Understanding of the source, transport, fate, and effects of mercury (Hg) from fish to humans and the detoxification role of selenium (Se)

Welcome to MERFISH Newsletter #4

We are pleased to bring you the latest edition, highlighting recent research, project activities, and key developments in our ongoing work on mercury and selenium in marine ecosystems.

In this issue, we celebrate the achievements of our Early Career Researchers, including Adna Alilović, who won the ICMGP Student Presentation Competition for her research on mercury exposure and selenium interactions.

We also highlight new research publications, covering mercury and selenium interactions in fish, detoxification in Atlantic bluefin tuna, and heavy metal accumulation in brown crab and fjord sediments—all contributing to a better understanding of seafood safety and environmental pollution.

Additionally, we showcase a special issue of *Environmental Pollution* on Climate Change, Mercury Pollution, and Global Ecology, guest-edited by MERFISH coordinator Dr. Zoyne Pedrero-Zayas and partners and provide a recap of a recent webinar on chemicals, waste, and pollution prevention, featuring MERFISH researcher Dr. Michael S. Bank.

We hope you find this issue insightful—thank you for being part of the MERFISH community!

Celebrating the Achievements of our Early Career Researchers

MERFISH ECR awarded for best presentations

MERFISH places considerable importance on the development of our Early Career Researchers, and for this reason we are delighted to announce that Adna Alilović won the Student Presentation Judging Competition at the 16th International Conference on Mercury as a Global Pollutant (ICMGP), held in Cape Town from July 21-26, 2024.

Her presentations, titled "Mercury Exposure Assessment and Model Validation through Controlled Tuna Consumption Study" and "Exploring Selenium-Mercury Interactions in Human Systems: Insights from Controlled Fish Consumption and Biomarker Analysis" were selected as the best among over 68 student contributions.

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News from MERFISH Partners

MERFISH Secondments at the University of Chester with Europe for Business

A key activity in the MERFISH project concerns the implementation of secondments throughout its duration.

On November 19th and 20th, 2024, the MERFISH Project advanced its mission of fostering cross-disciplinary research, collaboration, and innovation through a series of impactful secondment activities in Chester and Warrington.

These events involved Tina Vrabec from the Jozef Stefan Institute (JSI), alongside team members from Europe for Business, including Donatella Santoro, Maghraby Elseify, and Alessandro Tiraborelli.

Find out more here.

EFB Secondment in IMR : Advance Mercury Research

Europe for Business (EFB) and the **Institute of Marine Research (IMR)** successfully took part in a collaborative training initiative aimed at enhancing understanding of the complex interactions between mercury and selenium in fish and human health.

This training, led by EFB's Leonardo Piccinetti at IMR with Dr **Yiou Mike Zhu** focused on the latest research findings regarding the health implications of mercury exposure from fish consumption, with a particular emphasis on the protective role of selenium. was a key component of our Project.

This fruitful collaboration between the two entities has furthered developments in nutrient contaminant analysis. This partnership, born from a strategic secondment program, showcases our dedication to building research networks and tackling global environmental challenges.

Find out more here

And more information here

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Our Latest Research Publications

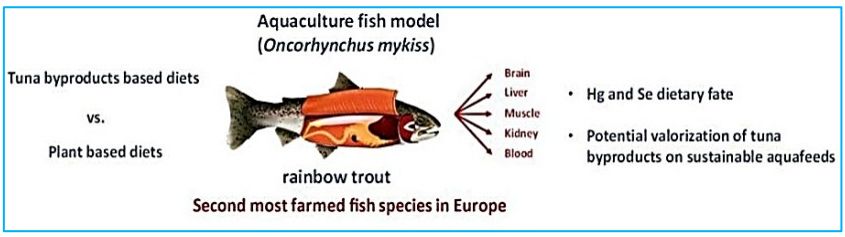
Exciting New Study Reveals Insights into Mercury and Selenium Interaction in Fish

We are pleased to highlight a recent publication offering new insights into the interaction between mercury (Hg) and selenium (Se) species in fish. The study, conducted on rainbow trout (*Oncorhynchus mykiss*) under controlled dietary conditions, examined how different Se compounds influence Hg bioaccumulation in muscle, brain, and liver tissue over a six-month feeding trial.

