Larger foraminiferal biostratigraphy of the middle Tertiary of Bey Dağlari Autochton, Menderes-Taurus Platform, Turkey

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ABSTRACT: Larger foraminifera are recognized from the middle Tertiary (Oligocene-Miocene) carbonate sediments, Bey Dağlari Autochton, which is a segment of a Tethyan Platform. Eight diagnostic species and their local ranges are documented. These 8 species establish three biostratigraphically useful faunal assemblages which are assigned to Tertiary e4 (Chattian), Tertiary e5 lower (Aquitanian) and Tertiary e5 upper (Burdigalian) of the Far Eastern Letter Stages. Diagnostic miogypsinid foraminifera and one new genus, *Spinosemiogypsina antalyaensis,* n. gen., n. sp. are described.

INTRODUCTION

Turkey is part of the Alpine Orogenic Belts of the Alpine-Himalayan-Indonesian Mountain Range. There are a number of microcontinents in Turkey which are bounded by suture zones of different ages. The Menderes-Taurus Platform in southern and eastern Turkey is composed of a large number of segments (microcontinents) representing repeated convergent events that accompanied the closure of the Neo-Tethys System between the Sakarya zone - Kirşehir Block (microcontinents) in northern Turkey and the Arabian Platform (microcontinent) in southern Turkey (Text-figure 1 upper). The Bey Dağlari Autochton, in the Menderes-Taurus Platform, represents a segment of a Cretaceous - Tertiary Tethyan Platform on which carbonate accumulation has persisted. This segment was overthrusted by the Antalya Nappes (unit) in the east, and the Lycian Nappes in the west (Poisson 1997). The sedimentary sequences of the Bey Dağlari Autochton area of the study were reported to be of the Oligocene-Miocene successions before the final emplacement of the Lycian Nappes during the late Miocene (Tortonian) (Collins and Robertson 2003). The purpose of the present study is to describe the larger foraminiferal biostratigraphy of the middle Tertiary succession in the Bey Dağlari Autochton. This provides the framework of a regional biozonation for the adaptation of the Far Eastern Letter stages (Leupold and van der Vlerk 1931).

STRATIGRAPHY, LITHOLOGY, FAUNAL SUCCESSION AND CORRELATION

The upper Createceous-Tertiary sequences of the Bey Dağlari Autochton are generally the middle Cenomanian - Santonian Bey Dağlari Formation (composed mainly of neritic limestone), upper Campanian - upper Maastrichtian Akdag Formation (cherty, pelagic and clayey limestones), upper Paleocene-lower Eocene Sobute Formation (limestone, marl and claystone), upper Lutetian - Oligocene Küçükköy Formation (marl, claystone and limestone), Aquitanian Karabayir Formation (algal limestone), Burdigalian Karakuştepe Formation (alternation of sandy limestone, claystone and limestone) and Burdigalian - Langian Kasabu Formation (conglomerate, sandstone and claystone) (Poisson 1997) (Text-figure 1 lower). The Sobute Formation is represented by thin marl in the middle part (Bozcalar Dere) of the study area, and does not appear in the geological map.

The detailed larger foraminiferal zonation of the Oligocene - Miocene succession, from the Bey Dağlari Autochton until present, has rarely been discussed. The present authors tried to focus their study on the Karabayir Formation, which was suggested to have been deposited from the Aquitanian transgression in the Bey Dağlari Platform (foreland basin) by Poisson and Poignant 1974. The Karabayir Formation unconformably overlies the Küçükköy Formation, but the lithologic aspects are nearly the same, making it vertically and laterally indistinguishable from the Küçükköy. In addition, the Karabayir Formation is represented by medium to thick-bedded gray to cream colored limestones that grade into the Karakuştepe Formation. The Karabayir Formation is generally a neritic limestone, with limestone turbidite and pelagic limestone lenses, in addition to brecciated limestone with both intraclasts from the basin and bioclasts with algae from the platform. Tectonics was the most influential control on the depositional history of the Bey Dağlari foreland basin during the Oligocene - Miocene time. As such, the study profiles from 13 sections may not be fit to the geological map (Poisson, op. cit.). It was difficult to interpret species contamination from the influence of tectonic events within the faunal assemblages. The distribution chart is, therefore, more complex than usual, and all the species of each sample were indicated irrespective of their occurrences (Text-figure 4).

The GPS geographical location from Section 1 to Section 13 is shown in the following table.

SECTION NUMBER	STARTING COORDINATES	ENDING COORDINATES
SECTION-1	0247840/4105051	0247686/4105250
SECTION-2	0247102/4104513	0246918/4104751
SECTION-3	0245027/4103206	0244960/4103304
SECTION-4	0243655/4102084	0243572/4102462
SECTION-5	0243178/4101275	0242969/4101626
SECTION-6	0242638/4100796	0241958/4101006
SECTION-7	0242733/4099669	0242568/4099674
SECTION-8	0242685/4099379	0242492/4099379
SECTION-9	0241698/4099098	0241367/4099118
SECTION-10	0241862/4098156	0241634/4098141
SECTION-11	0241385/4096160	0241100/4096229
SECTION-12	0245799/4094754	0245203/4094967
SECTION-13	0242813/4092957	0243068/4093127

Section 1 (Text-figures 1, 2a)

A northern hill composed of thick neritic limestone (mainly calcilutite) and alternation of limestone and marl about 80 m thick located 1 km SW of Korkuteli Village. A total of 11 samples of pelagic marl, clayey limestone, sandy limestone and limestone with pebbles were collected. The lower part (samples 97-441 to 97-444) of the sequence is characterized by the occurrence of *Miogypsinoides formosensis* Yabe and Hanzawa, *Mdes. bantamensis* (Tan Sin Hok), *Miogysina primitiva* Tan Sin Hok, which is used here as a synonym of *M. gunteri* Cole, *M. borneensis* Tan Sin Hok, which is used as a synonym of *M. tani* Drooger, *Eulepidina dilatata* (Michelotti), *Lepidocyclina boetonensis* van der Vlerk, *Nephrolepidina marginata* (Michelotti), which is originally a microspheric form of megalospheric *N. morgani* Lemoine and R. Douville (Matsumaru 1992), *Operculina complanata* (Defrance), *Cycloclypeus* spp., *Spiroclypeus margaritatus* (Schlumberger), *Miscellanea miscella* (d'Archiac and Haime) and Globigerinidae (not identified). This fauna, except for *Miscellanea miscella* derived from the Paleocene (Sobute Formation), is assigned to Assembalge 1. It is correlated to a fauna as shown in fine grained calcareous sandstones, Zone 5 (394.98-431.67 m) in drill cores taken from a well in Kita-Daito-Zima Atoll (North Borodino Island), Japan (Hanzawa 1940). Zone 5 contains a fauna including *Miogypsinella borodinensis* Hanzawa, which is referred to here as *Miogypsinoides formosensis* due to its very low trochoidal nepionic spirals, *Rotalia calcar* Linne and *Amphistegina radiata* (Fichtel and Moll).

The upper part, samples 97-445 to 97-449, is characterized by the occurrence of *Miogypsinoides bantamensis, Mdes. dehaartii* (van der Vlerk), *Miogypsina borneensis, M. globulina* (Michelotti), *Operculina complanata, Catapsydrax dissimilis* (Cushman and Bermudez) and Globigerinidae. This fauna is assigned to Assembalge 2. It is correlated to fauna as shown in the lower part of coarse grained calcareous sandstones, Zone 4 (lower part, 302.31-394.98 m) in drill cores of Kita-Daito-Zima (Hanzawa, op. cit.). The Zone 4 (lower) contains foraminifera such as *Nephrolepidina plicomargo* Hanzawa, which is a synonym of *N. morgani, Miogypsinoides bantamensis, Mdes. lateralis* Hanzawa, which is regarded as a synonym of *Mdes. bantamensis, Spiroclypeus margaritatus, Borodinia septentrionalis* Hanzawa and others. According to Ohde and Elderfiels (1992), the strontium isotope age for the carbonate rocks of Kita-Daito-Zima places the Oligocene (Chattian) - Miocene (Aquitanian) boundary (23.2 or 23.5 Ma) at near core of 394.98 m depth, and confirmed by Hanzawa's faunal boundary of Zone 5 and Zone 4 (lower), and the Aquitanian - Burdigalian boundary (20.3 or 21.1 Ma) at near core of 302.31 m depth, between Hanzawa's Zone 4 (lower) and Zone 4 (upper). These radiometric ages show similar ages of the boundary of the Chattian - Aquitanian and Aquitanian - Burdigalian by Berggren et al. (1995).

Section 2 (Text-figures 1, 2a)

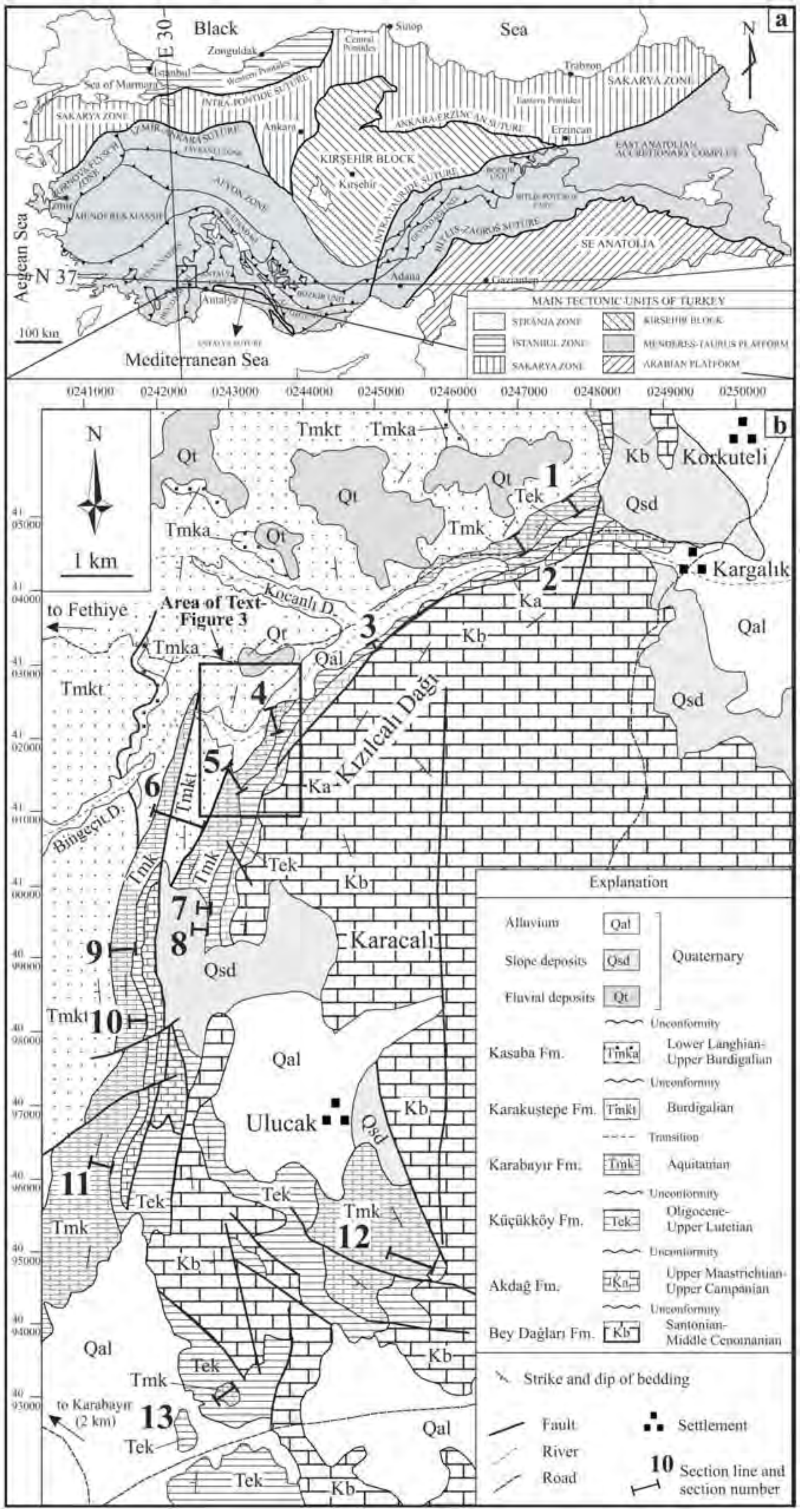
A northern hill composed of thick neritic limestone (algal biolithite and coral biolithite) and alternation of limestone and marl about 140 m thick located 0.8 km SW of Section 1. A total of 8 samples of massive and thin bedded neritic limestone, pelagic limestone and sandy limestone were collected. All samples except sample 96-60 contain foraminifera described in Assemblage 3. The foraminiferal contents are *Miogypsinoides dehaartii, Miogypsina globulina, Lepidosemicyclina thecidaeformis* Rutten, *Eulepidina dilatata, E. ephippioides* (Jones and Chapman), *Lepidocyclina boetonensis, Operculina complanata,* and Globigerinidae. This fauna, except for *L. boetonensis,* known from the Tertiary d (lower Oligocene), Boeton, East Celebes (van der Vlerk 1928), is similar to the faunal assemblage of Zone 4 (upper part, 209.26-302.31 m) from the upper part of coarse grained sandstone in cores from Kita-Daito-Zima (Hanzawa, op. cit.). Zone 4 (upper) contains foraminifera such as *Miogypsinoides dehaartii* var. *pustulosa* Hanzawa, which is regarded as a synonym of *Mdes. dehaartii, Miogypsina borneensis* and *Nephrolepidina tournoueri* (Lemoine and R. Douville), which is here regarded as a partial synonym of *N. morgani.*

Section 3 (Text-figures 1, 2a)

