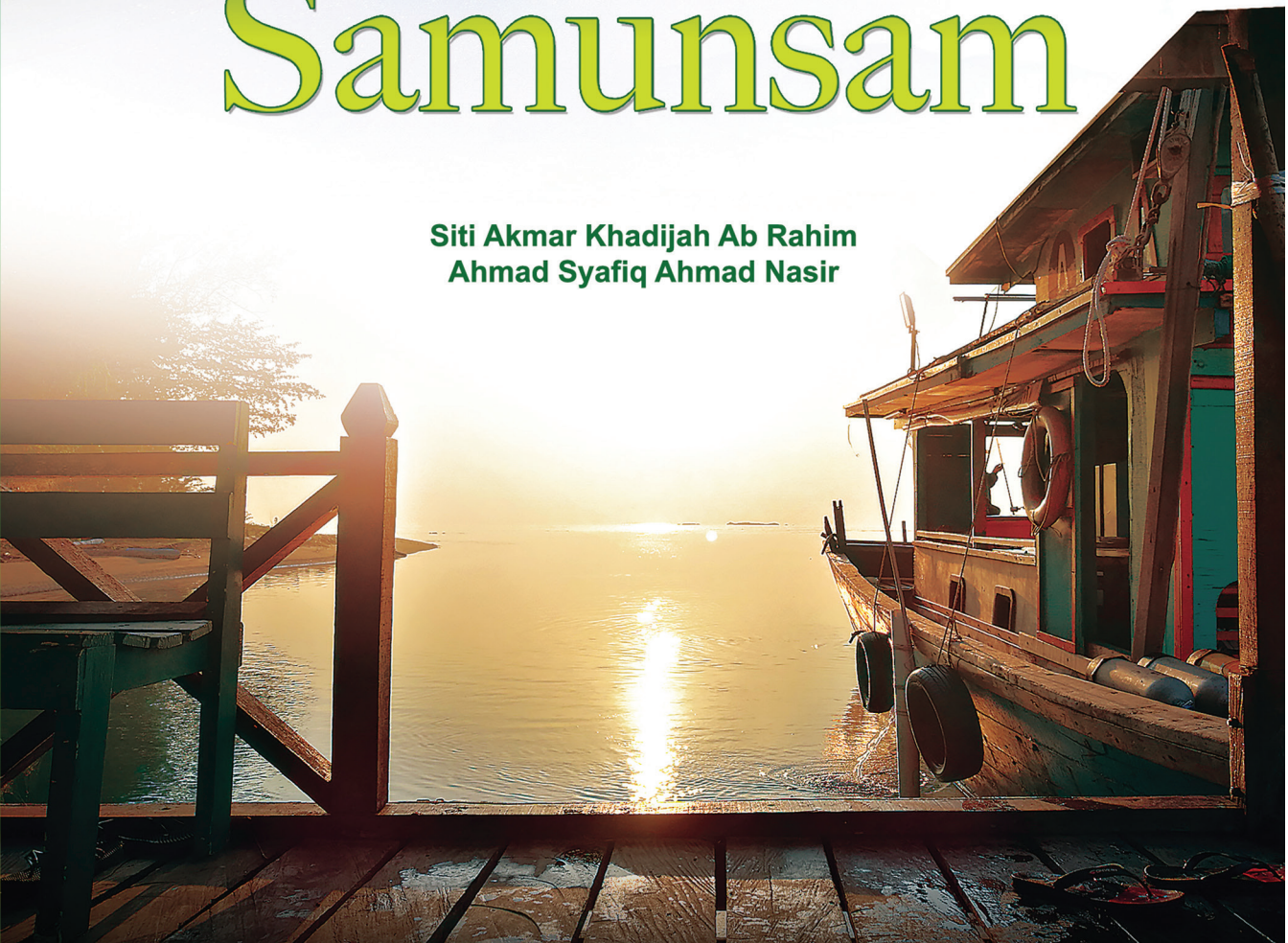


Proceeding of  
Aquatic Science Colloquium 2019 (AQUAColl 2019)  
Experience Sharing in Aquatic Science Research V

# Tanjung Datu — National Park — to Samunsam

Siti Akmar Khadijah Ab Rahim  
Ahmad Syafiq Ahmad Nasir





Proceeding of  
Aquatic Science Colloquium 2019 (AQUAColl 2019)  
Experience Sharing in Aquatic Science Research V

Tanjung Datu  
—— National Park ——  
to  
Samunsam



Proceeding of  
Aquatic Science Colloquium 2019 (AQUAColl 2019)  
Experience Sharing in Aquatic Science Research V

Tanjung Datu  
—— National Park ——  
to  
Samunsam

Siti Akmar Khadijah Ab Rahim  
Ahmad Syafiq Ahmad Nasir

# Tanjung Datu

National Park

# to Samunsam

© UNIMAS Publisher, 2024

All rights reserved. No part of this publication may be reproduced, stored in retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the publisher.

Published in Malaysia by

UNIMAS Publisher,  
Universiti Malaysia Sarawak,  
94300 Kota Samarahan,  
Sarawak, Malaysia.



