



ISSN: 0975-833X

RESEARCH ARTICLE

Abnormal growth of Benthic Foraminifera of Inter Generic individuals and Microboring indicating environmental stress in Portblair, India

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ARTICLE INFO

Article History:

Received 29<sup>th</sup> November, 2012  
Received in revised form  
16<sup>th</sup> December, 2012  
Accepted 22<sup>th</sup> January, 2013  
Published online 14<sup>th</sup> February, 2013

Key words:

Micro boring, Benthic foraminifera,  
Energy-Dispersive X-ray spectroscopy  
(EDAX EDS) and Intergeneric individuals.

ABSTRACT

Foraminifer a single shelled protozoan whose high level taxonomical studies are based on shell mineralogy can be categorized into four groups as taxa with organic shell, agglutinated taxa, calcareous perforate taxa and calcareous imperforate and habituating in marine and mangrove environments. For the present study benthic foraminifer fauna has been collected in the Van veen grab sampler in the Sosistris Bay, North Bay, Aberdeen jetty, Chidyatapu, and Wandoor of Port Blair India. To study the Shell abnormalities such as stunted foraminifera shells, abnormal wall structures and shell deformation, mineralogical projection, micro borings, pitted surface, calcification anomalies, dissolution and shell deformation in foraminifera the light microscopic SEM and EDAX studies are carried out. The basic finding of the study reveals that shell abnormalities are common in foraminifera species.

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INTRODUCTION

Micro boring is a strictly benthic activity which afflicts the carbon particles after they have settled at the sediment water interfaces. Endolithic micro-organisms (or microendoliths) are boring the foraminifers, algae and fungi and they produce boreholes less than 100 µm wide that correspond in most samples exactly with the outline of the boring organism. They mainly colonize calcareous substrates (such as shells and skeletons or stromatolites and ooids or hard grounds), more rarely also siliceous or phosphatic substrates these phenomena is called as micro boring. The mechanisms used by micro bores to penetrate into carbonate substrates (production of acids or chelating fluids; use of the products of photosynthesis / respiration and / or calcium pumps), their roles in reef bio erosion and sedimentation (major roles), their metabolism (important rates of production), their interactions with their live hosts (symbiosis, mutualism and / or parasitism) and the effects of various environmental factors such as eutrophication, sedimentation and rising atmospheric pCO<sub>2</sub> on micro boring activities. The abnormal peneroplids described herein may have formed by fusion of gametes from intergeneric individuals. The gametes of *P. pertusus* and *P. planatus* could have been combined with those of *Coscinospira. Hemprichii* (Jan Kresten Nielsen *et al* 2008).

Study Area

St.1-North Bay (15m depth), St.2-Aberdeen Bay (25 m depth), St.3-Sosistris Bay (10 m depth), St.4- Chidyatapu beach (11m depth)and St.5- Wandoor beach (12 m depth). MGMNP- Mahatma Gandhi Marine National Park.

MATERIALSAND METHODS

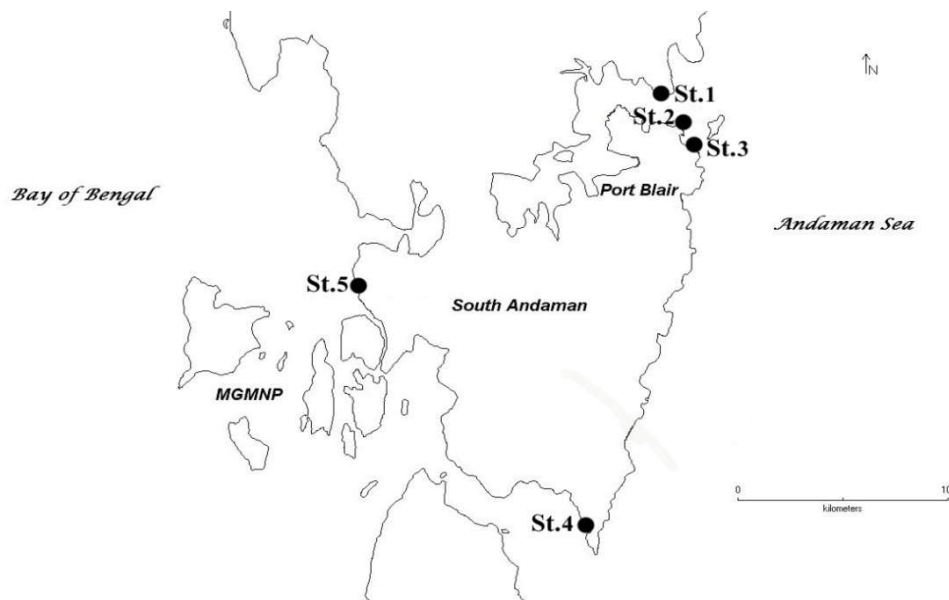
To study the common stress response of reef dwelling foraminiferal assemblages to the natural and human induced disturbances such as

