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Selandian (Upper Paleocene) benthic foraminiferal assemblages and their stratigraphic ranges in the northeastern part of Turkey

Türkiye'nin kuzeydoğu kesiminde Selandiyen (Üst Paleosen) bentik foraminifer toplulukları ve stratigrafik dağılımları

Nurdan İNAN, Selim İNAN
Department of Geological Engineering, Mersin University, 33343 MERSİN, TURKEY

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ABSTRACT

In this study, benthic foraminiferal assemblages are determined in the Selandian shallow marine carbonate successions of the northeastern part of Turkey. In these assemblages the first appearance data of *Laffitteina erki* (Sirel), *Kathina selveri* Smout, *Rotalia trochidiformis* (Lamarck) and *Cuvillierina sireli* İnan are indicative of the lower boundary of the Selandian, but they also occur in the Thanetian. The local sratigraphical ranges of *Kayseriella decastroi* Sirel, *Ankaraella trochoidea* Sirel and *Thalmannita* sp. appear to be limited to the Selandian in the northeastern part of Turkey

Keywords: Benthic foraminifera, Selandian, Stratigraphic ranges, Upper Paleocene, northeastern Turkey.

ÖZ

Bu çalışmada,Türkiye'nin kuzeydoğu kesimindeki bazı sığ denizel karbonat istiflerinde Selandiyen'in bentik foraminifer toplulukları tesbit edilmiştir. Bu topluluklardan, Laffitteina erki (Sirel), Kathina selveri Smout, Rotalia trochidiformis (Lamarck) ve Cuvillierina sireli İnan'ın ilk bulunuşları Selandiyen'in alt sınırını belirler ve bunlar Tanesiyen'de de mevcutturlar. Kayseriella decastroi Sirel, Ankaraella trochoidea Sirel ve Thalmannita sp.'nin, Türkiye'nin kuzeydoğu kesimindeki yerel stratigrafik dağılımları ise, sadece Selandiyen'le sınırlıdır.

Anahtar Kelimeler: *Bentik foraminifera, Selandiyen, stratigrafik dağılım, Üst Paleosen, kuzeydoğu Türkiye.*

N. İnan
E-posta: ninan@mersin.edu.tr

INTRODUCTION

The Selandian, introduced by Rosenkrantz (1924) and emended by Perch-Nielsen and Hansen (1981), the type area which is near Copenhagen-Denmark, lies immediately above the Danian and is the middle stage of the Paleocene (Perch-Nielsen and Hansen, 1981; Berggren et al., 1985 and 1995).

The Paleogene stages were accepted by the International Subcomission on Paleogene Stratigraphy at the 28 th International Geological Congress in Washington, July, 1989. In this Congress, the Selandian was placed between the Danian and Thanetian Stages of the Paleocene (Jenkins and Luterbacher, 1992; Odin and Luterbacher, 1992). In the Geological Time Scale (1999) it is accepted as the basal stage of the Upper Paleocene.

Up to now, the Paleocene in Turkey was recognized either as a loose serie or stages such as Danian, Montian, Thanetian (İnan, 1993) or as Danian and Thanetian (Sirel, 1998), and so Selandian has not been used as a stage. In recent years, two studies in the Western Pontides (Özgen-Erdem et al., 2005) and Eastern Pontides (İnan et al., 2005) have presented information on facies, foraminiferal content and outcrops of the Selandian.

The Eastern Pontides (Ketin, 1966; Figure 1), which are bounded by the Black Sea to the north and by the Ankara-Erzincan suture to the south, belong to the "Pontide Orogenic Belt" or to the "Rhodope-Pontide Fragment" (Tüysüz, 1993). The northern arm of the Neo-Tethys locates between the Apulian and Rhodope microcontinents (Şengör, 1987). The stratigraphic and structural development of the Eastern Pontides was described in Robinson et al. (1995) and Yılmaz et al. (1997). The Tecer Mountain, which is located at eastern end of the Anatolides, belongs to the Eastern Pontides (İnan, 1996; İnan and İnan, 2002). İnan et al. (2005) described and illustrated microfacies and benthic foraminiferal assemblages from the Paleocene shallow-marine carbonate successions of the Eastern Pontides (NE Turkey).

The Western Pontides Selendian units, which conformably overlie the Danian sediments, consist of limestones, clayey limestones and sandy limestones. The Selandian units are defined by the first presence of *Pseudocuvillierina sireli* (İnan). Other foraminiferal taxa *Rotalia perovalis* Terquem, *Miscellanea* sp., *Anomalina* sp., *Eponides* sp., *Lenticulina* sp. and *Planorbulina* sp. have also been recognized at this level (Özgen-Erdem et al., 2005).

