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Original Research Article

Mercury Levels Monitoring in Selected Marine Biota in Vlora Bay, Albania

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ABSTRACT

Coastal environments affected by historical industrial activity may accumulate mercury in marine organisms and pose risks to ecosystems and human consumers. The study was motivated by the need to assess whether legacy contamination continues to influence marine biota in the coastal area of Vlora Bay. It was hypothesised that mercury concentrations in selected molluscs and commonly consumed fish species reflect spatial differences in environmental contamination within the bay. Samples of two mollusc species and twelve fish species were collected from several locations and analysed for mercury concentration in tissue using standard laboratory procedures. The results showed low mercury levels in most organisms, with the lowest values recorded at the cleanest station and higher levels observed near the area influenced by past industrial activity. At the same time, fish concentrations remained below recommended limits for human consumption. These findings indicate a limited current risk for moderate consumers, confirm the persistence of localised contamination, and highlight the importance of regular environmental monitoring.

KEYWORDS

Mercury, Vlora Bay, Mytilus Galloprovincialis, Patella Caerulea, Fishes.

INTRODUCTION

A United Nations Environment Programme (UNEP) investigation in Albania identified severe mercury (Hg) contamination at a former chemical complex near Vlora Bay, which included a chlorine-alkali factory. The site and its surrounding environment were found to require urgent remediation due to the extent of pollution. Between 1976 and 1992, approximately 65 tons of mercury were released into the environment [1]. Most of the mercury pollution was caused by the chlorine-alkali unit, where mercury cathode was used for NaCl brine electrolysis and by the PVC unit, where mercury dichloride (HgCl2) was used as a catalyst for the monomer synthesis of vinyl chloride (C2H3Cl) [2]. During their operation (1976–1992), mercury-containing liquid wastes of about 500 m3/h, at 1.1 mg/L, were discharged directly into the sea without treatment [3]. In addition to liquid waste, polluted

sludge was deposited in an open, 25-hectare dump located near the shoreline, further contributing to environmental degradation. According to local reports, at least two workers died from Minamata disease, a severe neurological condition caused by mercury poisoning, and many others experienced premature deaths due to long-term exposure. The factory ceased operations in 1992, but the environmental and public health impacts of its activities remain a concern.

A soil sample showed mercury levels >10,000 mg/kg in the area of the former plant [1]. The most contaminated area was the Electrolysis Plant, with a maximum level of 2472 mg/kg [3]. Comprehensive mercury assessments of the contaminated area were conducted by Geotest (Brno, Czech Republic), which reported mercury (Hg) concentrations in soil of approximately 75 mg/kg [4]. These elevated levels were further confirmed by a subsequent study conducted by Beqiraj *et al*. [5]. Gworek *et al*. point out that environmental contamination by mercury is and will continue to be a serious risk for human health. Pollution of the terrestrial environment is particularly important, as it is a habitat for human life and a site of food production [6]. To address the contamination, a combination of containment measures and remediation strategies was implemented to limit the spread of pollutants and reduce existing environmental hazards. Materials with mercury concentrations exceeding 10 mg/kg, including contaminated soil, sludge, factory debris, underground cables, pipes and chemicals, were encapsulated within a Confined Disposal Facility (CDF), totalling approximately 50,000 m³ of hazardous waste [5]. However, remediation methods for heavy metals in the area around the hot spot, with concentrations below 10 mg/kg, might be effective [7].

Vlora Bay is one of the most significant coastal regions along the eastern shore of the southeastern Adriatic Sea. The bay is bordered by two protected areas: the Narta Lagoon to the north and the Karaburun Peninsula to the south. The Vjosa River, originating in Greece and flowing through much of southern Albania, empties into the northern part of the Narta Lagoon [8]. Recognised as the last wild river in Europe, the Vjosa was recently designated a national park due to its unique ecological value. The coastline of Vlora Bay exhibits two distinct morphological features. The northern section consists of a shallow, sandy, and accumulative coastline, where the former chemical plant was located. In contrast, the southwestern section is characterised by a high, rocky shoreline that supports diverse marine life, including mussels and clams [9].

Despite its rich biodiversity and abundance of flora and fauna, Vlora Bay has experienced significant ecological degradation due to human activities, notably the Soda-PVC Plant and other industrial facilities, situated approximately 5 km from Vlora City and 4 km from the Narta Lagoon [10].