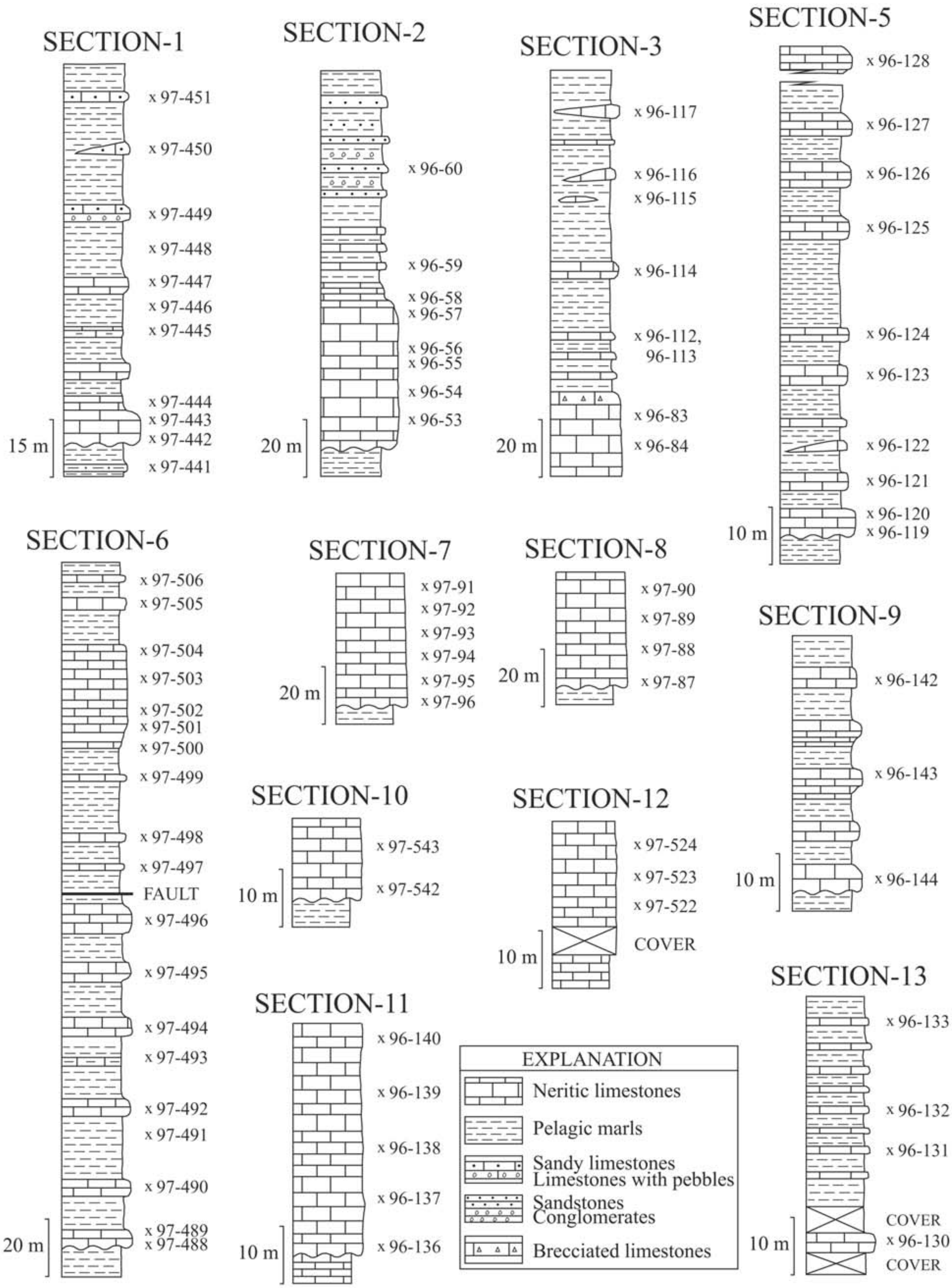
A southern hill composed of thick neritic limestone (algal biolithite) and alternation of limestone and marl about 140 m thick located 2.5 km SW of Section 2. A total of 8 samples of neritic limestone, brecciated limestone and pelagic limestone were collected. The lower part of samples 96-84 and 96-83 are characterized by the occurrence of *Miogypsina primitiva, M. borneensis, M. globulina, Lepidosemicyclina thecidaeformis, Eulepidina dilatata, Nephrolepidina marginata, Operculina complanata* and *Miscellanea miscella.* The last species are regarded as reworked species. These fauna are assigned to Assemblage 2 due to the common species of *M. borneensis, M. globulina* and *Operculina complanata* from the upper part in Section 1. The upper part of samples 96-113 to 96-117 contain fauna which includes *Miogypsinoides dehaartii, Miogypsina primitiva, M. borneensis, M. globulina, Lepidosemicyclina thecidaeformis, Eulepidina dilatata, E. ephippioides, Nephrolepidina marginata, Operculina complanata, Heterostegina borneensis* van der Vlerk and Globigerinidae. Both *Miogypsina primitiva and H. borneensis* are regarded as reworked species, due to their rare occurrence and broken specimens. This fauna recognized in Section 2 is correlated to Assemblage 3, due to the occurrence of *M. dehaartii, M. globulina, L. thecidaeformis, E. dilatata, E. ephippioides* and *O. complanata.*

Section 4 (Text-figures 1, 2b and 3)

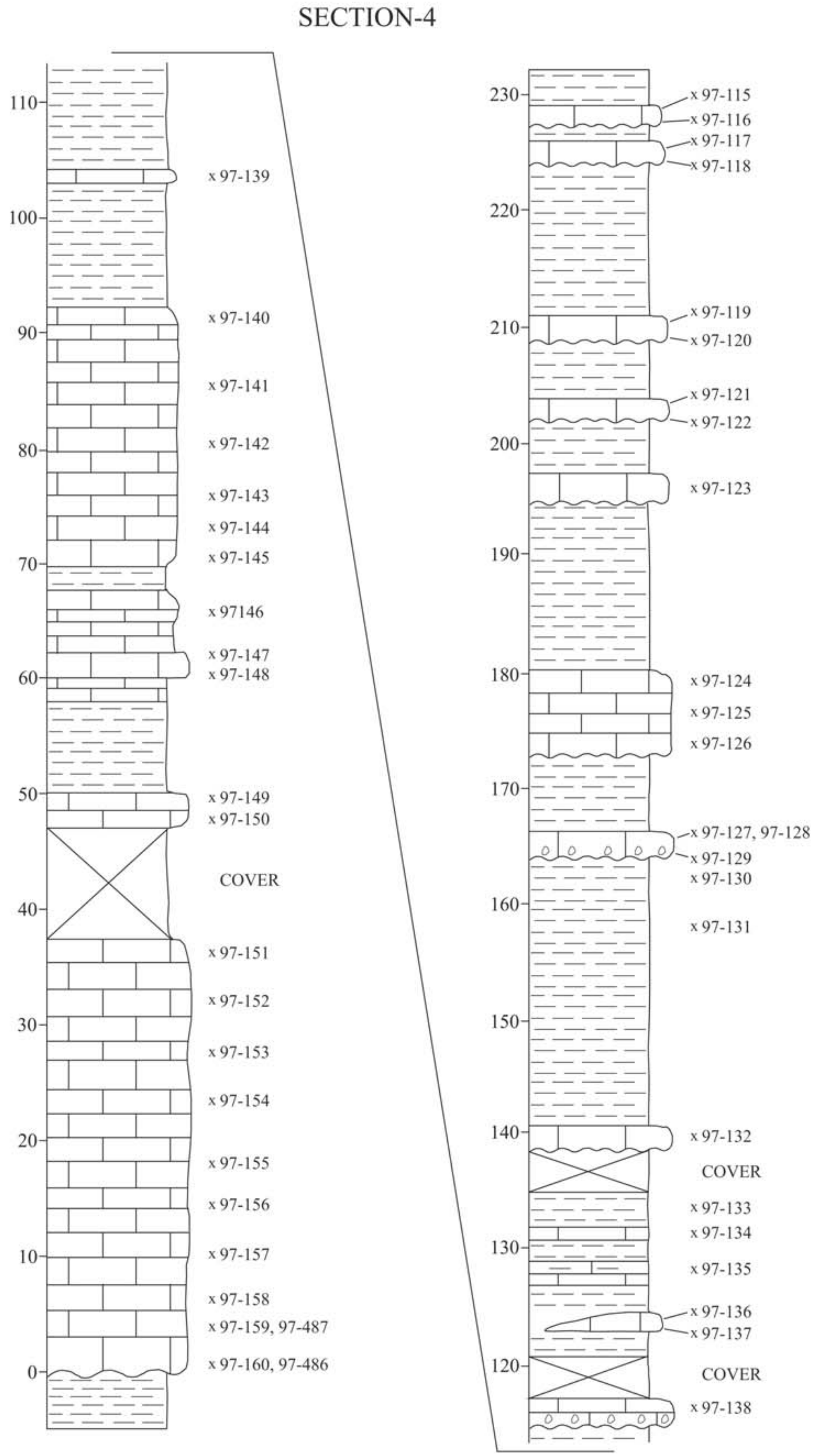
A southern hill composed of thick neritic limestone (algal biolithite and calcarenite) and alternation of limestone (mainly algae bearing calcarenite) and marl about 230m thick located 2.5km SW of Section 3. A total of 48 samples of neritic limestone, pelagic limestone and pelagic marl were collected. The lower part of samples 97-486 to 97-156 are characterized by the occurrence of *Paleomiogypsina boninensis* Matsumaru, *Mio-*



TEXT-FIGURE 1
a. Map showing main tectonic units of Turkey (Görür and Tüysüz 2001), and b. Geological map of the Korkuteli area in this study (simplified and modified after Poisson 1997), and it shows both the location of the measured columnar section from Section 1 to Section 13 for sampling stations, and the location of detailed area of Section 4 and Section 5 in Text-figure 3. The Korkuteli area corresponds geographically to the middle part of the Bey Dağlari Autochton, NW Antalya.



TEXT-FIGURE 2a
Studied sections (i.e. Section 1 to Section 3, and Section 5 to Section 13) with sampling stations in the Bey Dağlari Autochton.



TEXT-FIGURE 2b
Section 4 with sampling stations in the Bey Dağlari Autochton.

gypsinella complanata (Schlumberger), *Miogypsinoides formosensis, M. bantamensis, Miogypsina primitiva, M. borneensis, Eulepidina dilatata, Lepidocyclina boetonensis, Nephrolepidina marginata, Heterostegina borneensis, Cycloclypeus* spp., *Spiroclypeus margaritatus, Miscellanea miscella, Lockhartia conditi* (Nuttall), *Globigerina sellii* (Borsetti), *Globigerinoides primordius* Blow and Banner, and Globigernidae. Both *Miscellanea miscella* and *L. conditi* are reworked from the Sobute Formation. Further, *P. boninensis,* and *M. complanata* are reworked species because there is no evidence of the common occurrence with *M. bantamensis, M. primitiva,* and *M. borneensis* in the Arisan (or kaizan) Formation, Taiwan (Yabe and Hanzawa 1928, 1930), Oligocene-Miocene limestones, Kita-Daito-Zima (Hanzawa, 1940), Mamiyara and Khari Nadi Formations, Kutch and Karaihal well 4 and Madanam well 1, Cauvery Basin, India (Raju 1974), Tagpochau Limestone, Saipan Island (Hanzawa 1957; Cole 1957a) and Minamizaki Limestone, Chichi-Jima, Ogasawara Islands (Matsumaru 1996), respectively. The occurrence can rarely be seen in the Tertiary lower e (Oligocene) *Heterostegina barriei* Adams and Belford/*Spiroclypeus margaritatus* Assemblage on Christmas Island (Adams and Belford, 1974, text-fig. 3). In the assemblage, *Miogypsinoides complanata* (Adams and Belford, op. cit., pl. 73, figs. 4-5) from sample D3 on Christmas Island should be regarded as *Paleomiogypsina boninensis,* because they have few equatorial chambers and trochoid nepionic spirals, and *H. barriei* is regarded as a synonym of *H. duplicamera* Cole 1957b, since they have 5 to 8 operculine chambers. This assemblage may contain reworked species. As a conclusion, the lower part (samples 97-486 to 97-156) is correlated to Assemblage 1 in Section 1 due to the common species of *Mdes. bantamensis, M. primitiva, M. borneensis, E. dilatata, L. boetonensis, N. marginata, C.* spp. and *S. margaritatus.* Further, the lower part of Section 4 in the Küçükköy Formation is placed in Assembalge 1.

The middle part of samples 97-155 to 97-143 contains a fauna which includes *Miogypsinoides dehaartii, Miogypsina primitiva, M. borneensis, Lepidosemicyclina thecidaeformis, Nephrolepidina marginata, Operculina complanata, Cycloclypeus* spp., *Austrotrillina howchini* (Schlumberger), *Globorotalia mayeri* Cushman and Ellisor and Globigerinidae. This fauna is assigned to Assemblage 2 due to the common species of *M. primitiva, M. borneensis, N. marginata* and *O. complanata* from the lower part in Section 3. The upper part of samples 97-142 to 97-115 contains the following foraminifera: *Miogypsinoides formosensis, Mdes. dehaartii, Miogypsina primitiva, M. borneensis, M. globulina, Miolepidocyclina burdigalensis* (GÜmbel), *Lepidosemicyclina thecidaeformis, Eulepidina dilatata, Lepidocyclina boetonensis, Nephrolepidina marginata, N. tournoueri, Operculina complanata, Globorotalia mayeri, Globoquadrina dehiscens* (Chapman, Parr and Collins), *Hantkenina* spp. and Globigerinidae. *Hantkenina* spp. is a reworked species. This fauna, except for *Mdes. formosensis* and *L. boetonensis*, is correlated to Assemblage 3 in Section 2, and the upper part in Section 3, due to the common occurrence of *Mdes. dehaartii* and *M. globulina*. It is noted that sample 97-142 yields both *M. globulina* and *M. burdigalensis,* which are known from the type Burdigalian (Drooger et al. 1955). The upper part of Section 4 in the Karakuştepe Formation is placed in Assemblage 3.

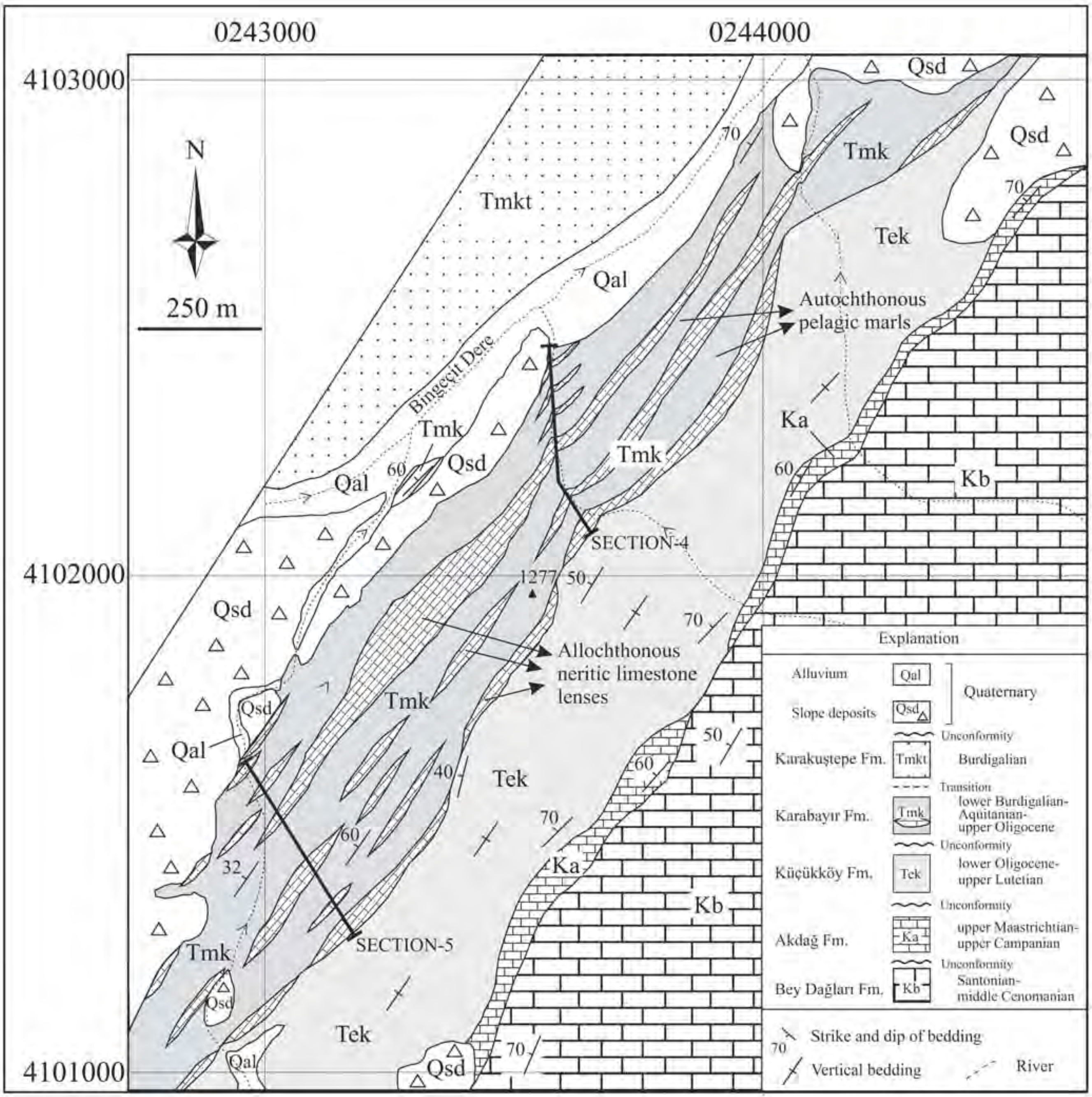
Section 5 (Text-figures 1, 2a and 3)

