

Mercury concentration on *Enhalus acoroides* and *Thalassia hemprichii* at Seribu Islands

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Abstract. Mercury is a toxic heavy metal element that can damage embryo development. Although this element is highly toxic, some human activities such as mining and industries are still using it. The uncontrolled usage of this element leads to pollution problem in the environment, which includes the seagrass ecosystem in the coastal area of Seribu Islands. For that, to gather more information about mercury pollution in the seagrass beds of these islands, the concentration of mercury (Hg) was measured in sediment, rhizomes, roots and leaves of two species of seagrass (*Enhalus acoroides* and *Thalassia hemprichii*) from Lancang Island, Pari Island and Panggang Island at Seribu Islands, Indonesia in April-May 2017. The highest concentration of mercury was found in sediment on Lancang Island. The concentration of mercury was significantly higher on leaves compare to on roots or rhizomes in *E. acoroides* on Lancang Island and Panggang Island. *T. hemprichii* accumulate mercury higher than *E. acoroides* on Lancang Island. Overall, mercury accumulation on both species ranges at 7.12 – 87.41 ug/kg dw and this shows that they have the potential as bio-indicator of mercury bio accumulation.

1. Introduction

An estuary is where land meets ocean; it is known as the most valuable aquatic ecosystem where seagrass beds housing extensive marine biodiversity are located [1, 2]. Seagrass beds represent one of the most important ecological components in the coastal ecosystem; seagrass leaves act as phytoremediators and cleanse seawater by absorbing dissolved metals while seagrass roots play a role in shoreline protection by reducing coastal erosion from raging storms [3]. Seagrasses are a primary food for many animals (e.g., manatee, dugong, green sea turtle) and they form a critical habitat for thousands of other animal and plant species. In shallow-marine ecosystems, seagrasses also play critical roles in the ecology and economy stabilizing sediment and carbon and nutrient cycling [4, 5]. Tropical seagrasses are found concentrated in two large areas worldwide: (1) the Indo-West Pacific and (2) the Caribbean and Pacific Coast of Central America [6]. Indonesia has 12 of 69 species of seagrass found in the world. Seagrasses in Indonesia are found in coastal areas and small islands where they are able to live up to a depth of 40 meters. Seagrasses live in sand, sandy mud, mud, and rubble substrate [7]. Seagrass bed areas in Indonesia are declined by about 30-40%, and the biggest damage of seagrass beds is found on Java Island [8].

Some of the areas around Java Island that still have relatively good seagrass beds than in the mainland Java Island are on Seribu Islands. This area is located on north of Jakarta (The capital city of Indonesia) and consists of more than 100 small islands (Figure 1) where seagrass beds still can be found. However, the north coast of Jakarta also has a lot of estuary that discharges the water from the mainland to the area where Seribu Islands are located. With the great development of Jakarta and the industrial areal



surrounding it, many pollutants can enter the waters on Seribu Islands, and some of them are heavy metals such as mercury. Mercury is widely considered to be among the highest priority environmental pollutants of concern on the global scale [9]. Mercury is a natural element but its level in the environment is raised by human activities, such as mining, coal combustion in power plant and chlorine manufacture [10]. This element is highly toxic and can affect a number of organs [11] and can cause developmental defects in embryos [12]. As a plant, seagrasses have the bioaccumulating property to act as a pollutant sink in the marine environment [13]. With that potential, the objective of this study are (1) to determine the accumulations of mercury (Hg) in two seagrass species on three islands of Seribu Islands and (2) to determine the potential of seagrass to be used as bioindicator.

2. Methods

The seagrasses tissue and sediment samples were collected from seagrass beds on three islands on Seribu Islands, which were Lancang, Pari and Panggang Island in April and May 2017. Lancang Island is located relatively closer to Jakarta Bay than Panggang Island, and Pari Island is located between them. Tidal of seawater at the seagrass bed was different each time, and it can reach low tide and high tide condition. Samples were taken during low tide condition when the seawater level was 10–40 cm during low tide condition.

