



## Rare heavy metals accumulation of ascidians in vizhinjam bay, southwest coast of India

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### Abstract

Heavy metals in the wrong place at the wrong time and in wrong concentration can be extremely noxious. Metals are integral components of the environment and of living matters. Some have beneficial biological influence, when present in certain concentration. The capacity of organisms to accumulate metals from the environment is well known, although variations exist in the extent of accumulation between species. The levels of metals in the organisms could be used as an index in assessing the quality of the environment. Further-more, the presence of heavy metals like Cd, Pb and Hg in the marine environment has strong effects on the ecology of the area affecting, shifting (or) destroying, sensitive populations leaving hardy organisms to dominate and proliferate in great number. Concentration of heavy metals in the seawater and animal tissues may not be high enough to kill the organisms but are presumably sufficient to destroy their food and have physiological, teratogenic, mutagenic and carcinogenic effects on organisms. Therefore, it is essential to study the bio-accumulation of metals in some organisms of ecological importance. Present study has been undertaken to understand the distribution pattern of heavy metals of Ascidians in Vizhinjam Bay.

**Keywords:** heavy metal, vizhinjam bay, ascidians, bioaccumulation

### Introduction

Ascidians are marine sedentary organisms – commonly called “Sea Squirts” because of their habit of squirting a jet of water when disturbed. They are found distributed from the littoral zone to the deep sea. The most important characteristic features of ascidians is the presence of a protective outer covering called test or tunic, tailed free swimming larva during development and the notochord in the tail region of the larva. They are broadly classified into two groups - the simple ascidians which are solitary living singly and the colonial ascidians in which many individuals called zooids live together to form a colony. In the present study determined the heavy metal abundances in seawater from the study site in order to quantify their relation to heavy metal content in the corresponding ascidians.

#### 1. Metal Concentration in Ascidians

Studies on concentration, distribution, sedimentation and accumulation of metals in the natural environment and in living organisms are of greater importance as they are interlinked with the health of human beings through a food chain. As per the available literature (Cain Luoma, 1990 and Badsha, 1991) <sup>[4, 5]</sup>, benthic organisms are highly prone to intake metals as they are closely contacted with the sediments. Ascidians are one such group of the organisms which is prone to accumulate over indulgence of metals in their body tissues than that of the environment. Owing to the presence of sedentary mode of life, primitive mode of ciliary, filter and mucous feeding, presence of specialized tunicrome and vanadocytes in the blood and lack of the kidney, the possibility of accumulation of metals in the body of tunicates is more. Some species of ascidians are spectacular in accumulating certain metals such as

Vanadium (Henze, 1911; Michibata, 2003; Abdul Jaffar Ali, 2014 <sup>[2]</sup> and Tamilselvi *et al.*,2010) <sup>[19]</sup>, Iron (Webb *et al.*,1981; Maria agudelo, 1983) <sup>[20, 13]</sup> Chromium (Levine, 1961) <sup>[12]</sup> Cadmium, Lead and Mercury (Meenakshi, 1997; Abdul Jaffar Ali, 2014 and Tamilselvi *et al.*,2010) <sup>[19 2, 19]</sup>, and Copper, Nickel, Manganese and Cobalt (Krishnan, 1992) <sup>[14, 11]</sup>. Rare metals such as vanadium and Mercury are dissolved in seawater at very low concentrations. Ascidians are known to accumulate extremely high levels of vanadium selectively.

### Materials and methods

#### 1. Sampling and preparation of samples of ascidians

Species of five chosen ascidians were collected with the help of SCUBA diver from 2-3 m depth in Vizhinjam port (south west coast of India. The collected samples were placed separately in containers filled with seawater and are transported to the laboratory immediately. With the application of brush, the adhered particles such as sand, silt, pieces of shell and other epibionts were carefully removed. The cleaned samples were dried using an oven at 110°C for 24 hours then powdered well using mortar and pestle and stored in clean dry polythene packets for further analysis.

#### 2. Analysis of metals

About one gram of tissue of each species was taken in a crucible and was digested using the acid mixture of 3ml of concentrated sulphuric acid and 60% perchloric acid in the ratio 3%. The sample and acid mixture was heated well till perchloric acid is completely evaporated. The crucible was then cooled to room temperature and the residue was dissolved by adding 20ml of 2N Hydrochloric acid. This solution was centrifuged and filtered. The clear filtrate was

transferred to screw capped tubes and sent for analyzing metals. The metals mercury (Hg), Copper (Cu), Vanadium (V), Lead (Pb) and Cadmium (Cd) were measured using Atomic Absorption Spectrophotometer (model name AA-6300) at a specific wavelength for each metal. Mercury (Hg) was analysed by Cold Vapour Technique using mercury analyzer.

