In this study, the late-Maastrichtian and early-Paleocene transition at the Ziarat-Kola section has been investigated to recognize the biostratigraphy and paleoenvironmental changes. We applied a high-resolution quantitative study by using planktic foraminifera taxa and benthic foraminiferal morphotypes. Sixty-five species belong to twenty-eight genera were identified and seven biozones were differentiated. These biozones are 1. *Racemiguembelina fructicosa*, 2. *Pseudoguembelina hariaensis*, 3. *Pseudoguembelina palpebra*, 4. *Parvularugoglobigerina eugubina*, 5. *Parasubbotina pseudobulloides*, 6. *Subbotina triloclinoides*, 7. *Globonomalina compressa-Preamurica inconstans*. In the late Maastrichtian, benthic and planktic foraminifera are well mixed of epifauna/infauna morphotypes and diversified suggesting a stable and mesotrophic environment. By contrast, the early Paleocene is marked by high values of epifaunal benthic morphogroups, and extinction of Cretaceous species suggesting highly unstable and variable conditions, partly due to the dramatic collapse of calcareous primary producers. Additionally, four different zones were determined based on the benthic foraminifera morphogroups that show several changes in oxygen and organic matter flux during this time. Also, analysis of planktic foraminifera genera in this section indicating a close similarity with assemblages in Tethyan provinces.

**Contribution/Originality:** This study contributes a new methods to understand the biostratigraphy and ageing the rock samples in late Cretaceous of eastern Tethys. Also, This study is one of very few studies which have investigated the pal ecology and oxygen changes in Campanian-Maastrichtian sediments by using the planktic and benthic foraminifera that are small microorganism.

**1. INTRODUCTION**

The Alborz range comprises Precambrian to Quaternary rocks, which contain unconformities in Paleozoic and Mesozoic formations (Alavi, 1996). Late Cretaceous succession has been poorly studied in northern Iran but strong variability in the sedimentary environments among sections has been observed (Asgharian et al., 2009; 2012; 2013a; 2013b; 2018). The very high rate of sediment accumulation in the studied area created a great potential for biostratigraphy and evaluating the timing of environmental changes during this age. The Ziarat-Kola section is located about 8 km south of Ziarat-Kola village, south of Neka city in the northern flank of Central Alborz Mountains (36°31'30" N, 51°45'30" E) (Figure 1). Late Maastrichtian and Paleocene strata are consisting of monotonous green to light grey marl, interbedded with marly limestones that are rich in foraminifera, ostracods and other microfossils (Asgharianrostami et al., 2009; 2012). In the last decades, one of the most utilized fossil
groups to address the environmental change has been known as planktonic and benthic foraminifera. Planktonic foraminifera are very sensitive to climatic and oceanographic changes and their dramatic event has been documented by many specialists in several sections and sites (Luterbacher and Premoli-Silva, 1964; Molina et al., 2005; Gallala et al., 2009; Asgharian et al., 2009; 2011; 2012; 2013a; 2013b; 2014; 2018; Frontalini et al., 2016; Menichetti et al., 2016; Martin et al., 2017; Amao et al., 2018; Rodelli et al., 2018). The aim of this paper is to provide a biostratigraphical scheme and the paleoenvironmental change in the Ziarat-Kola section (Northern Alborz, Iran) by using planktic and benthic foraminifera across the late Maastrichtian-early Paleocene.

2. MATERIALS AND METHODS

For this study, we collected ninety-one samples along a ~212-meter thickness at 2-2.5 meters intervals. The samples were disaggregated in tap water and washed through 125 μm and 63 μm sieves and dried at 50 °C. All the samples were used for planktic foraminifera biostratigraphy and some of them for quantitative analyses of planktic and benthic foraminifera. At least 300 specimens of planktic foraminifera were picked from the > 125 μm and 63-125 μm fractions, and 300 specimens of benthic foraminifera were picked from >125 μm fraction. The relative abundance of foraminiferal species is defined as follows: abundant (> 20%), common (> 5–20%), few (1–5%), and rare (< 1%) (Asgharian et al., 2018). A variety of late Maastrichtian and early Paleocene planktic foraminiferal biozonation schemes have been proposed in the literature, among them, Berggren et al. (1995); Olsson et al. (1999); Ben Abdelkader et al. (1992) and Berggren and Pearson (2005) are the most commonly used. Here, we adopted the zonal schemes of for the uppermost Maastrichtian, and Berggren and Pearson (2005) for the Danian. Additionally, benthic foraminiferal morphotypes have been used to infer microhabitat and reconstruct the paleoenvironmental condition (Corliss and Chen, 1988; Alegret et al., 2003).