Cataloguing-in-Publication Data

Perpustakaan Negara Malaysia

A catalogue record for this book is available  
from the National Library of Malaysia

eISBN 978-967-0054-79-7

# Contents

Preface	vii
Acknowledgement	ix
Local Communities' Involvement in Ecotourism around Tanjung Datu National Park: Potentials and Challenges	1
Status of Fisheries at Kg. Telok Melano and Kg. Telok Serabang	17
Types and Abundance of Marine Debris along the Coasts of Tanjung Datu National Park-Samunsam Wildlife Sanctuary	27
Assessment of Selected Trace Metals, Physicochemical Parameters and Total Organic Carbon in Seawater along Tanjung Datu and Sematan Coastal Area	37
Marine Phytoplankton Composition in Southern Coast of Sarawak	57
Short Notes of Fish Larvae from Samunsam River, Sarawak	69
Assessment of Selected Heavy Metals and Total Organic Carbon in Surface Sediments along Tg. Datu and Sematan Coastal Area	79
Macrobenthos of Subtidal Habitat in Sematan Coastal Water, Sarawak	93
Marine Macromollusc Fauna along Coastal Area of Tanjung Datu National Park-Samunsam Wildlife Sanctuary	103
Decapod Crustaceans from the Coastal Waters of Tanjung Datu, Sarawak	111
Ecological Characteristics of Arboreal Crab <i>Labuanium politum</i> from Samunsam Wildlife Sanctuary	139
Diet and Feeding Habits of Arboreal Crab <i>Labuanium politum</i> from Samunsam Wildlife Sanctuary, Sarawak	151
Species Checklist of Fishes from Samunsam River in Samunsam Wildlife Sanctuary, Sarawak	163
Long-Term Trends in Nesting Counts and Hatching Success of Painted Terrapin <i>Batagur borneoensis</i> at Samunsam Wildlife Sanctuary, Sarawak, Malaysia	175

Population Survey and Habitat Assessment of the Estuarine Crocodiles <i>Crocodylus porosus</i> at Samunsam River, Sarawak	185
Population Trend of Green Sea Turtle at Tanjung Datu National Park after 25 Years of Conservation Effort	199
Diversity and Abundance of Birds in Coastal Habitats of Tanjung Datu National Park and Samunsam Wildlife Sanctuary, Sarawak	207
Species Occurrence and Distribution of Cetacean in Tanjung Datu - Samunsam Coastal Waters of Sarawak	223



# Preface

The articles published in this proceeding are the research outcome of a joint scientific expedition in 2018 between the Programme of Aquatic Resource Science and Management, Faculty of Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS) and Sarawak Forestry Corporation Sdn Bhd (SFCSB) entitled Tanjung Datu National Park – Samunsam Wildlife Sanctuary Marine and Coastal Resources Expedition: Biodiversity Conservation and Sustainable Utilization’. The expedition was the second research collaboration between UNIMAS and SFCSB after the first ‘Pulau Sampadi Marine Life Expedition’ in 2012. The objectives of this expedition are: (1) to collect information and establish baseline data on the aquatic environments and its available resources from Tanjung Datu National Park to Samunsam Wildlife Sanctuary areas; (2) to contribute to the development of Sarawak Marine and Coastal Conservation Master Plan and also (3) to identify and recommend potential sustainable economic activities for the local communities.

This expedition’s findings were presented during the Aquatic Science Colloquium 2019 (AQUAColl 2019) which is the fifth series of a biennial academic event that acts as a scientific platform for researchers to update, exchange and sharing of research information and findings explicitly obtained from the scientific expedition.

This AQUAColl 2019 proceeding comprises 18 research papers which reflect the aquatic and terrestrial biodiversity, physical oceanography, the status of marine pollution and socio-economic activities occurring inside or surrounding the Tanjung Datu National Park – Samunsam Wildlife Sanctuary. It is hoped that these scientific data may provide important baseline information and be beneficial towards future fisheries, oceanographic surveys and ecotourism activities in these areas.

Assoc. Prof. Dr. Siti Akmar Khadijah Ab Rahim  
Dr. Ahmad Syafiq Ahmad Nasir  
Programme of Aquatic Resource Science and Management,  
Faculty of Resource Science and Technology,  
UNIMAS



# Acknowledgement

A huge number of people helped in conducting the expedition and colloquium, and made the publication of this proceeding a success. The editors are grateful to the researchers who have contributed their research findings during the colloquium and to this proceeding. The scientific committee also wish to extend their heartfelt gratitude to all reviewers that had worked diligently and made valuable suggestions on the improvement of the articles' quality. The reviewers are as follows:

