

Paleoecology of Upper Cretaceous Sediments in Central Iran, Kerman (Bondar-e Bido Section) Based on Ostracods

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Abstract In order to assess the biological potential of ostracods in response to environmental processes, in this study, the Upper Cretaceous sediments of Bondare Bido Section, has been studied. The study Section is located at 45 km away in South-West direction of the Kerman (Iran). The area between northern latitude 57°17' 48" and " western longitude 29°49'44". Due to high sensitivity to environmental changes, the Ostracods are reliable indicators to determine water depth in Upper Cretaceous. On the bases of identified microfossils, the Upper Cretaceous sediments of the study area are Turonian-Maastrichtian in age. These deposits have been biostratigraphically and paleoecological point of view evaluated and boundary between stages are determined. Here we report 13 genres of well preserved ostracods belong to two family Podocopida and Platycopida. The assemblage of ostracods and foraminifera are good indicator of ecological environment during deposition of Cretaceous sediments. The abundance of genus and species of planktonic foraminifera and the presence of some benthic foraminifera and ostracods, may indicate relatively deep and open marine (hemiplegic) environment for these deposits.

Keywords Paleoecology, Central Iran, Ostracod, Upper Cretaceous, Bondare Bido Section

1. Introduction

It is for the first time that foraminifera & ostracods from the Bondare Bido Section were studied by the authors.

The Cretaceous sediments have covered vast area of Kerman. These deposits outcropping at north, north- west and south of Kerman city as an important mountains of Reef limestone.

Samples have been systematically taken from Bondare Bido section and subjected for investigation.

Most of the ostracods have been identified at genus level and for determination of their age we used present foraminifera, associated with ostracods. The identified index fossils of foraminifera include:

Whiteinella archaeocretacea Pessagno, *Marginotruncana sigali* (Reichel), *Dicarinella concavata* (Brotzen), *Dicarinella asymetrica* (Sigal), *Muricohedbergella holmdelensis* Olsson, *Contusotruncana fornicata* (Plummer), *Macroglobigerinelloides bollii* (Pessagno), *Globotruncana ventricosa*, *Globotruncanita elevata* (Brotzen), *Radotruncana calcarata* (Cushman), *Globotruncanella*

havanensis (Voorwijk), *Globotruncana aegyptica* Nakkady, *Gansserina gansseri* (Bolli), *Contusotruncana contusa*.

The assemblage of index foraminifera fossils suggest Turonian-Maastrichtian age for Bondare Bido Sections.

2. Methodology

The ostracods were studied in three stages including library, field and laboratory studies. In field study, a section was chosen and sampling systematically was done.

In the present study, 58 samples of Upper Cretaceous sediments with a thickness of 265m has have been studied. About 300g of each sample was soaked in water for a few days, and then samples 12cc of 15% hydrogen peroxide solution then samples were macerated using, sieves with a diameter of 30 and 60 meshes.

The dried samples were poured into a tray and ostracods were picked up under optical microscope. After studying and Scanning Electron Microscopy was applied for identification.

2.1. The Geographical Location and Accessibility of Bondare Bido Section

The Bondare Bido Section is located at 45 km away in South-West direction of the Kerman. The area between northern latitude 57°17' 48" and " western longitude 29°49'44,

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this section is located in 1:100,000, geological map of Rayen.

The study area is accessible through the asphalt road of Kerman-Bam (Figure 1).



Figure 1. Accessing roads to Bondare Bido Section, IRAN Roads ATLAS, Gitashenasi Cartographic Geographical Institute (2007)

2.2. Lithostratigraphy of the Upper Cretaceous Sediments in Bondare Bido Section

In thick cream-colored layer of limestone in this region with Cenomanian age is overlaid with other sedimentary series as below:

- The alternation of medium - thick and cream- to yellow-colored layer of limestone with marl with thickness of 80m.
- The alternation of marl with green or cream-colored limestone with thickness of 15m.
- The thick layer of cream-colored limestone with thickness of 20m.
- The green-colored marl with thickness of 50m.
- The medium to thick and yellow- to cream-colored layers of limestone with thickness of 50m
- The red sandstone with thickness of 15m.
- The gray- to green-colored shales with thickness of 30m.
- The red sandstone with thickness of 5m.

