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# Diversity and Abundance of Copepods in Taninthayi Coastal Waters, Myanmar

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ABSTRACT

Diversity and abundance of copepods occurring in Taninthayi coastal waters were studied and analyzed from the samples collected by R/V DR. FRIDTJOF NANSEN during the Myanmar ecosystem survey 2018. Seventy-nine copepods species belonging to calanoids (51 species), cyclopoids (21 species), and harpacticoids (7 species) were identified in the copepods community of Taninthayi coastal waters. Copepods species number and density were high at the nearshore stations (Sts 799, 842, 788) and low at the offshore stations (Sts 846, 802, 823). The resulted diversity index values of copepods were varied from 2.61 to 3.78 in species diversity index ( $H'$ ), from 0.89 to 0.97 in the evenness index ( $E'$ ), and from 2.51 to 7.50 in species richness index ( $D'$ ). According to the correlation matrix, the abundance of copepods was positively correlated with temperature, chlorophyll a and fluorescence, and negatively correlated with salinity and oxygen.

## 1. Introduction

Copepods, microscope members of the subphylum Crustacea, are important and dominant zooplankton groups of the aquatic system. They are holoplanktonic organisms (permanent plankton) who spent their entire life cycle as the plankton. They provide a major food source for larval and juvenile fish. Therefore occurrence, abundance, and diversity of copepods are closely related to the abundance of fisheries resources.

Studies concerning on the zooplankton of Myanmar have been carried out by authors [1-3]. The zooplankton species composition and distribution of Southern Myanmar Waters from the samples collected by Dr. Fridtjof Nansen were studied during the Myanmar ecosystem sur-

vey 2013 [4]. Based on the zooplankton samples collected by RV Dr. Fridtjof Nansen during the Myanmar Ecosystem Survey 2018, this paper aims to observe the species diversity and abundance of copepods and to find out the relation between copepod density and physico-chemical parameters of Taninthayi coastal waters.

## 2. Materials and Methods

Water samples were collected by multinet (0.25 m<sup>2</sup> in the mouth area and 405 µm in mesh size) at 14 stations along the Taninthayi coastal waters from 16 to 27 September 2018 (Figure 1) to analyze the diversity and abundance of copepods. The collected water samples were sieved on a 180 µm mesh and fixed in 96% ethanol in a bottle of 100 mL and then stored for further analyses of identification.

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Copepods groups were examined under the light microscope and identified up as follows the classification systems [1-6].

Abundance of copepod species was presented as the individual number per m<sup>3</sup> of water. Species diversity indices were calculated by the formula of Shannon and Weaver (1963), Pielou (1966) as follows,

$$H' = -\sum P_i \ln P_i$$

$$E' = H' / \ln S$$

$$D' = S - 1 / \ln N$$

where  $H'$  is species diversity index,  $P_i$  is the population abundance of  $i$ th species calculated by  $n_i/N$ ,  $n_i$  is number of the  $i$ th species,  $N$  is all individuals number in a station,  $E'$  is species evenness index,  $S$  is total species number and  $D'$  is species richness index.

Temperature, salinity, oxygen, and fluorescence were measured by Seabird 911 CTD. Chlorophyll a analyses were carried out using the method of acetone extraction [8].

Multivariate statistics (nMDS) analysis of sampling stations was conducted by PRIMER v7 software package. The boxplot and correlation between physico-chemical water parameters and copepod abundance were analyzed using Microsoft Excel.