A southern hill composed of alternation of limestone (algae bearing calcirdite and calcarenite) and marl about 85 m thick located 0.5 km SW of Section 4. A total of 10 samples of neritic limestone and pelagic limestone were collected. The lower part of samples 96-119 and 96-120 yields *Miogypsinella complanata, Miogypsinoides formosensis, Mdes. bantamensis, Mdes. dehaartii, Miogypsina primitiva, Eulepidina dilatata, E. ephippioides, Lepidocyclina boetonensis, Nephrolepidina marginata, Operculina complanata, Heterostegina borneensis, Cycloclypeus* spp., *Spiroclypeus margaritatus, Miscellanea miscella, Globigerina sellii, Globotruncana* spp., *Hedbergella* spp. and others. Then species contamination can be seen in this fauna due to the influence of tectonic events during the late Oligocene. *Globotruncana* spp., *Hedbergella* spp. and others are regarded as reworked from the Akdag Formation, and *Miscellanea miscella* are regarded as reworked from the Sobute Formation. *Lepidocyclina boetonensis, Mnella. complanata,* and *Mdes. formosensis* are reworked from the Küçükköy Formation. The original assemblage is assigned to Assemblage 1 and it is characterized by the occurrence of *Mdes. bantamensis, Mdes. dehaartii, M. primitiva, E. dilatata, E. ephippioides, N. marginata, O. complanata, Heterostegina borneensis, Cycloclypeus* spp. and *S. margaritatus.* However, the occurrence of *Heterostegina borneensis* is known to range from Tertiary d (Rupelian) to Tertiary e3 (Chattian) in Chichi-Jima, Ogasawara Islands (Matsumaru, 1996). In Eniwetok drill holes, Cole (1957b, p. 759) showed that *H. borneensis,* occurred at a depth of 1688-1978 feet, eliminating 1210-1220 feet due to contamination, and appeared stratigraphically lower than *Mdes. dehaartii* occurring at depth 1160-1375 feet. Further, Cole (1963, p. E6) considered *H. borneensis* zone to be Tertiary lower e and *Mdes. dehaartii* zone to be Tertiary upper e. He concluded that the former is stratigraphically older than the latter in the Malayan Archipelago and areas adjacent to Guam Island, Micronesia. The middle part of samples 96-121 to 96-123 is correlated to Assemblage 2 in Section 4, due to occurrences of *Miogypsinoides bantamensis, Mdes. dehaartii, Miogypsina primitiva, M. borneensis,* and *Spiroclypeus margaritatus.* (Text-fig. 4). The middle part of Section 5 in the Karabayir Formation is placed in Assemblage 2. *Miogypsina globulina* in Assemblage 2 is generally present, but here is obscur.

The upper part of samples 96-124 to 96-128 yields *Miogypsina globulina, Eulepidina dilatata, Nephrolepidina marginata, Operculina complanata, Heterostegina borneensis* and Globigerinidae. This fauna, except for *H. borneensis*, is correlated to Assemblage 3 in Section 2, the upper part of Section 3 and upper part of Section 4, due to the occurrence of similar fauna.

Section 6 (Text-figures 1, 2a)

A western hill composed of alternation of limestone (mainly algae bearing calcarenite) and marl about 220 m thick located 300 m west of Section 5. A total of 19 samples were collected. The lower part of sample 97-489 yields *Miogypsinoides bantamensis, Miogypsina borneensis, Lepidosemicyclina thecidaeformis, Spinosemiogypsina antalyaensis,* n. gen., n. sp., *Eulepidina dilatata, Nephrolepidina marginata, Operculina complanata,* and reworked *Globotruncana* spp., *Hedbergella* spp. and others. The upper Cretaceous planktonic foraminifera are regarded to be carried from the Akdag Formation. This fauna is correlated to Assemblage 1 in Section 1, lower part in



TEXT-FIGURE 3
Detailed geological map showing the distribution of neritic limestone and pelagic marl, and the location of Section 4 and Section 5.

Section 4 and lower part in Section 5, due to the occurrence of similar fauna. The middle part of samples 97-490 to 97-496 yields *Mdes. bantamensis, M. borneensis, M. globulina, L. thecidaeformis, E. dilatata, L. boetonensis, N. marginata, O. complanata, Cycloclypeus* spp. and *Globoquadrina dehiscens.* Both *Mdes. bantamensis* and *L. boetonensis* are thought to be reworked species, and the present fauna is assigned to Assemblage 3 in Section 3 and upper part in Section 4, due to the common species of *M. borneensis, M. globulina, L. thecidaeformis, E. dilatata, N. marginata* and *O. complanata.*

The upper part of samples 97-497 to 97-503 yields *Paleomiogypsina boninensis, Miogypsinella complanata, Miogypsinoides formosensis, Mdes. bantamensis, Miogypsina primitiva, Eulepidina dilatata, Lepidocyclina boetonensis, Nephrolepidina marginata, Heterostegina borneensis, Cycloclypeus* spp., *Spiroclypeus margaritatus, Miscellanea miscella, Lockhartia conditi* and Globigerinidae. Both *Miscellanea miscella* and *Lockhartia conditi* are reworked from the Sobutepe Formation. The common occurrence of both species in the upper part in Section 6 is reason to believe they are reworked species from the older fauna. *Paleomiogypsina boninensis* and *Miogypsinella complanata* are reworked species from the older fauna. The present fauna is assigned to Assemblage 1 in Section 1, lower part in Section 4 and lower part in Section 5, due to the common occurrence of *M. bantamensis* and *M. primitiva.* The upper part in section 6 is considered to be obducted on the middle part by a thrust fault (Text-figure 2a).

Section 7 (Text-figures 1, 2a)

Samples were collected on a hill composed of neritic limestone (algae bearing calcarenite) about 50m thick located 1.5km south of Section 5. 6 samples were collected. The lower part of samples 97-96 and 97-95 yields *Miogypsinoides formosensis, Mdes. bantamensis, Mdes. dehaartii, Miogypsina primitiva, M. borneensis, Nephrolepidina marginata, Spiroclypeus margaritatus* and *Miscellanea miscella.* This fauna, except for *M. miscella*, is correlated to Assemblage 1 in Section 1, lower part in Section 4, lower part in Section 5 and both lower and upper parts in Section 6, due to the occurrence of similar fauna. The upper part of samples 97-94 and 97-93 yields *Mdes. bantamensis, Mdes. dehaartii, M. primitiva, S. margaritatus* and Globigerinidae. This fauna is correlated to Assemblage 2 in the upper part of Section 1, middle part in Section 4 and middle part in Section 5, due to occurrence of similar fauna.

Section 8 (Text-figures 1, 2a)

Samples were collected on a hill composed of neritic limestone (algae bearing calcarenite) about 50m thick located 400m south of Section 7. 4 samples were collected. The lower part of sample 97-87 yields *Miogypsinoides bantamensis, Mdes. dehaartii, Miogypsina primitiva, Eulepidina dilatata, Lepidocyclina boetonensis, Nephrolepidina marginata, Heterostegina borneensis* and *Miscellanea miscella.* This fauna, except for *M. miscella*, is correlated to Assemblage 1 in Section 1, lower part in Section 4, lower part in Section 5, both lower and upper part in Section 6 and lower part in Section 7, due to the occurrence of similar fauna. The upper part of sample 97-90 yields *M. primitiva*, *M. borneensis, M. globulina, N. tournoueri, Globigerinoides primordius* and Globigerinidae. This fauna is correlated to Assemblage 2 in the upper part in Section 1, lower part in Section 3, middle part in Section 4, middle part in Section 5 and upper part in Section 7, due to the occurrence of similar fauna.

Section 9 (Text-figures 1, 2a)

Samples were collected on a western hill composed of alternation of limestone (calcarenite) and marl about 45m thick located 0.9 km west of Section 8. 3. The lower part of samples 96-144 and 96-143 yields *Miogypsinoides bantamensis, Mdes. dehaartii, Miogypsina primitiva, Lepidosemicyclina thecidaeformis, Eulepidina dilatata, Nephrolepidina marginata, Miscellanea miscella* and Globigerinidae. This fauna, except for *M. miscella*, is correlated to Assemblage 1 in Section 1, lower part in Section 4, lower part in Section 5, both lower and upper part in Section 6, lower part in Section 7 and lower part in Section 8, due to the occurrence of similar fauna. The upper part of sample 96-142 yields *M. globulina, L. boetonensis* and *N. marginata.* This fauna, except for *L. boetonensis*, is correlated to Assemblage 2 in the upper part in Section 1, lower part in Section 3 and upper part in Section 8, due to the occurrence of *M. globulina.*

Section 10 (Text-figures 1, 2a)

Two samples were collected on a western hill composed of neritic limestone (algae bearing calcarenite to calcirudite) about 15 m thick located 1 km south of section 9.. Sample 97-543 yields *Miogypsinoides bantamensis, Mdes. dehaartii, Eulepidina ephippioides, Nephrolepidina marginata, Operculina complanata, Heterostegina borneensis, Spiroclypeus margaritatus* and *Miscellanea miscella.* This fauna, except for *M. miscella*, is correlated to Assemblage 1 in Section 1, lower part in Section 4, lower part in Section 5, both lower and upper part in Section 6, lower part in Section 7, lower part in Section 8 and lower part in Section 9, due to the occurrence of similar fauna.

Section 11 (Text-figures 1, 2a)

Five samples were collected on a western hill composed of thick neritic limestone (calcarenite and calcirudite) about 40m thick located 2km south of Section 10. These samples, except for sample 96-140, include *Miogypsinella complanata, Miogypsinoides formosensis, Mdes. bantamensis, Mdes. dehaartii, Eulepidina dilatata, Lepidocyclina boetonensis, Nephrolepidina marginata, Operculina complanata, Heterostegina borneensis, Cycloclypeus* sp., *Spiroclypeus margaritatus, Miscellanea miscella, Cartapsydrax dissimilis* and Globigerinidae. This fauna, except for *M. miscella*, is correlated to Assemblage 1 in Section 1, lower part in Section 4, lower part in Section 5, both lower and upper part in Section 6, lower part in Section 7, lower part in Section 9 and in Section 10, due to the occurrence of similar fauna.

Section 12 (Text-figures 1, 2a)

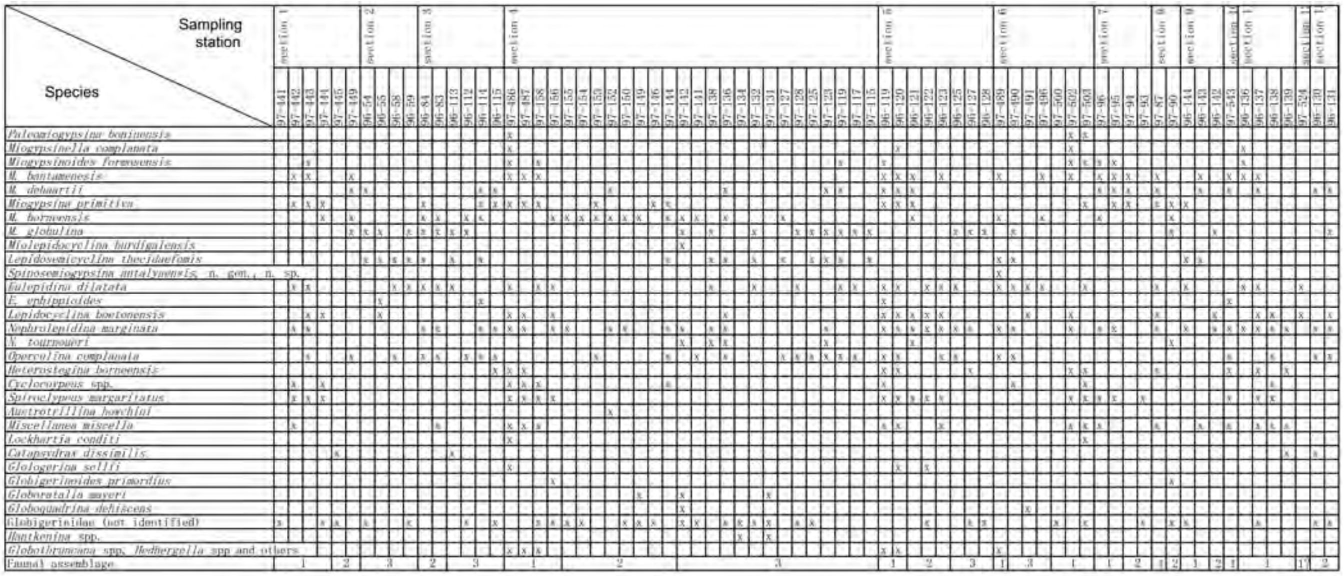
Three samples were collected from a southeast hill composed of thick neritic limestone (algae, miliolid foraminifera and pellet bearing calcarenite) about 25m thick located 2km SE of Ulucak Village. At sample 97-524, it yields *Eulepidina dilatata* and *Lepidocyclina boetonensis.* The foraminifer contents are poor, but this fauna is tentatively assigned to Assemblage 1.

Section 13 (Text-figures 1, 2a)

Four samples were collected from a southern hill composed of algal limestone and alternation of limestone and marl about 45 m thick located 4 km SW of Ulucak Village.. Samples 96-130 and 96-131 yield *Miogypsinoides dehaartii, Miogypsina globulina, Lepidocyclina boetonensis, Nephrolepidina marginata, Operculina complanata, Catapsydrax dissimilis* and Globigerinidae. This fauna, except for *L. boetonensis*, is correlated to Assemblage 2 and recognized in the upper part in Section 1, lower part in Section 3, middle part in Section 4, middle part in Section 5, upper part in Section 7, upper part in Section 8 and upper part in Section 9, due to the occurrence of similar fauna.

