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Research Article

Bioerosion in the Late Eocene *Discocyclina discus sowerbyi* (Nuttall, 1926) in Bayat Area, Indonesia: Implications for Paleoecology

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ABSTRACT
This paper discusses about the bioerosion discovered in carbonate tests of *Discocyclina discus sowerbyi* (Nuttall, 1926), a large benthic foraminifera from the Priabonian (Late Eocene). The study material was sampled from the Gamping beds in the Wungkal-Gamping Formation in Bayat, Indonesia. We discovered four bioerosional trace fossils from three different ichnogenera demonstrate bioerosion from the surface test analysis. *Oichnus simplex* and *Oichnus paraboloides* are ichnogenus *Oichnus* diagnostic drilling holes that are often found on the surface. *Caulostrepsis* isp. exhibits the presence of uncomplicated U-shaped borings. The observed formation of drill holes can be mostly linked to the predatory behaviour of gastropods, while other trace fossils are predominantly associated with the burrowing activities of worms. The occurrence of well-preserved individual tests exhibiting no signs of bioerosion is infrequently observed in *D. discus sowerbyi.* In addition, bioerosion occurs more frequently in the microspheric generation than in the megalospheric generation. This research also demonstrates for the first time in Indonesia that parrotfish bite marks have developed on individual tests of the microspheric generation of *D. discus sowerbyi.* The taphonomic characteristics exhibited by the bioeroded and encrusted *D. discus sowerbyi* specimens can serve as reliable paleoecological indicators for sediment deposition occurring at an intermediate to high sedimentation regime. The occurrence of larger foraminifera with some bioerosional trace fossil highly proficient at documenting shallow marine sclerobionts.

INTRODUCTION

Bioerosion is the process by which living organisms mechanically or chemically degrade hard substrates, including bones, shells, rocks, corals, wood, and also foraminifera test. This degradation can occur through various means, such as chemical dissolution facilitated by bacteria or fungi, as well as physical abrasion caused by animals like mollusks or echinoids (Hutchings et al. 2005; Tribollet et al. 2011; Wisshak & Tapanila 2008). The appearance and structure of these creatures can be greatly influenced by this phenomenon, hence offering valuable insights about environmental conditions and biodiversity. Bioerosional trace fossils, also known as bioerosion traces or ichnofossils, are the result of various organisms' activities that cause the erosion or degradation of hard substrates such as rocks, shells, bones, and other mineral surfaces. These can include borings (holes drilled into the substrate), etchings (surface marks), gnawings (marks from chewing or biting), and other forms of physical alteration. Bioerosional trace fossils can provide valuable insights into paleoecological and paleoenvironmental conditions. Here are few key points about them: (1) Organism Interactions; (2) Environmental Indicators; (3) Substrate Preferences; (4) Temporal Distribution; (5) Biodiversity Indicators; and (6) Taphonomic Information (Wisshak & Tapanila 2008). In larger foraminifera tests, bioerosion can occur due to the activity of fungi, bacteria, and other microorganisms (Vohník 2021). The phenomenon of bioerosion in the large foraminifera, *Discocyclina discus sowerbyi* has not been well studied, and there is a lack of comprehensive investigation about the ichnofacies in the Wungkal-Gamping area. This research studied the carbonate individual test of *Discocyclina discus sowerbyi* (Nuttall, 1926), which was found in Desa Gamping, the east part of Jiwo Hills, Bayat, Indonesia. Bioerosion not only plays a significant role in shaping ecosystems and influencing biodiversity but also provides valuable information about past environments and climate change, especially in the Late Eocene stage (Hutchings et al. 2005). A previous study of bioerosion in the carbonate Eocene-nummulite test has been carried out by (Abdel-Fattah 2018), but this study concerned the Eocene-orthophragminid test for the first time. Bioerosion plays a significant role in shaping both modern and ancient ecosystems. It can influence the distribution and abundance of species, can contribute to the recycling of nutrients, and can affect the physical structure of habitats.

MATERIALS AND METHODS

Materials

Individual tests of the larger benthic foraminifers *Discocyclina discus sowerbyi* (Nuttall, 1926) were studied from the Late Eocene Wungkal-Gamping Formation, Southern Mountain, Bayat, Indonesia. The Wungkal Gamping Formation was divided into two rock units, they are Wungkal beds and Gamping beds (Bothe 1929; Sumarso & Ismoyowati 1975). Wungkal beds are characterised by the abundance of *Planocamerinoides* (=*Assilina*, of the older workers), representing Ta3 age (Lutetian-Bartonian stage) The individual tests of *D. discus sowerbyi* were collected from the Gamping beds. Although the outcrop at sampling location 1 is completely eroded, we were still able to find numerous loose individual specimens. In the sampling location 2, we observed small outcrops, with no loose-individual test. The coordinate location is S 07°46'33.8", E 110°40'24.0" for the first sampling location and S 07°45'44,2", E 110°40'33.0" for the second sampling location (see Figure 1-2). However, this remains a minority due to the scarcity of sedimentological information regarding the Gamping beds from the Late Eocene. It is hoped that this research will provide valuable insights into the sedimentation history of the Wungkal-Gamping Formation. The sole remaining geological data in the studied area consists of the loose-individual calcareous test.

Methods

The ichnotaxonomy of the documented boring was established upon the examination of over 100 samples gathered from the defined study sites. Around 75-80% (75-80 specimens) of the specimens that were obtained