Fishing is an important economic activity for the local population in Vlora Bay, which also hosts Albania's second-largest port. Vlora City has a resident population of around 190,000, but this nearly doubles during the summer months due to tourism. This seasonal population increase leads to a substantial rise in pollution levels. Vlora is considered one of Albania's most attractive destinations, thanks to its natural beauty and historical significance.

The total concentration of heavy metals cannot provide useful information on bioavailability, toxicity, or the capacity for immobilisation in the environment [11]. However, mercury present in contaminated sediments can be transformed into bioavailable forms, making it accessible to aquatic life [12]. There is a tendency that elements introduced with solid waste material are less stably bound than those in natural systems [13]. Elevated mercury levels in sediments do not always correlate with increased concentrations in marine organisms, as the toxicity and bioaccumulation of mercury depend on its chemical form and environmental conditions [14]. Various physicochemical factors influence mercury's toxicity [15]. The highest concentration of methylmercury is associated with organic-rich soils in riparian zones (stream banks) [16]. Frohne *et al*. assessed the effects of various factors on mercury mobility [17]. A comprehensive analysis of factors controlling mercury methylation in aquatic ecosystems was reported by Ullrich *et al*. [18]. Luo *et al*. reviewed advances in microbial

mercury methylation [19]. Methylmercury is particularly concerning due to its strong tendency to accumulate in fish muscle [20], where it often constitutes more than 95% of the total mercury content [21].

Due to decades of pollution from the chlorine-alkali complex, Vlora Bay has become a critical environmental concern. The Minamata disaster in Japan during the 1950s illustrated the severe consequences of mercury emissions on ecosystems and human health [22]. Environmental contamination by mercury remains a growing problem [23]. Despite this, Vlora Bay lacks a comprehensive and ongoing mercury monitoring program. The first assessments of heavy metals, including mercury, in sediments, biota, and macroalgae were conducted under the Programme for the Assessment and Control of Marine Pollution in the Mediterranean [24]. Çoçoli *et al*. reported mercury concentrations of 0.712 mg/kg in Vlora Bay sediments, the highest levels recorded along the Albanian Adriatic coast, compared to the background mercury level of 0.0167 mg/kg [25]. However, the highest concentration reported in the Northern Adriatic is in sediments, ranging from 0.02 to 8.63 μg/g dry wt [26]. The Biomercury project (2005–2006) investigated the use of bacteria to remove mercury from a heavily contaminated PVC plant site in Vlora, Albania. [27]. However, the dumped sludge remained near the shore for a long time, with no precautions taken to prevent further contamination of the bay or nearby residents [28]. While reports are available on Hg concentrations in water and sediment along the Adriatic Sea Coast [29], limited research has focused on mercury accumulation in algae, fish and molluscs [30]. In 2011, Corsi *et al*. conducted an integrated ecotoxicological study in Vlora Bay, evaluating bioaccumulation and biomarker responses in sea urchins, mussels, and fish [31].

This study aims to assess mercury concentrations in the mussel *Mytilus galloprovincialis*, the limpet *Patella caerulea*, and twelve fish species commonly consumed by the population of Vlora. The generated data contribute to understanding mercury bioaccumulation patterns in coastal marine food webs and provide essential information for environmental monitoring and for assessing potential human exposure through seafood consumption. In addition to the analysis of marine organisms, two soil samples were collected and analysed from the area of the former chlor-alkali plant in Vlora following the remediation of the contaminated site. The inclusion of soil samples is important in order to evaluate the current status of residual mercury contamination in the terrestrial component of the former industrial area and to provide a reference for the effectiveness of the remediation measures implemented in recent years. Former chlor-alkali facilities are widely recognised as long-term sources of mercury contamination due to the historical use of mercury-cell technology, which often led to substantial releases into surrounding soils and sediments. Even after remediation actions, localised hotspots of contamination may persist and represent potential secondary sources of mercury to the adjacent coastal environment through surface runoff, groundwater transport, or sediment resuspension. Therefore, the analysis of soil samples from the remediated area provides an important complementary line of evidence for interpreting mercury levels observed in nearby marine organisms and contributes to a more comprehensive assessment of the environmental legacy of the former industrial activity in Vlora Bay.

MATERIAL AND METHODS

This section describes the study area, sampling procedures, analytical methods, and statistical analysis used in this study.

