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Diversity of Polychaeta (Annelida) in the Continental Shelf of Southern South China Sea

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Abstract: Polychaete is among the largest and most diverse benthic animal in many marine ecosystems. However, in Malaysia the study on diversity of polychaete from soft bottom habitats, especially at the continental shelf of southern South China Sea has not been widely explored. Therefore, this study specifically embarks to determine the diversity of polychaete (Annelida) collected from soft bottom habitats of offshore Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island. Results from 43 sampling stations shows that 12, 477 individual of polychaetes were recorded and grouped into 47 families, 217 genera and 368 species. Family Spionidae was found to be the most dominant family contributed 17.7% from the total number of polychaetes, followed by Nephtyidae (7.5%), Paraonidae (6.3%) and Capitellidae (6.1%). The cumulative number of polychaete species was found to be parallel with the increasing number of sampling stations in which it was relatively highest at the offshore area of Pekan-Dungun (302 species, 19 stations), followed by Kudat-Balambangan Island (190 species, 13 stations) and Kuala Terengganu (172 species, 11 stations). In terms of species diversity and evenness indices, the mean value of diversity (3.88 to 5.65) differ significantly ($p<0.05$) however evenness index (0.72 to 0.92) did not differ significantly ($p>0.05$) between the study areas off Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island.

Key words: Annelida · Polychaete · Diversity · Continental shelf · South China Sea

INTRODUCTION

Polychaetes are multi-segmented worms with huge morphological diversity [1] brightly coloured [2] and have sizes ranging from less than 1 mm to several meters length [3]. They are among the largest and most diverse benthic animal in many marine ecosystems and approximately 14, 000 species have been described worldwide [3]. Polychaetes play important roles in the environment especially in ecology, economic value and as bioindicator as described in [4-8].

The South China Sea is located in the East Asian Seas (EAS) region and has become one of the largest marginal seas of the western Pacific Ocean. It is a semi enclosed body of water and has been identified as one of Large Marine Ecosystem (LME). It is a strategic waterway [9] and connects with the East China Sea, the Pacific Ocean, the Sulu Sea, the Java Sea and the Indian Ocean through the Taiwan, Bashi, Balabac, Karimata and Malacca straits. Eight countries which border the region are Taiwan, the Philippines, Brunei, Indonesia, Singapore, Malaysia, Vietnam and China [10, 11].

The South China Sea is a tropical system that includes diverse habitats ranging from mangrove forests, seagrass beds, estuaries and coastal and offshore coral reefs [12]. It is categorised by high biodiversity parallel with the imagery Coral Triangle tropical fauna center. The species richness and species number of marine organisms in China seas are higher compared to the neighbouring sea in which the number is increase from north to south [13][14]. Unfortunately, although intensive explorations for

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production of natural gas and petroleum were done in South China Sea, the marine biota and ecology is poorly understood [12] due to very little study done in this area. Therefore, the study of marine organisms is very important for determining the status of biota and ecology in this area.

Recently, South China Sea has 661 polychaete species classified into 54 families [15] and the majority of them are belonging to the Indo-Malayan subregion of the Indo-West Pacific province [16]. However, polychaetes of Malaysia are still limited, even though some studies were published by [17], [18] and [19] where focus area are on the west coast of Peninsular Malaysia. The study on diversity of polychaete from soft bottom habitats especially at the offshore areas of Malaysia has not been widely explored even though Malaysia is covered with South China Sea; an area with mega biodiversity and there are intensive explorations for oil and gas within it. In most of the local references on benthic communities, the polychaetes are usually identified only to the familial and generic level [20]. There are no comprehensive, up-to-date data for the polychaetes group in Malaysia. Other neighbouring countries such as Indonesia [16], Singapore [20] and Thailand [21] already have a catalogue of polychaete species found in their waters.

Thus, the study on diversity of polychaetes is definitely needed for a better understanding in Malaysian waters. A lot of the polychaete fauna here are yet to be discovered and that many more of these species may represent new records [17]. This study may provide baseline data of future investigations on environmental changes in this area and reference for marine management activities. This could be helpful in many areas of the southern part of South China Sea where the research on the polychaete is not well-documented. Therefore, this study specifically embarks to determine the diversity of polychaete (Annelida) collected from soft bottom habitats of offshore Pekan-Dungun, Kuala Terengganu and Kudat-Balambanga Island.

