



# Assessment of heavy metal concentration in the blue swimming crab *Portunus pelagicus* from Manila Bay, Philippines

<sup>1,2</sup>Ken Joseph E. Clemente, <sup>3</sup>Nikki Rose N. Tosoc, <sup>3</sup>Cariza Jane M. Soriano, <sup>3</sup>Jeffrey R. Manalo, <sup>3</sup>Robert T. Padirogao, <sup>3</sup>Hazel Joy M. Pacis, <sup>3</sup>Vanessa Joy P. Gasat, <sup>3</sup>Michael Prince N. del Rosario, <sup>3</sup>Gerard Mark C. Santos, <sup>3</sup>Lourdes P. Terrado, <sup>1,3</sup>Alma E. Nacua

<sup>1</sup> Urban Biodiversity Laboratory, Universidad de Manila, 659-A Cecila Muñoz Street, Ermita, Manila 1000, Philippines; <sup>2</sup> Science Technology Engineering and Mathematics (STEM) Strand, Senior High School, University of Santo Tomas, España Blvd, Sampaloc, Manila 1015, Philippines; <sup>3</sup> Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines. Corresponding author: K. J. E Clemente, keclemente@ust.edu.ph

**Abstract.** There has been no follow up reports up to date regarding the heavy metal concentration in the blue swimming crab *Portunus pelagicus* from Manila Bay. Hence, this study aimed to provide a recent status on the concentration of heavy metals (Cd, Cr, Pb, and Hg) in the muscular tissues of *P. pelagicus* from Manila Bay, Philippines. Specimen samples were collected in August 2017 at the coastal area of the bay, immediately brought to the laboratory, morphologically identified, dissected for muscles, and subjected to heavy metal testing. Tissue samples were subjected to Flame-AAS (atomic absorption spectrophotometry) method for detecting and quantifying heavy metals such as total cadmium (Cd), total chromium (Cr), and total lead (Pb) while the analysis of total mercury (Hg) were done using the Cold Vapor-AAS method. *P. pelagicus* in Manila Bay did not exhibit any serious deformities and signs of visceral necrosis. With reference to a previous study, our study obtained a lower total Cd but higher in terms of total Cr and total Pb while total Hg concentration is below detectable limit. *P. pelagicus* tissues has tolerable levels of Cd, Cr, Pb, and Hg with reference to international/national standards. Still, it is recommended to have a follow up monitoring of heavy metals in fish and shellfish commodities in Manila Bay as a mitigating measure.

**Key Words:** Manila Bay, heavy metal, *Portunus pelagicus*, AAS, pollution.

**Introduction.** The Manila Bay is a popular body of water in the Philippines owing to its scenic view and industrial function. It is considered as the main harbor that serves as international port of entry in Metro Manila. The bay is characterized by abundant natural resources being the primary source of livelihood for people in the areas surrounding the bay though it suffered from serious water quality deterioration due to the rapid increase in population and industrialization (Chang et al 2009). A large increase in organic loads entering Manila Bay is due to excessive urban emissions of nutrients and heavy metals (Reichardt et al 2006; Urase et al 2006). Human activities contribute significantly to the release of heavy metals in Manila Bay which continuously poses an alarming concern for the future.

Heavy metal-contaminated water affects the lives of the organisms living in it (Ernawati 2014) as these heavy metals may enter the food chains, persist in the environment, bioaccumulate and biomagnify and increase the exposure to public health risks (Sia Su et al 2009). The biota in the Manila Bay being an important source of livelihood from Manileños offers a grave interest for health hazard studies. Among the famous commodity in the bay at risk for heavy metal exposure is the blue swimming crab *Portunus pelagicus* locally known as “kasag”. The blue swimming crab *P. pelagicus* is

widely distributed throughout the Indo-West Pacific (Kumar et al 2000). *P. pelagicus* is one of the important representatives of decapod crustacean commonly found in the Philippines and is becoming a commercially important species in the country (Cabacaba & Salamida 2015). *P. pelagicus* is rarely reported in toxicology literatures that deal with biota in coastal pollution and population-heavy areas like the Manila Bay. Globally, few studies dealing with heavy metal assessment on the tissues of *P. pelagicus* were those from Egypt (El-Moselhy 2006) and Iran (Hosseini et al 2012). In the Philippines, heavy metal detection in *P. pelagicus* from Manila Bay was only reported once by Sia Su et al (2009).

