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Concept article

Estimation of the evolution of metal pollution (Cu, Pb) on the Ghazaouet coast using a teleost bioindicator, the common sole *Solea solea* (Linnaeus, 1758)

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Abstract

The present study focuses on measuring the concentrations of metallic trace elements (MTEs) in the liver and muscle tissues of the common sole (*Solea solea*, Linnaeus, 1758) from the Ghazaouet coast. This species is a bony fish highly appreciated by the Algerian population. Fish were collected seasonally between April and September 2019. The concentrations of two metallic trace elements, copper (Cu) and lead (Pb), were analysed using atomic absorption spectrophotometry (AAS) in the two organs studied. The average copper concentrations in the liver and muscle were 6.65±0.38 µg/g and 6.04±0.44 µg/g, respectively. The average lead concentrations in the liver and muscle were 1.50±0.43 µg/g and 1.31±0.37 µg/g, respectively. Our findings reveal a higher accumulation of metals in the liver compared to muscle tissue. Comparative analysis shows an upward trend in the average levels of the two pollutants (Cu and Pb) during the summer period compared to the spring period. The average values found for copper and lead in the muscle of the common sole from Ghazaouet are 6.04±0.44 µg/g and 1.31±0.37 µg/g, respectively, which do not seem to pose a real danger to consumers compared to the maximum admissible doses (MAD). Nevertheless, the cumulative effect of these xenobiotics along the trophic chain poses potential long-term health risks.

Keywords: MTEs, common sole, AAS, MAD, Ghazaouet coast.

Introduction

Marine pollution is one of the most worrying problems today. It is often emitted by anthropogenic activities, such as industrial, agricultural or even domestic activities and in different forms (hydrocarbons, pesticides, trace metal elements, etc.) (Aydoğan et *al.*, 2017; Pal et *al.*, 2018). Aquatic environments are most affected by metal pollution (Rodrigue et *al.*, 2016). While copper (Cu) is an essential trace element and lead (Pb) is non-essential, both can become toxic when their concentrations exceed physiological thresholds (Richir, 2016). Such chemical contamination poses a toxicological risk, potentially disrupting marine ecosystems. Various studies have shown that these xenobiotics cause disruptions in the reproductive system, changes in behavior, disruptions in energy metabolism and the appearance of mutagenic or carcinogenic effects in aquatic species (Meyer, 2003). These contaminants also pose significant health risks to humans, particularly through bioaccumulation in the food chain (Merhaby et *al.*, 2018;Diop et *al.*, 2019; Karikari et *al.*, 2020). In Algeria, pollution is mainly generated by discharges of untreated industrial and urban water (Taleb 2007; Grimes et *al.*, 2010). Petrochemical, chemical, steel and agri-food activities are mainly concentrated on the Algerian coastal strip (Grimes et *al.*, 2010). Given this importance, our present study focuses on the estimation of the state of water quality of the Ghazaouet coast based on the evaluation of the quantity of metallic trace elements (Cu and Pb) in the organs (liver and muscle) of a teleost fish, the common sole *Solea solea* (Linnaeus, 1758) fished in the bay of Ghazaouet. Our choice fell on the common sole *Solea solea* (Linnaeus, 1758) because it is a species which is among the fish most consumed by the Algerian population, for this it is essential to carry out regular monitoring in order to have an idea of whether or not it is dangerous to consume this benthic species.

Material and Methods

Study sites

Algeria has a large maritime coastline located in the heart of the Mediterranean. From an ecological point of view, its coastline is rich and diverse. Its long maritime façade alternates between rocky shores, sandy beaches and wetlands (Benzohra et Millot, 1995).

The bay of Ghazaouet (Fig.1) is located at the western end of Algeria, it is 80 km north of the wilaya of Tlemcen and 50 km from the Moroccan border. Apart from the site housing the port and the old urban center, the entire coast is made up of very steep cliffs. Geologically, the Traras massif is the main structural unit of the coastal zone (Bengueda, 2012).

