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Preliminary investigation of candidate specimens for the Egyptian Environmental Specimen Bank

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Abstract

In the frame of establishing an environmental monitoring program related to environmental specimen banking in Egypt, some candidate specimens from the aquatic environment (fish muscle, fish liver; mussels) were investigated. The selection of specimens and sampling sites is described. Specimens are chemically characterised with respect to some major and trace elements and the results are compared with data obtained from comparable specimens collected in aquatic ecosystems of Germany.

Key words: element determination, environmental monitoring, environmental specimen bank, mussels, fish,

Introduction

Environmental specimen banking (ESB) allows to create a systematic repository of representative environmental specimens, which are collected regularly from different ecosystems, and stored at low temperature (< -150 °C) so that chemical changes can be avoided over a period of at least several decades [1, 2]. It is suitable for identifying environmental changes since the time of sampling independently from the availability of analytical methods at that moment. It also allows retrospective investigations of compounds, which were not yet known at the time of sampling or have not been considered to be significant. Furthermore, an Environmental Specimen Bank can contribute to the following tasks: continuous monitoring of the concentrations of currently known pollutants by the systematic characterisation of specimens prior to their storage, determination of trends of local, regional, and national developments in pollutant load and provision of reference specimens for analytical process developments and specimens for analytical process developments and quality control. Since the concentration of environmentally relevant substances in the individual compartments of the environment (e.g. air and water) is usually low, the role of representative biological samples with a considerable enrichment ability for the environmentally interesting substances increases. They should be to some extent tolerant, well adopted and respond to the changes of substance's concentration [3].

The aim of the work is the comparison between fish and mussel samples collected under controlled conditions (Standard Operating Procedures, SOPs) in Egypt and similar specimens collected in aquatic ecosystems of Germany.

Sampling areas and specimens

A network of ecologically significant areas in Egypt including the principal ecosystems are considered for the future phase of an Egyptian Environmental Specimen Bank. For this work the investigation of two sampling sites with possibly elevated contamination burden is described (Fig. 1). The River Nile as a limnic ecosystem is the main water source in Egypt and should be regularly controlled for contamination from industrial, municipal, and agricultural wastes. Muscle and liver of eel (*Anguilla anguilla* L.) were sampled from Giza as a middle point between upper Egypt and the Nile Delta. The Suez Canal affected by high shipment traffic was chosen to be a sampling site with elevated pollution. Trout (*Salmo trutta* L.) muscles were collected from El-Ismailiah city while common mussel (*Mytilus galloprovincialis* L.) samples were collected from El-Suez city. These specimens are dominant in the chosen sampling areas and are comparable with samples collected in Germany.

Sampling of specimens, transportation, storage and characterization of samples are performed according to the Standard Operating Procedure (SOPs) of the Federal Environmental Specimen Bank of Germany (FESB) [4, 5].

Sampling, sample processing and storage

Mussel

Mussels of about 3-4 cm length were sampled, washed in sea water and transported in polyethylene containers to the laboratory to be dissected [6]. The tissue (about 315 g) was then transported in a special glass container in the gaseous phase above liquid nitrogen at temperatures < -140 °C to the ESB Juelich, Research Centre Juelich, Germany, to be homogenized and stored [5]. The water content of mussel tissue samples was measured to be about 80.5%.

Fish

The biological data of the sampled fish as length, fresh weight, sex, and mass of muscles are presented in Table 1. Fishes were transported alive - in sea- / river water - to the laboratory, dissected, and directly deep frozen in the gaseous phase above liquid nitrogen [5]. All individuals from one sampling area were combined together to produce a representative fish sample. These samples were transported under cryogenic conditions to the ESB in Juelich. There, they were homogenized and stored/according to the FESB guidelines [5]. The water content of fish muscles sampled from the Suez Canal and the River Nile was measured to be 78.4 % and 81.3 %, respectively.

Methods

The initial chemical characterization of the samples included the following elements: As, Ba, Ca, Cd, Co, Cu, Fe, K, Mg, Mn, Na, Ni, P, Pb, S, Se, Sr, and Zn. For analytical sample preparation, all freeze-dried samples were digested using nitric acid (0.2 g sample and 2 ml HNO_3) in a high pressure digestion system (digestion temperature 300°C for mussels or 320°C for fish). For the determination of Ni and Co, adsorptive stripping voltammetry (AdSV) was used while for Cd and Pb differential pulse anodic stripping voltammetry (DPASV) was performed using 693 VA Processor with 695 Autosampler (Metrohm, Germany). The digested samples were also analysed for Ba, Ca, Cu, Fe, Mg, Mn, Na, P, S, Sr and Zn using an inductively coupled plasma atomic emission spectrometer (OPTIMA 3000

DV and PLASMA 40, Perkin Elmer, Germany). Arsenic and selenium were determined by hydride generated atomic absorption spectrometry (AAS 4100, Perkin Elmer, Germany). The detailed analytical parameters are described elsewhere [5, 7].