There have been no follow up reports up to date regarding the heavy metal concentration in *P. pelagicus* from Manila Bay. With these concerns therefore, this study aimed to provide a recent status on the concentration of heavy metals (Cd, Cr, Pb, and Hg) in the soft tissues of *P. pelagicus* from Manila Bay, Philippines. It is perceived that this update provides an insight whether the heavy metal concentration in *P. pelagicus* samples from the bay fall within the permissible limits of human consumption set by international standards. This study can also serve as an updated monitoring status to aide both government and non-government institutions in their effort to safeguard the country's natural resources.

**Material and Method.** In August 2017, sample collection was conducted in Manila Bay coastal area near Harbor Square Park at approximately 14°33'42.6"N 120°58'48.0"E. With the assistance of fishermen, *P. pelagicus* samples were collected, stored in a cooler, and immediately brought to the laboratory for processing. Specimen samples were morphologically identified through [www.sealifebase.org](http://www.sealifebase.org). Samples for analysis were dissected, and muscular tissues were obtained for heavy metal testing. Tissue samples were subjected to 3111B Flame-AAS (atomic absorption spectrophotometry) method for detecting and quantifying heavy metals such as total cadmium (Cd), total chromium (Cr), and total lead (Pb) following the standard procedures (APHA, AWWA, WEF 1998). The analysis of total mercury (Hg) were done using the 3112B Cold Vapor-AAS method (Beaty & Kerber 2002). All heavy metal analysis was performed at the Mach Union Laboratory, Las Piñas City, Philippines.

**Results and Discussion.** Samples of *P. pelagicus* obtained from Manila Bay in this study did not exhibit any serious deformities and signs of visceral necrosis. Gross morphological descriptions and measurements tend to be normal and coincide with published descriptions and values (Table 1).

Table 1  
Morphological characteristics of the male and female *Portunus pelagicus* obtained from Manila Bay as observed in this study

<i>Portunus pelagicus</i> (male)	<i>Portunus pelagicus</i> (female)
Males are bright blue in color with scattered dorsal white spots and with characteristically long claw, approximately 140 mm wide carapace, a more pointed abdomen which is opposite to females, telson is a bit pointed and longer compare to females.	Females have a light green or brown color, with a more rounded dorsal section of the exoskeleton, ranges 80 to 150 mm wide carapace, a more rounded telson, the egg-bearing mass are orange sometimes grey in color.

Table 2 shows the comparison of heavy metal concentrations (mg kg<sup>-1</sup>) of *P. pelagicus* from Manila Bay based on the only previous record by Sia Su et al (2009) and this study. International/national standards of permissible limits of heavy metals were indicated. Results showed that heavy metal values from both studies are lower than the maximum permissible limits set by the European Union [Commission Regulation (EC) No 1881/2006] and China (GB 2762-2012)]. With reference to the values in Sia Su et al (2009), this study obtained a lower total Cd but higher in terms of total Cr and total Pb. While this study is the first attempt to measure total Hg in *P. pelagicus*, the concentration

obtained is below detectable limit. It must be noted that crustaceans have heavy metal sequestration mechanisms through the action of metallothioneins (MTs) which had been reported to have an ability to detoxify heavy metals like cadmium and lead (Ghasemian et al 2016). This can be the reason for maintaining lower levels of cadmium, while the increased lead concentration can be attributed to extensive influx of industrial wastes overriding the activity of MTs at this point.

Table 2

Comparison of heavy metal concentrations (mg kg<sup>-1</sup>) of *Portunus pelagicus* based on different studies in Manila Bay

Heavy metal	Permissible limits	Sia Su et al (2009)	This study (2018)
Cd	0.500 <sup>a</sup>	0.095	0.079
Cr	2.000 <sup>b</sup>	0.019	0.159
Pb	0.500 <sup>a</sup>	0.199	0.369
Hg	0.500 <sup>a</sup>	no analysis done	0.000

<sup>a</sup>Commission Regulation (EC) No 1881/2006 by EU; <sup>b</sup>Maximum Levels of Contaminants in Foods (GB 2762-2012) by MHPRC.

