



Faculty of Resource Science and Technology

**Diversity of Sergestid Shrimp *Acetes* (Order Decapoda) in Selected Sites
of Sarawak Coastal Water and Its Autecology**

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Diversity of Sergestid Shrimp *Acetes* (Order Decapoda) in Selected Sites of
Sarawak Coastal Water and Its Autecology

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

Sergestid shrimps *Acetes*, locally known as ‘bubok’ in Sarawak is a valuable marine resource that supports the livelihood of the coastal communities, particularly during the blooming season (March –April). The shrimps play a significant role in transporting primary producers and consumers energy to higher trophic levels. Sergestid shrimp fishery in Sarawak depends heavily on traditional knowledge and practices, halting the sustainable utilization of this valuable resource. Therefore, the objectives of this study are to determine the diversity of *Acetes* living along the coastal water of Sarawak (Miri, Lundu, Telaga Air) based on morphological assessment and cytochrome oxidase subunit 1 (CO1) gene analysis and to analyse the interactions between the abundance of *Acetes* with selected environmental parameters namely dissolved oxygen (DO), temperature, turbidity, pH, salinity, total suspended solid (TSS) and chlorophyll *a* (chl *a*) as well as the presence of zooplankton (diet of *Acetes*) in coastal water of Miri, Sarawak. A total of four species of *Acetes* were identified living in Sarawak coastal water namely *Acetes erythraeus*, *A. serrulatus*, *A. indicus* and *A. japonicus*. Three species of *Acetes* were recorded in the coastal water of Miri namely *A. erythraeus*, *A. serrulatus* and *A. japonicus*. Two species were found in the coastal water of Telaga Air namely *A. serrulatus* and *A. indicus* while only one species in the coastal water of Lundu namely *A. erythraeus*. Single species namely *A. erythraeus* was recorded for the first time for coastal water of Sarawak. DNA barcoding of *A. erythraeus* and *A. serrulatus* using CO1 gene had successfully supported species identification using the morphological assessment method. This gene marker was able to differentiate wild sergestid shrimp populations based on geographical locations. Catch composition in Miri coastal water for five sampling months (May 2017, August 2017, November 2017, March 2018, April 2018) comprised of 26 species namely *Alectis ciliaris*, *Arius maculatus*, *Kurtus indicus*, *Plotosus*

lineatus, *Nibea soldado*, *Dussumieria elopoides*, *Opisthopterus tardoore*, *Metapenaeus affinis*, *Exopalaemon styliferus*, *Exhippolysmata ensirostris*, *M. brevicornis*, *Stolephorus* sp., *Secutor* sp., *Lactarius* sp., *Trichiurus* sp., *Harpiosquilla* sp., *Cynoglossus* sp., *Terapon* sp., *Setipinna* sp., *Leiognathus* sp., *Coilia* sp., *Drepane* sp., *Lagocephalus* sp., *A. erythraeus*, *A. serrulatus* and *A. japonicus*. The dominant species was *A. erythraeus* while *A. serrulatus* and *A. japonicus* could only be found in small numbers during March 2018 sampling. Canonical Correspondence Analysis (CCA) shows that the abundance of *A. erythraeus* was influenced by four environmental parameters namely salinity, turbidity, TSS and chl *a* concentration. The presence of *A. serrulatus* and *A. japonicus* in Miri coastal water depends on the concentration of DO. Analysis of the zooplankton composition shows 19 taxa living in the coastal water of Miri where *Paracalanus* was the dominant taxon. *Penilia* was identified as the rarest taxon, recorded only in April 2018. Seven zooplankton taxa namely *Paracalanus*, *Oithona*, *Acrocalanus*, *Sagitta*, *Penilia*, zoea and polychaete larvae including zooplankton density influenced the presence of *A. erythraeus* in the coastal water of Miri. The findings imply that a combination of environmental factors influence the presence and blooming of *Acetes* in Miri coastal waters. It is hoped that the information gathered here could become a framework to develop sustainable management of this valuable resource, consequently benefiting local people living along the coastal areas.

Keywords: *Acetes*, coastal water, DNA barcoding, environmental parameters, zooplankton

Kepelbagaian Udang Sergestid Acetes (Order Decapoda) di Kawasan Terpilih Pesisiran Sarawak dan Autecologinya