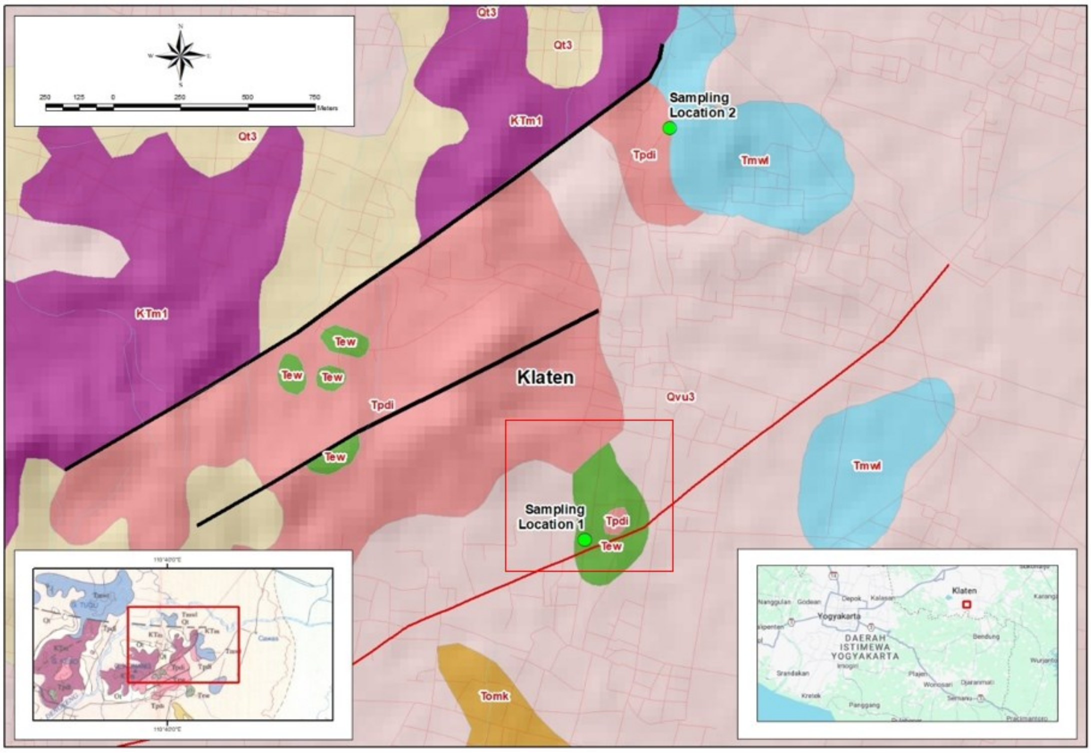

Figure 1. Geological map of the study area, red boxes show the studied sections (modified from Surono et al. 1992). At sampling location 1, the B-form of loose-individual *Discocyclina discus sowerbyi* test has sampled. At sampling location 2, the A-form occurs as small outcrops, without loose-individual test, therefore, preparing thin sections is necessary. Remarks: Tew = Wungkal-Gamping Formation; Tomk = Kebo-Butak Formation; Tms = Semilir Formation; Tmwl = Wonosari-Punung Formation; Tpdi = Pendul Diorite; Qvu = Merapi Volcanic Rocks; Qt: Older Alluvium; Qa = Alluvium; KTm = Metamorphic rocks.

exhibit signs of encrustation and/or bioerosion. The specimens underwent a process of washing and drying in order to facilitate thorough thin section examinations using a polarised microscope-*Olympus* BX53M. A number of specimens were subjected to axial sectioning in order to facilitate comprehensive investigations (see Plate 3).

Figure 2. Outcrop situation at the sampling location 2, Eastern Jiwo, Bayat. The outcrop has a very limited lateral extent, just spotted. Most of the outcrop is eroded, leaving only a small, massive outcrop that is less than one meter in height. There were no observable sedimentary structures, and the grain orientation did not show any signs of imbrication.

RESULTS AND DISCUSSION

Introduction to Reproduction and Life Span of Foraminifera

Discocyclina discus sowerbyi (Nuttall, 1926) is one of cosmopolitan species of larger benthic foraminifera with a complex life cycle that produces two distinct generations, haploid and diploid (Hallock 1985; Hallock & Reymond 2022). Figure 3 explains the haploid generation, called 'gamonts,' has a single set of chromosomes and produces numerous gametes through multiple fission (Hohenegger 2011). These gametes, which are small and possess flagella, are isogametes, meaning they are identical in form. When two gametes fuse, they form a diploid zygote with a double set of chromosomes (Hohenegger 2011). The diploid generation, called 'agamonts,' reproduces asexually and can grow larger than the gamonts before reproduction (Hohenegger 2011; Beavington-Penney & Racey 2004). The agamonts form the megalospheric generation (also known as the A-form, see Figure 4), while the gamonts form the microspheric generation (B-form). This study reveals that bioerosion occurs more frequently in the microspheric generation (B-form).