MATERIALS AND METHODS

Sample Collection: This study was conducted in April and July 2011 on board vessel FOS LEO and Sealink VANESSA 7 ship for one off sampling in the continental shelf of southern South China Sea. Selected 43 sampling stations were located at offshore areas of Pekan-Dungun (station A1 to A19), Kuala Terengganu (station B1 to B11) and Kudat-Balambangan Island (station C1 to C13) (Fig. 1 and 2). At each sampling station, sediment samples for polychaetes (n=5) were taken by Smith McIntyre grab (0.1 m^2) and was sieved through a set of wire mesh sieves (5.0, 3.0 and 0.5 mm). Polychaetes retained on the sieve were collected, fixed with 10% buffered formalin and were brought back to the laboratory for further analysis [22, 23].

Sample Analysis: In the laboratory, samples were gently rinsed with freshwater onto a 0.5 mm mesh sieve to remove all the excessive formalin [24]. All materials retained on the sieve were placed in small fractions into a labeled petri dish and was scanned systematically under the stereo microscope (Olympus SZX7). Polychaetes were counted and identified to the lowest possible taxonomic level. The identification of polychaetes were based on the morphological features under the stereo microscope and compound microscope (Leica DME) [22][25] and also through the comparison with the polychaetes illustrate in the literature. Each identified polychaetes were placed in the labelled container containing 70% ethanol and were deposited at the South China Sea Repository and Reference Centre (RRC), Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu (UMT).

Data Analysis: Univariate and multivariate analysis were used in this study. For univariate analysis, the diversity of polychaetes species at each station was described by diversity index of Shannon-Weiner, *H'* [26] and the evenness of polychaetes community was represented by Pielou's evenness index, *J'* [27]. Multivariate analysis (similarity analysis) and Hierarchical Cluster Analysis (CLUSTER) was performed using the software packages PRIMER V6 Version 6.1.12 programme (Plymouth Routines in Multivariate Ecological Research) [28]. One-way analysis of variance (ANOVA) was performed using SPSS (Statistic Package for Social Science) version 11.5 software to determine the significant differences on the mean of biological parameters (e.g. species number, diversity and evenness) among stations and sampling areas. For all tests, a criterion of $p<0.05$ was used to determine statistical significance.

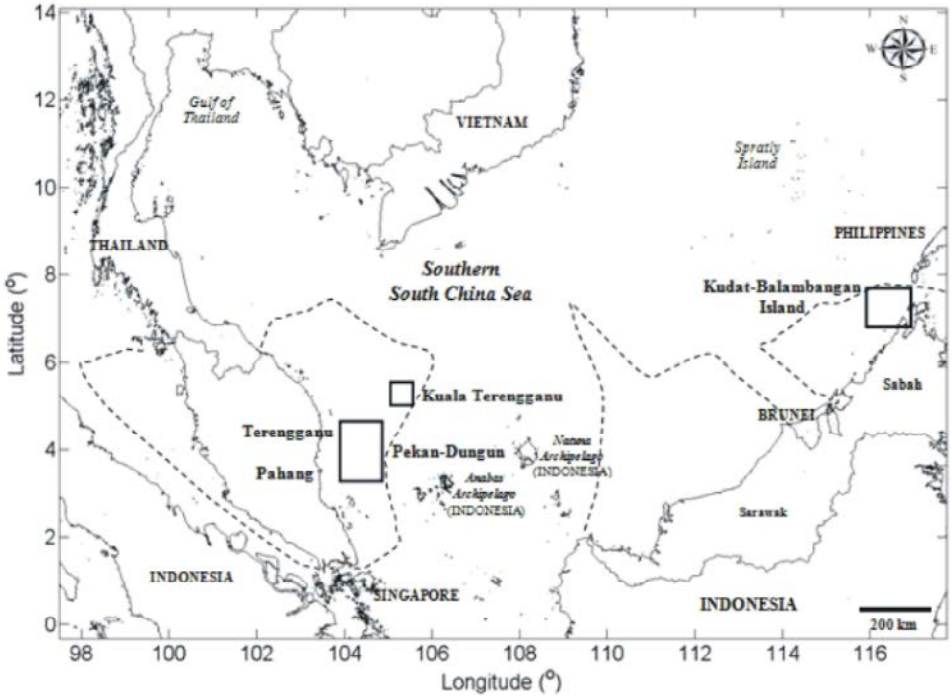

Fig. 1: Map of sampling areas off Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island, surrounding countries within southern South China Sea area and the border of Malaysia Exclusive Economic Zone (EEZ)

RESULTS AND DISCUSSION

Overall, a total of 12, 477 individuals of polychaetes were recorded and classified into 47 families, 217 genera and 368 species (Fig. 3). Spionidae was found to be the most dominant family, which contributed 17.7% from the total number of polychaetes, followed by Nephtyidae (7.5%), Paraonidae (6.3%) and Capitellidae (6.1%). Spionid was one of the most dominant, widespread polychaetes families and most abundant polychaete groups [29-33].

