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Taxonomic Composition and Abundance of Zooplankton Copepoda in the Coastal Waters of Bintulu, Sarawak, Malaysia

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ABSTRACT

The abundance and composition of copepod was carried out in the coastal waters of Bintulu, Sarawak, Malaysia on March 2005. Samples were collected using conical plankton net with the mesh size of 153 μm. Copepod identified comprised of four orders namely, Calanoida, Cyclopoida, Harpacticoida and Poecilostomatoida. A total of 49 species belonging to 26 genera were identified. Nine most abundant species were *Paracalanus crassirostris, Paracalanus elegans, Temora stylifera, Temora turbinata, Oncaea venusta, Corycaeus andrewsi, Corycaeus subtilis, Paracalanus parvus* and *Paracalanus denudatus*. The first four species mentioned were the most abundant species and they accounted for over 50% of the total numbers of identified copepods. Copepod species which were rare and low in abundance included *Delius nudus, Acrocalanus gracilis, Tortanus forcipatus, Centropages orsini, Corycaeus dahlia, Copilia mirabilis, Labidocera minuta, Microstetella rosea* and *Cosmocalanus darwini*. *Cosmocalanus darwini* is new record to Malaysian waters. Species richness and diversity tends to increase towards the offshore while abundance increased towards the inshore stations.

Key words: Zooplankton, Copepoda, coastal, tropical, offshore, inshore, Malaysia

INTRODUCTION

Copepods are the most dominant group in the zooplankton community (Lara-Lara and Matus-Hernandez, 1997). They formed the first vital link in the food chain that leads from the minute algal cells of the phytoplankton up to the larger fishes and mammals (Raymont, 1976). Studies reported that some species of fish feed mainly on zooplankton, especially copepods and may have an essential role to play in future development of fish farming and marine ranching (Zhuang, 1990; Gee, 1989).

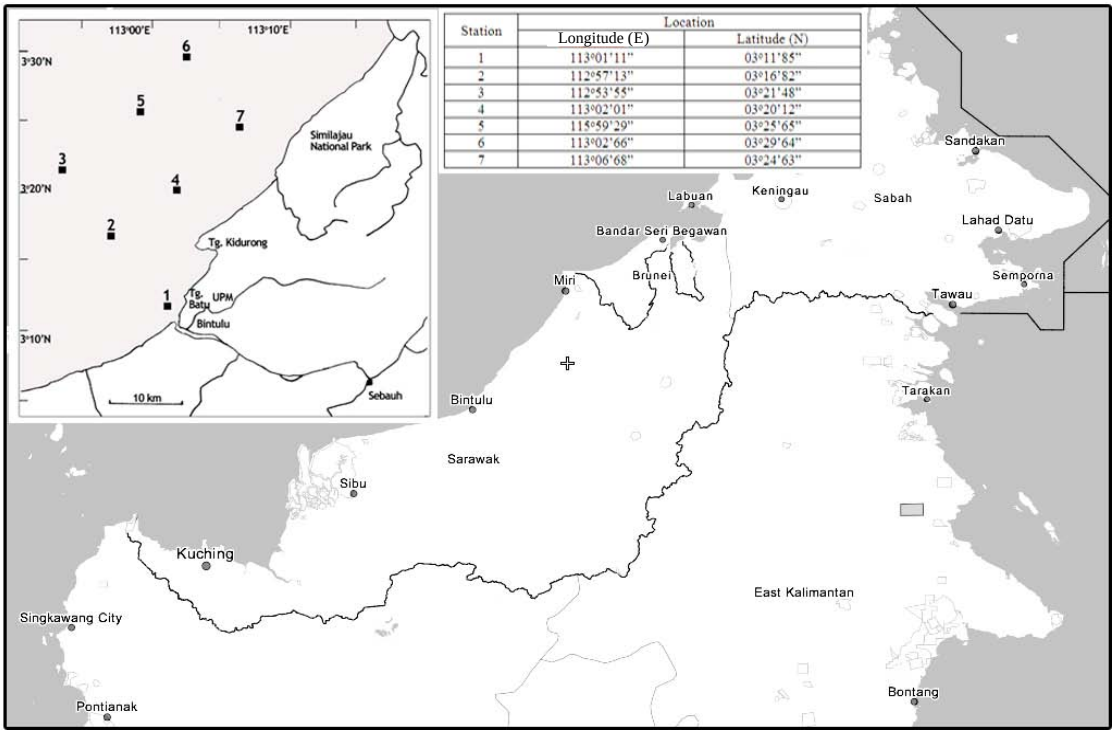
Copepods are a numerically important group of zooplankton in coastal open neritic as well as oceanic environments (Huys and Boxshall, 1991). The community structures of oceanic, neritic and estuarine zooplankton are quite distinct from each other and these differences can be identified in species composition, distribution, richness and abundance (Rezai *et al*., 2004). The areas of distribution of copepods species can be distinguished in to two distinct types namely, neritic and oceanic (Rezai *et al*., 2001). In neritic waters, the copepods species are abundant, where the ecological conditions particularly, temperature and salinity show large changes. In the oceanic