GEOLOGICAL AGE OF THE FAUNAS

Three faunal assemblages based on the larger foraminifera have been recognized from the middle Tertiary (Oligocene - Miocene) sedimentary rocks on the Bey Dağlari Autochton, Menderes-Taurus Platform, Turkey. Based on the stratigraphy and faunal assemblage of the Bey Dağlari Autochton, all the sedimentary rocks studied are referred to as the Küçükköy Formation (partial) within Assemblage 1, Karabayir Formation within Assemblage 2 and Karakuştepe Formation (partial) within Assemblage 3. The three assemblages in the Bey Dağlari Autochton are assigned to the Tertiary e4, Tertiary e5 lower and Tertiary e5 upper of the Far Eastern Letter Stages, respectively.



TEXT-FIGURE 4
Distribution chart of larger and planktonic foraminifera from the middle Tertiary sedimentary rocks in the Bey Daglari Autochton.

Further, based on strontium isotope ages, they are late Oligocene (Chattian), early Miocene (Aquitanian) and late early Miocene (Burdigalian), respectively.

1. *Miogypsinoides formosensis - Mdes. bantamensis - Mdes. dehaartii - Miogypsina primitiva - Spiroclypeus margaritatus* Assemblage (Assemblage 1)

This assemblage is defined by the above five species. The common occurrence is *Lepidosemicyclina thecidaeformis, Eulepidina dilatata, E. ephippioides, Nephrolepidina marginata, Operculina complanata* and *Cycloclypeus* spp. Both *Paleomiogypsina boninensis* and *Heterostegina borneensis* are found in this assemblage, but they are considered to be reworked from the lower assemblage as stated before. *Miogypsina borneensis* seems to be limited in the upper part of this assemblage. Further, the thickness of neritic limestone carrying Assemblage 1 varies abruptly in places (i.e. Sections 1, 4-12) within only 12 km in the north-south direction of the study area. This means there is a minor unconformity in the sedimentary rocks between the neritic limestone and overlying rocks. It is then impossible to make up an exact faunal assemblage. Assemblage 1 is, nevertheless, characterized by the common occurrence of *Miogypsinoides formosensis* and *Mdes. bantamensis.* This assemblage is developed in Section 1, Section 4 to Section 11, and probably Section 12. The type of Assemblage 1 is placed in the lower part of Section 4.

Assemblage 1 has the same fauna as the *Miogypsinella borodinensis* fauna of Zone 5 (Chattian) of Kita-Daito-Zima (Hanzawa 1940). Assemblage 1 is a younger assemblage than *Miogypsinella boninensis - Spiroclypeus margaritatus - Austrotrillina howchini* Assemblage (Assemblage V) from the upper Minamizaki Limestone, Chichi-Jima, Ogasawara Island, because of the occurrence of *M. boninensis* Matsumaru carrying primitive nepionic spirals and probable planktonic foraminiferal Zone P. 21 (Matsumaru 1996). The present assemblage is correlated with an assemblage from the Waiorian Indian Stage of Kutch, West India (Raju 1974), due to the occurrence of *Mdes. formosensis.* In addition, it is correlated with an assemblage of *Mdes. formosensis, Mdes. bantamensis* and *M. gunteri* in core samples (670-860 m) at the well TNR-A, Cauvery Basin, SE India, and with an assemblage of *Mnella. complanata, Mdes. formosensis, Mdes. bantamensis, M. basraensis* Brönnimann, *M. gunteri* and *Mdes. bantamensis/M. gunteri* from core samples (735-1125 m, upper "Straight" Formation of Waiorian Stage) of the well HLO-A, Andaman Basin, Andaman and Nicobar Islands, India (Mishra 1996).

Geological age: Late Oligocene (late Chattian) and Tertiary e4 (Chattian) of Letter Stages.

2. *Miogypsinoides bantamensis - Mdes. dehaartii - Miogypsina primitiva - M. borneensis - M. globulina - Spiroclypeus margaritatus* Assemblage (Assemblage 2)

This assemblage is defined by the above six species. Common occurrences include *Lepidosemicyclina thecidaeformis, Eulepidina dilatata, Nephrolepidina marginata, N. tournoueri, Operculina complanata, Cycloclypeus* spp. and *Austrotrillina howchini. Lepidocyclina boetonensis* is found in this assemblage, but it is believed to be a reworked species. This assemblage is developed in Section 1, Section 3 to Section 5, Section 7 to Section 9 and Section 13. The type of Assemblage 2 is placed in the middle part of Section 5.

Assemblage 2 is the same fauna with the occurrence of *Miogypsinoides bantamensis, Mdes. lateralis,* a progressive type of *Mdes. bantamensis, Nephrolepidina plicomargo,* a synonym of *N. marginata* as stated before, *Spiroclypeus margaritatus* and others of Zone 4 lower (Aquitanian) in Kita-Daito-Zima (Hanzawa, op. cit.). Assemblage 2 is correlated with assemblages of core No. 3 in Karaikal Well 4 and of core No. 5 in Madanam Well 1, Cauvery Basin, SE India, due to the occurrence of *Mdes. bantamensis, Mdes. dehaartii, M. gunteri* and *M. tani* (Raju 1974). Further, it is correlated with an assemblage of *Mdes. bantamensis, Mdes. dehaartii, M. gunteri, M. tani* and *Mdes. bantamensis/M. gunteri* recognized in core samples (600-720 m, "Straight Formation", Aidaian Stage; planktonic foraminiferal Zone N 4 B) of the well HLO-A, Andaman Basin, and an assemblage of *Mdes. bantamensis, Mdes. dehaartii* and *M. tani* in core samples (550-600 m) of the well TNR-A, Cuvery Basin (Mishra 1996). The present Assemblage 2 is correlated with *Mdes. dehaartii/Tayamaia marianensis* Assemblage of Tertiary upper e in Christmas Island, due to the occurrence of *Mdes. dehaartii* and *Mdes.* cf. *bantamensis* (Adams and Belford 1974).

Geological age: Early Miocene (Aquitanian) and Tertiary e5 lower (Aquitanian).

3. *Miogypsinoides dehaartii – Miogypsina borneensis – M. globulina – Miolepidocyclina burdigalensis* Assemblage (Assemblage 3)

This assemblage is defined by the above four species. Common occurrences include *Lepidosemicyclina thecidaeformis, Eulepidina dilatata, E. ephippioides, Nephrolepidina marginata, N. tournoueri* and *Cycloclypeus* spp. Further, *Miogypsinoides formosensis, Mdes. bantamensis, Miogypsina primitiva, Lepidocyclina boetonensis* and *Heterostegina borneensis* are regarded as reworked species. This assemblage is developed in Section 2 to Section 6. This type of Assemblage 3 is placed in the upper part of Section 4.

Assemblage 3 is regarded as the same fauna with the occurrence of *Miogypsinoides dehaartii* var. *pustulosa, Miogypsina borneensis* and *Nephrolepidina tournoueri* from Zone 4 (upper) of Kita-Daito-Zima, and this zone has been deposited during the Burdigalian age, supported by Sr isotope age from 20.3 to 21.1 Ma to 16.0 to 18.8 Ma (Hanzawa 1940; Ohde and Elderfield 1992). Further, this assemblage is correlated with *Miogypsina globulina* and *Globigerina* (*Catapsydrax*) *dissimilis* Assemblage in core 2 of Karaikal Well 4, and both core 2 and probably core 3 of Madanam Well 1, Cauvery Basin (Raju 1974). The present Assemblage 3 is correlated with *Miogypsina/Austrotrillina howchini* Assemblage (Tertiary upper e), Christmas Island, due to the occurrence of *Miogypsinoides* sp., *Mdes. bantamensis, Mdes. dehaartii* and *Miogypsina* cf. *neodispansa* (Jones and Chapman), which is here referred to as *Lepidosemicyclina thecidaeformis* (Adams and Belford 1974). Moreover, Assemblage 3 is correlated with an assemblage of *Miogypsinoides* ex. interc. *complanata – formosensis, Miogypsina* ex. interc. *tani – globulina, Miolepidocyclina* ex. interc. *burdigalensis – negrii,* and *Nephrolepidina tournoueri* in sample A179 (N5 – N6 planktonic Zones), Afales Bay, Ithaki Island, NW Greece (De Mulder 1975), due to the occurrence of *M.* ex. interc. *burdigalensis – negrii.*

Geological age: Late early Miocene (Burdigalian) and Tertiary e5 upper (Burdigalian).

SYSTEMATIC DESCRIPTION

As Matsumaru (1994, 1996) has described the megalospheric schizont (A1 form) and gamont (A2 form) reproducing from the microspheric agamont in both genera *Nummulites* and *Eulepidina,* it is indicated that A1 and A2 forms have been found in some miogypsinid foraminifera of the genera *Miogypsinella, Miogypsinoides, Miogypsina,* and *Lepidosemicyclina* in this study. The classification of foraminifera is basically followed by Loeblich and Tappan (1988), and the taxonomy of planktonic foraminifera is mainly referred to Sliter (1989) and Postuma (1971).

Family MIOGYPSINIDAE Vaughan 1928
Genus *Paleomiogypsina* Matsumaru 1996

Paleomiogypsina boninensis Matsumaru 1996
Plate 1, figures 1-4

Miogypsina (*Miogypsina*) *complanata* Schlumberger. – ADAMS and BELFORD 1974, p. 494-496, pl. 73, figs. 4-5.
Paleomiogypsina boninensis MATSUMARU 1996, p. 56-58, pl. 8, figs. 1-2; pl. 9, figs. 1-14; pl. 32, fig. 7; text-fig. 23-2 – BOUDAGHER-FADEL, LORD and BANNER 2000, p. 144, pl. 1, figs. 12-13 – GOVINDAN 2003, p. 67, pl. 4, figs. 17a-b.
Miogypsinoides with few equatorial chambers (MCSM group), MISHRA 1996, p. 136, pl. 1, figs. g-m; pl. 6, figs. i-o; pl. 8, figs. i, n; illustr. 1b-c, 3d.

Description: Test small, subcircular to flabelliform, and ventral side more convex than dorsal side; diameter from 0.56 to 1.26

PLATE 1

Figures 1-4. *Paleomiogypsina boninensis* Matsumaru

1-3 Equatorial sections of megalospheric form. Locality: 1. 97-502 in Section 6, 2-3. 97-486 in Section 4. ×40.

4 Axial section of megalospheric form. Locality: 97-486 in Section 4. ×42.

Figures 5-7. *Miogypsinella complanata* (Schlumberger)

5 Equatorial section, schizont megalospheric form. Locality: 96-120 in Section 5, ×28

6 Equatorial section, gamont megalospheric form. Locality: 97-486 in Section 4, ×30.

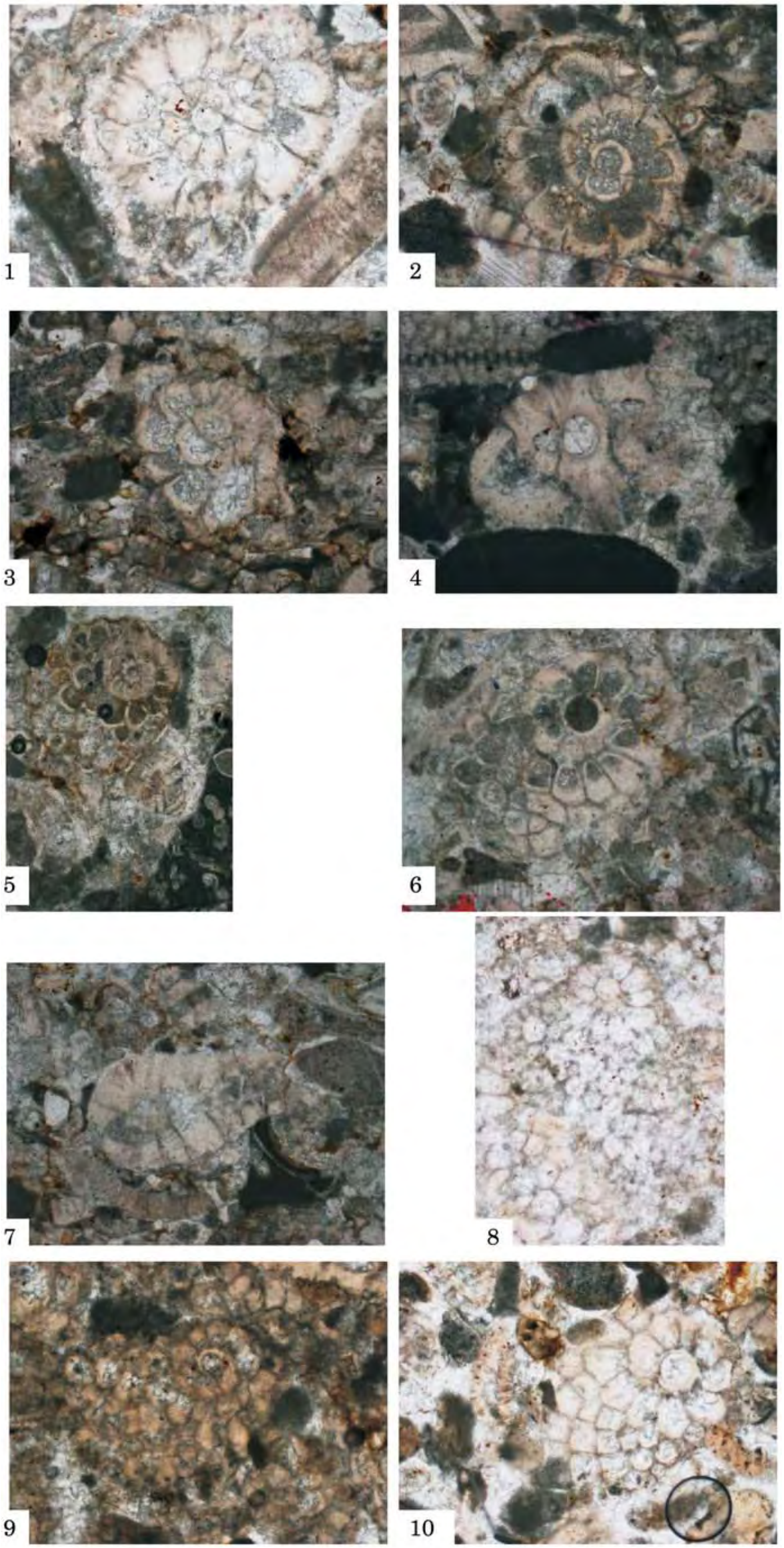
7 Oblique section. Locality: 97-486 in Section 4. ×30.

