Turkish Journal of Earth Sciences (Turkish J. Earth Sci.), Vol. 20, 2011, pp. 185–212. Copyright ©TÜBİTAK
doi:10.3906/yer-1001-43 First published online 13 July 2010

Integrated Oligocene–Lower Miocene Larger and Planktonic Foraminiferal Biostratigraphy of the Kahramanmaraş Basin (Southern Anatolia, Turkey)

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Received 27 January 2010; revised typescript receipt 10 July 2010; accepted 13 July 2010

Abstract: An integrated biostratigraphical analysis based on the larger and planktonic foraminifera from three sections provides a well-defined zonal scheme of the Oligocene–Lower Miocene successions in the Kahramanmaraş Basin. The planktonic foraminiferal zonation is based on a combination of standard (P) and Mediterranean (MMi) zonal schemes and consists of *Turborotalia ampliapertura* (P19), *Globigerina angulisuturalis-Paragloborotalia opima opima* (P21), *Globigerina ciperoensis* (P22) biozones spanning the Upper Rupelian–Chattian interval and *Globoquadrina dehiscens-Globigerinoides altiaperturus* (MMi 2a), *Globigerinoides altiaperturus-Catapsydrax dissimilis* (MMi 2b) and *Globigerinoides trilobus* (MMi 3) biozones in the Upper Aquitanian–Burdigalian interval. The larger foraminiferal zonation of the studied successions has been established by means of European shallow benthic foraminiferal zonation (SBZ). This zonal scheme consists of SB 22B-23 Zone and SB 23 Zone in the Chattian, SB 24 Zone in the Aquitanian and SB 25 Zone in the Burdigalian. By integrating the established foraminiferal zonal schemes, the stratigraphical ranges of some larger foraminifera with planktonic foraminiferal zones have been calibrated. According to the integrated zonation the FO of *Nephrolepidina morgani* falls into the P21 Zone; *Nummulites vascus* and *Eulepidina dilatata* last occur in the P22 Zone; *Miolepidocyclina burdigalensis*, *Miogypsina intermedia* and *Borelis curdica* first occur in the MMi 2b Subzone, whereas *Nephrolepidina* spp. last occur within the same subzone.

Key Words: larger foraminifera, planktonic foraminifera, integrated biostratigraphy, Oligocene, Early Miocene, Kahramanmaraş Basin, Southern Anatolia

Kahramanmaraş Havzası'nın Birleştirilmiş Oligosen–Alt Miyosen İri Bentik ve Planktonik Foraminifer Biyostratigrafisi (Güney Anadolu, Türkiye)

Özet: Kahramanmaraş Havzası, iri bentik foraminifer içeren sığ denizel kireçtaşları ile planktonik foraminifer içeren hemipelajik çökellerin ardalanmasından oluşan yaygın Oligo–Miyosen istifleri nedeniyle birleştirilmiş foraminifer biyostratigrafisinin uygulanabileceği ender bölgelerden birisidir. Bu istiflerde ölçülen üç stratigrafi kesitinde tanımlanan bentik ve planktonik foraminifer toplulukları havzanın detaylı Oligosen–Alt Miyosen biyostratigrafik çatısının kurulması yanında bazı iri bentik foraminifer taksonlarının stratigrafik dağılımlarının planktonik foraminifer zonları ile kalibre edilmesini de sağlamıştır. Çalışılan istiflerin planktonik foraminifer biyostratigrafisi için standard (P) ve Akdeniz (MMi) biyozon şemaları kullanılmış ve Üst Rupeliyen–Şatiyen'de *Turborotalia ampliapertura* (P19), *Globigerina angulisuturalis-Paragloborotalia opima opima* (P21) ve *Globigerina ciperoensis* (P22) zonları, Üst Akitaniyen–Burdigaliyen'de ise *Globoquadrina dehiscens-Globigerinoides altiaperturus* (MMi 2a), *Globigerinoides altiaperturus-Catapsydrax dissimilis* (MMi 2b) ve *Globigerinoides trilobus* (MMi 3) zonları saptanmıştır. Üst Oligosen–Alt Miyosen iri bentik foraminifer zonasyonunun oluşturulmasında ise Avrupa Sığ Bentik Foraminifer Zon şemasından (SBZ) yararlanılmış ve Şatiyen'de SB 22B-23 ve SB 23 zonları, Akitaniyen'de SB 24 Zonu ile Burdigaliyen'de SB 25 Zonu tanımlanmıştır. Birleştirilmiş zonasyonlara göre *Nephrolepidina morgani* P21 Zonu'nda ilk kez ortaya çıkarken *Nummulites vascus* ve *Eulepidina dilatata* P22 Zonu'nda ortadan kalkmaktadır. *Miolepidocyclina burdigalensis*, *Miogypsina intermedia* ve *Borelis curdica*'nın ilk ortaya çıkışları MMi 2b Altzonu'nda saptanırken *Nephrolepidina* spp. aynı zonda ortadan kalkmaktadır.

Anahtar Sözcükler: iri foraminifer, planktonik foraminifer, birleştirilmiş biyostratigrafi, Oligosen, Erken Miyosen, Kahramanmaraş Havzası, Güney Anadolu

Introduction

Larger benthic foraminifera occur most abundantly in shallow-water carbonates and are commonly used in biostratigraphy and palaeoenvironmental reconstruction. However, it is known that often the occurrences of larger foraminifera are controlled by facies changes. Moreover, they show provincialism resulting in the characterizing by different taxa of American, Indo-Pacific and Mediterranean bioprovinces in the Cenozoic (Adams 1983; Racey 1995; Wielandt 1996; Boudagher-Fadel & Banner 1999; Banerjee *et al.* 2000; Boudagher-Fadel 2002; Renema 2007). Faunal differences and non-contemporenous occurrences (diachronous first and last occurrences) arising from provincialism and migration events make interregional correlation based on larger foraminifera quite difficult and problematic. The only way of obtaining reliable worldwide correlation is to prepare the independent range charts of larger foraminifera for each province and to correlate them with planktonic biozonations (Adams 1983). Unlike the larger foraminifera, planktonic foraminifera are widely recognized as a key tool for regional and worldwide biostratigraphic correlations due to their extremely high abundance and widespread nature in marine sequences. Moreover, their short stratigraphical ranges as well as the revised calibration of a set of bioevents with geochronologic time scale make planktonic foraminifera an excellent calibration tool in different time intervals (Berggren *et al.* 1995; Iaccarino *et al.* 1996; Lourens *et al.* 2004). Adams's pioneering work (1984) started the integration of plankton biostratigraphy with 'Letter Stages' based on larger foraminifera in the Indo-Pacific realm. Subsequently a larger foraminiferal zonation (SBZ) for the Oligocene–Miocene of western European basins correlating with the revised standard planktonic foraminiferal scheme of Blow (1969) by Berggren *et al.* (1995) was proposed by Cahuzac & Poignant (1997). However, the coexistence of larger and planktonic foraminifera in the same stratigraphical sections is generally a rare opportunity to calibrate the stratigraphical range of larger foraminifera and to establish a well-defined biostratigraphical framework based on these two groups.

The Oligocene–Lower Miocene succession in the Kahramanmaraş Basin (Southern Anatolia, Southern Turkey) is one of the most suitable sequences for such an integrated biostratigraphic framework due to the occurrence of limestone containing larger foraminifera alternating with shale, marl and clayey limestone layers rich in planktonic foraminifera. The Kahramanmaraş Basin is part of an elongated foreland basin, extending from Hakkari to Adana which was formed as a result of the collision of Eurasian and Arabian plates along the Bitlis Suture Zone (Perinçek 1979; Şengör & Yılmaz 1981; Perinçek & Kozlu 1983; Hüsing *et al.* 2009). This basin is located on the Arabian Plate and near the triple junction of Anatolian, Arabian and African plates (Figure 1a). Marine sedimentary successions ranging from Eocene to Miocene age, widely exposed in the Kahramanmaraş Basin (Figure 1b), mainly consist of shallow-water carbonates and hemipelagic carbonate, marl and turbiditic sediments. A number of studies carried out in the basin have concentrated on the structural and depositional history and lithostratigraphy of these sedimentary successions (Gül 1987, 2000; Önalan 1988; Herece 2008; Hüsing *et al.* 2009). These studies reported that these successions contain rich planktonic and benthic foraminiferal assemblages characterizing the stratigraphical setting in the basin. Recently, various planktonic foraminiferal zonations (Blow 1969; Bizon & Bizon 1972; Iaccarino 1985; Berggren *et al.* 1995; Iaccarino *et al.* 1996) and the European larger foraminiferal zonation (SBZ) have been applied to Oligo–Miocene successions in Turkey (Sirel 2003; Nazik 2004; Sancay *et al.* 2006; Özcan & Less 2009; Özcan *et al.* 2009a, b; İslamoğlu & Hakyemez 2010). However, only Sirel (2003) has studied the biostratigraphic setting of Oligocene shallow-water successions in the Kahramanmaraş region. No investigations into the planktonic foraminiferal biostratigraphy or integrated larger and planktonic foraminiferal biostratigraphy in the Oligocene and Lower Miocene successions in the Kahramanmaraş Basin have hitherto been carried out.

This study of the Oligocene and Lower Miocene larger and planktonic foraminiferal biostratigraphy in the Kahramanmaraş Basin aims to: (1) establish the biostratigraphic framework of the basin; (2) correlate larger foraminiferal zones (SBZ) with standard and Mediterranean planktonic foraminiferal zones and (3) calibrate the stratigraphical ranges of some larger foraminifera with planktonic foraminiferal biozones.

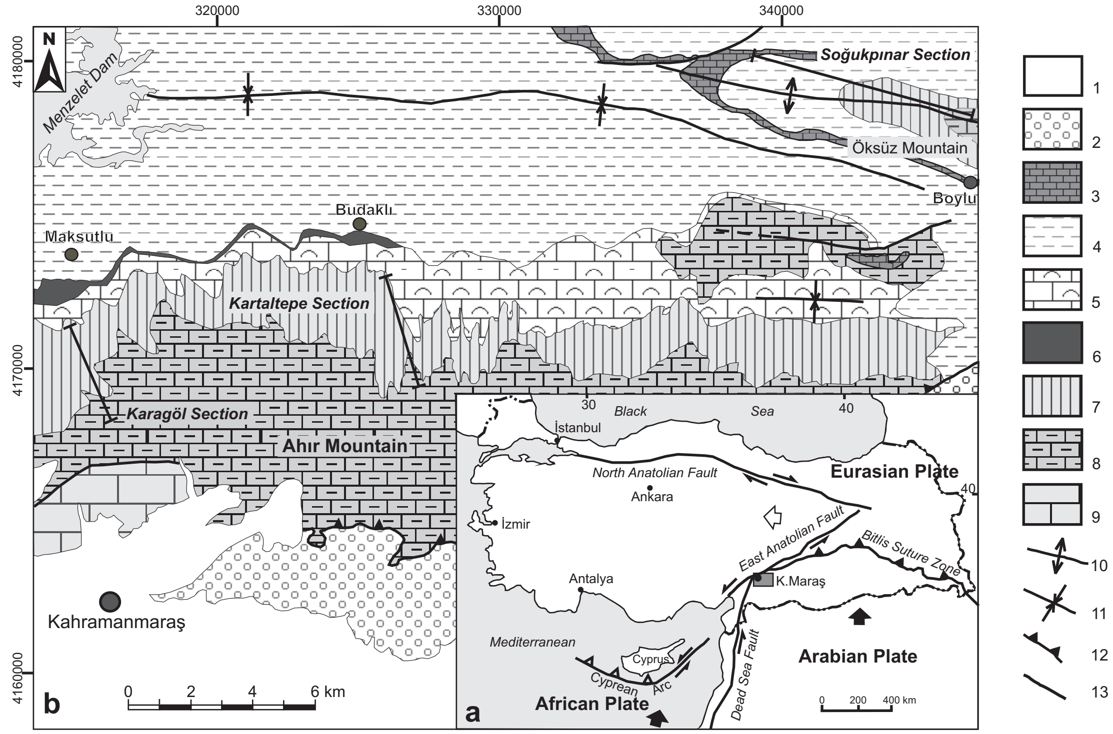

Figure 1. **(a)** Tectonic setting of the Kahramanmaraş Basin and surrounding area (from Bozkurt 2001). **(b)** Geological map of the study area (simplified from Herece 2008). 1– Plio–Quaternary units, 2– Şelmo Formation, 3– Karaisalı Formation, 4– Lice Formation, 5– Fırat Formation, 6– Kapıkaya Formation, 7– Çağlayancerit Formation, 8– Gaziantep Formation, 9– Hoya Formation, 10– syncline, 11– anticline, 12– thrust, 13– fault.