waters, the ecological conditions are much more stable as regards to temperature and salinity which showing greater diversity. Some copepods have 'intermediate' distributions as they may have "demands" lying between the conditions of the neritic and oceanic areas (Bougis, 1976).

The earliest report on copepods in Malaysian waters can be traced back to the early 1930 (Sewell, 1933). Studies on marine/estuarine zooplankton copepods in Malaysian waters have increased recently (Yoshida *et al.*, 2006; Rezai *et al.*, 2004; Johan *et al.*, 2000, 2002a; Johan and Idris, 2001; Idris *et al.*, 1995, 2000; Idris and Afandy, 1998; Rezai *et al.*, 2001; Othman *et al.*, 1990; Othman, 1988). However, no accounts of copepods were reported particularly in the waters of Sabah and Sarawak. This study presents the first report on the taxonomic composition and abundance of copepods in the coastal waters of Bintulu, Sarawak, Malaysia.

MATERIALS AND METHODS

Description of study area: The study was conducted in March 2005 to investigate the taxonomic composition and abundance of copepods at the coastal waters of Bintulu, Sarawak, Malaysia. Seven sampling stations were chosen for the study and the distance within two stations was approximately 10 km apart (Fig. 1). Stations 1, 2, 4 and 7 were categorized as inshore stations while station 3, 5 and 6 were categorized as offshore stations. Station 1 was located at the river mouth of Kemena river which is the main river of Bintulu. Station 4 was located near to the Bintulu industrialized zone while station 7 was located at the protected area of Similajau National Park.



Station	Location	
	Longitude (E)	Latitude (N)
1	113°01'11"	03°11'85"
2	112°57'13"	03°16'82"
3	112°53'55"	03°21'48"
4	113°02'01"	03°20'12"
5	115°50'29"	03°25'65"
6	113°02'66"	03°29'64"
7	113°06'68"	03°24'63"

Fig. 1: Sampling area location showing the sampling stations in the coastal waters of Bintulu, Sarawak (Wikimapia and Google earth)

Collection and identification of copepods: Copepods were collected using plankton net of 0.31 m^2 mouth area and a filtering conical section of 1.35 m long. Equipped with a mesh size of 153 µm, the net was towed vertically from the bottom. The volume of water filtered by the net was derived from the line-length and net opening, assuming 100% filtration efficiency (Kuipers *et al.*, 1993). Copepod samples were preserved in the bottle containing 4% of neutralized formalin diluted with seawater (Omori and Ikeda, 1984). In the laboratory, copepod species was enumerated under the stereo microscope and compound microscope. Only adult copepods were identified and counted. Identifications of all specimens were based on comparisons with published descriptions of Chihara and Murano (1997), Huys *et al.* (1996), Heron and Bradford-Grieve (1995), Bradford-Grieve (1994), Zhong (1989), Yamaji (1986) and Boxshall (1979). Physical parameters such as temperature, salinity, conductivity, dissolved oxygen and pH were recorded *in situ* using YSI SCT meter, YSI dissolved oxygen meter and Mettler Tolledo pH meter, respectively. Shannon-Weiner diversity index and Pielou evenness index were used to determine the diversity and distribution of the copepod community in the study area.

RESULTS AND DISCUSSION

The distribution of copepods was relatively patchy. The density of copepods varied widely among stations, ranging from 183 individuals/m^3 (station 6) to 1465 individuals/m^3 (station 1). A total of 49 species belonging to 26 genera were identified (Table 1). Species composition also varied among stations. Species richness ranged from 13 species at station 1 to 29 species at stations 4 and 7. The species diversity was relatively high for stations 3, 4, 5, 6 and 7 (Table 2).