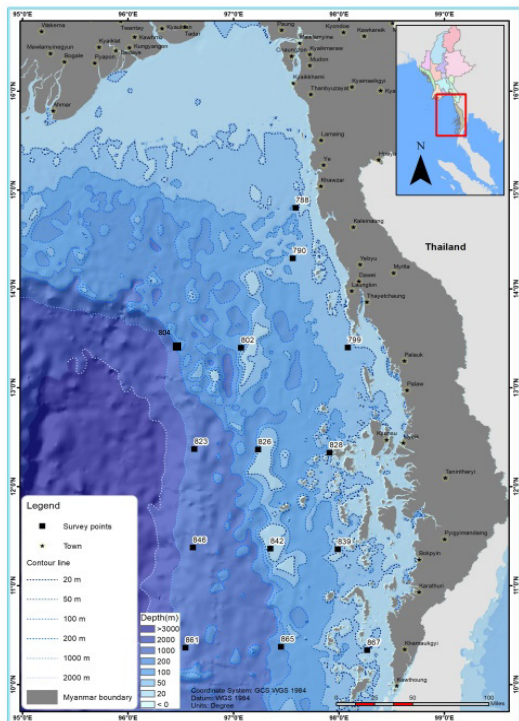


Figure 1. Map showing the water samplings stations

### 3. Results

Seventy-nine copepods species were recorded and com-

posed by 51 species of calanoids, 21 species of cyclopoids, and 7 species of harpacticoids (Figure 2).

#### 3.1 Composition

Calanoid copepods were dominated and accounted for 64.6% of the total sample, followed by cyclopoid copepod (26.6%) and harpacticoid copepod (8.8%). Copepod species composition by stations was presented in Figure 3. Calanoids dominated the copepod diversity of all stations. The species composition ranged from 16 species (St 846) to 59 species (St 799). High species composition was found at the nearshore stations (Sts 788, 790, 842, 867). Composition of copepod species was low at the offshore stations (Sts 802, 804, 823, 826, 865).

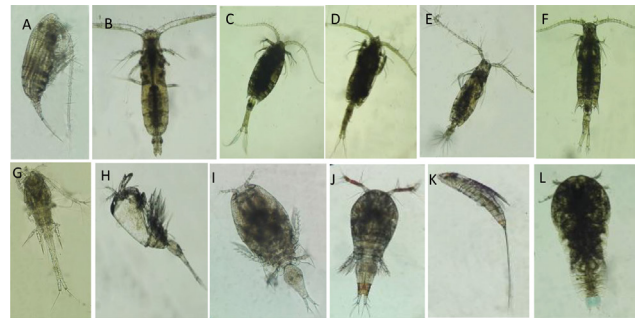


Figure 2. A-L Some copepods species occurring in Taninthayi coastal waters: A-F) Calanoids; G-J) Cyclopoids; K-L) Harpacticoids

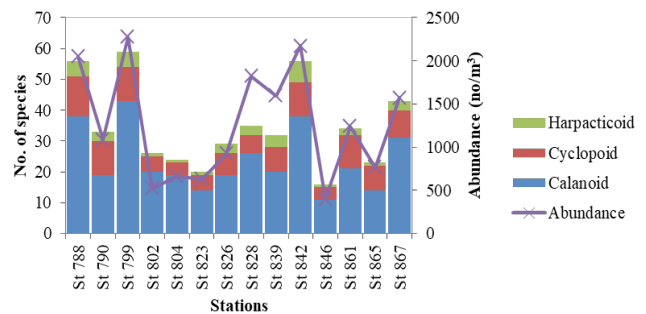
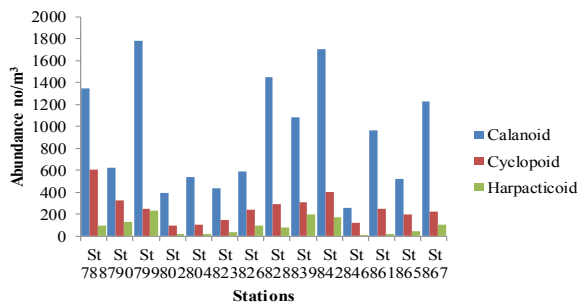


