

**DISTRIBUTION AND TAXONOMY OF SOFT-BOTTOM
CRUSTACEA FROM AN OFFSHORE AREA OF SOUTH
CHINA SEA**

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**Thesis Submitted in Fulfilment of the Requirement for
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DEDICATION

The work in this thesis is dedicated to my beloved parents

Hj. Haron bin Awang

&

Hjh. Nooru Aini binti Johan Noor

for their 25 years of love and patience in raising me up.

Alhamdulillah...

ABSTRACT

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfilment of the requirements of degree of Master of Science

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A study on the distribution and taxonomy of soft-bottom macrobenthos (Arthropoda: Crustacea) was conducted at the offshore areas of Southern South China Sea (Terengganu, Pahang and Sabah). The sampling had been done with the aid of 2 vessels which were FOS LEO (Pahang and Sabah) and Vanessa 7 (Terengganu). This study aims to determine species diversity and distribution of soft-bottom macrobenthos (Crustacea) in these mentioned areas. Besides, this study also aims to determine the interaction between soft-bottom macrobenthos (Crustacea) and few abiotic parameters such as sediment textures and total organic carbon contents. In addition to that, the purpose of this study is to illustrate the morphology of the selected soft-bottom macrobenthos Crustacea (Amphipoda).

A total of 42 stations were sampled in this study with total stations for each area was 10 (Terengganu), 19 (Pahang) and 13 (Sabah). The South China

Sea encompasses a portion of the Pacific Ocean stretching roughly from Singapore and the Strait of Malacca in the southwest, to the Strait of Taiwan (between Taiwan and China) in the northeast. South China Sea, has an area of approximately 3.4 million km². South China Sea is also well-known for its mega biodiversity. Samples were collected using Smith McIntyre sediment grab (0.1 m²). Sediments were pre-sieved on the vessel before being fixed with formalin. Samples were then brought to the laboratory for further analysis. Standard methods for sieving, sorting and species identification were utilized during this study.

In total, 1,127 740 individuals of soft-bottom Crustacean were sorted out from the study locations with the mean of density, 37 580 ind/m². Comparison among the studied areas found that the mean density of Crustacean were highest at Pahang and Sabah (3 037 ind/m² and 3 262 ind/m², respectively). Terengganu had the lowest mean density (1 262 ind/m²). There were three subclasses of Crustacea recorded in this present study, namely Malacostraca, Copepoda and Ostracoda. Malacostraca was the most diverse in term of number of species as well as morphological characteristics. The most abundant family were contributed by the order of Decapoda and Amphipoda. Decapoda made up twenty-one families and Amphipoda made up nineteen families. The highest density observed is in Order Amphipoda with the mean density 420.92 ind/m² followed by Cumacea and Decapoda, (372.23 ind/m², 362.03 ind/m²; respectively). The lowest density was recorded in Mysidacea with mean density value, 45.54 ind/m².

Species richness (D) at the offshore area of Terengganu was highest in station T4 (9.99). Species evenness (J') in this station was also high (0.92) which means that the macrobenthos (Crustacea) was equally distributed and value of species diversity index (H') was 3.56. The highest species diversity was recorded at station P14 of Pahang (H'= 2.87, D = 9.34, J' = 0.76) with total of 44 species were found. Station S4 from the offshore of Sabah appeared to have the highest diversity considered by the values of D, H' and J' with the values, 11.51, 0.92 and 3.67, respectively.

Pearson's correlation analysis for the macrobenthos (Crustacea) from the offshore area of Terengganu showed that, the only significant correlation was observed between species richness and total organic carbon content ($R^2 = 0.544$; $p = 0.01$). Meanwhile, in the offshore of Pahang, species evenness appeared to be significantly increase with the gaining value of sediment mean size ($R^2 = 0.259$; $p = 0.026$) and clay ($R^2 = 0.341$; $p = 0.008$). However in Sabah offshore area, the only value of coefficient correlation (r) which displayed a strong correlation was between the density of Crustacean and silt but the relationship was not significant.

