Landing Population and Toxicity Assessment of Common Horseshoe Crabs (Arthropoda: Xiphosura) from South West of Sarawak

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Doctor of Philosophy
2019
Landing Population and Toxicity Assessment of Common Horseshoe Crabs (Arthropoda: Xiphosura) from South West of Sarawak

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A thesis submitted
In fulfillment of the requirements for the degree of Doctor of Philosophy
(Aquatic Science)

Faculty of Resource Science and Technology
UNIVERSITI MALAYSIA SARAWAK
2019
DECLARATION

The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

________________________________
(NOOR JAWAHIR BINTI A.RAMAN)
Date: 17 July 2019
Faculty of Resource Science and Technology
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ACKNOWLEDGEMENT

In the name of Allah, Most Gracious, Most Merciful.

Salawat and salam to Prophet Muhammad SAW.

Alhamdulillah, fullest gratitude to the Almighty for His blessings, the faith and courage given, finally I was able to complete my PhD project. Firstly, I would like to express my greatest appreciation to my supervisor, Associate. Prof. Dr. Samsur bin Mohamad for his patience, courage, guidance, and undying support during supervising my PhD project.

Deepest gratitude and fondest love to my soul mate, Hishammudin Afifi, my daughters, Hannah, Aisyah and Alya, ma (Siti binti Musa) and abah (A.Raman bin Mat Adam). Thank you for being patient and supportive given during I finishing my project.

My appreciation goes to staff of the Aquatic Science Department for their kindness in guiding and helping me during laboratory works and sampling trips, and my colleagues for sharing their knowledge and sweet memories with me. Special thanks to all hardworking final year students that involved in this project.

I would like to thank Faculty of Resource Science and Technology, Universiti Malaysia Sarawak for providing the research facilities and Ministry of Higher Education Malaysia for financial support through research grants FRGS/STWN04(01)/986/2013(27). My appreciation goes to Dr. Mohd Nor Azman bin Ayub from Fisheries Research Institute Batu Maung, Penang for the permission, guiding and helpful advices in LC-MS/MS analysis and also to Dr. Bryan Raveen Nelson from Universiti Malaysia Terengganu for the guiding in using software Primer v.6.
ABSTRACT

_Tachypleus gigas_ and _Carcinoscorpius rotundicauda_ are commonly found in Malaysian waters, with both species co-existing in sandy beach, sandy-muddy and mangrove habitats. Although horseshoe crabs have long existed and are frequently consumed actively by Sarawakians, scientific literature on the horseshoe crab still remains inadequate. Therefore, this study covers the documentation for the spatial trend of landing population, morphometrics and toxicity of horseshoe crabs in three habitats in the south west of Sarawak, and the temporal trend of landing horseshoe crabs in a sandy-muddy habitat in Pasir Putih Village (2014-2016). The spatial trend shows that a high density of _T. gigas_ landing population was recorded in sandy-muddy (186.08 individuals/100 m²) and sandy beach (168.18 individuals/100 m²) habitats. Meanwhile, _C. rotundicauda_ dominated the sandy-muddy habitat (11.78 individuals/100 m²). The pH of sediments, sorting coefficient, percentage of silt-clay and percentage of total organic matter affected the density of landing horseshoe crabs in the south west of Sarawak. BEST and Particle Component Analysis performed between the environmental and the individual numbers (using Primer v.6) supported the results of the spatial and temporal trends. Only the carapace width-body weight relationship of female _C. rotundicauda_ from sandy muddy and mangrove habitats experienced isometric growth (b value=3.00). The temporal trend indicated that landing horseshoe crabs numbers on the intertidal area of Pasir Putih Village are influenced by certain environmental parameters (dissolved oxygen, mean of grain and sediment sorting). Pasir Putih Village is considered as non-favourable to the growth and health of both species as shown by the negative allometric growth in their length-weight relationship analysis with ‘b’ value ranging from -2.64 to 2.90. Both species demonstrate monogamous behaviour during spawning activity although _C. rotundicauda_ indicated a male-skewed
landing population. Carapace width measurement study revealed that horseshoe crabs appeared to be species with sexual dimorphism with adult females being larger and heavier compared to males. The tetrodotoxin (TTX) concentrations in tissues of both species were analysed and determined by using liquid chromatography-mass spectrometry/mass spectrometry (LC-MS/MS). For spatial trend, only male (n=4) and female (n=1) *C. rotundicauda* from sandy-muddy habitat contain a high TTX concentration in soft tissues ($\delta=48.70$ MU/g, $\varphi=35.91$ MU/g) and eggs ($\varphi=19.33$ MU/g), which is considered toxic for human. *C. rotundicauda* are considered as TTX-bearing organisms and the concentration of TTX in soft tissues of male *C. rotundicauda* is affected by their body mass index. A temporal study showed no TTX concentration was detected in *C. rotundicauda*. However, *T. gigas* from Pasir Putih Village was considered safe to be consumed during other months with caution since high TTX concentration was detected in soft tissues ($\delta=44.27$ MU/g, $\varphi=69.10$ MU/g) in August 2016 exceeded the regulatory limit for seafood (>10 MU/g).

