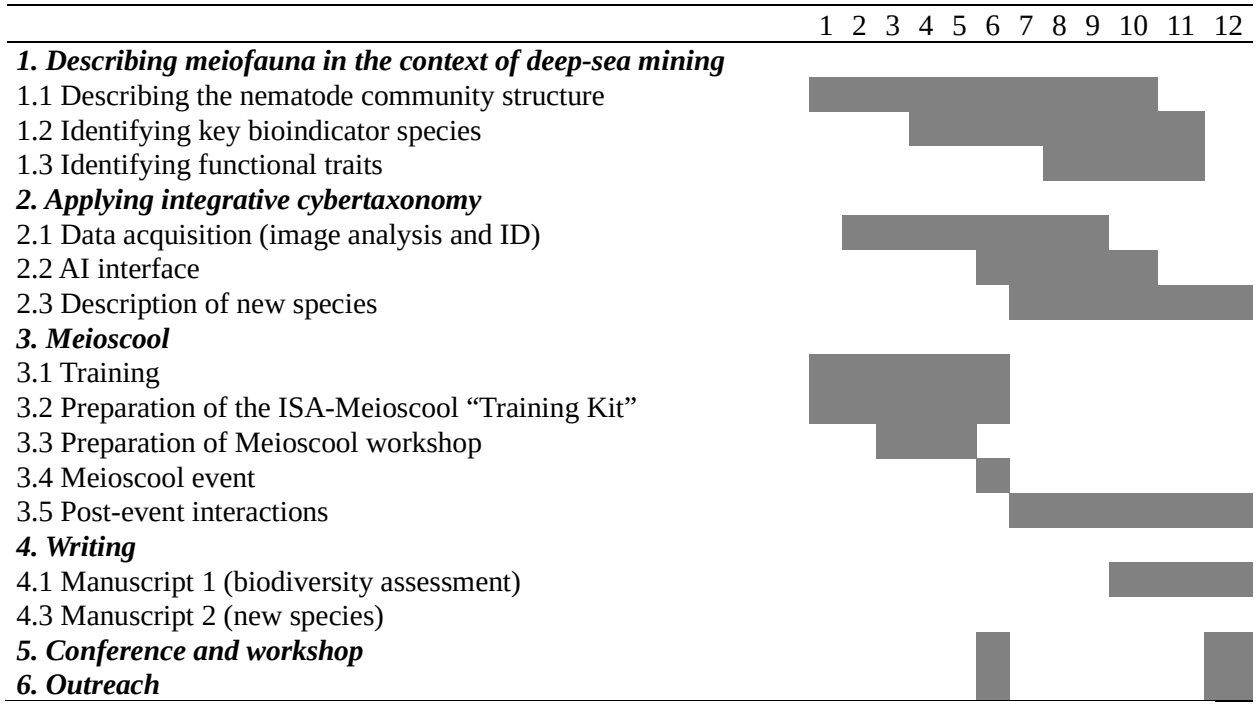
- National of a developing State Member of ISA
- Ph.D. degree in marine biology or ecology
- Background in the taxonomy of marine meiofauna
- Knowledge of deep-sea ecology
- Skills in microscopy (recommended)
- Experience working in a multidisciplinary team (recommended)
- Proficient in English language (written and oral)

Selection of applicants

Following the announcement of the postdoctoral fellowship on the ISA website, applications will be compiled by the ISA Secretariat and sent to Ifremer for review, assessment and selection of candidate(s) in line with the eligibility criteria mentioned above. ISA Secretariat will review and approve the selection.

Applications from qualified candidates should be received no later than **30 May 2025**.

Provisional schedule



Communications

All communication products developed by the parties and approved by ISA on the project and any presentation and related tools prepared should use ISA-approved templates and bear the ISA logo and appropriate reference to the grant provided by the ISA Partnership Fund.

References

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