temperature, sedimentation, inorganic nutrients and solar radiation samples were collected from the reefs in the North Bay (15m depth) Aberdeen Bay (25 m depth) Sosistris Bay (10 m depth) in Andaman Sea, and Wandoor beach (12 m depth) and Chidyatapu beach (11m depth) in Bay of Bengal South Andaman, India. Samples were collected through Van veen grab sampler subsequently treated with Rose Bengal dye to distinguish living and deceased species. Specimens were collected by hand after sieving and drying of the sediment samples, and preserved in paleontological slides. Using Stereoscopic Binocular Microscope (Nikon – SMZ1500) microscope, species were identified and taken photographs. FEI Quanta 200 Environmental Scanning Electron Microscope (ESEM) with Energy-Dispersive X-ray Spectroscopy (EDAX EDS) system was used to study the variety of anomalous ultra features and chemical characteristic of foraminiferal species. In this system The EDAX is attached with SEM that enables to analysis the elemental composition and also the ultra structure of the foraminiferal samples. For that specimens were rinsed in deionised water and air dried on paleontological slides. Then the species were mounted on aluminium SEM stubs using double-sided adhesive tabs. In this study the characteristic of an element with atomic structure is identified uniquely from one another in the form in the form of EDX spectrum along with ultra structures of the same species. After scrutinize the foraminiferal species through light microscope, species comes under the order Miliolida, Bulimida and Rotaliida. The species selected for SEM such as *Peneroplis cylindraceus*, *Spirolina arietinus*, *Peneroplis planatus*, *Quinqueloculina pulchella*, *Calcarina spengleri*, *Quinqueloculina intricate* and *Elphidium crispum*

RESULTS

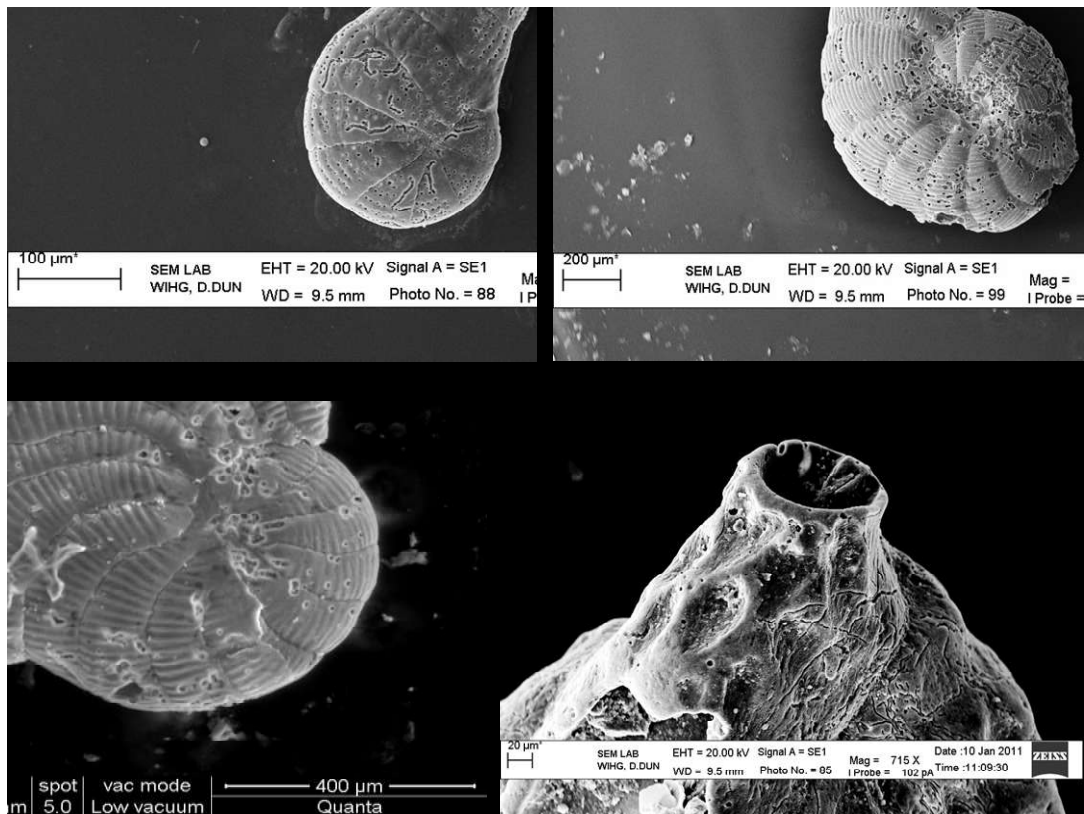
Micro boring is a process done by endolithic micro-organisms that boring the benthic foraminifers such as *Spirolina arietinus* (Batsch), *Calcarina spengleri* (Gmelin), *Quinqueloculina pulchella*, *Peneroplis cylindraceus*(Lamarck), and *Peneroplis planatus* (Fichtel and Moll) and these endolithic microorganisms produce borehole