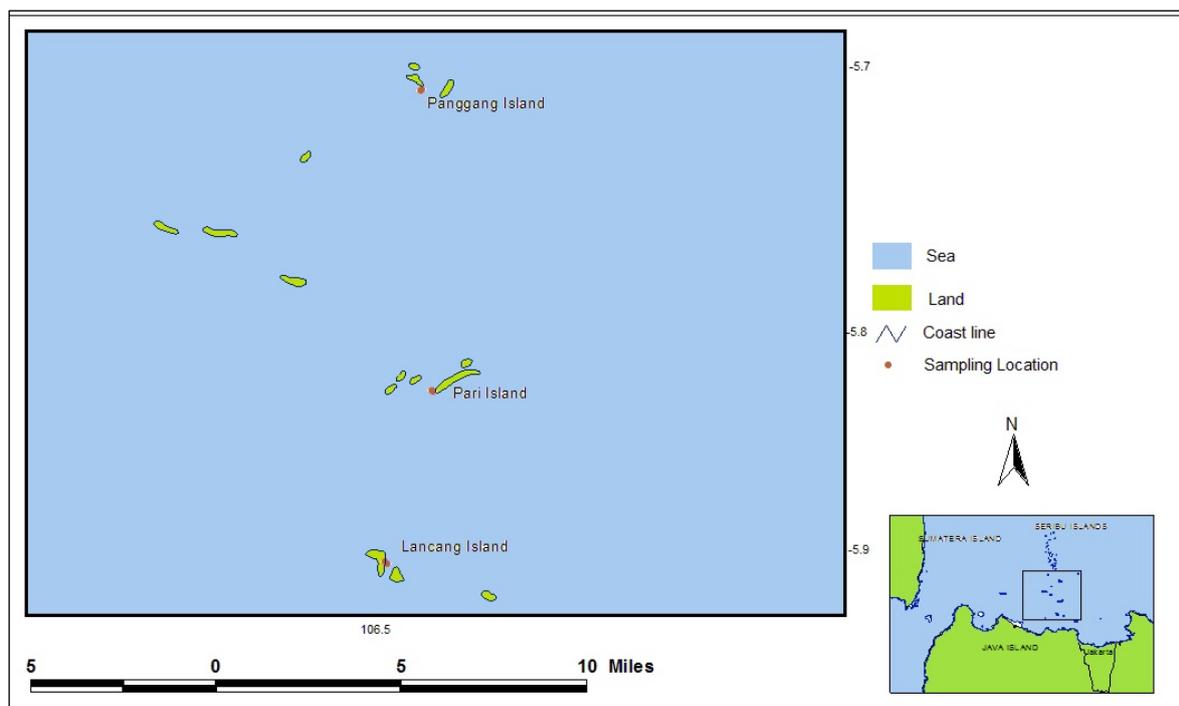


Figure 1. Map of location.

At each site, all the seagrass species were collected as a whole plant (consisting of all organs such as roots, rhizomes, leaves and leaf sheaths if any) as much as 50 – 100 g. The sediment samples were collected by using sediment core (diameter 5 cm) by the depth of 15 – 20 cm (seagrass roots depth zone). All the samples were then brought to the laboratory for analysis.

At the laboratory, all the seagrass samples were rinsed with fresh water (type I) and sorted based on their location, species and organs. All the sorted samples then wrapped by samson paper sheet and labeled before drying. Meanwhile, the sediment samples from each site were placed in petri dish for drying. All the samples then dried in an oven at 60 0C until their weight became constant (approximately 24 – 48 hours). Then the dried samples were homogenized by crushing them with a mortar and pestle. After that each sample was taken as many as 50-100 mg (5 replicate for each sample) for mercury

measurement using NIC MA-3000 Mercury Analyzer at Research Center for Oceanography, Indonesian Institute of Sciences. The analysis of the data used SPSS 16.