These sediments are overlaid by Kerman conglomerate.

2.3. Evaluating of Ostracods in the Studied Section

In this section, 13 genres of ostracods were identified.

The most famous families are *Platycopida* with most abundant genus of *Cytherella* and *Cytherelloidea*, *Podocopida*, *Pontocyprilla*, *Bairdoppilata*, *Pterygocythereis*, *Peleriops*.

Ostracods in Bondare Bido Section include:

The ostracods in samples from lower part of this section are less in numbers. The samples of with the Upper parts of section, Campanian-Maastrichtian in age yielded good number of ostracod. The number and diversity of ostracods are low in shales and calcareous shales. The numbers of ostracods are significantly increased in marls, median shales and calcareous bands. The diversity of ostracods has been reduced by increasing depth and transgression sea water, in this region.

The type of ostracod fauna indicates the depositional environment in different parts of the studied section in a way that *Cytherelloidea* and *Haplocytheridea* genres are related to inner to middle neritic parts. Also, in most samples, the presence of *Cytherelloidea* genus indicates a moderate to hot climate depositional condition.

Genus such as *Paracypris* indicates an increase in the depth and the presence of genus such as *Brachycythere* sp represents a reduction in the depth of the environment. The *Cytherella* specifies open sea with medium depth and neritic conditions of outer shelf to outer bathyal. The *Paracypris* and *Cytherella* show marine conditions with normal salinity.