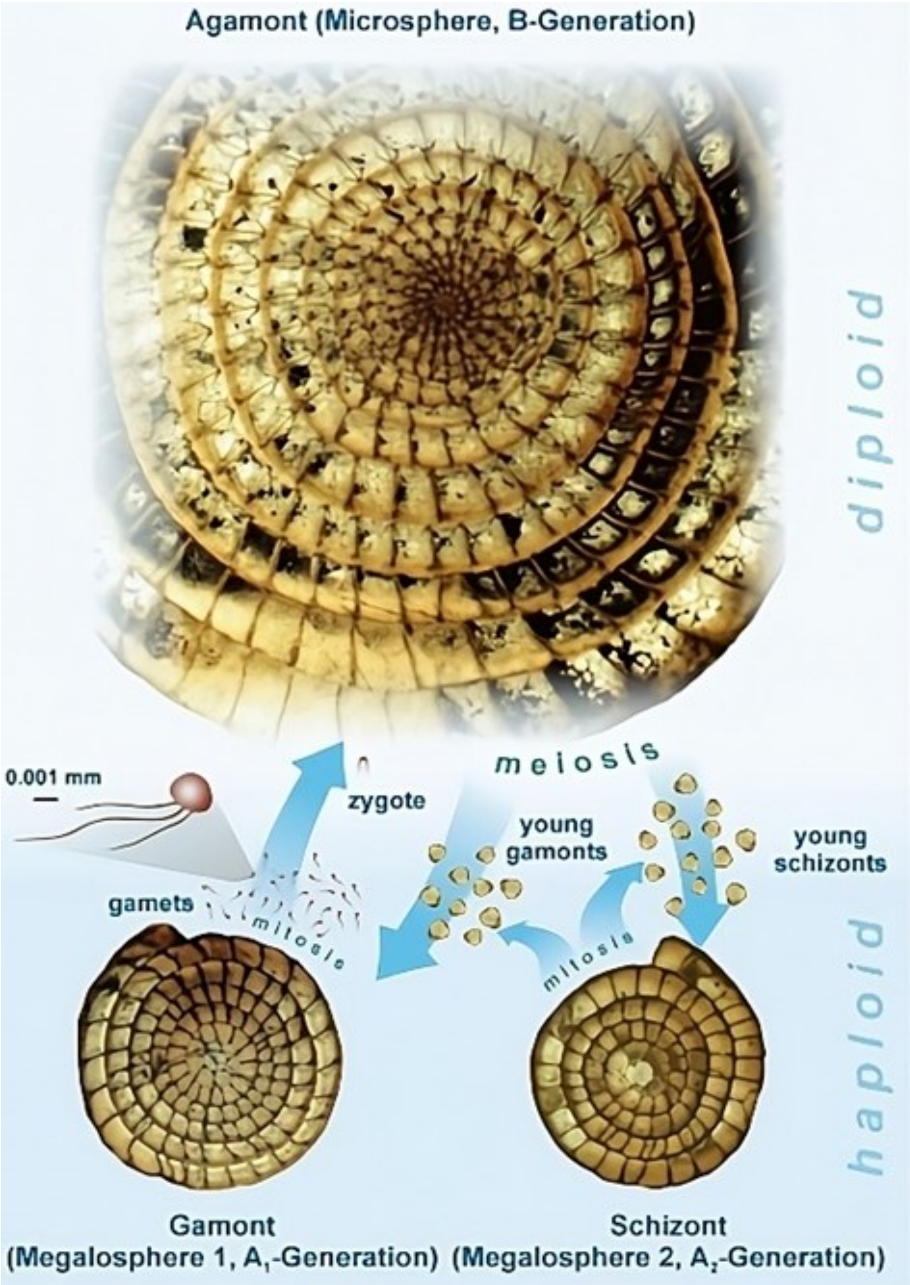

Figure 3. The life cycle of larger foraminifera, gamete seizes not to scale (Hohenegger 2011).

Bioerosion occurred more frequently in the microspheric generation, as our study showed that the megalospheric generation experiences less bioerosion (see Figure 4). Microspheric foraminifera, being larger, were more susceptible to bioerosion by marine organisms. Symbiotic organisms also preferred microspheric tests, increasing their vulnerability. These findings are aligned with previous research, indicating that organisms in sandy, medium to high-energy environments target microspheric generations. This selective bioerosion is important for paleoecological reconstructions and sedimentation rate assessments, highlighting differences in preservation potential between microspheric and megalospheric generations.

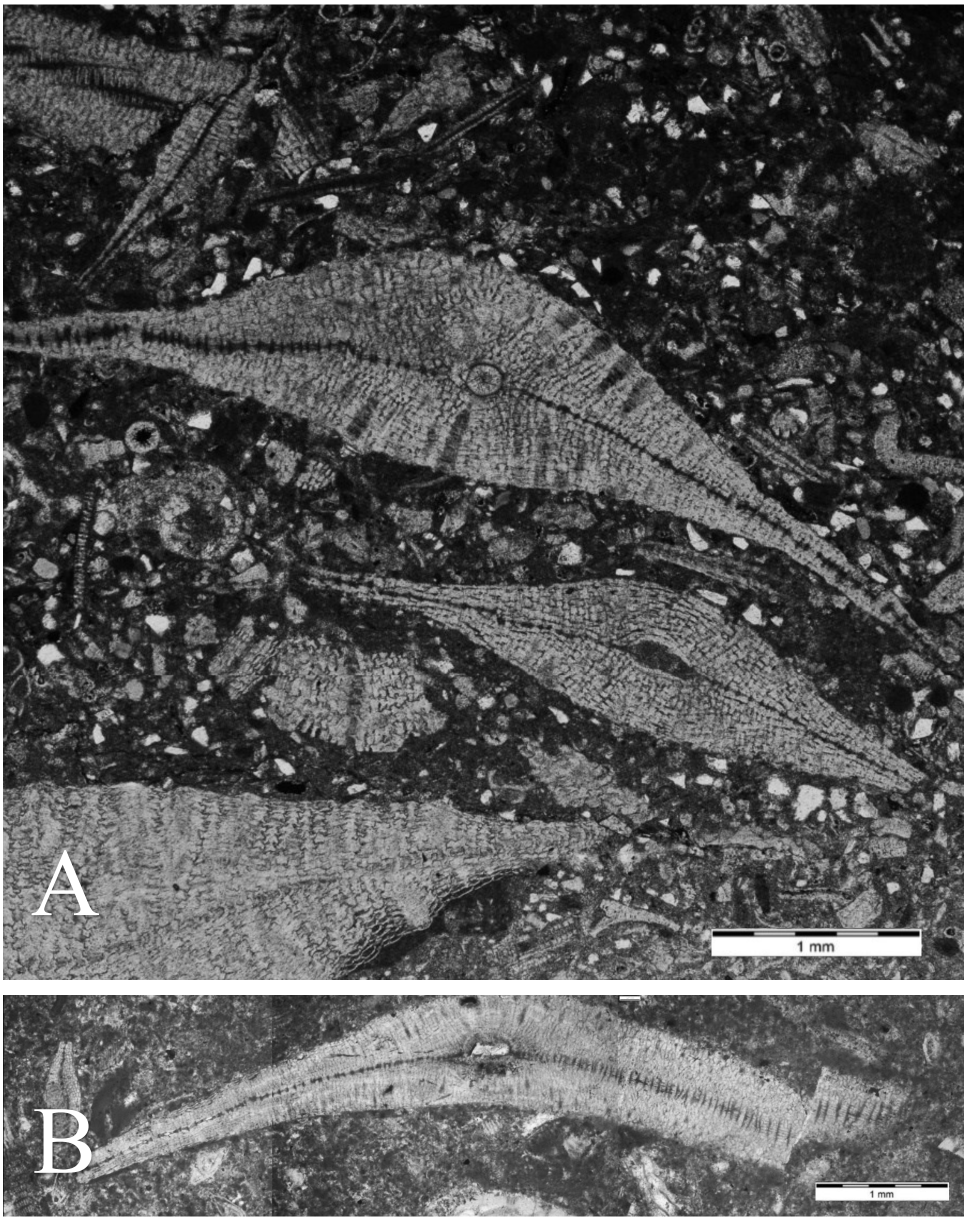

Figure 4. Photomicrographs showing megalospheric generation of different *Discocyclina* species. A) Thin section containing *D. discus sowerbyi* (A-form) sampled from location 2; B) Thin section containing *D. javana* (A-form) sampled from Wahau, North-east Kutai, Kalimantan (unpublished data). Both of them showing no sign of bioerosion penetrating into the test instead of any surface "shallow" bioerosion and/or abrasion indicates wave reworking during sedimentation. Scale bar = 1 mm.