The findings show that diets containing tuna by-products, enriched with specific selenium compounds, resulted in lower mercury accumulation compared to plant-based diets. Importantly, muscle mercury levels remained below the EC's safe threshold, reinforcing the potential benefits of incorporating fisheries byproducts into sustainable aquafeeds.

This research contributes valuable data to ongoing efforts in improving fish nutrition, food safety, and the responsible use of marine resources.

Find out more here



Assessment of dietary Selenium and its role in Mercury fate in cultured fish rainbow trout with two sustainable aquafeeds.

Claudia Marchán-Moreno, Silvia Queipo-Abad, Warren T. Corns, Maite Bueno, Florence Pannier, David Amouroux, Stéphanie Fontagné-Dicharry, Zoyne Pedrero (2024). *Food Chemistry,* Vol. 447.
DOI: https://doi.org/10.1016/j.foodchem.2024.138865

Investigating Selenium-Containing Biomolecules in Fish and Seafood Products

Following the publication described above on mercury and selenium interactions in aquaculture, the MERFISH project is pleased to highlight another study examining the presence of selenoneine and ergothioneine—two potent antioxidants—in fish and fish-derived commercial products.

This research marks the first time these compounds have been simultaneously quantified in commonly consumed fish species and seafood products. Using optimized extraction and advanced HPLC-ESI-MS/MS analysis, the study found that tuna and swordfish contained both selenoneine and ergothioneine, while fish roe and farmed salmon contained only ergothioneine. Additionally, the study investigated selenium-containing biomolecules in processed seafood, revealing notable differences in Se associations between fresh and ultra-processed products.

These findings provide valuable insights into the nutritional composition of seafood and the role of selenium-related compounds in food quality and safety.

Investigating the Presence of Selenoneine, Ergothioneine, and Selenium-Containing Biomolecules in Fish and Fish-Derived Commercial Products

Tamara Fernández-Bautista, Beatriz Gómez-Gómez, Emma Gracia-Lor, Teresa Pérez-Corona, Yolanda Madrid (2024). *Journal of Agricultural and Food Chemistry*, Vol 72/Issue 47
DOI: https://doi.org/10.1021/acs.jafc.4c06111

Understanding Mercury Detoxification in Atlantic Bluefin Tuna

Building on our growing body of research papers on mercury and selenium interactions in fish and the presence of selenium-containing antioxidants in seafood, this new study, published in the Journal of Haz. Mat. explores how Atlantic bluefin tuna naturally process and detoxify methylmercury—a toxic form of mercury found in marine food chains.