Prof. Dr. Ramlah Zainudin (UNIMAS)  
Assoc. Prof. Dr. Devagi Kanakaraju (UNIMAS)  
Prof. Dr. Ruhana Hassan (UNIMAS)  
Assoc. Prof. Dr. Samsur Mohamad (UNIMAS)  
Assoc. Prof. Dr. Siti Akmar Khadijah Ab Rahim (UNIMAS)  
Dr. Ahmad Syafiq Ahmad Nasir (UNIMAS)  
Dr. Fatimah A'tirah Mohamad (UNIMAS)  
Dr. Hii Kieng Soon (UM)  
Dr. Jongkar Grinang (UNIMAS)  
Dr. Mohamad Fizl Sidq Ramji (UNIMAS)  
Dr. Muhammad Asraf Abdullah (UNIMAS)  
Dr. Roslianah Asdari (UNIMAS)  
Dr. Tan Toh Hii (UPM)  
Dr. Wan Sofiah Meor Osman (UNIMAS)  
Dr. Wee Boon Siong (UNIMAS)  
Ms. Cindy Peter (UNIMAS)  
Mr. Oswald Braken Tisen (SFC)

Last but not least, we thank everyone for their hard work and dedication, and we look forward to future continuous collaboration. Well done and thank you to SFC and UNIMAS!



# Ecological Characteristics of Arboreal Crab *Labuanium politum* from Samunsam Wildlife Sanctuary

Siti Akmar Khadijah Ab Rahim, Akma Iddin Masini\* and Nur Amirah Mohamad Alwie

*Faculty of Resource Science and Technology,  
Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak.*

\*Corresponding author: [akmamasini@gmail.com](mailto:akmamasini@gmail.com)

## Abstract

*Labuanium politum* (Family Sesarmidae) is an arboreal crab known to associate with nipa vegetation in mangrove ecosystem but some ecological characteristics of the species in Samunsam Wildlife Sanctuary are unknown. Being a nipa-obligate species, the construction of Pan-Borneo Highway through the sanctuary might pose threat to the crab population. Yet, the dependency level of this crab towards its habitat intactness remain unknown. Therefore, this study aims to 1) determine the relationship between density of nipa forest and population of *L. politum* and 2) record the presence of parasite in samples obtained from six stations. Crab collections were done during daytime and standardised in two minutes per plot (three plots per station) along Samunsam River. A total of 42 individuals (male = 19, female = 23) were collected and the mean carapace width (CW) was  $23.42 \pm 7.04$  mm for male and  $24.01 \pm 5.48$  mm for female. Berried females were bigger with mean CW of  $27.07 \pm 3.09$  mm. Present study also showed that density of *L. politum* was not related to the nipa forest density and the size for both sexes were not significantly different with forest density (Kruskal Wallis,  $p > 0.05$ ). Interestingly, a new record of bopyrid isopod *Leidyia distorta* infestation was documented in one female crab with 2.38

% prevalence. Findings of this rapid survey provide useful ecological data that exclude the temporal effect which may not reflect the real impact of the highway project and other development that will occur in future. Thus, long term monitoring is needed in order to sustain the crab population inside the sanctuary.

*Keywords:* Sesarmid crab, distribution, parasite, mangrove ecosystem

## Introduction

Samunsam River flows through Samunsam Wildlife Sanctuary (SWS) which is the Sarawak oldest wildlife sanctuary. This sanctuary is located within Gunung Pueh Forest Reserve in Lundu, Sarawak, Malaysia has been gazetted in 1979 with 69 km<sup>2</sup> coverage under Wildlife Protection Ordinance. The primary goal of the establishment of SWS is to protect the habitat and population of proboscis monkey *Nasalis larvatus*, among the iconic mammals in the state. Protection of the umbrella species has significant conservation of biodiversity in the area of which also inhabited by a poorly known arboreal crab *Labuanium politum* associated with nipa vegetation *Nypa fruticans*.

*Labuanium* (Serene & Soh, 1970) is the genus of arboreal crabs that occur in Indo-West Pacific (Ng *et al.*, 2015) with *L. trapizoideum* that is literally inhabits cliffs and walls of waterfalls and fast flowing streams (Jeng *et al.*, 2003; Ng *et al.*, 2015). An arboreal crab *L. politum* occupies nipa palm vegetation spreads in Malaysia (Labuan and Sedili River, Johor), Philippines (Loboc River) and Singapore (Ubin Island) (Ng *et al.*, 2015). These studies had centred on taxonomic with scanty information on ecological characteristics. Therefore, this study aims to describe some ecological characteristics of the crab such as size, sexes and density from a nipa palm vegetation in Sarawak.