The purpose of this study is to describe microfacies and benthic foraminiferal assemblages of the Selandian shallow marine carbonate successions in the northeastern part of Turkey.

METHODS

Well exposed outcrop sections including the Selandian with characteristic fossils permit the litho, bio- and chronostratigraphic correlation between the Tecer Sections (Tecer Mountain-Sivas; İnan and İnan, 1987), Gölköy Section (Gölköy-Ordu; Meriç and İnan, 1998), Kuzulu section (Koyulhisar- Sivas; İnan et al., 2005) and Çalköy section (Düzköy- Trabzon; İnan et al., 1999) to be studied in detail. The main lithologies comprise massive to thick-bedded grey limestones, locally dolomitized and brecciated, with argillaceous and sandy intercalations (see Figure 1).

The fossil content of 56 thin-sections from these sections were analysed in this study with special emphasis on the benthic foraminiferal associations. A log of the Çalköy section and Körahmet section, measured at Düzköy- Trabzon (Figure 2) and Tecer Mountain (representative of the sections studied) is provided (Figure 3), and the important benthic foraminifera (Figure 4, Plates 1 and 2) from Tecer sections (Tecer- Sivas), Gölköy section (Gölköy- Ordu) , Kuzulu section (Koyulhisar-Sivas).

BENTHIC FORAMINIFERAL ASSEMBLAGES OF THE SELANDIAN

In the Çalköy section (see Figure 2) the Selandian starts with sandy limestones above the Danian which is represented by algal biosparites. The Danian benthic foraminiferal assemblages are characterized by the presence of the following taxa: *Planorbulina cretae* (Marsson), *Eponides* sp., *Mississippina* sp., *Globotextularia* sp., *Textularia* sp. , Miliolidae. The fossils of this lithology are intensively iron-oxided. This is interpreted here in as indication of an emergence period. The section continues with algal biosparites