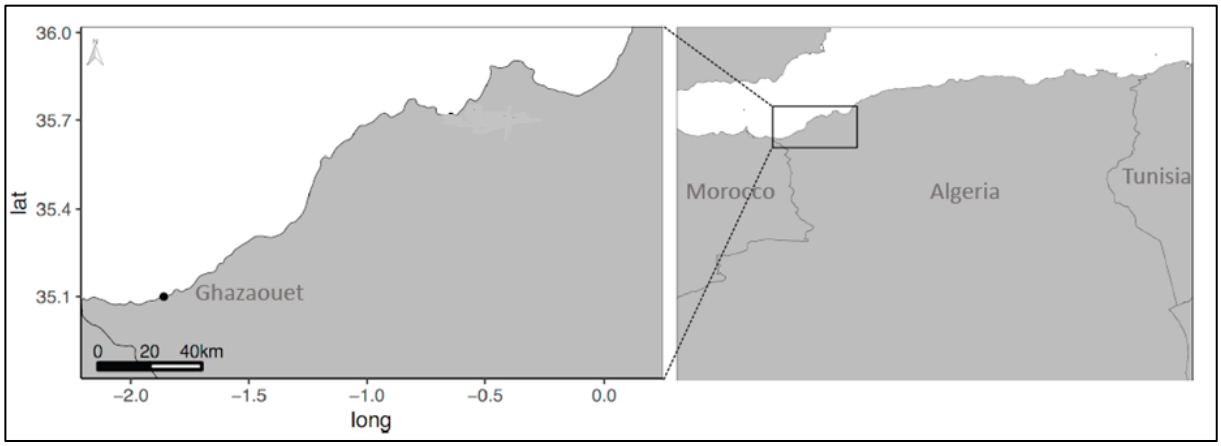

Fig.1. Location of the study site : Ghazaouet Bay (Tabeche et al., 2021)

Sample collection and processing

Sampling was carried out monthly between April and September 2019 in Ghazaouet Bay. In total, we collected 90 individuals of Solea solea (Linnaeus, 1758) including 12 females and 78 males. The samples were processed the same day at the laboratory. After the biometric measurements, the fish were dissected to remove the muscle and liver.

Analysis of metallic trace elements (Cu and Pb)

Before carrying out the analysis of the metals in the various organs studied, the samples studied had been mineralized (Chiffoleau et al., 2001). This step consists in the destruction of the organic matter by an acid attack (pure nitric acid HNO3). The subsamples were dried in an oven at 60° C until a constant weight was obtained (24 to 72 h), then crushed. 0.2 g of dried sample for each replica, had been mineralized in 4 ml of pure HNO_3 at room temperature overnight, then placed in an oven at 90 °C for 3h. The mineralisates were then filtered with wattman filter paper. The determination of the ETMs had been carried out by a flame atomic absorbance spectrophotometer of the Perkin Elmer precisely AAnalyst 400 type.

To ensure the absence of contamination during analysis, test blanks were included as controls. Negative controls underwent the same analytical protocol as the samples to confirm that detected compounds originated from the specimens rather than external contamination.

The reliability of the protocol described above was also validated using a homogenized standard sample called an inter-calibration sample provided by the International Atomic Energy Agency (I.A.E.A. 1995). In our case, it is a fish sample coded 140/TM.

Statistical analysis

Data analysis was performed using Microsoft Excel 2019.

Results and Discussion

Shown in Fig.2 is the average seasonal assessment of lead levels according to organs in the common sole *Solea solea* (Linnaeus, 1758) fished in Ghazaouet Bay.

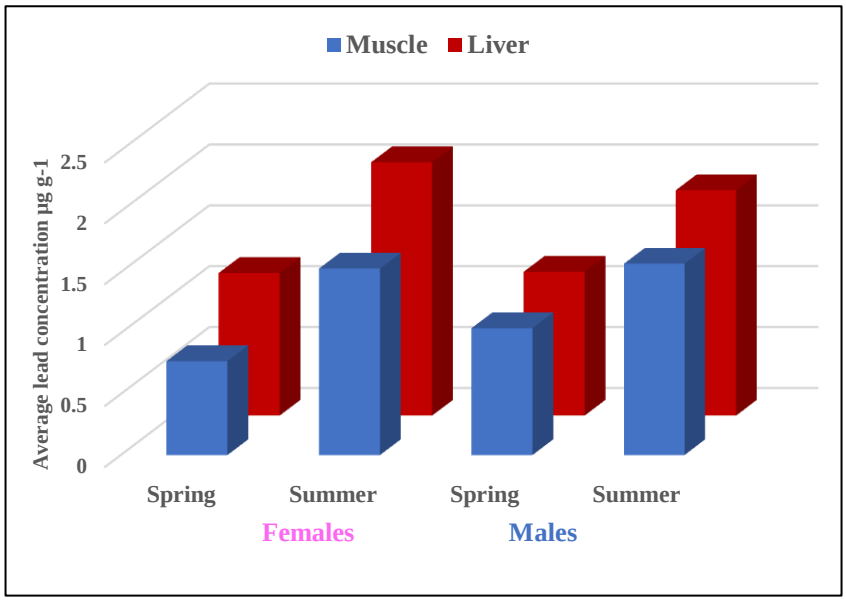

Fig.2. Average seasonal assessment of lead levels according to organs in the common sole Solea solea (Linnaeus, 1758) fished in Ghazaouet Bay.