Study Area and Sampling Stations

The study was carried out in Vlora Bay, Albania, a coastal area historically affected by mercury releases from a former chlor-alkali and PVC industrial complex. Seven stations were selected to represent locations with different expected contamination levels. Stations S1–S5 were located within Vlora Bay, whereas S6 (Porto Palermo) and S7 (Butrint Lagoon, Saranda)

were used as reference stations. **Figure 1** shows the location of the sampling stations, defined as follows: S1, Petrolifera, directly in front of the former chlor-alkali plant; S2, Military Marine Academy, where only *Patella* specimens were collected; S3, Kristera Hotel, near the main drinking-water intake area of Vlora; S4, Bova, a buoy station close to S3; S5, Karaburun Peninsula, a comparatively undisturbed military-restricted area; S6, Porto Palermo; and S7, Butrint Lagoon, where mussels were farmed under natural conditions.



Figure 1. Sampling stations

Sampling Design and Sample Collection

The sampling campaign was conducted during 2023 and 2024. Specimens of *Patella caerulea* and *Mytilus galloprovincialis* were collected manually from rocky coastal sites and placed in plastic bags containing seawater for transport to the laboratory. The samples were collected randomly at each station to provide representative coverage of the local population. More than 50 individuals of *Patella caerulea* were analysed from six stations (S1–S6). At station 7, *Patella caerulea* has not been found. Limpets from the genus *Patella* typically inhabit rocky coastal environments. In the Mediterranean Sea, this genus includes four species: *P. caerulea*, *P. ulyssiponensis*, *P. rustica*, and *P. ferruginea* **[32]**. *P. caerulea* (Linnaeus, 1758), endemic to the Mediterranean, is one of the most common species found on rocky shores **[33]**. In addition, intraspecific genetic variation has been reported in Mediterranean *P. caerulea* in response to changing hydrodynamic conditions **[34]**. Its presence extends to the rocky areas of Vlora Bay and the Ionian Sea coast.

A total of 33 individuals of *Mytilus galloprovincialis* were collected from six stations (S1 and S3–S7); mussels were not found at station S2. The collected *Mytilus galloprovincialis* specimens ranged from 2.9 to 4.7 cm in shell length, whereas *Patella caerulea* ranged from 1.3 to 4.3 cm. In the laboratory, samples were frozen at –20 C until analysis. Only the soft tissue of each individual was used for mercury determination; no pooled or composite samples were prepared.

Fish samples were obtained from local fishermen in Vlora, Durres, and Saranda during 2023–2024. Fifty four individuals representing 12 species were analysed. Each fish was identified before dissection, and muscle tissue was separated from the bone while keeping the skin attached to the muscle. Tissue samples were placed in polyethylene bags and immediately frozen. All biological samples were analysed for total mercury on a wet-weight basis.

In addition, two series of soil-core samples were collected from the remediated industrial area: one from the former electrolysis plant and one from the former catalytic plant. These samples were used to evaluate residual mercury in the terrestrial component of the former industrial hotspot.

Reagents *and Instrumentation*

All reagents used in this study were of high-purity grade (Suprapur, Merck, Germany), and Milli-Q water was used throughout the analytical procedure. Mercury concentrations were determined with a laboratory-constructed cold-vapour atomic absorption system coupled to an Analytik Jena Model 800 F instrument (Germany).

Sample Digestion and Mercury Determination

Validated digestion procedures were applied for both biota and soil in accordance with the Marine Environment Studies Laboratory standard operating procedures [35]. Approximately 1.0–1.5 g of each biological sample was digested with concentrated nitric acid. To ensure complete oxidation of mercury species to the inorganic form, the oxidation step was strengthened by adding bromine monochloride or dichromate ions. Mercury was quantified by absorbance spectroscopy using the standard-addition method.

During digestion, nitrogen oxides produced spectral interference even when deuterium-background correction was used. This interference was minimised by bubbling air through the reducing cell for 1 min before the addition of the reducing agent. Soil samples were digested and analysed by the same analytical principle [35].

Quality Assurance and Quality Control

Analytical accuracy was checked using the certified reference material IAEA-407 Fish. Recovery values for mercury ranged from 83% to 96%, confirming acceptable analytical performance. Procedural blanks showed no evidence of contamination. The use of individual samples, certified reference materials, blanks, and matrix compensation via the standard-addition method enhanced the reliability and repeatability of the measurements.