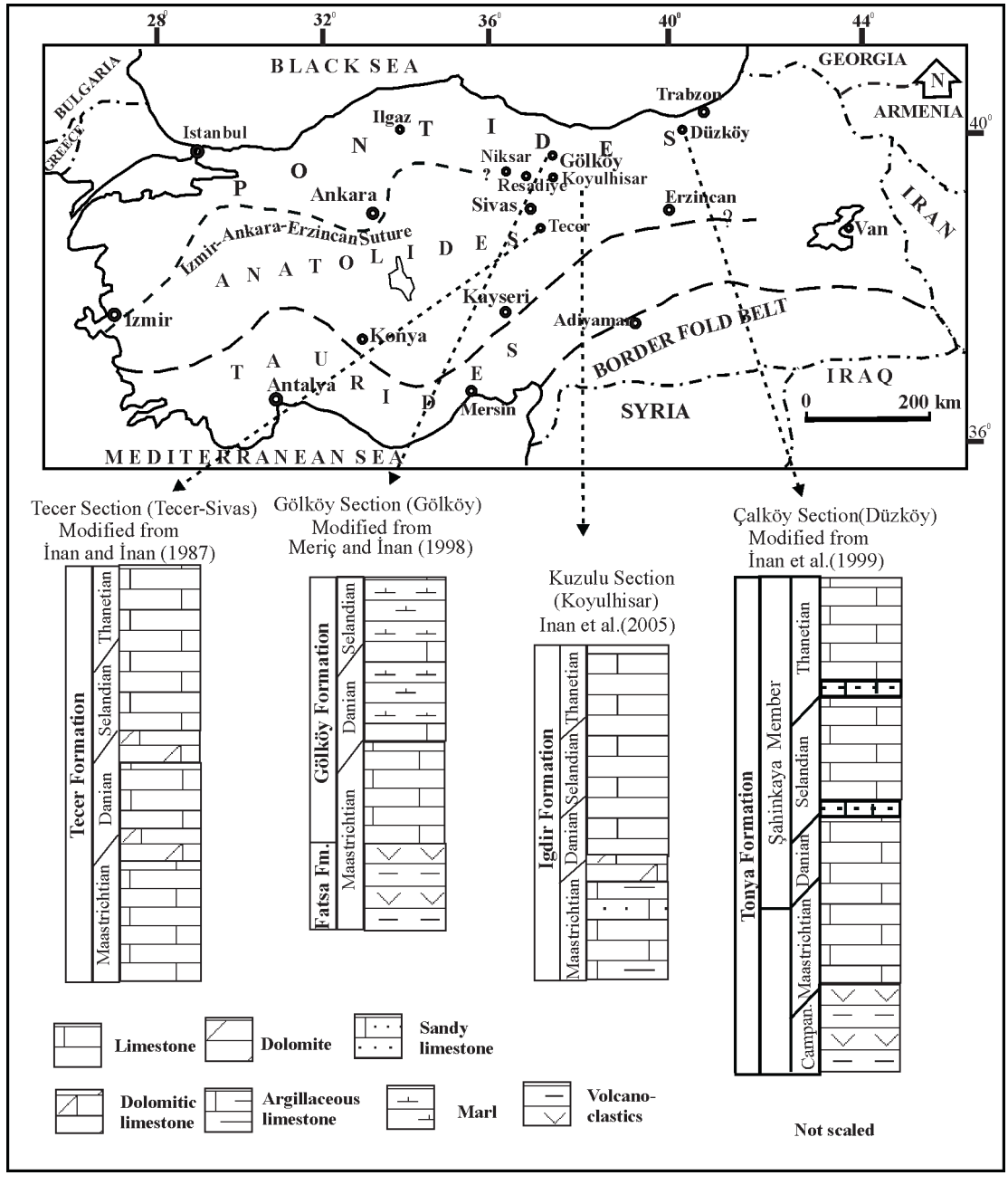

Figure 1. The measured section locations on the major tectonic units of Turkey (Ketin, 1966).
Şekil 1. Ölçülü kesit alınan yerlerin Türkiye'nin önemli tektonik birimleri üzerindeki konumu (Ketin, 1966).

representing reef environment and passes upward to the sandy limestones with iron of the Thanetian (İnan et al., 1999). The Thanetian units are defined by the first presence of *Coskinon rajkae* Hottinger and Drobne, *Miscellanea juliettae* Leppig and *Discocyclina seunesi* Douville. Other benthic foraminifera are represented by *Planorbulina cretae* (Marsson), *Rotalia trochidiformis* (Lamarck), *Rotalia perovalis* Terquem, *Kathina selveri* Smout, *Mississippina* sp., *Globotextularia* sp. and *Textularia* sp.

In the Çalköy section, the Selandian was deposited after an emergence period and lasted by an emergence period (İnan et al., 1999). It contains