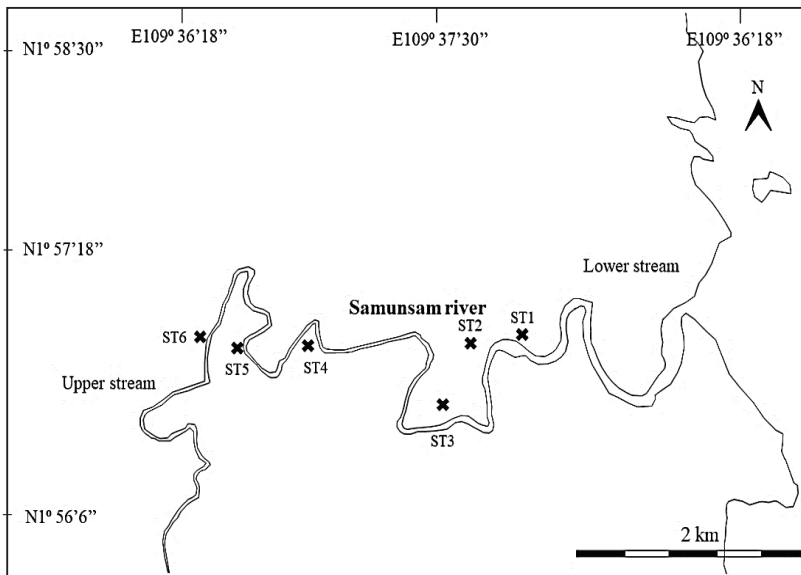
In addition, this study also investigates the presence of parasite infestation in *L. politum* inhabiting a protected area which had been previously reported in unprotected nipa habitats (Masini, pers. comm.). This parasite is identified as bopyrid isopod *Leidyia distorta* (Richardson, 1908; Roccatagliata & Jordà, 2002) which has free living larvae that seek out decapod crustacean host (Rohde, 2005) and settles between the gill lamellae. After several moulting, it will migrate to the roof of branchial chamber of its host as a matured female (Wunderlich *et al.*, 2017). Then, the subsequent ones will develop into small male that attached straight to the female for copulation (Reinhard, 1949; Smith *et al.*, 2008). The first discovery of *L. distorta* infestation in crab was originally described as *Cepon distortus* which infested *Uca pugilator* collected from

the coast of New Jersey, United States (Markham, 1985; Romero-Rodriguez *et al.*, 2017). To date, infestation by *L. distorta* had been reported only in crab species of Family Ocypodidae, Ucididae (Wunderlich *et al.*, 2017) and Sesarmidae (Masini, pers. comm). Thus, present study also screened the *L. politum* samples from SWS for *L. distorta* prevalence.

## Materials and Methods

### *Sampling strategy*

Samples were collected on 9-11 August 2018 at six stations along Samunsam River (Figure 1). The stations were marked based on density of nipa forest (high, medium, low) with 30 m interval between stations, and three plots at each station (Table 1). High density of nipa forest was recognised with overcrowded nipa palm tree and no other large mangrove plants spotted within the area. Meanwhile, medium density of nipa forest has minor patch or colonies of other mangroves plants growing along with nipa vegetation. For low density of nipa forest, there is only minor patch of nipa vegetation that grows among other mangrove plants. Crab samples were collected during low tide at daytime based on catch per unit effort by two people standardised in two minutes for each plot. This rapid survey involved only one visit per plot.



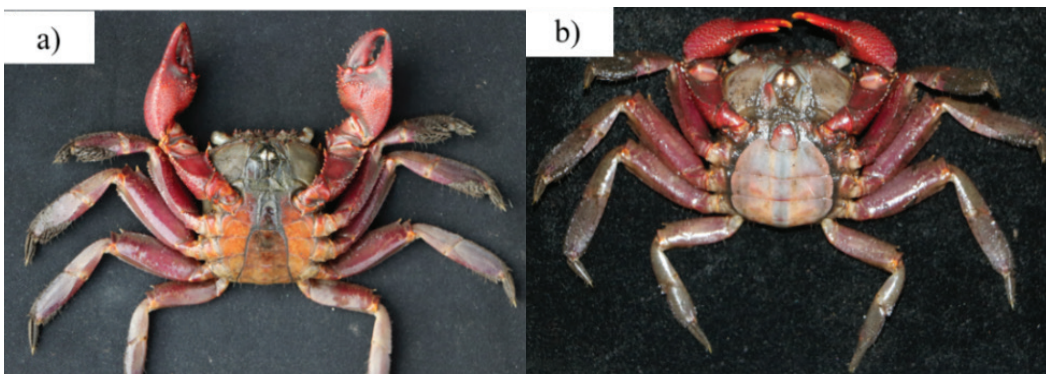
**Figure 1** : Sampling sites at Samunsam River from upper to lower stream which ST = station.

**Table 1 :** Categories of nipa density in six stations.

Station	Nipa forest density	Coordinates	Sampling dates
ST 1	Low	N 1°56'55.70" E 109°37'55.60"	11 Aug 2018
ST 2	Medium	N 1°56'35.80" E 109°37'32.50"	11 Aug 2018
ST 3	High	N 1°56'54.90" E 109°36'18.90"	10 Aug 2018
ST 4	High	N 1°56'50.70" E 109°36'32.00"	10 Aug 2018
ST 5	Medium	N 1°56'52.50" E 109°36'51.50"	10 Aug 2018
ST 6	Low	N 1°56'51.70" E 109°37'40.20"	9 Aug 2018

### *Samples processing*

All samples were measured for their carapace width (CW) to the nearest 0.02 mm using dial calliper and differentiated by sexes. Sexes were determined upon the shape of abdomen (Figure 2). The crabs' carapace was cut open to screen the presence of bopyrid isopod *L. distorta* and the parasite prevalence was calculated.