Bioerosion Type

As illustrated in Figure 5, a detailed analysis of bioerosion on *Discocyclina discus sowerbyi* demonstrates the relationships between marine organisms and their substrates during the Late Eocene. The shapes of the borings and spaces seen in this study are linked to four different ichnospecies that are grouped into three different ichnogenera and “unique” parrotfish bitemark. Those ichnogenera are *Oichnus* Bromley, 1981, *Caulostrepsis* Clarke, 1908, and *Helminthoidichnites* Fitch, 1850.

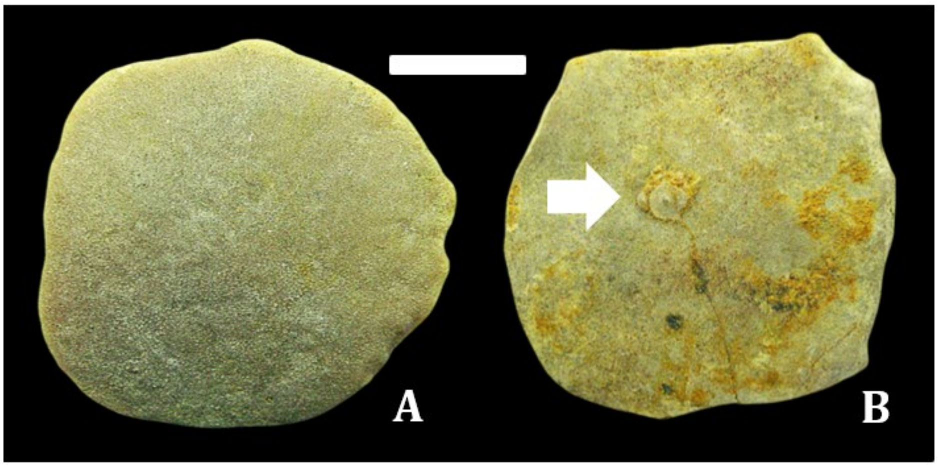

Figure 5. A) Well-preserved *Discocyclina discus sowerbyi* (Nuttall, 1926) without notable drilling and encrustations. B) A test of *Discocyclina discus sowerbyi* (Nuttall, 1926) showing encrustations (white arrow). Scale bar = 1 cm.

Ichnogenus: *Oichnus* Bromley, 1981

The ichnogenus *Oichnus* refers to bioerosive penetrations in calcareous skeletal substrates, which can be complete or incomplete (Wisshak et al. 2015). The trace fossils subject to examination exhibit round to subcircular perforations that are of biogenic nature, resulting from the drilling activity on rigid or calcareous skeletal surfaces (Bromley 1981) . *Oichnus* ichnogenera are morphologically identical to *Tremichnus* ichnogenera (Wisshak et al. 2015). Originally, *Oichnus* was exclusively established for bioerosion traces and interpreted as a result of predatory drilling. Meanwhile, *Tremichnus* specifically refers to shallow parabolic holes passing through echinoderm skeletons and is interpreted as *Domichnia* or *Fixichnia* (Wisshak et al. 2015). Two *Oichnus* ichnospecies were identified herein from the Late Eocene *Discocyclina discus sowerbyi* (Nuttall, 1926) in Bayat, Indonesia, which are *Oichnus simplex* and *Oichnus paraboloides.*

a. *Oichnus simplex* Bromley, 1981 (Plate 1A, 1B)

Ichnofossil group	:	Bioerosional trace fossils
Family	:	*Oichnidae*
Ichnogenera	:	*Oichnus*
Species	:	*simplex*

Description: *Oichnus simplex* is characterised by small cylindrical to sub-cylindrical borehole with sharp border (Wisshak et al. 2015). The drill holes exhibit a diameter range spanning from 0.1 mm to 0.5 mm, with an average diameter of 0.3 mm. The boreholes are typically spherical or subspherical in shape and more or less perpendicular to the substrate surface. The walls of the borehole are typically smooth, and there is no surrounding debris or excavation halo. The hole itself is often similar in size throughout its depth, without significant tapering. These characteristics differentiate *Oichnus simplex* from other types of trace fossils which might have different shapes, sizes or patterns of penetration into the substrate.

Remarks: *Oichnus simplex* is a frequent form of boring commonly observed in *Discocyclina discus sowerbyi*, characterised by its comparatively diminutive size and simple vertical perforations. Cylindrical tiny round holes, known as *O. simplex* Bromley (1981), are frequently generated by predatory muricid gastropods, however similar structures can also be produced by other invertebrate species, including cephalopods or annelids (Donovan 2017). The size of the drill holes observed in the examinations of larger benthic foraminifers are very substantial, typically measured in millimetres. These holes can be effectively linked to the species *O. Simplex* (Abdel-Fattah 2018). *O. simplex* borings have been found in various fossils, such as *Hemipneustes striatoradiatus* (Echinoidea) from the Maastrichtian type area (Donovan & Jagt 2020). The dimensions and surface features of the ichnogenus in inquiry are not essential to its ichnotaxonomy (Bromley 1981). The stratigraphic age of this cosmopolitan ichnogenus ranges from Neoproterozoic to Holocene (Abdel-Fattah 2018). As with other ichnofossils, *O. simplex* can provide valuable information about past ecological interactions - for instance, they might represent evidence of predation or parasitism on the organism that once inhabited the substrate where these traces are found in different environments throughout geological history.

b. *Oichnus paraboloides* Bromley, 1981 (Plate 1C, 1D)

Ichnofossil group	:	Biorosional trace fossils
Family	:	*Oichnidae*
Ichnogenera	:	*Oichnus*
Ichospecies	:	*paraboloides*

Description: This ichnospecies is characterised by a spherical paraboloid form. The drill holes exhibit a diameter variation spanning from 0.8 mm to 2.2 mm, with a mean diameter of 1.5 mm. The boring is perpendicular from the opening. Sometimes the boring is not penetrative which has a slightly raised central boss. In *Discocyclina discus sowerbyi*, outer opening is enlarged by local bevelling. The wall of the boring is commonly ornamented by etching patterns reflecting the ultrastructure of the substrate (Bromley 1981).