**Results**

The results on the accumulation of the metals of Copper, Vanadium, Cadmium, Lead and Mercury in the test and the mantle body of *P.nigra*, *H. momus*, *M. squamiger* and *P. indicum* collected from Vizhinjam port are shown in the Table 6.1.

**1. Vanadium**

It was found that *P. nigra* accumulates a higher concentration of vanadium in the test and mantle body (1.15 and 1.98 µg of metal / g dw respectively) and a lower value in *H. momus* with 0.98 and 1.1 µg / g dw in the test and body respectively. Along with *H. momus*, a low concentration was observed in *P. indicum* at a concentration of 1.1 µg of metal / g dw. The level of vanadium concentration in the test and the mantle body of *M. squamiger* was close to *P. nigra*.

**2. Cadmium**

The concentration level of cadmium in the whole body tissue of *P. indicum* was 0.52 µg metal / g dw whereas a lower value was observed in the *H. momus* in the test and mantle body (0.002 and 0.3 µg / g dw respectively). Together with *P. indicum*, it was found that *M. squamiger* accumulates 0.2 and 0.4 µg of cadmium / g dw in the test and body of the mantle, respectively.

**3. Lead**

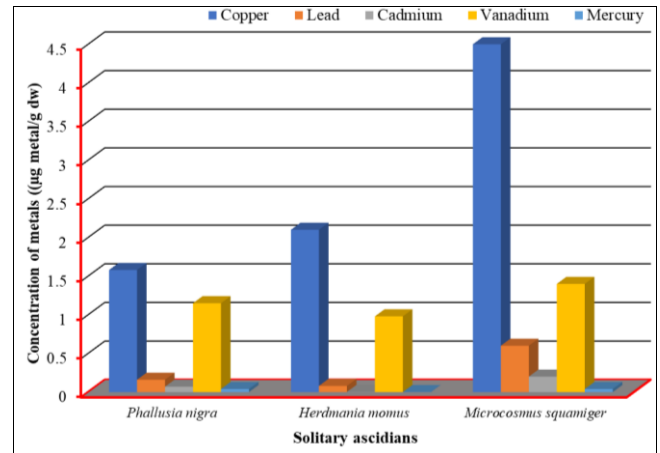
The highest concentration of about 0.6 and 0.8 µg of lead / g dw was found in the test and mantle body of *M. squamiger* respectively. As with other metal concentrations, *H. momus* accumulated a lower concentration of lead in the test and in the mantle body (0.08 and 0.11 µg / dw respectively).

**4. Mercury**

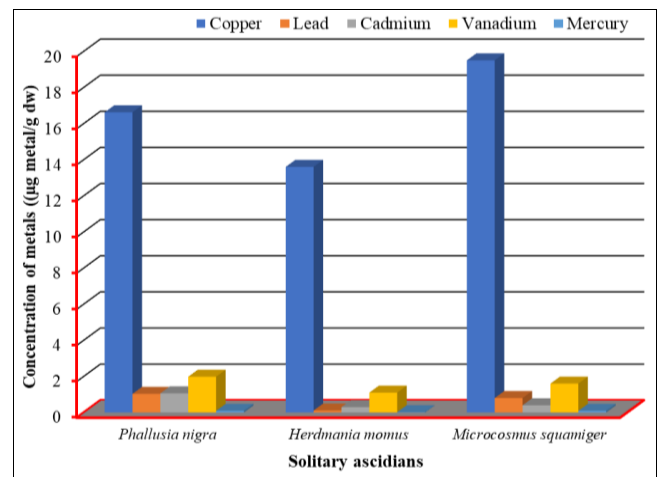
The maximum concentration of mercury was found throughout the body tissue of *P. indicum* (0.3 µg metal / g dw). The concentration of mercury in the test and the mantle body of *P. nigra* and *M. squamiger* were similar (0.04 and 0.09 µg / dl respectively).

**5. Copper**

The maximum concentration of cadmium in whole body tissue was found in *P. indicum* (31.2 µg metal / g dw) followed by the test and the mantle body of *M. squamiger*, *P. nigra* and *H. momus*. In the three solitary ascidians, the accumulation of these five metals was greater in the mantle body compared to the test (Figs 6.1 and 6.2). A one-way ANOVA application for the concentration of these metals between the test and the mantle body showed significant differences (P <0.005).