While the concentrations of heavy metals from both studies generally indicate that *P. pelagicus* commodity in Manila bay is safe to consume, it is still disturbing that Pb and Cr concentrations had increased. This can warrant an alarming notion to further monitor heavy metal bioaccumulation to fish and shellfish resources in the bay. Heavy metal detection in muscular tissues is important since it is a commonly consumed part in crabs. Also, despite safe heavy metal values, the number of exposure and dosage of consumption may be fatal to consumers. Because of their high degree of toxicity, Cd, Cr, Pb, and Hg rank among the priority metals that are of public health significance as they are considered systemic toxicants that are known to induce multiple organ damage, even at lower levels of exposure (Tchounwou et al 2012).

**Conclusions.** *Portunus pelagicus* in Manila Bay was observed for not having any serious deformities and signs of visceral necrosis with its gross morphology intact and concurring with published descriptions and values. It has been assessed that it has tolerable levels of Cd, Cr, Pb, and Hg with reference to international/national standards. With reference to the previous similar study done in Manila Bay, this study obtained a lower total Cd but higher in terms of total Cr and total Pb. This study is the first attempt to measure total Hg in *P. pelagicus* in Manila Bay but the concentration obtained is below detectable limit. It is recommended to have a follow up monitoring of heavy metals in fish and shellfish commodities in Manila Bay as the influx of industrial and anthropogenic wastes to the bay is becoming extensive.

**Acknowledgements.** Special thanks to Dr. Julian Abuso, Dean of the Graduate School of the University of the East for his permission and support for the field sampling of the student co-authors. Likewise, acknowledgment is due to the Commission on Higher Education (CHED) for the research funding extended to Universidad de Manila through the DARE-TO Research Grant.

## References

- APHA, AWWA, WEF - American Public Health Association, American Waterworks Association, Water Environmental Federation, 1998 Standard method for the examination of water and wastewater. 20th edition, Washington, DC, USA, 1325 pp.
- Beaty R. D., Kerber J. D., 2002 Concept, instrumentation and techniques in atomic absorption spectrophotometry. The Perkin-Elmer Corporation, Nowalk, USA, 96 pp.

