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The Assemblages of Benthic Foraminifera In The Muddy and Sandy Sediments of Andaman Islands

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ABSTRACT

Six core sediments and two surface sediments from seven locations were studied to understand the assemblages of benthic foraminifera in the mangrove muddy and adjacent sandy sediments from the Andaman Islands. Twenty eight species had been identified from these environments. Out of twenty eight species, fourteen species are calcareous forms and rest of fourteen species belongs to agglutinated forms. All these sandy sediments highly subjected with the calcareous species while the mangrove fine sediments were showed predominant assemblages of agglutinated forms. Furthermore, the association of *Elphidium advenum* of calcareous hyaline form with the mangrove agglutinated species was considered a significant because of its high resistant to organic carbon environment. Similarly, *Trochammina inflata,* the agglutinated form in the sandy environment suggested that it may be due to the transport history or paleo environmental condition of high organic nature. So, the species *Elphidium advenum* and *Trochammina inflata* may be considered as a specific indicator for environmental significance.

Key Words: Benthic Foraminifera; mangrove; sandy; fine sediment; agglutinated; calcareous; Port Blair; Andaman Islands, India.

INTRODUCTION

The tropical and sub-tropical intertidal environment exhibited high amount of mangroves which are salt tolerant forest ecosystem. This system complemented with benthic organism for its dynamic nature (Mohan et al., 2012). This system mainly covers muddy and silty size sediments. The particulate organic matter or the detritus derived from decomposition of litter fall has prime source for nutrient in this environment (Sidhu, 1963; Mathew, et al., 2005). The natural disturbances also affect repeatedly this eco system (Vidya and Patil, 2014). Similarly, the major intertidal environment noticed in the tropical and subtropical environment has sand sediments. In these two major intertidal environments, a single celled amoeboid rhizopodial protozoa called as foraminifera lived in planktonic and benthic forms. These foraminifera tests are made up of organic walled, agglutinated and calcareous materials. Organic walled mainly represented freshwater, agglutinated represented intermittence water and calcareous forms mainly in marine environment (Phleger and Parker, 1951; Bandy, 1953; Horton et al., 1999; 2003; Makled and Langer, 2010). Most of these studies on this group have been concerned with fossillised forms with reference to paleo-environment, paleo-oceanography and related fields. In general, the studies on the present environmental conditions that also with reference to Andaman and Nicobar Islands is very limited or nil. In these circumstances, an attempt was made to delineate the relationship between foraminifera and Andaman mangrove muddy and sandy environments.

Fig.1. Location of the Study Area in South Andaman

METHODOLOGY

Seven locations were selected as study area from the South to Middle Andaman environments (Fig.1 and 2). Those are Chidiyatappu, Barmanalla, Carbyns Cove, Sippighat, Baratang, Parrot Island and Mayabunder. The location Chidiyatappu is present in the eastern tip of South Andaman. This is a rocky coast with sandy environment. However, the mangroves presence are very much significance in this surrounding environment. Burmanallah is a rocky coast situated in the eastern side of the South Andaman. Mangroves are identified in between the freshwater streams connected to coastal environments. This part of the coasts is small patch of the mud and sandy covers on the rocky outcrops. Carbyns Cove is a sandy beach environment located in South Andaman. Nearby this beach a freshwater runoff joins and provides its banks a muddy deposit. Other than the small strips of the sandy beach all other side covers with rocky coast. The Sippighat is newly formed intertidal environment in South Andaman. This environment formed after 2004 mega earthquake subsidence occurred. This mudflat environment surrounded with good mangrove plants along with dead mangroves. The high tidal fluctuation has been observed in this part. Baratang Island located at southern tip of the Middle Andaman. The specialty of this Island is Mud Volcano and the samples collected in the mud flat environment and the mangrove vegetation here is very lush. Parrot Island is situated western side of Baratang Island in the southern end of Middle Andaman. This Island is very famous for the parrot which will stays more than thousand numbers on the mangrove trees. This is the Island has no human intervention and uninhibited Island. The coast of this Island covered by mangroves and the sediment character of this Island's eastern side is muddy layer covered on the rocky bottom and the western side exhibited a little elevated sandy sediment on reef bottom. These sediments covers with little vegetation of sea weeds and corals were also noticed. Since the hard bottom and thin veneer of sediment nature of this location was not permitted to collect core sediment for 10 cm. So, two surface sediments were collected from eastern and western side of the island. Mayabunder is a

