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BENTHIC FORAMINIFERAL BIOSTRATIGRAPHY OF MALATYA OLIGO-MIOCENE SUCCESSION (EASTERN TAURIDS, EASTERN TURKEY)

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ABSTRACT

The benthic foraminiferal biostratigraphy of Oligo-Miocene aged Muratlı and Petekkaya formations which crop out over wide regions around Akçadağ town, west of Malatya province in Eastern Taurids were revealed in this study. Systematical sampling was carried out in measured stratigraphical sections in four locations in order to perform stratigraphical and paleontological investigations. Benthic foraminifera taken from 182 hard rock samples were defined and three biozones were determined as; SBZ 21-22, belonging to Oligocene (Rupelian - Early Chattian), SBZ 23 (Late Chattian) and SBZ 25 belonging to Lower Miocene in shallow marine deposits in the region. It was stated that the assemblage of planktic foraminifer and nannoplankton which stratigraphically detected within Chattian - Burdigalian units in the succession most probably indicated Aquitanian age. Besides; Oligo-Miocene transition in the region was approved with this study based on biostratigraphical locations of benthic foraminiferal taxa.

1. Introduction

Malatya Oligo-Miocene basin is located in west of Malatya province around Akçadağ district at the junction of Tauride - Anatolide platform, East Anatolian Region and surrounded by districts of Doğanşehir in south, Hekimhan in north, Darende in northwest, Yazıhan in northeast and Yeşilyurt in southeast (Figure 1). Marine sediments observed in and around the study area have been deposited between Jurassic – Middle Miocene times, and Oligocene and Lower Miocene aged units in this study were investigated in detail. However, pre Eocene-Eocene rock units and post Miocene young units were not studied to the contrary of these aforementioned units. Basement units in the region are constituted by Middle Triassic – Cretaceous, Jurassic – Cretaceous and Upper Senonian neritic limestones, Late Cretaceous – Paleocene clastic and carbonate rocks, Early – Middle Eocene terrigenous clastic rocks, Middle – Late Eocene neritic limestones and sedimentary deposits formed by clastic and carbonate rocks and by Mesozoic ophiolites (Figure 2). As for the younger deposits cropping out near the study area are composed of Late Miocene – Pliocene terrigenous clastics, pyroclastic rocks and Pliocene - Plio Quaternary terrigenous deposits, alluvial fan, debris and young alluvial deposits (Figure 3). As geological units at the basement and young deposits are out of the scope of study, detailed information can be obtained from the articles of Ayan (1961), Akkuş (1971), Yoldaş (1972), Kurtman (1978), Örçen (1986), Karaman et al. (1993) and Alkan (1997).

Oligocene aged Muratlı formation and Lower Miocene aged Petekkaya formation investigated in eastern Taurus were studied in detail and four stratigraphical sections were measured within this purpose. Total of 28 taxa were defined in 182 rock samples which were taken from these sections (Gedik; 2010, 2014), and 3 biozones were detected as SBZ 21-22, SBZ 23 belonging to Oligocene and SBZ 25 belonging to Lower Miocene in shallow marine deposits in the region. With the help of stratigraphical horizons in which foraminiferal taxa are present all stratigraphical sections were correlated both by

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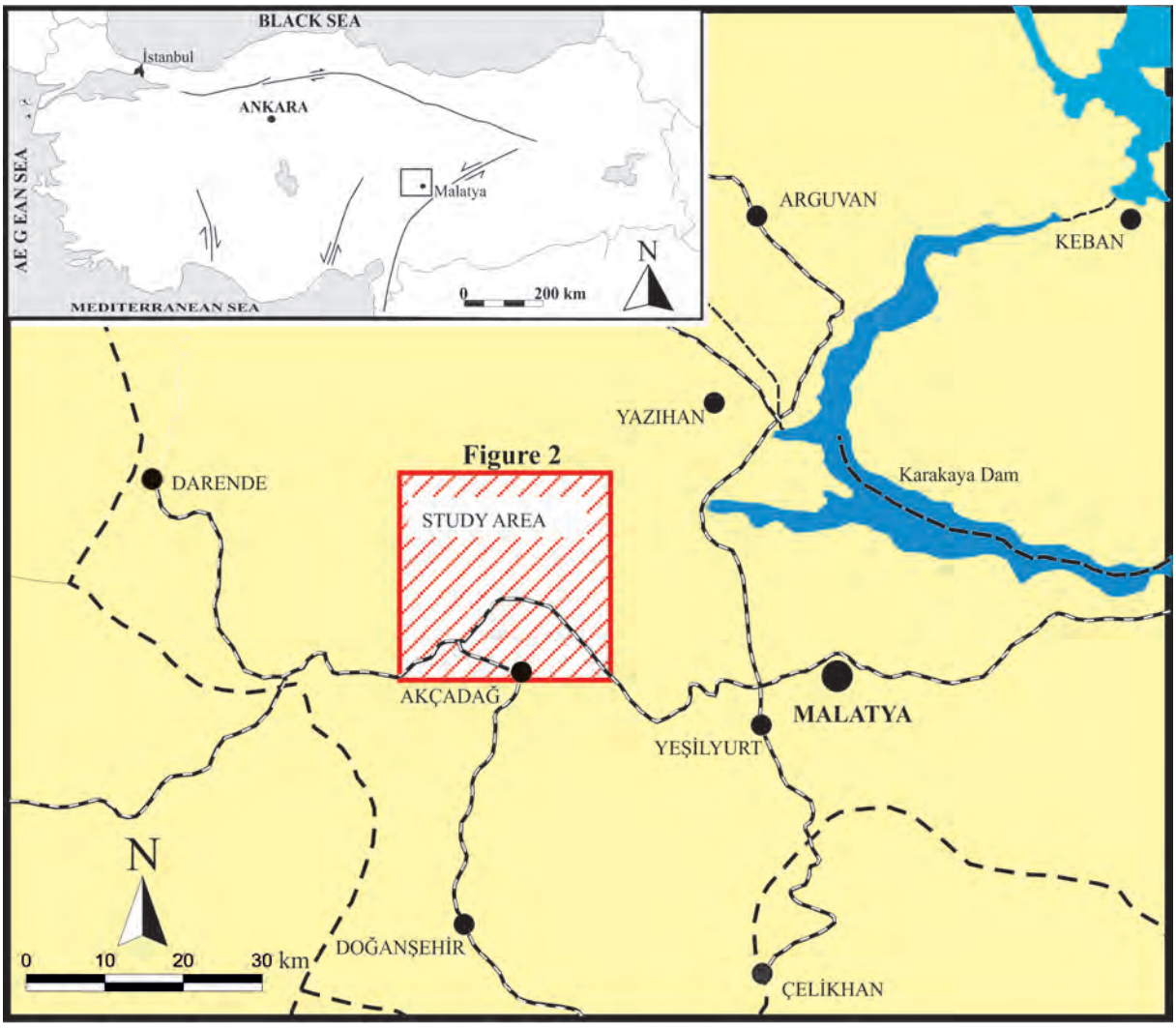

Figure 1- Location map.

lithologically and biostratigraphically (Gedik, 2014; Figure 4).

Thin sections of photographed foraminiferal taxa in this study are kept in the archive of the General Directorate of Mineral Research and Exploration.

Abbreviations: SBZ (Shallow benthic foraminiferal zone), HYM (Karamağara measured stratigraphical section), FGM (Edilme measured stratigraphical section), FGK (Kuzkaya measured stratigraphical section), FGD (Develi measured stratigraphical section).

2. Material and Method

Total of 182 hard rock samples taken from four measured stratigraphical sections form the material of this study. In hard rock samples, random and oriented thin sectioning method was applied. Besides; clayey limestone-marl samples and macrofossils collected for the determination of fauna and flora belonging to planktic foraminifera, nannoplanktons and ostracodes were used in the determination of biostratigraphy for correlation.

3. Measured Stratigraphical Sections

3.1. Kuzkaya Measured Stratigraphical Section (FGK)

Kuzkaya measured stratigraphical section starts at coordinates of X1: 02 869; Y1: 53 721 and finishes at coordinates of X2: 02 588; Y2: 54 505 (Figure 2). The length of the section which is composed of Early Miocene sediments was measured as 69 meters and total of 40 samples were collected. Samples collected from bottom to top were lithologically defined by giving their fossil contents and coded as FGK 1-26 (Figure 5). The succession of which its bottom contact relationship cannot be observed starts with

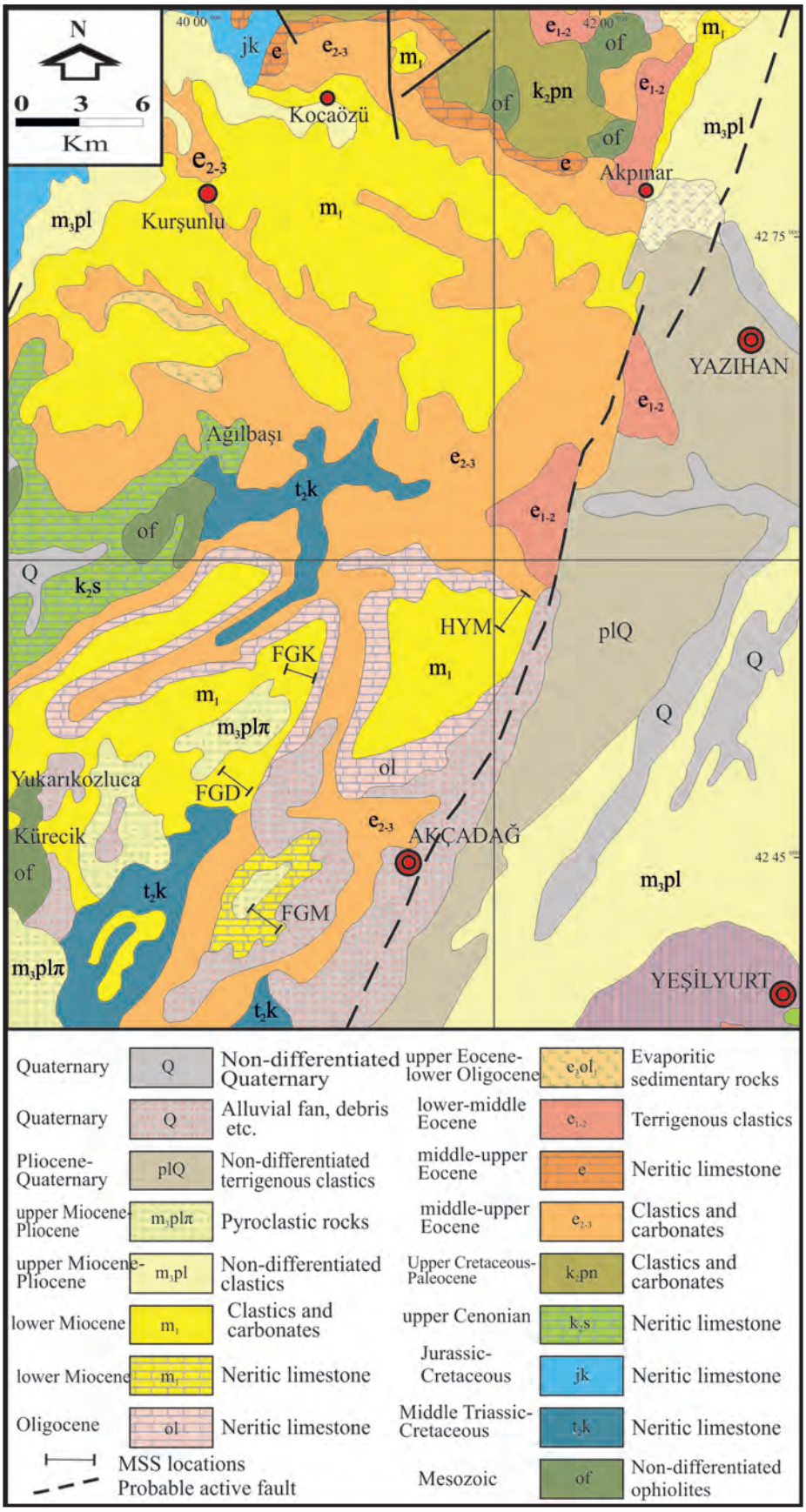

Figure 2- Geological map of the study area (from 1/500 000 scaled map of MTA).