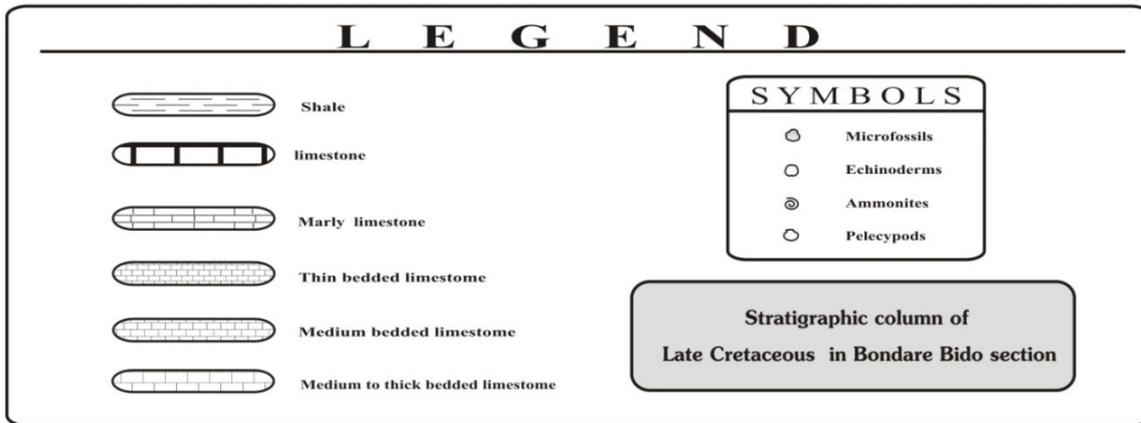
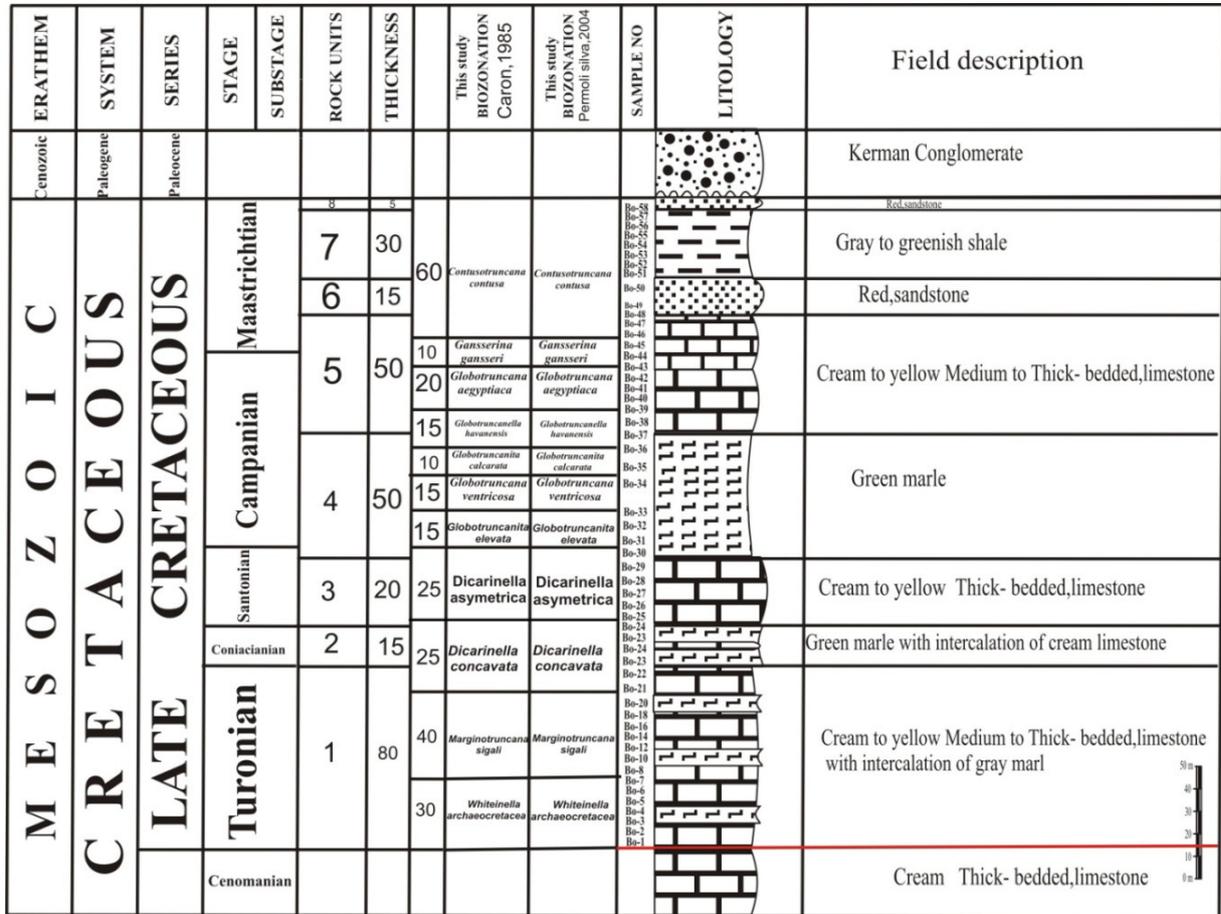


Figure 2. The stratigraphic column of Upper Cretaceous sediments in Bondare Bido Section

2.4. Paleoecological Studies

The Bondare Bido Section comprises diverse assemblages of ostracods fossil. The Platycopida family is one of the most famous families with its most abundant genera of *Cytherelloidea* and *Cytherella* which has been found. In addition, genus of *Pterygocythereis*, *Pontocyprilla* and

Bairdoppilata are the abundant fossils of the platycopida family. Meanwhile, genus *Cytherella* with 29% and genus *Cytherelloidea* with 24% are the most abundant genus. The paleoecological studies are by samples were counted and percentages were done and their graphs were drawn. Carried out by counting the numbers of species and graphs of their percentage is plotted (Fig.3 and 4).