Figures 8-10. *Miogypsinoides formosensis* (Yabe and Hanzawa)

8 Equatorial section, schizont megalospheric form. Locality: 97-95 in Section 7, ×35.

9 Centered oblique section of schizont megalospheric form. Locality: 97-96 in Section 7, ×35.

10 Equatorial section, gamont megalospheric form. Locality: 96-136 in Section 11, ×35.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mm, thickness from 0.43 to 0.96 mm, form ratio of diameter/thickness from 1.30 to 2.02; spiral chambers in low trochospiral coil with few equatorial chambers enlarged in last whorl along the margin of dorsal side, and showing lobate periphery; number of spiral chambers varying from 16 to 22, dimension of spiral chambers (i.e. tangential diameter and radial diameter), 70 × 50 to 175 × 200 microns; embryonic chambers consisting of protoconch (I) and deuteroconch (II) in three specimens, 96 × 96 microns (I) and 112 × 48 microns (II), 113 × 113 microns (I) and 145 × 70 microns (II), and 125 × 110 microns (I) and 150 × 125 microns (II); a few advanced equatorial chambers, ogival to rhombic shaped, present on the equatorial side of spiral chambers; dimension of equatorial chambers (i.e. tangential diameter and radial diameter), 38 × 75 to 175 × 200 microns; intraseptal canals present and ventral canal extend to both ventral and dorsal sides from the intersections of intraseptal canals; stolon system of equatorial chambers, simple; wall calcareous, coarsely perforate; rudimentary lateral chambers absent; dorsal pillars and umbilical plugs present.

Remarks: The present form is assigned to *Paleomiogypsina boninensis* Matsumaru 1996 from the Tertiary d (may be lacking Tertiary c in the lower Minamizaki Limestone without *Nummulites fichteli*) to Tertiary e3 (may be lacking Tertiary e4 in the upper Minamizaki Limestone without *Miogypsinoides formosensis*) Minamizaki Limestone, Chichi-Jima, Ogasawara Islands (Matsumaru 1996). This species has been found from the Chattian Gomanton Limestone, North Borneo (Bou-Dagher-Fadel et al. 2000), Tertiary lower e limestone, sample D3 in 'D' Traverse, Christmas Island (Adams and Belford 1974), and Chattian aged core samples (1945-1950 m and 1490-1495 m) of the well HLO-A, Andaman Basin (Mishra 1996; Govindan 2003).

Localities: Given in Text-figure 4.

Genus *Miogypsinella* Hanzawa 1940

Miogypsinella complanata (Schlumberger 1900)
Plate 1, figures 5-7

Miogypsina complanata SCHLUMBERGER 1900, p. 300, pl. 2, figs. 13-16; pl. 3, figs. 18-21.
Miogypsinella complanata (Schlumberger) – HANZAWA 1940, p. 766-767, fig. 1
Miogypsinella sanjosensis HANZAWA 1940, p. 766-767, fig. 3.
Miogypsina (*Miogypsinoides*) *complanata* Schlumberger – DROOGER and MAGNE 1959, p. 273-277, pl. 2, figs. 1-3 – RAJU 1944, p. 78, pl. 1, figs. 6-8 (non 9); pl. 3, figs. 3-6 (non 7) – MISHRA 1996, p. 158, pl. 1, figs n-p; pl. 2, figs. a-b, d, e, k; pl. 6, figs. q, s-t (non r); pl. 7, fig. a; pl. 8, figs. a-c, f-g.
Miogypsinoides complanatus Schlumberger. – HANZAWA 1962, p. 153-154, 157, pl. 7, fig. 11, text-fig. 5.
Miogypsina (*Miogypsinoides*) *formosensis* Yabe and Hanzawa. – MISHRA 1996, p. 158, 201, pl. 6, fig. r.

Description: Test flabellate, biconvex; diameter from 1.24 to 1.70 mm, thickness from 0.60 to 0.64 mm, form ratio of diameter/thickness from 1.90 to 1.95; embryonic chambers near apex, consisting of protoconch and deuteroconch, followed by subquadrate nepionic chambers, disposed in trochoid spirals to very low trochoid spiral; number of nepionic chambers (x) in one schizont specimen (A1 form; pl. 1, fig. 5), 20 and in one gamont specimen (A2 form; pl. 1, fig. 6), 19; diameter of protoconch (I) and deuteroconch (II) in A1 form (pl. 1, fig. 5), 72 × 68 microns (I) and 84 × 72 microns (II), and in A2 form (pl. 1, fig. 6), 166 × 166 microns (I) and 208 × 62 microns (II); rhombic equatorial chambers arranged toward the distal margin; rudimentary lateral chambers generally absent between lamellae of whorls and sometimes vacuoles present in dorsal side of test; stolon and canal system present; umbilical plug and stout pillars present.

PLATE 2

Figure 1. *Miogypsinoides formosensis* (Yabe and Hanzawa). Axial section of megalospheric form. Locality: 97-502 in Section 6. ×42.

Figures 2-6. *Miogypsinoides bantamensis* (Tan Sin Hok)

2 Equatorial section, schizont megalospheric form. Locality: 96-121 in Section 5, ×35.

3 Equatorial section, schizont megalospheric form. Locality: 97-95 in Section 7, ×35.

4 Gamont megalospheric form. Locality: 96-137 in Section 11. ×26.

5 Gamont megalospheric form. Locality: 96-137 in Section 11, 35.

6 Axial section of megalospheric form. Locality: 97-486 in Section 4. ×28.

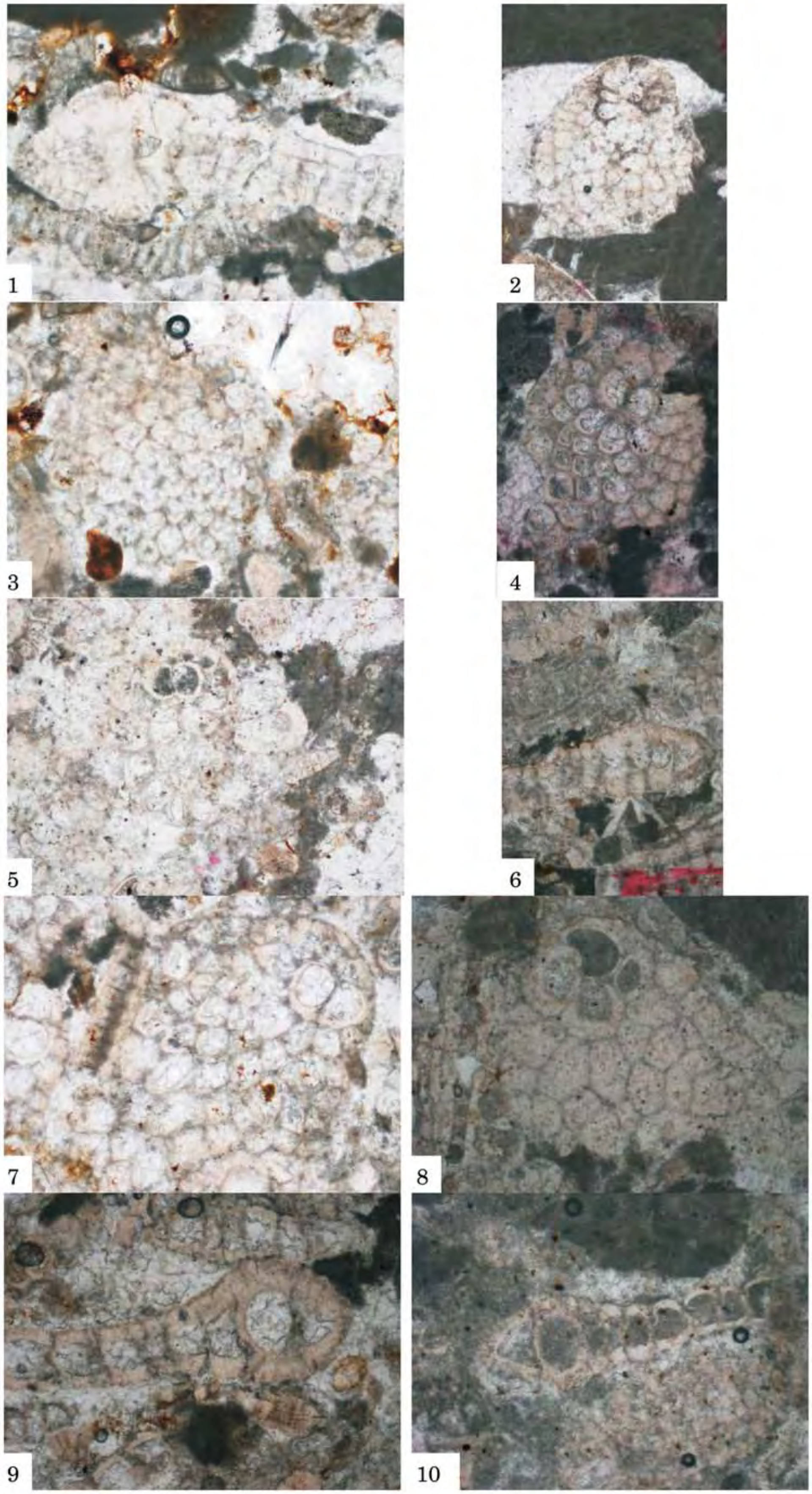
Figures 7-10. *Miogypsinoides dehaartii* (van der Vlerk)

7 Equatorial section of gamont megalospheric form. Locality: 97-95 in Section 7, ×48.

8 Equatorial section of gamont megalospheric form. Locality: 96-119 in Section 5, ×42.

9 Axial section of megalospheric form. Locality: 97-94 in Section 7, ×38.

10 Axial section of megalospheric form. Locality: 97-123 in Section 4, ×38.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Remarks: The present form is assigned to *Miogypsinella complanata* (Schlumberger) due to the rotaloid juvenaria and number of nepionic chambers (X). This species belongs to the transitional genus between the *Miogypsinella* with trochoid nepionic chambers and *Miogypsinoides* with planispiral nepionic chambers. Further *Miogypsinoides dehaartii,* a type species of the *Miogypsinoides*, lacks of the rotaloid juvenaria (van der Vlerk 1924, 1966). *Miogypsinella complanata* is similar to *Miogypsinella ubaghsi* (Tan Sin Hok) from S. Klindja, East Borneo (Tan Sin Hok 1936), and from Komahashi-Daini Seamount, Kyushu-Palau Ridge (Mohiuddin et al. 2000). However the former may be different from the latter in having more or less low trochoid nepionic chambers.

Localities: Given in Text-figure 4.

Genus *Miogypsinoides* (Yabe and Hanzawa 1928)

Miogypsinoides formosensis (Yabe and Hanzawa 1928)
Plate 1, figures 8-10; Plate 2, figure 1; Plate 5, figure 8 upper

Miogypsina (*Miogypsinoides*) *dehaartii* van der Vlerk var. *formosensis* YABE and HANZAWA 1928, p. 535, figs. 1a-b – YABE and HANZAWA 1930, p. 32-33, pl. 3, figs. 4-5; pl. 4, figs. 3-4; pl. 7, fig. 12; pl. 9, fig. 9; pl. 11, figs. 1-6, 12.
Miogypsinoides borodinensis (Hanzawa) – COLE 1954, p. 600-601, pl. 221, figs. 6-8 – HANZAWA 1957, p. 91, pl. 15, fig. 11; pl. 21, figs. 2-3.
Miogypsinoides formosensis Yabe and Hanzawa – HANZAWA 1957, p. 92, pl. 15, figs. 10, 20-21. – HANZAWA 1962, p. 153-154, 157, pl. 5, figs. 7-8, text-fig. 6.
Miogypsina (*Miogypsinoides*) *formosensis* Yabe and Hanzawa. - RAJU 1974, p. 79, pl. 4, fig. 1. – MISHRA 1996, p. 158, 201, pl. 1, fig. o; pl. 2, figs. c, f; pl. 4, figs. m-n; pl. 6, fig. p (non r).
Miogypsina (*Miogypsinoides*) *complanata* Schlumberger – RAJU 1974, p. 78, pl. 1, fig. 9; pl. 3, fig. 7.
Miogypsinoides bantamensis Tan Sin Hok. – COLE 1957a, p. 338-339, pl. 111, fig. 3.
Miogypsinoides dehaartii (van der Vlerk). – COLE 1957b, p. 769, pl. 243, fig. 3.
Miogypsina (*Miogypsinoides*) *bantamensis* (Tan Sin Hok). – RAJU 1974, p. 79-80, pl. 1, fig. 11; pl. 5, fig. 4.

Description: Test fan shaped, irregular in outline; diameter from 1.20 to 2.36 mm, thickness from 0.50 to 0.64 mm, form ratio of diameter/thickness from 2.90 to 3.70; embryonic chambers consisting of protoconch and deuteroconch, followed by planispiral nepionic chambers and/or very low trochospiral nepionic chambers, and later equatorial chambers arranged toward the distal margin of test; number of nepionic chambers in two A1 specimens, 13 (pl. 1. fig. 8) and 16 (pl. 1, fig. 9), and in one A2 specimen, 13 (pl. 1, fig. 10); diameter of protoconch (I) and deuteroconch (II) in two A1 specimens, 88 × 92 microns (I) and 96 × 40 microns (II)(pl. 1, fig. 8) and 88 × 96 microns (I) and 96 × 48 microns (II) (pl. 1, fig. 9), and in one A2 specimen (pl. 1, fig. 10), 160 × 160 microns (I) and 128 × 48 microns (II); rudimentary lateral chambers generally absent; canal system present in spiral walls, intrasepta and lateral walls; stolon system present in equatorial chambers; umbilical plugs can be seen.

Remarks: The present form is characterized in having spirally arranged nepionic chambers in the single equatorial layer to the apical border of test, and spiral chambers always develop from the frontal field of the test under the line connecting the centers of the embryonic chambers. Then the present form is assigned to *Miogypsinoides formosensis* Yabe and Hanzawa 1928 from the coal bearing Arisan Formation, Taiwan.

Localities: Given in Text-figure 4.

Miogypsinoides bantamensis (Tan Sin Hok 1933)
Plate 2, figures 2-6

Miogypsina bantamensis Tan Sin Hok 1933. In KOOLHOVEN, W.C. B. 1933, p. 26 (sample U895, S. Klindjau, East Borneo).
Miogypsinoides complanata (Schlumberger) forma *bantamensis* TAN SIN HOK 1936, p. 48-50, pl. 1, fig. 13.