ABSTRAK

Udang Sergestid Acetes atau dikenali oleh penduduk tempatan di Sarawak sebagai 'bubok' adalah sumber marin penting yang menyokong kehidupan masyarakat perairan pantai terutama semasa musim ledakan organisma ini (Mac – April). Udang ini memainkan peranan dalam menyalurkan tenaga dari pengeluar utama dan pengguna ke aras trofik yang lebih tinggi. Perikanan udang Sergestid di Sarawak masih bergantung kepada pengetahuan dan amalan tradisional yang menghadkan penggunaan mapan sumber yang berharga ini. Oleh sebab itu, objektif kajian ini adalah untuk mengenalpasti kepelbagaian spesies Acetes yang hidup sepanjang perairan pantai Sarawak (Miri, Lundu, Telaga Air) menggunakan data morfologi dan analisis gen sitokrom oksidase subunit 1 (COI) dan mengkaji hubungan antara taburan Acetes dengan parameter persekitaran yang terpilih iaitu kandungan oksigen terlarut (DO), suhu, kekeruhan air, pH, kemasinan, kandungan pepejal terampai (TSS) dan klorofil a (chl a) serta zooplankton (diet untuk Acetes) di perairan pantai Miri, Sarawak. Sebanyak empat spesies telah dikenalpasti di perairan pantai Sarawak iaitu Acetes erythraeus, A. serrulatus, A. indicus dan A. japonicus. Tiga spesies Acetes telah direkodkan di perairan pantai Miri iaitu Acetes erythraeus, A. serrulatus dan A. japonicus. Dua spesies telah dijumpai di perairan pantai Telaga Air iaitu A. serrulatus dan A. indicus manakala hanya satu spesies di perairan pantai Lundu iaitu A. erythraeus. A. erythraeus telah direkodkan buat kali pertama di perairan pantai Sarawak. Kod bar DNA menggunakan gen COI untuk A. erythraeus dan A. serrulatus telah berjaya dilaksanakan dan menyokong pengenalan spesies menggunakan kaedah morfologi. Analisis gen ini juga mampu membezakan populasi Acetes mengikut taburan geografi Sarawak. Komposisi penangkapan

di perairan Miri untuk lima bulan kajian (Mei 2017, Ogos 2017, November 2017, Mac 2018, April 2018) terdiri daripada 26 spesies iaitu *Alectis ciliaris*, *Arius maculatus*, *Kurtus indicus*, *Plotosus lineatus*, *Nibea soldado*, *Dussumieria elopoides*, *Opisthopecterus tardoore*, *Metapenaeus affinis*, *Exopalaemon styliferus*, *Exhippolysmata ensirostris*, *M. brevicornis*, *Stolephorus sp.*, *Secutor sp.*, *Lactarius sp.*, *Trichiurus sp.*, *Harpiesquilla sp.*, *Cynoglossus sp.*, *Terapon sp.*, *Setipinna sp.*, *Leiognathus sp.*, *Coilia sp.*, *Drepane sp.*, *Lagocephalus sp.*, *A. erythraeus*, *A. serrulatus* dan *A. japonicus*. *A. erythraeus* ialah spesies dominan di perairan pantai Miri manakala *A. serrulatus* dan *A. japonicus* hanya dijumpai dalam bilangan yang sedikit semasa pensampelan pada bulan Mac 2018. Analisis kesepadanan kanonik (CCA) telah menunjukkan taburan *A. erythraeus* dipengaruhi oleh empat parameter persekitaran iaitu kemasinan, kekeruhan, TSS dan chl a. Kewujudan *A. japonicus* dan *A. serrulatus* di perairan pantai Miri bergantung kepada kepekatan kandungan oksigen terlarut (DO). Analisis komposisi zooplankton menunjukkan 19 taksa hidup di perairan pantai Miri yang mana *Paracalanus* ialah taksa dominan. *Penilia* dikenalpasti sebagai taksa paling nadir, hanya direkodkan pada bulan April 2018. Tujuh taksa zooplankton iaitu *Paracalanus*, *Oithona*, *Acrocalanus*, *Sagitta*, *Penilia*, zoea dan larva polychaete serta ketumpatan zooplankton mempengaruhi kewujudan *A. erythraeus* di perairan pantai Miri. Hasil kajian ini menunjukkan kombinasi beberapa parameter persekitaran mempengaruhi kewujudan dan ledakan Acetes di pesisiran pantai Miri. Diharapkan maklumat yang dikumpul ini boleh dijadikan asas bagi rangka kerja pengurusan mapan untuk sumber berharga ini, seterusnya memberi manfaat kepada penduduk tempatan yang tinggal sepanjang kawasan perairan pantai.

Kata kunci: Acetes, perairan pantai, kod bar DNA, parameter persekitaran, zooplankton

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Figure 6.1 Biplot diagram of Canonical Correspondence Analysis between *Acetes* and zooplankton in Miri coastal water. Total variance explained by the two axis is 100.00 %. ZD: zooplankton density; D: zooplankton diversity; PL: polychaete larvae; P: *Penilia*; Z: zoea; LH: *Lucifer hansenii*; LHP: *Lucifer hansenii* (protozoa stage); LHM: *Lucifer hansenii* (mysis stage); A: *Acartia*; AC: *Acrocalanus*; CA: *Canthocalanus*; CE: *Centropages*; CL: *Clausocalanus*; EU: *Euterpina*; MA: *Macrosetella*; MI: *Microsetella*; NA: nauplius; O: *Oithona*; ON: *Oncaea*; P: *Paracalanus*; PA: *Parvocalanus*; SA: *Sagitta*; OI: *Oikopleura*