Figure 1. Map of the northern Iran and location of studied area.

3. RESULT AND DISCUSSION

3.1. Planktonic Foraminifera Biostratigraphy

Planktic foraminifera are one of the best groups for studying biostratigraphy, paleoecology, and paleogeography especially at the end of Cretaceous due to having high diversity, great preservation, and global distribution. Planktic foraminifera biostratigraphy of upper Cretaceous in Tethys basin has been studied by Caron (1985) that was subsequently revised by Robaszynski et al. (1995). Later, Li and Keller (1999a;1998b) divided the Campanian-Maastrichtian interval to ten biozones named as (CF, Cretaceous foraminiferal) based on the planktic foraminifera. Finally, the upper Cretaceous biozones in Tethys basin were revised by Petrizzo (2003) and Arenillas
et al. (2004). Additionally, Paleocene biostratigraphy by planktic foraminifera has studied by Berggren et al. (1995); Keller et al. (1995); Olsson et al. (1999) and Berggren and Pearson (2005). Here, we adopted the zonal scheme of Li and Keller (1998a;1998b) for the upper Maastrichtian and Berggren and Pearson (2005) for the Paleocene (Figures 2, 3, and 4; Plates 1-6). Planktic foraminifera in the Ziarat-Kola section are abundant and very well-preserved. On the basis of a high-resolution study of planktic foraminiferal, seven planktic foraminiferal biozones have been recognized through the late Maastrichtian-early Paleocene. In this study, classification and taxonomy of the planktic foraminifera are based on Postuma (1971); Caron (1985); Loeblich and Tappan (1988). These biozones are 1) Racemiguembelina fruticosa Zone (CF4), 2) Pseudoguembelina hariaensis (CF3) Zone, 3) Pseudoguembelina palpebra (CF2) Zone, 4) Parvularugoglobigerina eugubina Zone, 5) Parasubbotina pseudobulloides Zone, 6) Sabbotina triloculinoides Zone, and 7) Globanomalina compressa/Praemurica inconstans Zone (Figures 2 and 3; Plates 1-6). Most researchers define the late Maastrichtian interval by introducing *Abathomphalus Mayaroensis* Zone (Caron, 1985; Petrizzo, 2003). Then, Li and Keller (1998a;1998b) divide *A. Mayaroensis* Zone into four zones for better identification of high thickness of late Maastrichtian interval. Additionally, *A. mayaroensis* is known as a poor biostratigraphic marker due to *diachronity* (Li and Keller, 1998a;1998b; Petrizzo, 2003).

### 3.1.1. Racemiguembelina Fruticosa Partial range Zone (CF4) (Li and Keller, 1998a;1998b)

This zone was named by Li and Keller (1998a) and it is defined as a stratigraphic interval limited by the LO (lowest occurrence) of *R. fruticosa* and the LO of *Pseudoguembelina hariaensis* (Li and Keller, 1998a;1998b). This zone spans about 1.5 My (68.33-66.83) that showing upper Maastrichtian and beginning of this zone is approximately simultaneous with appearance *Abathomphalus mayaroensis* species (Caron, 1985). It consists of 22 m thick brown marlstone in this section. The dominant species in this zone are: *Racemiguembelina fruticosa*, *Racemiguembelina poczelli*, *Globotruncana havanensis*, *Globotruncanella petaloidea*, *Rugoglobigerina rugosa* *Pseudotextularia intermedia*, *Abathomphalus mayaroensis*, *Contusotruncana patelliformis*, *Gansserina gansseri*, *Gansserina wiedenmayeri*, *Globotruncanca egypitaca*, *Globotruncanca arca*, *Globotruncanca dupenblei*, *Globotruncanca mariei*, *Pseudoguembelina costulata*, *Pseudoguembelina palpebra*, *Pseudotextularia nutalli* and *Trinitella Scotti* (Figures 2 and 3; Plates 1-4). The age estimation of this biozone by (Li and Keller, 1998a) is early-late Maastrichtian.