3. Results and Discussion

Figure 2 and 3 show the concentration of Hg in *E. acoroides* and *T. hemprichii* on three islands of Seribu Islands. Overall, samples of seagrass tissue and sediment from Lancang Island show the highest value of mercury concentration compared with the other similar samples from Pari and Panggang Island. The highest concentration was found on *E. acoroides* leaves at 59,60 ug/kg dw, followed by *E. acoroides* rhizomes at 54,46 ug/kg dw. Lancang Island is the nearest island to Jakarta Bay and this island gets the first impact from anthropogenic pollution than the other islands. The mercury that was discharged into estuaries can be converted naturally into methylmercury compounds by bacteria, phytoplankton or oxidation-reduction processes [14]. Methylmercury is a hazardous compound due to its character that can be absorbed directly by the cell membrans of organisms [15], where the absorption rate is affected by several factors such as the existence of degraded planktons [16], other dissolved metals [17], oxidation-reduction of organic materials [18], and the presence of higher trophic levels organism [19].

There is a significant difference ($p < 0,05$) of Hg concentration from Lancang Island samples compared to the samples from the other islands (Table 1). On the other hand, there are no significant differences ($p > 0,05$) between samples from Pari Island and Panggang Island. Both facts indicate that the Hg that was carried by current from the mainland has already deposited first on Lancang Island. From the map in Figure 1, it can be seen that Pari Island and Panggang Island have a longer distance from mainland than Lancang Island.

Overall, both *E. acoroides* and *T. hemprichii* have the potential as bioindicator due to their tissues' ability to absorb metal from their surroundings [20]. In this case, both species have high Hg content on Lancang Island; however, they are very sensitive to their environmental quality changes.

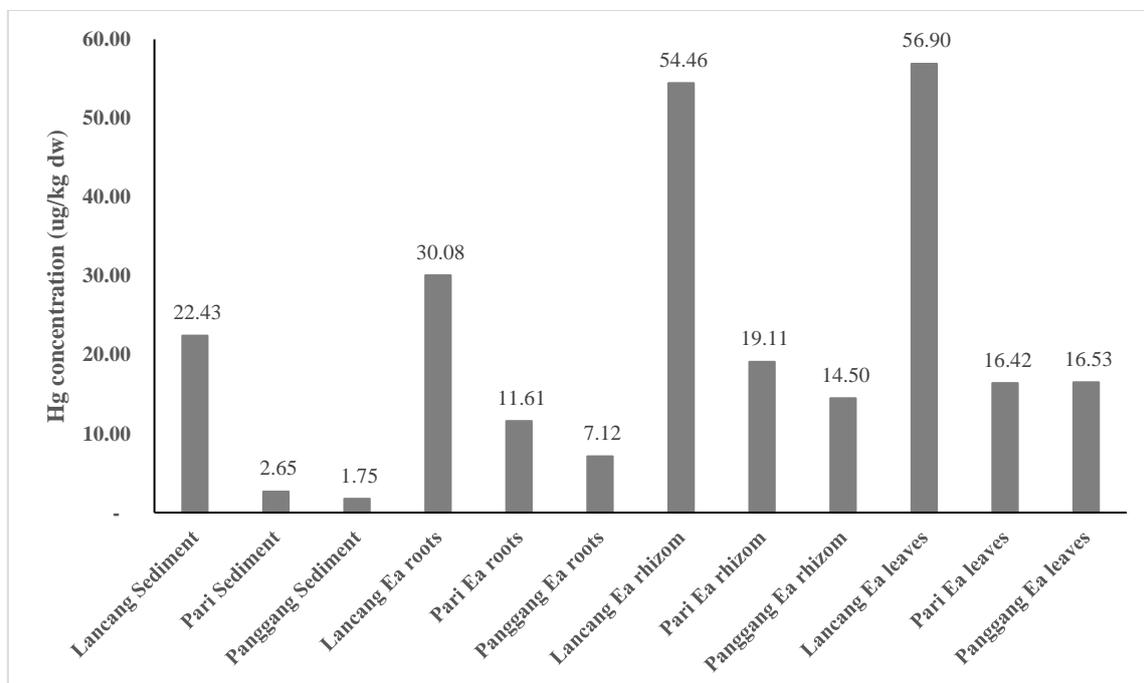


Figure 2. Hg concentration (ug/kg dw) in sediment, roots, rhizomes, leaves of *E. acoroides* at Lancang, Pari and Panggang islands.