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Study Area

Plate 1.

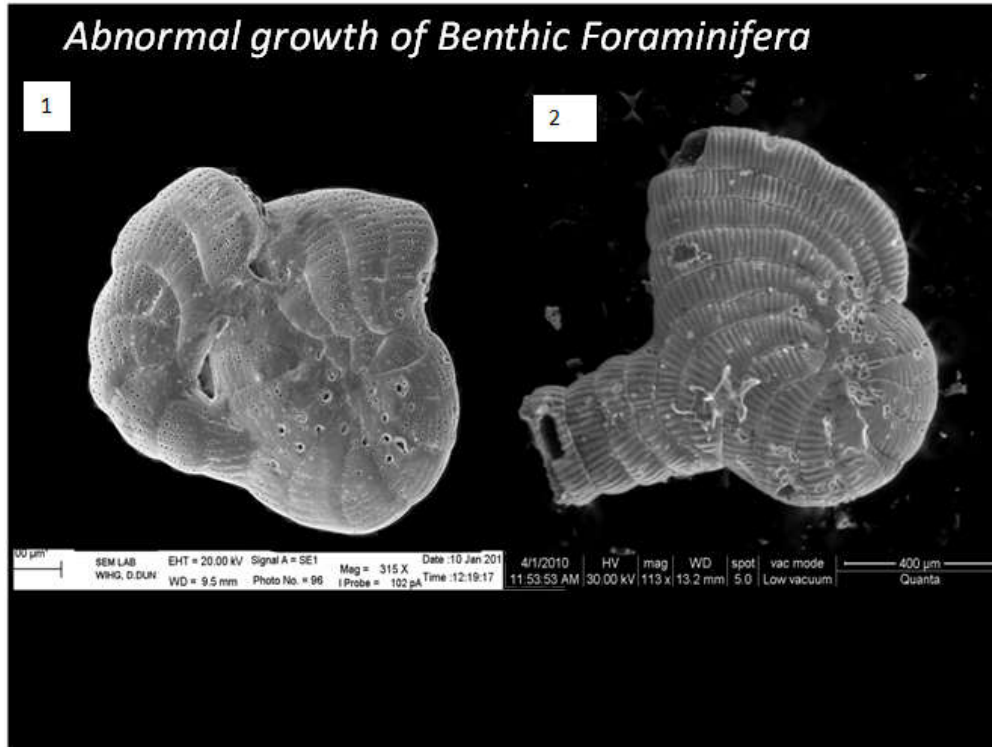


1. Microbial boring of *Peneroplis cylindraceus*(Lamark), 2. Microbial boring of *Quinqueloculina intricata*, 3. Microbial boring of *Spirolina arietinus* (Batsch), 4. Microbial boring of *Quinqueloculina pulchella* and 5. Microbial boring of *Peneroplis planatus* (Fichtel and Moll).