Material and Methods

In the Kahramanmaraş Basin three stratigraphic sections (Kartaltepe, Karagöl and Soğukpınar) cropping out in the northern part of Ahır Mountain and at the western end of Öksüz Mountain, were measured and sampled (Figure 1b). A total of 101 samples from the three sections were analysed for foraminiferal biostratigraphy. Planktonic foraminiferal taxa have been mainly identified in the washed residues from 47 clayey limestone, marl and shale samples. Samples were disaggregated by using diluted hydrogen peroxide (30%). The hard cemented clayey limestone samples (8 samples) from three sections were studied in thin sections. Larger foraminiferal analyses were carried out in a total of 270 thin sections from 46 limestone and sandstone samples. Kennett & Srinivasan (1983), Iaccarino (1985), Bolli & Saunders (1985) and Loeblich & Tappan's (1988) taxonomic classifications were mainly used for planktonic foraminiferal analyses. The taxonomic analyses of miogypsinids are based on Drooger's (1993) classification.

Stratigraphic Setting

In the Kahramanmaraş Basin the Oligocene sedimentary successions, overlying Upper Eocene shallow marine limestones of the Arabian Platform on Ahır Mountain (Robertson *et al.* 2004; Figure 1b), are represented by bioclastic limestones around Kahramanmaraş (Uysal *et al.* 1985; Karig & Kozlu 1990). The Eocene–Oligocene lithostratigraphic units of the basin have been assigned to the Gercüş Formation, Hoya Formation and Gaziantep Formation (Gül 1987, 2000; Yılmaz & Duran 1997) which constitute the Midyat Group in southeastern Anatolia (Açıkbaş *et al.* 1981). The Lower Eocene Gercüş Formation, consisting of polygenetic conglomerate, sandstones and mudstones (Duran *et al.* 1988) is overlain by the Middle Eocene Hoya

Formation that comprises neritic carbonates (Gül 2000). The Middle Eocene–Oligocene Gaziantep Formation (Gül 2000; Herece 2008), overlies the Hoya Formation and is composed of cherty, clayey and chalky limestones. The medium–thick bedded, benthic foraminifera-bearing limestones within this formation were described as 'Limestone Unit' by Duran *et al.* (1989) (Figure 2).

In the Kahramanmaraş region the Miocene lithostratigraphic units have been assigned to the Kapıkaya formation, Çağlayancerit Formation, Fırat Formation, Lice Formation, Şelmo Formation and Karaisalı Formation (Herece 2008) (Figure 1b). The Kapıkaya, Fırat and Lice formations are widespread in Southern Anatolia and constitute the Silvan Group (Duran *et al.* 1988; Yılmaz & Duran 1997). The Miocene Kapıkaya Formation and the Çağlayancerit Formation unconformably and conformably overlie the Oligocene Gaziantep Formation, respectively. The Kapıkaya Formation is composed of sandstones and basalt lavas with conglomerate and mudstone intercalations (Perinçek 1980; Herece 2008). It laterally grades into the Aquitanian–Burdigalian Fırat Formation which consists of reef limestones (Gül 1987; Herece 2008). The Çağlayancerit Formation is composed of calciturbidite, clayey and sandy limestones. The benthic foraminiferal assemblages of this formation were dated as Early–Middle Miocene (Aquitanian–Langhian) (Gül 1987). The Çağlayancerit Formation passes laterally and vertically into the Fırat Formation. The Çağlayancerit and Fırat formations are conformably overlain by the Lice Formation which is composed of sandstones in its lower part, and shales with limestone and turbiditic sandstone intercalations and a shale-sandstone alternation in its middle and upper parts. The Early–Middle Miocene (Burdigalian–Langhian) age was assigned to the Lice Formation based on the planktonic foraminiferal fauna (Gül 1987; Herece 2008). The Middle Miocene Karaisalı Formation, which conformably overlies the Lice Formation, consists of reef limestones containing coral, algae and foraminifera. The Karaisalı Formation is unconformably overlain by the fluvial and lacustrine deposits of the Şelmo Formation (Herece 2008). According to Gül (2000), the Middle Miocene units around the Kahramanamaraş Basin are represented

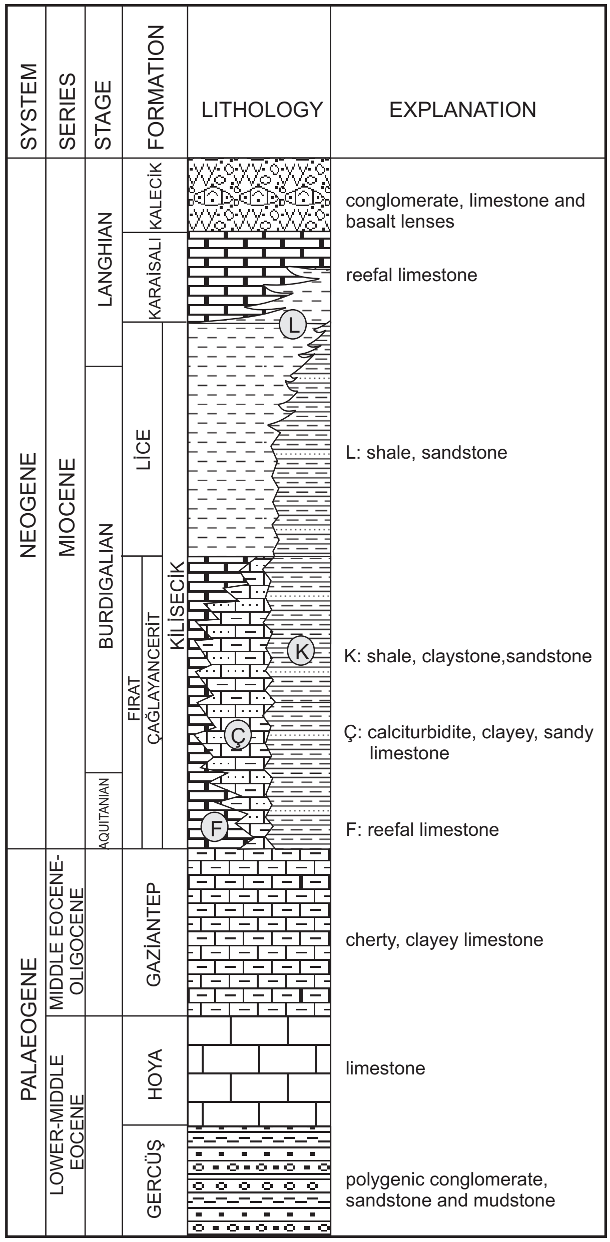

Figure 2. Generalized stratigraphical section of the Kahramanmaraş Basin (modified from Gül 2000).

by the Başdervişli and Kalecik formations, which comprise reef limestones and conglomerates containing limestone and basalt lenses, respectively. The Çağlayancerit, Fırat and Lice formations are coeval with the turbiditic sediments of the Kilisecik Formation in the north of the Kahramanamaraş Basin (Figure 2).

Studied Stratigraphical Sections

In order to obtain a continuous and complete foraminiferal record throughout the Oligocene–Miocene successions, three sections (Kartaltepe, Karagöl and Soğukpınar) encompassing the Gaziantep, Çağlayancerit and Lice formations were investigated in the Kahramanmaraş Basin (Figures 3–5).

Kartaltepe Section

The Kartaltepe section, about 66 m thick, is exposed south of Budaklı Village, on the northern flank of Ahır Mountain (Figure 1b). The base of the section has coordinates N4170205°, E326951° and its top N4172439°, E326354° in the M38-d1 Quadrangle. A total of 23 samples were investigated for taxonomic and biostratigraphic analyses. The lower unit, part of the Gaziantep Formation, 48 m thick, begins with 10 m of creamy white thick-bedded algal and shelly limestones ('Limestone Unit'). It is followed by 10 m of a clayey, sandy and cherty limestone-marl-limestone alternation. Planktonic and benthic foraminiferal assemblages in two samples collected from this part of the section (KT.08.76 and KT.06.76) indicate that the lower part of the Gaziantep Formation is late Middle–Late Eocene (Bartonian–Priabonian) in age (Figure 3). In its middle part, the Kartaltepe section consists of grey-beige thin-medium bedded clayey limestones with rare creamy white limestone and yellow sandy limestone intercalations. Upwards, the section continues with 12 m of clayey limestones and shales with limestone and calciturbidite intercalations of the Çağlayancerit Formation. In the upper part of the section, the Çağlayancerit Formation is overlain by the Karaisalı Formation which begins with 4 m of basal sandstones and conglomerate, overlain by 5 m of yellowish-beige fractured limestones rich in algae, corals and benthic foraminiferal assemblages and dissolution cavities.

Karagöl Section

The Karagöl Section is located south of Maksutlu Village, between the coordinates of N4168732°, E317561° (base) and N4172026°, E316937° (top), in the M37-c2 Quadrangle (Figure 1b). It covers an interval from Late Eocene to Middle Miocene, spanning the Gaziantep, Çağlayancerit, Lice and Karaisalı formations (Figure 4). A total of 44 samples were collected from the 123-m-thick section. Its lower 54-m-thick part exposes part of the Gaziantep Formation, and comprises grey-beige thin–medium bedded cherty, clayey limestones with rare cream-white limestone and grey marl intercalations. The benthic foraminiferal assemblage from the lowest part of the section (K.06.162) indicates the SBZ 18–20 zonal interval of the late Middle–Late Eocene (Bartonian–Priabonian) (Figure 4). The clayey limestones of Gaziantep Formation are overlain by a 43-m-thick alternation of clayey limestone-limestone with cross-bedded sandstone and marl intercalations belonging to the Çağlayancerit Formation. Overlying this is a 23-m-thick shale and marl alternation of the Lice Formation, which is in turn overlain by 6 m of cross-bedded sandstones and reef limestones belonging to the Karaisalı Formation (Figure 4).

Soğukpınar Section

This section crops out northeast of Boylu Village, in the westernmost part of Öksüz Mountain (Figure 1b). It was sampled in the M38-d2 Quadrangle, between the coordinates of N4177303°, E334216° (base) and N4177262°, E343077° (top). The Soğukpınar section, 72 m thick, embraces the Late Eocene–Middle Miocene interval corresponding to the Gaziantep, Çağlayancerit, Lice and Karaisalı formations (Figure 5). A total of 34 samples from the section were analyzed for foraminiferal biostratigraphy. The section starts with 10 m of yellowish grey, cream clayey and cherty limestones of the Gaziantep Formation. The clayey limestones are followed by 5 m of light cream medium thick-bedded shelly limestones with rich benthic foraminifera corresponding to the Limestone Unit of the Gaziantep Formation. This unit grades into the grey, greyish green thin–medium bedded, extensively bioturbated limestones of the Çağlayancerit Formation. Overlying this are 47 m of alternating thick greyish green thin-bedded fragile shales and greenish grey sandstones of the Lice Formation. In the top of the section, the sandstones are overlain by reef limestones of the Karaisalı Formation (Figure 5).