Remarks: *Oichnus paraboloides* is more common boring than *O. simplex* in the studied *Discocyclina discus sowerbyi* tests from the Wungkal-Gamping deposit. The stratigraphic range of this ichnospecies extended from the Cambrian to Holocene (Abdel-Fattah 2018). They are characterised by circular to subcircular holes of biogenic origin bored into hard substrates, such as foraminiferal tests and shells. *O. paraboloides* is an ichnospecies that has been interpreted as boring traces produced by predatory gastropods, particularly naticid gastropods (Kong et al. 2015). The ecological impact of *O. paraboloides* being found on a greater variety of foraminiferal tests can be attributed to the following factors: (1) The wide occurrence of *O. paraboloides* on the samples of foraminifera suggests that predation and parasitism of benthic foraminiferans are common phenomena in both contemporary and ancient marine ecosystems (Svensson Nielsen et al. 2003), (2) This suggests that the organisms responsible for creating *O. paraboloides* traces played a significant role in shaping the ecology of these environments. Bioerosion traces, such as those created by *O. paraboloides*, can have a direct impact on the foraminiferal tests, potentially affecting their structural integrity and can lead to changes in the distribution and abundance of foraminiferal species in the affected environments (Svensson Nielsen et al. 2003; Kong et al. 2015; Abdel-Fattah 2018), (3) The presence of *O. paraboloides* on a greater variety of foraminiferal tests implies that the trace makers had a broader range of prey preferences, which can provide insights into the ecological interactions between predators and prey in ancient marine environments. In summary, the ecological impact of *O. paraboloides* being found on a greater variety of foraminiferal tests can be attributed to its role in predation and parasitism, bioerosion, ecological interactions, and environmental parameters. Studying the distribution and abundance of these ichnospecies can help researchers understand the environmental factors that influenced the distribution of foraminiferal species and their predators in shaping the structure and dynamics of ancient marine ecosystems.

Ichnogenus: Caulostrepsis Clarke, 1908

Caulostrepsis is a genus of trace fossil associated with bioerosion, which refers to the biological activity of organisms in excavating or modifying hard substrates such as rocks, shells, or wood (Santos et al. 2011). The morphology of *Caulostrepsis* can vary depending on the specific species and environmental conditions, but typically exhibits multiple small, circular to subcircular external openings on the substrate surface. These openings can be arranged in irregular clusters or scattered individually. The size and shape of *Caulostrepsis* can vary depending on the species and growth stage. They can range from millimetres to centimetres in diameter, and their overall shape may be elongated, irregular, or branching.

a. *Caulostrepsis* isp. (Plate 1E, 1F)

Description: The length of this simple and cylindrical boring ranges from 3.3 mm to 7.7 mm with an average length 4.9 mm. The width ranges from 0.5 mm to 1.5 mm with an average width 1.0 mm. It is generally attributed to the work of spionid polychaetes.

Remarks: Common borings found in *Discocyclina discus sowerbyi*. These particular borings are not designated to a specific ichnospecies within this context due to their inadequate preservation. The boring's morphological characters show similarity to *Caulostrepsis taeniola* Clarke, 1908. Rocky shorelines, with their reduction or lack of sedimentation, offer exceptional conditions for these organisms (Lopes 2011). For instance, it is often found in association with other organisms in hard-substrate biota, which is less well known than that of soft-bottom communities (De Gibert et al. 1998). The presence of *Caulostrepsis* indicates conditions favourable for colonisation by boring and encrusting organisms. *Caulostrepsis* is widely distributed in shallow marine environments, and is produced by polychaetes, a group of marine worms, but is rarely known from polar regions (Hanken et al. 2012).

Ichnogenus: *Helminthoidichnites* Fitch, 1850

Helminthoidichnites is a type of trace fossil, which are geological records of biological activity. This ichnogenus displays only occasional loops, which distinguishes it from Gordia, where loops are a more characteristic feature. There is a single known ichnospecies of *Helminthoidichnites*, named *Helminthoidichnites* tenuis, but the morphological features found in study area is differ from H. tenuis. *Helminthoidichnites* represents a singular ichnotaxon that has been identified in both marine and non-marine sedimentary deposits spanning from the Precambrian to the Quaternary period (Lima et al. 2017).

a. *Helminthoidichnites* isp. (Plate 2A, 2B, 2E, 2E)

Description: This ichnospecies is characterised by simple and straight to slightly curved trail, unbranched. *Helminthoidichnites* are horizontal trace fossils that are straight or curved, and more rarely, circular. The length of the unary ichnospecies measures 23 mm, while the length of the trail is 0.5 mm. This probably the grazing or feeding structures produced by mobile and sessile deposit and detritus feeding organism. It has a slightly wide opening.

Remarks: Rarely found in this individual fossil test of *Discocyclina discus sowerbyi*. Grazing and feeding structures produced by mobile and sessile deposit- and detritus-feeding organisms (Knaust & Bromley 2012). *Helminthoidichnites* is a type of trace fossil, which are geological records of biological activity. The presence of *Helminthoidichnites* suggests mobility associated with significant sediment displacement, implying muscular mobility in the organisms that produced these traces (Evans et al. 2020).