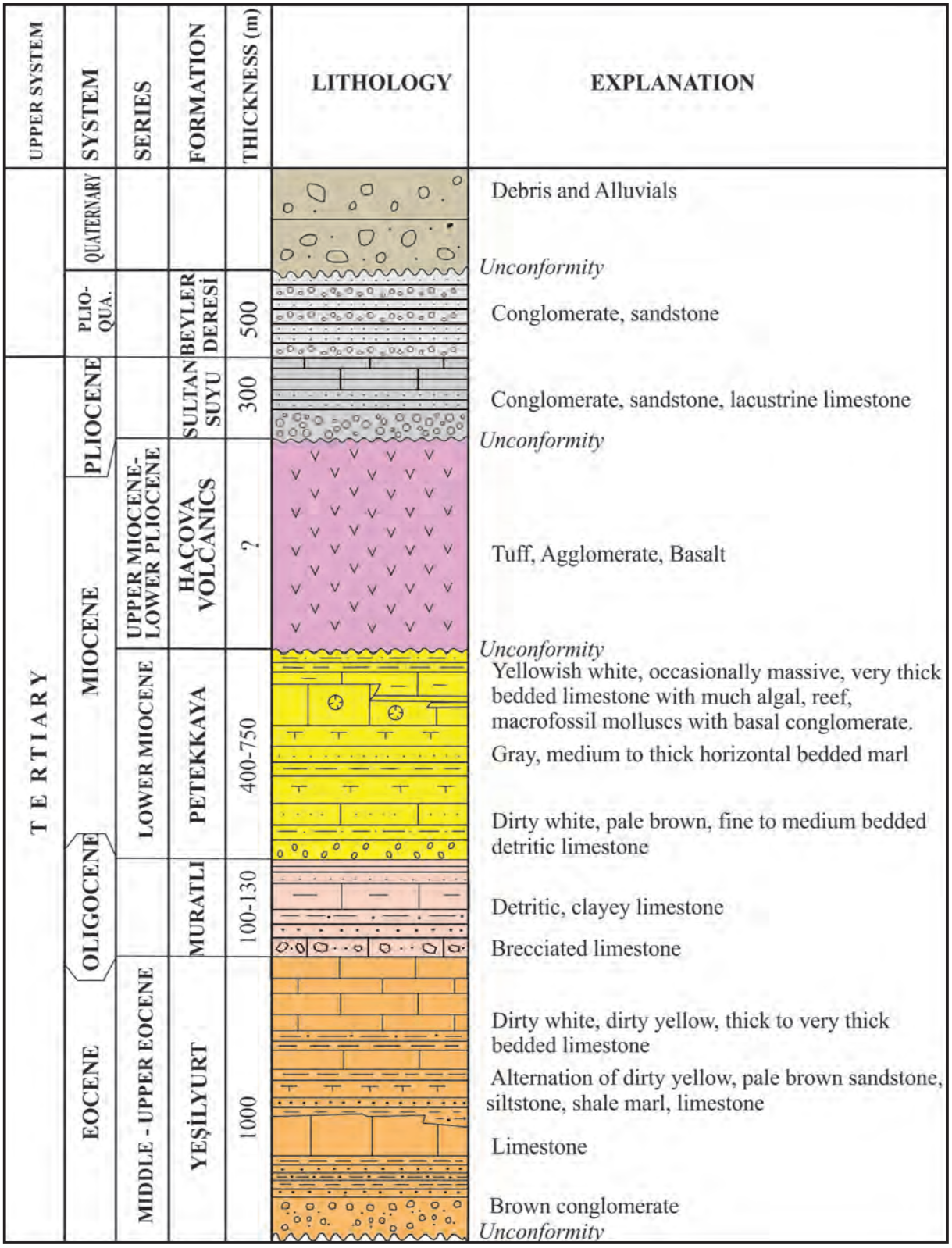

Figure 3- Generalized stratigraphical section of the study area (from Karaman et al., 1993).

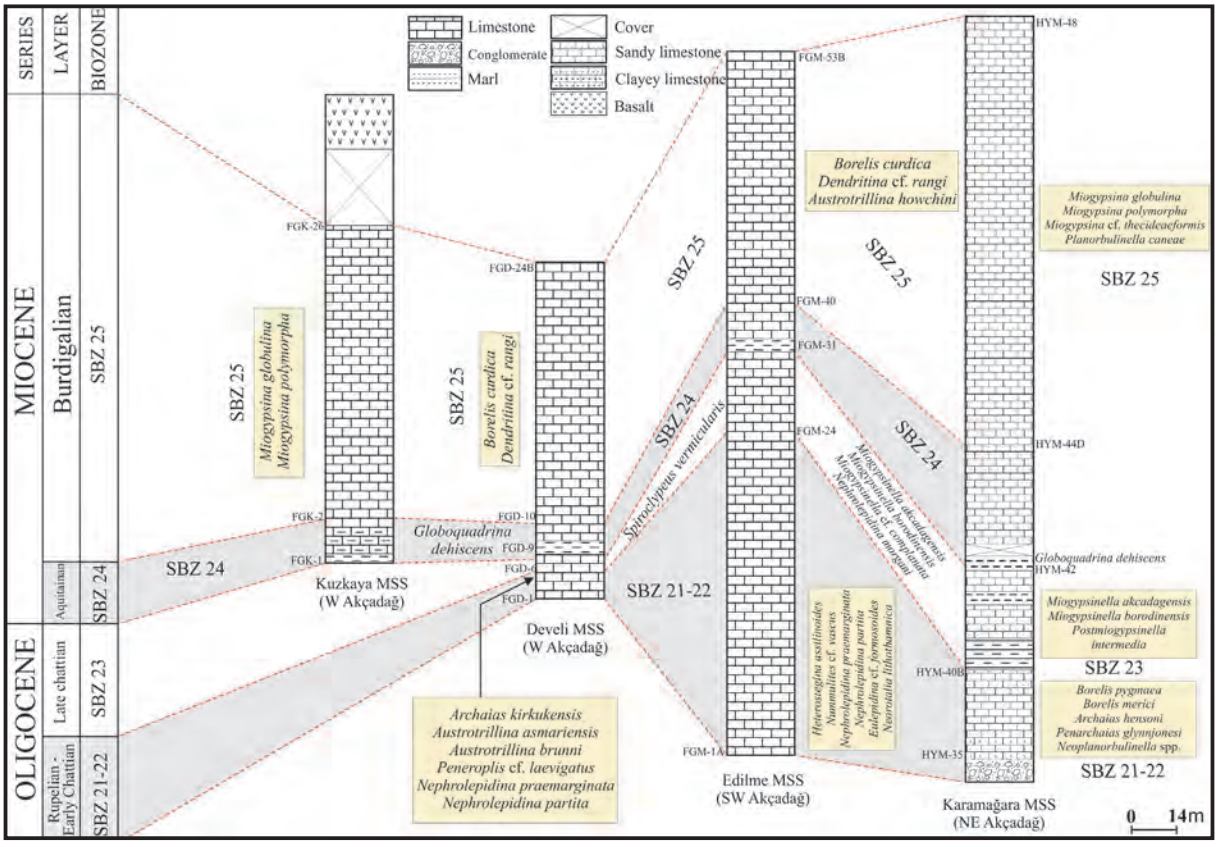

Figure 4- Lithological and biostratigraphical correlation table of the measured stratigraphical sections in the study area (Gedik, 2014; Figure 4).

approximately 3 meters thick, gray to beige colored, medium to thick bedded, fully horizontal, much macro shell imprint bearing, highly disintegrated marl and clayey limestones. The unit is highly rich in planktic foraminifer, nannoplankton and ostracode contents (FGK-1). Described planktic foraminifera are; *Globigerinoides primordius* Blow and Banner, *Globigerina ciperoensis* Bolli, *G. praebulloides occlusa* Blow and Banner, *G. praebulloides leroyi* Blow and Banner, *G. praebulloides* s.s. Blow, *G. ouachitaensis gnaucki* Blow and Banner, *G. ouachitaensis* s.s Howe and Wallace, *G.* cf. *angulisuturalis* Bolli, *Globigerinella* cf. *obesa* (Bolli), and nannoplanktons are; *Cyclicargolithus abisectus* (Müller), *C. floridanus* (Roth and Hay), *Coccolithus eopelagicus* (Bramlette and Riedel), *Dictyococcites bisectus* (Hay, Mohler and Wade), *Sphenolithus moriformis* (Brönnimann and Stradner). Ostracodes decribed within same samples are *Krithe papillosa* (Bosquet), *Ruggeria dorukae* (Bassiouni), *Xestoleberis* cf. *ventricosa* Müller, *Cytheropteron* sp., *Bairdia* sp., *Quadracythere* sp. Furthermore; small benthic foraminifera such as *Pararotalia* sp. and *Nonion* sp. were also described. The age of the unit is dated as Late Oligocene – Early Miocene according to planktic foraminifers and as Late Aquitanian - Burdigalian according to ostracodes. However; nannoplankton assemblage gives Oligocene age. The first occurance of *M. polymorpha* observed in limestones just above the unit indicates Burdigalian age. Taking the age intervals of planktic foraminifers and ostracode fauna in marls and the first occurance of *M. polymorpha* into consideration the unit was most probably thought to be in Aquitanian age, as *M. polymorpha* has not been reported in Aquitanian age in studies carried out so far (Drooger, 1993). The assemblage which constitutes the unit does not contain benthic foraminifer and is the equivalent of M1 of planktic foraminifera and NN1-NN2 zones of nannoplanktons according to Berggren (1995). However, its equivalence in shallow benthic zonation corresponds to SBZ 24 zone of Cahuzac and Poignant (1997). In beige to white colored, fine grained, medium to thick bedded clayey limestone layer Burdigalian aged *Miogypsina polymorpha* (Rutten) was described at 4th meter of the succession (FGK-2). The first occurance of *M. polymorpha* draws the lower boundary of SBZ-25 zone. Just

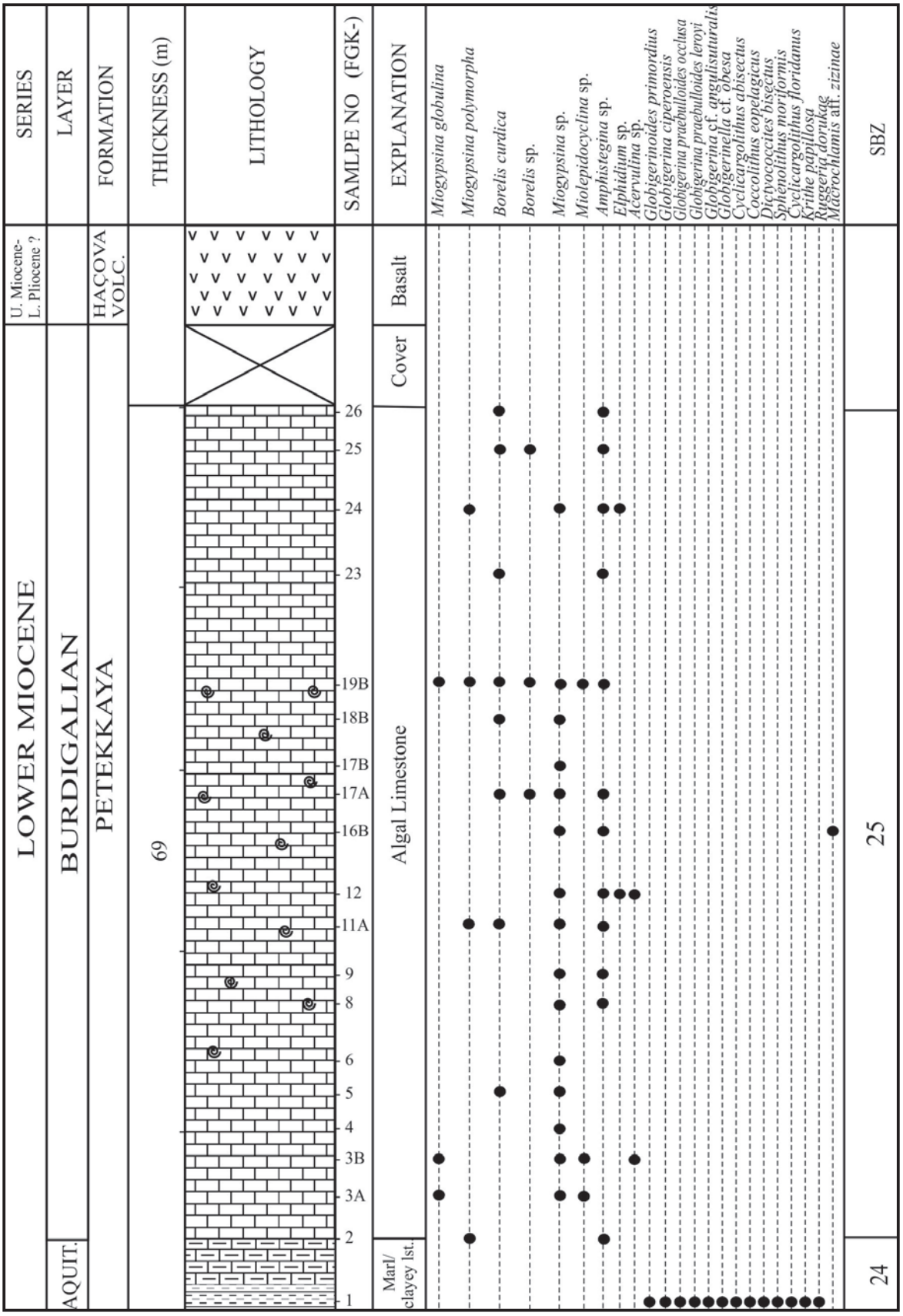

Figure 5- Stratigraphical distributions of larger benthic and planktonic foraminifera, nannoplankton, ostracode and macro fossils (NW Akçadağ, W Malatya).

in the following layers, *Miogypsina globulina* (Michelotti) was detected which is the characteristic of Burdigalian age (FGK-3A, 3B). The succession continues almost in the same characteristics until 69th meter starting from this level. Beige-white colored, medium to thick bedded, occasionally massive, with solution openings, chalky, with much macro shell limestones exhibit a reefal characteristic throughout the succession. Alga, bryozoa, coral and bivalves accompany with much large benthic foraminiferal fauna in almost all layers. Macro hand specimens were collected from the intermediate levels of reefal limestones (FGK-16B), and Burdigalian aged *Macrochlamis* aff. *zizinae* (Blanckenhorn) was described. It was determined that the life span of genus *Miogypsina* started approximately from the 4th meter of the succession and continued until 68th meter (i.e. the end of the succession). It was observed that Burdigalian aged *Borelis curdica* (Reichel), *Borelis* sp., *Miolepidocyclina* sp., *Amphistegina* sp., *Elphidium* sp., *Acervulina* sp. taxa accompany with genus *Miogypsina* in layers of reefal limestones. However; the last occurance of *B. curdica* draws the upper boundary of SBZ 25 zone. Approximately; 70 meters thick, covered area was passed after 69th meter, and it was seen that dense arenitized basalts had cut and covered Burdigalian aged reefal limestones in places where topography was high (1594th meter).

