Advances in Biological Chemistry, 2013, 3, 549-552 **ABC**
http://dx.doi.org/10.4236/abc.2013.36062 Published Online December 2013 (http://www.scirp.org/journal/abc/)

A preliminary effort to assign sponge (C*allispongia* sp) as trace metal biomonitor for Pb, Cd, Zn, and Cr, an environmental perspective in Hative gulf waters Ambon

Netty Siahaya[1*], Alfian Noor[2], Nunuk Sukamto[2], Nicole de Voogd[3]

[1]Department of Chemistry, Pattimura University Kampus Poka-Unpatti, Ambon, Indonesia
[2]Department of Chemistry, Hasanuddin University Kampus UNHAS Tamalanrea, Makassar, Indonesia
[3]Netherlands Center for Biodiversity Naturalis, Leiden, The Netherlands
Email: [*]Anethsia@gmail.Com

Received 4 November 2013; revised 5 December 2013; accepted 16 December 2013

ABSTRACT

The aim of this investigation is to estimate metal concentration distribution, Pb, Cd, Zn, and Cr, in *Callispongia* sp, sediment, and water column in Hative waters of Ambon bay. After sampling, analytical processes were conducted by using a standard method and measured by ICP-OES (Inductively Coupled Plasma Optical Emission Spectroscopy). The results showed that Zn concentration was highest, 0.231 mg/kg dry weight (ppm) while in sediment and water the numbers were 1.180 and 0.790 ppm respectively. In the meantime, functional group studies through Fourier Transformed Infra Red spectroscopy revealed that OH-group (3421 cm^{-1}), Conjugated Double Bond (1635 cm^{-1}) and Ether Groups (1049 cm^{-1}) of *callispongia sp* were found. Also, the appearance of wavenumber 2926 cm^{-1} clearly indicates the existence of –CH sp3 group. Combining both results may guide us to establish a relation between metal concentration and organic substance transformation made during interaction inside species. Thus, trace metal investigation can be a choice in doing rapid assessment and biomonitor for the quality of coastal marine life. Furthermore, by more extensive studies, this connection could be developed and proposed as a low cost method for EIA of metal pollution in coastal zone, particularly in coral reef system.

Keywords: *Callyspongia* sp; ICP-OES; FTIR; Metal Distribution

1. INTRODUCTION

The capital of Maluku province is surrounded by Ambon waters in the area about 187 thousand square kilometers, 17% slope, and relatively rugged land area. Its land use will have an impact on the ecological pressures to Ambon Bay waters [1]. Ambon Bay waters have multiple functions, namely as a regional fisheries and aquaculture, police seaport and Navy bases, PELNI ship port, and out of the traditional boats Ambon and ferry crossing pier, fishing port, Pertamina, ship repair dock space, recreation areas and sports, and electric power by PLN, so that the waters of Ambon Bay are very susceptible to environmental changes because each activity will produce many metal wastes. Island of Ambon is encircled by fringing type coral reefs which grow lengthwise along the shoreline on the north and south bay [2].

It is generally recognized that sponges are the animals that always associated with coral reefs. Sponges, in feeding, rely mostly on a constant flow of waters bringing its dissolved organic matters as well as particulate non organics such as metal associated compounds. The sponges also have long been a center of attention from scientists in different countries to look at the possibility using them as metal bioindicator due to its capacity to accumulate metals [3-6] without sacrificing its growth and survival rate. Copper, lead, and vanadium have been studied and showed a sponge capacity in absorbing them in high concentration [4]. Also, *Petrossian tertudinaria* species have been used as a biomarker for the detection of heavy metals in inshore areas (0.5 - 1 km) and offshore (5 - 7 km) in the Gulf of Mannar, India. In fact, sponge heavy metal concentration of inshore was about 64 times higher than the offshore [3].

The ability to accumulate heavy metals in the sponge is very important to be known as one of the guidelines in determining the status of water pollution in an area that has a coral reef ecosystem, in which the region is the

[*]Corresponding author.

habitat of a living sponge. This is in line with the opinions [3,4,9] that the metal content in aquatic biota generally increases over time because the metal is expected, so the presence of a sponge in water Hative cycle can be used to determine the heavy metals Pb, Cd , Cr, and Zn in the sponge type callispongia sp, sediments and water in the waters Hative Ambon bay.