- Cabacaba N. S., Salamida J. E., 2015 Seed production of the blue swimming crab (*Portunus pelagicus*). In: Resource enhancement and sustainable aquaculture practices in Southeast Asia: challenges in responsible production of aquatic species. Romana-Eguia M. R. R., Parado-Esteva F. D., Salayo N. D., Lebata-Ramos M. J. H. (eds), Proceedings of the International Workshop on Resource Enhancement and Sustainable Aquaculture Practices in Southeast Asia 2014 (RESA), Aquaculture Department, Southeast Asian Fisheries Development Center, Tigbauan, Iloilo, Philippines, 313 pp.
- Chang K. H., Amano A., Miller T. W., Isobe T., Maneja R., Siringan F. P., Imai H., Nakano S., 2009 Pollution study in Manila Bay: eutrophication and its impact on plankton community. In: Interdisciplinary studies on environmental chemistry – environmental research in Asia. Obayashi Y., Isobe T., Subramanian A. M., Suzuki S., Tanabe S. (eds), TERRAPUB, pp. 261-267.
- Commission Regulation EC No 1881/2006 of 19 December, 2006 Setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Union L 364: 5-24.
- El-Moselhy K. H., 2006 Bioaccumulation of mercury in some marine organisms from Lake Timsah and Bitter Lakes (Suez Canal, Egypt). Egyptian Journal of Aquatic Research 32(1):124-134.
- Ernawati Y., 2014 The analysis of the concentration of heavy metals cadmium, mercury and lead in the flesh of suckermouth catfish (*Pterygoplichthys pardalis*) in Ciliwung River, Indonesia. AACL Bioflux 7(1):33-42.
- Ghasemian S., Karimzadeh K., Zahmatkesh A., 2016 Metallothionein levels and heavy metals in Caspian Sea gammarid, *Pontogammarus maeoticus* (Crustacea, Amphipoda, Pontogammaridae). AACL Bioflux 9(1):1-7.
- Hosseini M., Vazirizade A., Parsa Y., Mansori A., 2012 Sex ratio, size distribution and seasonal abundance of blue swimming crab, *Portunus pelagicus* (Linnaeus, 1758) in Persian Gulf coasts, Iran. World Applied Sciences Journal 17(7):919-925.
- Kumar M., Ferguson G., Xiao Y., Hooper G., Venema S., 2000 Studies on reproductive biology and distribution of blue swimmer crab (*Portunus pelagicus*) in South Australian waters. SARDI Research Report Series 47:1324-2083.
- MHPRC (Ministry of Health of the People's Republic of China), 2012 Maximum levels of contaminants in foods (GB 2762-2012). Beijing, China, 17 pp.
- Reichardt W., Mcglone M. L. S. D., Jacinto G. S., 2006 Organic pollution and its impact on the microbiology of coastal marine environments: a Philippine perspective. Asian Journal of Water, Environment and Pollution 4: 1-9.
- Sia Su G., Martillano K. J., Alcantara T. P., Ragraio E., De Jesus J., Hallare A., Ramos G., 2009 Assessing heavy metals in the waters, fish and macroinvertebrates in Manila Bay, Philippines. Journal of Applied Sciences in Environmental Sanitation 4(3):187-195.
- Tchounwou P. B., Yedjou C. G., Patlolla A. K., Sutton D. J., 2012 Heavy metals toxicity and the environment. EXS 101:133-164.
- Urase T., Nadaoka K., Yagi H., Iwasa T., Suzuki Y., Siringan F., Garcia T. P., Thao T. T., 2006 Effect of urban emissions on the horizontal distribution of metal concentration in sediments in the vicinity of Asian large cities. Journal of Water and Environment Technology 4:61-71.

Received: 11 June 2018. Accepted: 03 July 2018. Published online: 14 July 2018.

Authors:

Ken Joseph E. Clemente, Urban Biodiversity Laboratory, Universidad de Manila, 659-A Cecila Muñoz Street, Ermita, Manila 1000; STEM Strand, Senior High School, University of Santo Tomas, España Blvd, Sampaloc, Manila 1015, Philippines, e-mail: kecclemente@ust.edu.ph

Nikki Rose N. Tosoc, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: nikkirose.tosoc@ue.edu.ph

Cariza Jane M. Soriano, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: carizajane.soriano@ue.edu.ph

Jeffrey R. Manalo, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: jeffrey.manalo@ue.edu.ph

Robert T. Padirogao, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: robert.padirogao@ue.edu.ph

Hazel Joy M. Pacis, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: hazeljoy.pacis@ue.edu.ph

Vanessa Joy P. Gasat, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: vanessajoy.gasat@ue.edu.ph

Michael Prince N. del Rosario, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: michaelprince.delrosario@ust.edu.ph

Gerard Mark C. Santos, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: gerardmark.santos@ust.edu.ph

Lourdes P. Terrado, Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: lourdes.terrado@ue.edu.ph

Alma E. Nacua, Urban Biodiversity Laboratory, Universidad de Manila, 659-A Cecila Muñoz Street, Ermita, Manila 1000, Philippines; Graduate School, University of the East, 2219 Recto Avenue, Sampaloc 1008, Manila, Philippines, e-mail: almanacua@yahoo.com

This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

How to cite this article:

Clemente K. J. E., Tosoc N. R. N., Soriano C. J. M., Manalo J. R., Padirogao R. T., Pacis H. J. M., Gasat V. J. P., del Rosario M. P. N., Santos G. M. C., Terrado L. P., Nacua A. E., 2018 Assessment of heavy metal concentration in the blue swimming crab *Portunus pelagicus* from Manila Bay, Philippines. AES Bioflux 10(2): 63-67.