Trace Elements in the brain of Rabbitfish *(Chimaera monstrosa*) from the Strait of Sicily

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Background

Numerous fish species worldwide have been documented as declining populations, largely because of anthropogenic pressures such as overfishing, climate change, habitat degradation, and pollution (Klein *et al.,* 2021). The marine environment is contaminated by trace elements (TEs), many of which originate from industrial, agricultural, and urban sources. The presence of TEs poses a significant ecological risk, as both are capable of accumulating within marine food webs and threatening marine species globally (Said *et al.,* 2022). Deep-sea elasmobranchs and chimaeras are of particular concern in this context, due to their biological characteristics. These species play a fundamental role in maintaining the structure and balance of deep-sea food webs (Aranha *et al.,* 2022). Their ecological position, longevity, and often slow reproductive rates make them especially susceptible to the bioaccumulation of contaminants. Exposure to elevated concentrations of TEs is particularly worrying, given the well-documented toxicological effects of elements such as mercury, cadmium, and lead (Asante *et al.,* 2008). Despite their ecological importance, limited research has been conducted on the extent of TEs bioaccumulation in deep-sea organisms in general (Asante *et al.,* 2008; 2010), and studies targeting elasmobranchs and chimaeras remain relatively scarce.

Fig 1. Rabbitfish, *Chimaera monstrosa* biometry analysis at the CNR-IRBIM, Mazara del Vallo.

Project Goals

This research project focuses on investigating the accumulation rates of trace elements in *Chimaera monstrosa*, a deep-sea cartilaginous fish that inhabits various regions of the Mediterranean Sea. *C. monstrosa* is of particular interest due to its unique ecological role, its occupation of diverse ecological niches, and its opportunistic feeding habits, which make it a valuable model for studying how contaminants accumulate in long-lived deep-sea organisms. By examining this species, the project seeks to improve current knowledge of how environmental and biological factors influence contaminant dynamics in deep-sea ecosystems. The primary objective of the study is to establish correlations between TEs accumulation and a range of biological and ecological parameters. These include growth rates, reproductive status, and potential neurobiological impacts. The geographical scope of the project spans several regions of the Mediterranean Sea, with a particular emphasis on the Strait of Sicily, an area known for its ecological complexity and high biodiversity. Analyses will focus on quantifying mercury levels, given its well-documented neurotoxic effects and prevalence in marine environments. Ultimately, the results of this research will be used to develop generalizable models of bioaccumulation rates for deep-sea chimaera species. Such models have the potential to inform broader ecological assessments, support conservation efforts, and contribute to the sustainable management of deep-sea resources. By combining ecological and toxicological data, the project aims not only to advance scientific understanding of contaminant dynamics in *C. monstrosa*, but also to highlight the importance of monitoring vulnerable deep-sea species in the context of increasing human impacts on marine environments.

Experimental Approach

The project will be focused on the collection of samples and laboratory analyses. For each individual, biological samples will be collected. Moreover, TEs analysis, dorsal fin spines for growth rate analysis, skin, brain, liver, muscle, microplastics analysis will be performed. Accumulation rates of different TEs in liver, muscle, and brain tissues will be assessed, and correlated with morphometrics, sex, reproductive status, growth rates. Data will be collected through the scientific survey, MEDITS (MEDiterranean International bottom Trawl Surveys), a project funded by the European commission. The MEDITS is carried out annually, during late spring/summer using a standardized sampling methodology and a stratified sampling scheme that includes several bathymetric limits. The samples collected for my PhD will be dissected, and the whole brain will be removed from each specimen and stored at -20 °C until shipment to the Department of Veterinary Medical Sciences in Bologna, Ecotoxicology Laboratory. Brain samples were weighed and microwave digested using a Milestone ETHOS ONE oven using 3 ml of 65% nitric acid (HNO_3). The digested mixture was transferred into a 15 ml flask and the final volume was obtained by adding Milli-Q water. Trace elements detection and quantification were determined by Inductively Coupled Plasma-Optic Emission Spectrometry technique (ICP-OES) using a Perkin Elmer Optima 2100 DV instrument, coupled with a CETAC U5000AT+ ultrasound nebulizer for mercury (Zaccaroni *et al.*, 2014). Data are reported as μg/g wet weight (w.w.). All experimental procedures will adhere to animal welfare regulations, and statistical analyses will be performed to determine significant differences between samples.

Expected Outcomes

The research project will make a successful contribution to the research community as it will provide data on chimaeras in the Mediterranean Sea. It will measure the impact of trace elements within the brain to assess their distribution in specific environments. The presence of contaminants in multiple organs will be linked to growth rates and brain anatomy. This involves determining the absorption percentage from the environment, mapping metal distribution in cerebral tissue, and assessing oxidative stress biomarkers. The question we would like to answer is: Can the rabbitfish (and other elasmobranchs) brain reduce its capacity for TEs accumulation with age, as an adaptation to TEs exposure, minimizing the risks for brain damage? To do this, we need for further research, particularly in understanding and potentially replicating this protective mechanism in other species as well as in the chimaera.

SUSTAINABLE DEVELOPMENT GOALS

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