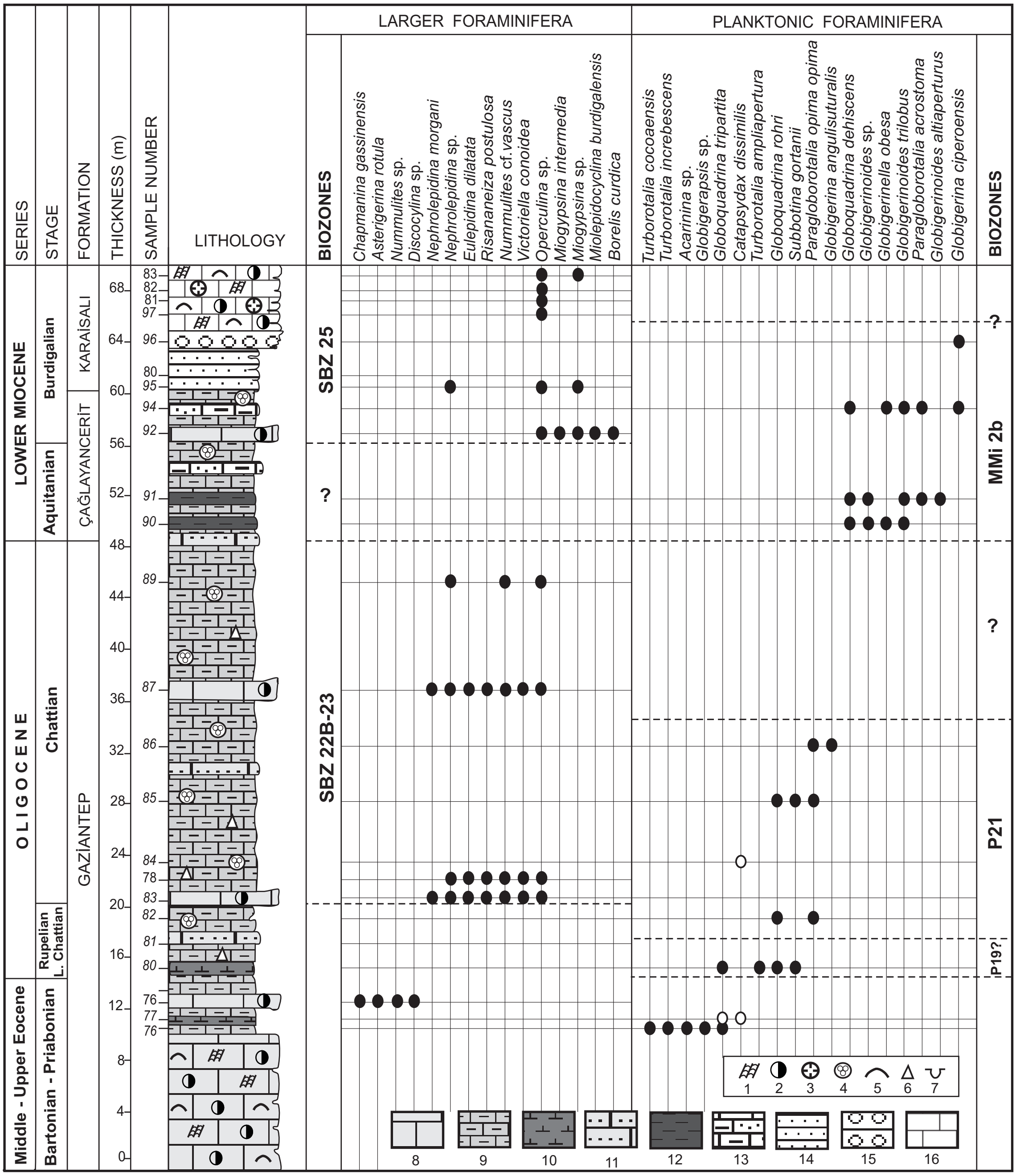

Figure 3. Distribution of some selected larger and planktonic foraminiferal taxa identified in the Kartaltepe section. 1– algae, 2– benthic foraminifera, 3– coral, 4– planktonic foraminifera, 5– shell fragment, 6– chert, 7– bioturbation, 8– limestone of Gaziantep Formation 9– clayey limestone, 10– marl, 11– sandy limestone, 12– shale, 13– calciturbidite, 14– sandstone, 15– conglomerate, 16– limestone of Karaisalı Formation (see Figures 4 & 5 for symbols 1–7).

Planktonic Foraminiferal Biostratigraphy

A total of 55 samples from the marl, shale and clayey limestones of the Kartaltepe, Karagöl and Soğukpınar sections were analysed for planktonic foraminiferal biostratigraphy. The planktonic foraminiferal zonation established for the Oligocene part of

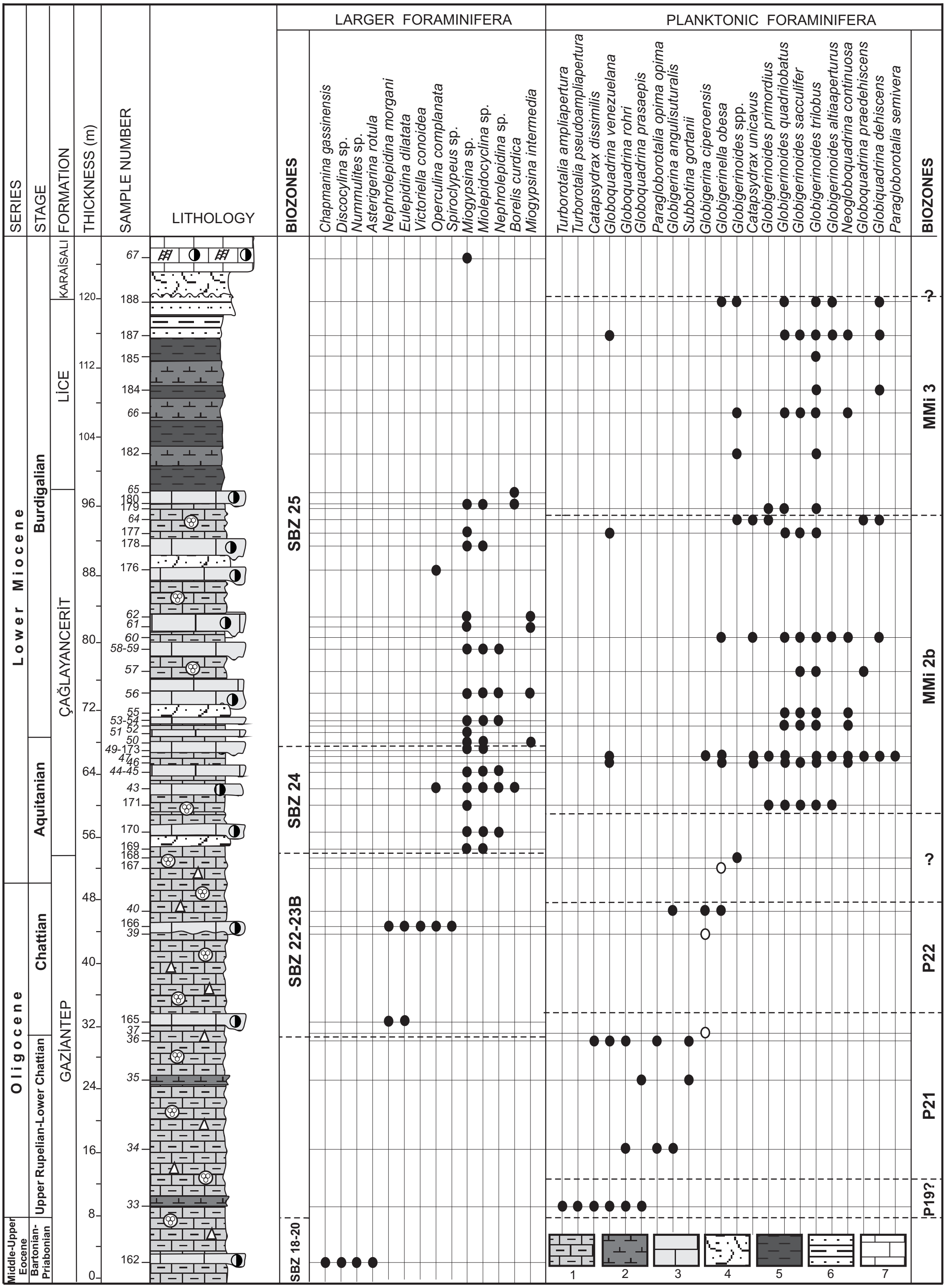

Figure 4. Distribution of some selected larger and planktonic foraminiferal taxa identified in the Karagöl section. 1– clayey limestone, 2– marl, 3– limestone, 4– cross-bedded sandstone, 5– shale, 6– sandstone, 7– limestone of the Karaisalı Formation.

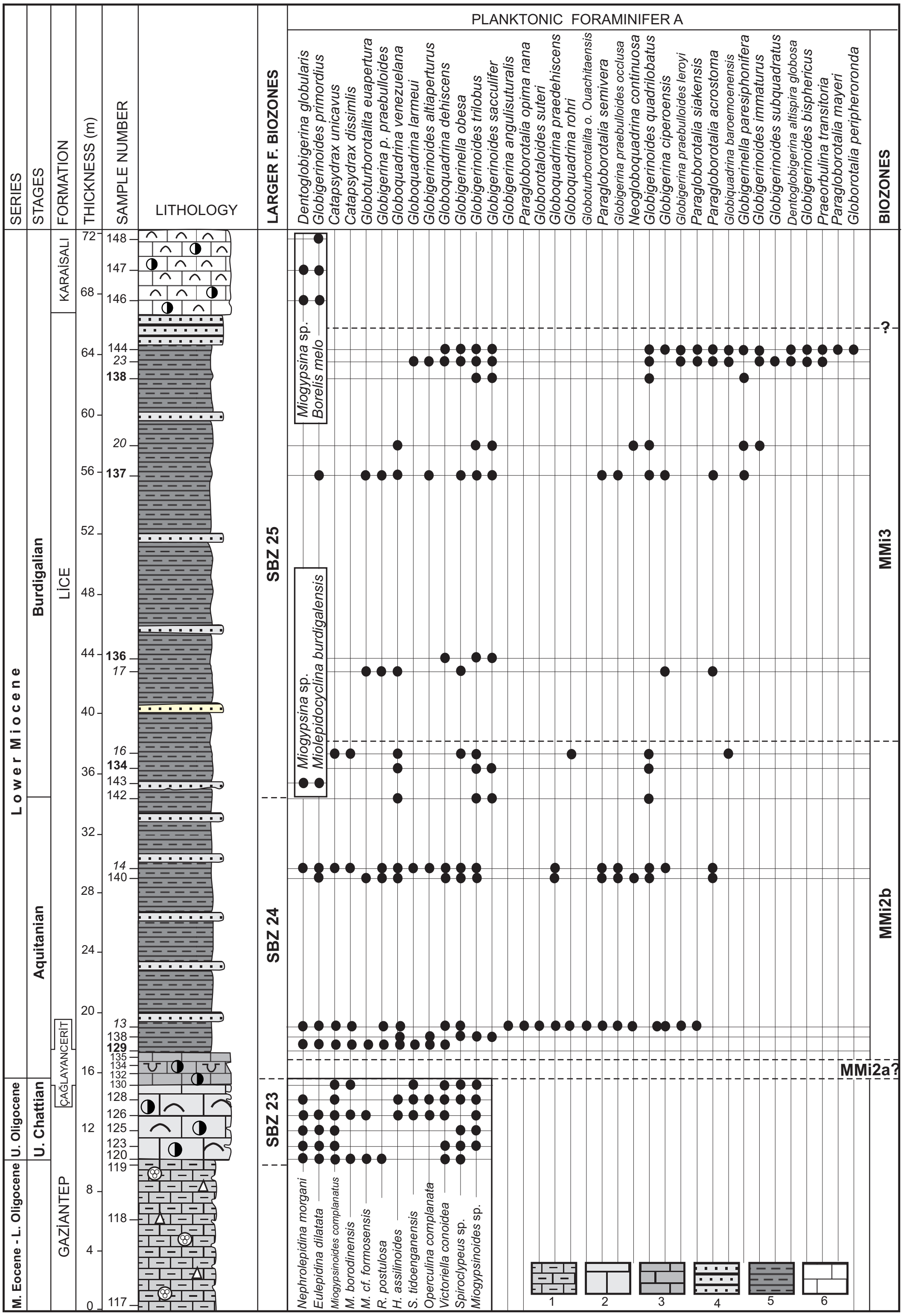

Figure 5. Distribution of larger and planktonic foraminiferal taxa identified in the Soğukpınar section. Larger foraminiferal species are shown in quadrangles.1– clayey limestone, 2– limestone of Gaziantep Formation, 3– Çağlayancerit Formation, 4– sandstone, 5– shale, 6– limestone of the Karaisalı Formation.

the sequence is based on Blow's (1969) Zonation, whereas the MMi Zonation is applied to the Lower Miocene part (Figure 6). The MMi acronym was first used by Sprovieri *et al*. (2002) for the Mediterranean Middle Miocene and was then extended to the Early and Late Miocene Zonation of Iaccarino (1985) with improving biochronological calibrations (Lourens *et al*. 2004).