**Fig 1:** Concentration of metals in the test of solitary ascidian species.



**Fig 2:** Concentration of metals in the mantle body of solitary ascidian species.

**Table 1:** Heavy metals concentration (µg metal/g dw) in test and mantle body of solitary and whole body tissue of colonial ascidians

Metals (µg metal/g dw)	<i>Phallusia nigra</i>		<i>Herdmania momus</i>		<i>Microcosmus squamiger</i>		<i>P indicum</i>	WHO*
	Test	Mantle body	Test	Mantle body	Test	Mantle body	Whole body	
Copper	1.58±0.1	16.62±1.4	2.1±0.02	13.6±1.4	4.5±0.32	19.5±0.2	31.2±0.42	30
Lead	0.16±0.006	1.03±0.3	0.08±0.003	0.11±0.001	0.6±0.04	0.8±0.06	0.4±0.02	0.5
Cadmium	0.07±0.005	1.06±0.04	0.002±0.0001	0.3±0.021	0.2±0.01	0.4±0.03	0.52±0.034	2
Vanadium	1.15±0.12	1.98±0.2	0.98±0.06	1.1±0.06	1.4±0.1	1.6±0.21	1.1±0.11	1.8
Mercury	0.04±0.003	0.09±0.008	0.001±0.0002	0.02±0.003	0.04±0.003	0.09±0.007	0.3±0.02	0.5

**Discussion**

All these contaminants tend to accumulate in sediments and are absorbed by organisms fed by filtration processes such as adsorption, precipitation and deposition. During this process, according to Bdcha (1991), it is possible to accumulate more from the sediments and surrounding medium. In this study, the accumulation of metal in selected types of tunicates may be due to the continuous entry and

exit of water between the medium and the branchial siphon. In addition, the living patterns and balanced dietary habits filter facilitate the absorption of absorbed minerals as they are continuously washed in the water environment. Depdale and Rainbow (1990) [8] discussed the absorption of minerals from food to sea water and the permeable surface of the body into the intestines of living organisms.

The difference in metal levels between ascidian species is likely to be evident due to differences in metal concentrations in the local environment and the chemical characteristics, environmental requirements, metabolism and dietary patterns of sessile species. [Raouf et al. 2009].

Although all of the selected species were collected in the same habitat, differences in metal concentration were observed. This difference between the types of metal deposition in macrofoulers may be due to differences in the presence of metals around them and their role in metabolism (Heath, 1987 Silva Prabhu et al., 2012) [9, 18]. Many scientists have reported this difference (Abdul Jaffar Ali, 2004, Tamilselvi et al., 2010) [1, 19]. The difference in the metal accumulation in the different species of ascidians can be attributed to the presence of the texture of the metals, their age, the type of species, and the presence of bonds in the tissues converging with the metals and / or the role of tissue in the detoxification process. Kendrick et al. (1992) reported that the accumulation of metals in aquatic animals may be due to the presence of binding metal proteins in tissues. The presence or absence of specific cells such as tunic and vanadocytes in the tunic of the tunicates may facilitate the accumulation of some minerals. In addition, bioaccumulation may be preferred due to other factors such as sedentary structure, nutrition, presence of vanadocytes and the absence of kidneys (except for the Molgulidae family).

From the 5 metals analyzed, the copper accumulation in the studied species was recorded as high. Cadmium contamination reaches the soil by precipitation (Amusan et al., 2002) [3]. The increase in the cadmium level in animal tissues can occur in the case of marine ecosystems (Satyanarian and Prabakaramurthy, 1990) in the case of enrichment of the cadmium in the surface waters and in the case of oxidation of the mineral pollutants reaching the sea. When aquatic organisms enter body tissues, they inhibit metabolic activities by inhibiting the normal functioning of enzymes.

It was observed that mercury accumulation was minimal. The limit of mercury allowed in foods is 0.5 mg / kg (Codex standards, 2015) [7]. The level of mercury in animal tissues can be the result of unprocessed domestic and industrial emissions, anthropogenic activities, and river flow in the river (Christopher and Betty, 1999). In all selected ascidian species, the mercury level is below the permissible limit. The level of cadmium allowed in foods is 2.0 mg / kg (Codex Alimentarius Standards, 2015) [7]. Similarly, the four types of cadmium levels selected are well below the permissible level.

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