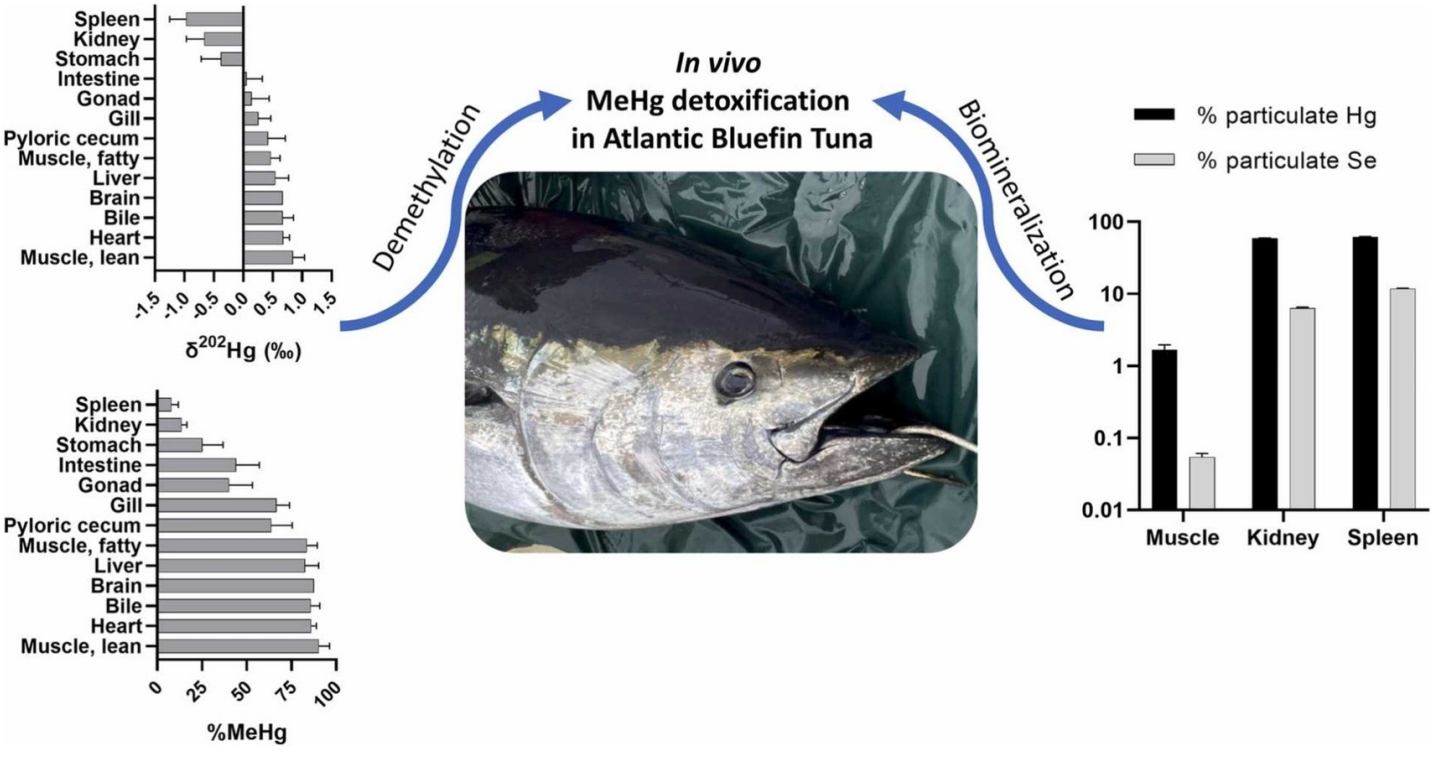
By analysing 13 different tissue types, researchers identified a two-step detoxification process in tuna: demethylation (breaking down methylmercury) and biomineralization (binding mercury to selenium to reduce toxicity). This process was most active in the spleen and kidney, where mercury breakdown was highest, while muscle tissue retained the most methylmercury.

These findings help explain how large marine fish manage mercury exposure and reinforce the important role of selenium in moderating mercury accumulation—a theme explored in earlier MERFISH publications on aquaculture diets and seafood composition. The study also suggests that stable mercury isotope signatures in tuna could be used to trace mercury pollution sources in marine ecosystems.

Organ-specific mercury stable isotopes, speciation and particle measurements reveal methylmercury detoxification processes in Atlantic Bluefin Tuna

Martin Wiech, André M. Bienfait, Marta Silva, Julien Barre, Veronika Sele, Michael S. Bank, Sylvain Bérail, Emmanuel Tessier, David Amouroux, Atabak M. Azad. (2024)

Journal of Hazardous Materials, Volume 473.
DOI: https://doi.org/10.1016/j.jhazmat.2024.134699



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Heavy Metal Accumulation in Brown Crab and Fjord Sediments

