Variation in the Distribution of Benthic Foraminifera from the Chandipur Beach during Low and High Tide

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Abstract: The variation in the distribution of the benthic foraminifera from the Chandipur Beach on the eastern coast of India has been determined during low and high tides. Of the seven benthic foraminiferal species encountered, two species, *Ammonia beccarii* and *Asterorotalia trispinosa* were the most dominant forms. The abundance of *Asterorotalia trispinosa* showed significant reduction during the low tide, showing a preference for the sandy bottoms during the low tide.

Key words: Benthic foraminifera, Chandipur Beach, *Ammonia beccarii* and *Asterorotalia trispinosa*

Introduction:

Foraminifera, an order of single-celled protozoa, predominantly inhabit marine environments, either as part of the benthic community or within the marine plankton. Foraminiferal tests are abundantly dispersed, comprising a substantial portion of marine biomass. Benthic foraminifera exhibit a heightened sensitivity to alterations in a broad spectrum of environmental parameters. Even minor fluctuations in these factors can precipitate changes in species composition and the overall structure of living populations, underscoring the pivotal roles these microorganisms play in environmental monitoring. The present study aims to study the variation in the distribution patterns of the benthic foraminifera in the Chandipur beach sediments. Chandipur is home to a diverse benthic faunal assemblage, dominated by ostracods and benthic foraminifera (Kathal, 2002). Among the benthic foraminifera, species like *Ammonia beccarii*, *Ammonia dentataz Asterorotalia trispinosa*, *Haplophragmoides sp., Haynesina depressula*, and *Quinqueloculina seminulum* are abundant, with the tidal flat serving as their primary habitat.

Study Area:

The study area (21° 44’ N and 87° 04’E) is located on the Chandipur Beach (figure1) along the eastern coast of India in the state of Odisha. Chandipur Beach is renowned for its unique tidal activity, where the water recedes up to 5 kilometers during low tide, revealing a vast expanse of sandy shoreline. This extraordinary phenomenon is primarily attributed to the interplay of the Bay of Bengal's monsoon winds and the Earth's rotational forces.

The Chandipur Beach is impacted by semidiurnal tidal pattern, which shows two high and two low tides of equal heights daily.