Head Quarters of Middle and North Andaman District. It has surrounded by muddy as well rocky coast. However, a few pockets of sandy deposit also noticed. Mangrove forest is also covered these muddy and rocky coast and the sampling site is a sheltered bay with mangrove patch.

The sediments were collected from the above stations by using 5 cm diameter plastic tube inserted into the sediments up to possible depths (maximum 12 cm). The collected core samples as such as marked and covered with plastic sheets in both the sides and kept in the ice box to maintain the freshness of the sediments. Once it reached to the laboratory, the sediments were cut into 5 cm interval and then half of the samples were preserved and the remaining half of the samples were used for further activities. The sediments used for the analysis were further divided into two half and one part used for the foraminiferal identification and the other half was used for the soil texture, organic carbon and carbonate analysis. The samples used for the foraminiferal study were sieved in 500 to 63 micron ASTM sieves and then the sieved sediments were observed under the Nikon Binocular Microscope for the identification and enumeration of foraminifera. The species identification was carried out based on keys of Chapman (1895), Leoblich and tappan (1989) and Hofker (1972 a, b). All the foraminiferal tests were collected from the samples due to less density of foram availability.

RESULTS AND DISCUSSION

Twenty eight species were identified among the studied location with different proportions (Plate 1 and 2). Out of these species fourteen were belong to agglutinated and rest were calcareous forms (Table 1). On the surface samples all the twenty eight species were represented and in 05-10m depth only twenty one species were represented (Table 2). Among the absentees one species belongs to calcareous form and the remaining six species belong to agglutinated forms. Another interesting fact was identified in this study i.e. the agglutinated forms were available only in the fine mangrove sediments (Table 3) and calcareous forms only available in sandy intertidal environment, except one species. Among the five missing agglutinated forms at 05-10m depth samples from fine mangrove sediments were highly proliferated in the surface environment. The remaining one was less proliferated. In the case of missing calcareous species it was available only one station in the surface and the same missing in the 05-10m depth.

Out of fourteen agglutinated species six species were dominated in these environments they were *Ammobaculites agglutinans, Ammobaculites exiguus, Ammotium fragile, Miliammina fusca, Textularia earlandi* and *Trochammina inflata*. Similarly, in the case of calcareous forms, nine species were dominant viz., *Ammonia beccarii, Amphisorus hemprichii, Calcarina spp., Elphidium craticulatum, Elphidium crispum, Elphidium discoidale, Peneroplis pertusus, Planarbulina mediterraneans* and *Rosalina globularis*.