The planktonic foraminiferal fauna in the studied samples vary from a very scarce assemblage characterized by a few specimens to highly abundant and diverse assemblages. In general, the planktonic foraminifera are more abundant, better preserved and diversified in the marl and shale samples of the Lice Formation than those in the clayey limestones of the Gaziantep and Çağlayancerit formations (Figures 3–5). Less abundant and less diverse planktonic foraminiferal assemblages were obtained from the lower parts of the studied sections corresponding to the P19, P21, P22 zones (Figure 3 & 4). In addition, poor preservation, scarcity or lack of marker species prevented any biozonal attribution for some parts of the studied successions equivalent to the P18, P20 and MMi 1 zonal intervals (Figures 3–5). Six Oligocene–Early Miocene planktonic foraminiferal biozones were distinguished by using 51 species belonging to 17 genera.

Turborotalia ampliapertura Zone (P19 Zone)

This zone was introduced by Bolli (1957) and emended by Blow (1969). It is defined by the interval from the LO of *Pseudohastigerina* spp. to the LO of *Turborotalia ampliapertura* (Figure 6). The zonal marker, *Turborotalia ampliapertura*, was recorded in only two samples (KT.08.80 and K.08.33) from the Kartaltepe and Karagöl sections, respectively (Figures 3 & 4). The planktonic foraminiferal assemblages are dominated by poorly preserved and recrystallized large globoquadrinids such as *Globoquadrina venezuelena, Globoquadrina tripartita, Globoquadrina rohri, Globoquadrina prasaepis, Globoquadrina sellii, Subbotina tapuriensis* and *Subbotina gortanii, Catapsydrax dissimilis, Globorotaloides suteri* and *Turborotalia pseudoampliapertura* associated with the zonal marker, *Turborotalia ampliapertura* (Plate IV). The lack of *Pseudohastigerina* spp. within this assemblage clearly refers to the *Turborotalia ampliapertura* (P19) Zone. Nevertheless, the *Turborotalia ampliapertura* Zone has been defined tentatively (as questionable) because this assemblage was found in only one sample (KT.08.80) from the Kartaltepe section and one sample (K.08.33) from the Karagöl section (Figures 3 & 4).

Globigerina angulisuturalis-Paragloborotalia opima opima (P21) Zone

Blow (1969) originally proposed this zone for the interval between the FO of *Globigerina angulisuturalis* and the LO of *Paragloborotalia opima opima*. In Berggren *et al.*'s (1995) standard zonation, this original definition is followed and the zone is subdivided into two subzones based on the FO of *Chiloguembelina cubensis* (Figure 6).

The FO of *Globigerina angulisuturalis* and the LO of *Paragloborotalia opima opima* have been recorded in samples K.08.34 and K.08.36 from the Karagöl section, respectively. This biostratigraphical data indicates the *Globigerina angulisuturalis-Paragloborotalia opima opima* Zone (about 22 m thick). Thus, it can be concluded that the unrecorded P20 Zone (*Globoquadrina sellii* Zone) is comparable with the 8 m interval between the samples K.08.33 and K.08.34 (Figure 4). However, the successive FOs of *Paragloborotalia opima opima* and *Globigerina angulisuturalis* have been recorded in samples KT.08.82 and KT.08.86 in the Kartaltepe Section, respectively. By considering both the scarcity of *Globigerina angulisuturalis* in the studied samples and the absence of *Turborotalia ampliapertura* in KT.08.82, the interval between the samples KT.08.82 to KT.08.86 (14 m thick) can be assigned to the *Globigerina angulisuturalis-Paragloborotalia opima opima* Zone (Figure 3). Actually, it is possible that the unrecorded P20 Zone could be coeval with the 4-m-thick unsampled interval between KT.08.80 and KT.08.82 (Figure 3).

In the Kartaltepe and Karagöl sections the *Globigerina angulisuturalis-Paragloborotalia opima opima* Zone is represented by scarcer and poorly preserved planktonic foraminiferal assemblages, including *Subbotina gortanii, Subbotina tapuriensis,*

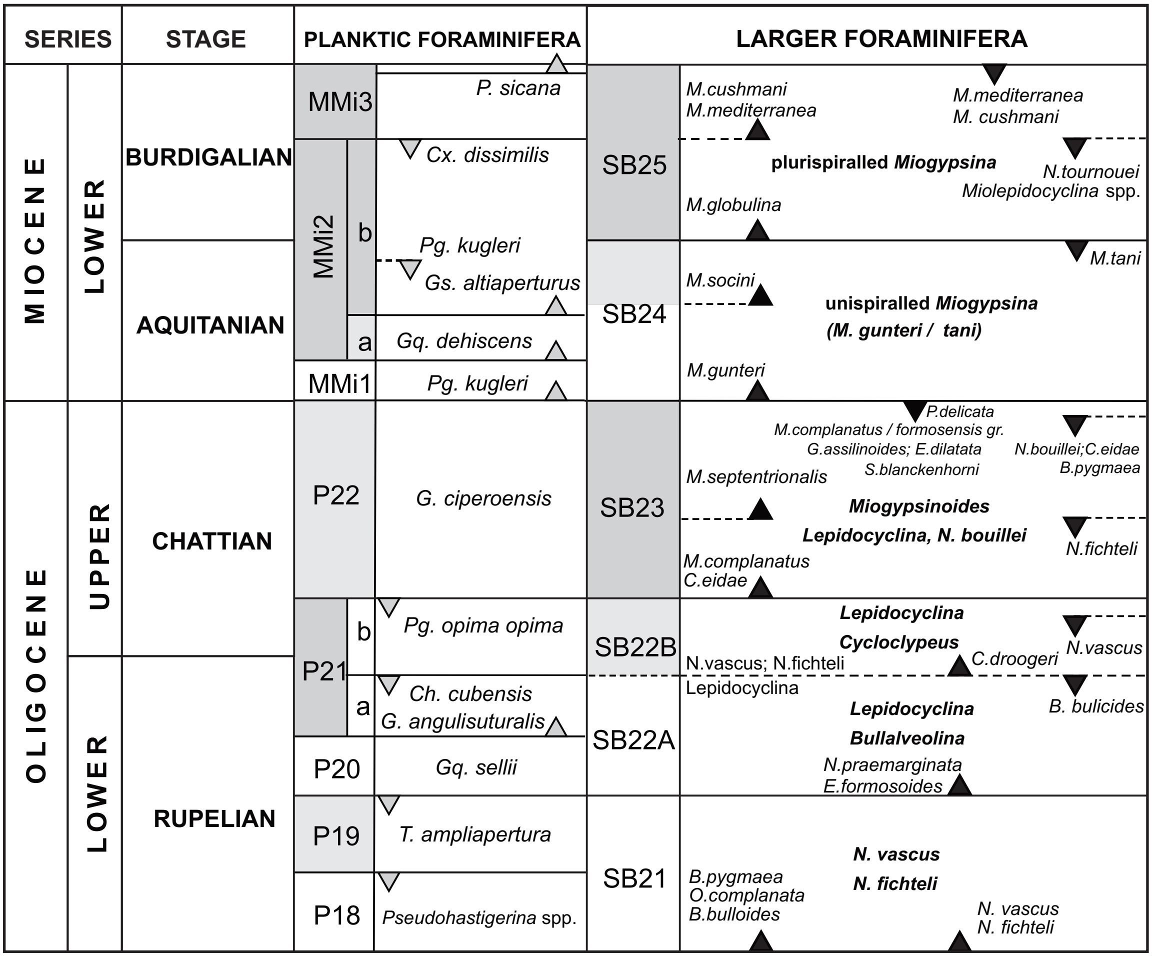

Figure 6. Correlation chart of Oligocene–Lower Miocene planktonic and larger foraminiferal biozones [compiled from Blow 1969; Iaccarino 1985; Berggren *et al.* 1995; Iaccarino *et al.* 1996; Lourens *et al.* 2004 (planktonic foraminifera); Cahuzac & Poignant 1997 (larger foraminifera)]. Recorded and tentatively recorded zones in this study are respectively shown with grey and light grey.

Paragloborotalia opima nana, Paragloborotalia pseudocontinuosa, Globoquadrina prasaepis, Globoquadrina rohri, Globoquadrina venezuelana, Catapsydrax dissimilis, Catapsydrax unicavus, Globorotaloides suteri and *Globigerina parebulloides praebulloides* (Figures 3 &4).

Globigerina ciperoensis Zone (P22)

The *Globigerina ciperoensis* Zone, firstly introduced by Bolli (1957), is defined by the partial range of *Globigerina ciperoensis* between the LO of *Paragloborotalia opima opima* and the FO of *Paragloborotalia kugleri* (Figure 6).

In the Karagöl section, the *Globigerina ciperoensis* Zone corresponds to the interval between the samples K.08.37 – K.06.40 (about 16 m thick). This zone is represented by a rare and poorly preserved planktonic foraminiferal assemblage including thin walled and small species such as *Globigerina ciperoensis, Globigerina angulisuturalis, Globigerina praebulloides praebulloides, Globorotaloides suteri, Tenuitellinata angustiumbilicata* associated with *Globigerinella obesa* and *Globigerinoides* sp. In the assemblage the lack of *Paragloborotalia opima opima* and the presence of *Globigerinella obesa* and *Globigerinoides* sp., both first occurring in the upper parts of the *Globigerinoides ciperoensis* zone, confirm this zonal assignment. Larger foraminiferal taxa identified in two limestone layers (K.06.165 and K.06.166) within this stratigraphic interval also indicate the Chattian SB 22B–23 Zone (Figure 4). An interval overlying the *Globigerina ciperoensis* zone (about 12 m thick) was not attributable to a zonal interval because of its very poor assemblage (Figure 4). Larger foraminiferal species identified in two samples (K.06.169 and K.06.170) from the upper part of this unzoned interval indicate the upper part of the SB 24 Zone (upper Aquitanian).

Globigerina ciperoensis was not recorded in the Kartaltepe section since the interval from the sample KT.08.87 to KT.08.90 was devoid of planktonic foraminifera (Figure 3). Nevertheless, the larger foraminiferal assemblage recorded in this part of the section (samples KT.08.87 and KT.08.89) is similar to that of SBZ 22B–23 Zone (Chattian) recognized in the Karagöl section (Figure 4).

Globoquadrina dehiscens-Catapsydrax dissimilis Zone (MMi 2)

This concurrent range zone, firstly proposed by Iaccarino & Salvatorini (1982), is defined by the interval from the FO of *Globoquadrina dehiscens* to the LO of *Catapsydrax dissimilis* and is subdivided into two subzones: *Globoquadrina dehiscens-Globigerinoides altiaperturus* Subzone (MMi 2a) and *Globigerinoides altiaperturus-Catapsydrax dissimilis* Subzone (MMi 2b) (Figure 6). In the present study, the MMi 2a subzone was tentatively defined by the occurrences of *Globoquadrina dehiscens* and *Globigerina* spp. and the lack of *Globigerinoides altiaperturus* identified in thin sections of three samples (S.06.132, S.06.134, 06.S.135) from the Soğukpınar section.

Globigerinoides altiaperturus-Catapsydrax dissimilis Subzone (MMi 2b)

This subzone, firstly introduced as a zonal interval by Bizon & Bizon (1972) and then assigned to a subzonal category by Iaccarino & Salvatorini (1982) is defined by the interval between the FO of *Globigerinoides altiaperturus* and the LO of *Catapsydrax dissimilis* (Figure 6).

