Description Criteria for Eocene Alveolinids: Examples from Inner Western Anatolia

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Abstract. Anatomical and morphological features which are used to describe alveolinid species, and their changes during Eocene are the subjects of this study. Changes in some of these features in time and place are important when interpreting geological history of the species. Thus, preliminary results of an ongoing research on Eocene of Inner Western Anatolia are exampled herein, and the relationship between the species is tried to be interpreted. Faunal associations and environmental characteristics of the species are mentioned. The obtained data show that the most important criteria for describing alveolinids are as follows: test shape, index of elongation, flosculinisation, and coiling types throughout ontogeny. In addition, shape and size of septula and chamberlets, axial thickening, shape and size of the protoconch, and the ratio between the thickness of basal layer and the height of chamber are also important to be considered.

1. Introduction

Alveolinids which are the porcelaneous calcareous larger benthic foraminifera, have been existing in various genera from Cretaceous to Holocene. It is an important foraminiferal group for biostratigraphical, paleoecological, and palaeoenvironmental studies due to representing standard biozones [1] particularly in Eocene. Anatomical and the morphological features which distinguish the species were developed and became more complicated during geological times and evolutionary steps. Both in Turkey and in the rest of the world, a large number of studies on alveolinid genera have been carried out [2-12]. Among them, Hottinger [3] and White's studies [5] reveal the criteria for species description.

Description of alveolinid species, as in all other foraminifera, can be possible by a proper generic description. Although the characteristic features for each genus are numerous, several of them such as: number and shape of apertures, septula patterns (alternating or in alignment), presence of preseptal and postseptal canals are enough for a proper generic description. An algorithm which can be used to determine Cenozoic alveolinid genera, is given in the Figure 1. When describing alveolinid species, axial sections are used; and if possible, megalospheric individuals should be preferred. Although some structural elements are visible in equatorial sections, oblique sections, and in tangential sections; they are insufficient for a clear description. Description criteria of species can be considered under two groups as: internal features and external features. External features related to test morphology are as follows: geometrical shape, axial diameter, equatorial diameter, and the index of elongation. Internal
features are the morphological and biometrical features such as: size and shape of septula and of chamberlets, flosculinisation, axial thickening, size and shape of the protoconch, the ratio between the thickness of basal layer and the height of chamber, presence or absence of juvenile/adult/senile stages and coiling types during these stages (Figure 2).

Figure 1. An algorithm for the determination of Cenozoic alveolinid genera.

Genus Alveolina, first appeared in late Paleocene, was mostly represented by spherical to ovoid shaped, smaller sized species during late Paleocene - early Eocene. Lutetian species were generally cylindrical to fusiform in shape, larger sized and having more number of whorls. Bartonian was the time that evolutionarily the most developed species of the genus Alveolina were come into existence. In this time, individuals were much larger with more whorls. Much fusiform shaped Bartonian species had largest index of elongation. In Priabonian, Alveolina became extinct, and the family Alveolinidae maintained its presence by another alveolinid genera. Index of elongation of the genus Alveolina shows a tendency to increase during Eocene towards the upper stages. Flosculinisation which is defined as the thickening of basal layers is typical for especially early Eocene alveolinids. Heavily flosculinised species are common in that period. In Lutetian, this type of species are exceptional. There is not any flosculinised species known in Bartonian and in Priabonian.
2. Results