3.2. Develi Measured Stratigraphical Section (FGD)

Develi measured stratigraphical section starts at coordinates of X1: 04 156; Y1: 48 465 and finishes at coordinates of X2: 03 601; Y2: 46 141 (Figure 2). The length of the section which consists of Oligocene and Early Miocene sediments was measured as 103.6 meters and total of 41 samples were collected. 22 hard rock samples are much fossilliferous and were selected for oriented thin section study. Collected samples were lithologically described from bottom to top by giving their fossil contents and coded as FGD 1-24B (Figure 6). Taxa of *Archaias kirkukensis* Henson, *Austrotrillina asmariensis* Adams, *A. brunni* Marie, *Nephrolepidina praemarginata* Douvillé, *N. partita* Douvillé, *Neorotalia lithothamnica* Uhlig and *Peneroplis* cf. *laevigatus* d'Orbigny were described in yellowish, beige to white colored, medium bedded limestones at the bottom of succession (FGD-2A, 2B, 3). According to shallow benthic foraminiferal zones which were prepared by Cahuzac and Poignant (1997) for whole Tethys Oligo-Miocene, these levels correspond with Rupelian – Early Chattian (i.e. SBZ 21-22). *Nephrolepidina* sp., *Eulepidina* sp. and *Austrotrillina* sp. were detected in beige-white colored limestones just above those levels (FGD-4, 5). *Pelecyora* (*Cordiopsis*) *islandicoides* (Lamarck) which can live in lower saline lagoonal environments and represent Burdigalian – Pliocene age interval was described though representing the shallow marine environment from bivalves in the same levels. Approximately; at 10th meter of the succession it was seen that beige to white colored limestone layers consisted taxa of *Planorbulina brönnimanni* Bignot and Decrouez, *Spiroclypeus vermicularis* Tan, *Spiroclypeus* sp., *Archaias* sp., *Nephrolepidina* sp., *Eulepidina* sp., *Miogypsinella* sp., *Austrotrillina* sp., *Amphistegina* sp. and of highly developed Rotaliid individuals (FGD-6, 7). These levels of the succession were dated as Late Chattian (SBZ-23) considering both the benthic foraminiferal fauna detected and the underlying Rupelian – Early Chattian aged limestone layers and in overlying Early Miocene (Aquitanian) aged marls in which planktic foraminiferal fauna is observed. The overlying, beige to white colored marls which are approximately 3 meters thick is rich in planktic foraminifer and nannoplankton content. From planktic foraminifers; *Globigerinoides primordius* Blow and Banner, *Globigerina ciperoensis* Bolli, *G. praebulloides occlusa* Blow and Banner, *G. praebulloides leroyi* Blow and Banner, *G. ouachitaensis* s.s. Howe and Wallace, *G. praebulloides* s.s. Blow, *G.* cf. *angulisuturalis* Bolli, *Globigerinella obesa* (Bolli), *Globoquadrina dehiscens* (Chapman, Parr and Collins), *G. venezuelana* (Hedberg), *Neogloboquadrina continuosa* (Blow), *Globoturborotalia euapertura* (Jenkins), ? *Globigerinoides sacculifer* (Brady), ? *G. quadrilobatus* (d'Orbigny), ? *G. altiaperturus* Bolli; and from nannoplanktons; *Cyclicargolithus abisectus* (Müller), *Coccolithus eopelagicus* (Bramlette and Riedel), *Dictyococcites bisectus* (Hay, Mohler and Wade), *Sphenolithus moriformis* (Brönnimann and Stradner), *Discoaster deflandrei* Bramlette and Riedel, *Pontosphaera plana* (Bramlette and Sullivan) and *Helicosphaera* sp. were described. *Siphonina* sp., *Elphidium* sp., *Ammonia* sp. and *Uvigerina* sp. were described among small benthic foraminifera at the same level (FGD-9). The age of this lithological unit according to planktic foraminifers are Early Miocene and Late Rupelian-Chattian according to nannoplanktons. The first occurance of *Globoquadrina dehiscens* from foraminiferal species described within unit shows Aquitanian age (zone M1b). So, the age of this unit which is in different lithology was accepted as Aquitanian. Beige to white, thick bedded, micritic limestone layers with solution

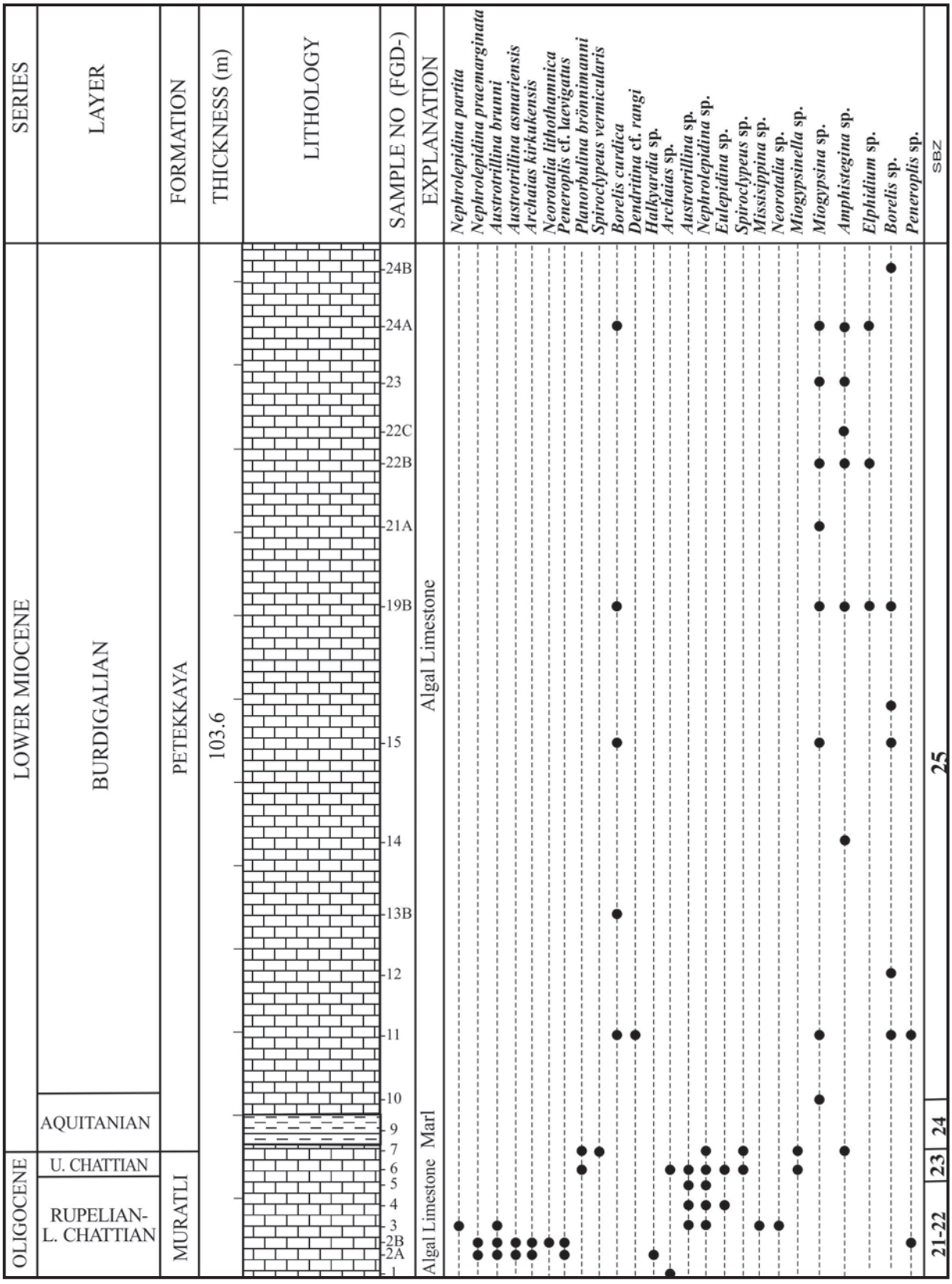

Figure 6- Stratigraphical distributions of larger benthic foraminifera detected in Develi measured stratigraphical section (W Akçadağ, W Malatya).

openings which have an approximate thickness of 10 meters and transitionally overlie the marl deposit (17th meter of the succession) are the levels in which genus *Miogypsina* was first observed. Starting from this level (FGD-11) to the uppermost level of the succession in shallow marine limestones which is characterized with similar features, it was seen that genus *Miogypsina* was sometimes accompanied by Burdigalian aged benthic foraminifers such as *Borelis curdica* (Reichel), *Dendritina* cf. *rangi* d'Orbigny, *Amphistegina* sp., *Elphidium* sp. and *Peneroplis* sp., and algae, bryozoas, corals and bivalves. Oligocene-Early Miocene aged (most probably Burdigalian according to its level structure) *Hyotissa hyotis* (Linné) which represents very shallow marine environment with average salinity in bivalves was described at 50th meter of the succession. However, at 93rd meter of the succession Burdigalian aged *Pecten* aff. *burdigalensis* Lamarck was described. Besides, it was also seen that *Clypeaster* sp. from echinides was abundant in identical levels (FGD-22B).

3.3. Edilme Measured Stratigraphical Section

Edilme measured stratigraphical section starts at coordinates of X1: 06 627; Y1: 43 539 and finishes at coordinates of X2: 05 020; Y2: 44 990 (Figure 2). The length of section which consists of Oligocene and Early Miocene sediments was measured as 218.4 meters and total of 94 samples were collected. 27 hard rock samples are much fossilliferous and oriented thin section study was carried out for these specimens. Collected samples were lithologically described from bottom to top by giving their fossil contents and coded as FGM 1A-53 B (Figure 7). At the bottom of the succession *Pelecyora* (*Cordiopsis*) *islandicoides* (Lamarck) and *Glycymeris bimaculatus* (Poli) from bivalves were described which represent Burdigalian – Pliocene age interval. The succession is represented by limestones in which similar features are observed up to 126th meter. Limestones are beige to white colored, thick to very thick bedded and much fossilliferous. From benthic foraminifers, taxa of *Nephrolepidina praemarginata* Douvillé, *N. partita* Douvillé, *Planorbulina brönnimanni* Bignot and Decrouez, *Austrotrillina asmariensis* Adams, *Heterostegina assilinoides* Blanckenhorn, 1890 emend. Henson, *Eulepidina* sp., *Nephrolepidina* sp., *Miogypsinella* sp., *Austrotrillina* sp., *Operculina* sp., *Asterigerina* sp., *Spiroclypeus* sp. and *Amphistegina* sp. were described in beige to white colored limestones until 103rd meter. Furthermore; alga, coral, bryozoa and bivalves accompany with foraminiferal fauna at almost all levels. It was seen that at 103rd meter Lepidocyclinid foraminifers formed peak zone in yellowish to beige colored, medium to thick bedded limestone layers (FGM -19). At this level, taxa of *Nephrolepidina praemarginata* Douvillé, *N. partita* Douvillé, *Eulepidina* cf. *formosoides* Douvillé, *Heterostegina assilinoides* Blanckenhorn, 1890 emend. Henson, *Neorotalia lithothamnica* Uhlig, *Spiroclypeus* sp., *Eulepidina* sp., *Nephrolepidina* sp., *Amphistegina* sp. were described. The location of these species in the zonation prepared for all Tethys Oligocene is Rupelian – Early Chattian (SBZ 21-22) (Cahuzac and Poignant, 1997). *Nephrolepidina morgani* (Lemoine and Douvillé) was described in limestones just above this level (FGM-24). The first occurance of this species draws the lower boundary of zone SBZ 23. In identical levels, *N. morgani* species is also accompanied by taxa of *Austrotrillina asmariensis* Adams, *A. brunni* Marie, *Miogypsinella* sp. ve *Amphistegina* sp. (FGM-29). In beige to white colored, thick bedded limestones at 155th meter, taxa of *Miogypsinella akcadagensis* (Gedik and Sirel), *M. borodinensis* Hanzawa, *M.* cf. *complanata* (Schlumberger), *Postmiogypsinella* sp., *Miogypsina* sp., *Amphistegina* sp., *Nephrolepidina* sp. were described (FGM-30A). Considering the interpretations made for the stratigraphical distributions of taxa described, it was determined that the age of these levels were Late Chattian (SBZ 23). In these limestones layers, the last occurance of *M.* cf. *complanata* species specifies the upper boundary of the zone SBZ 23 (FGM 30B). In identical levels *Spondylus* aff. *podopsideus* Lamarck was described which represents Eocene – Early Miocene age interval from bivalves. Following these layers, white colored, 4 meters thick marls were observed nearly at 127th meter. *Cyclicargolithus floridanus* (Roth and Hay), *Coccolithus eopelagicus* (Bramlette and Riedel), *Ericsonia robusta* (Kamptner) and *Cyclicargolithus abisectus* (Müller) were described from nannoplanktons in marly layers. Nannoplankton species decribed within unit give the age of Oligocene. However, the unit was correlated with Aquitanian aged marls (SBZ 24) which was characterized by the first occurance of *G. dehiscens* located over Late Chattian in Develi and Karamağara sections and was considered that these units were isochronous. Limestones of which their thicknesses were estimated as 87.6 meters and continue up to 219th meter on marls constitute the uppermost levels of the succession. Limestones are