In the Soğukpınar section, the *Globigerinoides altiaperturus-Catapsydrax dissimilis* Subzone was identified in the 23-m-thick interval between samples S.05.129 and S.08.16, based on the concurrent ranges of two subzonal markers. Its lower boundary was not identified in the section because of the lack of planktonic foraminifera in the shallow water limestones of the Gaziantep Formation, rich in larger foraminifera and shell fragments. The planktonic foraminiferal assemblage, more abundant, well diversified and preserved than those of the other studied sections (Figure 5), is dominated by *Globoquadrina venezuelena*, *Globigerinoides quadrilobatus, Globigerinoides trilobus* and *Globigerinella obesa* whereas *Globoturborotalita euapertura, Paragloborotalia acrostoma, Paragloborotalia semivera, Paragloborotalia siakensis* and *Neogloboquadrina continuosa* rarely occur in this zone. The subzonal markers, *Catapsydrax dissimilis* and *Globgerinoides altiaperturus*, are scarce and discontinuously present while *Paragloborotalia opima nana* last occurs in the lower part of the section (Figure 5).

Similarly, the upper part of the Kartaltepe section, between samples KT.08.90 and KT.08.94 (about 10-m-thick), contains a planktonic foraminiferal assemblage which is very comparable with the *Globigerinoides altiaperturus-Catapsydrax dissimilis* Subzone. *Globigerinoides altiaperturus,* associated with *Globgerinoides trilobus, Globoquadrina binaiensis* and *Catapsydrax unicavus,* clearly refers this stratigraphic level to the *Globigerinoides altiaperturus – Catapsydrax dissimilis* (MMi 2b) Subzone (Figure 3).

The planktonic foraminiferal assemblage identified in the 30 m between sample K.08.47 and sample K.08.64 in the Karagöl section is assignable to the *Globigerinoides altiaperturus-Catapsydrax dissimilis* Subzone. Although one of the subzonal markers (*Catapsydrax dissimilis*) was not identified at this stratigraphic level, the presence of *Globigerinoides altiaperturus,* together with *Globoquadrina praedehiscens* and *Catapsydrax unicavus*, both which last occur approximately at the same level with *Catapsydrax dissimilis*, supports the definition of this subzone. No planktonic foraminifera were recorded in the interval between K.06.168 and K.06.171 due to the hard cemented limestone (Figure 4).

Globigerinoides trilobus Zone (MMi 3)

This partial range zone was first proposed by Bizon & Bizon (1972) for the interval between the LO of *Catapsydrax dissimilis* and the FO *Praeorbulina sicana*. In the present study, the lower zonal boundary was defined by the LO of *Catapsydrax dissimilis* whereas the upper boundary was not recorded due to the hard cemented limestone of the overlying Karaisalı Formation (Figure 5).

In the Soğukpınar section, the *Globigerinoides trilobus* Zone corresponds to the approximately 24-m-thick stratigraphic interval between samples S.08.17 and S.06.144. It is dominated by globoquadrinids (*Globoquadrina dehiscens, Globoquadrina baroemoenensis, Globoquadrina larmeui, Globoquadrina venezuelana*), and globigerinoidids (*Globigerinoides trilobus, Globigerinoides immaturus, Globigerinoides quadrilobatus, Globigerinoides subquadratus, Globigerinoides bisphericus*). *Paragloborotalia mayeri, Praeorbulina transitoria, Dentoglobigerina altispira globosa* and *Globigerinoides bisphericus* first occur within the uppermost part of the zone (Figure 5).

In the Karagöl section, the marl-shale alternation and overlying sandstones from the sample K.06.182 to K.06.188 (about 22 m thick) are also ascribed to the *Globigerinoides trilobus* Zone based on the absence of *Catapsydrax* species. The planktonic foraminiferal assemblage observed in this part of the section is comparable with that of the *Globigerinoides trilobus* Zone of the Soğukpınar section (Figure 4).

Larger Foraminiferal Biostratigraphy

A total of 46 limestone samples from the Gaziantep, Çağlayancerit, Lice and Karaisalı formations were analysed for larger foraminiferal biostratigraphy. In the Soğukpınar section abundant and well-diversified taxa occur in the ‘Limestone Unit’ of the Gaziantep Formation whereas elsewhere in the Gaziantep, Çağlayancerit, Lice and Karaisalı formations the assemblage is generally less or moderately abundant and less diverse. The biozonation has been established using the European SB Zonation. A total of 25 larger foraminiferal species belonging to 16 genera were identified in the Chattian–Burdigalian interval. These taxa allowed identification of the SB 22B–23, SB 23, SB 24 and SB 25 biozones.

SB 22B-23 Zone– This zonal interval was defined by the coexistence of *Eulepidina dilatata* and *Nephrolepidina morgani*. However, SBZ 23 was not distinguished from SBZ 22B since *Miogypsinoides complanatus* was not seen. The SB 22B–23 Zone was recorded in two stratigraphic intervals (KT.06.78–KT.08.79 and KT.08.87–KT.08.89) from the Kartaltepe section and in two limestone layers (K.06.165 and K.06.166) from the Karagöl section (Figures 3 & 4). The assemblage is represented by *Eulepidina dilatata, Nephrolepidina morgani, Risananeiza postulosa, Nummulites* cf. *vascus, Operculina complanata, Victoriella conoidea*, *Spiroclypeus* sp., *Amphistegina* sp., *Operculina* sp. A similar assemblage was referred to the SBZ 23 Zone by Sirel (2003) in the Ahırdağı, Kahramanmaraş region.

SB 23 Zone– It is defined by the total range of *Miogypsinoides complanatus* (Figure 6). The phylogenetic evolution of *Miogypsinoides* species from *Miogypsinoides complanatus* is also recognized within the SB 23 Zone (Cahuzac & Poignant 1997). The SBZ 23 Zone corresponds to the interval between samples S.06.120 and S.06.131 (5 m) in the Soğukpınar section (Figure 5). The species associated with the zonal taxon are *Miogypsinoides borodinensis, Miogypsinoides formosensis, Miogypsinoides ahirdagensis, Nephrolepidina morgani, Nummulites vascus, Nummulites* cf. *vascus, Eulepidina dilatata, Risananeiza postulosa, Spiroclypeus tidoenganensis, Heterostegina assilinoides, Victoriella conoidea, Operculina complanata, Nummulites* sp.1, *Nummulites* sp.2, *Miogypsina* sp. and *Amphistegina* sp. The LO of *Nummulites vascus* is recorded within SBZ 23 Zone. This bioevent is not consistent with the zonation of Cahuzac & Poignant (1997) but is consistent with that of Bassi *et al*. (2007).

SB 24 Zone– Defined by the interval between the FO of *Miogypsina gunteri* and the FO of *Miogypsina globulina,* it corresponds to the Aquitanian (Figure 6). In this study, although *Miogypsina gunteri* was not recorded, the SB 24 Zone was determined based on the coexistence of *Miogypsina* sp. and *Miolepidocyclina* sp. Cahuzac & Poignant (1997) suggested that *Miolepidocyclina* first appears in the upper part of the SB 24 Zone (Figure 6). Therefore, the approximately 14-m-thick stratigraphic interval between the samples K.06.169 and K.08.49, where

Miolepidocyclina sp. was identified, is comparable to the upper part of the SBZ 24 in the Karagöl section (Figure 4). Although, the lower boundary of the SB 24 Zone was not recorded, its upper boundary was defined by the FO of *Miogypsina intermedia,* which is the typical taxon of the SBZ 25 of the Burdigalian (Cahuzac & Poignant 1997; Özcan & Less 2009). Other species recorded with *Miolepidocyclina* sp. within the zone are *Nephrolepidina* sp., *Borelis curdica* and *Operculina complanata* and *Miogypsina tani*, whose LO defines the upper boundary of the SBZ 24 Cahuzac & Poignant (1997) (Figure 4–6).

SBZ 25 Zone– This is defined as the interval between the FO of *Miogypsina globulina* and the LO of *Miogypsina*. In this study, since *Miogypsina globulina* was not recorded, the lower boundary of the SB 25 Zone was defined by the FO of *Miogypsina intermedia,* whose stratigraphical range is same as that of *Miogypsina globulina* (Cahuzac & Poignant 1997). The SB 25 Zone corresponds to the approximately 38-m-thick interval between K.08.50 and K.08.65 in the Karagöl section (Figure 4). *Miogypsina cushmani, Miogypsina* (*Lepidosemicyclina*) *polymorpha*, *Miogypsina* cf. *mediterranea*, *Miogypsina* spp., *Miogypsinoides* sp., *Nephrolepidina* sp. are associated with *Miogypsina intermedia*. However, the SB 25 Zone was determined tentatively based on the occurrences of *Miogypsina intermedia*, *Miolepidocyclina burdigalensis* and *Miogypsina* sp. in one sample (06.S.143) in the Soğukpınar section and in one sample (08.KT.92) in the Kartaltepe section (Figures 4 & 5).

Discussion and Conclusion

In the Kahramanmaraş Basin the coexistence of larger and planktonic foraminifera in the shallow water carbonates and hemipelagic sediments of the same stratigraphical sections allowed direct comparison of larger foraminiferal zones with planktonic foraminiferal zones. Thus, both a well-defined biostratigraphic framework was established and stratigraphic ranges of some larger foraminifera were calibrated with planktonic foraminiferal zones throughout the Oligocene–Lower Miocene interval.

According to the biozonal schemes established in this study, in the Kartaltepe and Karagöl sections the Gaziantep Formation embraces the *Turborotalia ampliapertura* (P19), *Globigerina angulisuturalis-Paragloborotalia opima opima* (P21) and *Globigerina ciperoensis* (P22) zones (Oligocene). Larger foraminiferal species identified in the same sections ascribe the Gaziantep Formation to the SBZ 22B–23 corresponding to the Chattian whereas in the Soğukpınar section the Gaziantep Formation embraces the SBZ 23 Zone (late Chattian). Thus, the Gaziantep Formation in the studied succession ranges from the late Middle Eocene (Bartonian) to the Late Oligocene (Chattian) based on the integrated biostratigraphic data. The Çağlayancerit Formation is represented by the *Globigerinoides altiaperturus-Catapsydrax dissimilis* (MMi 2b) and *Globigerinoides trilobus* (MMi 3) planktonic foraminiferal biozones (upper Aquitanian–Burdigalian interval) in the Karagöl and Kartaltepe sections. In addition, the *Globoquadrina dehiscens-Globigerinoides altiaperturus* Subzone (MMi 2a), early Aquitanian in age, is tentatively identified from the Soğukpınar section. The larger foraminiferal zones SBZ 24 and SBZ 25, identified in the Karagöl section and SBZ 25 Zone in the Kartaltepe section, also indicate an Early Miocene age of the Çağlayancerit Formation. The Lice Formation spans the *Globigerinoides altiaperturus-Catapsydrax dissimilis* (MMi 2b) and *Globigerinoides trilobus* (MMi 3) biozones (upper Aquitanian–Burdigalian interval) in the Soğukpınar section, whereas this formation is restricted the *Globigerinoides trilobus* (MMi 3) Zone (Burdigalian) in the Karagöl section. Thus the planktonic foraminiferal data obtained from these two sections reveals that the Çağlayancerit Formation grades laterally into the Lice Formation during the late Aquitanian–early Burdigalian (MMi 2b Subzone), whereas the former is overlain by the Lice Formation in the late Burdigalian (MMi 3) (Figures 4 & 5). Larger foraminiferal species identified in one level of the Soğukpınar section clearly indicate that the Lice Formation is comparable with the SBZ 25 (Burdigalian).

The correlation between larger and planktonic foraminiferal zones shows that the P19 Zone was not correlated with a larger foraminiferal zone since the Rupelian is represented by hemipelagic sediments devoid of larger foraminifera in the studied area. The P20 Zone was not recorded in this study possibly due to the widely spaced sampling. The P21 and P22 zones (late Rupelian–Chattian) are comparable to SBZ 22B–23 (Chattian). In the studied successions, the P21 Zone was not divided into two subzones (P21a and P21b) because of the absence of the subzonal marker *Chiloguembelina cubensis*. The SBZ 23 and the SBZ 22B were not differentiated due to the lack of *Miogypsinoides complanatus* in the Kartaltepe and Karagöl sections where even the P21 Zone was not subdivided. For this reason, the Chattian larger and planktonic foraminiferal zones were not correlated with one another perfectly. However, the SBZ 23 was recorded in the Soğukpınar section with the occurrence of *Miogypsinoides complanatus*. A planktonic foraminiferal zone was not recorded in the upper Chattian because of the absence of planktonic foraminifera.