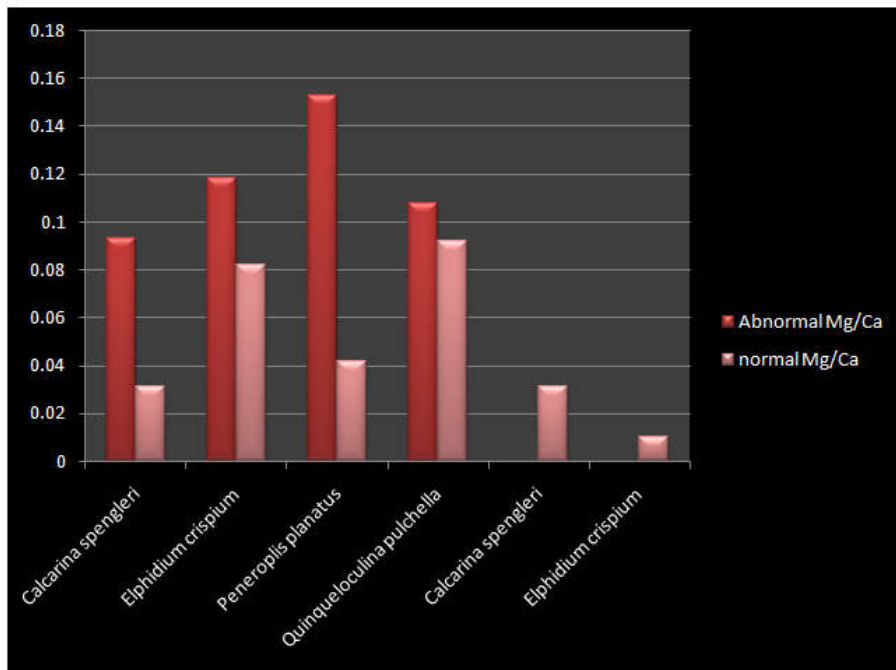
less than 100µm the wide that correspond in most samples exactly with the outline of the boring organisms. Micro borings are straight, curved and formed dense networks with dendritic appearance. The endolithic micro- organisms colonize the calcareous, siliceous and phosphatic substrate. In *Peneroplis cylindraceus* the boring features were straight, cured and they are randomly distributed. The length of boring is ranging from 46.87µm to 21.87µm and the width of the boring is same it is 3.1 µm. In *Peneroplis planatus* the boring features were long, coiled and they are thickly distributed. The length of boring is ranging from 188µm to 62.5 µm and the width of the boring is ranging from 60µm to 6.25µm. *Spirolina arietinus* the

boring features were short, cured and they are densely distributed. The length of boring is ranging from 60µm to 100µm and the width of the boring is same it is 20 µm. *Quinqueloculina pulchella* the boring features were long, cured and they are randomly distributed. The length of boring is ranging from 29µm to 105µm and the width of the boring is same it is 2.8 µm. In *Spirolina arietinus* the boring features were straight, cured and they are randomly Adistributed. The length of boring is ranging from 267µm to 133µm and the width of the boring is ranging from 13 µm to 27 µm. *Calcarina spengleri* the boring features were straight, cured and they are randomly distributed. The length of boring is 54µm and the width of the boring

Plate 2.



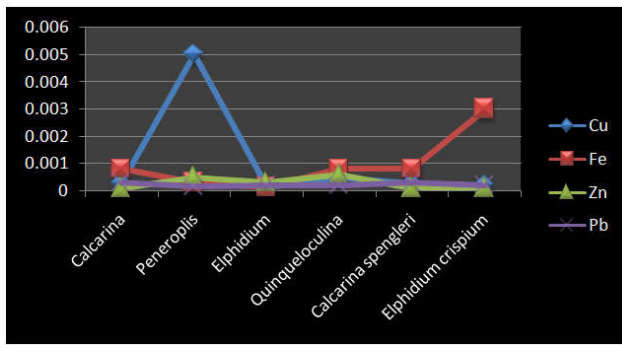
1- The fusion of gametes from intergeneric individuals of *peneroplis pertusus* and *Coscinospira hemprichii*,  
 2- The fusion of gametes from intergeneric individuals of *Peneroplis planatus* and *Coscinospira hemprichii*.