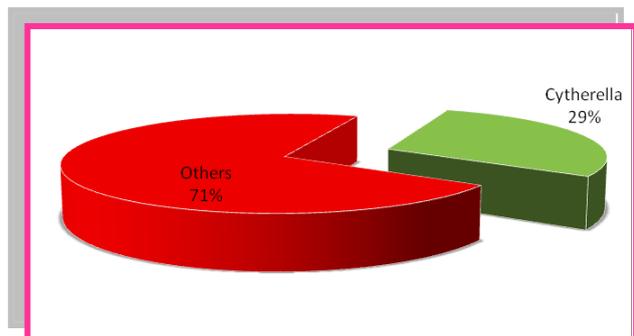


Figure 3. The frequency percentage of *Cytherella* in Bondare Bido Section

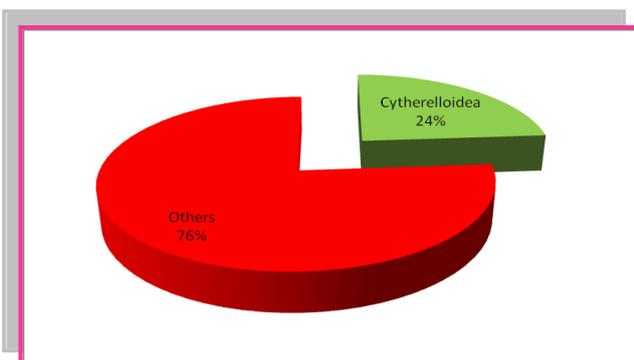


Figure 4. The frequency percentage of *Cytherelloidea* in Bondare Bido Section

The interpretation of the above-mentioned graphs enable us to disuse the, ecological factors based on ostracods in the studied section as follow:

- Salinity

Ostracods basically live in all aquatic environments with different salinities (Moore 1961). The presence of the reported ostracod species and genres such as *Haplocytheridea* in the Bondare Bido Section indicate marine environments with medium salinity of 36 to 39 per thousand and considering of ostracods of this section, it can be said that the salinity of water during the deposition of sediments was between 30 to 40 per thousand.

- Oxygen

The rate of dissolved oxygen in water plays an essential role in distribution of ostracods. Some ostracods species are good indicator of the rate of oxygen in environment. In many gatherings of ostracods in sediments. The percentage of the presence of the fossil ostracods of Platycopids family may use to determine the past oxygen level and as an oxygen dissolution scale in paleo seas. An increase in the presence of fossil Platycopids ostracods indicates the reduction of oxygen in the environment (Whatley *et al.*, 2003).

Considering the presence of fossil Platycopids ostracods (40 to 60%) (Figure 5), one can say that the Upper Cretaceous sediments of Bondare Bido Section is deposited at an environment with moderate oxygen level. Table 1 shows the rate of dissolved oxygen in the water in terms of ml per liter and based on the percentage of the presence of Platycopids.

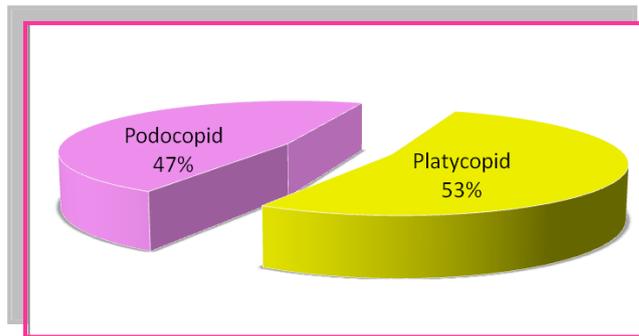


Figure 5. Frequency percentage of Podocopid and Platycopid in Bondare Bido Section

Table 1. Rate of dissolved oxygen in water in terms of ml/l and based on the percentage of Podocopids (according to Whatley and Bajpai 2000)

| Percent | Fossil | Oxygen | Amount |
|---------|-------------|------------------|-------------|
| 80%-90% | Platycopids | Very low oxygen | 2-1ml/l |
| 60%-80% | Platycopids | low oxygen | 3-2ml/l |
| 40%-60% | Platycopids | Medium oxygen | 4-3ml/l |
| 20%-30% | Platycopids | High oxygen | 5-4ml/l |
| 20% | Platycopids | Very high oxygen | Above 5ml/l |

Changes of the percentage of oxygen of the environment have a direct relation with the frequency and diversity of ostracods, therefore the frequency and diversity of ostracods will be declined by decreasing the rate of oxygen in environment. Since the fossil ostracods in Bondare Bido Section had a moderate frequency and diversity, this may confirm the on oxygenated environment.

Some ostracods such as *Xestoleberididae* from *Xestoleberise* family, can not survive in low-oxygen environments. The absence of this genus moderate in the studied section, may indicate the oxygen condition was not dominant in the environment during the deposition of this section.