The MMi 1 Zone, corresponding to the lowest part of the Lower Miocene (lower Aquitanian), was not identified in the studied sequence due to the lack of *Paragloborotalia kugleri* which is generally rare in the Mediterranean region. Nevertheless, a questionable MMi 2a Subzone (lower Aquitanian) was recorded only in the Soğukpınar section. The Aquitanian corresponds to the SB 24 Zone (Cahuzac & Poignant 1997) (Figure 6), was recorded only in the Karagöl section with the occurrence of *Miogypsina* sp. However, *Miolepidocyclina* sp. accompanied with *Miogypsina* sp. in the same level indicates the upper part of the SBZ 24 (Upper Aquitanian). Moreover, the planktonic foraminiferal assemblage represents the MMi 2b Zone, whose lower part corresponds to the upper part of the SBZ 24 (Figure 6). For this reason, the base of the Aquitanian was not recorded in the studied sequence due to a lack of biostratigraphic data based on the larger and planktonic foraminifera (Figure 6). However, the Aquitanian–Burdigalian boundary falls within the MMi 2b Subzone corresponding to a long interval in the Mediterranean region (Figure 6). The determination of this boundary is generally difficult due to the rare occurrence of *Paragloborotalia kugleri* of which the LO is the closest bioevent to this boundary. In the Cahuzac and Poignant SBZ (1997) the SB 25 Zone corresponds to the Burdigalian and its lower boundary is defined by the FO of *Miogypsina globulina* (Figure 6). In this study, since *Miogypsina globulina* was not recorded, SBZ 25 was recognized by the occurrence of *Miogypsina intermedia* whose range is the same as that of *Miogypsina globulina* (Cahuzac & Poignant 1997). In the studied sections the SBZ 25 is comparable with the upper part of the MMi 2b and MMi 3 biozones according to the Cahuzac and Poignant SBZ (1997).

The almost continuous character of the studied sections, with the occurrence of larger and planktonic foraminiferal fauna has led to the calibration of the stratigraphic ranges of some larger foraminiferal taxa with standard and Mediterranean planktonic foraminiferal zones. The FO of *Nephrolepidina morgani* was recorded in the SBZ 22B–23 before the FO of miogypsinids. In the studied sections this level was determined within the P21 Zone. According to the zonation of Cahuzac & Poignant (1997), the upper part of the P21 Zone (P21 b Subzone) corresponds to SBZ 22B. Thus, our data clearly indicates that *Nephrolepidina morgani* first occurs in the SBZ 22B, not in the SBZ 23 as reported by Cahuzac & Poignant (1997). In contrast, *Nephrolepidina morgani* was reported in the SB 23 Zone by Sirel (2003), based on a similar larger foraminiferal assemblage to that of this study, although it has been identified together with the miogypsinids in the SBZ 23 Zone by Özcan *et al.* (2009b). The LO of *Nummulites vascus*, in the SBZ 22B (Cahuzac & Poignant 1997), was recorded in the SBZ 23 Zone together with the LO of *Eulepidina dilatata*. These two bioevents take place in the P22 Zone on the basis of our biostratigraphic results. The FOs of *Miolepidocyclina burdigalensis* and *Miogypsina intermedia*, characteristic Burdigalian taxa, were observed in the MMi 2b Subzone. However, the lower boundary of this subzone, which falls within the upper Aquitanian, was not determined in this study. Therefore, the stratigraphic ranges of these larger foraminiferal species within the MMi 2b Subzone were not calibrated precisely in this study. Finally the FO of *Borelis curdica* was recorded in the MMi 2b Subzone whereas *Nephrolepidina* spp. last occurred within the same subzone.

Acknowledgements

Larger foraminiferal data of this study is based on the PhD Thesis of the first author that was financially supported by Turkish Petroleum Corporation (TPAO). The author would like to thank Ercüment Sirel for his valuable support and help, Hüseyin

Kozlu and Osman Er for their kind assistance in the fieldwork. The authors are grateful to Demir Altıner for his encouragement in the preparation of this paper and for his advice and constructive comments, which greatly improved the manuscript. Critical reviews and contributions by Ercan Özcan and an anonymous reviewer are gratefully acknowledged. The English of the original manuscript was significantly revised by the anonymous reviewer. Thanks are due to Hayrettin Sancay for editing the English of the revised manuscript.

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PLATE 1

Scale bar: 200 µm

Figure 1. *Miogypsinoides complanatus* (Schlumberger), Non-centred equatorial section, sample no. S.08.2c/1, Soğukpınar section.

Figure 2. *Miogypsinoides borodinensis* (Hanzawa), almost equatorial section, A form, sample no. S.06.130c/2, Soğukpınar section.

Figure 3. *Miogypsinoides* cf. *formosensis* (Yabe and Hanzawa), almost equatorial section, A form, sample no. S.08.04f/2, Soğukpınar section.

Figures 4, 5. *Eulepidina dilatata* (Michelotti), 4– equatorial section, A form, sample no. S.06.122c/1, 5– axial section, sample no. S.06.120c/3, Soğukpınar section

Figures 6, 7. *Nephrolepidina morgani* Lemoine and Douville, 6– external view, sample no. S.06.124b/5, 7– equatorial section, A form, sample no. S.06.126h/1, Soğukpınar section.

Figure 8. *Miolepidocyclina burdigalensis* (Gümbel), equatorial section, A form, sample no. K.08.61b/1, Karagöl section.

Figure 9. *Miogypsina intermedia* Drooger, equatorial section, A form, sample no. K.08.62d/1, Karagöl section.

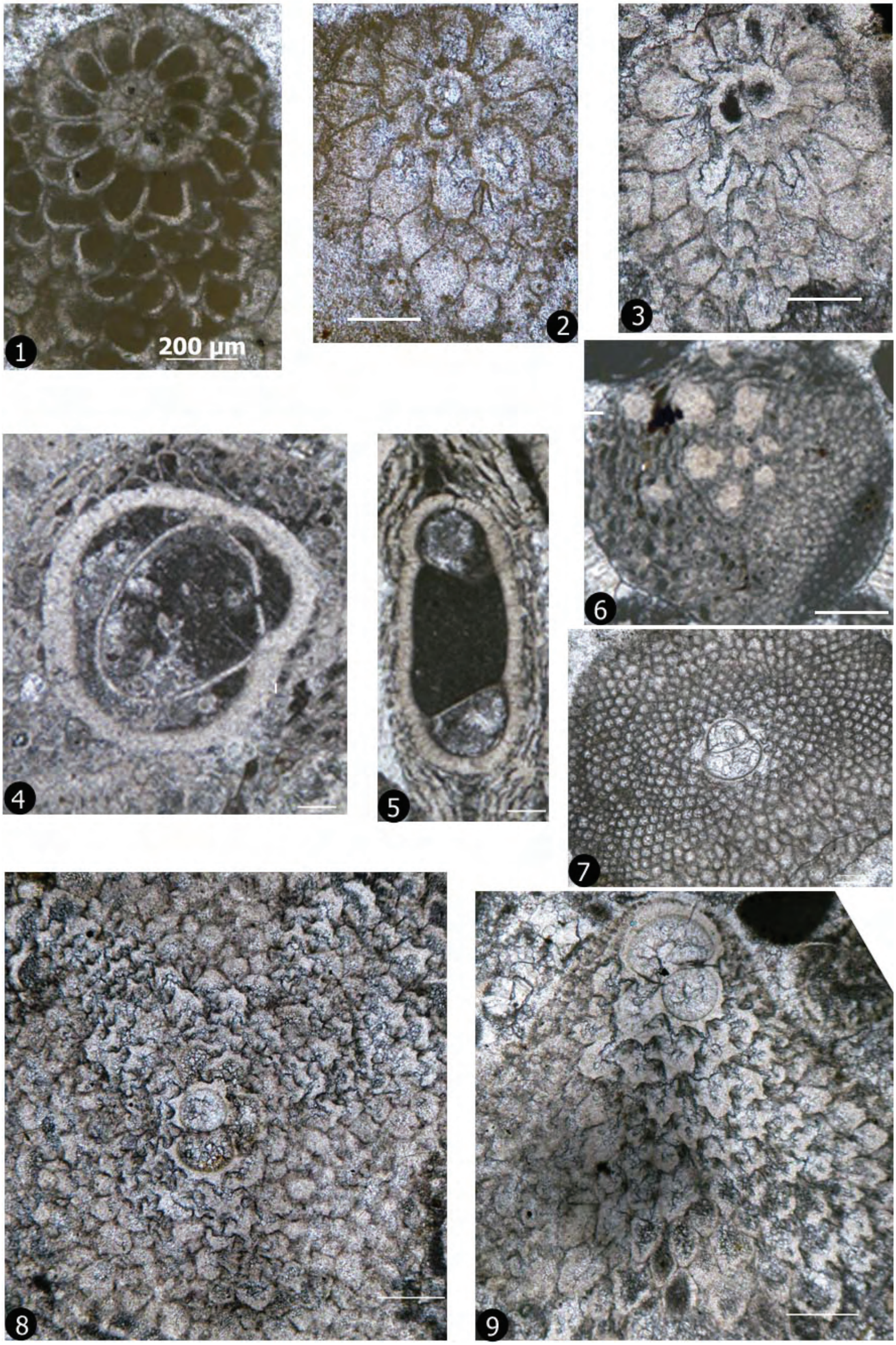
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PLATE 2

Scale bar: 100 µm in Figures 1–16; 20 µm in Figures 2a, 6a, 11a, 16a.

Figures 1–3. *Globigerinoides trilobus* (Reuss), 1– spiral view, 2– umbilical view, 2a– ultra wall structure of Figure 2, sample no. S.08.23, 3– spiral view, sample no. S.08.14, Soğukpınar section.

Figure 4. *Globigerinoides subquadratus* Brönnimann, spiral view, sample no. S.08.14, Soğukpınar section.

Figure 5, 6. *Globigerinoides altiaperturus* Bolli, 5– spiral view, 6– side view, 6a– ultra wall structure of Figure 6, sample no. S.08.14, Soğukpınar section.

Figures 7, 8. *Globigerinoides bisphericus* Todd, umbilical views, sample no. S.08.23, Soğukpınar section.

Figures 9, 10. *Globigerinoides primordius* Blow and Banner, 9– spiral view, 10– umbilical view, sample no. S.08.13, Soğukpınar section.

Figures 11. *Globoturborotalita ouachitaensis ouachitaensis* (Howe and Wallace), 11–umbilical view, 11a– ultra wall structure of Figure 11, sample no. S.08.14, Soğukpınar section.

Figure 12, 13. *Globigerinoides quadrilobatus* (d'Orbigny), 12– spiral view, 13– umbilical view, sample no. S.08.14, Soğukpınar section.

Figure 14. *Praeorbulina transitoria* (Blow), sample no. S.06.144, Soğukpınar section.

Figure 15. *Globigerinoides sacculifer* (Brady), spiral view, sample no. S.08.23, Soğukpınar section.

Figure 16. *Globigerina praebulloides occlusa* Blow and Banner, 16– umbilical view, 16a– ultra wall structure of Figure 16, sample no. S.08.13, Soğukpınar section.