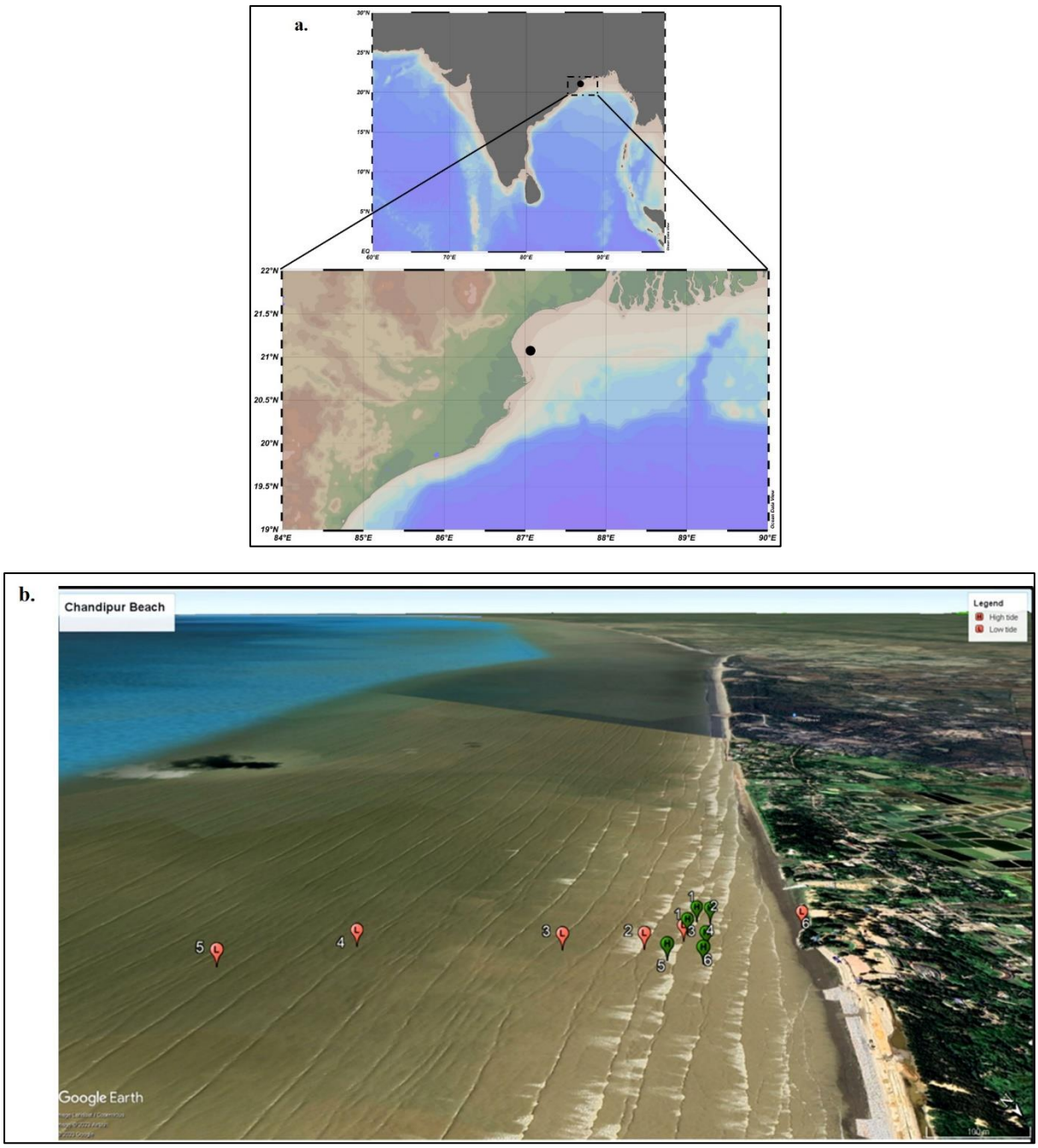

Figure 1. Study area: a. location of the study area on the Chandipur Beach; b. location of the site from where the samples were collected. Green colour is used to show the sites of sample collection during high tide and red colour marks the sites during low tide. The map is prepared using the Ocean Data View software (Schlitzer, 2022) and the sample locations are plotted using the coordinates from Google Earth.

Material and Methods:

The coastal region of Chandipur exhibits significant geomorphological diversity, including a narrow siliciclastic beach, an extensive tidal flat, an estuary, and a marsh situated behind a coast-parallel sandbar. The tidal flat, characterized by its soft substrate, retains a thin layer of water even during low tide, facilitating the presence of marine organisms (Mondal et al., 2010;

Pahari et al., 2016. For this study, we collected 6 samples from various locations along the beach, tidal flat, and marsh area, of which 3 samples were collected during high tide and the remaining 3 during low tide in December 2022. The samples were obtained by inserting a 2-foot-long plastic pipe vertically into the surface. Subsequently, the samples were passed through a mesh sieve to remove excess water. Once water removal was complete, the samples were placed into zip-lock bags, labelled as either high tide or low tide samples.

Following the sieving of each sample through a 100-µm mesh sieve, the residue was oven-dried at temperature of 50°C. The dried samples were then transferred to plastic tubes. A small amount of sand sample was then transferred to a picking tray and examined under a stereo-binocular microscope at the microscopy laboratory of IGNTU, Amarkantak. Microfauna was carefully picked from the beach sand particles and mounted on individual 48-square slides on their spiral view. Subsequently, the calcareous microfauna present on each slide were quantified, and each species was identified. Following identification, microfauna was photographed using a light microscope.

Systematic Taxonomy of the Benthic Foraminifera from Study Area:

Ammonia (A.) becarri (Linnaeus, 1758)

The species *A. beccarii* exhibits a biconvex, trochospiral shell structure with approximately 10 chambers in the final whorl. These chambers are vaulted on the umbilical side and are granular with umbilical plugs in fully grown specimens (Plate I, 1a-b). The sutures are incised and thickened on both the umbilical and spiral sides, resulting in open interlocular spaces which are interconnected with the chambers in the umbilical area. *A. beccarii* shows cosmopolitan behaviour, dwelling in the coastal and neritic environments. Several workers have studied its geographic distribution, ecology, biology, life cycles, morphology, structure, and environmental applications worldwide (Cifelli, 1962; Seibold, 1971; Schnitker, 1974; Banner and Williams, 1973; Vénec-Peyré, 1983; Lévy et al., 1984)

Ammonia (A.) dentata (Parker and Jones, 1865)

This species exhibits distinctive features, including a robust peripheral rim adorned with short, blunt peripheral spines (Plate I, 2a-b). The umbilical surface displays a granular texture, and the central spinal area is characterized by the presence of reticulated, thick calcite riblets. These riblets exhibit a low pore density, yet possess an appreciable average pore size. Furthermore, conspicuous irregular secondary calcification is prominently observed on the folia of this species. It is notably abundant in tidal flat muddy sediment habitats.