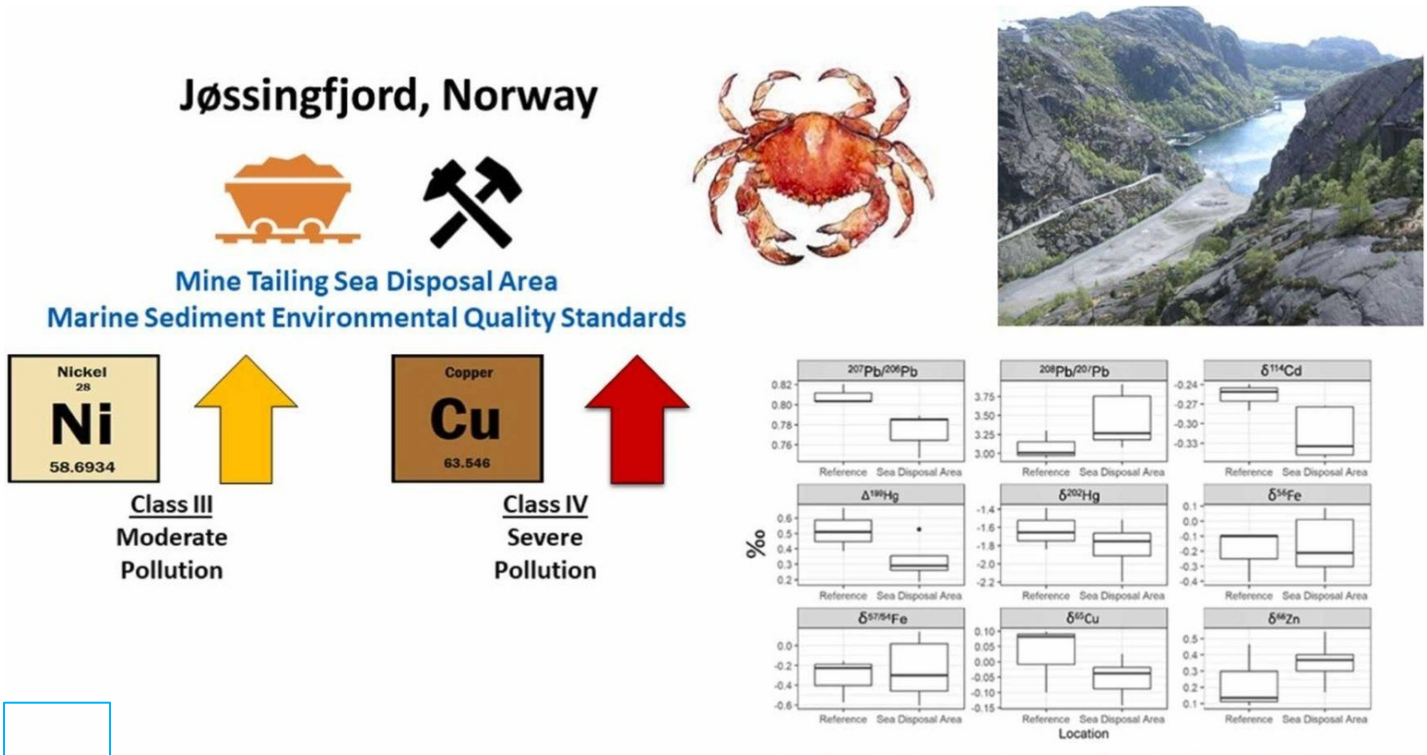
Continuing our exploration of mercury and selenium dynamics in seafood and marine ecosystems, this latest MERFISH-supported study examines how heavy metals accumulate in brown crab (*Cancer pagurus*) and seafloor sediments in a Norwegian fjord affected by historical mine tailing disposal.

The research focused on Jøssingfjord, Norway, where mining waste has been released into the sea, leaving behind long-term contamination. Findings showed that nickel and copper levels in sediments remain high, classified as moderate and severe pollution under Norwegian environmental quality standards. In brown crabs, mercury (Hg), zinc (Zn), and arsenic (As) were most concentrated in muscle tissue, likely due to their strong binding properties.

Using multi-isotopic analysis, the study identified lead (Pb) isotopes as the most effective tool for tracing pollution sources, demonstrating how this method can be applied to assess contamination in fjord ecosystems. The research underscores the value of brown crab as an eco-indicator for heavy metal pollution and highlights the long-term environmental impact of mine tailing disposal on marine life.

Multi-isotopic composition of brown crab (*Cancer pagurus*) and seafloor sediment from a mine tailing sea disposal impacted fjord ecosystem

Michael S. Bank, Quang Tri Ho, Tina Kutti, Tanja Kögel, Ilia Rodushkin, Terje van der Meeren, Martin Wiech, Samuel Rastrick (2024)
Journal of Hazardous Materials, Volume 471.
DOI: https://doi.org/10.1016/j.jhazmat.2024.134406



