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Community Structure and Abundance of Tintinnids in the Bay of Bengal During the Spring

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ABSTRACT

The Bay of Bengal (BoB) locates in eastern part of the northern Indian Ocean, with a unique inter-related oceanographic system due to the monsoon and enormous runoffs' supply. microbial food web often dominated the stratified Tropical Ocean, while few studies have been taken up to the tintinnids ciliates. Community structure and abundance of tintinnids were investigated in transact 10° N of the BoB during April 23 to May 2 of 2010. Discrete samples (for tintinnids and environment parameter analysis) were collected at various depths of 0, 25, 50, 75, 100, 150 and 200 m at each station. The tintinnids abundance vertically increased from surface water to maximal at the 75 m, decreased thereafter to the 200 m layer. A total of 20 tintinnids species that belong to 16 genera. *Undella ostenfedi* was dominant species, followed by *Eutintinnus fraknoii* and *Amphorella quadrilineata*. Tintinnids abundance was positively correlated to chlorophyll a concentration ($p<0.01$), indicating the vertical distribution of the tintinnids community was regulated by available food resource.

Keywords: Tintinnids, Abundance, Community Structure, Bay of Bengal

1. INTRODUCTION

Tintinnids ciliates that have a lorica into which the ciliate cell can withdraw, occur in the worldwide oceans (Pierce and Turner, 1993; Dolan, 2000; Dolan *et al*., 2006). Many studies have provided quantitative data on tintinnids diversity of the world (Verity, 1985; Cariou *et al*., 1999; Thompson *et al*., 2004; Zhang *et al*., 2008). Biogeographic distributions of tintinnids related to hydrographics are well known for several oceanic provinces (Modigh *et al*., 2003; Thompson *et al*., 1999). The tintinnids are agreed to present as the tracers of upwelling, oceanic currents and water masses (Pierce and Turner, 1993; Krsinic and Grbec, 2006).

The BoB locates in eastern part of the northern Indian Ocean, with a unique inter-related oceanographic system due to the semi-annually reversed monsoon winds and enormous land-derived runoffs' supply (Jyothibabu *et al*., 2008). The BoB was conventionally referred as an oligotrophic water where nutrients (e.g., nitrate and phosphorus) were deplete (Narvekar and Kumar, 2006; Li *et al*., 2012) and solar radiation was low caused by cloudy days, restricting the phytoplankton growth (Madhupratap *et al*., 2003; Madhu *et al*., 2006). Moreover, microbial food web often dominated the stratified Tropical Ocean, microzooplankton may thus play important role in the BoB. Many studies of the BoB have focused on the hydrological features (Gomes *et al*., 2000), physical circulations (Schott and McCreary, 2001; Shankar *et al*., 2002) and phytoplankton characters (Li *et al*., 2012). However, few studies have been taken up to the tintinnids ciliates. In this study, vertical changes in community structure and ab.

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2. MATERIALS AND METHODS

The tintinnids samples were collected during the BoB research cruise (April 23 to May 2, 2010), initiated by the South China Sea Institute of Oceanology, Chinese Academy of Science. Samples were collected from six sites along the transact 10°N of the BoB (**Fig. 1**), after the profiles of environmental factors being obtained as described in details by Li *et al*. (2012). The water column of the sampling area was severely stratified with the upper mixed layer of ~75 m where the nutrientcline and maximal chlorophyll layers almost located (Li *et al*., 2012).

At each station, seven discrete tintinnids samples (1L for each) were collected at various depths of 0, 25, 50, 75, 100, 150 and 200 m, using a Rosette sampler fitted with 2.5-L Niskin Bottles. The collected water samples (1L) were fixed with Lugol's solution (final concentration of 1%). Back in the laboratory, the samples were settled and concentrated to a volume of about 20 mL. To examine tintinnids, the samples were thoroughly mixed and then 3mL was dropped into a count chamber. Lorica of the tintinnids in the chamber was examined and counted under a Nikon stereomicroscope. Species were identified according to the shape of lorica with reference to Kofoid and Campbell (1929; 1939) and Carey (1992).

Pearson correlation analysis was applied to find the tintinnids community in relation to the environmental variables (SPSS 16.0 software).