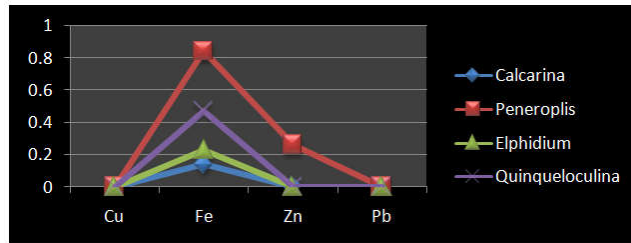
Mg/Ca Ratio (ppt)

is 3 µm. *Quinqueloculina intricate* the boring features were straight cured and they are randomly distributed. The length of boring is ranging from 200µm to 120 µm and the width of the boring is 8 µm. Surface pits are the abnormal features were occurred in *Spirolina arietinus*, *Peneroplis planatus*, Some pits were as small as 25 µm and circular in shape with ragged edges. Others looked like sink holes on the surface of the shells, and when they coalesced into large pockmarks 100µm a crumbly appearance was evident. Pitting was often found in combination with dissolution giving a smooth polished look to the pits abnormal features.

Profoundly deformed is one of the abnormal features were occurred in *Spirolina arietinus*, *Peneroplis pertusus*, *Peneroplis planatus* a *Elphidium crispum*, and individuals were highly variable in appearance. The abnormal peneroplids described herein may have formed by fusion of gametes from intergeneric individuals. The gametes of *P. pertusus* and *P. planatus* could have been combined with those of *Coscinospira hemprichii* (Jan Kresten Nielsen *et al* 2008). They had no planispiral characteristics what so ever and possessed obscured apertures. They were often spheroid in shape. Uncoiled is the abnormal features were occurred in *Peneroplis pertusus*, *Elphidium crispum*, were characterized by a normal



Heavy metal composition of Normal foraminifers (ppt)



Heavy metal composition of abnormal foraminifers (ppt)

juvenile portion of the shell. However as rows of chamber lets were added, the involute characteristics were lost and the individuals looked long, slender, and uncoiled. The multiple deformities is more than one abnormal features occur in single species is such as Micro boring, pitted surface, profoundly deforms are occur in the *Peneroplis planatus*. In *Spirolina arietinus* Micro boring and pitted surface are occur. In *Peneroplis pertusus* Micro boring, profoundly deforms and uncoiled are observed. So these species is considered as multiple deformities. Shell construction in the Miliolida appears to be particularly sensitive to environmental influences. Symbiont-bearing miliolids, such as *Peneroplis pertusus* and *Peneroplis. planatus*, exhibited an uncoiled chamber arrangement, reduction in the size of the last chamber, and protuberances [1]. Smaller miliolids from their study site exhibited multiple apertures, a change in the direction of the axis of coiling, and lateral asymmetry of apertural position. [2]. also documented a similar variety of morphological deformities among miliolids, including *Peneroplis. planatus*. Other studies looking specifically at heavy metal contamination noted stunt foraminiferal shells [3]. as well as low abundance and diversity [4]. Described abnormal wall structures and shell deformation in *Ammonia* due to heavy metal contamination. The "crystal disorganization" they described may have been the result of alien elements, such as Cu and Zn, being introduced into the crystalline framework [5]. The elemental analysis such as Mg/Ca ratio and heavy metal composition in abnormal foraminifer were carried out by EDAX analysis. SEM ultra structures shows that the *Peneroplis. Planatus* and *Spirolina arietinus* species having multiple abnormal features such as micro boring pitted surface and profoundly deforms. In Mg/Ca ratio of abnormal *Peneroplis planatus* is 0.153 shows the higher concentration than other species.

In EDAX analysis shows that heavy metals composition he are the maximum of Fe is 0.8 and Zn is 0.2 are present in the *peneroplis planatus*.

## Conclusion

The abnormal peneroplids described herein may have formed by fusion of gametes from intergeneric individuals. The gametes of *P. pertusus* and *P. planatus* could have been combined with those of *Coscinospira hemprichii*. *Peneroplis planatus*, *Peneroplis arietinus*, *Peneroplis cylindraceus* Features typically considered taphonomic included microborings, pitted surfaces, and growth abnormality evidence of shell repair was also documented. The elemental composition of the abnormal forams the mg/ca and heavy metal composition is higher than elemental composition of normal forams. So I conclude that forams in occurrence of such features may indicate that the environmental stress.

## Acknowledgment

Authors are thankful to the Head of the Department, Disaster Management, Pondicherry University, and Port Blair for providing facilities and permission accorded by Vice-chancellor of Pondicherry University Prof. J. A. K. Tareen, Director, Dean and Registrar for constant encouragement and support.

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