**Figure 2 :** Ventral view of *L. politum* showing differences between a) male and b) female.

### *Statistical analyses*

Statistical analyses were performed using Minitab 17 software and the significant level was tested at 95% confidence level (Zar, 1996). The comparisons for size and density of *L. politum* collected from all stations among three nipa forest densities were tested using Kruskal Wallis test. According to different sexes, the mean CW sizes were tested using

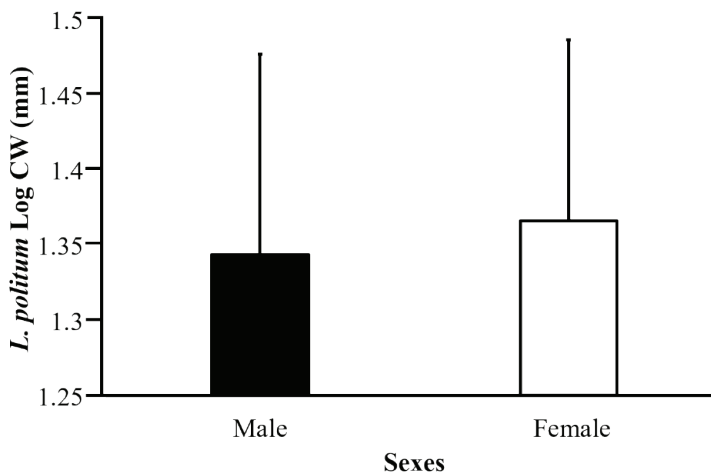


two sample independent t-test. Besides, the sex ratio based on CW size class distribution was constructed at 4-mm intervals and further analysed using Chi-square ( $\chi^2$ ) test.

## Results and Discussion

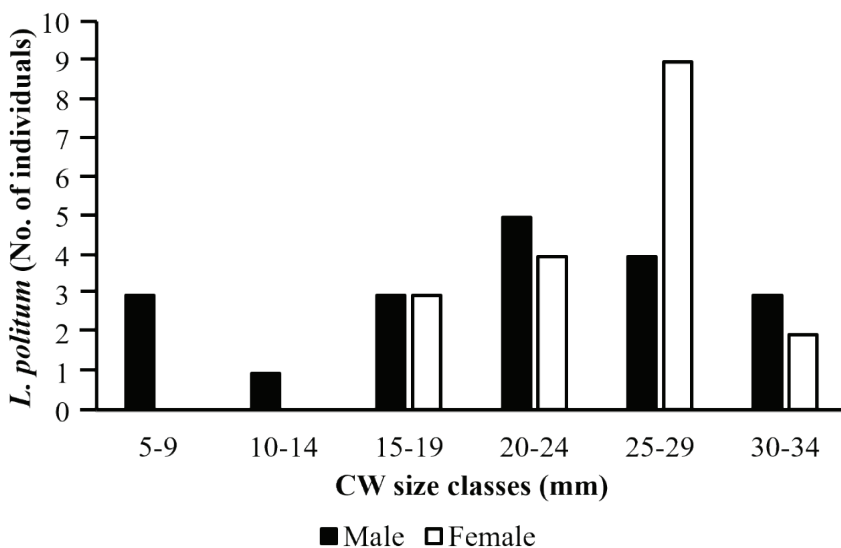
### *Population of L. politum according to different nipa forest density*

A total of 42 individuals were collected comprising 19 males and 23 females with 5 berried females. The carapace width (CW) of *L. politum* ranged from 8.32–34.00 mm for male and 17.00–32.10 mm for female, while berried females were found to be in the range of 25.12–32.10 mm. The maximum size of *L. politum* male is larger than female. It has been reported in other decapods that males are larger in size due to higher growth rate or longer growth period and probably females allocate most of their energy towards reproduction instead of growth (Fransozo & Mantelatto, 1998). Higher growth rate of male crabs could be related to the needs to be bigger in size in order to successfully mate with female crabs (Devi & Smija, 2013). Although the maximum CW of males are bigger, the overall CW of male and female *L. politum* collected from SWS was not significantly different (t-test,  $T = -0.50$ ,  $p = 0.6172$ ) (Figure 3) between sexes. This contradiction on sex-biased sizes of *L. politum* from SWS could be due to different cohort samples and small sample size that was obtained in short duration of sampling period.