2. MATERIALS AND METHODS

Research materials are: sponges from Hative waters in Ambon bay; Acetone (Merck), HNO_3 (p.A), double distilled water and Whatman filter paper. Sponge samples were collected by diving, cleaned and then placed in a plastic bag and put in the ice box. 0.5 grams of sample was put in beaker glass, add 5 mL HNO_3 and then heated at 150˚C for 2 hours. After being cooled at room temperature, sample put in 25 mL volumetric flask, match the volume with double distilled water and filtered with Whatman paper and solution is ready to be analyzed by ICP-OES Perkin Elmer 3000. One litre of water sample was taken at the bottom, and immediately filtered with filter paper of cellulose nitrate (0.45 μ) after previously washed with 1N HNO_3 and then preserved in HNO_3 5%. 250 ml water sample is inserted in a Teflon separating funnel, then extracted with APDC- NaDDC/MIBK. The organic phase was extracted again with 5% HNO_3 solution, filtered back, and ready for analysis by ICP-OES Perkin Elmer 3000.

For sediments, they were taken from the bottom with a Van Veen Grab sampler, stored in polyethylene bottles and taken in laboratory put in a Teflon beaker and dried in an oven at a temperature of 105˚C and after drying, rinsed 3 times with double distilled water then dried again. A total of 5 g sample was destructed in Teflon beaker with solution of HNO_3/HCl (1:3) at 100˚C for 8 hours. After that, the solution was filtered, and the filtrate is ready to be analyzed by ICP-OES Perkin 3000.

3. RESULTS AND DISCUSSION

3.1. General Situation of Sampling Locations

Sampling was conducted on July 4, 2011, about noon under cloudy weather in Hative waters (**Figure 1**) surrounded by population settlement, estuaries, navy complex, harbour, oil depot of Pertamina, and sago plantation. *Callispongia sp*, ca 50 grams were taken under physicochemical as shown in **Table 1**. The data clearly shows that its water quality fits with environmental conditions in general where sponges grow in tropical and subtropical conditions with vertical distribution on coral reefs at low tide up into the area of approximately 50 meters [6]. Also, water content, ash, and biomass of *Callispongia sp*, represent an integral part of metal content in a biological sample [9].

Accumulation of Pb, Cd, Cr and Zn *Callispongia sp* can be seen in **Table 2** as a function of organ as skeleton and tissue. Also determined were water and sediment around sponge. Logically before entering into cellular level of sponge, metals will be firstly existed in water and sediment It seems obvious that each element shows a different partitional pattern where cadmium as the least amount remain largely in sediment (86.4 %). Oppositely, chromium was almost all adsorbed by cellular sponge. It was also clear that majority of elements have stayed in cellular level.

As for zinc as an essential element, its highest concentration revealed that the source might not only come from industrial by products but also from excretion of living system in marine environment. So the total zinc in this *Callispongia sp* apparently not an abnormal case especially if one looks at a fraction remaining in sediment (54.1%) and consumption level of skeleton and tissue on zinc. Generally the highest metal concentration in sediments is influenced by several processes like sedimentation, flocculation, precipitation, and adsorption [5,6]. Another important parameter is bioconcentration factor (BCF) in measuring the capability of organisms to accumulate metals from environment into its tissue. According to Abdullah *et al*. 2007, BCF can be estimated by comparing metal absorption between in sponge tissue and in water (BCF sw) or sediment (BCF ss).

The ability of organisms to accumulate metals from the environment into the tissues of the body can be calculated using the bioconcentration factor (BCF). BCF value can be obtained by comparing the ability of organisms (e.g. sponges) to absorbsi metals from water and sediment. Therefore there are two BCF values, BCF sponge-sediment (BCFs-s) and BCF-water sponge (BCFs-w). BCFs-s is the value of the ratio between the concentration of the metal absorbed into the sponge tissue with metal concentrations in the sediment, while the BCF sw is the value of the ratio between the concentration of metal that accumulates into the sponge tissue metal concentrations in water [8] as found in table-3 below.

From the result in **Table 3** one can find the highest value for BCF is Cr either in water or in sediment. and this indicated that for the case of the location and sponge, Cr is the most appropriate element to be assigned as a bioindicator or biomonitor for *Callispongia sp* compared to other metals. Some results from several investigations have used the same method [4,5,7].