Figure 3. Abundance and composition of copepods group by stations

#### 3.2 Abundance and Diversity

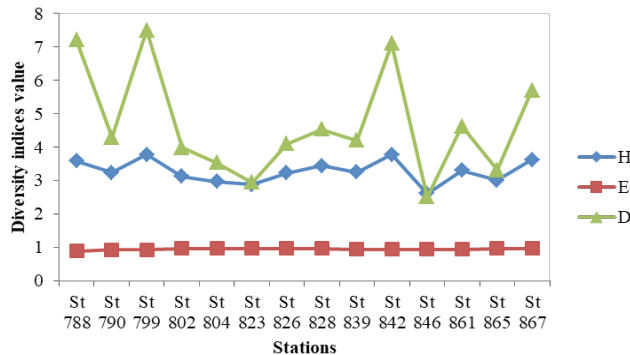
Copepods abundance by stations estimated from the direct counts of a sample (referring to the number per m<sup>3</sup>) was presented in Figure 4. Density was found to be high at the nearshore stations: St 799 (2273 no/m<sup>3</sup>), St 842 (2270 no/m<sup>3</sup>), St 788 (2049 no/m<sup>3</sup>), St 828 (1821 no/m<sup>3</sup>) and low at offshore stations: St 846 (395 no/m<sup>3</sup>), St 802 (520 no/m<sup>3</sup>), St 823 (627 no/m<sup>3</sup>). A high abundance of copepod species occurred in all stations were *Paracalanus parvus* (1071 no/m<sup>3</sup>), *Acrocalanus gibber* (740 no/m<sup>3</sup>), *Nanocalanus minor* (462 no/m<sup>3</sup>) for calanoids, *Oithona rigida* (535 no/

m<sup>3</sup>), *Corycaeus andrewsi* (491 no/m<sup>3</sup>) for cyclopoids, and *Microsetella rosea* (296 no/m<sup>3</sup>), *Euterpina acutifrons* (338 no/m<sup>3</sup>) for harpacticoids.



**Figure 4.** Abundance Calanoid, Cyclopoid and Harpacticoid group by stations

Diversity indices ( $H'$ ,  $E'$ ,  $D'$ ) calculated from copepod species was shown in Figure 5. The resulted values ranged from 2.61 to 3.78 in species diversity index ( $H'$ ), from 0.89 to 0.97 in the evenness index ( $E'$ ), and from 2.51 to 7.50 in species richness index ( $D'$ ).



**Figure 5.** Copepods diversity indices ( $H'$ ,  $E'$ ,  $D'$ ) by station

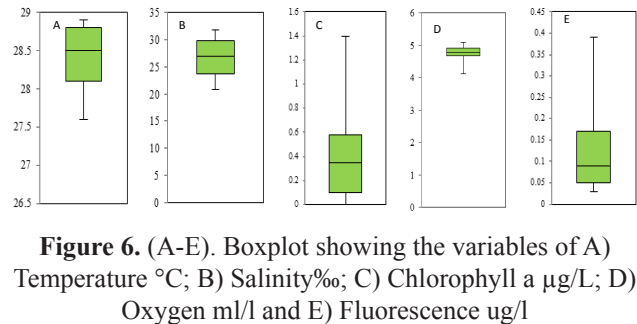
### 3.4 Physico-chemical Parameters, Correlation Matrix and nMDS Plot

Mean values of physico-chemical parameters along Taninthayi coastal waters were 28.4°C ± 0.42 for temperature, 26.2‰ ± 3.4 for salinity, 0.4 µg/L ± 0.4 for chlorophyll a, 4.74 ml/l ± 0.3 for oxygen and 0.13 ug/l ± 0.1 for fluorescence (Figure 6).

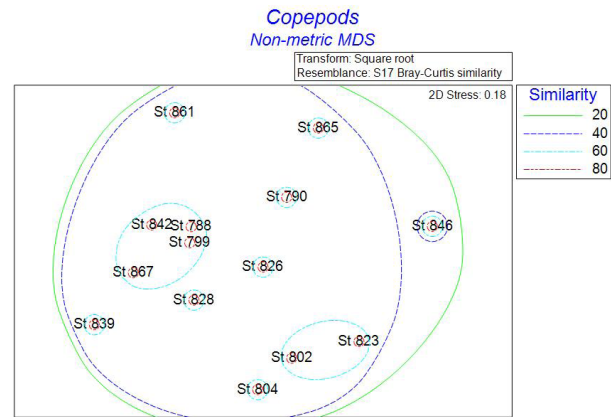
According to the correlation matrix between the abundance of copepods density and environmental parameters, it showed a positive correlation with the temperature ( $r=0.19$ ), chlorophyll a ( $r=0.26$ ), and fluorescence ( $r=0.27$ ) and negative correlation with the salinity ( $r=-0.11$ ) and oxygen ( $r=-0.19$ ) (Table 1).

Non-parametric MDS based on copepods composition (Figure 7) showed two distinct groups composed of near-shore stations (Sts 788, 799, 842, 867) and offshore sta-

tions (Sts 802, 823) exhibited more than 60% of similarity. Except for the outer station St 846, all of the stations showed 40% of similarity level.