**Figure 3:** Comparison of *L. politum* mean size (CW) between male (n=19) and female (n=23) (t-test,  $p > 0.05$ ).

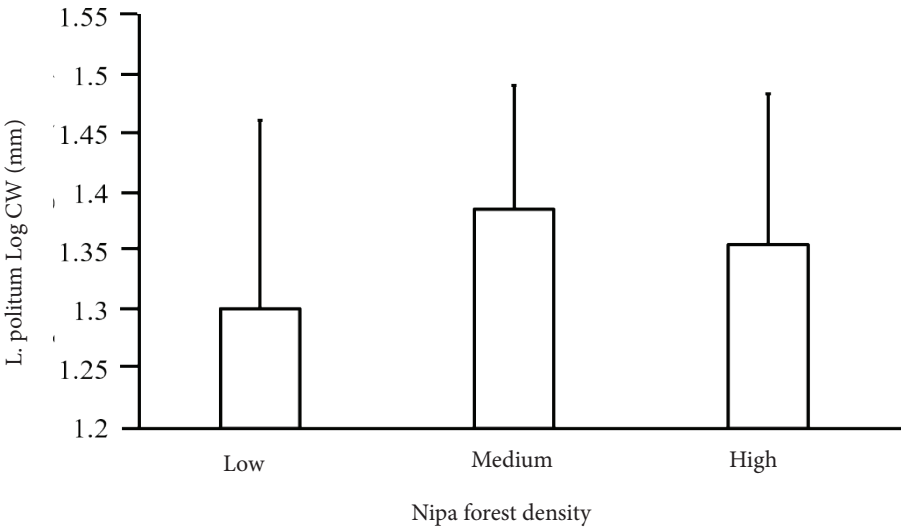
The size class distribution showed that 90.7% of *L. politum* samples were concentrated from 15–19 mm until 30–34 mm and these classes contained both sexes (Figure 4). Highest number of males was recorded in 20–24 mm size class while female was in 25–29 mm. For smaller size class i.e. 5–9 mm and 10–14 mm, they were only made of male crabs. However, overall sex ratio did not show significant bias across the size class distribution ( $\chi^2$  test,  $p>0.05$ ). The absent of smaller size females could be due to different microhabitat preference within the nipa forest prior to becoming adult, in which they prefer to stay hiding deep inside the nipa stalk crevices. Such behaviour had been observed in mud crab *Scylla serrata* (Alberts-Hubatsch *et al.*, 2016). Sex ratio is also being regulated by the breeding and mating seasons which can result in a bias ratio as being observed in other crab species (Linhares and Silva, 2012). Since the current finding was based on a very short sampling period, a concrete explanation on the absent of female at the lowest size classes remain unresolved.



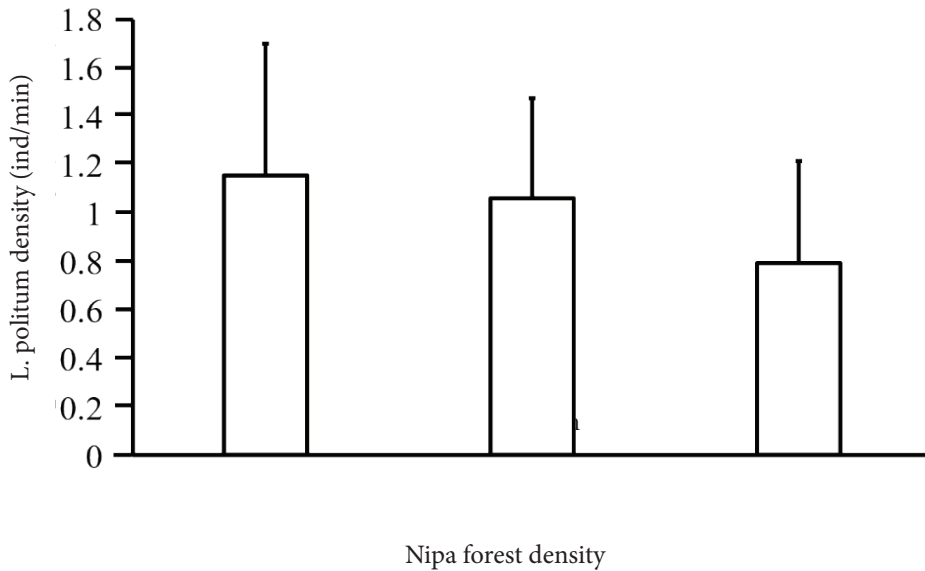
**Figure 4** : Sex ratio based on CW size class distribution of *L. politum* ( $\chi^2$  test,  $p>0.05$ ).

Mean size of crab found at three different nipa forest density were  $21.10 \pm 6.15$  mm (low),  $25.00 \pm 5.33$  mm (medium) and  $23.92 \pm 6.81$  mm (high) (Figure 5). However, preliminary result showed that the CW size of *L. politum* were not significantly different among the three categories nipa density (Kruskal Wallis,  $H = 3.001$ ,  $p = 0.2230$ ). Mean

density of crab population found at three different nipa forest density were  $0.53 \pm 0.19$  ind/min (low),  $0.45 \pm 0.07$  ind/min (medium) and  $0.3 \pm 0.05$  ind/min (high) (Figure 6). However, current study showed that the population density of *L. politum* were not significantly different among the three-nipa density (Kruskal Wallis,  $H = 2.056$ ,  $p = 0.3572$ ). These findings proved that *L. politum* population along Samunsam River within the SWS was not associated with nipa density even though this crab is obligate to nipa tree and mainly consuming on nipa leaves (Ng *et al.*, 2015; Alwie, pers. comm.). This might be due to the territorial behaviour of *L. politum* as being observed during sample collection in SWS. A single crab did not share the same nipa tree despite a single nipa tree has more than three hiding stalks. Different density of nipa forest may cause different number of *L. politum* individuals caught, but the ratio of nipa tree and crab remain the same. Whether low, medium or high nipa forest density, it supports equal ratio *L. politum* population with the nipa forests density.