Results and Discussion

Mytilus galloprovincialis L.

Information is accruing on trace element content of many marine molluscs in various areas of the Mediterranean Sea [8-10] but there is a definitive lack of data from species in Egypt. Element concentrations found in mussel tissue collected from El-Suez city are presented in Table 2. However, trace element concentration in these organisms can be influenced by many environmental and biological factors which must be carefully considered. Due to the one time sampling no seasonal fluctuations could be studied and the comparison with literature data can only be an indication and help for future investigations. From the presented data it is obvious that the concentrations of Sr and Ca were higher in mussels from Egypt than found in mussels from the North Sea [12]. The opposite situation for sodium allows the assumption that these differences are connected with the different concentrations of these elements in the surrounding waters. High concentrations of phosphorus found in mussels from Egypt can indicate the water pollution by fertilizers. Elevated values (up to 300 µg/g d.w.) for manganese were found by Regoli and Orlando [9] in digestive gland of *Mytulis galloprovincialis* from polluted areas. Lower values for Zn, Cd, and Pb found in sample from Egypt indicated that no significant heavy metal input into the ecosystem exists in the sampling area. Only for Mn, P and As perhaps a pollution problem may occur.

Fish

Table 3 shows the concentration of some of the bulk and trace elements among two different bioindicators, trout muscles, and eel liver from Egyptian sampling sites. Similar concentrations in both bioindicators were found for following elements: Fe, Mg, K, P, S, and Pb. In the liver sample low values with increasing difference were obtained for Zn, Na, Ca, Sr, and As. These data are being in accordance with the results presented by Gomaa [13] where the concentration of Zn in fish muscles from the Suez is less than that in the Nile River. A comparison between element concentrations in trout muscle with the bream muscle (*Abramis brama* L.) from the River Rhine (Table 3) demonstrates that in the sample from

Egypt elevated levels were observed for Zn, Ca, Na, and As.

The concentration of As in fish liver was about 3.9 % of that measured in muscle while the concentration of As in fish muscle presented 6.2 % of what has been detected in mussel. In Fig. 3 three selected bioindicators are presented with respect to their As concentration.

Conclusions

Using nearly the same sampling techniques and processing the sampled material according to accepted guidelines such as the Standard Operating Procedures of the Federal Environmental Specimen Bank of Germany allows the comparison not only of data but although the comparison of material which is unchanged in its composition because of using techniques such as the cryogenic cooling chain from the sampling to analytical sample characterisation. From all the analyzed elements in the Egyptian samples only As was found in the mussels and also in the fish muscle in elevated concentrations in comparison with literature data. Further studies should be invented to identify the source of this findings.

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Tables

Table 1: Biological data of Egyptian fish samples

location	specimen no.	total weight [g]	muscles mass [g]	length [cm]	sex
Suez	S 1	18	6	10.0	m
Suez	S 2	25	4	11.5	m
Suez	S 3	21	2	11	f
Suez	S 4	24	4	11.5	f
Suez	S 5	23	3	11	m
Suez	S 6	22	5	10.5	f
Suez	S 7	22	4	10.5	f
Suez	S 8	16	2	10	m
Suez	S 9	17	4	9.5	f
Suez	S 10	15	4	9	m
Suez	S 11	27	6	11.5	m
Suez	S 12	24	5	12	f
Nile	N 1	235	86	27	f
Nile	N 2	162	57	28	m
Nile	N 3	253	95	34	m

m = male, f = female

Table 2: Concentration of trace elements based on dry weight in soft parts of *Mytilus* from El-Suez city (n = 4)