In terms of polychaete occurrence, the cumulative number of polychaete species was found to be parallel with the increasing number of sampling stations (Fig. 4). In general, the cumulative number of species relatively highest at the offshore area of Pekan-Dungun (302 species, 19 stations), followed by Kudat-Balambangan Island (190 species, 13 stations) and Kuala Terengganu (172 species, 11 stations). Offshore area of Kuala Terengganu had the lowest species number most probably because this area was smaller than offshore Pekan-Dungun and offshore Kudat-Balambangan Island. The number of species found in this study was considered higher compared to previous studies done in South China Sea [15] with about 59 polychaetes species were similar with those study. This might be because the present study covered three large areas of southern South China Sea even though it was only one off sampling. The South China Sea is categorised as high biodiversity in which the species richness and species number are higher compared to neighbouring sea [13].

The mean value of polychaete diversity (3.88 to 5.65) was differ significantly (p<0.05) however the value of evenness index (0.72 to 0.92) did not differ significantly (p>0.05) between the study areas off Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island (Fig. 5). Throughout all sampling stations, the significantly highest mean value of diversity and evenness was found to be same stations of A9 and A13, while the lowest value of both parameters was at station C10 and B7, respectively. By comparing the diversity value of this study with the scale of pollution in terms of Shannon's species diversity in [33], this study area was categorised as undisturbed by pollution as the values were more than 4.5 except for 10 stations that had values between 3.88 to 4.5. For evenness values, it indicates non-domination within the area by any specific species [35]. The unbalanced of polychaete populations were because predominance of a few opportunistic polychaetes [36].

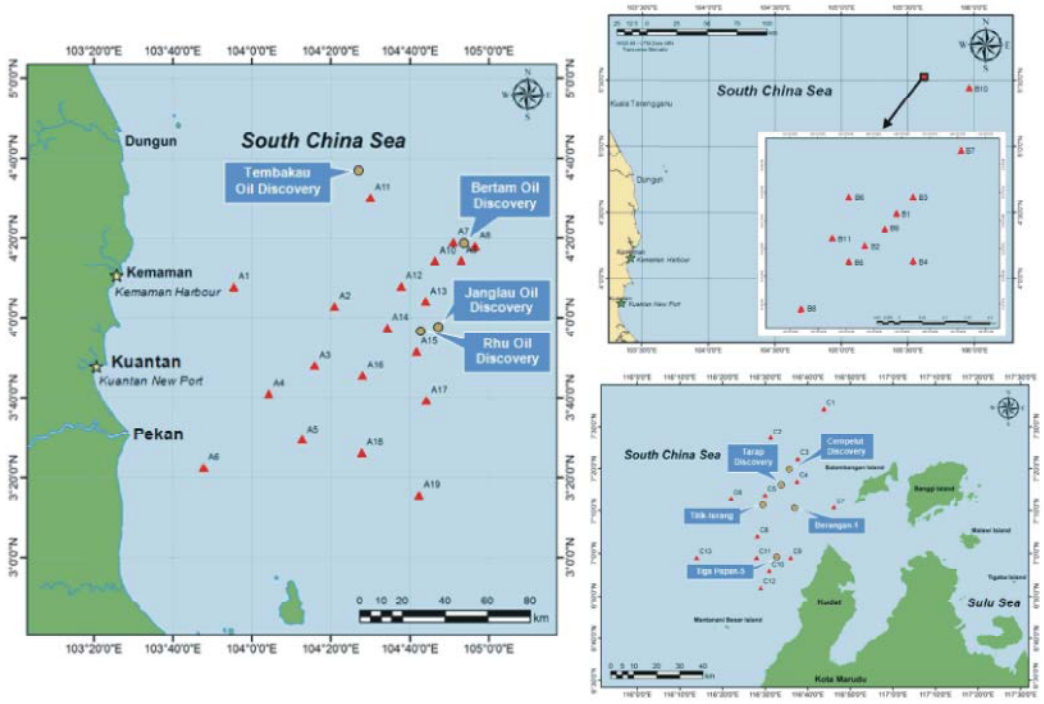

Fig. 2: Map of 19 sampling stations of offshore Pekan (Pahang)-Dungun (Terengganu), 11 sampling stations of offshore Kuala Terengganu (Terengganu) and 13 stations of offshore Kudat-Balambangan Island (Sabah)