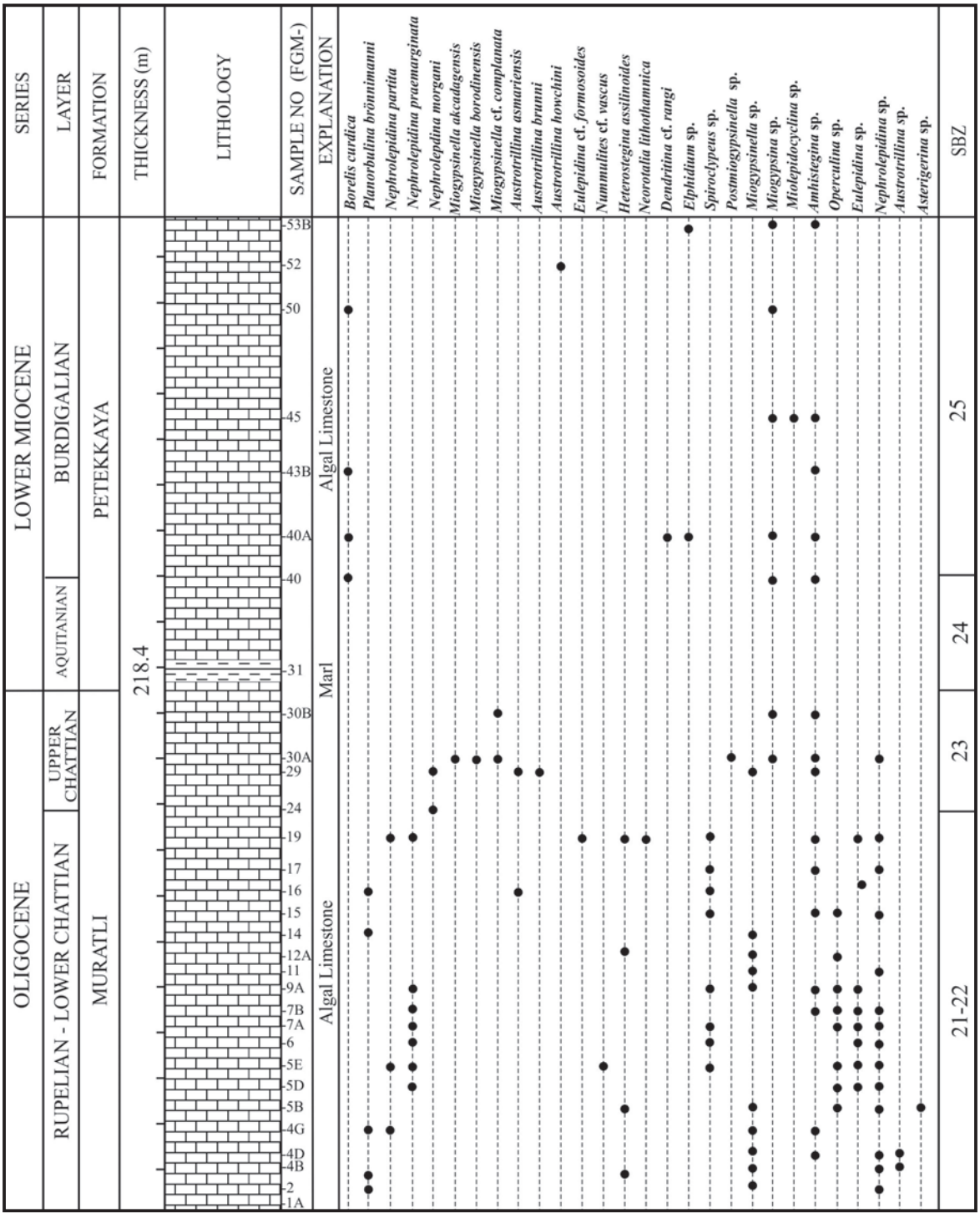

Figure 7- Stratigraphical distributions of larger benthic foraminifera detected in Edilme measured stratigraphical section (SW Akçadağ, W Malatya).

beige to white colored, medium, thick to very thick bedded, occasionally massive and have solution openings. The taxa of Burdigalian aged (SBZ 25) *Borelis curdica* (Reichel), *Austrotrillina howchini* (Schlumberger), *Dendritina* cf. *rangi* d'Orbigny, *Miolepidocyclina* sp., *Amphistegina* sp., *Elphidium* sp. were described, and *Miogypsina* species in these levels which have rich foraminiferal fauna are accompanied with alga, bryozoa, coral and bivalves. *B. curdica* starts from the bottom of Burdigalian and continues its presence almost until the uppermost levels of the succession.

3.4. Karamağara Measured Stratigraphical Section (HYM)

Karamağara measured stratigraphical section starts at coordinates of X1: 16 599; Y1: 57 032 and finishes at coordinates of X2: 12 705; Y2: 58 026 (Figure 2). The length of the section which consists of Oligocene and Early Miocene sediments was measured as 237.6 meters and total of 25 samples were collected. 9 hard rock samples are much fossilliferous and oriented thin section study was carried out for these specimens. Collected samples were lithologically described from bottom to top by giving their fossil contents and coded as HYM 35-48 (Figure 8). At the bottom of the succession 6 meters thick, gray-white-beige colored, fine to medium bedded monogenic pebble, and beige to yellow colored, fragile-brecciated limestone layers with rounded carbonate pebbles-sands were observed. Then, 1 meter thick, cream to pale brown colored, thick bedded, massive, fine textured, much fossilliferous sandy limestone layer was observed over the succession. *Austrotrillina brunni* Marie, *Miogypsinella* sp., *Archaias* sp., *Penarchaias* sp., *Asterigerina* sp. and much Miliolidae (HYM-35) was observed in these levels. The succession continues primarily with pebbly-sandy limestones then with yellow-beige-white colored, medium to thick bedded, fractured, sandy-chalky limestones until 32nd meters. In these limestones which continue up to marls, taxa of *Borelis pygmaea* Hanzawa, *Borelis merici* Sirel, *Penarchaias glynnjonesi* (Henson), *Austrotrillina brunni* Marie, *Archaias hensoni* Smout and Eames, *Neoplanorbulinella* spp., *Asterigerina* sp., *Operculina* sp. and *Amphistegina* sp. were determined. Based on this fossil assemblage, the age of the bottom for the succession was determined as Rupelian - Lower Chattian (SBZ 21-22). In hand specimens collected from sandy limestone levels at 35th meter of the succession *Pecten burdigalensis* Lamarck (HYM-40A) from bivalves was described. One to two meters ahead of these layers are the first levels in which species belonging to genus *Miogypsina* is observed (HYM-40B). In these partly clastic limestones, it was observed that genus *Miogypsina* was accompanied by taxa of *Miogypsinella* sp., *Amphistegina* sp., *Heterostegina* sp., *Operculina* sp., *Asterigerina* sp. and *Elphidium* sp. Just above these elevations, it was seen that 10 meters thick, white-greenish colored marls were deposited. Nevertheless; the age data in marls could not be found. Yellow to beige colored, 15 meters thick, fine to medium bedded, jointed, much fossilliferous sandy limestone and sandstone, and 8 meters thick, white to green colored marl and beige colored, fine to medium bedded limestone deposition was observed on marls (HYM-41). In marls, Chattian - Aquitanian aged *Globigerinoides primordius* Blow and Banner, *Tenuitellinata juvenilis* (Bolli), *Globigerinita incrusta* Akers, *Globigerina praebulloides leroyi* Blow and Banner, *G. praebulloides occlusa* Blow and Banner, *G. praebulloides praebulloides* Blow, *G. ouachitaensis gnaucki* Blow and Banner, *G. ouachitaensis ouachitaensis* Howe and Wallace, *G.* cf. *angulisuturalis* Bolli, *Globorotaloides* cf. *suteri* Bolli, *Paragloborotalia* spp., *Globoguadrina* sp. and *Globigerinoides* sp. were described. In clayey limestones over marls, *Miogypsinella akcadagensis* (Gedik and Sirel), *M. borodinensis* Hanzawa, *Postmiogypsinella intermedia* Sirel and Gedik and *Miogypsina* spp. were described. This limestone layer which consists of rich benthic foraminiferal taxa (HYM-42) was aged as Upper Chattian (SBZ 23) as the lower boundary of the underlying marls had been drawn based on the first occurance of *G. dehiscens*. Marly layers which remain just below the covered area and correspond with 70th meter of the succession are rich in terms of planktic foraminifer and nannoplankton content (HYM-42A). Planktic foraminifera described in the unit are *Globoturborotalia euapertura* (Jenkins), *Globigerina ouachitaensis* s.s. Howe and Wallace, *G. ouachitaensis gnaucki* Blow and Banner, *G. praebulloides occlusa* Blow and Banner, *G. praebulloides leroyi* Blow ve Banner, *G. praebulloides* s.s. Blow, *G.* cf. *angulisuturalis* Bolli, *G. ciperoensis* Bolli, *Globoquadrina dehiscens* (Chapman, Parr ve Collins), *G. venezuelana* (Hedberg), *G. praedehiscens* Blow and Banner, *G. selli* Borsetti and *Globigerinoides primordius* Blow and Banner. Nannoplanktons described in the unit are on the other hand; *Discoaster deflandrei* Bramlette and Riedel, *Coccolithus eopelagicus* (Bramlette and Riedel), *Cyclicargolithus abisectus* (Müller), *C. floridanus* (Roth and Hay), *Reticulofenestra hampdenensis* Edwards, *R. umbilica* (Levin), *R. reticulata* (Gartner and Smith), *R. hillae* Burky and Percival, *Zygrhablithus bijugatus* (Deflandre), *Lanternithus minutus* Stradner, *Ericsonia formosa* (Kamptner), *E. subdisticha* (Roth and Hay), *Cruciplacolithus tenuis* (Stradner), *Braarudosphaera bigelowi* (Gran and Braarud), *Helicosphaera perch-nielseniae* Haq, *H. euphratis* Haq, *H. obligua* Bramlette and Wilcoxon, *H. kamptneri* Hay and Mohler, *H. recta* Haq, *Coronocyclus nitescens* (Kamptner), *Dictyococcites bisectus* (Hay, Mohler and Wade), *Pontosphaera multipora* (Kamptner), *P. plana* (Bramlette and Sullivan), *Micrantholithus crenulatus* Bramlette and Sullivan, *Sphenolithus moriformis* (Brönnimann and Stradner), *S. predistentus* Bramlette