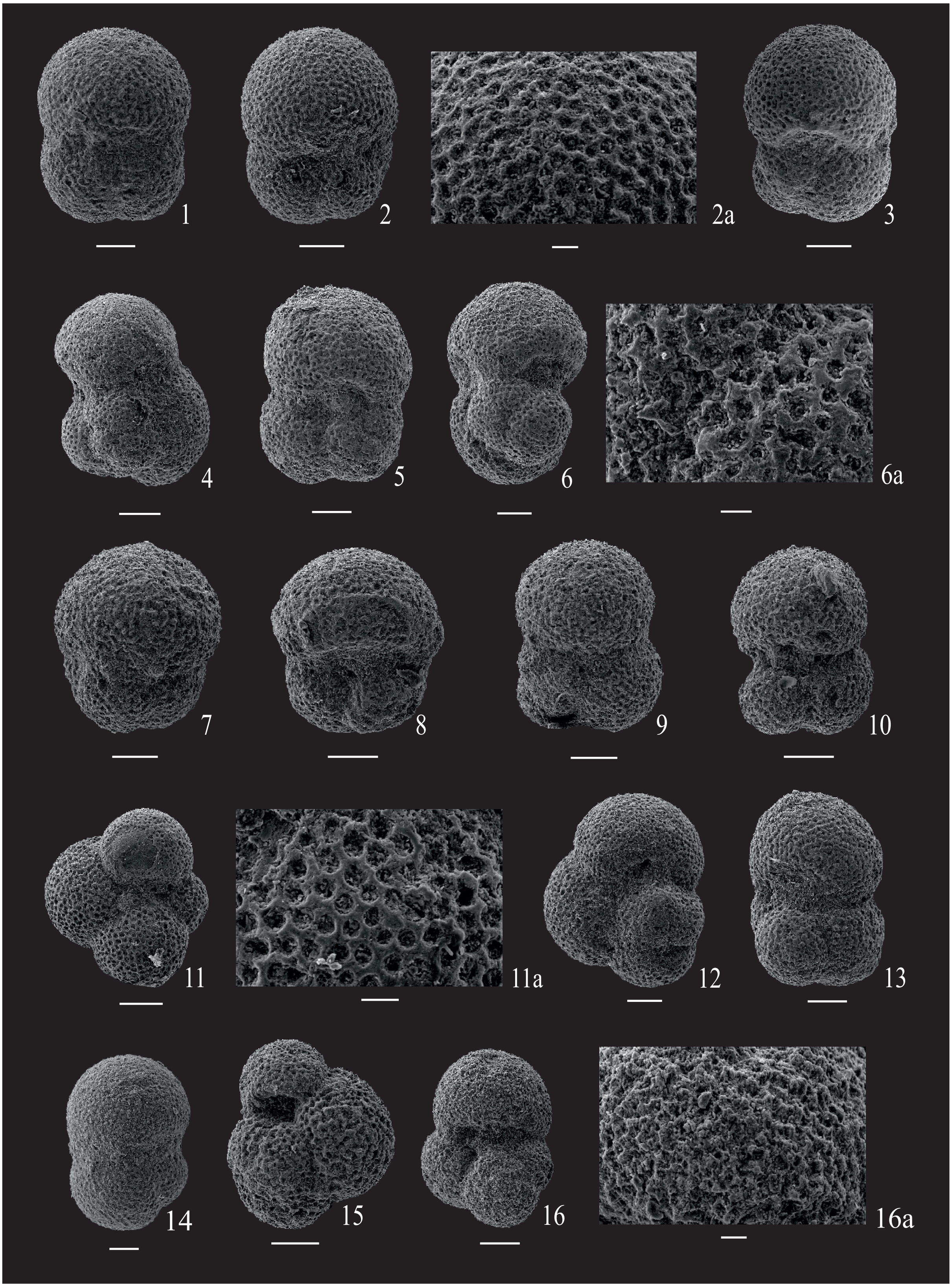
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PLATE 3

Scale bar: 100 µm in Figures 1–11, 13–17; 50 µm in Figure 12; 20 µm in Figures 6a, 10a, 14a; 10 µm in Figure 16a.

Figures 1, 2. *Paragloborotalia siakensis* (LeRoy), 1– spiral view, sample no. S.06.144, Soğukpınar section, 2– umbilical view, sample no. KT.08.90, Kartaltepe section.

Figures 3-5 *Paragloborotalia acrostoma* (Wezel), 3– umbilical view, sample no. S.08.23, 4– spiral view, sample no. S.08.14, 5– side view, sample no. S.08.14, Soğukpınar section.

Figure 6. *Paragloborotalia opima nana* (Bolli), 6– umbilical view, 6a– ultra wall structure of Figure 6, sample no. S.08.13, Soğukpınar section.

Figures 7, 8. *Paragloborotalia semivera* (Hornibrook), 7– spiral view, 8– umbilical view, sample no. S.08.13, Soğukpınar section.

Figures 9, 10. *Paragloborotalia mayeri* (Cushman and Ellisor); 9, 10– spiral views, 10a– ultra wall structure of Figure 10, sample no. S.06.144, Soğukpınar section.

Figure 11. *Neogloboquadrina continuosa* (Blow), umbilical view, sample no. S.08.13, Soğukpınar section.

Figure 12. *Globigerina* sp., umbilical view, sample no. S.08.13, Soğukpınar section.

Figures 13, 14. *Globigerinella praesiphonifera* (Blow), 13– umbilical view, sample no. S.08.14, 14– side view, 14a– ultra wall structure of Figure 14, sample no. S.08.13, Soğukpınar section.

Figures 15, 16. *Globigerinella obesa* (Bolli), 15– umbilical view, sample no. KT.08.90, Kartaltepe section, 16– umbilical view, 16a– ultra wall structure of Figure 16, sample no. S.08.14, Soğukpınar section.

Figure 17. *Globoquadrina rohri* (Bolli), spiral view, sample no. S.08.13, Soğukpınar section.

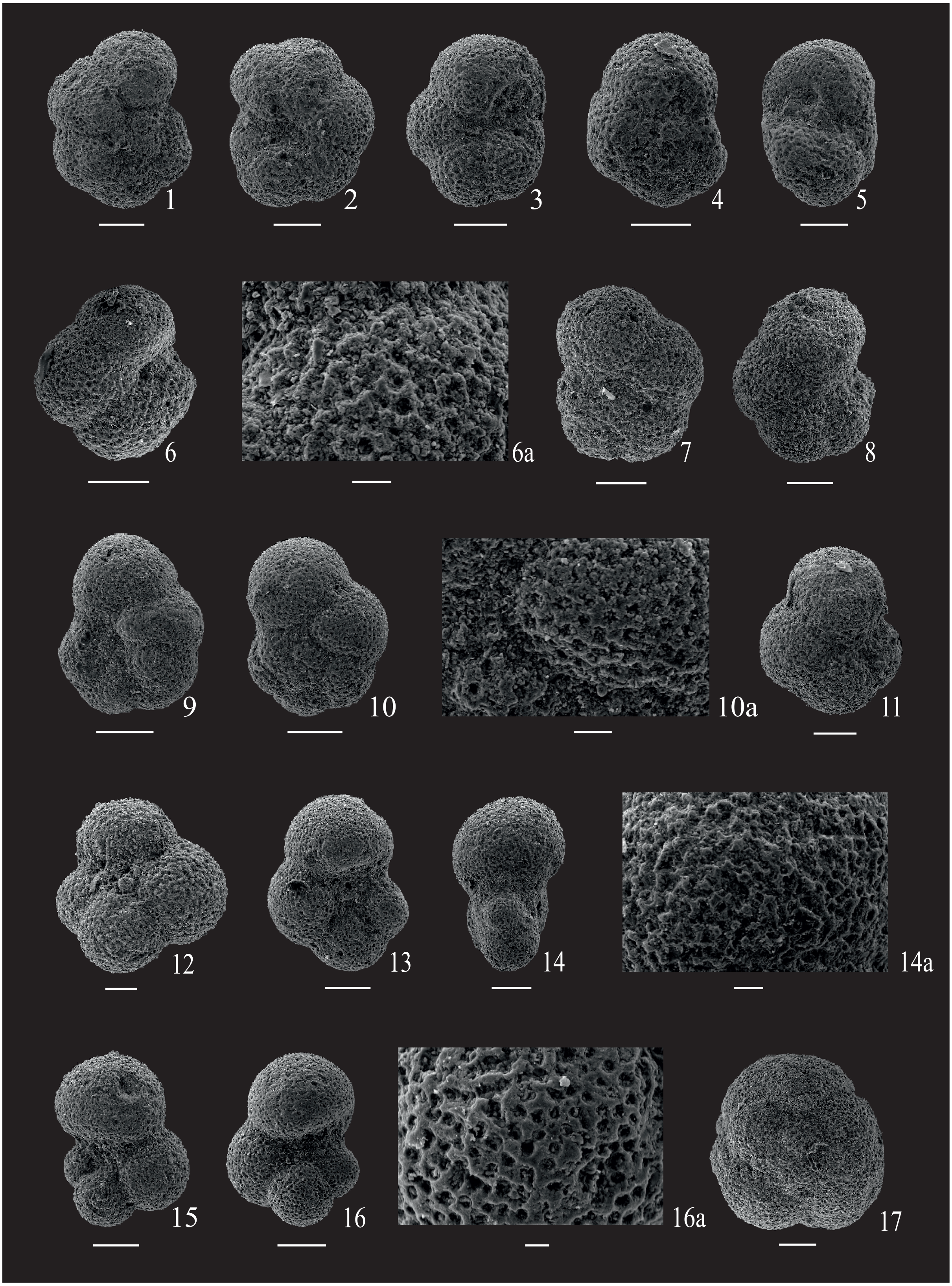
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PLATE 4

Scale bar: 100 µm in Figures 1–17; 20 µm in Figures 5a, 9a, 13a.

Figures 1, 2. *Globoquadrina praedehiscens* Blow and Banner, 1– spiral view, sample no. S.08.13, 2– umbilical view, sample no. S.08.14, Soğukpınar section.

Figure 3. *Globoquadrina dehiscens* (Chapman, Parr and Collins), umbilical view, sample no. S.08.14, Soğukpınar section.

Figure 4. *Globoquadrina venezuelana* (Hedberg), umbilical view, sample no. S.08.13, Soğukpınar section.

Figures 5, 6. *Catapsydrax unicavus* Bolli, Loeblich and Tappan, 5– spiral view, 5a– ultra wall structure of Figure 5, 6– umbilical view, sample no. S.08.14, Soğukpınar section.

Figure 7. *Globoquadrina baroemoenensis* (LeRoy), spiral view, sample no. S.08.23, Soğukpınar section.

Figures 8-10. *Catapsydrax dissimilis* (Cushman and Bermudez), 8– umbilical view, sample no. S.08.13, 9– umbilical view, 9a– ultra wall structure of Figure 9, 10– side view, sample no. S.08.14, Soğukpınar section.

Figures 11, 12. *Dentoglobigerina globularis* (Bermudez), 11– spiral view, 12– umbilical view, sample no. S.08.13, Soğukpınar section.

Figure 13. *Dentoglobigerina altispira globosa* (Bolli), 13– spiral view, 13a– ultra wall structure of Figure 13, sample no. S.06.144, Soğukpınar section.

Figure 14. *Globorotaloides suteri* Bolli, umbilical view, sample no. S.08.13, Soğukpınar section.

Figures 15-17. *Globoquadrina dehiscens* (Chapman, Parr and Collins), sample no. S.06.132, Soğukpınar section.