**Figure 5 :** Comparison of *L. politum* size collected within three different density of nipa forest (Kruskal Wallis,  $p > 0.05$ ).



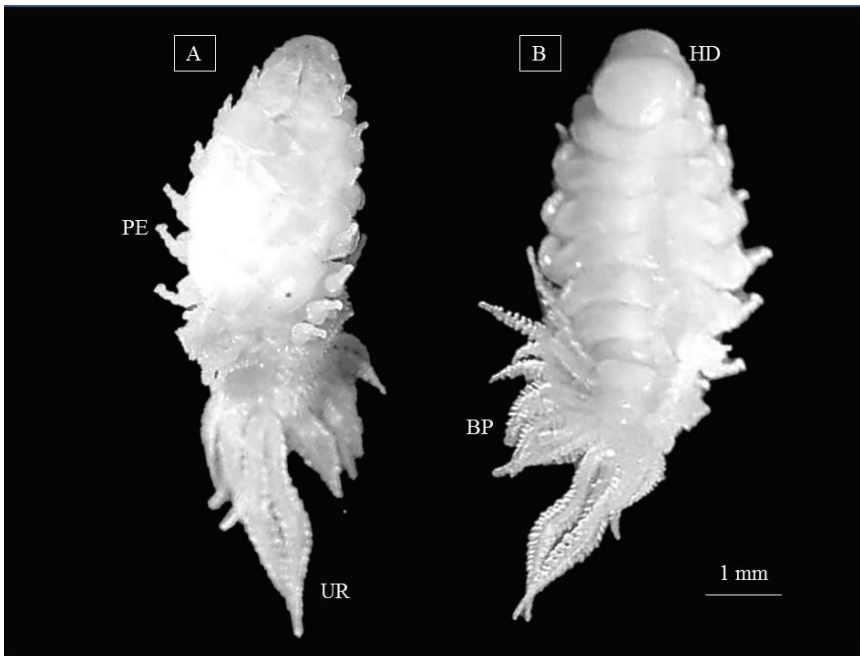
**Figure 6 :** Comparison of *L. politum* density collected within three different density of nipa forest (Kruskal Wallis,  $p > 0.05$ ).

### ***Screening of bopyrid isopod infestation on L. politum***

Screening of the bopyrid isopod *Leidya distorta* infestation on *L. politum* collected from SWS showed a low prevalence of 2.38%. The infestation was observed in the branchial chamber of only one female *L. politum* (25.42 × 28.00 mm) (Figure 7). For Sarawak protected area, this is a first record for the *L. distorta* prevalence in *L. politum*. Previously, this isopod had been reported in crab species of Family Ocypodidae and Ucididae as its host (Romero-Rodríguez *et al.*, 2017; Wunderlich *et al.*, 2017). Further inspection on the bopyrid isopod revealed that it was a young matured female (Bourdon & Bowman, 1970; Roccatagliata & Jordà, 2002) (Figure 8) and no male was found together with the female isopod.



**Figure 7 :** *L. politum* infested with a bopyrid isopod *Leidyia distorta* (in circle) at the right branchial chamber.



**Figure 8 :** Parasitic bopyrid isopod *Leidyia distorta* found in the branchial chamber of *L. politum* (host). A) Ventral view, B) Dorsal view. PE = pereopod, UR = uropod, BP = biramous pleopod, and HD = head.

## Summary

This rapid survey enhances our knowledge on ecology of an arboreal crab *L. politum* in nipa forest within a protected area i.e. Samunsam Wildlife Sanctuary, Sarawak. Findings showed that the body size and population density of *L. politum* were not associated with density of nipa tree. A low prevalence of parasitic bopyrid isopod *L. distorta* was detected in *L. politum*, the first record in Sarawak. Being obligate species to habitat currently disturbed by road construction and potential future land uses, a long-term monitoring on the population of the crab is highly recommended.

## Acknowledgements

We would like to thank UNIMAS and Sarawak Forestry Corporation (SFC) for providing assistance, logistics and transportation during the Tanjung Datu National Park – Samunsam Wildlife Sanctuary Marine and Coastal Resources Expedition. Special thanks also go to Faculty of Resource Science and Technology, UNIMAS staffs who were involved in samples collection. This work was granted a research permit by the Forestry Department Sarawak and supported by small fund from *Belanjawan Mengurus Fakulti 2018*.