Statistical Analysis

Descriptive statistics were calculated for each species and station. Before analysis of variance, the assumptions of normality and homogeneity of variances were assessed using the Shapiro-Wilk and Levene tests, respectively. Differences among stations or species were evaluated by one-way analysis of variance, followed by Tukey's honest significant difference post hoc test when the overall test was significant. Statistical significance was defined at $p < 0.05$. Statistical analyses were performed using StatSoft Statistica 12.

RESULTS AND DISCUSSION

This section presents and discusses the main findings of the study regarding mercury distribution across the investigated environmental compartments. The results are structured to address mercury concentrations in remediated soils and in marine biota (molluscs and fish), and their spatial variability across the selected sampling stations. Statistical analyses are applied to evaluate differences among species and locations, providing insight into potential contamination patterns and sources. The findings are further interpreted in the context of existing literature to assess the persistence of historical pollution and its implications for environmental quality and food safety.

Mercury Concentration in the Remediated Area of the Chlor–Alkali Plant

Two core soil samples were collected from the areas historically identified as the most contaminated zones of the former electrolysis plant (series 1, Figure 2) and the catalytic plant (series 2, Figure 2), both located within the former chlor-alkali industrial complex that has undergone remediation in recent years. These locations were selected because they were previously associated with intensive industrial activities and were therefore considered potential hotspots of mercury contamination. The measured mercury concentrations in the analysed samples ranged from 0.023 to 0.076 µg/g.

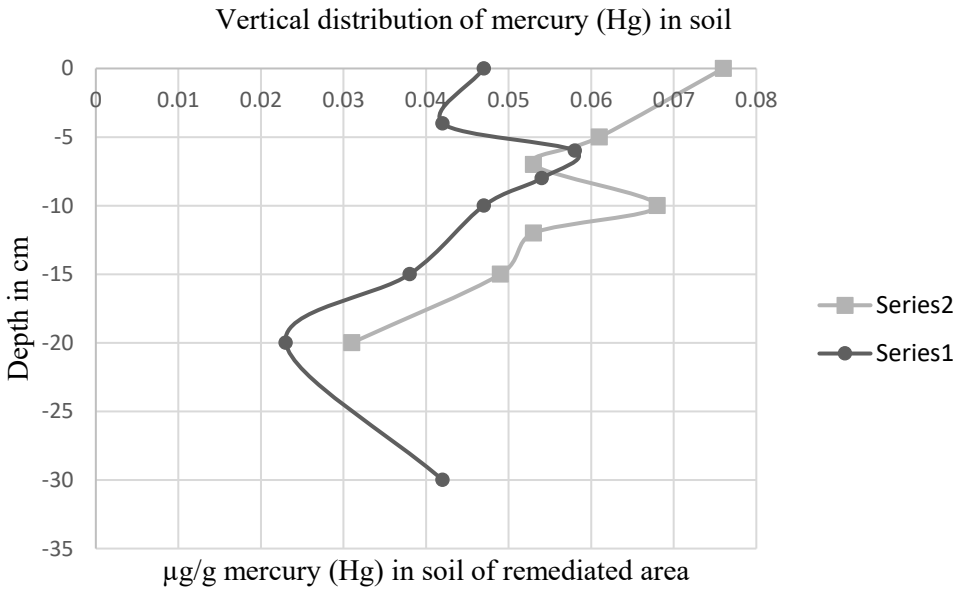


Figure 2. Mercury (Hg) concentration in the soil of the former Soda Chlor-Alkali Plant.

These values are relatively low and indicate that the remediation measures implemented at the site have been highly effective in reducing residual mercury contamination in surface soils [6]. Numerical sediment quality guidelines (SQGs) for freshwater ecosystems have previously been developed [36]. In our study, to better evaluate the environmental significance of these concentrations, the results were compared with international sediment quality guidelines. In particular, the measured values were assessed against the Threshold Effects Level (TEL = 0.13 µg/g) established by the National Oceanic and Atmospheric Administration (NOAA). All measured concentrations were well below the TEL value, suggesting that the current levels of mercury in the remediated soils are unlikely to cause adverse ecological effects. This finding is particularly important for post-industrial coastal environments where historical mercury use in chlor-alkali processes has often resulted in persistent contamination of soils and sediments [37].

Although only a limited number of soil cores were analysed, the results provide valuable supporting evidence that the remediation efforts at the former industrial site have significantly reduced the potential for mercury release to the surrounding environment. Moreover, these findings complement the analysis of mercury concentrations in marine organisms conducted in the present study, contributing to a more comprehensive assessment of the environmental legacy of the former industrial activity in the coastal area near Vlora.