These documentations are important for better management and conservation of horseshoe crabs in Sarawak. In addition, data obtained in this study will act as guidelines for the authorities to create public awareness in avoiding food poisoning due to the consumption of horseshoe crabs in the future. A consistent study and the latest sampling methods are crucial for future research in the distribution of horseshoe crabs in Sarawak.

**Keywords:** Horseshoe crab, density, morphomeric, tetrodotoxin, Liquid chromatography-mass spectrometry/mass spectrometry (LC-MS/MS)
**ABSTRAK**

Belangkas Tachypleus gigas dan Carcinoscorpius rotundicada biasanya ditemui di sepanjang perairan Malaysia, hidup bersama di habitat pantai berpasir, pantai berlumpur dan paya bakau. Walaupun belangkas sudah lama wujud dan dimakan oleh penduduk tempatan Sarawak, dokumentasi saintifik berkaitan belangkas masih terhad. Oleh itu, kajian ini merangkumi dokumentasi pola reruang untuk populasi singgah, morfometrik dan ketoksidan belangkas dari tiga habitat dan pola bermusim belangkas singgah di pantai berlumpur, Kampung Pasir Putih (2014-2016). Untuk pola reruang, kepadatan tinggi populasi singgah T. gigas dari pantai berlumpur (186.08 individu/100 m²) dan pantai berpasir (168.18 individu/100 m²) telah direkodkan. Manakala, C. rotundicada mendominasi pantai berlumpur (11.78 individu/100 m²). pH pasir, pekali pengasingan, peratusan lumpur dan peratusan bahan organik mempengaruhi kepadatan belangkas singgah di pantai barat daya Sarawak. BEST dan komponen utama (PCA) antara persekitaran dan jumlah bilanga digunakan untuk mengesahkan keputusan pola reruang dan bermusim (Primer v.6). Hanya hubungan lebar karapas-berat C. rotundicada betina dari pantai berlumpur dan paya bakau menunjukkan pertumbuhan isometrik (nilai $b=3.00$). Pola bermusim menunjukkan belangkas singgah di kawasan landai dipengaruhi oleh kandungan oksigen terlarut, min butiran dan pengasingan pasir. Kampung Pasir Putih tidak sesuai untuk pertumbuhan kedua spesies berdasarkan pertumbuhan allometrik negatif dari analisis hubungan panjang-berat dengan nilai ‘$b$’ antara -2.64 hingga 2.90. Kedua-dua spesies menunjukkan kelakuan monogami ketika mengawan walaupun C. rotundicada menunjukkan kecondongan kepada jantina jantan. Kajian pengukuran...
lebar karapas menunjukkan belangkas adalah species mempunyai perbezaan dimorphism seksual melalui saiz betina dewasa lebih besar dan berat berbanding jantan. Kepekatan tetrodotoxin (TTX) dianalisis dan ditentukan dengan menggunakan kromatografi cecair-spektrometri jisim. Kajian pola reruang menunjukkan tisu badan (♂=48.70 MU/g, ♀=35.91 MU/g) dan telur (♀=19.33 MU/g) dari jantan (n=4) dan betina (n=1) C. rotundicauda daripada pantai berlumpur mengandungi kandungan TTX tinggi dan dianggap toksik untuk manusia. C. rotundicauda dikelaskan sebagai organisma pembawa TTX dan kandungannya di dalam tisu badan jantan dipengaruhi oleh indek jisim badan. Kajian bermusim menunjukkan tiada kepekatan TTX dikesan dalam C. rotundicauda. Walaupun T. gigas dari Kg. Pasir Putih dianggap selamat dimakan dengan berhati-hati kerana kehadiran kandungan TTX dalam tisu badan di bulan Ogos 2016 melebihi had kawalselia makanan laut (>10 MU/g). Dokumentasi ini adalah penting untuk pengurusan dan pemuliharaan lebih berkesan, dan sebagai rujukan oleh pihak berkuasa untuk mengelakkan keracunan makanan akibat pemakanan belangkas di masa hadapan. Kajian yang konsisten dan cara persampelan terkini adalah penting untuk kajian taburan belangkas di Sarawak di masa hadapan.

Kata kunci: Belangkas singgah, kepadatan, morfometrik, tetrodotoxin, kromatografi cecair-spektrometri jisim
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