Canthocalanus pauper, *Oithona rigida*, *Oncaea venusta*, *Paracalanus crassirostris*, *Paracalanus denudatus*, *Paracalanus elegans* and *Paracalanus parvus* were found in all seven sampling stations. *Paracalanus crassirostris* was the most dominant species during the study period, constituted about 35% of the total copepods present. The species *P. elegans*, *Temora stylifera* and *T. turbinata* made up more than 5% of the total copepod composition.

The sea water parameters are given in Table 3. Salinity ranged from 12 psu in station 1 to 32 psu in station 6. Temperature was relatively stable ranging from 28.8-29.8°C. Lower readings of dissolved oxygen were recorded at stations 1-4 (3.6-4.8 mg L^{-1}) compared to while in stations 5-7 (5.7-5.8 mg L^{-1}). The lowest pH reading (6.6) was recorded at the river mouth (St.1) while the pH recorded at other sampling stations ranged from 7.9-8.2.

The composition of copepods as well as other species of zooplankton reflects the characteristics of an estuarine environment. The total number of copepod species was relatively lower when compared to the previous data obtained from other study areas in Malaysian waters, 88 species by Johan *et al.* (2002b), 117 species by Rezai *et al.* (2004) and 74 species by Othman (1988). Despite the insignificant variation in physical parameters of Malaysian coastal waters, the study again supported the fact on the diverse occurrence of copepod species in tropical waters. On the variation, it is assumed that factors such as sampling apparatus, techniques and area of coverage could all attribute to these differences.

All sampling stations were located in the estuarine waters where salinity values never reach 35 psu. The lowest (12 psu) salinity was recorded in station 1 with 13 species of copepods while >20 species of copepods was recorded in other stations with slightly higher salinity (>20 psu). Although, some of these observations may be attributed to the patchy characteristics of the copepods (Hwang *et al.*, 2000), salinity would also probably play a major influence in the distribution

Table 1: Composition and abundance of copepods in the coastal waters of Bintulu Sarawak

	Density (individuals/m^3)							
Species	St. 1	St. 2	St. 3	St. 4	St. 5	St. 6	St. 7	Total
Acartia erythraea Giesbrecht	52							52
Acartia pacifica Steuer		26	13	57			21	146
Acrocalanus gibber Giesbrecht	62							62
Acrocalanus gracilis Giesbrecht		3		5				10
Acrocalanus longicornis Giesbrecht				10			5	18
Bestiolina similis Sewell	93	5		15	10		10	143
Calocalanus styliremis Giesbrecht			5			5	5	19
Candacia catula					10	5		18
Candacia tuberculata Wolfenden		3					10	16
Canthocalanus pauper Giesbrecht	10	21	3	62	10	21	10	166
Centropages furcatus Dana		5		15			5	32
Centropages orsini Giesbrecht				5			0	6
Clausocalanus furcatus Brady		8		10	10	10	15	66
Clausocalanus minor Sewell				15			15	37
Clytemnestra scutellata Dana		5	3	0		5	5	23
Copilia mirabilis Dana			3	0				4
Corycaeus (Ditrichocorycaeus) *dahli* Tanaka				5				6
Corycaeus (Ditrichocorycaeus) *erythraeus* Cleve		8		15	5		5	42
Corycaeus (Ditrichocorycaeus) *subtilis* M. Dahl		21	18	83	36	5	57	269
Corycaeus (Ditrichocorycaeus) *andrewsi* Farran	155	52	3	31	5		5	279
Corycaeus (Onchocorycaeus) *pumilus* M. Dahl		5	3					11
Cosmocalanus darwini						15		18
Delius nudus Andronov	10							10
Eucalanus subcrassus Giesbrecht					5	5	15	31
Eucalanus subtenuis Giesbrecht		13						18
Euterpina acutifrons Dana	62	46			31	5	5	176
Farranula concinna Dana		8		52	5	15		97
Farranula gibbula Giesbrecht				10	83			111
Labidocera minuta Giesbrecht		3						4
Macrosetella gracilis Dana		8	5	26	83	15	15	184
Microsetella norvegica Boeck	21		3			10	21	61
Microsetella rosea Dana			3					4
Oithona decipiens Farran			8					11
Oithona plumifera Baird			8	10				23
Oithona rigida Giesbrecht	62	10	10	36	5	21	21	189
Oithona similis						10		12
Oithona simplex Farran				26	15	15	31	105
Oncaea clevei Fruchtl		8		36	10		5	72
Oncaea venusta Philippi	21	39	34	36	5	21	103	318
Paracalanus crassirostris Dahl	846	735	5	155	124	124	160	2545
Paracalanus denudatus Sewell	21	18	23	41	10	31	41	226
Paracalanus elegans Andronov	52	83	10	5	52	67	98	445
Paracalanus parvus Claus		31	5	15	72	10	62	241
Sapphirella-like copepod			5	5	10	0	10	38
Temora discaudata Giesbrecht			8			15	10	42
Temora stylifera Mori		5	5	26	243	41	31	421
Temora turbinata Dana		21	3	15	46	227	10	390
Tortanus forcipatus Giesbrecht		3		5				10
Undinula vulgaris Dana						10		12
Total density	1465	1189	183	831	888	712	810	7238