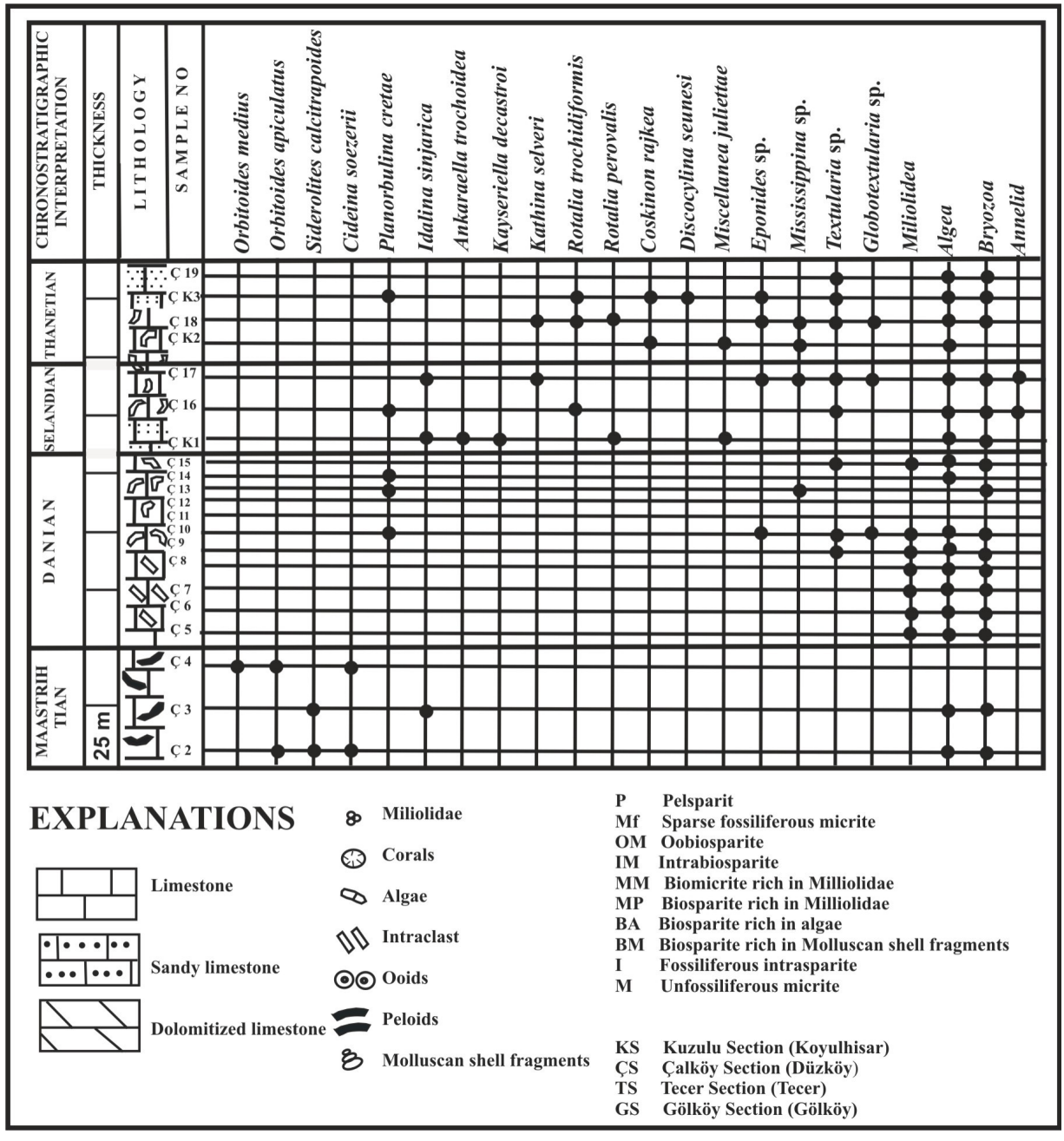

Figure 2. Stratigraphic distrubition of the benthic foraminifera identified from the Çalköy (Trabzon) section (modified from İnan et al., 1999).

Şekil 2. Çalköy kesitinde (Trabzon) belirlenen bentik foraminiferlerin stratigrafik dağılımı (İnan et al., 1999'dan değiştirilerek).

Idalina sinjarica Grimsdale, *Rotalia trochidiformis* (Lamarck), *Kathina selveri* Smout (Plate 2 C), *Rotalia perovalis* Terquem (Plate 2 D) and also continues into Thanetian. In this section, the local variations of *Kayseriella decastroi* Sirel and *Ankaraella trochoidea* Sirel seem to be limited to the Selandian (see Figure 2).

In the Kuzulu section (see Figure 1) the Selandian, overlying the dolosparites of the Danian, starts with biosparites rich in miliolids and ends with intraclasts and ooids-bearing levels, which are indication of a tidal environment (İnan et al., 2005). The Danian benthic foraminiferal assemblages are represented by the occurrence of