PLATE 3

Figures 1-5, 7-8. *Miogypsina primitiva* (Tan Sin Hok)

1 Oblique section. Locality: 96-114 in Section 3, ×45.

2 Equatorial section, schizont megalospheric form. Locality: 97-90 in Section 8, ×26.

3 Equatorial section, schizont megalospheric form. Locality: 97-153 in Section 4, ×35.

4 Equatorial section, schizont megalospheric form. Locality: 97-95 in Section 7, ×35.

5 Equatorial sections, gamont megalospheric form. Locality: 97-95 in Section 7, ×25.

7 Axial section, megalospheric form. Locality: 96-120 in Section 5, ×35.

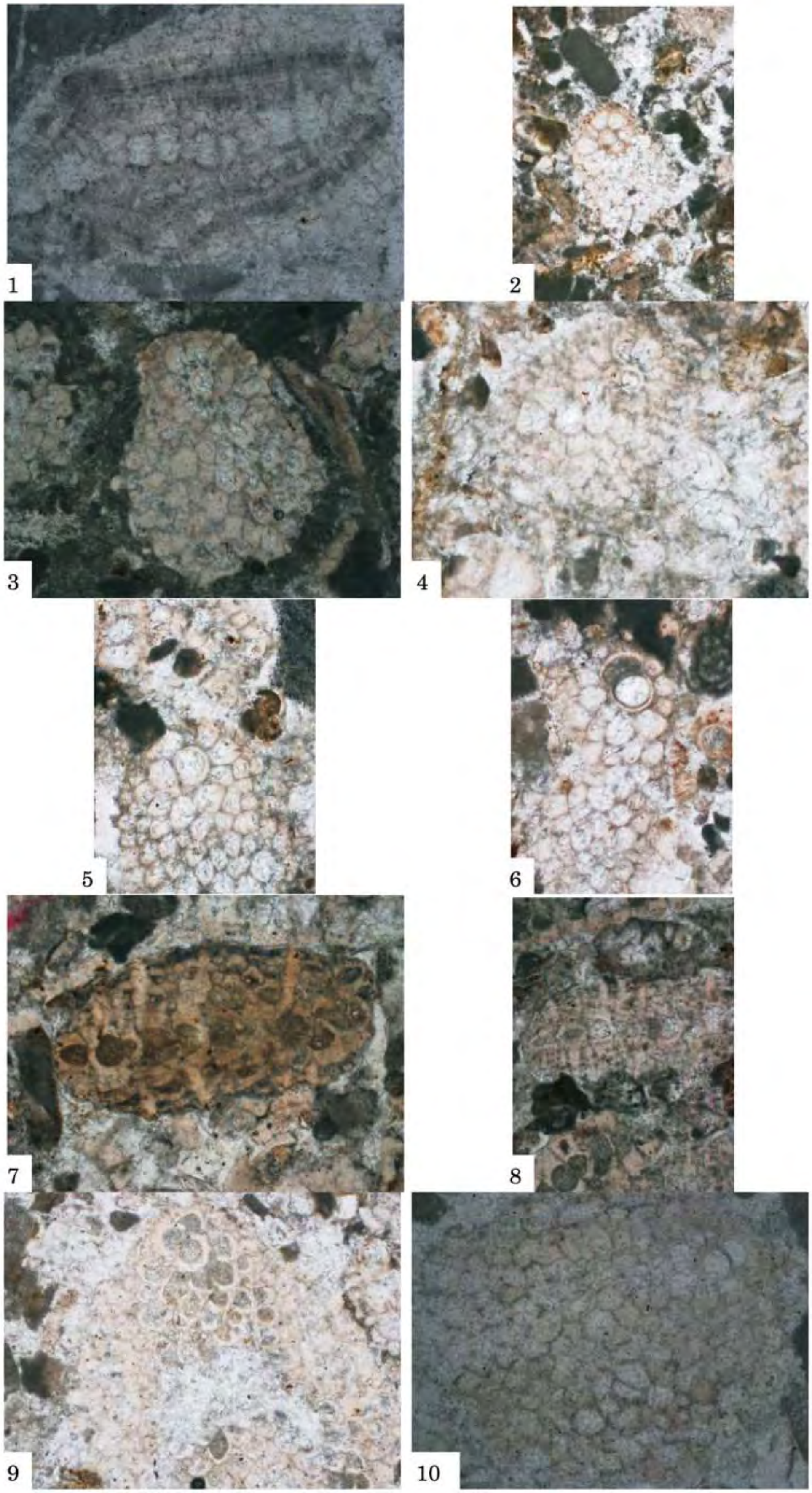
8 Axial section, microspheric form. Locality: 97-486 in Section 4, ×28.

Figure 6. *Miogypsinoides dehaartii* (van der Vlerk). Equatorial section of gamont megalospheric form. Locality: 97-95 in Section, ×30.

Figures 9-10. *Miogypsina borneensis* Tan Sin Hok

9 Equatorial section of gamont megalospheric form. Locality: 97-90 in Section 8, ×35.

10 Equatorial section of gamont megalospheric form. Locality: 97-152 in Section 4, ×38.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Miogypsinoides bantamensis (Tan Sin Hok) – HANZAWA 1940, p. 782-783, pl. 39, figs. 15-19; pl. 41, figs. 24-26.– HANZAWA 1957, p. 91,pl. 15, figs. 4-6. – COLE 1957a, p. 338-339, pl. 110, figs. 8-18; pl. 111, figs. 1-2, 4 (non 3).
Miogypsinoides lateralis HANZAWA 1940, p. 783, pl. 39, figs. 10-14.
Miogypsinoides complanata (Schlumberger) var. *mauretanica* BRÖNNIMANN 1940, p. 77-80, pl. 7, figs. 7-14; pl. 8, fig. 18; pl. 9, figs. 1-2; pl. 11, figs. 9-17,
Miogypsina (*Miogypsinoides*) *bantamensis* (Tan Sin Hok). – RAJU 1974, p. 79-80, pl. 1, figs. 10, 12-13 (non 11) – ADAMS and BELFORD 1974, p. 496-497, pl. 73, figs. 8-11. – MISHRA 1996, p. 201, pl. 2, figs. g-j, l-p; pl. 3, figs. a-c; pl. 4, figs. c, h; pl. 7, figs, b-c, o; pl. 8, figs. d-e.
Miogypsinoides dehaartii (van der Vlerk). – COLE 1957a, p. 339-340, pl. 111, figs. 8, 10. – COLE 1957b, p. 769, pl. 243, fig. 1.

Description: Test fan shaped, irregular in outline, biconvex; diameter from 1.34 to 2.10 mm, thickness from 0.40 to 0.50 mm, form ratio of diameter/thickness from 4.09 to 4.20; embryonic chambers consisting of protoconch and deuteroconch, followed by planispiral nepionic chambers, and later equatorial chambers arranged toward the distal margin; number of nepionic chambers in two A1 specimens, 12 (pl. 2, fig. 2) and 13 (pl. 2, fig. 3), and in two A2 specimens, 10 (pl. 2, fig. 5) and 11 (pl. 2, fig. 4); diameter of protoconch (I) and deuteroconch (II) in two A1 specimens, 104 × 112 microns (I) and 84 × 44 microns (II)(pl. 2, fig. 3) and 112 × 96 microns (I) and 120 × 72 microns (II)(pl. 2, fig. 2), and in two A2 specimens, 136 × 120 microns (I) and 128 × 80 microns (II)(pl. 2, fig. 5) and 184 × 168 microns (I) and 192 × 136 microns (II)(pl. 2, fig. 4); rudimentary lateral chambers generally absent; canal system present in spiral walls, intrasepta and lateral walls; stolon system present in equatorial chambers; umbilical pillars developed.

Remarks: The present form is characterized by having spiral nepionic chambers beside the embryonic chambers (consisting of protoconch of apical side and deuteroconch of frontal side) situated the apical – frontal line of the test and/or develop from the apical field of the test above the line connecting the centers of the embryonic chambers. The present form is assigned to *Miogypsinoides bantamensis* (Tan Sin Hok 1933).

Localities: Given in Text-figure 4.

Miogypsinoides dehaartii (van der Vlerk 1924)
Plate 2, figures 7-10; Plate 3, figure 6

Miogypsina dehaartii VAN DER VLERK 1924, p. 429-432, text-figs. 1-3 – DROOGER 1953, p. 110-114, figs. 15-19.
Miogypsinoides dehaartii (van der Vlerk) var. *pustulosa* HANZAWA 1940, p. 780-782, pl. 40, figs. 2-29; pl. 42, fig. 13.
Miogypsina cupulaeformis Zuffardi-Comerci 1928. – DROOGER 1953, p. 114-115, pl. 1, figs. 20-23. – COLE 1954, p. 601-602, pl. 222, figs. 4-11.
Miogypsina verrucosa Zuffardi-Comerci 1929.– DROOGER 1953, p. 116, pl. 1, figs. 24-26.
Miogypsinoides dehaartii (van der Vlerk). – COLE 1954, p. 602, pl. 220, figs. 1-8 – COLE 1957a, p. 339-340, pl. 111, figs. 5-7, 9, 11-16 (non 8, 10) – COLE 1957b, p. 769, pl. 243, fig. 2 (non 1, 3) - HANZAWA 1957, p. 92, pl. 15, figs. 3, 7, 9; pl. 19, fig. 3; pl. 21, fig. 4. – VAN DER VLERK 1966, p. 422-423, pl. 1, figs. 1-3, 7-10; pl. 2, fig. 1.
Miogypsina (*Miogypsinoides*) *dehaartii* van der Vlerk. – RAJU 1974, p. 80-81, pl. 1, figs. 21, 24-25 (non 19-20, 22-23); pl. 3, fig. 8; pl. 4, figs. 2-4. – ADAMS and BELFORD 1974, p. 497, pl. 73, fig. 12 (non 13-14) – CHAPRONIERE 1984, p. 46-47, pl. 7, fig. 7a-b; pl. 8, figs. 1-3; pl. 17, figs. 15-17; text-fig. 17-1b, 2e (non 1a) – MISHRA 1996, p. 201, pl. 3, figs. d-f; pl. 4, figs. g, l; pl. 7, figs. d-e, n

Description: Test fan shaped with irregular or rather rounded in outline, biconvex; diameter from 1.60 to 2.60 mm, thickness from 0.48 to 0.84 mm, form ratio of diameter/thickness from 3.00 to 3.33; embryonic chambers consisting of protoconch and deuteroconch, followed by planispiral nepionic chambers, and later equatorial chambers, ogival to rhombic shaped, arranged toward the distal margin; number of nepionic chambers in three A2 specimens, 7 (pl. 2, fig. 8), 9 (pl. 2, fig. 7) and 10 (pl. 3, fig. 6); diameter of protoconch (I) and deuteroconch (II) in three A2 specimens, 152 × 116 microns (I) and 168 × 88 microns (II)(pl. 2, fig. 7), 176 × 168 microns (I) and 208 × 160 microns (II)(pl. 2, fig. 8), and 224 x200 microns (I) and 244 × 112 microns (II)(pl. 3, fig. 6); equatorial chambers ogival and rhombic shaped, and dimension of main chamber (i.e. tang. diam. and rad. diam.), 200 × 260 microns; rudimentary lateral chambers generally absent; pillars, small and thin, 50 to 72 microns in diameter.

Remarks: The present form is characterized having spiral nepionic chambers that always develop from the apical field of

PLATE 4

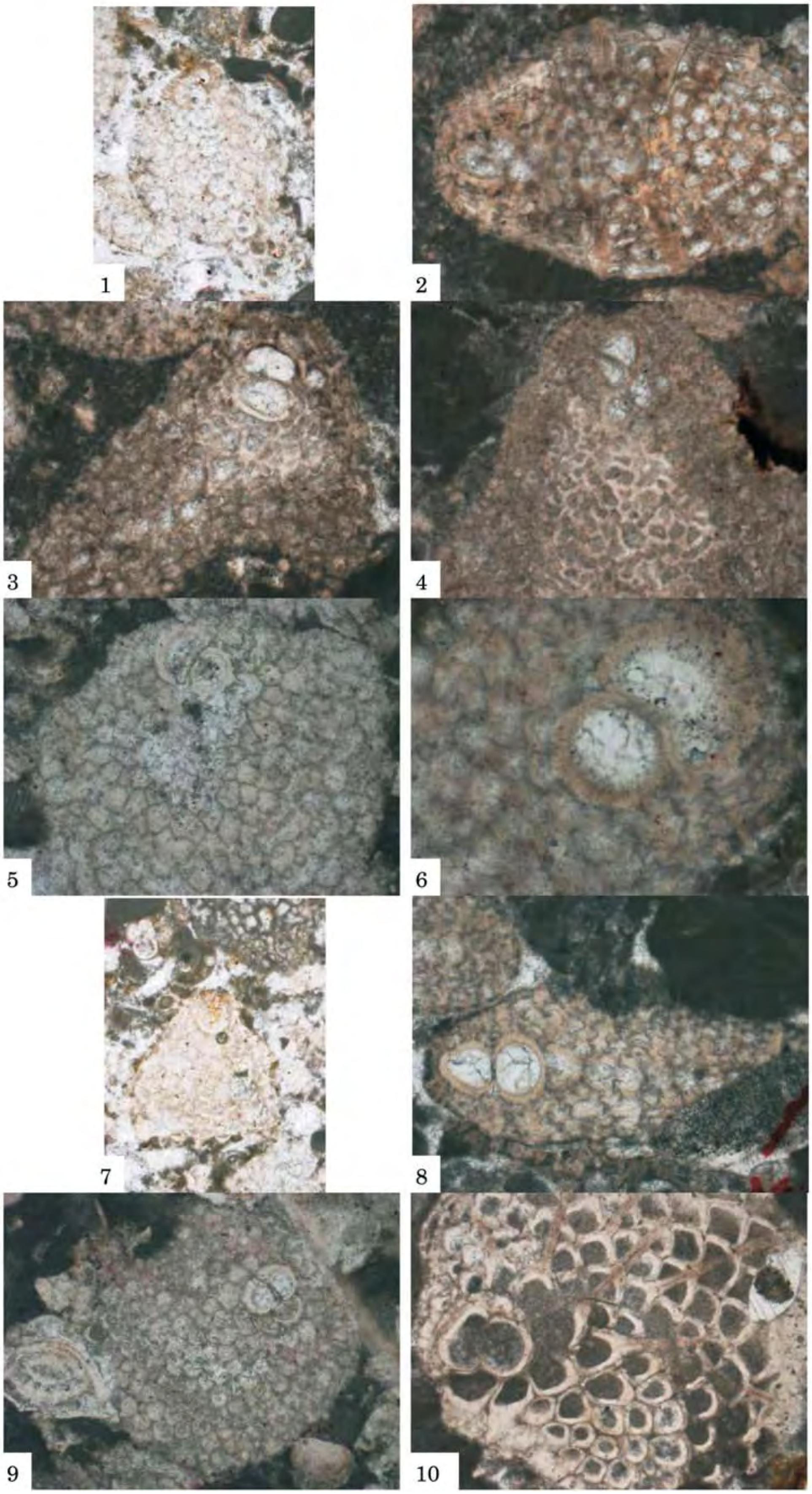
Figures 1-2. *Miogypsina borneensis* Tan Sin Hok
1 Equatorial section of schizont form. Locality: 97-90 in Section 8, ×30.
2 Axial section of megalospheric form. Locality: 96-114 in Section 3, ×38.

Figures 3-4. *Lepidosemicyclina thecidaeformis* (Rutten)
3 Equatorial section, gamont megalospheric form. Locality: 96-114 in Section 3, ×38.
4 Equatorial section, schizont megalospheric form. Locality: 96-114 in Section 3, ×36.

Figures 5-8. *Miogypsina globulina* (Michelotti)
5 Equatorial section, gamont megalospheric form. Locality: 97-142 in Section 4, ×32.
6 Equatorial section, gamont megalospheric form. Locality: 97-125 in Section 4, ×94.
7 Equatorial section, schizont megalospheric form. Locality: 97-90 in Section 8, ×36.
8 Axial section of megalospheric form. Locality: 97-119 in Section 4, ×36.