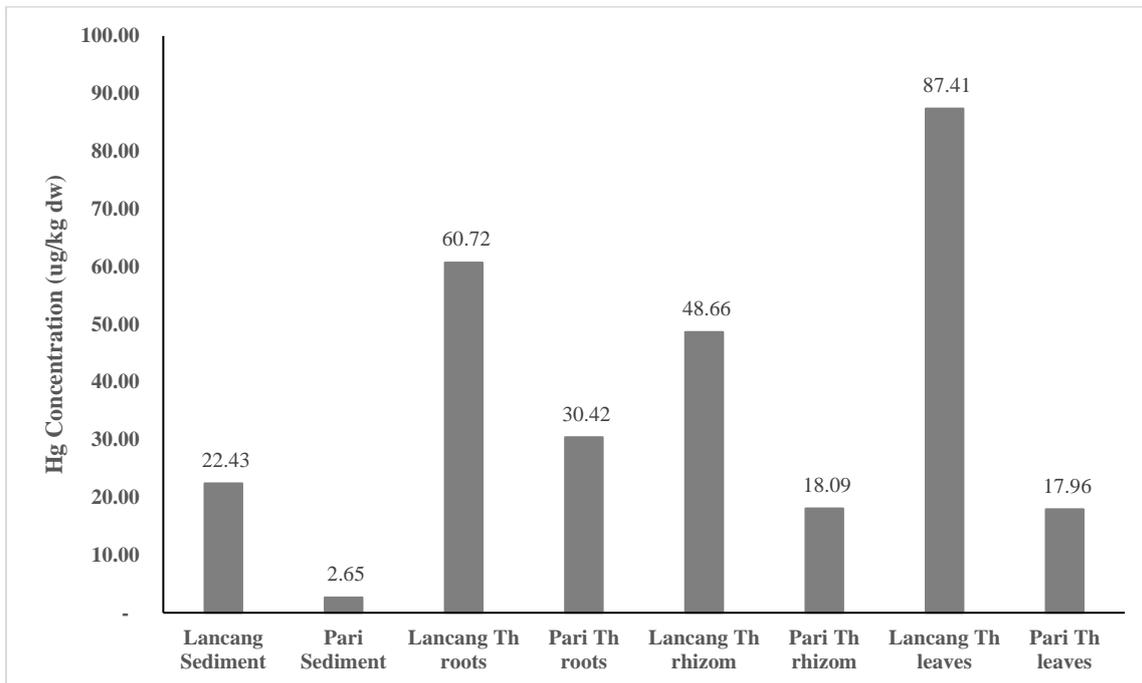


Figure 3. Hg concentration in sediment, roots, rhizomes, leaves of *T.hemprichii* at Lancang and Pari islands.

Table 1. Hg concentration (ug/kg dw).

	Lancang	Pari	Panggang
Sediment	22.43 ± 5.59 ^a	2.65 ± 0.85 ^b	1.75 ± 1.12 ^b
<i>E.acoroides</i>			
Roots	30.08 ± 10.79 ^a	11.61 ± 1.16 ^b	7.12 ± 2.12 ^b
Rhizomes	51.23 ± 23.99 ^a	19.11 ± 0.49 ^b	14.30 ± 1.76 ^b
Leaves	56.90 ± 4.75 ^a	16.42 ± 3.15 ^b	16.53 ± 1.30 ^b
<i>T.hemprichii</i>			
Roots	60.72 ± 3.95 ^a	30.42 ± 3.57 ^b	
Rhizomes	48.67 ± 20.60 ^a	18.09 ± 11.07 ^b	
Leaves	87.41 ± 8.20 ^a	17.96 ± 1.18 ^b	

Noted: The same alphabet indicates there is no significant difference value ($p < 0.05$)

4. Conclusions

The accumulations of mercury (Hg) in two seagrass species on three islands of Seribu Islands range at 7.12 – 87.41 ug/kg dw, with a pattern of the highest to lowest concentration in accordance with the distance from the mainland of Java. With their ability to accumulate mercury, the seagrasses have the potential to be used as bioindicator for mercury contamination.

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