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Pollutant exposure in Manila Bay: Effects on the allometry and histological structures of *Perna viridis* (Linn.)

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ABSTRACT

Objective: To determine the effects of the water quality of Manila Bay on allometric parameters and histological biomarkers of selected organs of *P. viridis*.

Methods: Green mussels were collected from two coastal sites of Manila Bay, Las Piñas – Parañaque (LPP) and Bacoor, Cavite (BC). Twenty-four green mussels from each site were used for the assessment of allometric parameters, and six green mussels from LPP and eight from BC were used for the assessment of histological structures of gonads, gut, and digestive glands. Gonad development was categorized into five stages, whereas gut and digestive glands were scored into four categories.

Results: Allometric parameters that include shell height, weight, and total wet and dry soft tissue weight were significantly different between LPP and BC. It was also observed that exposure to the pollutants in Manila Bay resulted to delays in gonadal development, and detrimental changes and lesions in the histostructure of digestive gland and gut.

Conclusions: Pollutants in Manila Bay have detrimental effects to the growth, reproductive development, and histological structure of digestive organs of *P. viridis*.

1. Introduction

Water pollution is one of the biggest problems that our world is facing. Water is considered polluted when certain substances or contaminants are present and makes it unfit for specific purposes. These pollutants are mostly products of anthropogenic activities, specifically as agricultural, domestic and industrial wastes. Common pollutants include heavy metals such as lead, copper, chromium, cadmium, and mercury [1,2]. Moreover, pesticides used in protecting crops and other plants are also considered pollutants once they are introduced in the water system [3].

In the Philippines, many bodies of water are now classified as massively polluted. One of which is Manila Bay, a semi-enclosed marine inlet surrounded by Metro Manila and different municipalities of Cavite, Bulacan, Bataan, and Pampanga [4–6]. At present, it has deteriorating water quality because of the intensified disposal of human wastes [5,6]. Water samples collected from the coastal lagoon of Manila Bay have varying levels of heavy metals [6,7], polycyclic aromatic hydrocarbon (PAH) [8], benzotriazole ultraviolet stabilizers and organophosphorus flame retardants and plasticizers [9,10], and tributyltin (TBT). These water pollutants directly endanger the health of aquatic animals [2] resulting to a decline of marine resource production.

Perna viridis (*P. viridis*), commonly known as Asian green mussel or tahong, is one of the marine resources that are harvested in the coastal areas of Manila Bay. Green mussels generally grow on hard surfaces, and is said to be invasive for its wide range of tolerance. However, a recent report showed that there is a decline in the population of this aquatic species [6]. According to DENR (2004), the decline in mollusk production is attributed to the high levels of heavy metals, oil and grease, and suspended solids in Manila Bay. This

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problem in green mussel population tremendously affects the livelihood of people living in the coastal areas of the bay which rely mostly on fisheries and aquaculture [9]. As a common and affordable food and rich source of iodine, green mussels are available in the local markets in the cities and municipalities around Manila Bay.

Aside from the alarming state of *P. viridis* population, this mollusk species is considered as a bioindicator responding well to environmental changes. It was reported that green mussel is an organism suited for biomonitoring studies of coastal waters because of their widespread geographical distribution, sedentary mode of life, and filter feeding mechanism [11,12]. As a filter feeder, they have the ability to store and accumulate several organic and inorganic contaminants [13], which is used for studies in detecting chemical pollutants in the coastal waters and their possible effects to the aquatic organism. Pollution impacts to organisms can be assessed or measured through biomarkers at the cellular, histological, molecular, biochemical or physiological level [11]. The abundance of *P. viridis* in Manila Bay is a good criterion for its use as a bioindicator, specifically in determining the effects of chemical pollutants present in the bay on bivalves. This will clarify and explain the reports on the gradual decline of mollusk production, which vehemently results to economic losses in the aquaculture sector. At present, no other studies were conducted on determining the health and growth status of green mussels in Manila Bay.