Asterorotalia (A.) trispinosa (Thalmann, 1933)

A. trispinosa (Plate I, 3a-b) has been observed in various ecological settings in the Bay of Bengal. Ganapati and Satyavati (1958) noted that this species is common in the littoral zone. The presence of spines may enable these organisms to stay suspended slightly above the sediment-water interface in the inner continental shelf environment (Ghose,1966). Bhalla (1968) documented the presence of *A. trispinosa* in the sands of Visakhapatnam Beach as part of an assemblage he tried to associate with the known foraminiferal geographic provinces in the Indian Ocean.

Haynesina (H.) depressula (Walker and Jacon, 1978)

H. depressula shows planispiral coiling, consisting of up to 12 chambers in each whorl, with a rounded periphery. The shell surface is perforated, and nearly completely involute (Plate I, 4a-c). The test has a narrow and reduced umbilicus, covering only about half of a whorl of the inner spiral suture. The primary aperture is low arch and marginal in position, sometimes obscured externally due to the presence of tubercles.

Quinqueloculina (Q.) seminulum (Linnaeus,1978)

The test of this species is non-perforate and porcelain-like. Its chambers are coiled at an angle of 72 degrees from each other, but each successive chamber is positioned in a plane 144 degrees apart. This distinctive arrangement results in four chambers being visible from one side and three from the other. The chambers have a sub-rounded periphery, and their rounded apertures have thick rims (Plate I, 5). This resilient species can be found in a wide range of environments, from marshes to shelf areas. Research conducted in both northwest Europe and southeast Australia suggests that this species primarily inhabits the inner shelf region.

Haplophragmoides sp. (Cushman, 1910)

The shell of this species is planispiral and biumbilicate (Plate I, 6a-b), featuring a finely agglutinated and smooth surface. The sides of the shell are somewhat flattened. The peripheral outline is circular and somewhat lobulated, and the last forming whorl typically consists of eight slightly inflated chambers. The sutures on the shell are depressed and have a slight curve to them. The aperture is an elongated equatorial slit located at the base of the last forming chamber

Caudammina (C.) gigantea (Geroch, 1960)

The shell is made up of large, spherical chambers that are arranged in either a straight or curved series. However, these chambers are typically found as single-chamber fragments (Plate I, 7). The aperture is terminal. The chamber walls are thick, multilayered, finely agglutinated, and smoothly joined with organic cement.

Results and Discussion:

The abundance of benthic foraminiferal species encountered was determined by performing the census count of the samples from both, the low and high tide conditions (figure 2 and 3).

In the samples pertaining to high tide, the predominant species included *Ammonia beccarii, Asterorotalia trispinosa, Ammonia dentata, Quinqueloculina, Haynesina depressula, Haplophragmoides sp.* and *Caudammina gigantea*, while in the samples collected during low tide, the most abundant species present were *Ammonia beccarii, Asterorotalia trispinosa, Ammonia dentata,* and *Haplophragmoides sp.*

Comparing the abundance of the species during high tide and low tide, it becomes evident that *A. trispinosa* exhibits a significant difference in abundance between the two conditions, with a notably higher presence during low tide conditions.

Based on previous studies (Thalmann, 1933; Ganapati and Satyavati, 1958; Bhatia and Bhalla, 1959; Ghose, 1966; Bhalla, 1968; Murray 1973; Panchang and Nigam, 2012), *A. trispinosa* emerges as a characteristic warm-water epifaunal species, thriving within a temperature range of 23.05°C to 27.54°C. This species exhibits a preference for shallow water environments, such as estuaries, lagoons, and inner shelves. Its abundance is particularly notable in the inner continental shelf regions, near river mouths

characterized by silty sand and muddy substrates. A decrease in abundance is observed as one moves away from river mouths, with rare occurrences in continental slope and abyssal regions

Saraswat et al. (2017) suggest that *A. trispinosa* favours hyposaline waters, indicating a preference for areas with lower salinity and a higher influx of freshwater. The highest abundance of *A. trispinosa* is associated with the lowest salinity and the highest freshwater influx, while the lowest abundance corresponds to the highest salinity conditions.

Notably, Thalmann (1933) hypothesized that the elongated spines of *A. trispinosa* contribute to buoyancy, allowing these organisms to remain suspended above settling sediments for extended periods and avoid burial in high sedimentation areas.