Generally, Amphipoda comprised of 14% relative abundance of all macrobenthos (Crustacea) in the studied areas. The highest family recorded was Family Ampeliscidae with the abundance value, $2\ 216.667\ \text{ind}/\text{m}^2 \pm 2\ 901.006$, followed by Leucothoidae and Colomastigidae with the density value, $473.33\ \text{ind}/\text{m}^2 \pm 552.208$ and $366.33\ \text{ind}/\text{m}^2 \pm 586.543$, respectively. Fifty-two Amphipoda species were identified from all of the three areas of

South China Sea. *Ampelisca* sp. 4 was the most abundant species found with the percentage, 14.295%. The second most abundant species was *Leucothoe* sp.1 (7.472%) and followed by *Byblis* sp. (6.489%). These three species were illustrated and the morphological components were described. The relationship between density of Amphipoda and sediment sorting was negatively correlated. Meanwhile, density of Amphipoda and silt was proportional to each other.

In conclusion, this optimistic documentation of soft-bottom (Crustacea) in the present study will induce and encourage the future study of ecology and taxonomy in South China Sea, particularly in Malaysia.

ABSTRAK

Abstrak thesis yang dikemukakan kepada pihak senat Universiti Malaysia Terengganu sebagai memenuhi keperluan ijazah Master Sains

TABURAN DAN TAKSONOMI KRUSTASEA DASAR LEMBUT DARI LAUT LEPAS, LAUT CHINA SELATAN

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Satu kajian mengenai taburan dan taksonomi macrobenthos dasar lembut (Arthropoda: Krustasea) telah dijalankan di kawasan luar pesisir Laut China Selatan. Persampelan telah dilakukan dengan bantuan 2 buah kapal penyelidikan iaitu FOS LEO (Pahang dan Sabah) dan Vanessa 7 (Terengganu) . Kajian ini bertujuan untuk menentukan kepelbagaian spesies dan taburan makrobentos dasar lembut Krustasea di kawasan-kawasan tersebut. Selain itu, kajian ini juga bertujuan untuk menentukan interaksi antara makrobentos dasar lembut Krustasea dan beberapa parameter abiotik seperti tekstur sedimen dan total karbon organik. Akhir sekali, tujuan kajian ini juga adalah untuk meneliti sifat taksonomi untuk beberapa makrobentos (Pekarida: Amfipoda) yang terpilih.

Sejumlah 42 stesen yang terlibat dalam kajian ini dengan bilangan stesen bagi setiap kawasan adalah 10 (Terengganu), 19 (Pahang) dan 13 (Sabah). Laut China Selatan merangkumi bahagian Lautan Pasifik yang menjangkau kawasan dari Singapura dan di barat daya Selat Melaka, hingga ke timur laut Selat Taiwan (antara Taiwan dan China). Laut China Selatan, mempunyai keluasan kira-kira 3.4 juta km². Laut China Selatan juga terkenal dengan kepelbagaian biodiversiti yang mega. Sampel makrobentos Krustasea dikumpul dengan menggunakan alat pengaut Smith McIntyre (0.1 m²). Kesemua sampel tanah telah ditapis di atas kapal dahulu sebelum diawet dengan formalin. Kemudian, sampel sedimen tadi dibawa ke makmal untuk analisis selanjutnya. Kaedah baku telah digunakan bagi melakukan proses pengasingan dan identifikasi makrobentos.

Secara keseluruhan, sebanyak 1, 127 740 individu makrobentos dasar lembut Krustasea telah dicatatkan dari lokasi kajian (Terengganu, Pahang dan Sabah) dengan nilai min kepadatan, 37 580 ind/m². Perbandingan diantara ketiga-tiga kawasan menunjukkan bahawa kepadatan min makrobentos Krustasea adalah tertinggi di Pahang dan Sabah (masing-masing, 3 037 ind/m² dan 3 262 ind/m²). Manakala, pengairan Terengganu mempunyai kepadatan min terendah iaitu, 1 262 ind/m². Order Amphipoda menunjukkan kepadatan min paling tinggi iaitu 420.92 ind/m², diikuti dengan Kumasea dan Dekapoda (masing-masing, 372.23 ind/m², 362.03 ind/m²). Kepadatan min 45.54 ind/m². paling rendah dalam rekod adalah Maisidasea, dengan kepadatan min, 45.54 ind/m².