- Depth

Many important ecological factors such as density, hydrostatic pressure, light, oxygen, temperature and size of bottom are controlled by depth. Ostracods live at various depths of sea from coastline to abyssal area (Cabral, *et al.* 1897). Depth is one of the most important factors that control the diversity of species of ostracods (Cass, 2002). Environment is the main factor in natural selection and evolution of many different forms and structures in the outer skeleton of ostracods. Shape and ornamentations of Carapace reflect their living environment (Gwyneth *et al.*, 1991).

In shallow sea-beds, ostracods have thick valves with eye spots, hard carapace, and amphidetic hinge line and pore channels in beds with coarse sediment. In shoreline (neritic), deeper waters with more fine-grained sediments contain ostracods with smooth, thin, mostly transparent carapaces with a relatively weak hinge line, blind with eye spots.

The presence of *Cytherelloidea*, *Bairdoppilata* and *Pontocyprilla* genres are good indicator of deep sea environment and along with the presence of genus *Brachycythere*, this fossil assemblage represents abyssal

platform depositional condition.

The ratio of carapaces to valves is used to determine the energy of depositional environment. If the number of carapaces is more than valves, this will indicate the quiet and low energy environment condition and vice versa. Since in the studied area, the number of carapaces and valves is almost equal, therefore the environment energy could be moderate.

3. Temperature

Most of the ostracods have the capability of enduring certain range of temperature. Like most of the other creatures, the ostracod assemblages are more diverse in shallow waters of low geographical latitudes than fossil ostracods belong to high latitudes (Friedwald and Mostafavi, 1998). Since the identified medium depth environment, therefore they have been benefited by proper light and temperature. The frequency of *Cytherelloidea* species indicate warm climatic conditions during Upper Cretaceous for Bondare Bido Section

4. Conclusions

In assessing and studying the fossil assemblages of Bondare Bido Section, 13 genus of ostracods were identified. Based on the identified planktonic foraminifera and ostracods, in Bondare Bido Section, the time interval of Upper Cretaceous sediments is proposed as from Turonian to Maastrichtian.

The ostracod genus such as *Haplocytheridea* of Cretaceous sediments in Bondare Bido Section, may indicate marine environments with medium salinity of 36 to 39 per thousand. On the bases of identified ostracod assemblages of studied section, it can be said that during deposition of this formation, the salinity of sedimentary basin was 30 to 40 per thousand.

The increase of fossil ostracod of platycopid families show the reduction of the oxygen of the environment by (Whatley et al, 2003). With regard to the presence of platycopids in the studied section which is 40 to 60%, and it can be concluded that during the deposition of Upper Cretaceous sediments in Bondare Bido Section, the environment had medium oxygen.

The presence of *Cytherelloidea*, *Bairdoppilata* and *Pontocyprella*, indicate deep sea environment and along with *Brachycythere*, this ostracod fossil assemblages indicate the deep part of the platform.

Since the identified medium depth environment, therefore they have been benefited by proper light and temperature. The frequency of *Cytherelloidea* species indicate warm

climatic conditions during Upper Cretaceous for Bondare Bido Section.

Appendix

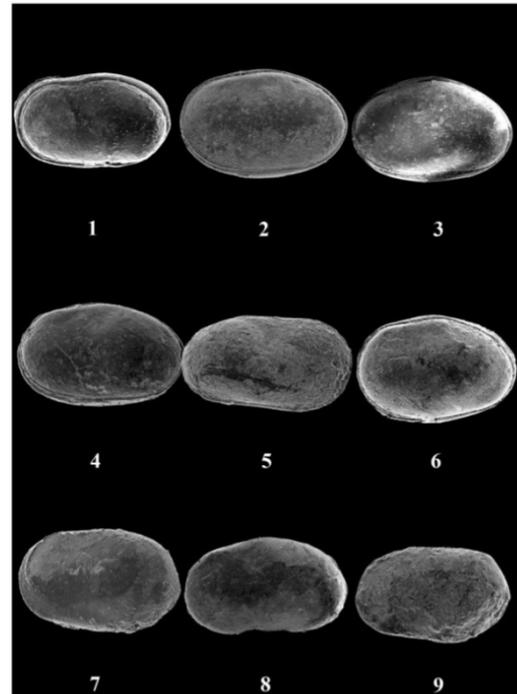


Plate 1.