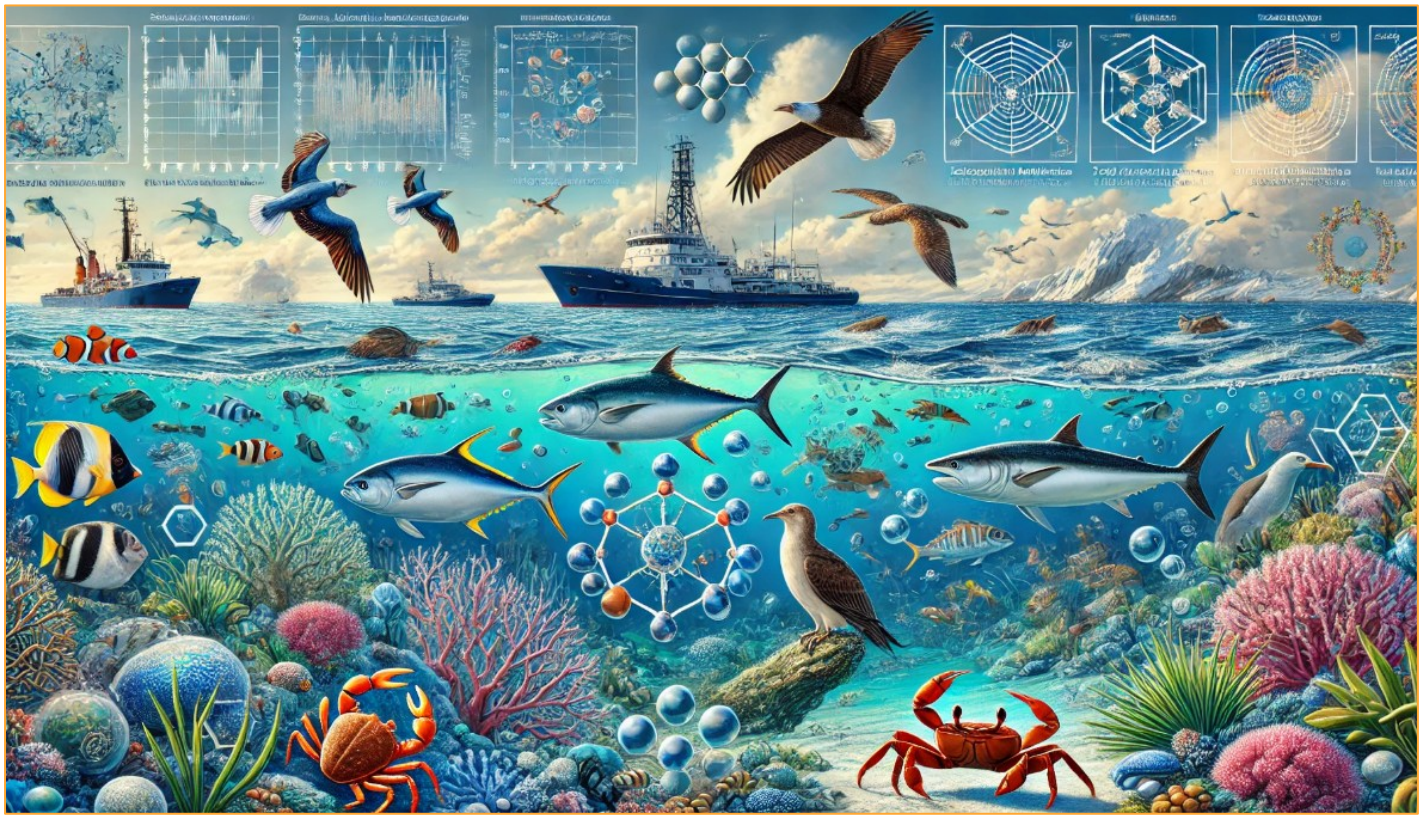
New MERFISH Publication: Selenium Isotopic Composition in Marine Top Predators

Building on recent MERFISH research into mercury and selenium interactions in marine ecosystems, MERFISH partners PS Analytical, AIA, and CNRS have collaborated on a pioneering study examining the selenium isotopic composition in top predator seabirds.

This study, the most comprehensive of its kind, analyzed giant petrels (*Macronectes spp.*) to explore how selenium moves through different organs, including the liver, kidneys, muscle, and brain. Researchers used advanced isotopic techniques to distinguish selenium fractions, such as selenoneine and mercury-selenium nanoparticles, revealing key insights into selenium's role in detoxification and nutrient cycling.

The findings complement our recent studies on selenium's influence on mercury accumulation in fish and detoxification processes in bluefin tuna, reinforcing selenium's crucial role in marine food webs. This research also highlights selenium isotopes as a promising tool for tracing environmental selenium sources and understanding its biological functions in top predators.