Mercury Content in Patella Caerulea

Table 1 presents the descriptive statistics for mercury (Hg) concentrations in *Patella caerulea*. The results indicated that mercury concentrations in *P. caerulea* at all sampling stations were below the maximum allowable limit for food safety (0.5 µg/g wet mass). This situation suggests that prolonged mercury release from sediments has not significantly increased mercury accumulation in local biota. Consequently, they are safe for human consumption [38]. The relatively low mercury levels detected, even near previously contaminated sites, could be due to mercury converting to highly insoluble forms such as mercury sulfide (HgS), which has a solubility product constant of approximately 10^{-53} [39]. This transformation reduces mercury's bioavailability and its potential entry into the food chain [14].

Table 1. Descriptive statistics for Patella caerulea, µg/g wet mass

Station	Mean. conc. [µg/g]	Max. conc. [µg/g]	No. of individuals	St. dev. [µg/g]
S1	0.053	0.084	13	0.0189
S2	0.035	0.048	7	0.0082
S3	0.020	0.035	11	0.0103
S4	0.023	0.036	7	0.0067
S5	0.028	0.037	5	0.0063
S6	0.026	0.033	7	0.0066
All groups	0.033	0.084	50	0.0173

In all cases, prior to performing analyses of variance (ANOVA), the assumptions of normality and homogeneity of variances were evaluated using the Shapiro-Wilk and Levene tests, respectively. The results showed that the data did not significantly deviate from normality and that variances were homogeneous ($p > 0.05$). Analysis of variance for *Patella caerulea* was applied to determine whether significant differences exist in the mean mercury) concentrations among the selected sampling stations. The results are shown in **Table 2**. When the p-value is less than the 0.05 significance threshold, the null hypothesis is rejected, indicating that the observed differences in mean mercury concentrations are statistically significant. Although the mercury concentration at station S1 did not reach the critical significance level, it was notably higher compared to other stations. The mean mercury concentration at S1 was significantly different from that at stations S2, S3, S4, S5, and S6, with p-values of 0.0258, 0.0001, 0.0002, 0.0039, and 0.0003, respectively.

Table 2. Analysis of variance (ANOVA) results; significant value 0.05

Tukey HSD test; variable Hg [µg/g], *Patella Caerulea*, results and stations; approximate probabilities for post hoc tests error: between MS = 0.00015, df = 44.000						
Stations	(1) 0.053	(2) 0.035	(3) 0.020	(4) 0.023	(5) 0.028	(6) 0.260
S1		0.0258	0.0001	0.0002	0.0039	0.0003
S2	0.0258		0.1516	0.4553	0.9360	0.687
S3	0.0001	0.1516		0.9974	0.8278	0.953
S4	0.0002	0.4553	0.9974		0.9754	0.999
S5	0.0039	0.9360	0.8278	0.975		0.998
S6	0.0003	0.6870	0.9533	0.999	0.998	

These results suggest that historical mercury deposition at station S1 may still contribute to moderately elevated mercury levels in *Patella caerulea* collected from this site. The highest mercury concentration was recorded at station S1 (0.084 µg/g), followed by station S2 (0.048 µg/g), which is situated near the Naval Military Academy – an area still affected by illegal urban wastewater discharges.

Interestingly, the lowest average mercury concentration (0.020 µg/g) was detected at station S3, rather than at reference sites such as Porto Palermo or the Karaburun Peninsula. It had been expected that the military base area would represent the cleanest site, due to its relatively greater distance from the former soda factory. However, this area may still be influenced by past and ongoing military-related activities, including mechanical operations and the construction or maintenance of small military vessels, which could contribute to local contamination. In addition, the sampling site near the Karaburun Peninsula is located close to a fish farming facility, which may represent an additional local source of organic matter and

trace elements through aquaculture-related activities. In contrast, station S3 appears to be characterised by relatively cleaner seawater conditions, likely influenced by substantial inputs of freshwater from nearby mountainous catchments that may dilute contaminants before they reach the coastal zone. Moreover, this station is located close to the drinking water intake area supplying Vlora, which further supports the interpretation that this site is subject to comparatively lower levels of pollution.