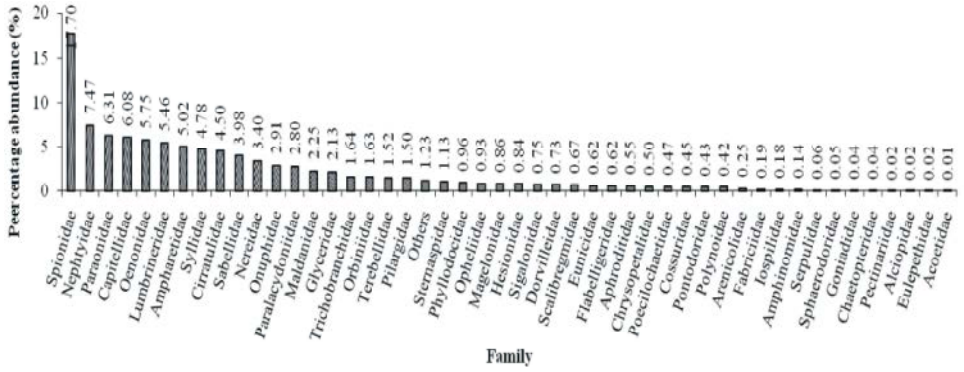

Fig. 3: Percentage abundance (%) of polychaete families in southern South China Sea (offshore Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island)

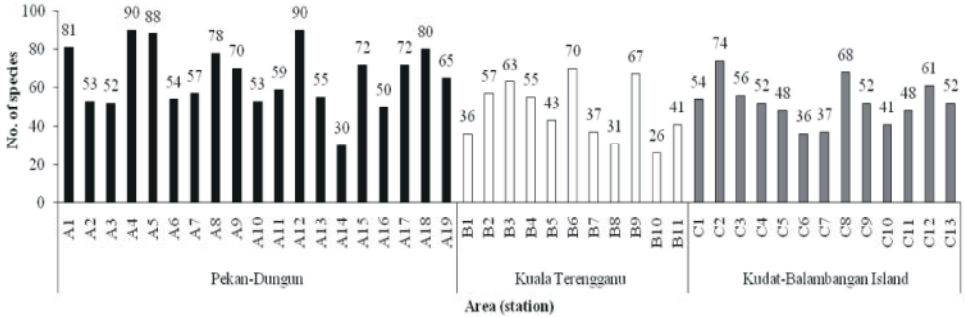

Fig. 4: Total number of polychaete species at each station in southern South China Sea (offshore Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island)

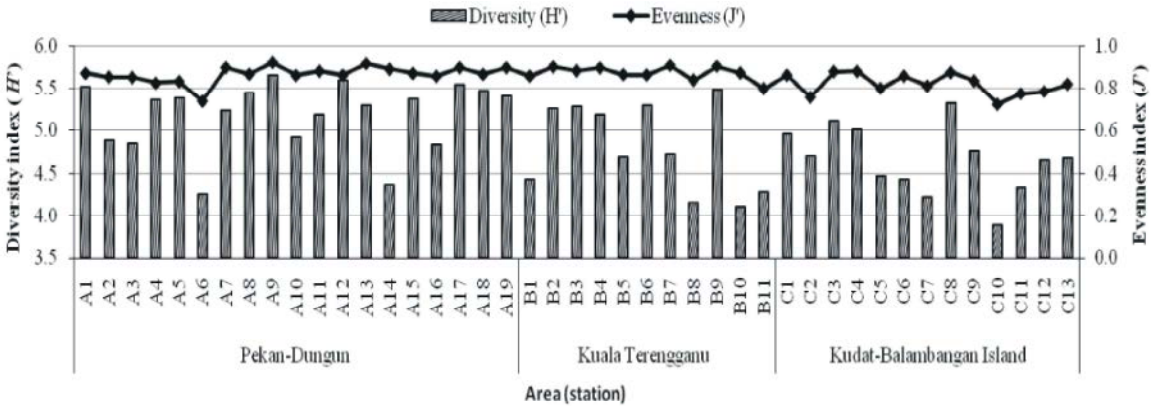

Fig. 5: Diversity (*H'*) and evenness (*J'*) index of polychaetes at each station in southern South China Sea (offshore Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island)