First-Time Isotopic Characterization of Seleno-Compounds in Biota: A Pilot Study of Selenium Isotopic Composition in Top Predator Seabirds
Claudia Marchán-Moreno, Pascale Louvat, Maite Bueno, Sylvain Berail, Warren T. Corns, Yves Cherel, Paco Bustamante, David Amouroux, and Zoyne Pedrero. (2024)
Environmental Science & Technology Vol 58/Issue 30
https://doi.org/10.1021/acs.est.4c02319



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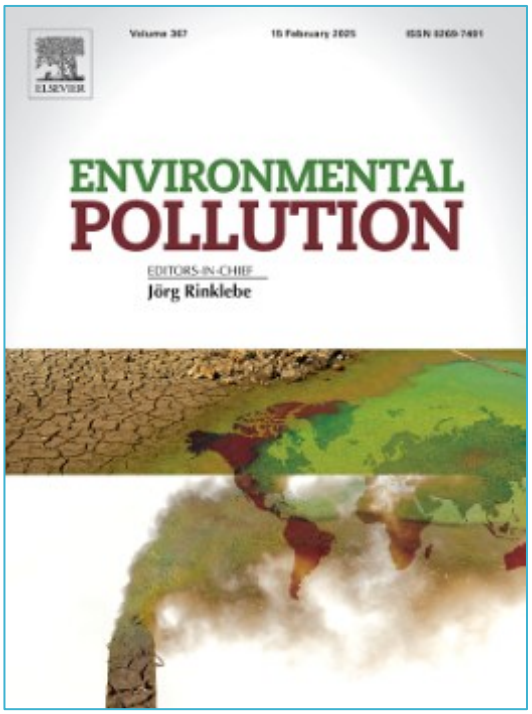
Environmental Pollution: Special Issue on Mercury

MERFISH partners are pleased to announce that the Open Access journal '*Environmental Pollution*' has published a special issue titled "Climate Change, Mercury Pollution, and Global Ecology." This edition explores the intricate relationships between climate change and mercury pollution, examining their combined effects on global ecosystems.



The Special Issue has as its Guest Editors Dr. Zoyne Pedrero-Zayas, the coordinator of the MERFISH project, along with Dr. Michael S. Bank, Dr. Baohua Gu, Dr. Milena Horvat, Dr. Vernon Somerset, and Dr. Lynwill Martin. Their collective expertise ensures a comprehensive examination of the latest research.

Enhancing our understanding of how climate change influences mercury dynamics and the subsequent ecological and health implications, this issue features extensive research on topics such as:

- The impact of climate-induced environmental changes on mercury cycling.
- The role of global ecological processes in modulating mercury pollution.
- Innovative approaches to monitoring and mitigating mercury contamination in the context of a changing climate.

Access the special issue here

Webinar: Science and Capacity Building to Support the United Nations Science-Policy Panel on Chemicals, Waste and Pollution Prevention.

In case you missed it, the recent webinar on chemicals, waste, and pollution prevention, hosted by the Institute of Marine Research (IMR) Norway, brought together leading experts to discuss strategies for addressing global pollution challenges. Among the speakers was Dr. Michael Bank, a key MERFISH partner, who introduced and contributed to discussions on the role of environmental science in shaping effective policies for chemical and waste management.

The webinar covered a range of critical topics, including:

- The global impact of hazardous chemicals and waste on ecosystems and human health.
- Strategies for monitoring and mitigating chemical pollution in marine and terrestrial environments.
- The importance of capacity building and international collaboration in pollution prevention efforts.
- The role of scientific research in informing policy and regulatory frameworks.

For those who would like to explore further, additional information and resources can be found here

This webinar reinforced the need for continued collaboration between scientists, policymakers, and industry stakeholders to address the growing challenges of chemical pollution and waste management.

About the MERFISH Project

Project aims:

MERFISH aims to develop our understanding of the source, transport, fate, and effects of mercury (Hg) from fish to humans and the detoxification role of selenium (Se). The project will help establish new guidelines for aquaculture feeding practices to avoid fish contamination with Hg toxic forms and to insure proper bio-assimilation of its antagonist, Se.

The project brings together the knowledge and expertise of nine expert partners from research, business, and industry:

Project Coordinator

Get in touch and find out more: **www.merfish.eu**

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