**Figure 6.** (A-E). Boxplot showing the variables of A) Temperature °C; B) Salinity‰; C) Chlorophyll a µg/L; D) Oxygen ml/l and E) Fluorescence ug/l



**Figure 7.** nMDS plot showing copepod species composition groups by stations

**Table 1.** Correlation matrix between the copepods density and physico-chemical parameters

	Copepods count	Temperature	Salinity	Chlorophyll a	Oxygen	Fluorescence
Copepods count	1					
Temperature	0.19	1				
Salinity	-0.11	0.42	1			
Chlorophyll a	0.26	-0.09	-0.0008	1		
Oxygen	-0.19	-0.20	-0.50	-0.46	1	
Fluorescence	0.27	-0.16	-0.14	0.94	-0.34	1

### 4. Discussion

A total of seventy-nine marine copepods species were recorded from the zooplankton samples collected by multi-net along Taninthayi coastal waters. The total recorded copepod species during the present survey period was lower than that of copepods results by R/V Dr. Fridtjof Nansen 2013 [4] in which total copepods species revealed were

collected by three types of equipment: Juday net, WP2 net, and Hydrobios multinet in November- December 2013. That could be due to the different sampling periods, and plankton net mesh size used.

Although there was a difference in species composition and abundance by the station, calanoid copepods dominated and accounted for 64.6% of all recorded copepods, followed by cyclopoid copepods (26.6%) and harpacticoid copepod (8.8%). Similarly higher species numbers of calanoids copepods were observed in Ayeyarwaddy and Taninthayi coasts<sup>[9]</sup>, on the southeast coast of India<sup>[10]</sup>, and in the Bay of Bengal<sup>[11]</sup>. But the predominant of cyclopoids was stated in the zooplankton diversity of Wular Lake, Kashmir Himalaya<sup>[12]</sup>.

In the present study, the population density of zooplankton ranged from 500 no/m<sup>3</sup> to 3230 no/m<sup>3</sup> which was higher than that of zooplankton standing stock collected by MV SEAFDEC 2 in Ayeyarwaddy and Taninthayi coasts<sup>[9]</sup>. Common copepods species of the present survey were *Canthocalanus pauper*, *Paracalanus parvus*, *P. crassiostris*, *Centropages furcatus*, *Acartia eurythraea*, *A. centrula*, *Oncaea clevei*, *O. venusta*, *Microsetella norvegica*, and *M. rosea*. The common copepods species in R/V Dr. Fridtjof Nansen survey in 2013 were *Canthocalanus pauper*, *Acartia eurythraea*, *Eucalanus subcrassus*, *Oithona nana*, *Oncaea venusta*, and *Microsetella norvegica*<sup>[4]</sup>.

The species diversity index of plankton communities can indicate that the ecosystem is under the influence of pollution or eutrophication. An increase in diversity values means the water quality is recovered. Lower species diversity indicated the influence of pollution<sup>[13]</sup>. The calculated copepod diversity of the present study (2.61-3.78 for  $H'$ , 0.89-0.97 for  $E'$  and 2.51-7.50 for  $D'$ ) indicated higher species diversity of the copepod community in the Taninthayi coastal waters.

According to the correlation matrix between the abundance of copepods density and physico-chemical parameters, it showed a positive correlation with the temperature ( $r=0.19$ ), chlorophyll a ( $r=0.26$ ), and fluorescence ( $r=0.27$ ) and negative correlation with the salinity ( $r=-0.11$ ) and oxygen ( $r=-0.19$ ). Chlorophyll a, pH, and salinity seem to play a role in the copepod abundance<sup>[14]</sup>. Chlorophyll a and phosphate concentration is a major factor controlling the abundance of copepod<sup>[15]</sup>.

## 5. Conclusion

Abundance and diversity of copepods in the water are of significance for fishery management, fertility, and the health status of the ecosystem. A total of 79 copepod species was composed in the zooplankton community of Taninthayi coastal waters. Copepods species number and

density were found to be high at the nearshore stations and low at the offshore stations. Long term monitoring survey on the status of copepods of Taninthayi coastal waters is still needed to give base line information for fisheries resources management.

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