Mercury Content in Mytilus Galloprovincialis

The mercury concentration results for *M. galloprovincialis* are presented in **Table 3**. The use of bivalve organisms as bioindicators for assessing chemical pollution in estuarine environments began in the early 1970s. Notably, Goldberg (1975) introduced the "Mussel Watch" program, describing it as a method to evaluate ocean health **[40]**.

Table 3. Descriptive statistics for Mytilus galloprovincialis, µg/g wet mass

Station	Mean. conc. [µg/g]	Max. conc. [µg/g]	No. of individuals	St. dev. [µg/g]
S1	0.050	0.076	6	0.021
S3	0.019	0.057	6	0.019
S4	0.025	0.049	7	0.014
S5	0.041	0.054	4	0.011
S6	0.019	0.026	5	0.006
S7	0.018	0.028	5	0.008
All groups	0.028	0.076	33	0.019

Farrington *et al*. reflect on 40 years of the "Mussel Watch" program, reviewing its evolution, effectiveness, and scientific impact in monitoring coastal water contamination using bivalves **[41]**. In Albania, mussels were first employed as bioindicators in the early 1990s. Upon comparison of our data on *Mytilus galloprovincialis* with previously obtained results for the same species collected in Durrës, Vlorë, and Sarandë, no statistically significant differences were observed **[30]**.

Similar to findings for *Patella caerulea*, analysis of variance (**Table 4**) revealed significant differences in mean Hg concentrations at station S1 compared to other stations. The highest mercury concentration was detected at station S1 (0.076 µg/g), while the lowest mercury concentration was observed at station S3 (0.010 µg/g). In contrast, station S5 showed no statistically significant differences in mercury (Hg) levels when compared with the other stations.

Table 4. Analysis of variance (ANOVA) results; significant value 0.05

Tukey HSD test; variable Hg [µg/g], *Mytilus galloprovincialis* results and stations; approximate probabilities for post hoc tests error: between MS = 0.00022, df = 27.00						
Stations	(1) 0.050	(2) 0.018	(3) 0.0245	(4) 0.0410	(5) 0.0188	(6) 0.0177
S1		0.012	0.048	0.932	0.019	0.014
S3	0.012		0.978	0.215	1.00	0.999
S4	0.048	0.978		0.502	0.98	0.967
S5	0.932	0.216	0.501		0.256	0.213
S6	0.019	1.000	0.984	0.256		0.999
S7	0.015	0.999	0.967	0.213	0.999	

Overall, the data on mercury accumulation in both *Patella caerulea* and *Mytilus galloprovincialis* provide no evidence of mercury contamination in seafood from historical elemental mercury pollution in the area. This absence of significant contamination may be due to the mercury in sediments, which exists primarily in elemental or inorganic forms that are poorly bioavailable to marine organisms and thus unlikely to enter the food chain.

Mercury Content in Fish from the Albanian Coast

The analysed fish ranged in mass from 15 to 500 grams. No significant correlation was observed between fish mass and mercury concentration. Most species exhibited average mercury content below 0.06 µg/g. **Table 5** shows the mercury concentrations and descriptive statistics for the fish.

Table 5. Descriptive statistics for fish, sampling size N=54

Descriptive statistics (Spreadsheet fish)					
Level factor	N	Mean [µg/g]	St. dev [µg/g]	–95.0% [µg/g]	+95.0% [µg/g]
	54	0.07	0.067	0.051	0.088
Dicentrarchus labrax	7	0.060	0.026	0.036	0.084
Mugil cephalus	3	0.024	0.001	0.022	0.026
Merluccius merluccius	5	0.036	0.014	0.019	0.054
Sparus aurata	5	0.046	0.011	0.033	0.059
Engraulis encrasicolus	4	0.019	0.004	0.012	0.026
Mullus surmuletus	7	0.04	0.034	0.009	0.071
Lithognatus mormyrus	4	0.046	0.016	0.022	0.071
Squalus acanthias	3	0.172	0.042	0.067	0.276
Trigla lyra	4	0.154	0.038	0.093	0.215
Sphyraena sphyraena	5	0.175	0.125	0.019	0.330
Octopus vulgaris	2	0.044	0.028	0.210	0.298
Solea sp.	5	0.046	0.022	0.018	0.074

But, among the analysed species, three predatory fish, *Trigla lyra*, *Sphyraena sphyraena*, and *Squalus acanthias* showed higher average mercury levels compared to other species, with mean content of 0.154, 0.175, and 0.172 µg/g mercury, respectively. Some individuals of these species exhibited even higher mercury levels, with maxima of 0.207, 0.394, and 0.210 µg/g mercury, respectively. Statistical analysis using analysis of variance confirmed a significant difference in Hg concentrations between the three predatory species, *Trigla lyra*, *Sphyraena sphyraena*, and *Squalus acanthias* and the other analysed fish species (**Table 6**). According to FDA/EPA fish consumption guidelines, most fish species analysed from the Albanian Coast fall under the "Best Choices" category (less than 0.15 µg/g mercury), which recommends consuming 2–3 servings per week **[38]**.