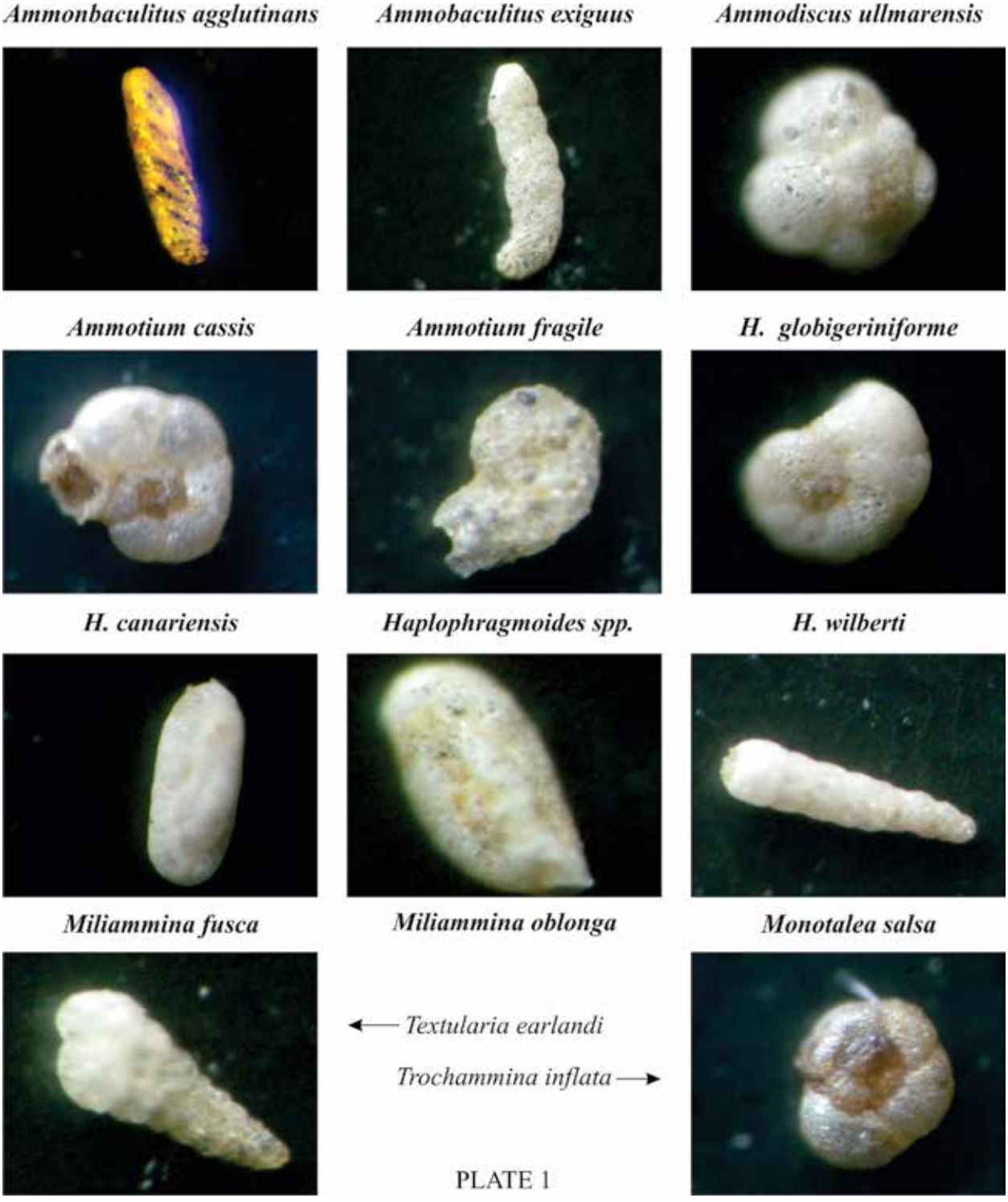
Ammonbaculitus agglutinans
Ammobaculitus exiguus
Ammodiscus ullmarensis
Ammotium cassis
Ammotium fragile
H. globigeriniforme
H. canariensis
Haplophragmoides spp.
H. wilberti
Miliammina fusca
Miliammina oblonga
Monotalea salsa
Textularia earlandi
Trochammina inflata

PLATE 1

Ammonia beccarii *Amphisorus hemprichii* *Calcarina spp*

Elphidium advenum *Elphidium craticulatum* *Elphidium crispum*

Elphidum discoidale *Hauerina spp* *Neoconorbina spp*

Peneroplis pertusus *Planrbulina mediterraneans* *Rectobolivina raphanus*

Rosalina globularis

Spiroloculina spp

PLATE 2

Table 1. The foraminiferal distribution in the surface sediment (0-5cm) of the study area