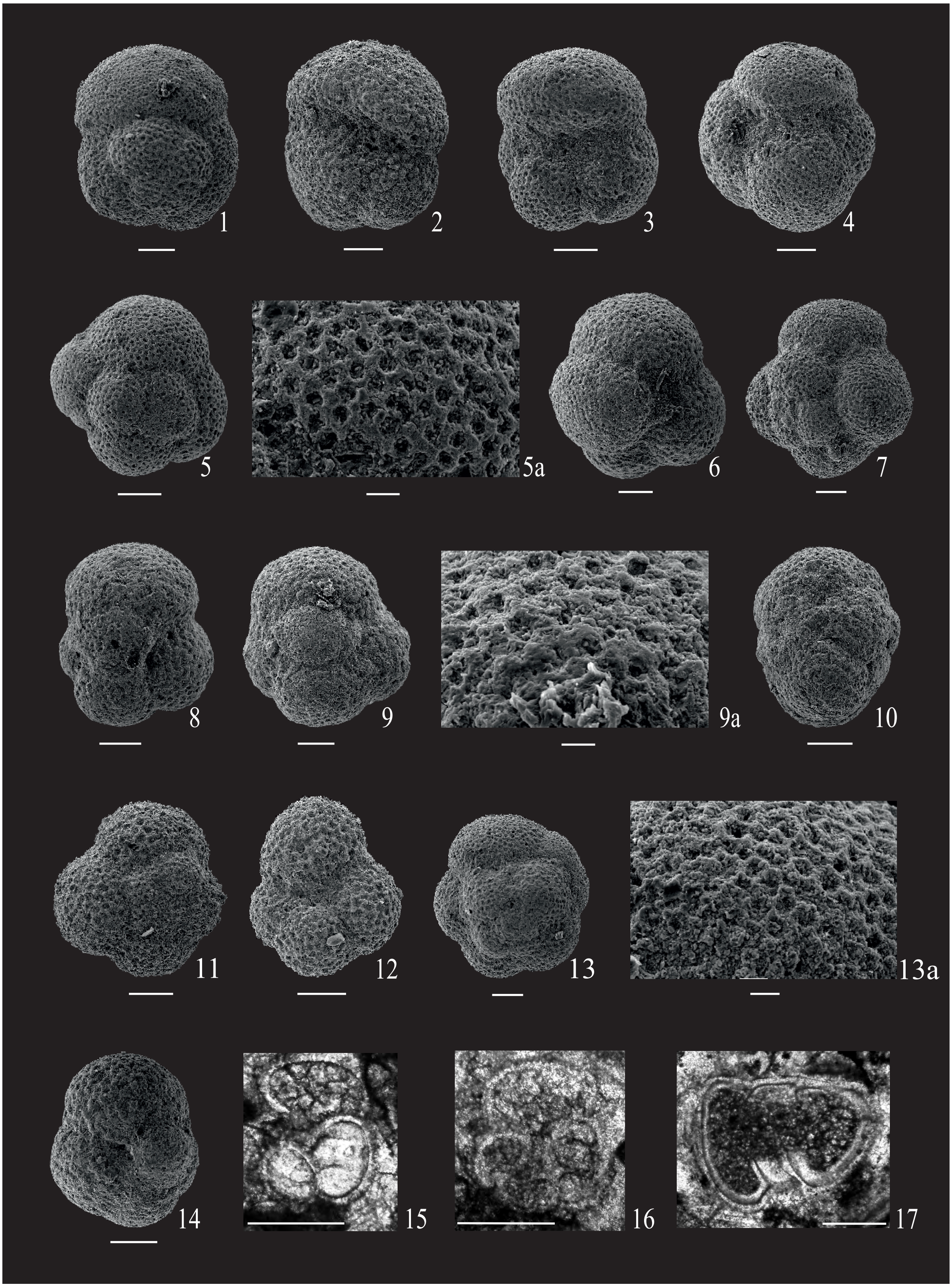
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PLATE 5

Scale bar: 50 µ in Figures 4–8; 100 µ in other Figures.

Figures 1, 2. *Paragloborotalia opima opima* (Bolli), 1– spiral view, 2– umbilical view, sample no. K.08.34, Karagöl section.

Figures 3, 4. *Paragloborotalia pseudocontinuosa* (Jenkins), 3– spiral view, sample no. KT.08.85, Kartaltepe Section, 4– umbilical view, sample no. K.08.35, Karagöl section.

Figure 5. *Paragloborotalia opima nana* (Bolli), umbilical view, sample no. K.08.35, Karagöl section.

Figure 6. *Globigerina angulisuturalis* Bolli, umbilical view, sample no. K.08.34, Karagöl section.

Figure 7. *Globigerina ciperoensis* Bolli, umbilical view, sample no. K.08.35, Karagöl section.

Figure 8. *Tenuitellinata angustiumbilicata* (Bolli), umbilical view, sample no. K.08.40, Karagöl section.

Figure 9. *Globoquadrina prasaepis* (Blow), umbilical view, sample no. K.08.35, Karagöl section.

Figure 10. *Globoquadrina venezuelana* (Hedberg), umbilical view, sample no. K.08.34, Karagöl section.

Figure 11. *Globoquadrina sellii* Borsetti, spiral view, sample no. KT.08.80, Kartaltepe section.

Figure 12. *Globoquadrina tripartita* (Koch), spiral view, sample no. KT.08.80, Kartaltepe section.

Figure 13. *Subbotina tapuriensis* (Blow and Banner), spiral view, sample no. K.08.33, Karagöl section.

Figure 14. *Subbotina gortanii* (Borsetti), side view, sample no. K.08.36, Karagöl section.

Figure 15. *Turborotalia ampliapertura* (Bolli), umbilical view, sample no. K.08.33, Karagöl section.

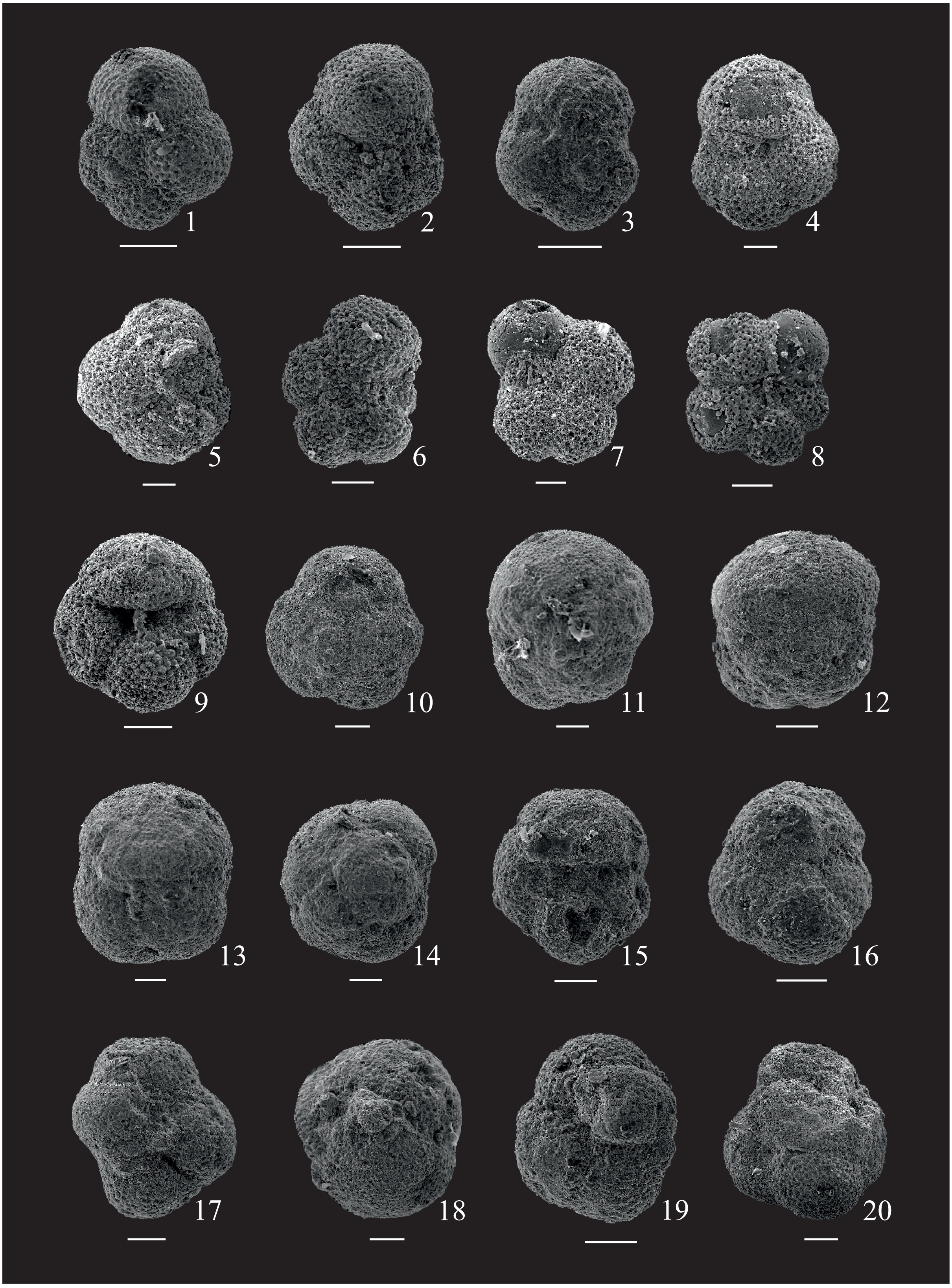
Figure 16. *Turborotalia increbescens* (Bandy), umbilical view, sample no. KT.08.80, Kartaltepe section.

Figure 17. *Subbotina cryptomphala* (Glaessner), umbilical view, sample no. K.08.33, Karagöl section.

Figure 18. *Globigerapsis* sp., oblique view, sample no. KT.08.76, Kartaltepe section.

Figure 19. *Catapsydrax martini* (Blow and Banner), umbilical view, sample no. K.08.33, Karagöl section.

Figure 20. *Catapsydrax dissimilis* (Cushman and Bermudez), umbilical view, sample no. K.08.33, Karagöl section.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Taxonomic Appendix

***Miogypsinoides complanatus* (Schlumberger)**

(Plate 1, Figure 1)

1900 *Miogypsina complanata* Schlumberger, p. 330, plate 2, figures 13–16; plate 3, figures 18–21.

2008 *Miogypsinoides complanatus* (Schlumberger), Boukhary, Kuss & Abdelraouf, p. 186, 188, plate 3, figures 1–7.

Diagnosis: The number of spiral chambers following the deuteroconch is about 17 or 22.

***Miogypsinoides borodinensis* (Hanzawa)**

(Plate 1, Figure 2)

1940 *Miogypsinella borodinensis* Hanzawa, p. 755–802, plate 39, figures 1–9.

2003 *Miogysinoides bermudezi* (Drooger), Sirel, p. 300–301, plate 14, figures 1–27.

Diagnosis: The number of spiral chambers following the deuteroconch is about 13 or 14.

***Miogypsinoides* cf. *formosensis* (Yabe & Hanzawa)**

1928 *Miogypsina (Miogypsinoides) dehartii* Van der Vlerk var. *formosensis* Yabe & Hanzawa, p. 536, figure 1a, b.

1997 *Miogypsinoides formosensis* Yabe & Hanzawa, Cahuzac ve Poignant, p. 159, plate 2, figure 10.

Diagnosis: The number of spiral chambers following the deuteroconch is 15.

***Eulepidina dilatata* (Michelotti)**

(Plate 1, Figures 4, 5)

1861 *Lepidocyclina (Eulepidina) dilatata* Michelotti, plate 1, figures 1, 2

2008 *Eulepidina dilatata* (Michelotti), Özcan, Less, Báldi-Beke, Kollányi & Acar, figures 15.19–20.

Diagnosis: Only the A form was observed in the Kahramanmaraş region. The embryonic apparatus has a spherical or hemispherical protoconch (diameter is between 0.67 mm and 1.1 m) and spherical or hemispherical deuteroconch (diameter between 1.1 mm and 1.57 mm).

***Nephrolepidina morgani* Lemoine and Douville**

(Plate 1, Figures 6, 7)

1904 *Lepidocyclina morgani* Lemoine and Douville, p. 5–41, plate 1, figures 12, 15, 17; plate 2, figure 4; plate 3, figure 2.

2003 *Nephrolepidina morgani* (Lemoine ve Douville), Sirel, p. 303, plate 5, figures 11–16; plate 6, figures 1–7.

Diagnosis: The test has numerous central pustules. The embryonic apparatus has a hemispherical protoconch (diameter is between 0.18 mm and 0.31 mm) and reniform deuteroconch (diameter between 0.32 mm and 0.50 mm).

***Miolepidocyclina burdigalensis* (Gümbel)**

(Plate 1, Figure 8)

1870 *Orbitoides burdigalensis* Gümbel, p. 719

2009 *Miolepidocyclina burdigalensis* (Gümbel), Özcan ve Less, p. 33, plate 1, figures 26–31; plate 2, figure 5.

Diagnosis: *Miolepidocyclina burdigalensis* has a centrally located embryonic apparatus and V value of 45.

***Miogypsina intermedia* Drooger**

(Plate 1, Figure 9)

1952 *Miogypsina (Miogypsina) intermedia* Drooger, pp. 35–36, plate 2, figures 30–34, plate 3, figure 4a, b

2008 *Miogypsina intermedia* Drooger, Özcan, Less, Baldi-Beke, Kollanyi and Acar, figures 12.9–19.

Diagnosis: Specimens have a V value of between 50 and 69.5.