Biomonitoring of Heavy Metal Plumbum (Pb) in Spermonde Island Makassar
Using Starfish as Bio-Indicator (*Protoreaster nodosus*)

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ABSTRACT

Biomonitoring is a method of monitoring water quality using biological indicators (bioindicator). This study aims to develop methods of biomonitoring and potential of the marine biota as bioindicator for marine pollution. To optimize the analysis, samples suspected to contain heavy metals Pb were taken at three points from three different locations, and a point at random from a single location in Makassar Spermonde Islands, using AAS asanalytical techniques.
The results showed that Pb levels in starfish *Protoreaster nodosus* types ranged from 2,6080 to 2,8876 ppm, bigger than the distribution in the sediment ranged between 0,4862 to 0,5582 ppm and in sea water ranges between 0,6732 to 0,8724 ppm. The results obtained have exceeded the threshold of water quality standards.

Keywords : Biomonitoring, Starfish (*Protoreaster nodosus*), Lead (Pb), Spermonde Islands, Atomic Absorption Spectrophotometer (AAS).

INTRODUCTION

Indonesia has about 13,000 islands (Hutabarat and Evans, 1985) which has a wide range of marine biodiversity which is abundant in it, whether plant, vertebrate and invertebrate animals. Echinoderms are marine invertebrates of the most widely known and has 6.000 species have been identified, and in Indonesia there are 295 known species (Nontji, 1993) which consists of sea cucumbers (*Holothuroide*), sea stars (*Asteroidea*), brittle sea stars (*Ophiuroidea*), sea urchins (*Echinoidea*), and sea lilies (*Crinoidea*) (Jasin, 1992).

Phylum *Echinodermata* scattered from shallow intertidal areas to the deep sea (Jeng, 1998). This fauna is generally inhabit coral reefs and seagrass beds and the like rather hard substrates, especially substrates in a mixed seagrass beds consisting of sand and rubble (Aziz, 1994). *Echinoderms* is one of the most important animals in the marine ecosystem and useful as one component in the food chain, eating organic waste and other small animals .

In connection with the increased activity in the field of economic and community development in various sectors has implications and pressure on areas of the islands (Hutabarat and Evans, 1985). Heavy metals accumulate in aquatic environments are usually derived from natural and industrial activities (Tarigan *et al*, 2003). Type of pollutant metals are usually found in the waters of Pb, Cd, Cr, Fe and Sn, if the concentration of these metals in the waters high enough to be toxic to aquatic organisms, therefore, the

presence of metal in the water needs to be controlled (Connell and Miller, 1995).

Heavy metal pollution on coastal and marine ecosystems is now a central issue and an important study because it is generally heavy metals are toxic , but the body needs a certain amount. Metal poisoning can be acute or chronic. Acute poisoning caused by contamination of the organism in high metal levels and chronic poisoning caused by contamination in the low metal content, with a long time (Palar, 1994). Heavy metals that enter the waters will undergo various processes include transport by tides, dilution, associated with suspended material, coagulation and sedimentation to the bottom, is absorbed by plankton (Siregar, 2009).

Research on metal dynamics in the water and the creatures that live in water have been carried out, especially in monitoring heavy metal pollution in aquatic environments. In monitoring heavy metal pollution, analysis of water biota is better than water analysis for water content can vary and depends heavily on the environment and climate, while the metal content in the water biota usually will always increase over time due to the bioaccumulative properties of the metal so that aquatic biota is best used as an indicator of metal pollution in aquatic environments (Darmono, 1995). The concentration of metal residues in tissues of biota will always fluctuate influenced by the age and size of the biota (Al-Yousef *et al*, 2000), eating habits or trophic levels in biota tissue (Watanabe *et al*, 2003), as well as species or types of biota (Qugun *et al*, 2005; Calta and Canpolat, 2006; Abdallah and Abdallah, 2008).

Biomonitoring of heavy metals to marine biota have been carried out since the last few years ranging from coral reefs (Susiati, 2008), sponges (Rashid, 2012), sea urchins (Flammang, 1997) and fish (Nurrachmi *et al*, 2011). But until now there has been no research on biomonitoring of heavy metals in starfish.

This study aims to determine the heavy metal content of Pb in waters Lompo Barrang island using starfish species *Protoreaster nodosus* as biomonitoring. As previous studies (Adiman, 2011; Rashid, 2012; Oktaviani, 2012) showed that the waters around the Spermonde islands has occurred pollution from heavy metal contaminant inputs associated with intense multi-sector activity.

MATERIALS AND METHODS

The materials used in this experiment are starfish *Protoreaster nodosus*, HNO_3 p.a (Merck), HCl p.a (Merck), $Pb(NO_3)_2$, distilled water, aquabides, detergent, pH paper, the solution of technical acetone, aluminum foil, paper filter Whattman 42, paper labels, tissue roll, and a plastic airtight .

Sample Preparation. The sample used was washed with hot water added a little detergent. After the sample is cut radially follow oralnya the starfish position gradually. After the sample was cut into small pieces and then washed with acetone sample starfish in drying in the hot sun to dry. Furthermore, the sample is crushed in a porcelain mortar to a powder .