	Mayabunder	Parrot Island - East	Parrot Island - West	Baratang	Sippighat	Carbyns Cove	Burmanalla	Chidiyatappu
Ammonia beccarii	23.88	16.23				22.55	9.15	9.26
Amphisorus hemprichii		7.79				4.9	9.86	19.44
Ammonbaculites agglutinans			3.47	16.39				
Ammodiscus gullmarensis			2.78		7.27			
Ammobaculitus exiguus			4.17	11.48				
Ammotium cassis					18.18			
Ammotium fragile			17.36	9.84				
Calcarina spp.		5.19					23.94	15.74
Elphidium advenum								2.78
Elphidium craticulatum	14.93	32.47				24.51	2.11	6.48
Elphidium crispum	8.96	3.25				11.76		6.48
Elphidum discoidale	52.24	12.99					11.97	2.78
Haplophragmoides canariensis			9.72		6.36			
Haplophragmoides spp.			9.72	9.84	9.09			
Haplophragmium globigeriniforme			7.64		8.18			
Haplophragmoides wilberti			4.86		5.46			
Hauerina spp.						3.92		
Monotalea salsa					4.55			
Miliammina fusca			7.64	13.11	13.64			
Miliammina oblonga			1.39		4.64			
Neoconorbina spp.		1.95				1.96		
Peneroplis pertusus						17.65	21.13	27.78
Planarbulina mediterraneans		9.74				9.8	10.56	
Rectobolivina raphanus		4.55						
Rosalina globularis		5.84				2.94	11.27	6.48
Spiroloculina spp.								2.78
Textularia earlandi			24.31	11.48				
Trochammina inflata			6.94	27.87	23.64			
Total Number of Species available	04	10	12	07	10	09	08	10

Table 2. The foraminiferal distribution in the sediment (05-10cm) of the study area

	Mayabunder	Parrot Island - East	Parrot Island - West	Baratang	Sippighat	Carbyns Cove	Burmanalla	Chidiyatappu
Ammonia beccarii	---					38.83		18.92
Amphisorus hemprichii	---					5.82	9.26	
Ammonbaculites agglutinans	---				12.05			
Ammodiscus gullmarensis	---				7.23			
Ammobaculitus exiguus	---							
Ammotium cassis	---							
Ammotium fragile	---			38.63	30.12			
Calcarina spp.	---					4.85	18.52	
Elphidium advenum	---			15.91				
Elphidium craticulatum	---					5.83	31.48	40.54
Elphidium crispum	28.5					5.83	16.67	10.81
Elphidum discoidale	71.4					10.68		
Haplophragmoides canariensis	---			9.09	9.64			
Haplophragmoides spp.	---							
Haplophragmium globigeriniforme	---			14.46				
Haplophragmoides wilberti	---				8.43			
Hauerina spp.	---							
Monotalea salsa	---			11.36				
Miliammina fusca	---							
Miliammina oblonga	---							
Peneroplis pertusus	---					7.77	11.11	
Planarbulina mediterraneans	---					2.91		
Neoconorbina spp.	---					1.94		13.51
Rectobolivina raphanus	---					5.83		
Rosalina globularis	---					1.94	12.96	
Spiroloculina spp.	---					7.77		
Textularia earlandi	---							
Trochammina inflata	---			25	18.07			16.22
Total Number of Species available	02	---	---	05+01	06	12	07	03+01

Table 3. Distribution of Organic Carbon, Carbonate and Sediment Character

	Surface (0-5cm)			05-10cm		
	Organic Carbon %	Carbonate %	Sediment	Organic Carbon %	Carbonate %	Sediment
Maybunder	0.2	07	Siltysand	1.4	04	Siltysand
Parrot -E	0.7	07	Sand	---	---	---
Parrot -W	6.8	03	Clayeysilt	---	---	---
Baratang	7.0	03	Slityclay	2.7	04	Slityclay
Sippighat	3.6	03	Mud	2.5	03	Mud
CarbynsCove	0.6	06	Sand	2.6	07	Sand
Burmanalla	0.3	19	Sand	1.0	21	Sand
Chidiyatapu	0.4	17	Sand	0.8	24	Sand

Among the sandy environment surface samples suggested that Parrot Island –East and Chidiyatappu consists of high diversity i.e. 10 species and Mayabunder stated that least diversified i.e. only four samples. Similarly, in the case of fine sediment mangrove environment suggested that Parrot Island – West followed by Sippighat and Baratang stations, respectively, distributed twelve, ten and seven species. The 05-10m depth samples suggested for sandy sediments the Carbyns Cove exhibited highest diversity i.e. 12 species and least noticed in Mayabunder i.e. 2 species only. The fine sediment suggested that Sippighat followed by Baratang locations, respectively, 6 and 4 species. However, the interesting noticed in this depth fine sediment has calcareous species (*Elphidium advenum*) and sandy one reported with agglutinated form (*Trochammina inflata*).