Element	**c** [μg/g]	**RSD** [%]	**Literature** [μg/g]
Zn	49.5	4.9	97-644 [8]
Ba	3.5	8.1	
Mn	319.5	6.33	3.3 – 70 [8]
Fe	301.5	3.9	150 –2220 [8]
Sr	178	3.4	25- 30 [10]
Ca	26.9×10^3	4.9	$(2.8 - 8.8) \times 10^3$ [11,12]
Na	20.9×10^3	2.9	$(27 - 74) \times 10^3$ [11,12]
Mg	5.38×10^3	4.6	$(4.2 - 10.2) \times 10^3$ [11,12]
K	13.4×10^3	3.6	$(8.8 - 13.6) \times 10^3$ [11,12]
P	15.1×10^3	5.3	$(6.1 - 7.6) \times 10^3$ [11,12]
S	21.6×10^3	1.7	$(16 - 20) \times 10^3$ [11,12]
As	25.9	3.9	(7.8 – 16.5) [11,12]
Se	2.97	1.7	2 –4 [11]
Cd	0.221	2.4	0-4 – 5.9 [8]
Pb	1.99	5.5	2.7 – 117 [8]
Cu	7.1	10	2.4 – 154 [8]
Ni	7.13	3.7	0.9 – 14.1 [8]
Co	2.11	3.3	0.5 – 7.4 [8]

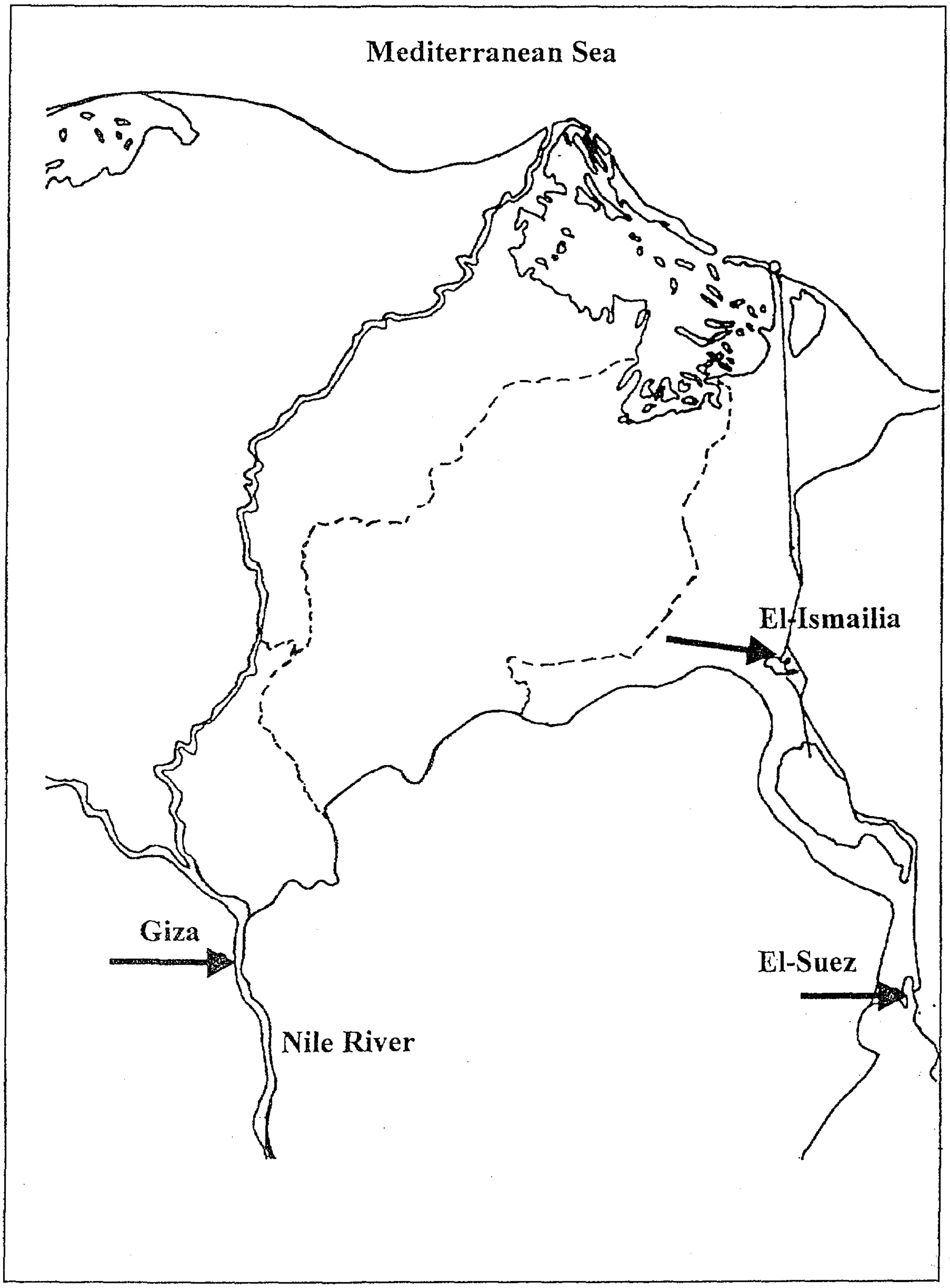
Table 3: Mean concentrations of trace elements based on dry weight in trout muscle (*Salmo trutta* L.) from Suez and eel liver (*Anguilla anguilla* L.) from river Nile (n = 4)