### 3.1.2. Pseudoguembelina Hariaensis Partial Range Zone (CF3) (Li and Keller, 1998a;1998b)

This zone characterized by the first appearance of *Pseudoguembelina hariaensis* at the base and the HO (Highest occurrence) of *Gansserina gansseri* at the top (Li and Keller, 1998a) This biozone spans about 1.4 My (66.8-65.45 Ma) that showing late-Maastrichtian stage (Li and Keller, 1998a). This zone spans 66 m of brown marl and limy marl. The dominant species in this zone are *Gansserina gansseri*, *Globotruncanca egypitaca*, *Globotruncanca arca*, *Globotruncanella havanensis*, *Globotruncanella petaloidea*, *Planoglobulina carseeae*, *Planoglobulina riograndensis*, *Pseudoguembelina costulata*, *Pseudoguembelina exclata*, *Pseudoguembelina palpebra*, *Pseudotextularia elegans*, *Pseudotextularia intermedia*, *Rugoglobigerina rugosa*, *Trinitella Scotti*, *Racemiguembelina poczelli*, *Heterohelix globulos* and *Laeviheterohelix gabrans* (Figures 2 and 3; Plates 1-4). This biozone is placed in the middle of Late-Maastrichtian by Li and Keller (1998a).

### 3.1.3. Pseudoguembelina Palpebra Partial Range Zone (CF2) (Li and Keller, 1998a;1998b)

This zone has been limited between the LO of *Gansserina gansseri* to LO of *Plummerita hantkeninoides* Zone (Li and Keller, 1998a). However, due to lack of *Plummerita hantkeninoides* species, this zone defined by last appearance of *Gansserina gansseri* to the HO of Cretaceous taxa. Lack of *Plummerita hantkeninoides* can be due to unconformity in this section. This biozone spans about 0.45 My (65.45-65.00) that showing uppermost part of Maastrichtian. This partial range zone comprises 136 m of grey marl and limy marl. The dominant species in this zone
are Globotruncanara arca, Globotruncanamarie, Globotruncanella havanensis, Pseudoguembelinapalpegra, Pseudotextulariae e
egs, Pseudotextulariaintermedia, Rugoglobigerinahexacamerata, Rugoglobigerinarugosa, Trinitellascotti, Racemiguelbelinaposselli, Heterohelixglobosus, Laeviheterohelixglabrana, Globigerinelloloidesbollii,
Globigerinelloloides subcarinata and Schackoinamultispinata (Figures 2 and 3; Plates 1-4). The age estimation of this
biozone show late Maastrichtian based on (Li and Keller, 1998a). Absent of Plummeritahankkeninoides and
Guembelitriacretacea Zones and stratigraphic evidence show an unconformity between Cretaceous and Paleocene
succession in the Ziarat-Kola section Northern Alborz. Additionally, it is possible these zones have been missed due
to low-resolution sampling.

3.1.4. Parvularugoglobigerina Eugubina Total Range Zone (Pt)

This zone firstly introduced as the total range of the Pseudoglobigerinapseudobulloides Zone. This zone was defined
by Luterbacher and Premoli-Silva (1964). Later, this zone was emended by Toumarkine and Luterbacher (1985); Molina et al. (1996) and Arenillas et al. (2004) that indicated the top part of Pseudoglobigerinapseudobulloides Zone. The age estimate for this zone is between 64.981 and 64.945 Ma (Berggren and Pearson, 2005).
At Ziarat-Kola section, this zone is 1m thick, and Parvularugoglobigerinaeugubina, Eoglobigerinaedita, Parasubbotinaff. Pseudoglobuloides, Hedbergella holmdelensis, Hedbergellamonnathoensis, Globocunusa daubjergensis, Chiloguembelina
morsae and Parvularugoglobigerinabalambamensis dominated the planktic foraminiferal assemblages (Figures 2 and 3;
Plates 5-6). The age of this zone is defined as early Danian.

3.1.5. ParasubbotinaPseudobulloides Partial Range Zone (P1a)

This zone has been defined as the partial-range zone from the HO of Pseudoglobigerinapseudobulloides Zone. This zone was firstly introduced by Leonov and Alimarinia (1961) as Globigerinapseudobulloides-Globigerinadaubjergensis Zone, and Bolli (1966) changed the name to G. pseudobulloides Zone. This zone was defined by Toumarkine and Luterbacher (1985) as HO of Pseudoglobigerinapseudobulloides and the LO of Acrinarinatrinidadensis. Later, this zone emended by Molina et al. (1996) and was defined as the LO of Ps. pseudobulloides and LO Globanomalina compressa species. This biozone spans about (64.8-64.3 Ma) that showing early Paleocene (Danian). At Ziarat-Kola section, the Parasubbotinapseudobulloides Zone with a 2 m thickness is dominated by Eoglobigerinedita, E. eobulloides, Pseudoglobuloides, P. pseudoinconstans, P. taurica, C. morsae, G. planocompressa and Globocunusa daubjergensis species (Figure 3; Plates 5-6).