The organic carbon concentration in the fine surface sediments suggested that 3.6 %, 6.8% and 7.0% in the descending order from the stations Sippighat, Parrot Island –West and Baratang (Table 3). The sandy surface sediments reported that the organic carbon presented in the range of 0.2% to 0.7% . The 05 to 10m depth samples suggested that 2.5% to 2.7% for fine sediment and sandy sediment exhibited 0.8% to 2.6%. The carbonate concentration for these studied environment suggested that the sandy environment has high carbonate concentration (6% to 24%) and fine sedimentary environment suggested that comparatively low carbonate concentration (3% to 4%).

Based on the above results it can be easily understood the two biofacies of foraminiferan noticed in the study area. The agglutinated form which were available only in the fine mangrove environment to be considered as one of the biofacies. The next biofacies belongs to calcareous form which was available only from the sandy environment. The agglutinated forms stand alone environment suggested that due to high organic carbon (3.6 to 7.0%) availability may not permit to survival of calcareous forms and the same way the less organic carbon (0.2 to 0.7 %) environment not permitted to survival of agglutinated forms. This inference was not exactly matching with the 05 to 10m depth samples which exhibited one station in fine sediment and sandy environment, respectively, i.e. station Baratang for fine sediment exhibited one calcareous species *Elphidium advenum* and similarly in the sandy environment the station Chidiyatappu exhibited one agglutinated species *Trochammina inflata*. These species availability indicate that probably the calcareous species *Elphidium advenum* can survive in moderate organic carbon environment or it may be sandy environment in the past. Similarly, the agglutinated forms availability in the Chidiyatappu stations suggested that the agglutinated form availability in deep may be transported from nearby fine sediment environment or this species may be able to survive in this sandy environmental condition.

Ammonia beccarii has been available in all the types of intertidal and sub-tidal environment along with wide range of dissolved oxygen availability (Moodley

and Hess, 1992; Alve and Murray, 1999). Similarly, the species *Elphidium crispum* also noticed in cosmopolitan environment (Narayan and Pandolfi, 2010). *Planarbulina mediterranenas* mainly associated with *Thalassia* leaves and *Posidonia oceanica* (Wilson and Ramsook, 2007; Vicens et al., 2011). The studied locations were represented those above plants and species. The genus *calcarina* and *Peneroplis* represented the reefoidal environment which has been matched with the present studied environment (Schueth and Frank, 2008; Natsir and Subkhan, 2011). Wang and Chappel (2001) and Hussain et al., (2006) reported that the calcareous forms which were normally noticed from the high dynamic environment also support the present finding in these study area. Gregory (1973), Horton et al. (2005), Berkeley et al. (2009), Goineau et al. (2010), Haynert et al. (2012) and Sathyanarayana (2014) were reported that the mangrove environment, high organic matter sediment and high CO_2 environment were the most suitable place for the agglutinated forms of the foraminifera proliferation and the same was observed in the present studied environment.

CONCLUSION

Benthic foraminifera have the potential to operate as proxies of environmental factors such as chemical and biological factors. The present study confirms these by the way of agglutinated form represented exclusively the fine, organic carbon enriched and carbonate depleted environment. Similarly, calcareous forms available in the sandy, organic poor, carbonate enriched and high dynamic environment. Over and above, the species like *Elphidium advenum* and *Trochammina inflata* may also indicate that the paleo status of their environmental conditions because of its high resistivity for chemical and transport capability in the new environment.

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