Terdapat tiga subkelas Krustasea yang terlibat dalam kajian ini, iaitu Malakostraka, Kopepoda dan Ostrakoda. Antara subkelas tersebut, Malakostraka adalah subkelas yang paling variasi dari segi bilangan spesies serta ciri-ciri morfologi. Famili yang terbesar disumbangkan oleh Order Dekapoda dan Amfipoda. Dekapoda terdiri 21 famili manakala Amfipoda terdiri daripada 19 famili. Kepadatan tertinggi disumbangkan oleh Order Amfipoda dengan min kepadatan sebanyak 420.92 ind/m^2 , diikuti pula oleh Kumasea dan Dekapoda (masing-masing, 372.23 ind/m^2 , 362.03 ind/m^2). Order Maisidasea mempunyai kepadatan terendah iaitu 45.54 ind/m^2 .

Kekayaan spesies (D) di kawasan laut lepas Terengganu yang tertinggi adalah di stesen T4 (9.99). Kesamarataan spesies (J') di stesen ini juga tinggi (0.92) yang menunjukkan taburan makrobentos Krustasea adalah sama rata dengan nilai kepelbagaian spesies indeks (H') ialah 3.56 . Kepelbagaian spesies tertinggi bagi Krustasea laut lepas Pahang adalah dicatatkan di stesen P14 (H' = 2.87, D=9.34, J'=0.76) dengan jumlah sebanyak 44 spesies telah dikenalpasti. Stesen S4 dari laut lepas Sabah mempunyai kepelbagaian tertinggi dengan nilai-nilai D, H' dan J', masing-masing adalah 11.51, 0.92 dan 3.67.

Analisis korelasi Pearson untuk makrobentos Krustasea dari kawasan laut lepas Terengganu menunjukkan bahawa, satu-satunya hubungan yang signifikan adalah di antara kekayaan spesies dan kandungan total karbon organik ($R^2 = 0.544$; $p = 0.01$). Manakala di laut lepas Pahang,

kesamarataan spesies (J') meningkat dengan kenaikan purata saiz nilai sedimen ($R^2 = 0,259$; $p = 0.026$) dan tanah liat ($R^2 = 0.341$; $p = 0.008$). Walau bagaimanapun, di kawasan laut lepas Sabah, satu-satunya nilai pekali korelasi (r) yang menunjukkan korelasi yang kuat adalah di antara kepadatan Krustasea dengan lumpur, walaupun hubungan tersebut tidak signifikan.

Secara umumnya, Amphipoda terdiri 14% daripada kelimpahan relatif semua makrobenthos Krustasea dalam kajian yang dijalankan. Famili tertinggi dicatatkan adalah daripada famili Ampeliscidae dengan nilai min kepadatan, $2\ 216.667\ \text{ind}/\text{m}^2 \pm 2\ 901.006$, diikuti oleh Leucothoidae dan Colomastigidae dengan nilai min kepadatan, $473.33\ \text{ind}/\text{m}^2 \pm 552.208$ dan $366.33\ \text{ind}/\text{m}^2 \pm 586.543$, masing-masing. Lima puluh dua spesies Amphipoda telah dikenalpasti dari ketiga-tiga kawasan Laut China Selatan. *Ampelisca* sp. 4 adalah spesies yang paling banyak dijumpai dengan peratusan, 14.295%. Spesies yang mengambil tempat kedua adalah *Leucothoe* sp. 1 (7.472%) dan diikuti oleh *Byblis* sp. (6.489%). Ketiga-tiga spesies telah dipilih bagi mengenalpasti ciri-ciri penting taksonomi dalam spesies Amphipoda.

Oleh itu, dokumentasi makrobentos Krustasea dalam kajian ini diharap akan mendorong dan menggalakkan lagi kajian dalam ekologi dan taksonomi di Laut China Selatan, khususnya di Malaysia pada masa hadapan.