3.1.6. Subbotinatriloculinoides Partial Range Zone (P1b)

This zone is a partial range of Subbotinatriloculinoides taxon limited by the LO of S. triloculinoides and the first
appearance of Globanomalina compressa-Praemurica (Berggren and Pearson, 2005). The age estimated for this zone
spans about 64.3-62.87 Ma that determining early Paleocene (Early to mid-Danian). This biozone also introduced
by Berggren (1969); Berggren et al. (1995); Berggren and Norris (1997); Olsson et al. (1999) and it consists of 5 m
brown gray and green clayey marl at the Ziarat-Kola section. The dominated species in this zone include
Eoglobigerinedita, Parasubbotinaff. Pseudoglobuloides, Hedbergella holmdelensis, Hedbergellamonnathoensis, Globocunusa daubjergensis, Chiloguembelina morsae, Parvularugoglobigerinabalambamensis, Woodringina hornerstownensis and
Woodringinaclaytonensis (Figure 3; Plate 5-6).

3.1.7. GlobanomalinaCompressa/PraemuricaInconstans Interval Zone

This biostratigraphic interval identified by LO of Globanomalina compressa and/or Praemurica inconstans and the
LO of Praemuricauncinata which show middle to late Danian age (62.87-61.37 Ma) (Berggren and Pearson, 2005).
This zone nominated by Slutskaya (1970) at Trinidad and later emended by Berggren (1969); Berggren et al. (1995); Berggren and Norris (1997); Olsson et al. (1999) and Berggren and Pearson (2005). This biozone is consists
of 2 m monotonous grey marl and limestone. The dominated species of this zone are *Parasubbotina Pseudobulloides*, *Parasubbotina aff. pseudobulloides*, *Globoccona daubjergensis*, *Chiloguembelina morssei*, *Parvularugoglobigerina alabamensis*, *Preamurica psudoconstans*, *Preamurica constans*, *Woodringina hornerstonensis*, *Chiloguembelina morssei* and *Subbotina trilocinoides* (Figure 3; Plates 5-6).

### 3.2. Paleoenvironmental Reconstruction

Benthic foraminifera are critical tool for determining of environmental conditions, such as bathymetry, sea level change, water mass, productivity and oxygenation (Culver, 2003; Asgharianrostami et al., 2013a; 2014; Frontalini et al., 2016; Menichetti et al., 2016; Amao et al., 2018; Rodelli et al., 2018). Based on quantitative analysis of the late Maastrichtian and early Paleocene benthic foraminiferal morphotypes (Epifauna/Infauna) two distinct assemblages were recognized (Figure 5). The comparison of fossil and recent communities of benthic foraminifera, in addition to morphotype analysis (Corliss and Chen, 1988) allows us to monitor probable microhabitat preferences and environmental parameters such as the nutrient availability to the seafloor and seawater oxygenation (Bernhard, 1986; Jorissen et al., 1995; Alegret et al., 2003). We divided all benthic foraminiferal taxa to epifauna and infauna morphogroups by using Corliss and Chen (1988) and Alegret et al. (2003). In general, benthic foraminifera with plano-convex, biconvex, rounded trochosphiral, tubular, coiled flattened, as well as miliolite and palimate tests are inferred to have an epifaunal mode of life (living at the sediment surface or in upper few centimeters). Infaunal morphotype living in the deeper layers of the sediment (4-10 cm within the sediment) and have cylindrical flattened tapered, spherical, rounded planispiral, flattened ovoid, globular unilocular and elongate multilocular shape tests. Generally, benthic foraminifera epifauna indicates well oxygenated and decrease food supply condition and infauna show high food supply condition. The first assemblage characterizes the late Maastrichtian interval which is highly diversified and composed of a mixture of epifaunal and infauna morphogroups, though epifaunal are less abundant (Figure 5). Based on high diversity and high infauna percentage, this assemblage suggests stable and mesotrophic to moderately eutrophic conditions with high availability of food at the seafloor. Additionally, the relatively high percentages of the agglutinated test might indicate high supply of terrigenous material in this part. At the second assemblage (early Paleocene), a dramatic change in the benthic foraminiferal morphotypes and tests was recognized (Figure 5). At this part, the relative abundances of infauna morphotype decreased drastically (~30% of the assemblages). This assemblage is mostly composed of epifaunal species that account up to ~70% that clearly reflects a drastic collapse in the food supply to the seafloor and oligotrophic condition. This pattern was also reported in many sections and sites above the K/Pg boundary (Alegret et al., 2003; Coccioni and Marsili, 2007; Alegret and Thomas, 2009; Asgharian et al., 2018). Additionally, this change may suggest mainly oligotrophic conditions and a lowered food supply to the sea floor that probably related to the mass extinction of calcareous plankton include nannoplankton and planktic foraminifera.