Sample Preparation Solution. Carefully weighed as much as 2 grams of dried sample powder, then add 30 mL of HNO_3 p.a, heated electric in the space above the bath of acid, at a temperature of 150° C (up to half the volume of the initial volume). Solution samples were heated cooled to room temperature. Sample solution is filtered using ash-free filter paper (Whatman 42) into a 100 mL volumetric flask and washed 2 or 3 times with distilled water, then the pH was adjusted to 1, diluted up to the mark and shaken until homogeneous. The filtrate obtained was then analyzed heavy metals using AAS (SNI 06-1138-1989) .

SSA Measurements Using Standard Addition. Sample solution obtained by 5 mL

pipetted into 10 ml volumetric flask, then added a standard solution of Pb with concentrations of 0, 0,5, 1, 1,5, 2,5 and 4 ppm were prepared from stock solutions of 10 ppm Pb, align up to the mark and shaken until homogeneous. The solution can be directly measured using the SSA.

RESULTS AND DISCUSSION

Overview Location

Sampling was done on August 19, 2013 at 14:41 pm in Lompo Barrang Island. Random sampling taken at three sampling points are:

Location	Geographical Location		Depth (cm)
	S	E	
Stasiun I	05°02' 35,1''	119°19' 46,1''	41
Stasiun II	05°02' 32,5''	119°19' 44,3''	85
Stasiun III	05°02' 29,4''	119°19' 44,0''	163

Water Conditions

Based on the results of measurements in the field and in the laboratory, physical chemical conditions at the sampling site is shown in Table 2.

Table 2. Physical-chemical conditions of water at the sampling site

Loca-tion	Temperature (°C)	pH	Salinity (ppt)	DO (ppm)
Stasiun I	26	8	36,8	4,80
Stasiun II	26	8	37,0	5,12
Stasiun III	25,5	8	35,2	4,48

Based on Table 2, the value of the water temperature ranged from 25-36° C. The temperature range is obtained by the general range found in tropical waters and still support for marine life. Temperature affects dissolved oxygen values, the higher the water temperature, it will cause the decrease of the value of dissolved oxygen and increase the toxicity of certain ingredients. If the water temperature rise of 10° C the oxygen consumption by the marine life is also increased by approximately 2-3 fold.

The degree of acidity (pH) is a very important change in the water. This can affect the metal concentrations of a chemical. pH affects metal solubility in water which lowers the pH increase in metal solubility in water, due to the increase in pH alter the stability of the form of carbonate into hydroxide which forms a bond with the particles in the water body that will settle to form sludge. The degree of acidity (pH) sector in waters affected by photosynthetic activity, temperature and salinity. Limitation of pH value has been determined by the office of the State Ministry of Population and Environment No. 51/2004 ie 6,5-8. In general, the pH of natural waters ranges between 4-9. This can be compared to the acidity of the third condition, namely the sampling point 8 (Sastrawijaya, 1991).

Salinity is the amount of dissolved salts in one kilogram of sea water. According Supardi (1984), salinity greatly influence the state of the aquatic ecosystem. Salinity is usually influenced by the pattern of water circulation , evaporation , precipitation and river flow. Salinity values obtained in these waters ranged between 35-37 ‰, larger than the normal value range of salinity is 30-35 ‰ . Salinity also affects the presence of heavy metals in water bodies, if there is a decrease in salinity due to the desalination process will lead to increasing levels of toxic heavy metals and heavy metal bioaccumulation greater.

Distribution of Heavy Metals of Pb in Starfish (Protoreaster nodosus), Sea Water and Sediment

Concentrations of heavy metals were found in starfish (*Protoreaster nodusus*), sea water and sediment varies depending on whether the poor conditions and activity around these waters. The higher activity going on around the water, land and in the water itself, the assay can be increased. Water conditions also affect the rate of absorption of heavy metals in water and body organism, ie salinity, temperature, pH, salinity, dissolved oxygen and physiological activity of the organism. The concentration of heavy metals in aquatic ecosystems can be monitored by measuring the concentration in water and sediment. In addition, marine life can also be used as an indicator of the level of contamination that occurred in the waters. Table 3 shows the Pb concentrations of heavy metals in water, sediments and starfish (*Protoreaster nodosus*) in the waters of the island Barrang Lompo.