Element	**Trout muscle** [μg/g]	**Literature** [11]	**Eel liver** [μg/g]
Zn	40.1	15 –23	25.8
Fe	32.9	24 - 42	30.6
Sr	37.2		3.84
Ca	6.57×10^3	$(1.6 - 3.3) \times 10^3$	1.13×10^3
Na	4.58×10^3	$(1 - 2) \times 10^3$	1.2×10^3
Mg	1.9×10^3	$(1.2 - 1.4) \times 10^3$	1.52×10^3
K	18×10^3	$(14 - 19) \times 10^3$	20.1×10^3
P	13.2×10^3	$(9 - 13) \times 10^3$	10.4×10^3
S	12.3×10^3	$(9 - 12) \times 10^3$	9.77×10^3
As	1.6	0.3 – 0.6	0.062
Pb	0.25		0.25

Figure captions

Fig. 1: Location of fish and mussel sampling sites in Egypt.

Fig. 2: Concentrations of As in Egyptian fish liver, fish muscles and mussel.


Mediterranean Sea
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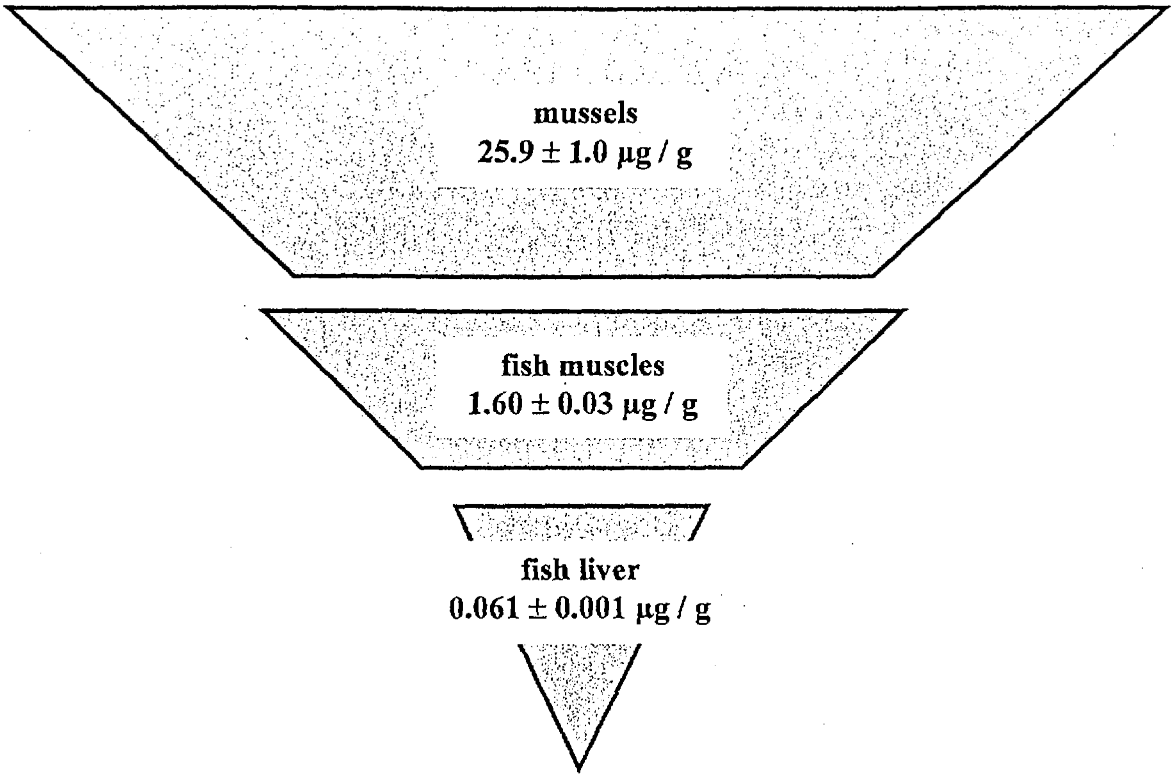
mussels
25.9 ± 1.0 μg / g
fish muscles
1.60 ± 0.03 μg / g
fish liver
0.061 ± 0.001 μg / g