3. RESULTS

A total of 20 tintinnids species belonging to 16 genera were identified in present study (**Table 1**). Maximum species number were found at B1 and B5 (10), followed by B4 and B6 (6); only 3 species presented at B3. Surface tintinnids abundance was only a few tens per liter, with the mean value of <40 ind L^{-1}. Vertical distribution of tintinnids abundance coincided well with chl-a concentration (for details in Li *et al*., 2012), with the mean cell-density gradually increased from surface to DCM layer (except B2), then sharply decreased to the 200 m layers (**Fig. 2**).

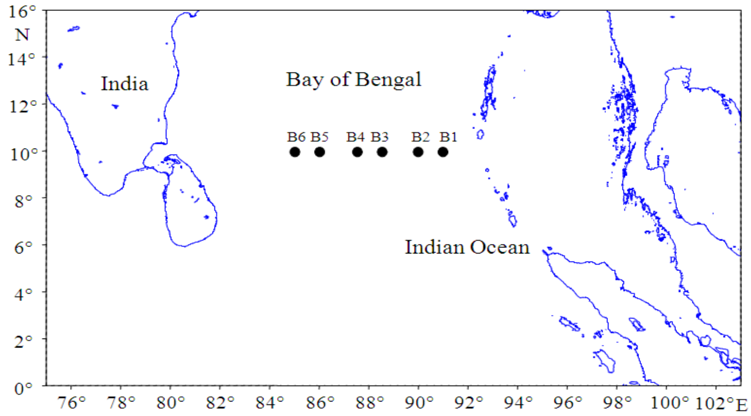

Fig. 1. Location of sampling site in the Bay of Bengal

Table 1. Tintinids species encountered in Bay of Bengal, *Common species (>10% total cells)

Depth/m	B1	B2	B3	B4	B5	B6
0	*Marshallia aperta,* *Undella ostenfedi**	*Craterella retusa*	nd	*Eutintinnus stramentus* *Steenstrupiella gracilis*	*Eutintinnus fraknoii**	*Tintinnopsis schotti*
25	*Stenosemella inflate* *Eutintinnus stramentus* *Marshallia aperta*	nd	*Undella ostenfedi**	*Steenstrupiella gracilis* *Undella ostenfedi**	*Eutintinnus fraknoii** *Marshallia aperta* *Rhabdonella sanyahensis*	*Undella ostenfedi**
50	*Dadayiella ganymedes* *Eutintinnus fraknoii**	nd	*Amphorella quadrilineata* *Undella ostenfedi*	*Eutintinnus fraknoii** *Undella ostenfedi**	*Amphorella quadrilineata* *Epirhabdonella niei* *Proplectella claparedei* *Undella ostenfedi*	*Amphorella quadrilineata* *Undella ostenfedi**
75	*Eutintinnus fraknoii** *Amphorella quadrilineata* *Proplectella claparedei* *Stenosemella inflata*	*Dictyocysta reticulata* *Salpingella minutissima* *Salpingella minutissima*	*Eutintinnus fraknoii**	*Ormosella bresslaui* *Salpingella attenuata*	*Amphorella quadrilineata* *Eutintinnus fraknoii** *Proplectella claparedei*	*Salpingella attenuata* *Salpingella cuneolata* *Ormosella bresslaui*
100	nd	*Salpingella minutissima*	nd	nd	nd	*Salpingella cuneolata* *Xystonellopsis heroica*
150	*Eutintinnus stramentus* *Eutintinnus* sp.	*Eutintinnus stramentus* *Eutintinnus* sp.	nd	nd	*Salpingella attenuata*	nd
200	*Eutintinnus stramentus* *Eutintinnus* sp.	nd	nd	*Steenstrupiella gracilis*	nd	nd

nd: no detected

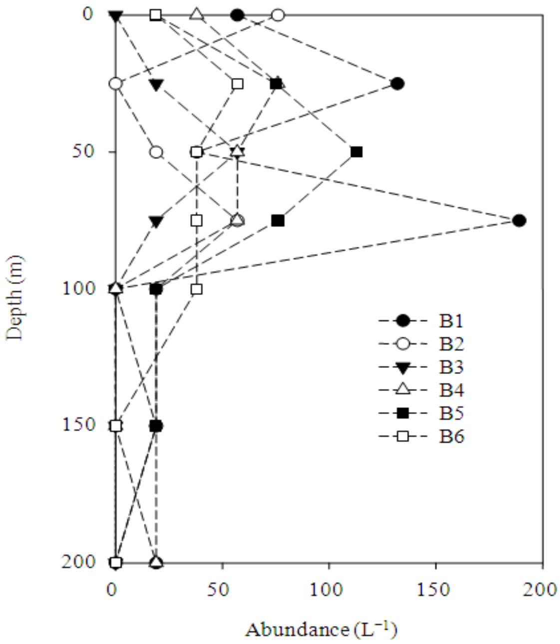

Fig. 2. Vertical distribution tintinnids abundance (ind L^{-1})