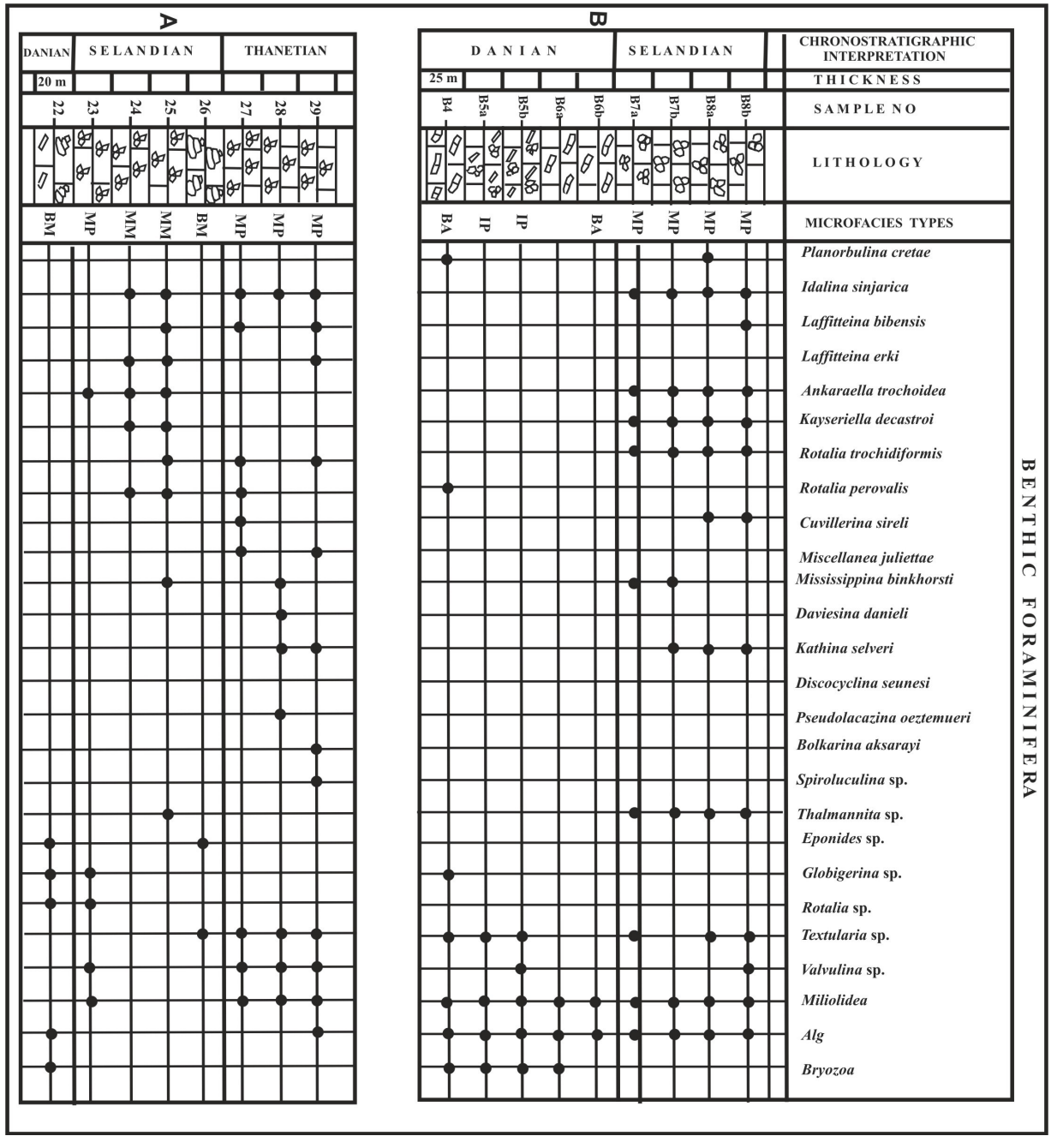

Figure 3. Stratigraphic distrubition of the benthic foraminifera identified from the Tecer (Tecer Mountains) sections (A- Körahmet section and B- Kabaktepe section. Modified from İnan and İnan, 1987, see Figure 2 for explanations).

Şekil 3. Tecer kesitinde (Tecer Dağları) belirlenen bentik foraminiferlerin stratigrafik dağılımı (A- Körahmet kesiti ve B- Kabaktepe kesiti, İnan ve İnan, 1987'den değiştirilerek, açıklamalar için Şekil 2'ye bakınız).

Idalina sinjarica Grimsdale, *Laffitteina bibensis* Marie, *Mississippina binkhorsti* Reuss, *Eponides* sp., *Textularia* sp., *Valvulina* sp., *Globigerinatheka* sp., *Globigerina* sp., Miliolidae. The Thanetian starts with peloids and intraclasts-bearing levels. The Thanetian units are defined by the first appearance of *Bolkarina aksarayi* Sirel, *Anatoliella ozalpiensis* Sirel. Other foraminiferal fauna, *Idalina sinjarica* Grimdale, *Laffitteina bibensis* Marie, *Laffitteina erki* (Sirel) and Miliolidae have

also been recognized at this level. In this section (İnan et al., 2005), the first occurence of *Laffitteina erki* (Sirel) is indicative of beginning of the Selandian which is represented by occurrence of *Ankaraella trochoidea* Sirel, *Kayseriella decastroi* Sirel and *Thalmannita* sp. Other foraminiferal fauna, *Idalina sinjarica* Grimsdale, *Laffitteina bibensis* Marie, *Eponides* sp., *Globigerina* sp., *Textularia* sp., *Valvulina* sp., Miliolidae.