To assess the possible chemical bonding occurs between organic molecules in sponge and metal, an FTIR analysis was carried out to look at the key functional groups that may link to bond formation with metals. FTIR spectrum of *Callispongia sp* sample can be seen in **Figure 2**.

According to Terada *et al*. (1983) the interactions that

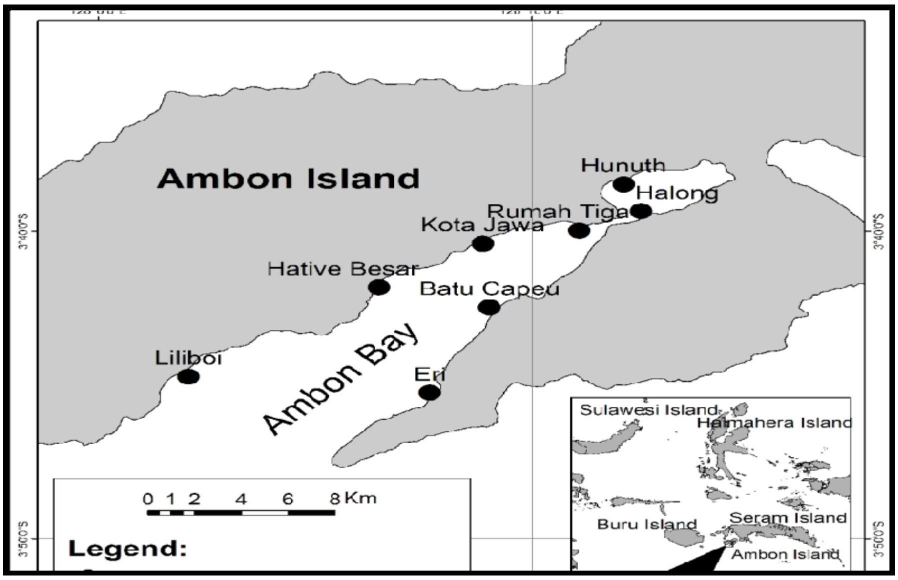

Figure 1. Sampling location is in the waters of Hative Besar municipal.

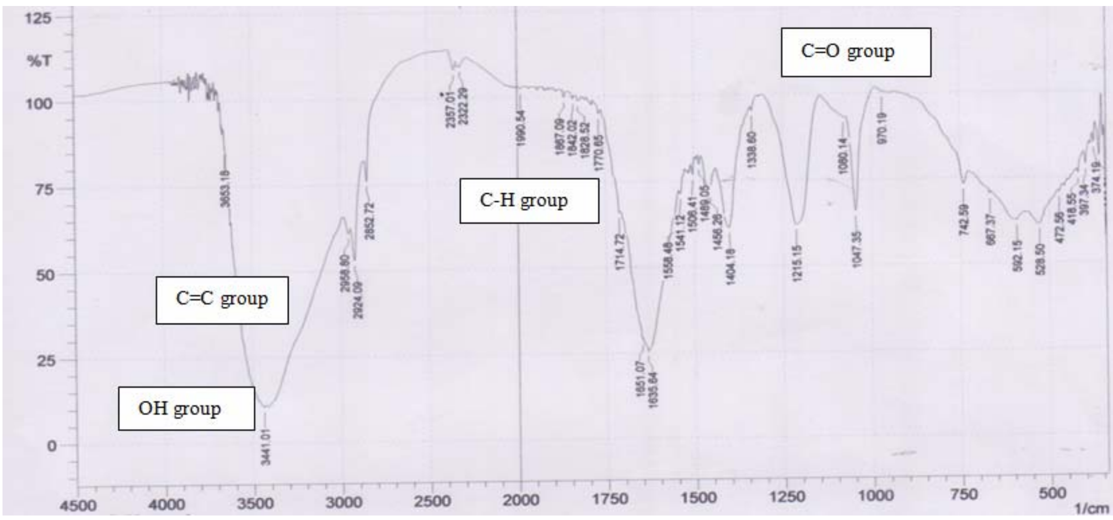

Figure 2. Fourier Transformed Infra Red (FTIR) spectrum of *Callispongia sp* tissue sample.

Table 1. Physicochemical conditions in Hative and sponge *Callispongia sp*.