However, *Trigla lyra*, *Sphyraena sphyraena*, and *Squalus acanthias* are classified in the "Good Choices" category, which limits consumption to one serving per week. Fish with average Hg concentrations exceeding 0.46 µg/g mercury are categorised as "Choices to Avoid" by Food and Drug Administration / Environmental Protection Agency (FDA/EPA) guidelines **[38]**.

In addition, it has been reported that frequent consumption of large predatory fish, such as swordfish, tuna, and halibut, may significantly increase methylmercury intake, potentially exceeding the tolerable weekly intake (TWI) **[42]**.

Table 6. Analysis of variance (ANOVA) results; significant value 0.05

Tukey HSD test; variable Hg [µg/g] (Spreadsheet fish); approximate probabilities for post hoc tests error: between MS =.00206, df = 42.000												
Fish species	.060	.024	.036	.046	.019	.039	.046	.171	.154	.175	.044	.046
Dicentrarchus labrax		0.99	0.99	0.99	0.94	0.99	0.99	0.038	0.071	0.005	0.99	0.99
Mugil cephalus	0.99		1.0	0.99	1.0	0.99	0.99	0.01	0.02	0.002	0.99	0.99
Merluccius merluccius	0.99	1.0		1.0	0.99	1.0	1.0	0.01	0.06	0.001	1.0	1.0
Sparus aurata	0.99	0.99	1.0		0.99	1.0	1.0	0.02	0.04	0.003	1.0	1.0
Engraulis encrasicolus	0.94	1.0	0.99	0.99		0.99	0.99	0.003	0.01	0.001	0.99	0.99
Mullus surmuletus	0.99	0.99	1.0	1.0	0.99		1.0	0.01	0.01	0.001	1.0	1.0
Lithognatus mormyrus	0.99	0.99	1.0	1.0	0.99	1.0		0.03	0.06	0.006	1.0	1.0
Squalus acanthias	0.04	0.01	0.01	0.02	0.003	0.01	0.034		0.99	1.0	0.12	0.02
Trigla lyra	0.07	0.02	0.016	0.04	0.006	0.01	0.06	0.99		0.99	0.21	0.039
Sphyraena sphyraena	0.01	0.002	0.001	0.003	0.001	0.001	0.006	1.0	0.99		0.05	0.003
Octopus vulgaris	0.99	0.99	1.0	1.0	0.99	1.0	1.0	0.12	0.21	0.052		1.0
Solea sp.	0.99	0.99	1.0	1.0	0.99	1.0	1.0	0.02	0.04	0.003	1.0	

Based on the results and in reference to the new EU regulation, the average mercury concentrations in the analysed fish samples were below the recommended permissible limits. However, one *Sphyraena sphyraena* individual exceeded the maximum mercury limit established by the latest EU regulation [43]. In Albania, public awareness of the risks associated with methylmercury in seafood is low. This situation is particularly concerning for vulnerable groups such as women and children, who are more sensitive to mercury exposure. It is essential to provide information on the potential health risks of consuming seafood with elevated mercury levels.

CONCLUSIONS

The contents of Hg in *Mytilus galloprovincialis***,** *Patella caerulea* and fishes did not show critical values. However, given that over a 16-year period, the total mercury released into the environment was estimated at approximately 65 tons, continuous monitoring is essential, especially during activities such as port dredging, as these activities may mobilise mercury into more bioavailable and toxic forms. We recommend establishing a comprehensive monitoring program to track mercury levels in soil, water, and biota over multiple years. Climate change may also influence mercury cycling and mobility, particularly in wetlands and coastal areas; consequently, understanding the biogeochemical cycling of mercury to assess its mobility and bioavailability at the remediated site is important. Encouraging interdisciplinary research that combines ecology, toxicology, social sciences, and environmental engineering to address the complex problems of mercury contamination is a serious challenge.

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