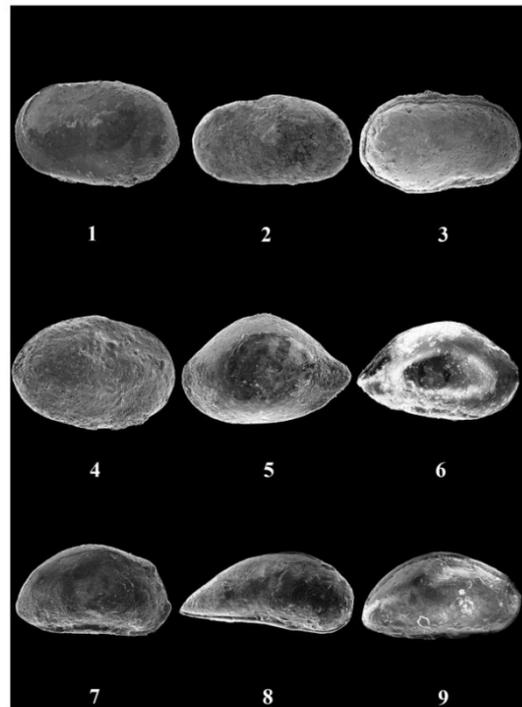


Plate 2.

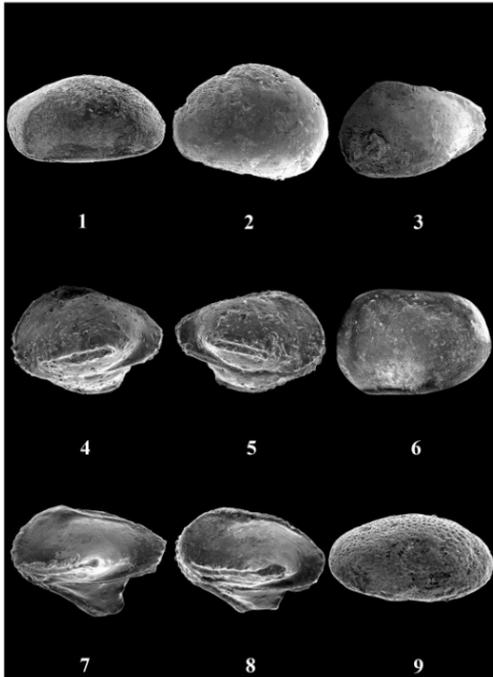


Plate 3.

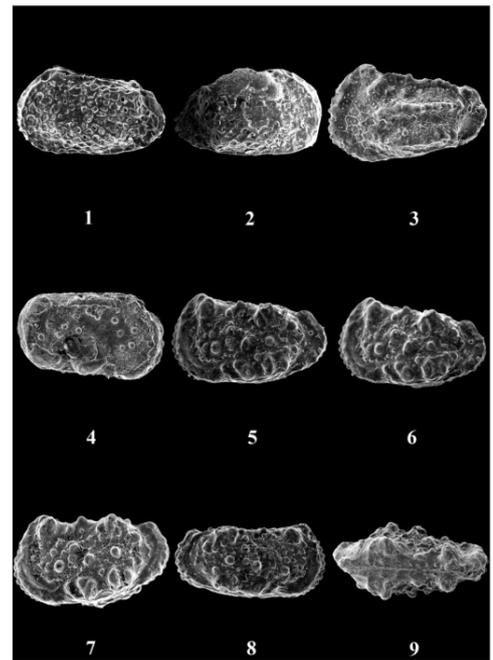


Plate 4.