Table 3. Pb heavy metal concentrations in water, sediments and starfish (*Protoreaster nodosus*)

Location	Levels of Pb (ppm)		
	Starfish	Sea Water	Sediment
Stasion I	2,6080	0,8724	0,4862
Stasion II	2,8876	0,7836	0,5544
Stasion III	2,6646	0,6732	0,5582

Based on Table 3 , the levels of Pb in starfish, sea water and sediment can be displayed in a histogram form which can be seen in Figure 1 .
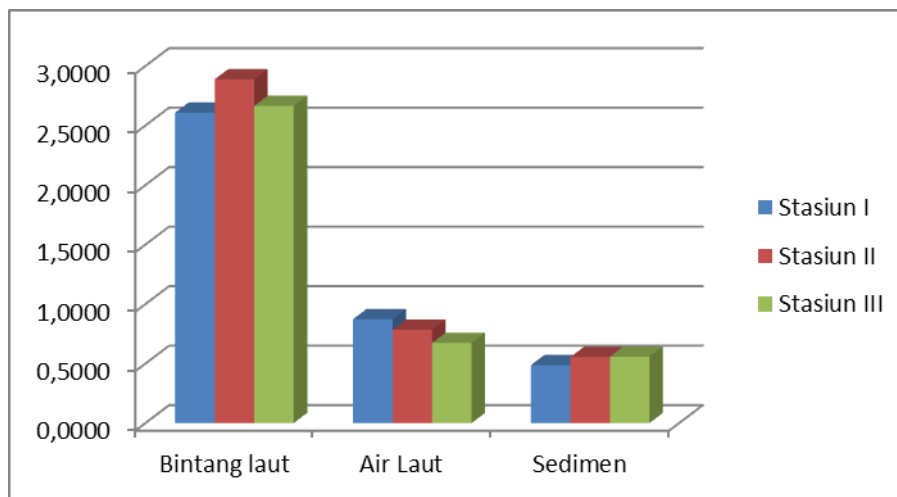

Figure 1. Diagram of Pb heavy metal distribution in water, sediment and starfish (*Protoreaster nodosus*)

Based on Table 3, it is seen that the levels of heavy metals Pb is highest in starfish and sea then the smallest levels that sediment. According Darmono (1995), the metal content in the water can vary and depend on the environment and climate. In the rainy season, the metal content will be smaller due to the leaching process, while the metal content in the dry season will be higher because the metals become concentrated. Heavy metals contained in the water is also influenced by currents and waves that cause the concentration of heavy metals spread to all parts of the waters.

The content of metals in aquatic biota will usually always increases over time due to the bioaccumulative properties of the metal. Dangerous heavy metals enter water bodies will accumulate in sediments that have binding properties easily and settles in the bottom waters and aquatic organisms will absorb and transfer through the food chain.

Heavy Metal Content of Pb in Starfish (Protoreaster nodosus)

Based on Table 3, the levels of heavy metals Pb on 3 samples show that starfish contains heavy metals Pb at different levels. Environmental factors affecting the heavy metal content of Pb in seawater and marine sediments. Seawater is a big influence because in search of food, starfish actively absorb and filter water through a sieve plate madriporit as the inclusion of water in the water vascular system or ambulakral (Jasin , 1992). Based on Table 3 levels of heavy metals Pb apparent that sea water containing heavy metals are higher than the sediment, so it can be said that sea water is a major contributor to the heavy metal content of Pb in the starfish.

Based on the results of the determination of heavy metal content of Pb in Table 3 indicate that the starfish were alive at stasion II (2,8876 ppm) or a transition area between the area of seagrass and coral areas have the most Pb levels greater than starfish that live in stasion I (2,6080 ppm) and the stasion III (2,6646 ppm).

High levels of Pb in stasion II is caused by conditions and activities around the region. Stasion II is an area where reliance vessels thus allowing an oil spill. The use of fuel additives and pigments of lead in the paint on the hull is the main cause elevated levels of Pb in aquatic environments (Lu, 1995). In addition, the second stasion which is an area of transition between areas of seagrass and coral daerang is a contributing factor to high levels of Pb in the area. According Langoy (2001), seagrass is a primary food for starfish *Protoreaster nodosus*. Also based on the results of his research , in the belly of the starfish *Protoreaster nodosus* was found dead coral rubble and fine sand (sediment) . This allows the level of Pb levels in the body due to a large starfish starfish that are eating sediment (deposit feeder) takes heavy metals adsorbed on particles of water to accumulate in the sediment surface due to the accumulation of sediment is the last place any type of metal that is not absorbed by biota in the water. Many starfish live in the coral reef exposure or sandy beaches to rocky (Nontji, 1993) .

In addition to human activities in the waters, the pH affects the solubility of the metal. However, in this study the temperature and pH slightly contributed to the high metal content of Pb in the sample. pH on the third point still meet the standards, the pH value in Table 3 can not increase the solubility of Pb in sea water so that the metal lead into the sediment accumulating more.

High levels of heavy metals Pb starfish does not cause damage to the starfish itself. This suggests that the starfish has a pretty high tolerance to toxic metals Pb, where the tolerance limits of heavy metals in starfish is currently not known .

CONCLUSION

Based on the research that has been done, it can be concluded that the levels of Pb contained in starfish (*Protoreaster nodosus*) vary at each point. Pb levels of heavy metals found in most large second stasion which is an area of transition between regions gradually and coral area that is equal to 2,8876 ppm, while the concentration of heavy metals Pb on the first satsion and the third stasion in a row is 2,6080 ppm and 2,6646 ppm. High levels of heavy metals Pb starfish does not cause damage to the starfish itself. This suggests that the starfish has a pretty high tolerance to toxic metals Pb so that the starfish is one animal that can play a role in tackling pollution and can be used as bio-indicators of heavy metal pollution in waters.

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