Alveolinids obtained from the measured stratigraphical sections in Keçiborlu (Isparta) and Dinar (Afyonkarahisar) areas in the Inner Western Anatolia (Figure 3), indicate two different stages of Eocene. Alveolinid fauna of the Keçiborlu section contains: *Alveolina* (*Alveolina*) *aragonensis*, *A.* (*A.*) *gambaensis*, *A.* (*A.*) *rotundata kazancii*, *A.* (*A.*) gr. *dedolia*, *A.* (*A.*) gr. *triestina*, *A.* (*A.*) gr. *ellipsoidalis*, *Alveolina* (*Gloma*) *karsica*, *A.* (*G.*) *pilula*, *A.* (*G.*) *lepidula*, *A.* (*G.*) cf. *darendensis* (Plate 1). These alveolinids are the individuals of mostly 500 µm to a few millimeters in size, spherical to ovoid in shape. Index of elongation of the species varies between 1 – 2.05. Species with different degree of flosculinisation are present in the association. These alveolinids are associated with such foraminifera as: *Orbitolites bellus*, O. cf. *megaspheiricus*, *Lockhartia* cf. *conditi*, *Nummulites* spp., *Discocyclina* spp., *Asterocyclina* sp., *Opertorbitolites* sp., *Assilina* sp., *Operculina* sp., *Ranikothalia* ? sp. This faunal association is aged as early Ypresian (Ilerdian).

Alveolinid fauna of the Dinar section consists of *A.* (*A.*) *tenuis*, *A.* (*A.*) cf. *orhaniyensis*, *A.* (*A.*) cf. *stercusmuris*, *A.* (*A.*) gr. *levantina* (Plate 1) representing the Lutetian age. These species are generally larger varying between 4-5 mm ovoid to 10-12 mm fusiform shaped individuals. Rarely 3-4 mm sized, spherical to subspherical species are also present. Index of elongation of the species which reaches up to 6.61 are much bigger compared to early Eocene species’. Flosculinisation is observed in only one species. This alveolinid fauna is associated with *Orbitolites complanatus*, *Sphaerogypsina globula*, *Fabiania cassis*, *Gyroidinella magna*, *Nummulites* spp., *Assilina* sp., *Opertorbitolites* sp., *Discocyclina* sp., *Asterigerina* sp., *Gypsina* sp., *Spirolina* ? sp., *Chrysalidina* ? sp., *Soriella* ? sp.

The association of *Alveolina*, *Orbitolites* and *Opertorbitolites*, also the dominant foraminiferal genera of Keçiborlu and Dinar sections, has been reported to be characteristic for the paleoenvironments with low energy [12]. It has also been stated for Paleogene basins that while spherical alveolinids were seen in lagoon sediments, fusiform shaped alveolinids were observed in restricted platform sediments [13], [14]. Faunal associations indicated that early Ypresian levels of Keçiborlu section was deposited in a shallow – very shallow marine environment with low energy which extends from lagoon to restricted shelf with normal salinity. On the other hand, Lutetian levels of Dinar section was interpreted to be deposited in a restricted shelf environment with normal salinity.
3. Conclusions
The study presents description criteria for alveolinids and preliminary results of Eocene alveolinids from the Keçiçorlu (Isparta) and Dinar (Afyonkarahisar) areas (inner western Anatolia). Alveolinids from the investigation areas indicate that the age of the Keçiçorlu section is early Ypresian, and the Dinar section is Lutetian. It has been revealed that alveolinids of the study referring to early Ypresian and to Lutetian ages present similar biometrical and morphological trends with the samples of same species in the literature. Foraminiferal associations show that Keçiçorlu area was a shallow – very shallow marine environment with low energy which extends from lagoon to restricted shelf with normal salinity in early Ypresian. However, in Lutetian, Dinar area was a restricted shelf environment with normal salinity.

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References

[1] J. Serra-Kiel, L. Hottinger, E. Caus, K. Drobne, C. Ferrández, A. K. Jauhri, G. Less, R. Pavlové, J. Pignatti, J. M. Samsó, H. Schaub, E. Sirel, A. Strougo, Y. Tambareau, J. Tosquella, E. Zakrevskaya, “Larger foraminiferal biostratigraphy of the Tethyan Paleocene and Eocene,” Bull. Soc. géol. France, t. 169, no:2 pp. 281-299, 1998.

[2] M. Reichel, “Etude sur les Alvéolines,” Schweizerische Paläontologische Abhandlung (1936), 57 (4), 1-93, II, (1937), 59 (3), 95-147, 1937.

[3] L. Hottinger, “Alveolinids, Cretaceous-Tertiary Larger Foraminifera,” Esso Production Research-European Laboratories, Text and Plate Volumes, 70p., 106 plates, 1974.