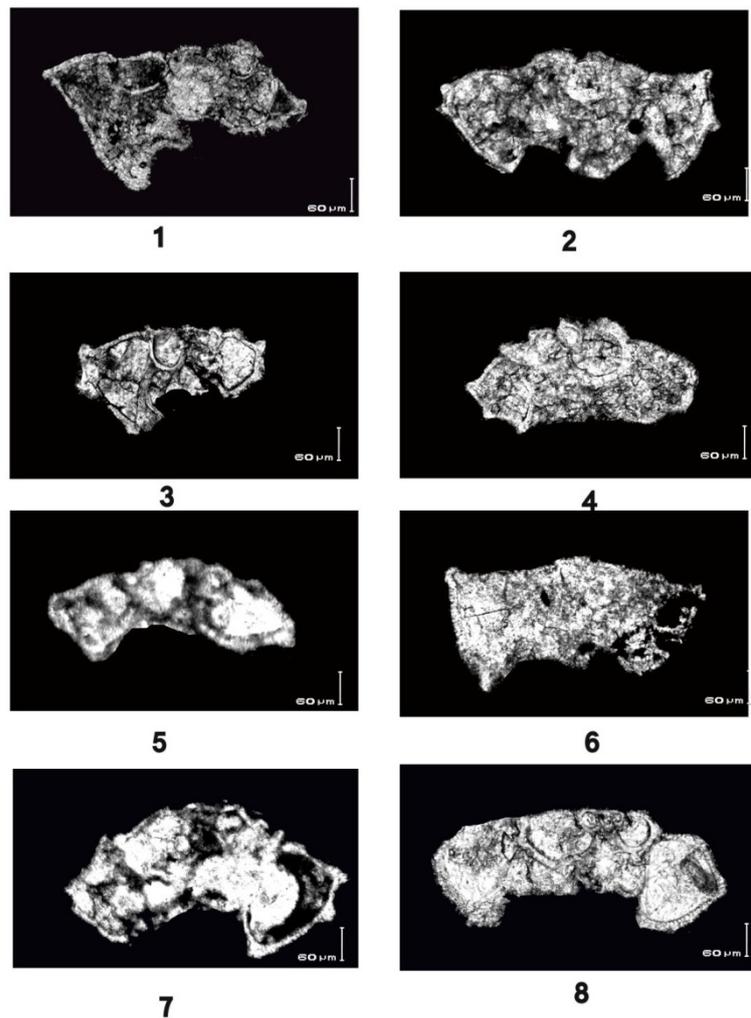


Plate 5.