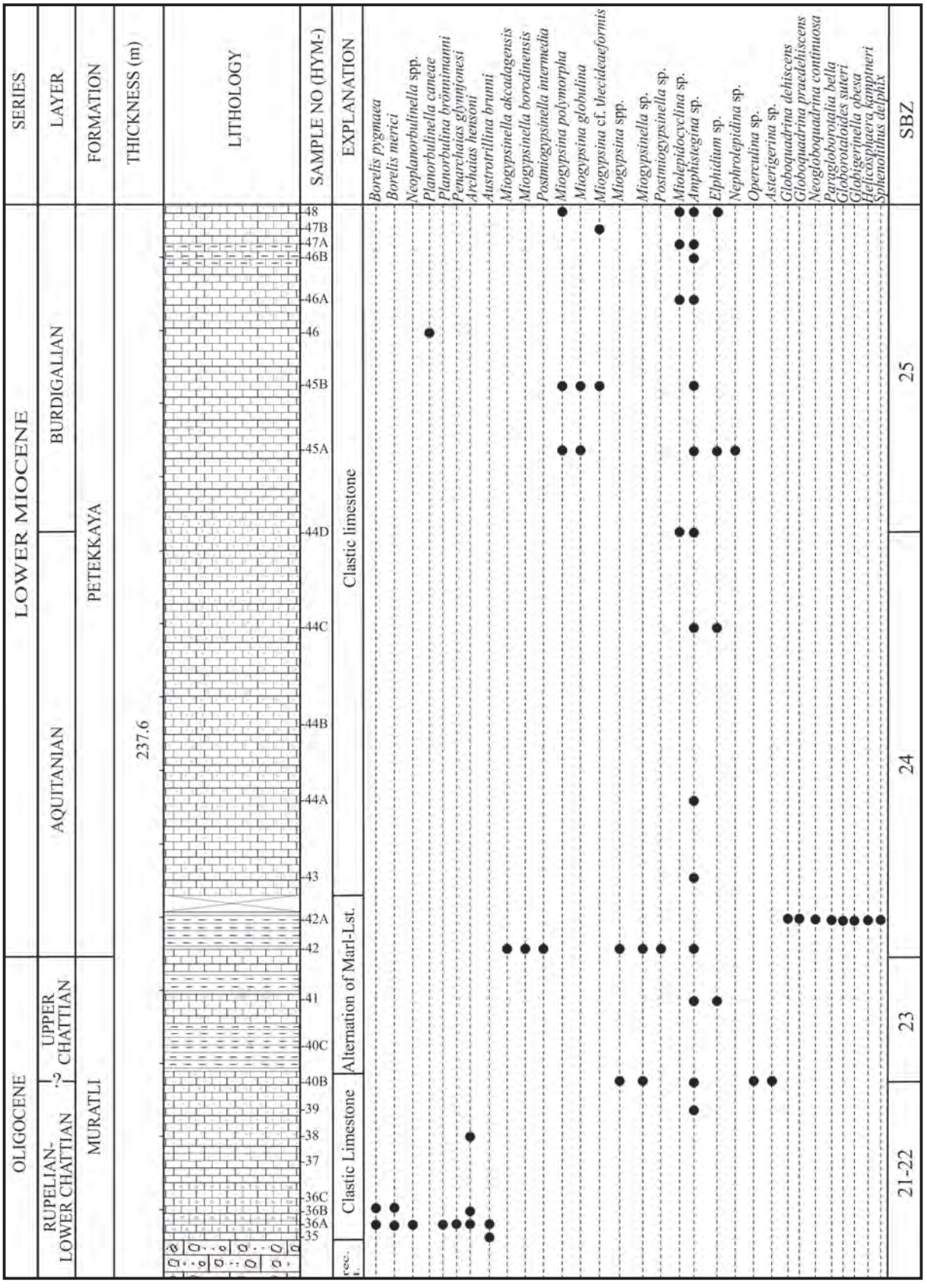

Figure 8- Stratigraphical distributions of larger benthic foraminifera, planktonic foraminifera and nannoplanktons detected in Karamağara measured stratigraphical section (NE Akçadağ, W Malatya).

and Wilcoxon, *S. distentus* (Martini), *S. delphix* Burky and *Sphenolithus* sp. The age of the unit according to planktic foraminifera and nannoplanktons are Early Miocene. The presence of typical planktic foraminiferal species *G. dehiscens* and nannoplankton species *S. delphix* indicate M1b and NN1-NN2 (Aquitanian) zones (Berggren et al., 1995). Then, thick covered area was passed and it was considered that marl-claystone deposition could occur in this area as well. The succession, starting from covered area to uppermost levels, is white colored, medium to thick bedded, much macro fossilliferous, chalky, with solution openings, sandy and clayey in places, and continues with the characteristic of reefal limestone and ends at 237.6th meter. Reefal limestones were fully traced in terms of benthic foraminifers such as; *Miogypsina globulina* (Michelotti), *M. polymorpha* (Rutten), *M.* cf. *thecideaeformis* (Rutten), *Planorbulinella caneae* Freudenthal, *Miogypsina* sp., *Miolepidocyclina* sp., *Heterostegina* sp., *Amphistegina* sp., *Asterigerina* sp., *Operculina* sp. and *Elphidium* sp. and of alga, bryozoa, coral and bivalves in all layers which is the characteristics for Burdigalian (HYM 43-48). These reefal limestones based on benthic foraminiferal taxa detected were accepted as the Burdigalian age and its equivalence is SBZ 25 in larger foraminiferal zonation.

4. Biostratigraphy

In order to carry out biostratigraphical study, first all paleontological data in sections were revealed and their stratigraphical distributions were traced as much as possible. All collected fossils were studied again considering their lithological and stratigraphical sequence and age intervals of sections were determined. While determining the age of sections stratigraphical sequence and characteristics of similar facies were used in cases when fossil data are insufficient or missing. Total of three larger benthic foraminiferal zones were detected in measured sections (Figure 9). The study of Cahuzac and Poignant (1997) was taken as a basis in the zonation of larger benthic foraminifer. Besides, it was benefited from the geological time table in which biozones of planktic foraminifera and nannoplanktons, and Mediterranean layers were explained ranging from Late Eocene to Late Miocene (Hardenbol et al., 1998).

Detected biozones are given below as;

4.1. SBZ 21-22 (Rupelian-Early Chattian)

The lower boundary of this biozone was drawn by the last occurance of Discocyclinides and a couple of *Nummulites* species (*N. retiatus*); whereas, the upper boundary was drawn by the first occurance of Lepidocyclinides (Cahuzac and Poignant, 1997). Investigators have divided this biozone into two parts as; SBZ-21 which corresponds to Early-Middle Rupelian which its lower boundary was drawn by the first occurance of *Nummulites vascus* and *Nummulites fichteli*, and SBZ-22 (22a, 22b) which corresponds to Late Rupelian-Early Chattian which its lower boundary was drawn by the first occurance of Lepidocyclinides. However; in this study *Nephrolepidina praemarginata* and *N. partita* which are the first representatives of Lepidocyclinid foraminifera, and *Nummulites* cf. *vascus* which draw the lower boundary of Rupelian with its first occurance were observed together in the Edilme measured stratigraphical section. And, in the Develi measured stratigraphical section, Lepidocyclinid foraminifera were observed at the bottom of Oligocene lithostratigraphical units. Similar finding was also observed in another comprehensive study carried out in east and southeast of Turkey (Sirel 2003; Hatay-Arabil Section; Elazığ-Karaman and Sarıbuğday Sections; Muş-Kelereşdere Section). As the first and last occurances of species mentioned in measured stratigraphical sections in the study region could not be traced sufficiently considering these findings, this biozone was described as SBZ 21-22.

SBZ 21-22 biozone is formed by the representatives of families of Soritid, Peneroplid, Miliolid and Austrotrillinid, and was determined by taxa of *Archaias kirkukensis*, *Austrotrillina asmariensis*, *A.brunni* and *Peneroplis* cf. *laevigatus*. Sirel (2003) defined similar foraminiferal assemblage in west of Malatya province between Priabonian with *Nummulites fabianii* and Late Chattian with *Miogypsinoides complanatus,* and dated as Rupelian-Early Chattian. Oligocene aged this foraminiferal assemblage with porcelain test was described in several previous studies carried out in regions belonging to Mediterranean Tethys (Iran, Iraq, Spain, Italy, Turkey) (Henson 1950, Grimsdale 1952, Hottinger 1963, Bignot 1972, Barbin and Bignot 1986, Sartorio and Ventruni 1988, Sirel 1996, Sirel et al., 2013).

SBZ 21-22 is characterized by *Nephrolepidina partita* and *N. praemarginata* species in shallow marine limestones of the Edilme measured stratigraphical section. Besides; these index species are accompanied by taxa of *Eulepidina* cf.

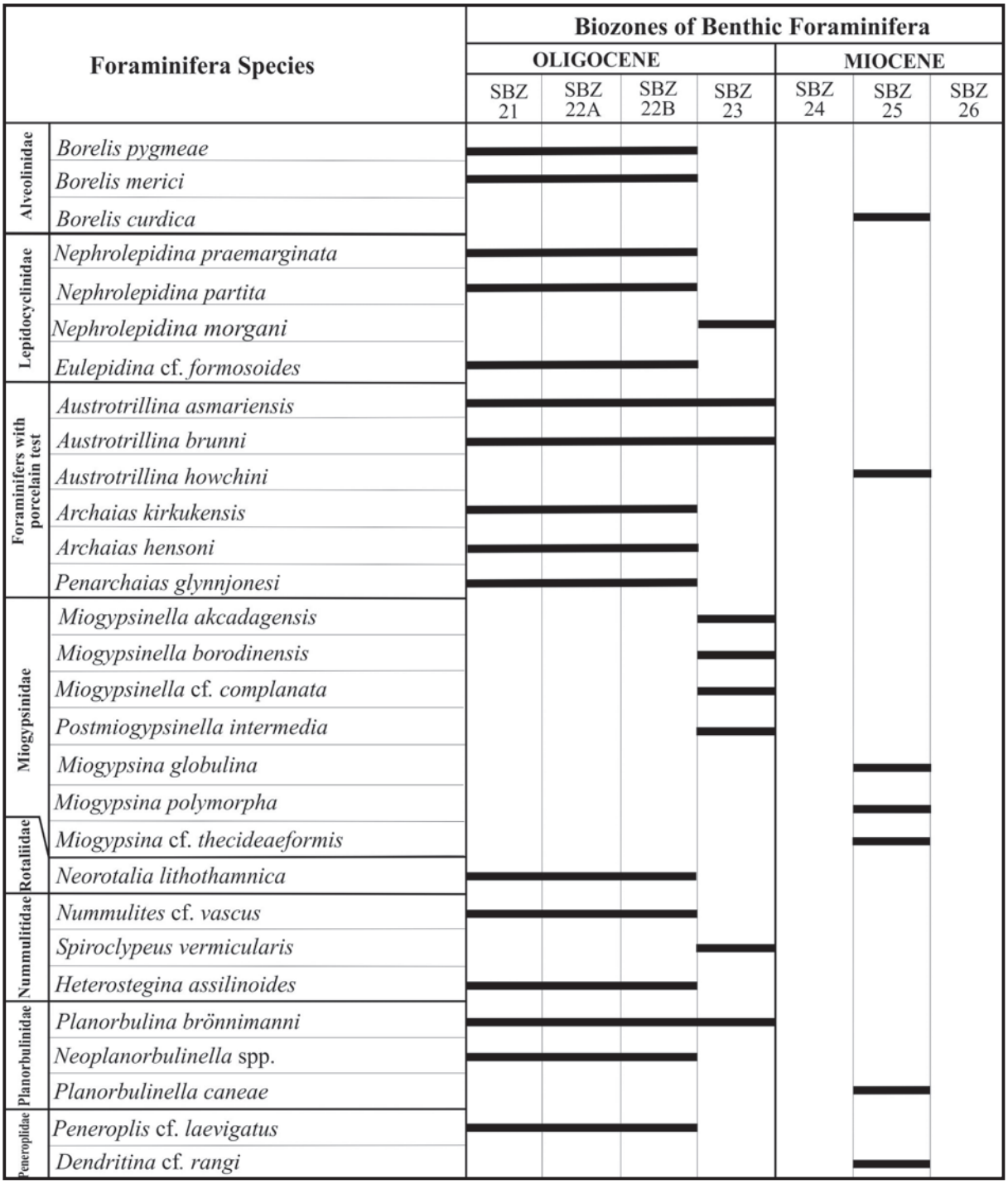

Figure 9- Stratigraphical distributions of larger benthic foraminiferal species in biozones of Oligocene-Lower Miocene.

formosoides, *Nummulites* cf. *vascus*, *Heterostegina assilinoides* and *Neorotalia lithothamnica*.

This biozone was discriminated by the presence of *Borelis pygmaea* and *Borelis merici* species in clastic limestones of the Karamağara measured stratigraphical section. These species are accompanied by taxa of *Archaias hensoni*, *Penarchaias glynnjonesi* and *Neoplanorbulinella* spp.

4.2. SBZ 23 (Late Chattian)

The lower and upper boundaries of this biozone were drawn by the first occurance of *Miogypsinoides* species and the first occurance of *Miogypsina*

gr. *gunteri*, respectively (Cahuzac and Poignant, 1997). Investigators have made the description of this biozone especially by taking the developments of *Miogypsinoides* species (*M. complanatus*, *M. borodinensis*, *M. formosoides* and *M. lateralis*) as basis. The development of Miogypsinid species were clearly seen in this study too.

Late Chattian SBZ 23 zone is characterized with the finding of *Miogypsinella akcadagensis*, *M. borodinensis* and *M.* cf. *complanata* together with *Nephrolepidina morgani* in shallow marine carbonates of the Edilme stratigraphical section and with the presence of *Miogypsinella akcadagensis* and *M. borodinensis* in Karamağara section. Moreover; accompany of *Postmiogypsinella intermedia* to index species is significant in the Karamağara measured stratigraphical section. SBZ 23 was also determined by the coexistence of miogypsinids (*Miogypsina basraensis*, *Miogypsinoides formosensis* and *M. sivasensis*) which occur in shallow marine carbonates and clastic rocks in Muş Kelereşdere section in eastern Turkey and *Nephrolepidina morgani* (Özcan et al., 2009).

4.3. SBZ 25 (Burdigalian)

The lower and upper boundaries of this biozone were drawn by the first occurance of *Miogypsina* gr. *globulina* and by the extinction of species belonging to genus *Miogypsina*, respectively (Cahuzac and Poignant, 1997).

In the study area, marls rich in planktic foraminifera and nannoplankton assemblages take place among layers of shallow marine limestone where larger benthic biozones of SBZ 23 (Late Chattian) and SBZ 25 (Burdigalian) are defined. This unit which is in different lithology does not contain any benthic foraminifer. However, considering both the presence of index planktic foraminifer species *G. dehiscens and S. delphix* in nannoplanktons which are defined in Develi and Karamağara Measured Stratigraphical Sections, and the presence of marls which are stratigraphically defined in the succession between the zones of SBZ-23 and SBZ-25 indicate that this marly unit indicates Aquitanian age.