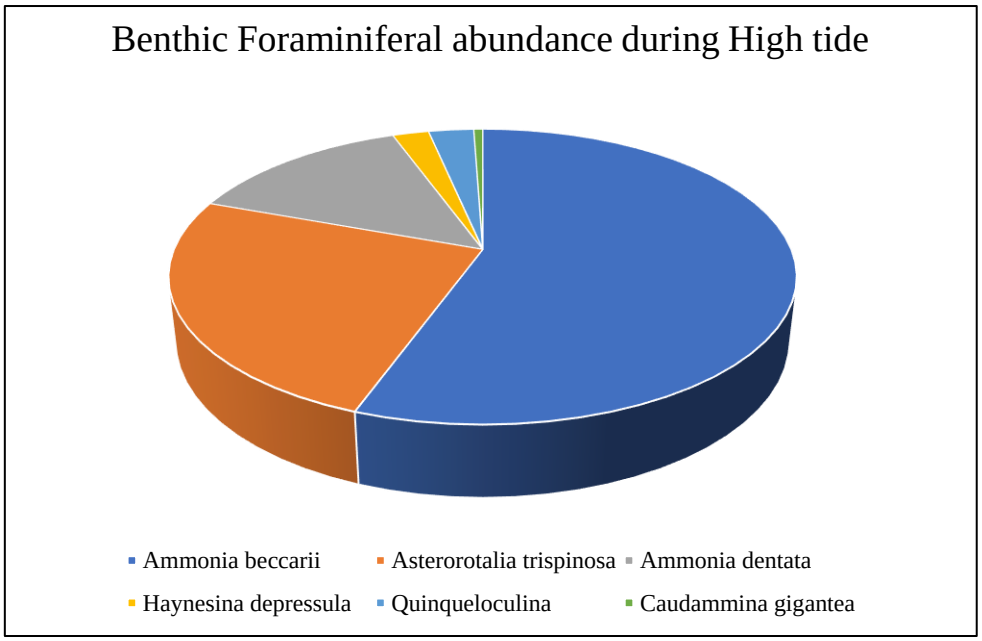

Figure.2 Showing abundance of benthic foraminiferal species during high tide

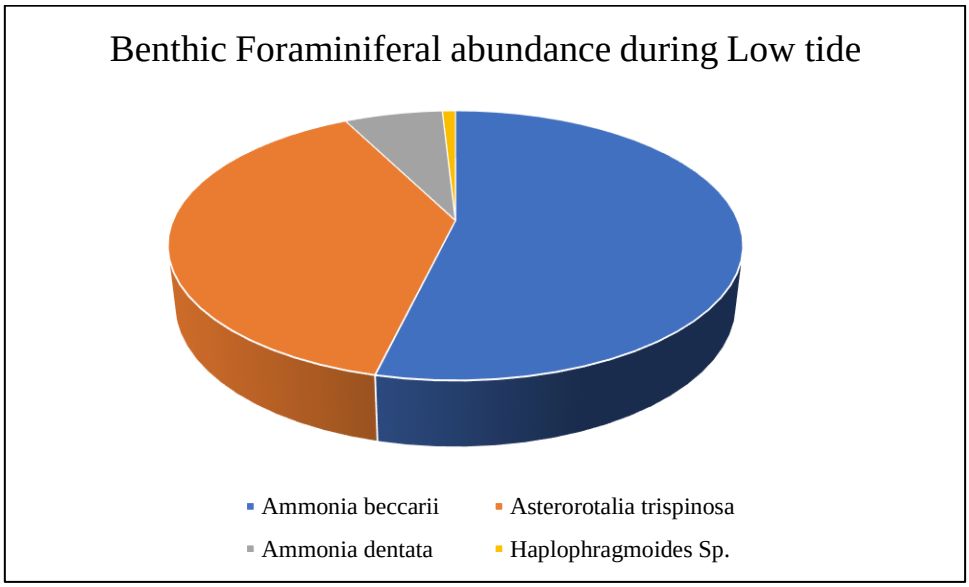

Figure.3. Showing abundance of benthic foraminiferal species during low tide

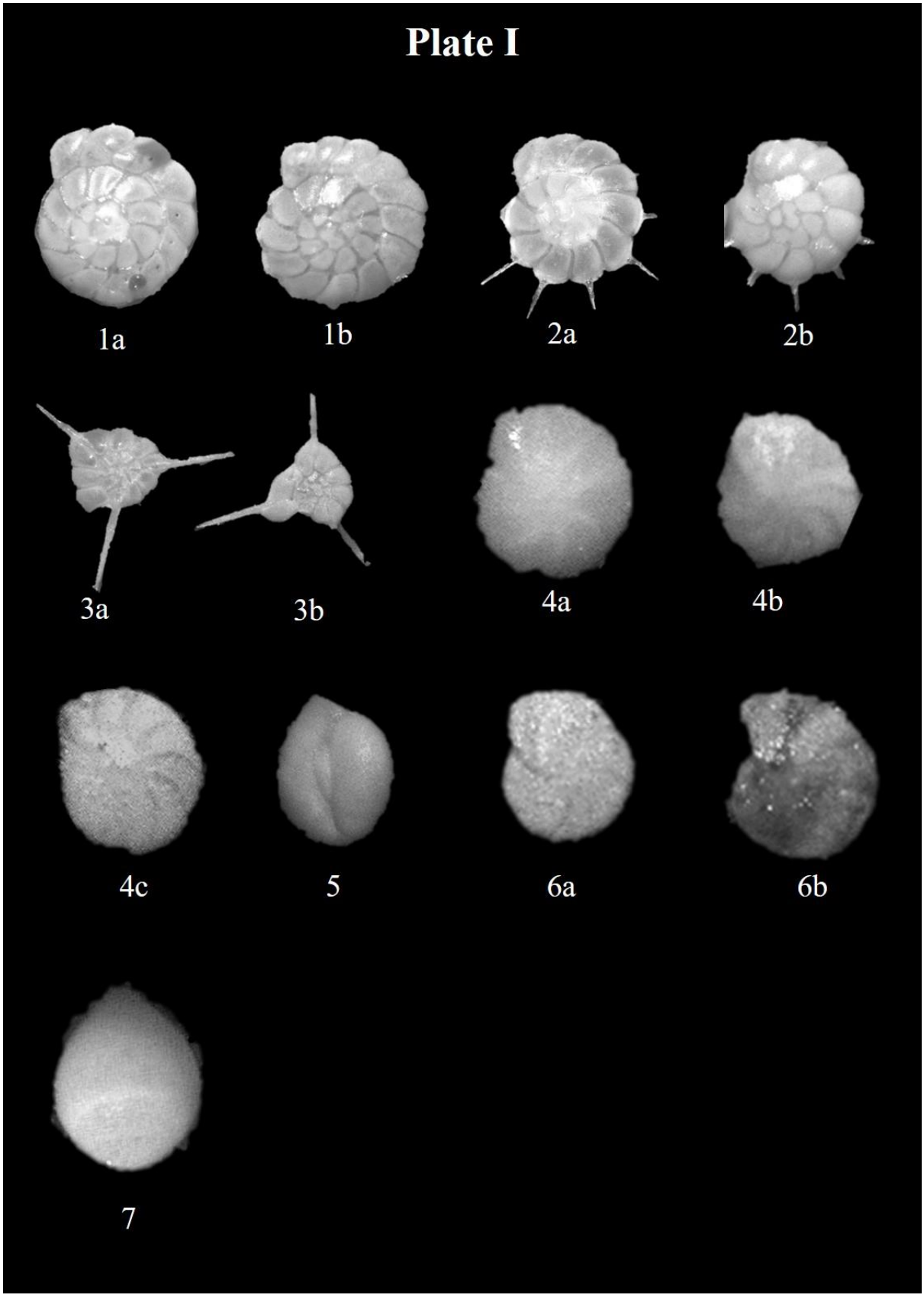

Plate I: **1.** *Ammonia beccarii,* ***2.*** *Ammonia dentata,* ***3***. *Asterorotalia trispinosa,* ***4.*** *Haynesina depressula,* ***5.*** *Quinqueloculina seminulum,* ***6.*** *Haplophragmoides sp.,* ***7.*** *Caudammina (C.) gigantea*

Conclusion:

Chandipur Beach exhibits a rich diversity of benthic foraminiferal fauna. From the samples collected during high and low tide, seven dominant benthic foraminiferal forms were encountered.

The most abundance species is *Ammonia beccarii*, indicating that Chandipur Beach represents a shallow marine environment characterized by a sandy bottom substrate.

The documented assemblage of foraminifera aligns with the characteristics typically found in tropical, shallow, inner-shelf environments. Notably, benthic foraminifera appear to inhabit primarily sandy substrates within Chandipur Beach.

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