Parrotfish bite mark (Plate 2C, 2D)

This paper is also aims to be the first to record parrotfish bite mark on the *Discocyclina discus sowerbyi* test in Indonesia after being first reported by Syed & Sengupta (2019). Their work focused on the discovery of parrotfish bite marks on larger foraminifera (*Assilina exponens*) fossils from the Middle Eocene period in Kutch, Gujarat, India, which are attributed to nectobenthic parrotfish (class *Actinopterygii*, family *Scaridae*) (Syed & Sengupta 2019). There is a similarity between what happens to the bioerosion in *Discocyclina discus sowerbyi* in Indonesia and *Assilina exponens* in India. The observations suggested that the bite marks are predominantly found on large microspheric specimens of both species. The comparison of the bioerosion patterns with those of extant parrotfish suggests that the ancient parrotfish belonged to the excavator category or the scraper-excavator category.

Paleoecology significance

Tracemaker ethology and biological affinities

Ethology, as a branch of biology, is the scientific study of animal behaviour. It includes both the behaviour under natural conditions and also under controlled conditions. In advanced ethology, the focus is often on more complex aspects of animal behaviour and its interpretation. In the other hand. bioerosion can also be related to paleoproductivity, as shown by a significant correlation between bioerosion rates and paleoproductivity estimates (Frozza et al. 2020). Bioerosion in the *Discocyclina discus sowerbyi* exhibits encrustation and predation scars in may imply commensalism, mutualism, parasitism, or scavenging. Nematodes bore holes into foraminiferal tests to feed on their soft tissues (Sliter 1971). Neoichnological investigations indicated the tracemakers of numerous trace fossils, although bioeroders of various fossil borings are difficult to determine (Abdel-Fattah 2018). The drilling holes of the ichnogenus *Oichnus* are typically caused by gastropod predation, while the borings of *Caulostrepsis* and *Helminthoidichnites* are caused by polychaete worms. Parrotfish bite marks are typically indicative of coral reef environments. Parrotfish are known for their distinctive feeding behaviour, which involves scraping algae and small organisms off coral reefs using their beak-like teeth. Therefore, parrotfish bite marks are commonly employed as indicators of the vitality and activity of coral reef ecosystems.

Paleoenvironmental and larger foraminifera assemblages

The Eocene deposits found in Bayat, Indonesia primarily consist of shallow open marine sediments that were deposited in melange tectonic settings inside the Jiwo Hills, which are a component of the southern mountain range (Bothe 1929; Sumosusastro 1956; Sumarso & Ismoyowati 1975). The biofacies study from Wungkal-Gamping Formation can be classified as foreslope biofacies which dominantly show the fair to good imbrications of *Planocamerinoides* sp., *Nummulites javanus* Verbeek, 1891, *Palaeonummulites variolarius* (Caudri, 1934), and *Discocyclina discus sowerbyi* during Late Eocene (Choiriyah et al. 2006; Rahmawati et al. 2012). The biometrical study based on the larger benthic foraminifera accumulation in Wungkal-Gamping Formation shows that conducive paleoecological conditions to reproduce compared to the Wungkal-Gamping formation which are shallow, warm and full of nutrients (Rahmawati, unpublished work). The distribution of larger foraminifera in carbonate deposits can provide a graphic indication of paleoenvironment (Hallock & Glenn 1986). Additionally, the biostratigraphy and facies of larger foraminifera can provide insights into sedimentary cover and paleoenvironmental conditions (Consorti & Köroğlu 2019). Therefore, bioerosion in larger foraminifera tests can provide valuable information about past environmental conditions and paleoecology. The search results suggested that there is a relationship between paleoenvironment and larger foraminifera accumulation. Larger foraminifera can be used as a tool for paleoenvironmental analysis of carbonate depositional facies (Hallock & Glenn 1986).

Paleoproductivity estimates and bioerosion rates show a significant correlation, suggesting that bioerosion is more frequent in eutrophic environments (Frozza et al. 2020). Additionally, bioerosion in larger foraminifera tests can be used as a tool for paleoenvironmental analysis (Beavington-Penney & Racey 2004). The effects of external influences on test size, shape, and distribution for some calcareous-walled foraminifera have been studied. This result show consistency with the bioerosion observed in the nummulitid group reported by Abdel-Fattah (2018).

CONCLUSIONS

1. *Discocyclina discus sowerbyi* (Nuttall, 1926) demonstrated evident bioerosion and most of them occur in microspheric generation, which was distinguished by a varied collection of four ichnospecies from three ichnogenera. The boreholes that are linked to the predation of gastropods can be classified as *Oichnus simplex* and *Oichnus paraboloides*, *Caulostrepsis* isp., and *Helminthoidichnites* isp.
2. *Oichnus* was found on commonly on *Discocyclina discus sowerbyi* test, it might suggest that there were drilling predators in that environment. In some cases, these holes are not made by predators but by parasites attaching to their hosts. Changes in size or shape patterns across geological timescales might also reveal evolutionary trends among both prey (e.g., shell thickness or hardness) and predators (e.g., drilling mechanism). A high concentration of bioerosion may suggest favourable conditions for predators or a high population density, or vice versa.
3. The bite marks on the individual microspheric *Discocyclina discus sowerbyi* test indicated that the parrotfish were herbivorous, feeding on algae that grew on the foraminiferal test as bioclasts, same as those of Middle Eocene deposit in India (Syed & Sengupta 2019). This information adds to the knowledge of the feeding habits of ancient parrotfish species.

4. The presence of larger foraminifera, which are excellent recorders of shallow marine sclerobionts, suggested that the depositional environment during Late Eocene in Bayat was a shallow marine carbonate setting with medium to high sedimentation regimes.

AUTHOR CONTRIBUTION

D.R.: Conceptualisation, Methodology, Investigation, Data curation, Writing-original draft. S.S.S.: Supervision, Validation. D.H.B.: Funding acquisition, Data curation. W.R.: Conceptualisation, Methodology, Validation.

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CONFLICT OF INTEREST

The authors of this paper declare that they are free from any ties or financial conflicts of interest that may have seemed to impact their work.