5. Results

• Four stratigraphical sections were measured in the study area which covers Oligo-Miocene successions and; systematically, 182 hard rock samples were taken from these sections. As a result of paleontological studies, total of 28 taxa were defined belonging to Soritidae, Planorbulinidae, Peneroplidae, Austrotrillinidae, Alveolinidae, Lepidocyclinidae, Miogypsinidae and Nummulitidae families.

• In Oligocene shallow marine deposits, SBZ 21-22 biozone with species of *Archaias kirkukensis*, *A. hensoni*, *Penarchaias glynnjonesi*, *Borelis merici*, *B. pygmaea*, *Austrotrillina asmariensis*, *A. brunni*, *Peneroplis* cf. *laevigatus*, *Nephrolepidina praemarginata*, *N. partita*, *Eulepidina* cf. *formosoides*, *Nummulites* cf. *vascus*, *Heterostegina assilinoides*, *Neorotalia lithothamnica* and SBZ 23 biozone with speices of *Miogypsinella borodinensis*, *M.* cf. *complanata*, *Nephrolepidina morgani* and *Spiroclypeus vermicularis* were detected.

• As a result of biostratigraphical study of Miocene aged marine units, zone SBZ 25 was described, and limestones characterized by very shallow and shallow marine environments were characterized by the presence of *Borelis curdica*, *Dendritina* cf. *rangi, Austrotrillina howchini* and *Miogypsina globulina*, *M. polymorpha*, *M.* cf. *thecideaformis*, *Planorbulinella caneae* species, respectively.

• Biozones determined in the study area were correlated by Cahuzac and Poignant (1997) with larger benthic foraminifer zonation which was prepared for European Oligocene - Miocene. It was also seen that, biozones defined in the region had been in mainly compatible with European zonation.

• Based on biostratigraphical locations of benthic foraminiferal taxa defined in Develi, Edilme, Kuzkaya and Karamağara measured stratigraphical sections, Oligo – Miocene transition was observed in the region. Marine units ranging from Oligocene to Miocene exhibit the characteristic of uninterrupted succession in lithostratigraphically and biostratigraphically correlated sections. Paleontological findings also support this observation.

• Stratigraphically, Chattian - Burdigalian aged marls in the region consist assemblages of rich planktic foraminifer and nannoplankton assemblages. Considering both the presence of index planktic foraminifer species *G. dehiscens and S. delphix* in nannoplanktons which are defined in Develi and Karamağara measured stratigraphical sections, and the presence of marls which are stratigraphically defined within Late Chattian - Burdigalian aged shallow marine carbonate succession indicate that this

unit which is in different lithology indicates Aquitanian age.

• Cosmopolitan species *M. globulina* was observed in Burdigalian aged shallow marine carbonates in Kuzkaya and Karamağara measured stratigraphical sections, and was described over wide geographical regions ranging from Central America to Indo-Pacific and West (Mediterranean) Tethys. The co-existence of this species with *M. polymorpha* which is seen in stratigraphical records (only from Indo-Pacific) highly support the assumption of a probable marine connection between Indo-Pacific and Mediterranean Tethys in Burdigalian time in the region (Harzhauser et al., 2002; Reuter et al., 2009, Qom formation, Iran).

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PLATES

PLATE - 1

Figures 1-7: *Archaias kirkukensis* Henson

Rupelian- Early Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, X20

1: Equatorial section, A form (FGD-2A/11/1; Gedik 2014, plate 1, figure 3); 2: Equatorial section, A form, (FGD-2B/5/2; Gedik 2014, plate 1, figure 13); 3: Slightly tangential equatorial section, (FGD-2A/11/3; Gedik 2014, plate 1, figure 12); 4: Axial section, A form, (FGD-2A/4/5; Gedik 2014, plate 1, figure 14); 5: Axial section, A form,(FGD-2B/12/7; Gedik 2014, plate 1, figure 4); 6: Equatorial section, A form, (FGD-2A/7/2; Gedik 2014, plate 1, figure 6); 7: Equatorial section, A form, (FGD-2A/11/4; Gedik 2014, plate 1, figure 7).

Figures 8-9: ***Archaias hensoni*** Smout and Eames

Rupelian-Early Chattian, Karamağara measured stratigraphical section, NE Akçadağ, W Malatya, Eastern Turkey, X20.

8: Axial section, A form, (HYM-38/1; Gedik 2014, plate 2, figure 1); 9: Equatorial section, A form, (HYM-38/2/1; Gedik 2014, plate 2, figure 5).

Figures 10, 11: *Penarchaias glynnjonesi* (Henson)

Rupelian-Early Chattian, Karamağara measured stratigraphical section, NE Akçadağ, W Malatya, Eastern Turkey, X 40.

Axial section, A form, planispiral septa following the first septum and septa belonging to uniserial stage are seen, (HYM-36A; Gedik 2014, plate 2, figure 9), (HYM-36A/3; Gedik 2014, plate 2, figure 7).

Figures 12-16, 24, 29: *Austrotrillina asmariensis* Adams

Rupelian-Early Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, X 36.

12: Equatorial section, A form, (FGD-2B/8/1; Gedik 2014, plate 4, figure 3); 13: Slightly tilted equatorial section, (FGD-2A/3/13; Gedik 2014, plate 4, figure 7); 14: Equatorial section, B form, (FGD-2A/7/1; Gedik 2014, plate 4, figure 1); 15: Equatorial section, A form, (FGD-2A/3/8; Gedik 2014, plate 4, figure 12); 24: Equatorial section, A form, (FGD-2A/3/12; Gedik 2014, plate 4, figure 10); 29: Tilted equatorial section, A form, (FGD-2A/4/3).

16: Late Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 36.

Equatorial section, (FGM-29/1/6; Gedik 2014, plate 3, figure 25).

Figures 17, 18: Miliolid forms with agglutinated shells X 30, (FGD-6; FGD-7; Gedik 2014, plate 3, figure 6, 7).

Figure 19-23, 26, 27: *Austrotrillina brunni* Marie

Rupelian-Early Chattian, Develi and Karamağara measured stratigraphical sections, W Malatya, Eastern Turkey, X 36.

19, 20, 21, 23, 27: Equatorial section, (FGD-2B/7/1; Gedik 2014, plate 3, figure 14); (FGD-2B/13/3; Gedik 2014, plate 3, figure 15); (FGD-2B/12/1; Gedik 2014, plate 3, figure 20); (HYM-35/1/1; Gedik 2014, plate 3, figure 19); (FGD-2A/9/7; Gedik 2014, plate 3, figure 13).

Figure 22: Late Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 36.

Equatorial section, (FGM-29/7/2; Gedik 2014, plate 3, figure 5); 26: Tilted equatorial section, (HYM-36A/3/1; Gedik 2014, plate 3, figure 18).

Figure 25, 28: *Austrotrillina howchini* (Schlumberger)

Burdigalian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 36.

25: Non centered equatorial section, (FGM-52/2; Gedik 2014, plate 3, figure 24); 28: Tangential section showing subepidermal thick alveolarine structure, (FGM-52/1; Gedik 2014, plate 3, figure 17).

PLATE - 1

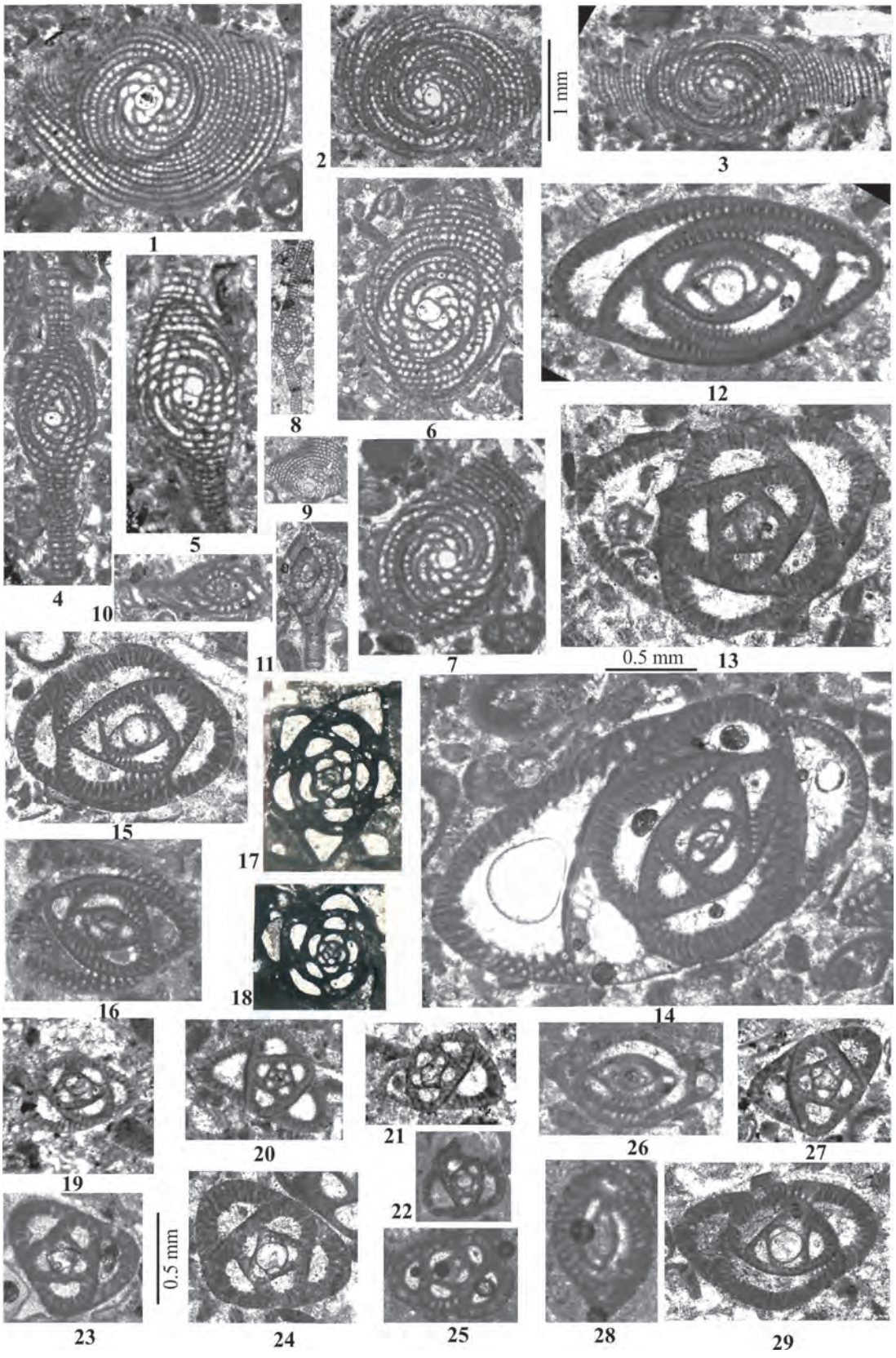
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PLATE - 2

Figure 1-8: *Borelis curdica* (Reichel)

Burdigalian, Develi, Edilme and Kuzkaya measured stratigraphical sections, W Malatya, Eastern Turkey, X 40.

1, 5: Equatorial section, (FGD-11/7/1; Gedik 2014, plate 5, figure 1); (FGK-25/3); 2, 3, 6, 7, 8: Axial section, (FGD-11/6/1; plate 5, figure 4); FGM-40A/1; FGK-23/1; FGK-25/11; FGM-43B/1); 4: Mature individual, axial section showing the aperture especially in the last whorl, (FGD-13B/1/1; Gedik 2014, plate 5, figure 5).

Figures 9, 10: *Borelis merici* Sirel

Rupelian-Early Chattian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey, X 60.

9: Non centered axial section, (HYM-36A/5/4; Gedik 2014, plate 3, figure 10); 10: Axial section, young individual, (HYM-36W/2; Gedik 2014, plate 3, figure 8).

Figure 19: *Borelis pygmaea* Hanzawa

Rupelian-Early Chattian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey, X 60.

Axial section, A form, (HYM-36A/1/1; Gedik 2014, plate 3, figure 11).

Figures 11, 13-15, 17, 21-23: *Planorbulina brönnimanni* Bignot and Decrouez

Oligosen, Develi, Karamağara and Edilme measured stratigraphical sections, W Malatya, Eastern Turkey, X35.

11, 15, 22: Oblique equatorial section, (MA-91; Gedik 2014, plate 2, figure 10); (MA-89; Gedik 2014, plate 2, figure 12); (MA-92; Gedik 2014, plate 2, figure 14); 13, 14, 17, 21: Sub axial section, (FGM-12D/1, FGM-2/1, FGM-4G/3, MA-90); 23: Oblique section, (MA-69; Gedik 2014, plate 2, figure 15).

Figures 12, 16, 18, 20: *Neoplanorbulinella* spp.

Rupelian-Early Chattian, Karamağara measured stratigraphical section, NE Akçadağ, W Malatya, Eastern Turkey, X 72.