[4] K. Drobne, “Alvéolines paléogenes de la Slovénie et de l’Istrie,” Mémoires Suisses de Paléontologie 99, 9–174, 1977.

[5] M. R. White, “On species identification in the foraminiferal genus Alveolina (Late Paleocene–Middle Eocene),” Journal of Foraminiferal Research 22 (1), 52–70, 1992.

[6] A. Dizer, “Sur quelques Alveolines de l’Eocene de Turquie,” Revue de Micropaléontologie 7 (4), 265–279, 1965.

[7] E. Sirel, “Description of six new species of the Alveolina found found in the South of Polatlı (SW Ankara) region,” Bulletin of the Geological Society of Turkey, v. 19, 19-22, 1976.

[8] E. Sirel, and H. Gündüz, “Description of new Borelis species from the Hatay (S of Turkey) and Elazığ region (E of Turkey),” Bulletin Of The Mineral Research and Exploration, Turkey, 92: 70-74, 1981.

[9] E. Sirel, and Ş. Acar, “Praebullalveolina, a new foraminiferal genus from the Upper Eocene of the Afyon and Çanakkale region (west of Turkey),” Eclogae geologicae Helvetiae, Vol. 75/3, 821-839, 1982.

[10] E. Sirel, and Ş. Acar, Glomalveolinids and Alveolinids of Turkey,” Chamber of Geological Engineers of Turkey, Publication 103, Scientific Synthesis of the Lifelong Achievement, Special Volume 2, 108 p., 108 pls., Ankara, 2008.

[11] E. Sirel, N. Özgen-Erdem, and Ö. Kangal, “Systematics and biostratigraphy of Oligocene (Rupelian-Early Chattian) foraminifera from lagoonal-very shallow water limestone in the eastern Sivas Basin (Central Turkey),” Geologia Croatica, 66/2, 83-109, 2013.

[12] L. Hottinger, “Recherches sur les Alveolines du Paleocene et de l’Eocene,” Abhandlungen der Schweizerischen Paläontologischen Gesellschaft, v. 75-76, p. 1-243, 1960.

[13] H. P. Lutherbacher, “Environmental distribution of early Tertiary microfossils, Tremp Basin, Northeastern Spain,” ESSO Production Research- European Laboratories, 46p, 1970.

[14] N. Özgen-Erdem, “Biosstratigraphy of Thanetian-Ilerdian benthic foraminifera in the Akçaatash-Cebeci (NW Tosya-SE Kastamonu) region,” Mineral Research and Exploration Bulletin, 137, 49-59, 2008.
Plate 1: Foraminiferal associations of Keçiborlu section (1-16) and Dinar section (17-30). 1: *Alveolina* (*Alveolina*) aragonensis, 2: *Alveolina* (*Glomalveolina*) cf. darendensis, 3: *A.(G.) pilula*, 4: *A.(G.) lepidula*, 5: *A.(G.) karsica*, 6: *A.(A.) gambaensis*, 7: *A.(A.) rotundata kazancii*, 8: *A.(A.) gr. dedolia*, 9: *A.(A.) gr. triestina*, 10: *A.(A.) gr. ellipsoildalis*, 11: *Orbitolites* cf. megasphericus, 12: *O. bellus*, 13: *Discocyclina* sp., 14: *Asterocyclina* sp., 15: *Nummulites* sp., 16: *Lockhartia* cf. conditi, 17: *A.(A.) tenuis*, 18: *A.(A.) gr. levantina*, 19: *A.(A.) cf. orhaniyensis*, 20: *A.(A.) cf. stercusmuris*, 21: *O. complanatus*, 22: *Gyroidinella magna*, 23: *Sphaerogypsina globula*, 24: *Fabiana cassis*, 25: *Opertorbitolites* sp., 26: *Discocyclina* sp., 27-28: *Nummulites* sp., 29: *Soriella*? sp., 30: *Asterigerina* sp.