Hence, this study was conducted to determine the effects of the water quality of Manila Bay on allometric parameters and histological biomarkers of selected organs of green mussels (*P. viridis*). Specifically, this study assessed shell and soft tissue allometric parameters and histological structures of the gonads, gut and digestive glands of *P. viridis* collected from Manila Bay.

2. Materials and methods

2.1. Sampling of green mussels (*P. viridis*)

Green mussels (*P. viridis*) were collected from two coastal sites of Manila Bay, Las Piñas – Parañaque (LPP) and Bacoor, Cavite (BC). Form each site, 30 green mussels were randomly collected by the local fisherman. The collected samples were placed in a container with water from the Bay, and were immediately transported to the Science Laboratory of Las Piñas National High School (LPNHS) for assessment.

2.2. Taxonomic identification of *P. viridis*

The taxonomic identification of green mussels collected from two sampling sites of Manila Bay was based on the certification of the Zoology Division, National Museum of the Philippines.

2.3. Assessment of allometric parameters

Twenty-four green mussels from each site were used for the assessment of allometric parameters. Using a ruler, the following shell dimensions were measured in centimeters: shell length (SL) measured from anterior to posterior; shell width (SWI) measured in the lateral edge; and shell height (SH) measured from dorsal to ventral [14]. Shell volume (SV) was computed using this formula:

$$\text{Shell volume (SV)} = \text{SL} \times \text{SWI} \times \text{SH}$$

Using an electronic weighing scale, shell weight (SWE), total wet (WWE) and dry soft tissue weights (DWE) were measured in grams [14]. The wet soft tissue was weighed 10 min after it was removed from the container full of water [15]. The dry soft tissue on the other hand, was weighed after the soft tissues were dried for at least 60 °C for 48 h [16].

Consequently, condition index (CI) was computed by dividing total dry soft tissue weight in grams to shell volume in cubic centimeters multiplied to a constant 1 000 [14].

$$\text{CI}\ (\text{g/cm}^3) = \frac{\text{Total dry soft tissue weight (g)}}{\text{Shell volume (cm}^3)} \times 1\,000$$

2.4. Histopathological assessment

Six green mussels from LPP and eight from BC were used for the assessment of histological structures. Gonads and guts with digestive glands were dissected out and were placed in 10% buffered formalin. The samples were brought to the Philippine Kidney Dialysis Foundation Institute for histopathological slide preparation. Each organ was stained with hematoxylin and eosin. Histological slides were observed under an inverted microscope at 200× and 400×.

The histopathological structure of gut epithelium and digestive gland were scored based on the following observed

Table 1

Allometric parameters of *P. viridis* collected from two sampling sites in Manila Bay (n = 24).

Allometric parameters	Sampling sites (Manila Bay)	
	Las Piñas – Parañaque Coastal side (LPP)	Bacoor, Cavite Coastal side (BC)
Shell length (SL) (cm)	5.54 ± 0.47[a]	5.50 ± 0.99[a]
Shell width (SWI) (cm)	1.80 ± 0.21[a]	1.79 ± 0.38[a]
Shell height (SH) (cm)	2.56 ± 0.25[a]	2.74 ± 0.25[b]
Shell volume (SV) (cm^3)	25.61 ± 5.53[a]	26.86 ± 8.24[a]
Shell weight (SWE) (g)	5.51 ± 1.10[a]	6.66 ± 1.93[b]
Total wet soft tissue weight (WWE) (g)	3.81 ± .071[a]	4.43 ± 0.78[b]
Total dry soft tissue weight (DWE) (g)	2.78 ± 0.52[a]	3.17 ± 0.66[b]
Condition index (CI) (g/cm^3)	113.01 ± 30.48[a]	131.98 ± 64.89[a]

Values are given as mean ± SD. n = Number of *P. viridis*. Values in the same row with different superscript letters are significantly different (P < 0.05).