12, 18, 20: Axial section, A form, (HYM-36A/11/1, HYM-36A/5/2, HYM-36A/3/2); 16: Axial section, B form, (HYM-36A/2/1; Gedik 2014, plate 2, figure 30).

PLATE - 2

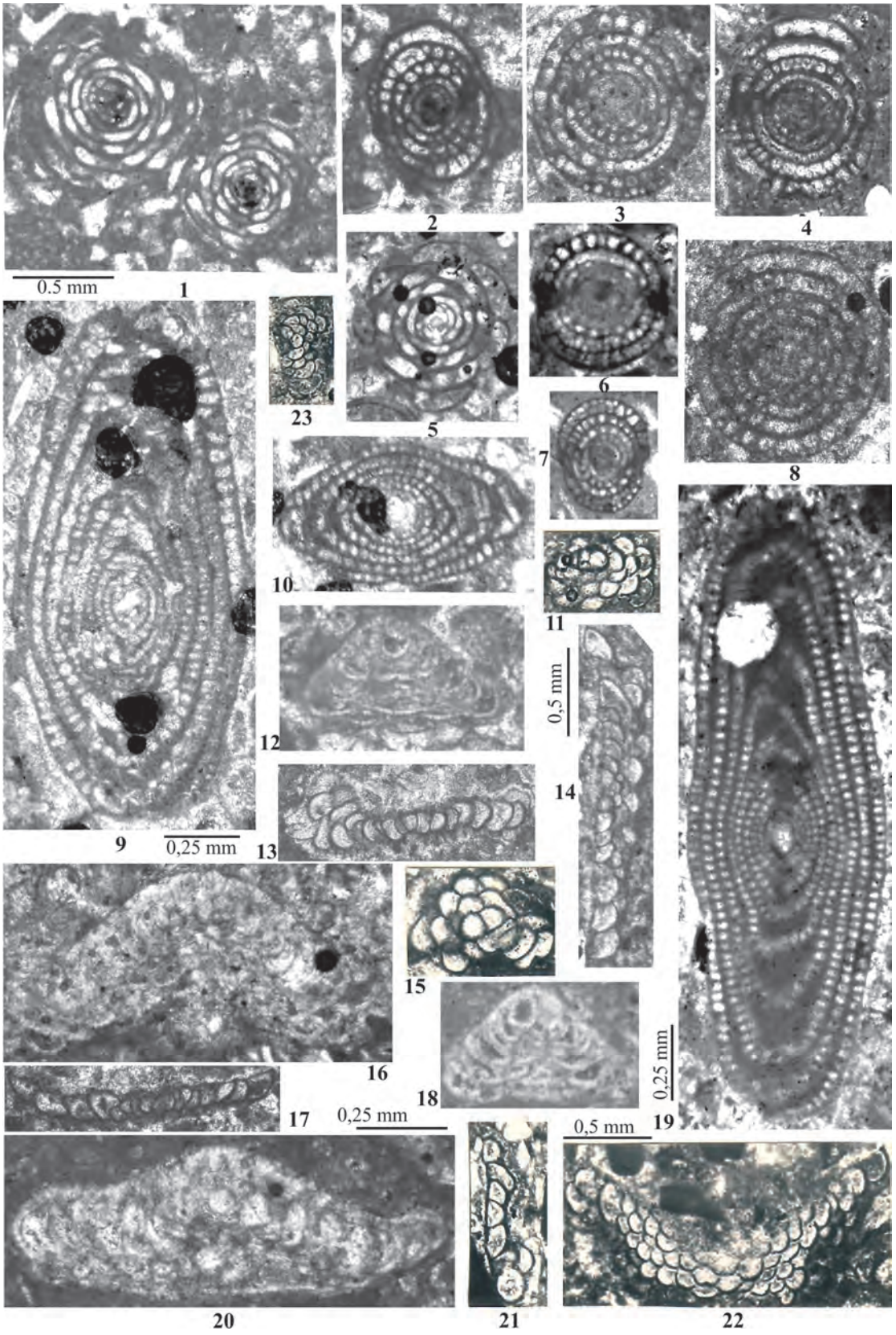
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PLATE - 3

Figures 1-5: *Nephrolepidina praemarginata* Douvillé

Rupelian-Early Chattian, Edilme and Develi measured stratigraphical sections, W Malatya, Eastern Turkey, all figures, X 30.

1, 3: Equatorial section, (FGM-19/3, FGD-2B); 2: Oblique equatorial section, (FGD-2B; Gedik 2014, plate 6, figure 4); 4: Axial section, (MA-88; Gedik 2014, plate 6, figure 10); 5: Oblique equatorial section, (FGM-19/4/1; Gedik 2014, plate 6, figure 2).

Figures 6, 7: *Nephrolepidina morgani* (Lemoine and Douvillé)

Late Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 30.

6: Equatorial section, (FGM-29/7/5; Sirel and Gedik 2011, plate 3, figure 8); 7: Axial section, (FGM-29/1/4; Sirel and Gedik 2011, plate 3, figure 9).

Figure 9: *Eulepidina cf. formosoides* Douvillé

Equatorial section, (FGM-19/11/1; Gedik 2014, plate 7, figure 10).

Figure 8: *Eulepidina sp.*

Axial section, (FGM-19/11/3; Gedik 2014, plate 7, figure 11).

Figure 10, 11: *Nephrolepidina partita* Douvillé

Rupelian-Early Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 30.

10: Equatorial section, tiny sphere like first septum and half-moon shaped second septum are seen, (FGM-19/27/4; Gedik 2014, plate 7, figure 9); 11: Axial section, large umbo at the center of the test is very clearly seen, (FGM-5E/6/1; Gedik 2014, plate 7, figure 2).

Figures 12-14: *Neorotalia lithothamnica* Uhlig

Rupelian-Early Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 50.

12: Equatorial section, (FGM-19/3/1; Gedik 2014, plate 12, figure 5); 13: Non centered equatorial section, (FGM-19/24/2; Gedik 2014, plate 12, figure 4); 14: Axial section, (FGM-19/25/1; Gedik 2014, plate 12, figure 7).

PLATE - 3

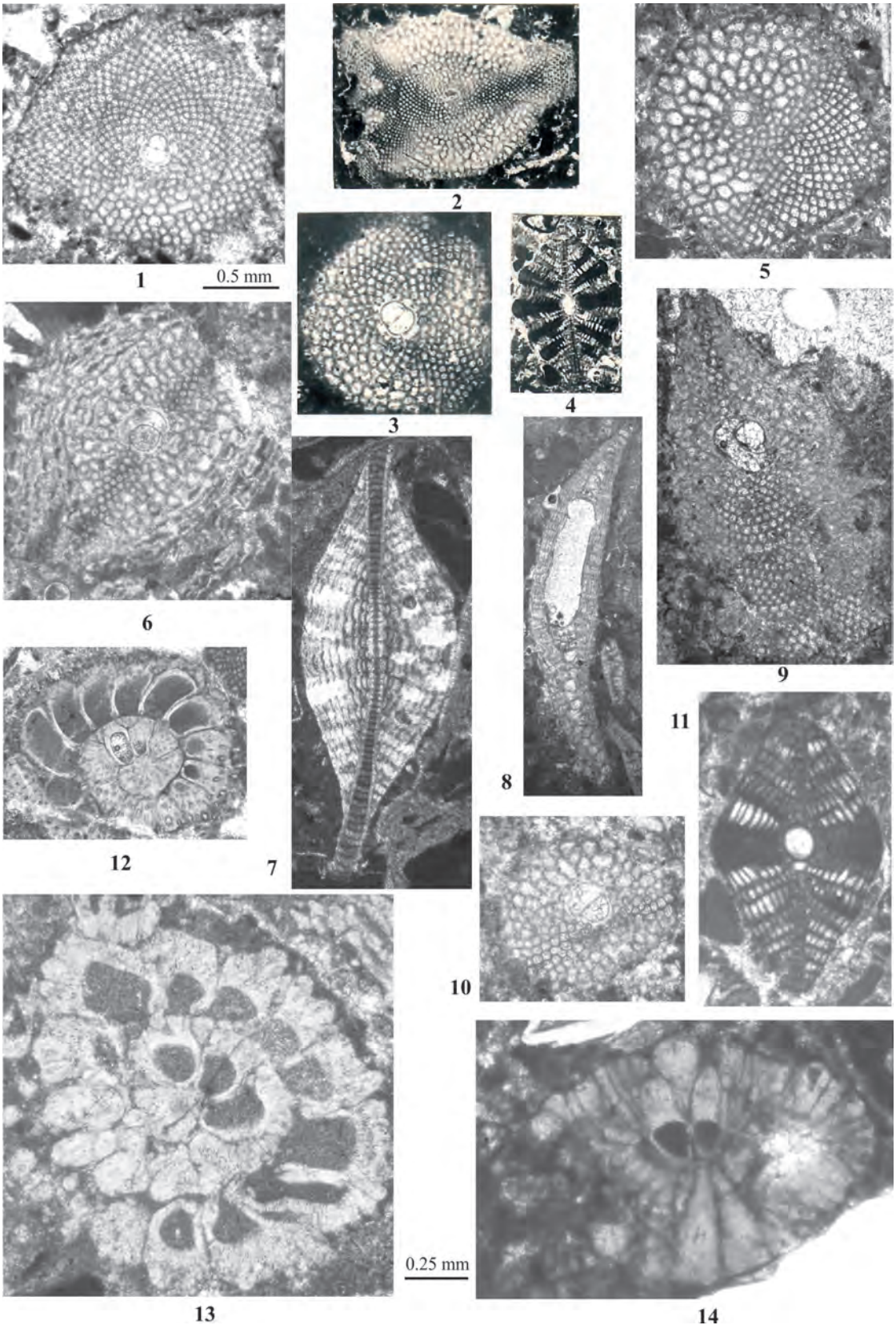


PLATE - 4

Late Chattian, Edilme and Karamağara measured stratigraphical sections, W Malatya, Eastern Turkey, X 60.

Figures 1, 2: *Miogypsinella borodinensis* Hanzawa

1: Equatorial section, showing embryonic chambers and spiral chambers (X=13) and miogypsinid equatorial chambers with basal stolons, (FGM-30A/6/3; Sirel and Gedik 2011, plate 2, figure 7); 2: Axial section, (FGM-30A/11/1; Sirel and Gedik 2011, plate 2, figure 6).

Figures 3, 4: *Miogypsinella akcadagensis* (Gedik and Sirel)

3: Equatorial section, (FGM-30A/3/1; Sirel and Gedik 2011, plate 2, figure 1), showing embryonic, spiral chambers of the rotaloid stage with X=9 (number of spiral chambers) and miogypsinid equatorial chambers, megalospheric form; 4: Axial section, (FGM-30A/5/2; Sirel and Gedik 2011, plate 2, figure 5).

Figures 5-9: *Postmiogypsinella intermedia* Sirel and Gedik

5, 7-9: Axial section, A form, (HYM-42/3/1; Sirel and Gedik 2011, plate 1, figure 5); (FGM-30A/3/2; Sirel and Gedik 2011, plate 1, figure 9); (FGM-30A/2/3; Sirel and Gedik 2011, plate 1, figure 6); (HYM-42/1/4; Sirel and Gedik 2011, plate 1, figure 7); 6: Equatorial section, (HYM-42/7/4; Sirel and Gedik 2011, plate 1, figure 12).

Figure 10: *Miogypsinella cf. complanata* (Schlumberger)

Axial section, A form, (FGM-30A/2/2; Sirel and Gedik 2011, plate 3, figure 1).