Figure 9. *Miolepidocyclina burdigalensis* (Gümbel). Equatorial section of megalospheric form. Locality: 97-142 in Section 4, ×38.

Figure 10. *Spinosemiogypsina antalyaensis* Matsumaru, Ozer and Sari, n. gen., n. sp. Equatorial section of megalospheric form. Holotype, Saitama Univ. Coll. No. 8868. Locality: 97-489 in Section 6, ×38.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the test above the line connecting the centers of the embryonic chambers. The present form is assigned to *Miogypsinoides dehaartii* (van der Vlerk 1924) from Larat Island, Tanimbar Islands. Van der Vlerk (1966, pl. 2, fig. 3) considered an equatorial specimen from Larat Island as an intermediate form between *Mdes. dehaartii* and *M. borneensis.* However, the present authors consider it as a schizont (A1 form) of *Mdes. dehaartii* due to having small embryonic chambers. This schizont cannot be found in Turkey.

Localities: Given in Text-figure 4.

Genus *Miogypsina* Sacco 1893

Miogypsina primitiva Tan Sin Hok 1936
Plate 3, figures 1-5, 7-8

Miogypsina primitiva TAN SIN HOK 1936, p. 50, 52-53, pl. 1, figs. 14-16, 17
Miogypsina (*Miogypsina*) *gunteri* COLE 1938, p. 42-43, pl. 6, figs. 10-12, 14; pl. 8, figs. 1-9. – VAUGHAN and COLE 1941, p. 79, pl. 45, fig. 8 – DROOGER 1952, p. 22-23, 50; pl. 2, figs. 11-15. - COLE 1957c, p. 321-322, pl. 26, figs. 1-4, 8-9; pl. 27, fig. 1 – SACKS 1959, p. 409, pl. 34, figs. 9, 11; pl. 36, figs. 1, 3-4. – RAJU 1974, p. 81-82, pl. 1, figs. 14-18. – MISHRA 1996, p. 202, pl. 7, figs. i-e; pl. 8, fig. p.
Miogypsinopsis gunteri (Cole 1938). – HANZAWA 1940, p. 773.
Miogypsinopsis primitiva (Tan Sin Hok). – HANZAWA 1940, p. 776.
Miogypsinodella primitiva (Tan Sin Hok). – BOUDAGHER-FADEL, LORD and BANNER 2000, p. 145-146, pl. 2, figs. 8-11.

Description: Test fan shaped, biconvex; diameter from 0.92 to 2.00 mm, thickness from 0.50 to 0.78 mm, form ratio of diameter/thickness from 1.90 to 3.33; embryonic chambers consisting of protoconch and deuteroconch, followed by planispiral and single nepionic chambers, and later equatorial chambers arranged toward the distal margin; number of nepionic chambers (X) in three A1 specimens, 9 (pl. 3, fig. 3), 11 (pl. 3, fig. 2) and 12 (pl. 3, fig. 4), and in one A2 specimen, 10 (pl. 3, fig. 5); diameter of protoconch (I) and deuteroconch(II) in three A1 specimens, 84 × 88 microns (I) and 72 × 56 microns (II)(pl. 3, fig. 4), 96 × 72 microns (I) and 88 × 40 microns (II)(pl. 3, fig. 2), and 96 × 90 microns (I) and 88 × 64 microns (II)(pl. 3, fig. 3), and in one A2 specimen, 200 × 176 microns (I) and 176 × 128 microns (II)(pl. 3, fig. 5); lateral chambers present and developed; canal and stolon systems present; pillars traversing lateral walls.

Remarks: The present form is characterized in having deuteroconch situated on the frontal side of test and/or situated beside protoconch along the outer wall of protoconch, and in having values of X from 8 or 9 to 12. The present form is identical to *Miogypsina primitiva* (Tan Sin Hok 1936), which is senior synonym of *M. gunteri* Cole 1938. Cole (1938) did not compare *M. gunteri* from cores (Oligocene Suwannee Formation), Florida, USA with *M. primitiva* from the Tertiary e beds of S. Klindjau, East Borneo. Later Cole (1964, 1967) regarded *M. gunteri* as *M. panamensis* (Cushman 1918). Hanzawa (1940, p. 773) established the *Miogypsinopsis* based on *M. gunteri* Cole as a type species due to having deuteroconch situated on the frontal side of the test and several layers of lateral chambers. He also regarded *M. primitiva* Tan Sin Hok as *Miogypsinopsis primitiva.* BouDagher-Fadel et al. (2000, p. 145) established the *Miogypsinodella* based on *M. primitiva* Tan Sin Hok with a single whorl nepionic chambers and lateral chambers. However they did not describe the structure of embryonic chambers, especially in the situation of deuteroconch, and their equatorial form (pl. 2, fig. 8) is nothing but *Miogypsinopsis primitiva.* BouDagher-Fadel et al. consider *M. primitiva* evolved directly from *Mdes. dehaartii*, but the present authors consider *M. primitiva* evolved directly from *Mdes. bantamensis* based on the situation of deuteroconch and nepionic acceleration (Tan Sin Hok 1936; Drooger 1952).

Localities: Given in Text-figure 4.

Miogypsina borneensis Tan Sin Hok 1936
Plate 3, figures 9-10; Plate 4, figures 1-2

Miogypsina borneensis TAN SIN HOK 1936, p. 50, 53-54, pl. 1, figs. 18-19. – HANZAWA 1940, p. 783-785, pl. 4, figs. 11-23. – COLE

PLATE 5

Figures 1-3. *Spinosemiogypsina antalyaensis* Matsumaru, Ozer and Sari, n. gen., n. sp.

1 Equatorial section of megalospheric form, ×26.

2 Oblique section, ×38.

3 Axial section. Locality: 97-489 in Section 6, ×38.

Figure 4. *Operculina complanata* (Defrance). Equatorial section of megalospheric form. Locality: 96-123 in Section 5.,×30.

Figures 5-7. *Heterostegina borneensis* van der Vlerk

5-6 Centered oblique sections of megalospheric form carrying one operculine chamber. Locality: 96-120 in Section 5, ×26.

7 Axial section of megalospheric form. Locality: 97-503 in Section 6, ×30.

Figure 8. *Miogypsinoides formosensis* (Yabe and Hanzawa), *Cycloclypeus* spp. and *Spiroclypeus margaritatus* (Schlumberger). Axial sections of three species. Locality: 97-503 in Section 6, ×30.

Figures 9-10. *Spiroclypeus margaritatus* (Schlumberger)

9 Centered oblique section of megalospheric form. Locality: 96-121 in Section 5, ×30.

10 Axial section of megalospheric form. Locality: 97-158 in Section 4, ×28.

Figure 11. *Eulepidina dilatata* (Michelotti). Axial section of megalospheric form. Locality: 97-158 in Section 4, ×30.

Figure 12. *Eulepidina ephippioides* (Jones and Chapman). Axial section of megalospheric form. Locality: 96-119 in Section 5, ×30.


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1954, p. 598-599, pl. 220, figs. 9-21. – VAN DER VLERK 1966, p. 422-423, 427, pl. 1, figs. 4-6; pl. 2, fig. 2.
Miogypsina (*Miogypsina*) *tani* DROOGER 1952, p. 26-27, pl. 2, figs. 20-22 (non 23-24); pl. 3, figs. 2a, 2b. – RAJU 1974, p. 82-83, pl. 1, figs. 26-28, 30 (non 29); pl. 5, fig. 5. – MISHRA 1996, p. 202, pl. 3, figs. k-l; pl. 4, fig. c; pl. 7, fig. m.
Miogypsina globulina (Michelotti)- MATSUMARU 1968, p. 341-343, pl. 36, figs. 2-6. (non pl. 35, figs. 1-6; pl. 36, fig. 1)

Description: Test fan shaped to subcircular, biconvex; diameter from 1.93 to 2.30 mm, thickness from 1.10 to 1.16 mm, form ration of diameter/thickness from 1.75 to 2.40; embryonic chambers consisting of protoconch and deuteroconch, followed by planispiral and uniserial nepionic chambers, and later equatorial chambers, ogival to rhombic shaped, arranged toward the distal margin; number of nepionic chambers (X) in A1 specimen (pl. 4, fig. 1), 7 and in two A2 specimens, 7 (pl. 3, fig. 10) and 8 (pl. 3, fig. 9); diameter of protoconch (I) and deuteroconch (II) in A1 specimen (pl. 4, fig. 1), 96 × 72 microns (I) and 88 × 40 microns (II), and in two A2 specimens, 120 × 112 microns (I) and 128 × 84 microns (II)(pl. 3, fig. 9), and 120 × 116 microns (I) and 140 × 83 microns (II)(pl. 3, fig. 10); lateral chambers, well developed and occurring in regular tiers between pillars; pillars present and diameter of pillars is 90 to 145 microns.

Remarks: The present form is characterized as having a deuteroconch situated almost at the apex of the test, and having X value from 6 or 7 to 8. The present form is identical to *Miogypsina borneensis* Tan Sin Hok (1936), which is a senior synonym of *M. tani* Drooger 1952. Drooger (1952, p. 52) compared *M. tani* from Costa Rica, CR72, Rio Reventazon and Caribbean region with *M. borneensis* from S. Riko (Z394) and S. Tempoetoel (U24), East Borneo. He distinguished both species, due to the presence of a second principal auxiliary chamber. It is absent of a secondary principal auxiliary chamber and/or intercalary chambers in the nepionic stage for Turkish specimens. As such, the present form is assigned to *M. borneensis* Tan Sin Hok 1936.

Localities: Given in Text-figure 4

Miogypsina globulina (Michelotti 1841)
Plate 4, figures 5-8

Nummulites globulina MICHELOTTI 1841, p. 297, pl. 3, fig. 6.
Nummulites irregularis MICHELOTTI 1841, p. 297, pl. 3, fig. 5.
Miogypsina kotoi HANZAWA 1931, p. 154, pl. 25, figs. 14-18. – Hanzawa 1935,p. 23-25, pl. 3, figs. 1-40. – TAN SIN HOK 1937, p. 31-32, pl. 1, figs. 1-6. – MATSUMARU 1982, p. 53-54, figs. 1-14.
Miogypsina irregularis (Michelotti). – DROOGER 1952, p. 54-55, pl. 2, figs. 26-29 (non 25).
Miogypsina (*Miogypsina*) *thecidaeformis* (L. Rutten). – COLE 1957b, p. 771-772, pl. 244, figs. 1-2, 4-7, 11-14.
Miogypsina (*Miogypsina*) *globulina* (Michelotti). – DROOGER and SOCIN 1959, p. 420-422, pl. 1, figs. 5-6; tab. 2. – RAJU 1974, p. 82-83, pl. 2, figs. 1-4; pl. 5, figs. 6-7; pl. 6, fig. 1. – CHAPRONIERE 1984, p. 42-43, pl. 6, figs. 5a-b; pl. 16, figs. 14-15; text-fig. 16-1b-c (non 1a, 1d). – MISHRA 1996, p. 202, pl. 4, figs. a-b, j-k, o-p; pl. 5, fig. p; pl. 9, figs. n, p; pl. 10, figs. m-o.
Miogypsina globulina (Michelotti). – MATSUMARU 1968, p. 341-343, pl. 35, figs. 1-6; pl. 36, fig. 1. (non pl. 36, figs. 2-6). – MATSUMARU 1971, p. 174-176, pl. 25, figs. 1-22. – MATSUMARU and TAKAHASHI 2004, p. 17-26, pl. 1, figs. 1-4.

Description: Test fan shaped to subcircular, biconvex; diameter from 1.60 to 2.10 mm, thickness from 0.60 to 0.72 mm, form ratio of diameter/thickness from 2.10 to 2.30; embryonic chambers consisting of protoconch and deuteroconch, followed by two principal auxiliary chambers of unequal size, each single along outer side of junction between protoconch and deuteroconch, each having both protoconchal nepionic spirals, and both spirals meeting at a closing chamber (counting 1/2), total spiral chambers counting 7 due to 5 1/2 and 1 1/2 (pl. 4, figs. 5-7), but not developed deuteroconchal spirals; later growing stage, equatorial chambers, ogival and rhombic shaped, ar-

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PLATE 6

1 *Lepidocyclina boetonensis* van der Vlerk. Centered oblique section. Locality: 97-486 in section 4. ×30.

2 *Nephrolepidina marginata* (Michelotti). Centered oblique section of megalospheric form. Locality: 97-489 in Section 6. ×30.

3 *Nephrolepidina tournoueri* (Lemoine and R. Douvillei). Centered oblique section of megalospheric form. Locality: 96-121 in Section 5. ×30.

4 *Miscellanea miscella* (D'Archiac and Haime). Equatorial section of microspheric form. Locality: 96-119 in Section 5. ×30.

5 *Lockhartia conditi* (Nuttall). Axial section of megalospheric form. Locality: 97-486 in Section 4. ×30.

6 *Globotruncana* spp., *Hedbergella* spp. and others. Axial and oblique sections. Locality: 96-120 in Section 5. ×30.

7 *Hantkenina* spp. Axial section. locality: 97-131 in Section 4. ×90.

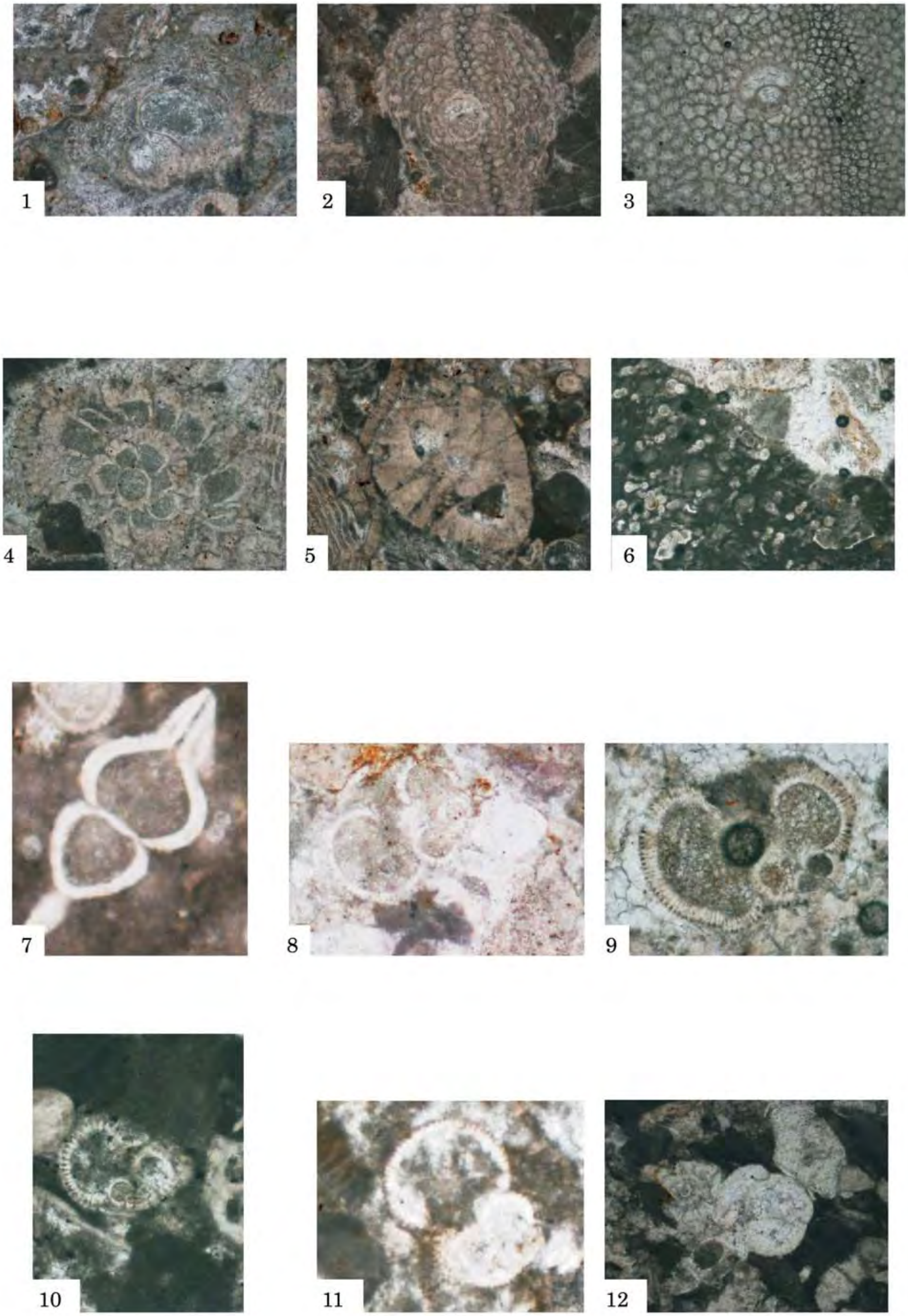
8 *Catapsydrax dissimilis* (Cushman and Bermudez). Axial section. Locality: 96-139 in Section 11. ×72.

