

# Higher bioavailability of Cu and Zn in the eastern part of Johore Causeway: Will the pattern remain the same beyond 2030?

## Abstract

The purpose of this paper is to discuss Cu and Zn concentrations in *Perna viridis* soft tissues from the western and eastern parts of Johore Singapore Causeway. The polluted eastern portion of the Causeway had greater levels of Cu and Zn in different areas of the soft tissues of mussels than the western part. This indicated the eastern section of the semi-enclosed Causeway had higher Cu and Zn bioavailability than the western part. With some reports of high metal levels in the eastern part of the Causeway from 2015 to 2018, it is predicted that there will be a plausible constant source of anthropogenic metal contamination in the eastern part of the Causeway beyond 2030 if anthropogenic activities are not effectively controlled.

**Keywords:** different tissues, metal distribution, mussels, biomonitoring organs

Volume 6 Issue 4 - 2021

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**Received:** July 10, 2021 | **Published:** July 26, 2021

## Introduction

Between southern Johore (Peninsular Malaysia) and Singapore, the Straits of Johore are located. This research focuses on the Straits of Malacca because of its importance from an ecotoxicological standpoint.<sup>1-4</sup> The relevance of the Straits as a key culture site for the commercial green-lipped mussel *Perna viridis* was reported by Yap et al.<sup>5</sup> This mussel species has been identified as a good biomonitor of heavy metal contamination because it meets many of the biomonitor's recommended criteria.<sup>6</sup> The metal concentrations reported in mussel tissues are indicative of bioavailable metals in the test sites' coastal waters.<sup>7</sup> Human activity such as fossil fuel, electrical generating plants, construction sites, and shipping terminals have been documented along the Straits.

The goal of this study was to analyse the distribution of Cu and Zn in different areas of *P. viridis*, as well as to discuss the pattern of metal bioavailability between the eastern and western sides of the Johore Causeway beyond 2030.

## Materials and methods

The present data of Cu and Zn were cited from Yap et al.<sup>2</sup> in different tissues of *P. viridis* from western (4 sites) and eastern (4 sites) parts of Johore Causeway, with sampling taking place in 2004-2005. Whereas, another set of data were cited from Yap et al.<sup>3</sup> from almost the same sites in the western (3 sites) and eastern (3 sites) parts of Johore Causeway, with sampling taking place in 2006.

## Results and discussion

Cu and Zn concentrations in different soft tissues of *P. viridis* cited from Yap et al.<sup>2,8</sup> from the western and eastern sides of the Johore

Causeway are shown in Table 1. In general, Cu and Zn values were greater in the Eastern part half than Gelang Patah in the western section of the Johore Causeway. There were varied levels of heavy metal concentration in different parts of the mussel soft tissues. Metal bioavailability, season, and mussel physiology may all impact variations in metal concentrations in mussels.<sup>9</sup> The change in metal concentrations could also be explained by variations in water salinity and temperature, according to Wong et al.<sup>10</sup>

**Table 1** Mean concentrations (µg/g dry weight) of heavy metals in the different soft tissues of *Perna viridis* originating from the western and eastern portions of the Johore Straits separated by the Johore Causeway

		West	East	References
Foot	Cu	6.2	10.6	Yap et al. <sup>6</sup>
		7.42	8.73	Yap et al. <sup>2</sup>
	Zn	52.5	67.1	Yap et al. <sup>6</sup>
		62.9	56.9	Yap et al. <sup>2</sup>
Gill	Cu	11.1	12.1	Yap et al. <sup>6</sup>
		8.92	13.4	Yap et al. <sup>2</sup>
	Zn	95.8	123	Yap et al. <sup>6</sup>
		102	124	Yap et al. <sup>2</sup>
Gonad	Cu	10.8	10.6	Yap et al. <sup>6</sup>
		7.34	9.23	Yap et al. <sup>2</sup>
	Zn	84	77.3	Yap et al. <sup>6</sup>
		76.1	76.2	Yap et al. <sup>2</sup>

Table Continued...