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APPENDICES

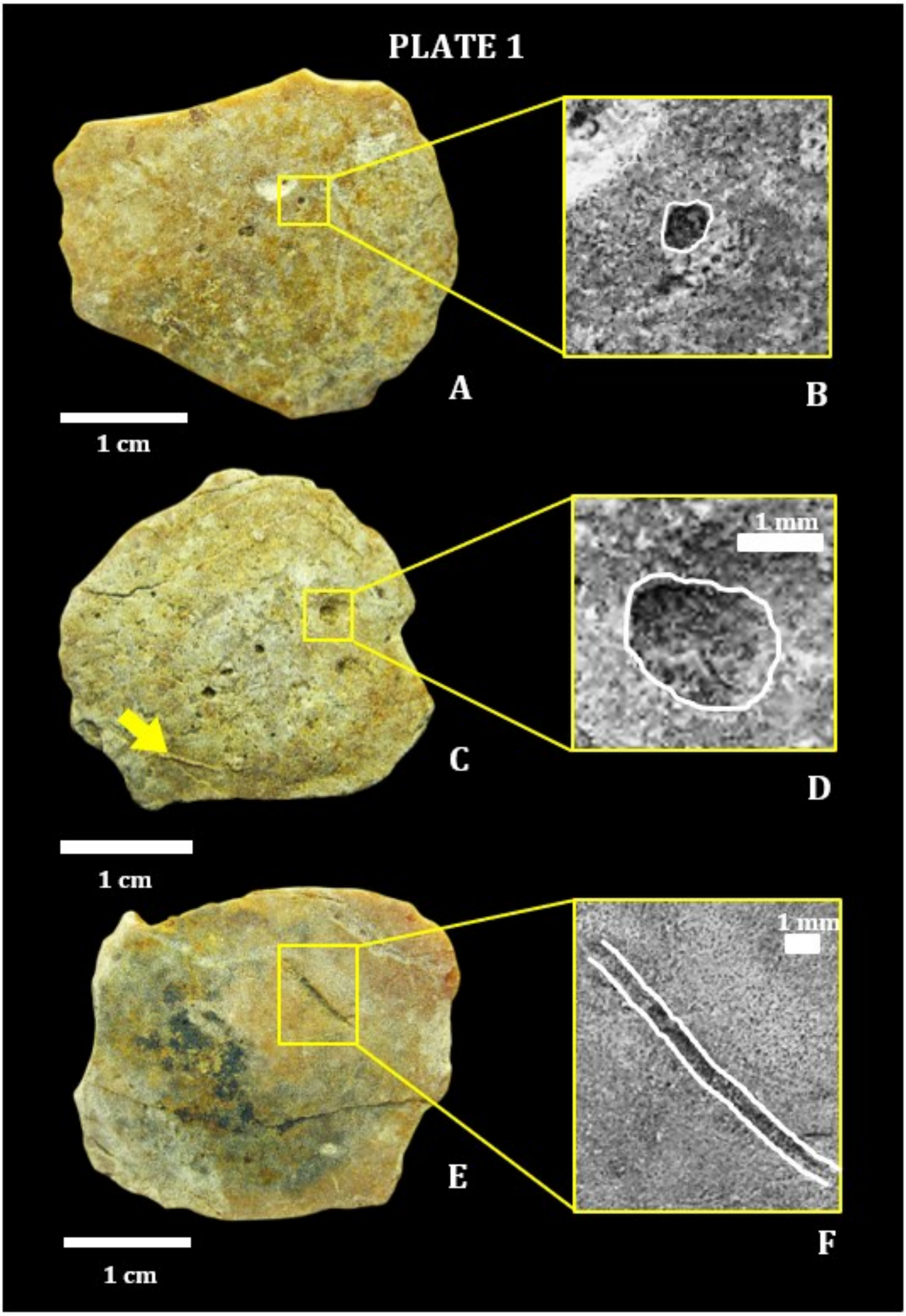

PLATE 1

A, C, E: External view on individual microspheric test of *Discocyclina discus sowerbyi* (Nuttall, 1926);
B, D, F: Closer zoom view showing the bioerosional trace fossil.
(A – B) *Oichnus simplex*; (C – D) *Oichnus paraboloides*; (E – F) *Caulostrepsis* isp. Scale bar = 1 cm