PLATE - 4

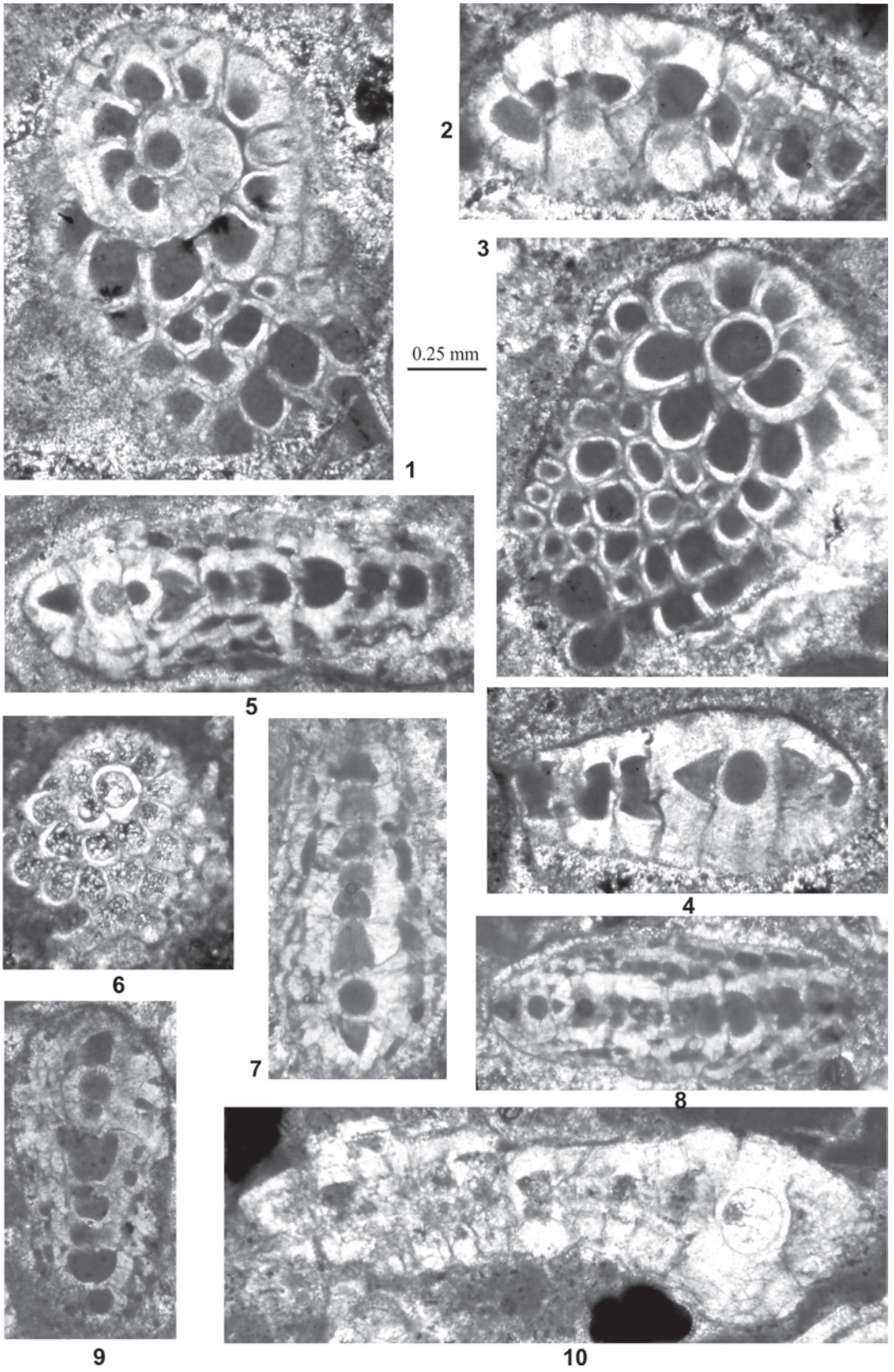


PLATE - 5

Burdigalian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey, X 60.

Figures 1, 2: *Miogypsina globulina* (Michelotti)

1: Equatorial section, (HYM-45A; Gedik 2014, plate 10, figure 1); 2: Axial section, (HYM-45A; Gedik 2014, plate 10, figure 2).

Figure 3, 4: *Miogypsina polymorpha* (Rutten)

3: Equatorial section, (HYM-48/1/1; Gedik 2014, plate 11, figure 3); 4: Axial section, (HYM-45A/1/2).

Figure 5: *Miogypsina cf. thecideaeformis* (Rutten)

Axial section, (HYM-45W; Gedik 2014, plate 9, figure 1).

PLATE - 5

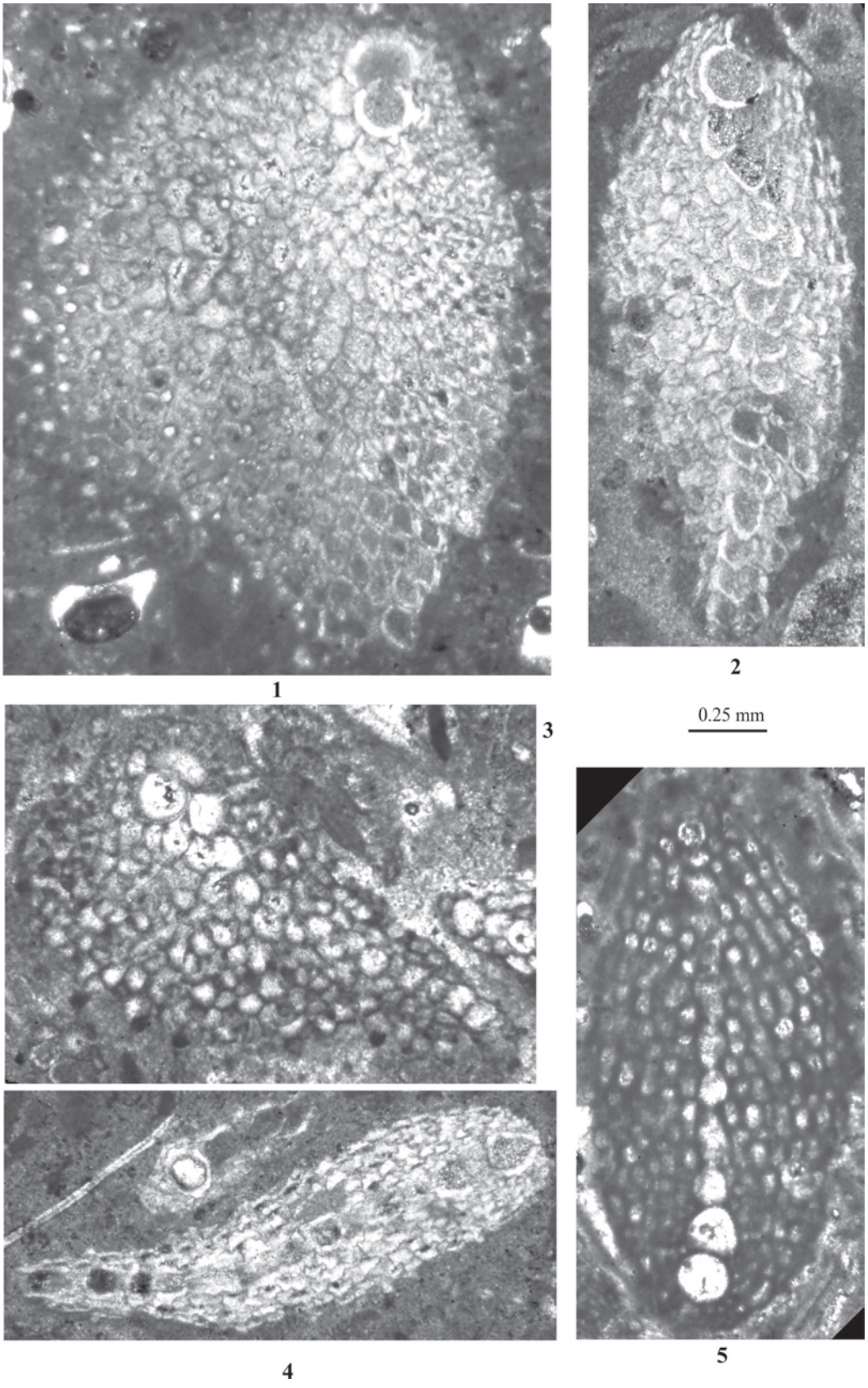


PLATE - 6

Figures 1, 2, 4: *Spiroclypeus vermicularis* Tan, 1937

Late Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, X 15.

1, 2: Equatorial section, A form, (FGD-7; Gedik 2014, plate 13, figure 1, figure 2).

4: Axial section, A form, (FGD-7; Gedik 2014, plate 13, figure 5).

Figures 3, 5: *Spiroclypeus* sp.

Oligocene, Develi and Edilme measured stratigraphical sections, W Malatya, Eastern Turkey, X 15.

Equatorial section, (FGD-6, FGM-18; Gedik 2014, plate 13, figure 3, figure 4).

Figure 6: *Planorbulinella caneae* Freudenthal

Burdigalian, Karamağara measured stratigraphical section, W Malatya, Eastern Turkey.

Equatorial section, (HYM-46; Gedik 2014, plate 9, figure 9).

Figures 7-10, 20: *Heterostegina assilinoides* Blanckenhorn, 1890 emend. Henson, 1937

Rupelian-Early Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 20.

7: Equatorial section, A form, (FGM-19/2); 8, 9, 10: Axial section, A form, (FGM-5W, FGM-4A, FGM-19); 20: Uncompleted equatorial section, A form, (FGM-19/8; Gedik 2014, plate 13, figure 10).

Figures 11, 12: *Peneroplis cf. laevigatus* d'Orbigny

Rupelian-Early Chattian, Develi measured stratigraphical section, W Malatya, Eastern Turkey, X 20.

Equatorial section, (FGD-2A, FGD-2B; Gedik 2014, plate 3, figure 3, figure 2).

Figure 13: *Peneroplis sp***.**

Equatorial section, X20, (FGD-2B; Gedik 2014, plate 3, figure 4).

Figures 14-16: *Nummulites cf. vascus* Joly and Leymerie

Rupelian-Early Chattian, Edilme measured stratigraphical section, W Malatya, Eastern Turkey, X 20.

14-16: Axial section, (FGM-5E/2/3, FGM-5E/5/5, FGM-5E/3/1; Gedik 2014, plate 13, figure 16, figure 19, figure 17).

Figures 17, 18: *Dendritina cf. rangi* d'Orbigny

Burdigalian, Develi measured stratigraphical sections, W Malatya, Eastern Turkey, X 40.

Equatorial section, (FGD-11/5/1, FGD-11/6/7; Gedik 2014, plate 9, figure 7, figure 8).

Figure 19: *Operculina sp.*

Equatorial section, (FGM-9B; Gedik 2014, plate 13, figure 20).

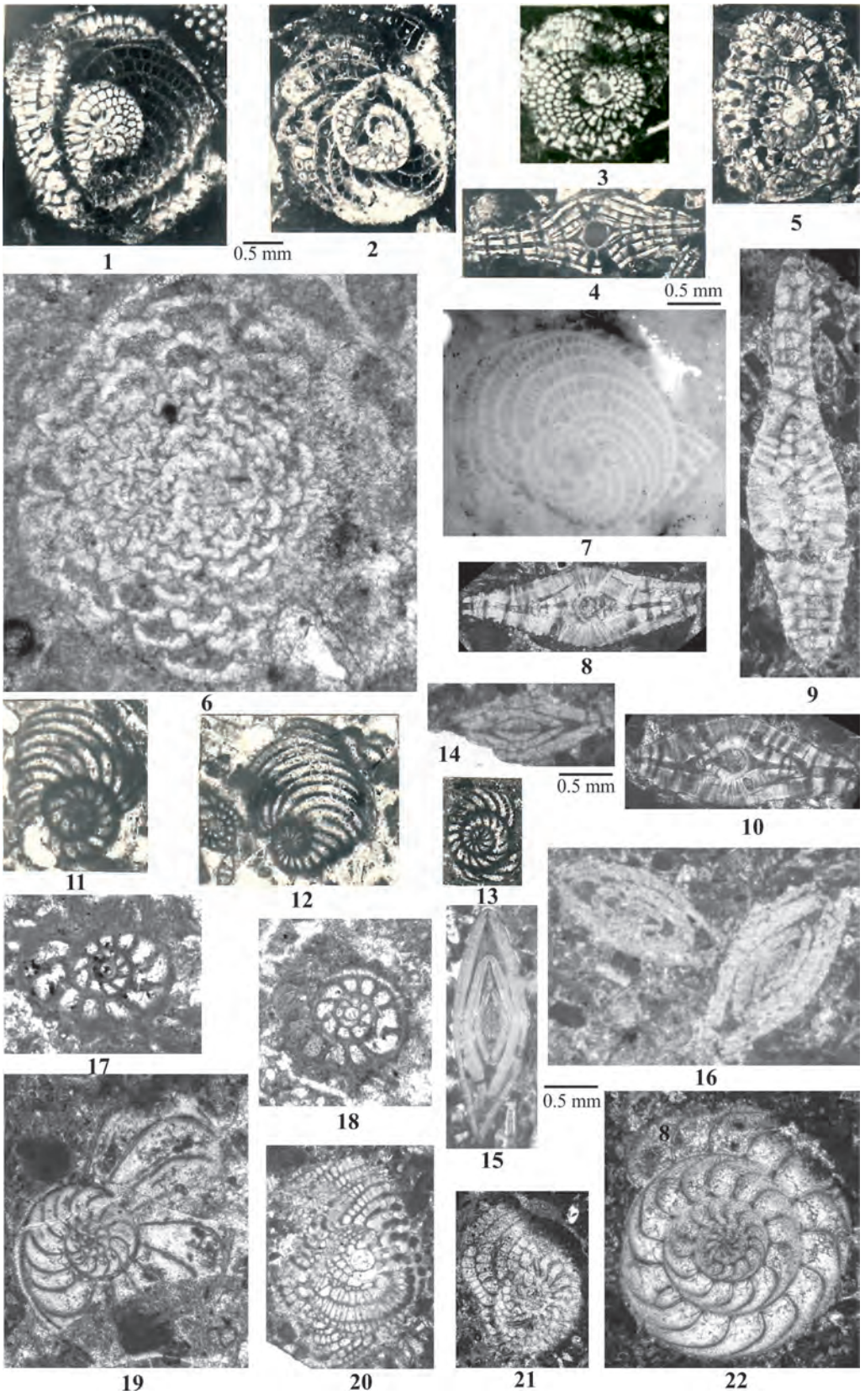
Figure 21: Nummulitidae (*Spiroclypeus ?/ Heterostegina ?* sp.)

Tilted equatorial section, (FGM-5W; Gedik 2014, plate 13, figure 11).

Figure 22: *Amphistegina sp.*

Equatorial section, (FGM-7A; Gedik 2014, plate 13, figure 21).

PLATE - 6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