		West	East	References
Mantle	Cu	11	11.9	Yap et al. <sup>6</sup>
		<b>6.94</b>	11.4	Yap et al. <sup>2</sup>
	Zn	63.3	71.9	Yap et al. <sup>6</sup>
		64.5	62.4	Yap et al. <sup>2</sup>
Muscle	Cu	5.2	8.4	Yap et al. <sup>6</sup>
		<b>5.51</b>	8.45	Yap et al. <sup>2</sup>
	Zn	65.9	81.4	Yap et al. <sup>6</sup>
		<b>69.6</b>	85.1	Yap et al. <sup>2</sup>
Remainder soft tissues	Cu	12	15.6	Yap et al. <sup>6</sup>
		<b>10</b>	13	Yap et al. <sup>2</sup>
	Zn	113	101	Yap et al. <sup>6</sup>
		<b>84.9</b>	99	Yap et al. <sup>2</sup>

Note: \*Values in bold are metal concentrations that are higher in the eastern part than in the western part. Data cited from Yap et al.<sup>2</sup> collected in 2005, and Yap et al.<sup>6</sup> collected in 2006

The soft tissues of *P. viridis* from the eastern part of the causeway contained higher amounts of Cu and Zn, indicating that the eastern part of the causeway had higher Cu and Zn bioavailability than the western part.<sup>7</sup> This is most likely due to anthropogenic activity including petrochemical plants, land reclamation, urbanisation, shipping, and other industrial operations.<sup>11</sup>

### Pattern beyond 2030

According to many recent reports, the eastern side of the Johore Causeway will continue to receive anthropogenic inputs. The contamination in Pasir Gudang was reported by Yap et al.<sup>12</sup> in the local newspaper as the Kim Kim River chemical waste contamination. Yap et al.<sup>13</sup> reported greater Cu bioavailability and contamination in three mollusks, including *P. viridis*, at Kg. Pasir Puteh. Mahat et al.<sup>14</sup> reported Cu levels in the whole soft tissues of *P. viridis* obtained from Kg. Pasir Puteh ranged from 11.2-13.8 mg/kg dry weight in 2015, compared to 20.1 mg/kg dry weight for mussels collected from the same site in 2000.<sup>15</sup> When comparing the 2015 samples to those from 2000, the level of Cu in the mussels is lower. Mohamat-Yusuff et al.<sup>16</sup>, on the other hand, found a moderate degree of Cu contamination in *P. viridis* at Kong Kong Laut. Previously, Cu levels in the mussel soft tissues collected from the eastern side of the Causeway had been observed to be increased in the mussels collected in 2000,<sup>11,15,17</sup> 2005 (Yap et al., 2006a), 2006<sup>8</sup> and 2009,<sup>18-20</sup> and in the sediments.<sup>1,4,21,22</sup> Because the eastern parts of the Johore Causeway, such as Kg. Pasir Puteh and Kg. Masai, are close to a busy harbour and industrial sectors near Pasir Gudang, the likelihood of anthropogenic heavy metal pollution in this area beyond 2030 is projected to be considerable. As a result, future efficient metal pollution control management in the eastern portion of the Straits of Johore should be in line with Goal #12 of the United Nations Sustainable Development Goals (UNSDGs), which mentions the economy, the environment, and the society.<sup>23,24</sup>

### Concluding remarks

In general, higher levels of Cu and Zn were found in most of the soft tissues of *P. viridis* from the east coast of The Straits of Johore than the west coast, indicating that the eastern half of the Causeway

has higher Cu and Zn bioavailability than the western part. With some reports of high metal levels in the eastern part of the Causeway from 2015 to 2018, it is predicted that there will be a plausible constant source of anthropogenic metal contamination in the eastern part of the Causeway beyond 2030 if anthropogenic activities are not effectively controlled.

### Acknowledgments

None.

### Funding

None.

### Conflicts of interest

None.

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