The average seasonal evaluation of copper levels is shown in Fig.3 according to organs in the common sole *Solea solea* (Linnaeus, 1758) fished in Ghazaouet Bay.

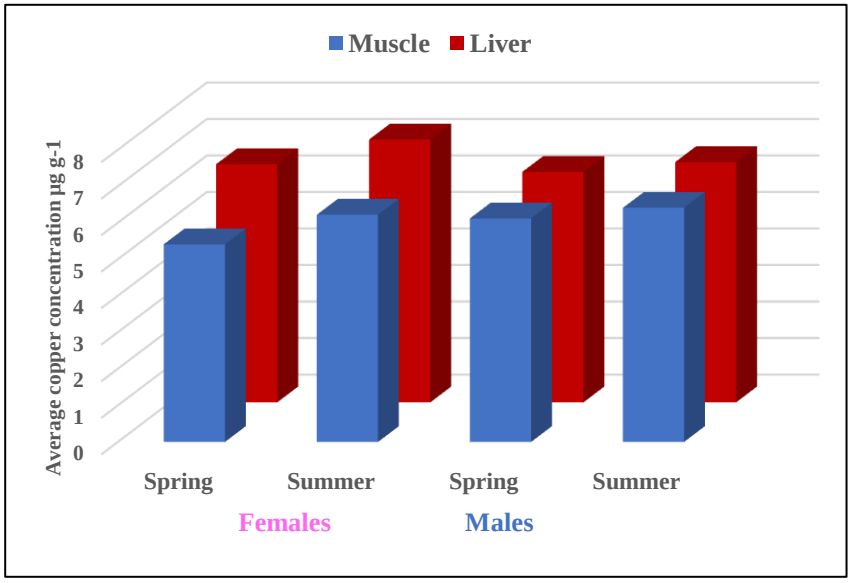

Fig.3. Average seasonal evaluation of copper levels according to organs In the common sole *Solea solea* (Linnaeus, 1758) fished in the bay of Ghazaouet.

The table below, Tab.1, groups together the results of the average concentrations of the two metallic trace elements in the muscle taken from the common sole Solea solea (Linnaeus, 1758) from the Ghazaouet coast compared to maximum admissible doses (MAD).

Tab.1. Comparison of heavy metal contents in dry weight in the common sole *Solea solea* (Linnaeus, 1758) compared to MAD.

		Pb	**Cu**
Present study	**The common sole *Solea solea (Linnaeus, 1758)***	1.31 ± 0.37 µg g^{-1}	6.04 ± 0.44 µg g^{-1}
Fish (MAD)		0.3 to 6 mg Kg^{-1} **(a) (b)**	5 mg g^{-1} **(c)**

(a) G.I.P.P.M (1973) [Interministerial Group on Sea Pollution Problems]

(b) CSHPF (1990) [Higher Council of Public Hygiene of France]

(c) Australian CNRMS (1992) [National Council for Health and Medical Research]

Comparative analysis indicates a higher accumulation of lead and copper in the liver than in muscle tissue (Fig.2 and 3). A similar pattern of trace metal accumulation has been documented in various marine species within this region (Borsali et *al.*, 2014; Belhoucine et *al.*, 2015; Guendouzi et *al.*, 2017; Rouabhi et *al.*, 2019; Kaddour et *al.*, 2021).

Our results suggest an increasing trend in copper and lead concentrations during the summer compared to spring (Fig.3 and 4). The seasonal factor is therefore important and numerous studies have shown that the metal concentrations measured in marine species vary seasonally (Borsali et *al.*, 2015).

The results reported in this present work show an increase in the average accumulation of Pb and Cu in male tissues compared to female tissues (Fig.2 and Fig.3). Sex is one of the predominant biological factors due to the difference in growth between males and females (Belhoucine et *al.*, 2014).

The recorded heavy metal concentrations in the fillets of the studied specimens remain within acceptable limits based on established MAD (Tab.1) and do not pose an immediate health concern.

Conclusion

For two decades now, marine pollution has been a very worrying universal problem. Given the severity of marine pollution, global awareness and policy efforts are increasingly focused on mitigating its impacts through regulatory and conservation measures. Man being the last link in the food chain and the final consumer of marine products can be victims at any time. The bioavailability and toxicity of these trace metals remain a critical concern, as they pose persistent risks to the food chain and public health.

This present work, the interest of which we underline, allows us to take stock of the current situation of the Bay of Ghazaouet in terms of coastal and marine environmental pollution, and although a diagnosis is difficult to establish, our data perfectly illustrate the degradation of this marine environment and the danger it represents in terms of metal pollution.

We conclude that the sole coming from the bay of Ghazaouet does not seem to present a real danger for the consumer, it should be remembered that these micropollutants have a cumulative effect through the trophic chain, and that they have a harmful effect in the long term on public health.

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