## References

- Alberts-Hubatsch, H., Lee, S.Y., Meynecke, J.-O., Diele, K., Nordhaus, I. and Wolff, M. (2016). Life-history, movement, and habitat use of *Scylla serrata* (Decapoda, Portunidae): current knowledge and future challenges. *Hydrobiologia* 763(1), pp. 5–21.
- Bourdon, R and Bowman, T.E. (1970). Western Atlantic species of the parasitic genus *Leidyia* (Epicaridea: Bopyridae). *Proceedings of the Biological Society of Washington* 83, pp. 409–424.
- Devi, A.R.S and Smija, M.K. (2013). Reproductive biology of the freshwater crab, *Travancoriana schirnerae* Bott, 1969 (Brachyura: Gecarcinucidae). *Indian Journal of Fisheries* 60(3), pp. 13–21.
- Fransozo, A and Mantelatto, F.L.M. (1998). Population structure and reproductive period of the tropical hermit crab *Calcinus tibicen* (Decapoda: Diogenidae) in the region of Ubatuba, São Paulo, Brazil. *Journal of Crustacean Biology*, 18(4), pp. 738–745.
- Jeng, M-S, Liu, H-C, Tzeng, C-S. and Ng, P.K.L. (2003). On the taxonomy and ecology of *Labuanium trapezoideum* (Decapoda: Brachyura: Sesarmidae), a crab living on riverine cliffs in Taiwan. *Crustaceana* 76, pp. 227–240.
- Jordà, M.T. and Roccatagliata, D. (2002). Population dynamics of *Leidyia distorta* (Isopoda: Bopyridae) infesting the fiddler crab *Uca uruguayensis* at Rio de La Plata Estuary, Argentina. *Journal of Crustacean Biology* 22(4): 719–727.
- Linhares, J.C.S. and Silva, J.R.F. (2012). Reproductive behavior of the mangrove crab *Ucides*

- cordatus* (Crustacea; Brachyura; Ucididae). *Brazilian Archives Biology and Technology*. 55(6): 903–910.
- Markham, J.C. (1985). A review of the bopyrids isopods infesting caridean shrimps in the north western Atlantic Ocean, with special reference to those collected during the hourglass cruises in the Gulf of Mexico. *Memoirs the Hourglass Cruises* 7: 1–156.
- Ng, P. K. L., Lee, B.Y and Tan, H. H. (2015). Notes on the taxonomy and ecology of *Labuanium politum* (De Man, 1887) (Crustacea: Sesarmidae), an oligate arboreal crab on the nipah palm, *Nypa fruticans* (Arecales: Arecaceae). *Raffles Bulletin of Zoology* 31, pp. 216–225.
- Reinhard, E.G. (1949). Experiments on the determination and differentiation of sex in the bopyrid isopod *Stegophryxus hyptius* Thompson. *Biological Bulletin* 96: 17–31.
- Richardson, H. (1908). The parasitic isopod *Leidyia distorta* found on a new host. *Proceedings of the United States National Museum* 34(1593), pp. 23–26.
- Roccatagliata, D and Jordà, M.T. (2002). Infestation of the fiddler crab *Uca uruguayensis* by *Leidyia distorta* (Isopoda, Bopyridae) from the Rio De La Plata Estuary, Argentina. *Journal of Crustacean Biology* 22(1), pp. 69–82.
- Rohde, K. (2005). *Marine Parasitology*. Wallingford, United Kingdom: CABI Publishing (Southeast Asia).
- Romero-Rodríguez, J., Guillén-Hernández, S and Simões, N. (2017). First report of the parasite crustacean *Leidyia distorta* (Isopoda: Bopyridae) on the fiddler crab *Uca spinicarpa* (Decapoda: Brachyura) in Yucatán coasts, Mexico. *Revista Mexicana de Biodiversidad* 88, pp. 459–463.
- Serene, R and Soh, C.L. (1970). New Indo-Pacific genera allied to *Sesarma* Say, 1877 (Brachyura, Decapoda, Crustacea). *Treubia* 27(4), pp. 387–416.
- Smith, A.E., Chapman, W.J. and Dumbauld, B.R. (2008). Population Structure and energetic of the bopyrid isopod parasite *Orthione griffenis* in mud shrimp *Upogebia pugettensis*. *Journal of Crustacean Biology* 28(2): 228–233.
- Wunderlich, A.C., Carmona-Suarez, C.A and Pinheiro, M.A.A. (2017). New records of the isopods *Leidyia distorta* infesting the mangrove crab *Ucides cordatus* from South America. *Boletim do Instituto de Pesca* 43(2), 283–290.
- Zar, J.H. (1996). *Biostatistical Analysis*. Prentice Hall, Upper Saddle River.







Proceeding of  
Aquatic Science Colloquium 2019 (AQUAColl 2019)  
Experience Sharing in Aquatic Science Research V

# Tanjung Datu

— National Park —

to

# Samunsam

This proceeding contains an overview of inventory works performed at Tanjung Datu National Park to Samunsam Sanctuary in the year 2018 to 2019, encompassing the organisms of terrestrial and aquatic ecosystems. Simultaneously, the status of local ecotourism, fisheries and pollution were also reported. This wide coverage of findings is very useful to complement the current and future development of the Tanjung Datu – Santubong Marine and Coastal Conservation Master Plan. With the construction of the Pan Borneo coastal highway, the impacts on marine environment and socio-economic are very important to be monitored. Thus, this book can be used as the main reference for future research in that area by scientists, policymakers and stakeholders, especially the relevant state and federal agencies in Sarawak. Environmental consultancy companies can also use the baseline data for Environmental Impact Assessment purposes.



**UNIMAS**  
UNIVERSITI MALAYSIA SARAWAK

e ISBN 978-967-0054-79-7



**UNIMAS PUBLISHER**