### 3.3. Paleogeography

Planktic foraminifera are not only applied for biostratigraphy, paleoecological and palaeoceanographical but they can also use for paleogeography studies. During the Cretaceous, the temperature gradient from equator to pole was less than today and Boreal and Tethyan basins were separated from each other by a warm water mass current (Bailey and Hart, 1979; Caron, 1985). The cold boreal and austral provinces characterized by planktic foraminifera forms like globular chambers and thin walls such as Hedbergella, Globigerinelloids, Heterohelix, Whiteinella, Archaeoglobigerina and Rugoglobigerina (Caron, 1985) (Table 1). On the other hand, the warm water provinces are characterized by species with thick-walled and ornamented by keels. These taxa include Marginotruncana, Globotruncana and Globotruncanita and Gansserina that occupy the Tethyan province (Table 1). Based on the study of planktic foraminifera genera at the Ziarat-Kola section, Globotruncanita and Globotruncanita genera are
dominated at this section compare to Globogerinoides and Hedbergella. Therefore, these data suggest this section has a close similarity with the planktic foraminifera genera in the Tethyan provinces.

| Genus of cold water | Genus of warm water | Abundance genus in this section |
|---------------------|---------------------|-------------------------------|
| Archaeoglobigerina  | Dicarinella         | Globotruncanita                |
| Globigerinelloides  |                     | Globotruncanita                |
| Heterohelix         |                     | Marginotruncanita              |
| Hedbergella         |                     | Planomalina                    |
| Whiteinella         |                     | Rotalipora                     |
|                     |                     | Helvetoglobotruncanina         |

Source: (Modified from Bailey and Hart (1979); Caron (1985)).

4. CONCLUSION

Sixty-five species belong to twenty-eight genera were identified and seven zones were differentiated. These zones include 1. Racemiguembelina fructicosa, 2. Pseudoguembelina hariaensis, 3. Pseudoguembelina palpabra, 4. Parzularugoglobigerina eugubina, 5. Parasubbotina pseudohulloides, 6. Subbotina trilocinoides 7. Globonomalinana compressa-Preamurica inconstans. Based on these zones, late Maastrichtian-early Paleocene age is determined for this section. Additionally, two zones were defined by using benthic foraminifera morphogroups. The first zone indicates a normal and mesotrophic condition with low oxygen and high food supply. However, in the second zone, increasing epifauna show oligotrophic condition with high oxygen and collapse of food availability. Also, comparing planktic foraminifera genera recovered from this section with those of Cretaceous biogeographical provinces indicate a close similarity with assemblages in Tethyan basin.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: We are grateful to Ebrahim Ghasemi-Nejad and Behrouz Darvishzad for their comments.

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| System     | Series | Stage | Biozone          | Thickness | lithology |
|------------|--------|-------|------------------|-----------|-----------|
| Paleogene  | Lower  | Danian| *Pseudoguembelina*  |           |           |
|            | Upper  |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |
|            |        |       | *Pseudoguembelina* |           |           |

Figure 2. Distribution and planktonic foraminiferal zonation of the Ziarat-Kola section. Scale: 20 meter.
| System   | Series | stage | Biozone            | thickness | lithology | sample No |
|----------|--------|-------|--------------------|-----------|-----------|-----------|
| Paleocene| Lower  | Danian| Sublithina contorta/Placoceras |           |           |           |
|          |        |       | Pseudoguembelina pseudobulgarica |           |           |           |
|          |        |       | Pseudoguembelina bulgarica |           |           |           |
|          |        |       | Racemiguembelina fructicosa |           |           |           |
|          | Upper  | Maastrichtian | Pseudoguembelina helgaensis |           |           |           |
|          | Upper  | Maastrichtian | Pseudoguembelina helgaensis |           |           |           |
|          | Upper  | Maastrichtian | Pseudoguembelina helgaensis |           |           |           |

Figure 3. Continue.
Figure 4. Correlation of the proposed biostratigraphic zonal scheme at this study with other accepted standard biozones of other parts of the world.