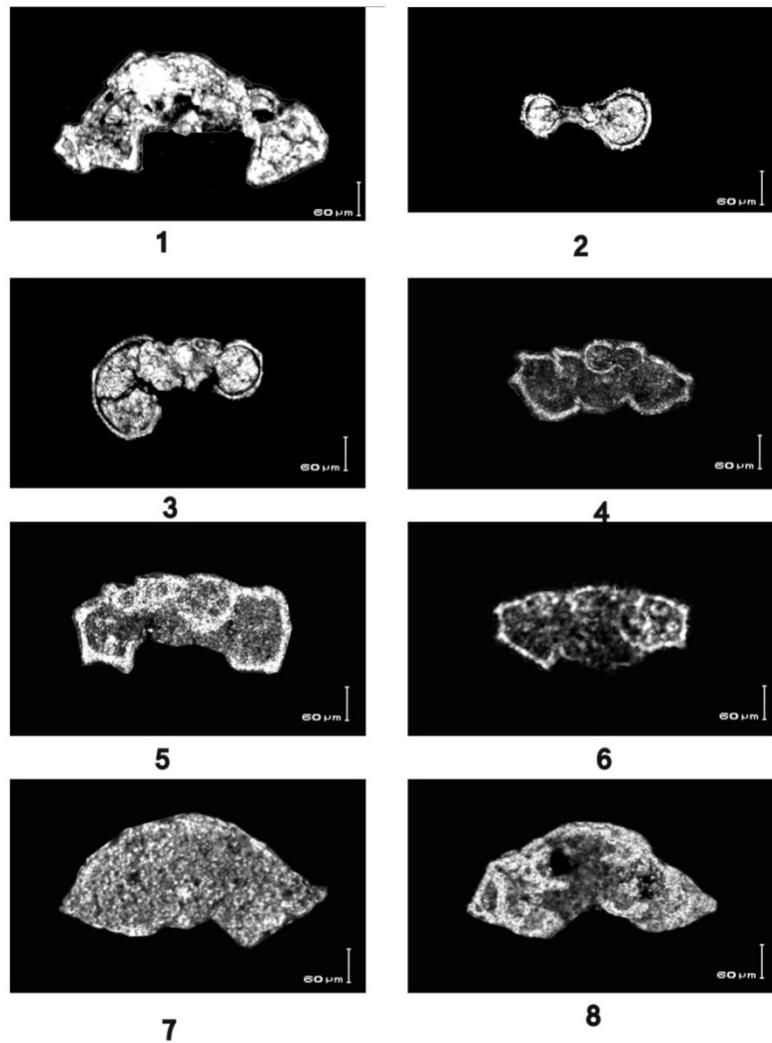


Plate 6.

Plate 1

1-9: *Cytherella* spp., Bondar bido section, Campanian-Maastrichtian

- 1: Carapace, Left valve
- 2: Carapace, Left valve
- 3: Carapace, Left valve
- 4: Carapace, Left valve
- 5: Carapace, Right valve
- 6: Carapace, Left valve
- 7: Left valve
- 8: Left valve
- 9: Left valve

Plate 2

1-4: *Cytherella* spp., Bondar bido section, Campanian-Maastrichtian

- 1: Left valve
- 2: Left valve
- 3: Carapace, Left valve
- 4: Right valve

5-7: *Bairdoppilata* spp., Bondar bido section, Campanian-Maastrichtian

- 5: Left valve
- 6: Carapace, Right valve
- 7: Carapace, Right valve

- 8-9:** *paracypris* spp., Bondar bido section, Campanian-Maastrichtian
8: Carapace, Right valve
9: Carapace, Right valve

Plate 3

- 1:** *Pontocyprilla* sp., Bondar bido section, Campanian-Maastrichtian
 Carapace, Left valve
2: *Eucythere* sp., Bondar bido section, Campanian-Maastrichtian
 Right valve
3: *Pterygocythereis* sp., Bondar bido section, Campanian-Maastrichtian
 Left valve
4-5: *Brachycythere* sp., Bondar bido section, Campanian-Maastrichtian
4: Carapace, Left valve
5: Carapace, Right valve
6: Indet. gen. et sp., Bondar bido section, Campanian-Maastrichtian
 Left valve
7-8: *Pterygocythere* spp., Bondar bido section, Campanian-Maastrichtian
7: Carapace, Left valve
8: Carapace, Left valve
9: *Haplocytheridea* sp., Bondar bido section, Campanian-Maastrichtian
 Left valve

Plate 4

- 1-2:** *Cristaeleberis* spp., Bondar bido section, Campanian-Maastrichtian
1: Carapace, Left valve
2: Right valve
3: *Veeniacythereis* sp., Bondar bido section, Campanian-Maastrichtian Left valve
4: *Cytherelloidea* sp., Bondar bido section, Campanian-Maastrichtian Right valve
5-9: *Peleriops* spp., Bondar bido section, Campanian-Maastrichtian
5: Left valve
6: Left valve
7: Carapace, Left valve
8: Right valve
9: Carapace

Plate 5

- 1:** *Globotruncanita elevata* (Brotzen), Early Campanian
2: *Globotruncana ventricosa* White, Middle Campanian
3: *Globotruncana ventricosa* White, Middle Campanian
4: *Globotruncana bulloides* Vogler, dorsal view, Campanian
5: *Contusotruncana fornicata* (Plummer), Santonian
6: *Gansserina gansseri* (Bolli), Maastrichtian
7: *Globotruncana arca* (Cushman), Late Campanian
8: *Globotruncana bulloides* Vogler, Santonian

Plate 6

- 1:** *Contusotruncana fornicata* (Plummer), Campanian
2: *Macroglobigerinella bollii* (Pessagno), Santonian
3: *Macroglobigerinella prairiehillensis* (Pessagno), Campanian
4: *Globotruncana bulloides* Vogler, Campanian
5: *Globotruncana linneiana* (d'Orbigny), Middle Campanian
6: *Globotruncana ventricosa* White, Campanian
7: *Globotruncanita stuarti* (de Lapparent), Late Campanian
8: *Globotruncanita conica* (White), Late Maastrichtian

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