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LIST OF ABBREVIATIONS

%	Percentage
°C	Degree Celsius
µm	Micrometre
µL	Microliter
AIC	Akaike Information Criterion
ANOVA	Analysis of variance
bp	Base pair
BLAST	Basic Local Alignment Search Tool
BPP	Bayesian inference
Chl <i>a</i>	Chlorophyll <i>a</i>
CIA	Chloroform-isoamyl alcohol
CCA	Canonical Correspondence Analysis
CO1	Cytochrome oxidase subunit 1
CTAB	Cethy-trimethyl ammonium bromide
DBT	Dibutyltin
DNA	Deoxyribonucleic acid
DO	Dissolved oxygen
dNTP	Deoxynucleotide triphosphate
EtBr	Ethidium bromide ethidium bromide
EtOH	Absolute ethanol
F	Female

g	Gram
H ₀	Null hypothesis
H _A	Alternative hypothesis
kb	Kilobyte
km	Kilometre
km/h	Kilometre per hour
L	Litre
M	Male
m	Metre
mg	Milligram
mL	Millilitre
MP	Maximum parsimony
mm	Millimetre
mg/L	Milligram per litre
mg/m ³	Milligram per metre cube
MgCl ₂	Magnesium chloride
mtDNA	Mitochondrial DNA
nDNA	Nuclear DNA
nm	Nanometre
NJ	Neighbour joining
NTU	Nephelometric turbidity unit
PCA	Principal component analysis
PCR	Polymerase chain reaction
PSU	Practical salinity unit

rpm	Revolutions per minute
rRNA	Ribosomal RNA
tRNA	Transfer RNA
TBE	Tris-borate-EDTA
TBT	Tributyltin
TL	Total length
TW	Total weight
TSS	Total suspended solid
UV	Ultraviolet
V	Volt

CHAPTER 1

INTRODUCTION

1.1 Study Background

Genus *Acetes* (Family Sergestidae) is a group of small planktonic shrimps commonly found in the estuaries and marine coastal waters of the tropical and subtropical areas with a size range from 10 mm to 40 mm (Omori, 1975). Only a single species namely *Acetes paraguayensis* is found in the freshwater lake and river of Parana River, Argentina (Collins & Williner, 2003). *Acetes* shrimp lives in a wide range of habitats namely seagrass bed, mangrove and calm sandy-mud areas, frequently swimming in a group at the bottom of the water column as deep as 50 metres. The diets of *Acetes* is mainly made up of diatom and copepod (Santos et al., 2015). The shrimp is identified based on the shape of telson, the length of rostrum, presence of dorsal denticles, supraorbital, hepatic spine and procurved tooth between the base of the first pleopod (Omori, 1975).

Fourteen species of *Acetes* are recorded around the world, commonly found in the Indo-West Pacific region, Indo-Malayan region, Pacific America and Atlantic America (Omori, 1975; Vereshchaka et al., 2016). Five species of *Acetes* were recorded in East and West of Peninsular Malaysia (Arshad et al., 2007; Nurul Amin, et al., 2010; Nurul Amin et al., 2011). They are widely distributed in coastal water of Malacca, Perak, Pulau Pinang, Kedah, Perlis and Terengganu. Sarawak had recorded three species of *Acetes* namely *Acetes intermedius*, *A. japonicus* and *A. indicus*, which occur in coastal water of Miri, Bintulu and Kuching (Ali, 2017; Nurul Amin et al., 2011).

Acetes in Malaysia is known with a variety of local names. In Peninsular Malaysia, the local people called *Acetes* shrimp ‘udang geragau’, ‘udang baring’ and ‘udang siring’

(Arshad et al., 2007) while in Sarawak, the shrimp is known as ‘bubok’. *Acetes* is caught by using various fishing gears such as push net or ‘sungkor’ where hands manually operate it at shallow water against the flow of water (Nurul Amin, et al., 2010). In Sarawak, the local people also use a gear called ‘sobo’, a net attached to two long poles put in front of their boats. Another gear called beam trawl net is used to catch *Acetes* at the bottom of the sea.

Temperature, salinity and type of sediments are among the key environmental parameters that influence the distribution and variation of *Acetes* in any given area. Simoes et al. (2013) reported that *A. americanus* in south-eastern Brazilian inhabit shallow waters with lower salinity (28 PSU – 30 PSU) and high temperature (23.5 °C – 28.5 °C). Chiou et al. (2000) found that a large amount of freshwater discharge into the river and heavy rain could change the environmental parameters in the coastal water of southwestern Taiwan and influence the distribution of *A. intermedius*. Besides, *Acetes* is found in areas with bottom sediment comprised of wood and leaf litter fragments. These items are believed to act as shelters and provide protection against predators (Omori, 1975).

Acetes plays a vital role in terms of socio-economic for people in Asia. It is considered one of the major sources of protein, sold in the markets as fresh shrimps or processed as shrimp paste and sauce (Arshad et al., 2007). In Malaysia, *Acetes* is exploited by local people as source of income where it is processed into products such as ‘belacan’ (fermented shrimp paste) and ‘cincalok’ (pickle). Taiwan increases its revenue by commercialising food products from *Acetes* (Chiou et al., 2000). From the ecological point of view, *Acetes* acts as a food source for higher trophic levels, transferring energy in the food web and being used as live food in the aquaculture industry (Jaiswar & Chakraborty, 2005; Huang et al., 2019).