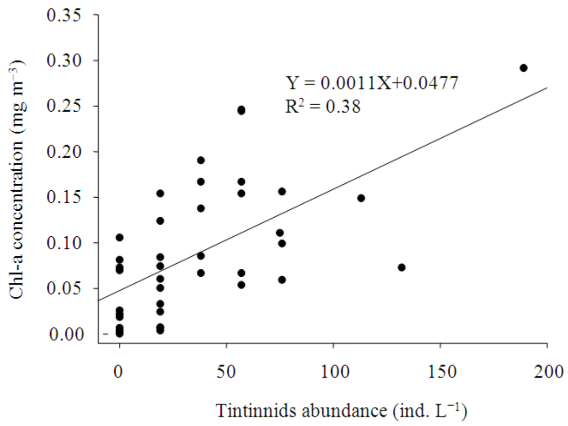

Fig. 3. Correlation between tintinnids abundance (ind. L^{-1}) and Chl-a concentration (mg m^{-3}) in the BoB

Dominate species showed an obvious spatial difference in the BoB, with *Undella ostenfedii* found at most site expcept B2, followed by *Eutintinnus fraknoii* and *Amphorella quadrilineata*. Tintinnids community structure changed site by site, with *Tintinnopsis schotti* dominated the community at B1, *E. fraknoii* at B2, *E. fraknoii* and *Proplectella claparedei* at B5 and *U. ostenfedii* at B6. In particular the tintinnids abundance positively correlated to chl-a concentration ($P<0.01$) at each sampling layer (**Fig. 3**).

4. DISCUSSION

The activities of tintinnids such as grazing or excretion are probably much less important than those of the naked oligotrich taxa in marine ecosystems, since they merely account for low proportion (<10% of cell numbers or biomass) of the ciliate community (Dolan and Marrase, 1995; Dolan, 2000). Furthermore, the tintinnids may play a relatively minor role in e.g., carbon flux or nutrient regeneration; however, they are ideal organisms (easily be detected) to mark the changes in species structure or community of microzooplankton (Thompson *et al*., 1999; Dolan, 2000). Krsinic and Grbec (2006) thus suggested that ingression of water masses from the Ionian Sea and formation of cyclonic gyre was important in determining the horizontal distributions of tintinnids in the south Adriatic. In this study, tintinnids abundance and integrated Chl-a concentration at B1 was higher than B2. Nevertheless, B1 (low temperature and high salinity) and B2 (high temperature and low salinity) showed differential environment characters (Li *et al*., 2012). Different environments resulted in different tintinnids compositions, in turns, indicated the responses of that the tintinnids to the environmental changes.

Chl-a concentrations and primary productivity values were low in present study (Li *et al*., 2012; Liu *et al*., 2011), as a consequence, tintinnids abundance was relative low (**Fig. 2**). Due to the weaker wind force and relative warmer climate that depress the exchanges of the nutritious deeper water with the surface water, the BoB is considered as a region of low biological productivity (Gomes *et al*., 2000; Kumar *et al*., 2002; 2007).

Dolan *et al*. (2002) postulated that the tintinnids diversity reflected the resource diversity more closely than the competitive interactions or predation. The abundance of tintinnids positively correlated to chl-a concentration in present study, this could be explained by their feeding on phytoplankton (especially pico and nanophytoplankton), indicated the phytoplankton biomass regulated the ciliates abundance in the BoB.

5. CONCLUSION

Surface tintinnids abundance was only a few tens per liter and the mean cell-density gradually increased from surface to DCM layer (except B2), then sharply decreased to the 200 m layers. *Undella ostenfedii* was the dominate species at most site in the BoB. Tintinnids abundance was positively correlated to chlorophyll a concentration, indicating the vertical distribution of the tintinnids community was regulated by available food resource.

6. ACKNOWLEDGMENT

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