Figure 5. Planktonic foraminifera genus, benthic foraminifera tests and benthic foraminifera morphotypes in Ziarat-Kola section through late Maastrichtian-early Paleocene.
Plate 1. Scale bar represents 100 µm

1, 2 - Planoglobulina brazoensis; 3 - Planoglobulina acervulinoides; 4 - Pseudoguembelina palpebra; 5, 6 - Pseudoguembelina hariaensis; 7 - Pseudoguembelina costellifera; 8 - Pseudoguembelina costulata; 9 - Laeviheterohelix pulchra; 10 - Laeviheterohelix glabrata; 11a, b - Laeviheterohelix dentata; 12 - Guembilitria cretacea; 13 - Heterohelix punctulata; 14 - Heterohelix globulosa; 15 - Heterohelix navarroensis; 16, 17 - Pseudotextularia elegans; 18 - Pseudotextularia nutallii; 19, 20 - Racemiguembelina fructicosa; 21, 22 - Racemiguembelina poselli; 23 - Pseudotextularia intermedia; 24a, b - Globootruncanella havanensis; 25a, b - Globootruncanella petaloides; 26 - Rugoglobigerina rugosa; 27a, b - Rugoglobigerina macrocephala; 28a, b, c - Rugoglobigerina milamensis.
Plate 2. Scale bar represents 100 µm

1a, b - Globigerinelloides multispinus; 2a, b - Globigerinelloides impensus; 3a, b - Globigerinelloides alvarezi; 4a, b - Globigerinelloides subcarinata; 5a, b - Globigerinelloides asperus; 6a, b - Globigerinelloides prairiehillsensis; 7a, b - Globigerinelloides rosebudensis; 8a, b - Globigerinelloides yaucoensis; 9a, 9b - Globigerinelloides rosebudensis; 10a, b - Hedbergella holmdelensis; 11a, b, c - Contusotruncana patelliformis; 12a, b, c - Contusotruncana contusa; 13, 14 - Contusotruncana contusa; 15a, b, c - Contusotruncana sp.; 16a, b, c - Contusotruncana walfischensis.
Plate 3. Scale bar represents 100 µm

1a,b - Contusotruncana patelliformis; 2a,b,c - Contusotruncana fornicate; 3, 4 - Globotruncanita stuartiformis; 5a,b,c - Globotruncanita stuartii; 6a,b,c - Globotruncanita angulata; 7a,b,c - Globotruncanita insignis; 8a,b,c - Globotruncanita stuartiformis; 9a,b - Contusotruncana sp.; 10a, b - Globotruncanana limusiana; 11a, b, c - Globotruncanana mariei; 12a, b, c - Globotruncanana rosetta; 13a, b, c - Globotruncanana arca.
Plate-4. Scale bar represents 100 µm

1a,b,c- Globotruncanita stuarti; 2a,b,c- Globotruncanita stuartiformis; 3a,b,c- Globotruncanita stuartiformis; 4a,b,c- Gansserina wiedenmayeri; 5a,b,c- Gansserina gansseri; 6a,b,c- Gansserina gansseri; 7a,b,c- Abathomphalus mayaroensis; 8a,b- Trinitella scotti; 9a, b- Schackoina multispinata; 10- Schackoina ernomana.
Plate 5. Scale bar represents 100 µm.

1a,b,c - Praemurica inconstans; 2, 3 - Praemurica pseudoinconstans; 4, 5 - Praemurica taurica; 6, 7 - Subbotina triloculinosida; 8 - Parvularugoglobigerina eugubina; 9a,b - Globanomalina compressa; 10, 11, 12 - Eoglobigerina spiralis; 13, 14, 15 - Eoglobigerina edita; 16a,b - Eoglobigerina eobulloides.
Plate 6. Scale bar represents 100 μm
1, 2, 3- Eoglobigerina eobulloides; 4, 5- Parasubbotina aff. Pseudobulloides; 6- Parasubbotina pseudobulloides; 7- Woodringina hornerstownensis; 8- Chiloguembelina morsei; 9- Woodringina claytonensis; 11, 12- Woodringina hornerstownensis; 13, 14- Zea uvigerina waiparaensis; 15, 16- Globoconusa daubjergensis; 17, 18- Rectoguembelina cretacea.

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