9 *Globigerina sellii* (Borsetti). Axial section. Locality: 96-120 in Section 5. ×70.

10 *Globorotalia mayeri* (Cushman and Ellisor). Axial section. Locality: 97-142 in Section 4. ×70.

11 *Globigerinoides primordius* Blow and Banner. Axial section. Locality: 97-90 in Section 8. ×72.

12 *Globoquadrina dehiscens* (Chapman, Parr and Collins). Transverse section. Locality: 97-142 in Section 4. ×30.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ranged toward the distal margin; diameter of protoconch(I) and duteroconch (II) in one A1 specimen (pl. 4, fig. 7), 128 × 104 microns (I) and 144 × 80 microns (II), and in two A2 specimens, 176 × 152 microns (I) and 248 × 152 microns (II) (pl. 4, fig. 6) and 200 × 136 microns (I) and 216 × 120 microns (II) (pl. 4, fig. 5); lateral chambers well developed and occurring in regular tiers between pillars; pillars present.

Remarks: The present form is characterized having different protoconchal nepionic spirals. Following to Drooger's biometry (1952, V value, 200 α/β and γ value), the present forms have V value of 30 and γ value of 10 in A1 form (pl. 4, fig. 7), V value of 25 and γ value of 34 in A2 form (pl. 4, fig. 6) and V value of 35 and γ value of 40 in A2 form (pl. 4, fig. 5). Compared to the measurement of V values from numerous Japanese miogypsinid foraminifera (Matsumaru and Takahashi 2004, 520 specimens), the V value is exceptionally larger in arc length compared to the smaller spiral (α value) than half in total protoconchal spiral (1/2 β value). However, the V value is mostly smaller in the former than the latter, and the present form is identical with *M. globulina* based on V value and γ value.

Localities: Given in Text-figure 4.

Genus *Lepidosemicyclina* Rutten 1911

Lepidosemicyclina thecidaeformis (Rutten 1911)
Plate 4, figures 3-4

Orbitoides (*Lepidosemicyclina*) *thecidaeformis* RUTTEN 1911, p. 1157-1158.
Miogypsina thecidaeformis (RUTTEN) 1912, p. 204, pl. 12, figs. 1-5. – DROOGER 1953, p. 109-110, pl. 1, figs. 10-14, 32.
Miogypsina (*Miogypsina*) *thecidaeformis* L. Rutten. – TAN SIN HOK 1937, p. 38-40, pl. 1, figs. 9, 11, 13; pl. 2, fig. 15; pl. 3, figs. 10, 11a-b.
Miogypsina (*Lepidosemicyclina*) *thecidaeformis* (Rutten). – RAJU 1974, p. 84-85, pl. 6, figs. 2-4. – CHAPRONIERE 1984, p. 44-46, pl. 7, figs. 3-6; pl. 17, figs. 1-11; pl. 25, fig. 14; Text-fig. 17-3-5.
Miogypsina (*Lepidosemicyclina*) *polymorpha* Rutten. – MISHRA 1996, p. 203, pl. 3, figs. o-p; pl. 5, figs. a-h; pl. 9, fig. o; pl. 10, figs. a-c, g-h.

Description: Test fan shaped with or without protruding apical portion, unequally biconvex; diameter from 2.12 to 3.00 mm, thickness from 0.76 to 1.00 mm, form ratio of diameter/thickness from 3.00 to 3.26; embryonic chambers consisting of protoconch and deuteroconch, followed by two principal auxiliary chambers of unequal size, and both protoconchal nepionic spirals meeting with a closing chamber; total number of protoconchal nepionic chambers including a closing chamber from 6 (pl. 4, fig. 3) to 7 (pl. 4, fig. 4); diameter of protoconch (I) and deuteroconch (II) in two A1 specimens, 160 × 160 microns (I) and 260 × 240 microns (II), and 166 × 112 microns (I) and 168 × 140 microns (II) (pl. 4, fig. 4), and in one A2 specimen (pl. 4, fig. 3), 230 × 162 microns (I) and 270 × 142 microns (II); later equatorial chambers, ogival, rhombic and short hexagonal shaped, arranged toward the distal margin; lateral chambers well developed and occurring in regular tiers between pillars; pillars present.

Remarks: The present form is characterized having short hexagonal equatorial chambers. The present form seems to be an intermediate morphology between *Miogypsina globulina* and *Lepidosemicyclina polymorpha.* According to Drooger's (1953) type material research of Rutten's (1911) both *M. thecidaeformis* and *M. polymorpha,* the present form is identical to the former, and is assigned to *L. thecidaeformis.*

Localities: Given in Text-figure 4.

Genus *Miolepidocyclina* A. Silvestri 1907

Miolepidocyclina burdigalensis (Gümbel 1870)
Plate 4, figure 9

Orbitoides (*Lepidocyclina*) *burdigalensis* GÜMBEL 1870, p. 719.
Miogypsina burdigalensis (Gümbel). – SCHLUMBERGER 1900, p. 330, pl. 2, figs. 11-12; pl. 3, figs. 22, 25. – BRÖNNIMANN 1940, p. 81-85, pl. 7, figs. 1-6; pl. 8, figs. 20-22; pl. 9, figs. 4-7, 9.
Miogypsina (*Miolepidocyclina*) *burdigalensis* Gümbel. – DROOGER 1952, p. 58, 61, pl. 1, figs. 30-34. – KÜPPER 1960, p. 60-61, pl. 7, figs. 1-2, 5 (non 3-4); pl. 8, fig. 1.

Description: Test subcircular, biconvex; diameter of 1.00 and 1.30 mm in two specimens, thickness of 0.61 mm; form ratio of diameter/thickness, 1.64; embryonic chambers consisting of protoconch and deuteroconch, followed and girded by two spiral nepionic chambers originating from one principal auxiliary chamber and both chambers meeting at a closing chamber; and embryonic and nepionic chambers, not apical portion, but eccentric in position; total nepionic chambers including a closing chamber, counting 11 (pl. 4, fig. 9); diameter of protocconch (I) and deuteroconch (II) in two specimens, 120 × 96 microns (I) and 144 × 100 microns (II) and 120 × 104 microns (I) and 144 × 88 microns (II) (pl. 4, fig. 9); dimension of principal auxiliary chamber (i.e. tang. diam. and rad. diam.), 180 × 140 microns; later equatorial chambers, ogival to short spatulate shaped toward the periphery; dimension of equatorial chambers (i.e. tang. diam. and rad. diam.), 80 × 86 to 80 × 96 microns; lateral chambers present on both sides of the equatorial layer; pillars present.

Remarks: The present form is comparable with *Miolepidocyclina burdigalensis* (Gümbel) with ecuadorensis type carrying one principal auxiliary chamber and two nepionic spirals (Brönnimann 1940, fig. 22). The present form is assigned to *Mcyclina. burdigalensis.* In this study, *Mcyclina. burdigalensis* with bifida type nepionic chambers (Brönimann, op. cit., fig. 23) is not found in Turkey. The species with bifida type have two principal auxiliary chambers, and then it may be difficult to discriminate with *Miolepidocyclina negrii* (Ferrero).

Localities: Given in Text-figure 4.

Spinosemiogypsina Matsumaru, Özer and Sari, n. gen.

Name: This genus is named for many sharp pointed spines carrying miogypsinid foraminifera from the Oligocene Küçükköy Formation of the Bey Dağlari Autochton, west Antalya, Turkey.

Type species: *Spinosemiogypsina antalyaensis* Matsumaru, Özer and Sari, n. gen., n. sp.

Diagnosis: Test large, fan shaped with rounded frontal margin, thick biconvex with sharp pointed spines; embryonic chambers consisting of subspherical protoconch and kidney shaped deuteroconch, followed by main planispiral and large nepionic chambers, originating from the first principal auxiliary chamber, while short spirals of small nepionic chambers from the secondary principal auxiliary chamber were observed as the system of intercalary chambers between the embryonic chambers and main planispiral nepionic chambers; later ogival to rhombic equatorial chambers, arranged toward the distal margin; lateral chambers present in both sides of the equatorial layer; long and short coarse spines arise from the early to late arranged equatorial and lateral chambers; calcareous wall, thickly lamellar, perforate; stolon system present in equatorial chambers; canal system present in interseptal, lateral walls and spines; stout pillars present.

Remarks: This genus resembles the uniserial *Miogypsina* such as *M. primitiva* and *M. borneensis* in general shape, but it is different from both species by having spines and short intercalary chambers from the secondary principal auxiliary chamber. Adams and Belford (1974, p. 497, pl. 73, fig. 13) found this form from the Tertiary upper e limestone of Christmas Island, but they considered the form without lateral chambers. This form is probably derived from the Tertiary lower e in Christmas Island.

Spinosemiogypsina antalyaensis Matsumaru, Özer and Sari, **n. gen., n. sp.**
Plate 4, figure 10; Plate 5, figures 1-3

Material and type specimen: Specimens of limestone rock sample 97-489 in Section 6, Küçükköy Formation, exposed about 4.3 km NW of Ulucak Village (Text-figure 1 lower). Holotype, a megalospheric specimen in equatorial section of thin section 97-489-1, Saitama University Coll. no. 8868 (Plate 4, figure 10).

Name of species: *antalyaensis,* found from northwestern Antalya City.

Description: Test large, thick lenticular; megalospheric diameter from 1.92 to 2.10 mm, thickness 0.65 to 0.76 mm, form ratio of diameter/thickness from 1.80 to 1.85, one microspheric form lacking apical portion, diameter and width in equatorial section, 3. 80 × 3.34 mm; embryonic chambers, probably of A2 form, consisting of subspherical protoconch and kidney shaped deuteroconch; diameter of protoconch (I) and deuteroconch (II) in two specimens, 216 × 176 microns (I) and 176 × 96 microns (II) (pl. 5, fig. 1), and 216 × 208 microns (I) and 248 × 80 microns (II) (pl. 4, fig. 10); both embryonic chambers, followed by uniserial large chambers, rhombic to rectangular shaped, each whorl with five and seven chambers in two specimens; dimension of maximum chamber (i.e. tang. diam and rad. diam.), 187 × 227 microns; dimension of maximum equatorial chamber (i.e. tang. diam. and rad. diam.), 227 × 180 microns; lateral chambers in axial section, which are roughly arranged in tiers or among stout pillars over equatorial layer; number of lateral chambers, 5 or 6; dimension of lateral chambers (i.e. length and height), 86 × 46 to 160 × 66 microns; diameter of stout pillars, 92 to 140 microns (max. 280 microns); radial spines arise from the early to late arranged chambers, and length of spines from their origin to tips, measuring 366 to 635 microns and width of spines, 52 to 80 microns; wall calcareous and perforate.

Stratigraphic horizon: Limestone in the Küçükköy Formation (sample 97-490 in Section 6, Text-figs. 1, 2a and 4).

Geological age: Late Oligocene (Late Chattian) and Tertiary e4 (Chattian).

CONCLUSION

The middle Tertiary larger foraminifera from the Bey Dağlari Autochton, Menderes-Taurus Platform, SW Turkey include characteristic fauna from the late Oligocene (Chattian) to late early Miocene (Burdigalian). Three significant faunal assemblages based on 8 diagnostic species could be recognized. *Miogypsinoides formosensis, Mdes. bantamensis, Mdes. dehaartii, Miogypsina primitiva,* and *Spiroclypeus margaritatus* were proved to be diagnostic species for the regional zonation of Assemblage 1. This assemblage is regarded as a faunal recognition of late Oligocene (Chattian). This is assigned to be Tertiary e4 of the Far Eastern Letter Stages. Under the influence of tectonic events, this assemblage comprises reworked lower Oligocene species such as *Paleomiogypsina boninensis, Miogypsinella complanata, Lepidocyclina boetonensis,* and *Heterostegina borneensis*: late Paleocene species of *Miscellanea miscella* and *Lockhartia conditi*: and late Cretaceous planktonic foraminifera of *Globotruncana* spp. and *Hedbergella* spp. Further, it is interesting to observe *Lepidosemicyclina thecidaeformis* for the first time in this assemblage, because the ancestor of this species is uncertain and former researchers regarded it as a Miocene species.

Miogypsinoides bantamensis, Mdes. dehaartii, Miogypsina primitiva, M. borneensis, M. globulina and *Spiroclypeus margaritatus* were proved to be diagnostic species for Assembalge 2. This assemblage is regarded as a faunal recognition of early Miocene (Aquitanian), and is assigned to be Tertiary e5 lower of the Letter Stages. *Austrotrillina howchini* could be found in this assemblage, and it is similar form from the Minamizaki Limestone (Matsumaru 1996, p. 214, 216, pl. 84, fig. 3a), but not figured. Assemblage 2 comprises reworked species such as *Lepidocyclina boetonensis* and *Miscellanea miscella.*

Miogypsinoides dehaartii, Miogypsina borneensis, M. globulina and *Miolepidocyclina burdigalensis* were proved to be diagnostic species for Assemblage 3. This assemblage is regarded as a faunal recognition of late early Miocene (Burdigalian) and is assigned to Tertiary e5 upper of the Letter Stages. Reworked species can be found in this assemblage. The species contamination occurred due to tectonic movement during the carbonate accumulation in the Bey Dağlari Autochton during the Oligocene - Miocene ages.

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