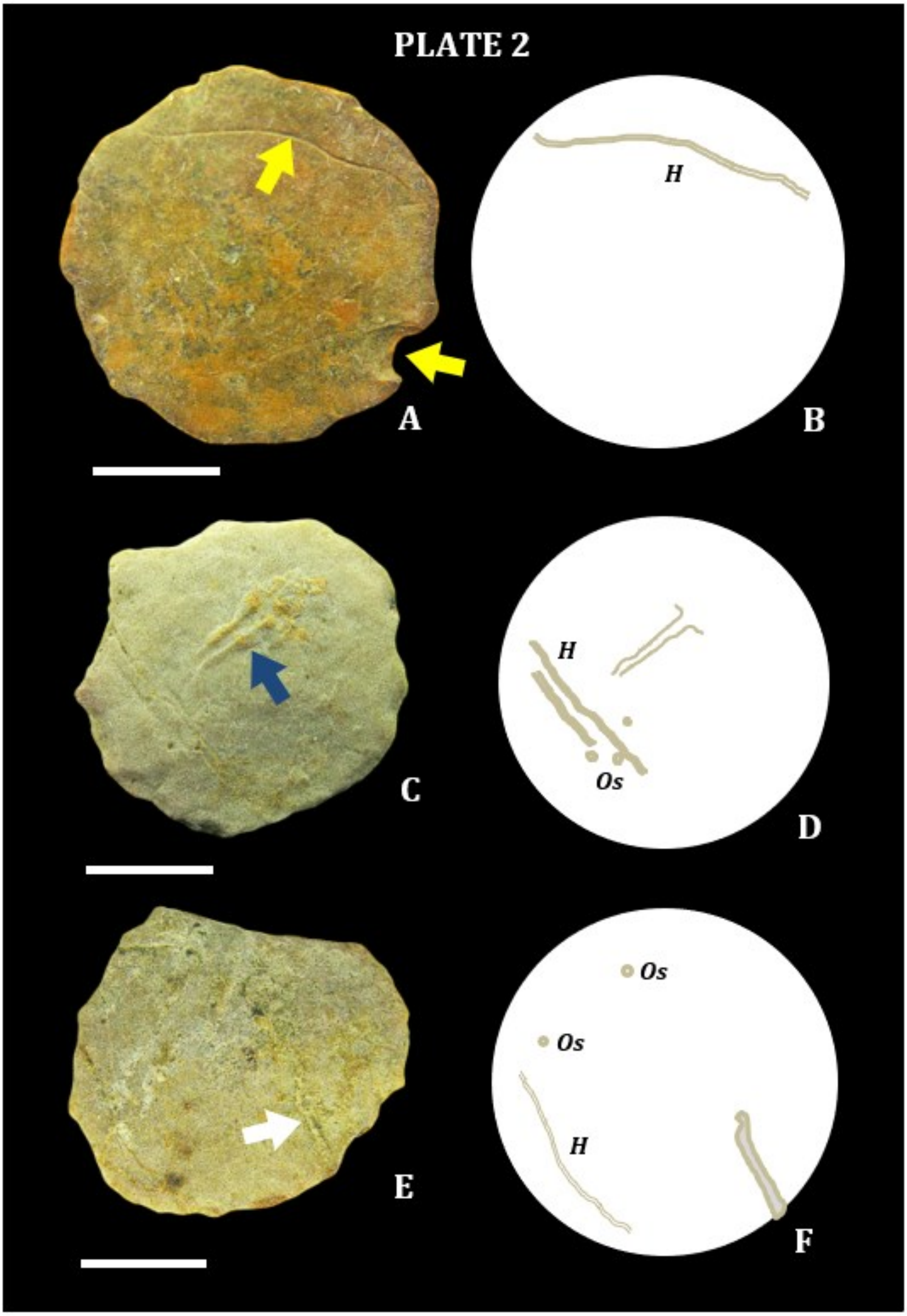

PLATE 2

A, C, E: External view on individual microspheric test of *Discocyclina discus sowerbyi* (Nuttall, 1926)
B, D, F: Closer zoom view showing the bioerosional trace fossil. (A – B) *Helminthoidichnites* isp (yellow arrow); (C – D) *Oichnus simplex*, *Helminthoidichnites* isp, parrotfish bitemark (yellow arrow); (E – F) *Oichnus simplex*, *Helminthoidichnites* isp, and some algae-symbiont traces (white arrow). Scale bar = 1 cm.

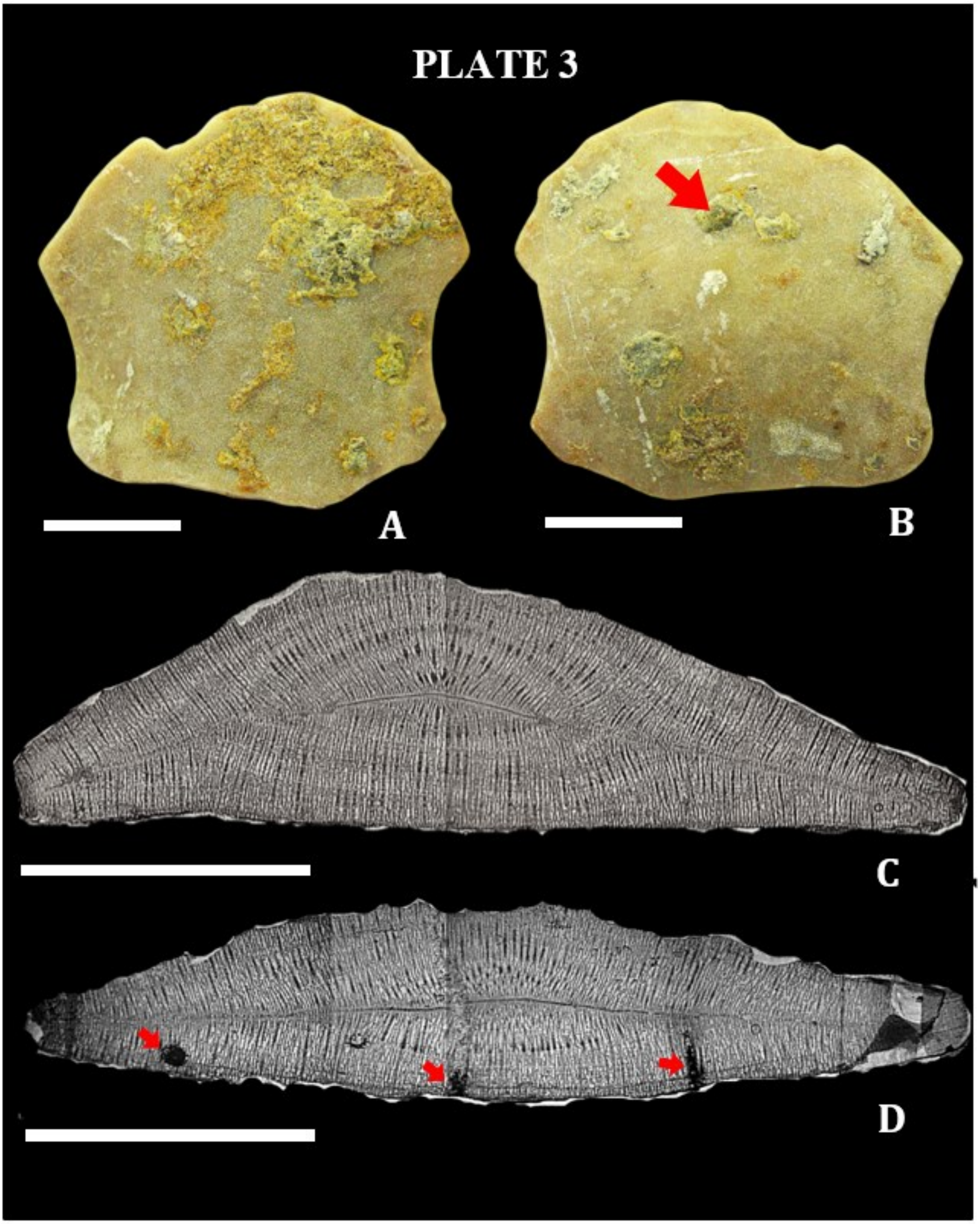

PLATE 3

A – B: External view on individual B-form of *Discocyclina discus sowerbyi* (Nuttall, 1926)
C – D: Axial section of internal B-form of *Discocyclina discus sowerbyi* (Nuttall, 1926)