Table 2: Copepod community indices

	Station							
Parameter	1	2	3	4	5	6	7	Total
Species richness	13.00	27.00	23.00	29.00	23.00	24.00	29.00	49.00
Diversity (H')	2.33	2.52	4.06	4.24	3.53	3.50	4.02	3.98
Evenness	0.63	0.53	0.90	0.87	0.78	0.76	0.83	0.71

Table 3: Characteristics of seawater in the coastal waters of Bintulu, Sarawak

	Station						
Parameters	1	2	3	4	5	6	7
Salinity (psu)	12.0	24.0	30.0	28.0	31.0	32.0	29.5
Temperature (°C)	28.8	28.8	29.1	29.1	28.5	29.0	29.8
Dissolved oxygen (mg L^{-1})	4.0	3.6	4.8	4.8	5.8	5.8	5.7
pH	6.6	8.0	8.0	7.9	8.1	8.1	8.2

of the species. Species richness of copepods tends to increase towards the outer region of the estuary, indicating that most species were of oceanic origins (Tam *et al.*, 2000).

The calanoid composition was dominated by herbivorous copepods from the family Paracalanidae. The dominance of *P. crassirostris, P. parvus, P. denudatus* and *P. elegans* has been reported from other coastal waters of Malaysia (Rezai *et al.*, 2004). *Paracalanus crassirostris* was most abundant at the river mouth and showed its dominance at the inner estuarine waters (Tam *et al.*, 2000). Moreover, *P. aculateus* and *P. crassirostris* have also been recorded in other estuarine waters elsewhere (Mazzochi and d'Alcala, 1995; Alvarez-Silva and Samuel, 1994). Studies found that several copepod species present in coastal areas are usually euryhaline species (Lakkis, 1994). The species found in this study were mostly euryhaline and occurred in great abundance in estuaries and shallow waters as it was observed for family Paracalanidae (Johan *et al.*, 2000, 2002a; Johan and Idris, 2001; Idris *et al.*, 2000; Othman *et al.*, 1990; Othman, 1988).

The copepod species *Oncaea* are closely living with the appendicularian with benefits such as attachment and feeding and commonly occur in tropical and subtropical regions as well as in the deep seas (Ohtsuka *et al.*, 1996). The species *O. clevei* was most dominant among Poecilostomatoida in the South China Sea (Othman, 1988). The copepod species *O. venusta* was reported to breed intensively at higher temperatures, especially in the range of 25 to 27.5°C in the Japan Sea (Hirakawa, 1995). *Corycaeus andrewsi* and *Farranula gibbula* have been reported to be indicator species of the warm-oceanic waters (Kang *et al.*, 1990). The species *E. acutifrons* was found in greater abundance in coastal waters compared to open neritic waters. Although, the species survives a wide range of salinities (Moreira, 1975; Moreira *et al.*, 1982; Turner, 1994), it is more abundant in the coastal waters than in the offshore. Sautour and Castel (1995) reported that *E. acutifrons* grazes on detritus and algal diet. It is interesting to note that the occurrence of *Cosmocalanus darwini* is new to Malaysian waters. This species was reported in the northern waters of South China Sea near Taiwan (Hwang *et al.*, 2000; Tam *et al.*, 2000). The copepod *C. darwini* was reported to be found in tropical and subtropical waters but usually restricted to surface layer of the sea (Heinrich, 1968).

CONCLUSION

A total number of 49 copepod species was recorded from the coastal waters of Bintulu and one of which was newly recorded (*Cosmocalanus darwini)* to Malaysian marine waters. Many of the copepods found in this coastal area had been previously reported in the adjacent waters such as the Malacca Straits and Taiwan Straits. This study suggests that the South China Sea and its adjacent waters share many similar type of copepod diversity. A more comprehensive investigation covering larger areas is needed to observe the diversity of copepod in the coastal environment of Sarawak.

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