Site	Waters conditions			Content (%)		
Hative	Temperature (˚C)	pH	Salinity (0/00)	Water	Ash	Biomass
	28	6.8	30	78.74	87.00	16.90

Table 2. Metal content (ppm) in the sponge *Callispongia sp.*

Metal	Total Skeleton + Tissue	Skeleton	Tissue	Waters	Sediment
Pb	0.039	0.008	0.031	0.075	0.098
Cd	0.012	0.002	0.01	0.001	0.019
Zn	0.213	0.109	0.104	0.790	1.180
Cr	0.280	0.018	0.262	0.001	0.001

Table 3. BCF s-s and BCF sw of Pb, Cd, Zn, & Cr calculated from *Callispongia sp.*

Metal	BCF ss	BCF sw
Pb	0.32	0.41
Cd	0.52	10.0
Zn	0.09	0.13
Cr	262.0	262.0

have occured between active functional groups of organic molecules can be described as the behaviour of Lewis acid-base interaction to form a complex chemical structure. In case of metal adsorption in a solution system, these reactions may be generalized as follow :

$$[\mathrm{GH}] + \mathrm{MZ}^{+} \leftrightarrow \left[\mathrm{GM}(Z-1)\right]^{++} + \mathrm{H}^{+} \qquad (1)$$

$$2\left[\mathrm{GH}\right]+\mathrm{MZ}^{+}\leftrightarrow\left[\mathrm{G}_{2}\mathrm{M}\left(Z-2\right)\right]+2\mathrm{H}^{+} \qquad (2)$$

3.2. Where GH Is a Functional Group and M Is a Divalent Metal Ion Z

The FTIR results showed that functional groups found in *Callispongia sp* are OH (3421 cm^{-1}), the group of conjugated double bonds (1635 cm^{-1}), and ether groups (1049 cm^{-1}). While the wave number 2926 cm^{-1} region of the spectrum shows the possibilities that come from sp3 CH orbital. These are functional groups that have possibility to bind metals thus potential active groups to catch metals.

4. CONCLUSION

It can be concluded that *Callispongia sp* may be assigned as a pollutant indicator for metal especially element chromium which is very toxic in certain forms and valences. A further investigation will be needed to explore sponge potential as the metal pollution bioindicator in appropriate locations particularly in eastern island littoral regions where coral reef is found predominantly.

REFERENCES

[1] Pelasula, "Preliminary Studies of Ambon Bay Ecosystem," *Journal of Marine Fisheries*, LON-LIPI, Vol. 14, No. 53, 2009.

[2] Leatemia, "Kajian Asal Muasal Terumbu Karang Teluk Ambon," *Jurnal Osenologi*, Vol. 7, No. 14, 1996.

[3] Hansen, Andrew and Forester, "The Association between the Sponge *Halichondria panacea* (pallas) and Scallop *chlamys varza*: A Commensal-Protective Mutualism," *Journal Marine Ecology Biology*, Vol. 36, No. 120, 1995, pp. 1- 10.

[4] Ceberean, J. Bremer, S. J. Rogers and C. L. J. Frid, "Assesing Functional Diversity in Marine Benthic Ecosystems," *Journal Marine Ecology Progress*, Vol. 76, No. 328, 2003, pp. 11-25.

[5] Olsen and Weeks, "The Ecology Sponges at Lough Hyne Marine Natural Reserve," PhD Thesis, University College Cork, Ireland, 1994.

[6] Pattel and J. J. Bell, "Contrasting Patterns of Species and Functional Composition for Coral Reef Sponge Assemblages," *Marine Ecology Progress*, Vol. 20, No. 201, 1985, pp. 73-81.

[7] Perez, J. J. Bell and D. Smith, "Ecology of Sponges in the Wakatobi Region, South-Eastern Sulawesi-Indonesia: Richness and Abudance," *Journal of Marine Biological Associations Kingdom*, Vol. 113, No. 50, 2005, pp. 1199-1208.

[8] Darmono, "Logam Dalam Sistem Lingkungan Hidup," Universitas Indonesia, Jakarta, 1995.

[9] H. A. W. Cappenberg, "Galore and Diversity of Megabentos in the Waters of the Ambon Bay," LON LIPI, Indonesian Oceanological Center, 2011.