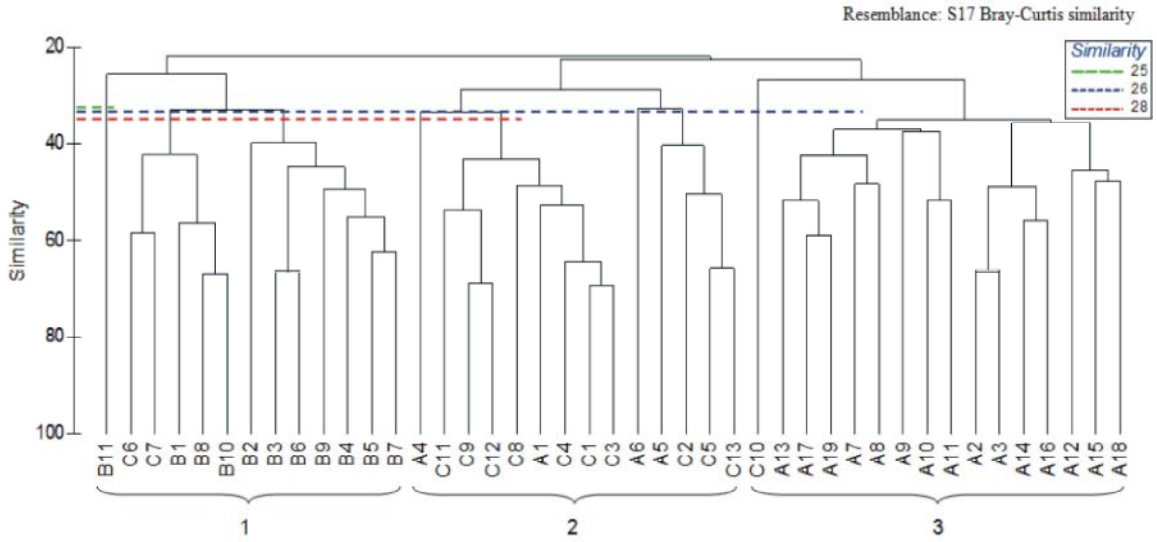

Fig. 6: Dendrogram for hierarchial agglomerative clustering of square-root transformed polychaete data using group average linking of Bray-Curtis similarities at southern South China Sea (offshore Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island).

Cluster analysis to examine similarities in species composition of polychaetes at Pekan-Dungun, Kuala Terengganu and Kudat-Balambangan Island of southern South China Sea were shown in Fig. 6. Results from cluster analysis indicated three clusters: 1) Cluster 1, average similarity = 25%: station B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, B11, C6 and C7; 2) Cluster 2, average similarity = 28%: station A1, A4, A5, A6, C1, C2, C3, C4, C5, C8, C9, C11, C12 and C13; and 3) Cluster 3, average similarity = 26%: Station A2, A3, A7, A8, A9, A10, A11, A12, A13, A14, A15, A16, A17, A18, A19 and C10. These indicated species abundance and composition among stations within each group were more similar among themselves compared to other stations.

CONCLUSION

12, 477 polychaetes individual, 47 families, 217 genera and 368 species were recorded. Family Spionidae was found to be the most dominant family at the southern South China Sea. The cumulative number of polychaete species was found to be parallel with the increasing number of sampling stations. The diversity and evenness value was higher compared to previous studies.

The data obtained from this study might contribute as additional information on the biodiversity of polychaetes community, their abundance and distribution at the offshore areas of southern South China Sea and eventually provide significant baseline information for

sustainable management of South China Sea Large Marine Ecosystem (LME). Further collections around Malaysia waters will undoubtedly increase the number of specimens available for many taxa, enabling descriptions of new taxa in the future. The sampling of polychaetes for determination of polychaete changes could be done according to monsoonal seasons which covered pre, inter and post monsoon period. Besides, a list of local polychaetes, taxonomic keys and atlases or inventory showing their distribution also could be done. Hence, the expertise to work on polychaetes will be improved and the potential for their greater use will be recognized. Therefore, the ability to use polychaetes to study long-term changes in biota due to pollution becomes better when the dataset spans a long period and the pollution has been increasing steadily. It will also able to generate effective conservation schemes and guidelines for the sustainable exploitation of natural resources, the dynamics in relation to environmental, spatial and temporal process in general and benthic community in particular.

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