In the Tecer sections (Körahmet and Kabaktepe sections), the Selandian overlies the Danian, which is represented by algal biosparites, and starts with miliolids, algae and bryozoa bearing biosparite rich in miliolidae, biomicrite rich in miliolidae and biosparite rich in molluscan shell fragments. In this sections (see Figure 3), the Selandian is represented by the occurence of *Ankaraella trochoidea* Sirel (see Plate 1 A-C), *Kayseriella decastroi* Sirel (see Plates 1, F – G), *Cuvillierina sireli* İnan (see Plate 2 I), *Idalina sinjarica* Grimsdale (see Plate 1 D-E), *Planorbulina cretae* (Marsson), *Laffitteina bibensis* Marie, *Laffitteina erki* (Sirel), *Kathina selveri* Smout, *Rotalia trochidiformis* (Lamarck), *Rotalia perovalis* Terquem, *Mississippina binkhorsti* Reuss (see Plate 1 J) and *Thalmannita* sp. (see Plate 2 K), *Valvulina* sp. (see Plate 2 H), *Spiroloculina* sp. (see Plate 1 H), *Pyrgo* sp. (see Plate 2 G), *Globigerinatheka* sp. (see Plate 2 J) and *Globigerina* sp. (see Plate 2 L). In this sections the Danian benthic foraminifera assemblage is characterized by the presence of the following taxa: *Planorbulina cretae* (Marsson), *Rotalia perovalis* Terquem, *Globigerina* sp., *Textularia* sp., *Valvulina* sp. and Miliolidae. The Thanetian units are defined by the first appearance of *Pseudolacazina oeztemueri* (Sirel), *Bolkarina aksarayi* Sirel. Other foraminiferal taxa are *Idalina sinjarica* Grimsdale, *Laffitteina bibensis* Marie, *Laffitteina erki* (Sirel), *Cuvillierina sireli* İnan, *Rotalia trochidiformis* (Lamarck), *Rotalia perovalis* Terquem, *Kathina selveri* Smout, *Daviesina danieli* Smout, *Mississippina binkhorsti* Reuss, *Textularia* sp. and Miliolidae (see Figure 3).

In the Gölköy section (see Figure 1), the Selandian overliying the Danien which is composed of miliolid-biosparites, is represented by miliolid-biomicrites (Meriç and İnan, 1998). In this section the Selandian starts with the first appearance of *Laffittteina erki* (Sirel) (see Plates 2 A-B), *Ankaraella trochoidea* Sirel and *Thalmannita* sp.. Other foraminiferal taxa are represented by *Idalina sinjarica* Grimsdale, *Laffitteina bibensis* Marie (see Plates 2 E-F), *Valvulina* sp., *Textularia* sp., *Anomalina* sp., *Quinqueloculina* sp. and Miliolidae. In these sections, the Danian benthic foraminiferal assemblage is characterized by the presence of the following taxa: *Idalina sinjarica* Grimsdale, *Rotalia perovalis* Terquem, *Eponides* sp., *Valvulina* sp., *Textularia* sp., *Anomalina* sp. , *Globigerina* sp., *Globigerinatheka* sp., *Quinqueloculina* sp. and Miliolidae.

The algae of the Selandian in the Eastern Pontides are represented by *Dactylopora bystrickyi* Dieni, Massari and Radoicic, *Neomeris (Neomeris) berouvalensis* Steinmann, *Cymopolia elongata* Munier and Chalmas, *Furcoporella* sp., *Archaelithothamnium* sp., *Lithophyllum* sp., *Goniopora* sp.

STRATIGRAPHIC RANGES AND COMPARISON WITH THE PROPOSED BIOZONATION OF THE TETHYAN SELANDIAN

Firstly, in SE Spain, oriental Betic Cordillera, Sierra Espuna area, an intermediate carbonated member contains benthic foraminifera such as *Cuvillierina sireli* İnan, *Miscellanea globularis* Rahaghi, *Planorbulina cretae* (Marsson), *Linaresia* sp., *Haddonia* sp., miliolids and textularids. Algae are represented by *Ethelia alba* Pfender, *Acicularia* sp., *Marinella* sp. In these levels, the presence of *Miscellanea globularis* Rahaghi and *Cuvillierina sireli* İnan indicates a Selandian age or SBZ 2 (Serra-Kiel et al., 1998a).

Afterwards, the SBZ 2 Selandian is defined by the biostratigraphic ranges of: *Miscellanea globularis* Rahaghi , *Ornatononion minutus* (Rahaghi), *Paralockhartia eos* Hottinger and Tambareau and *Lockhartia akbari* Hottinger and Tambareau in Serra-Kiel et al. (1998b). Also, stratigraphic distribution of some benthic foraminifers: agglutinated forms *Coskinon* n.sp., *Dictyoconus turriculus* Hottinger and Drobne; porcelaneous forms *Periloculina* n.sp., *Globoflarina sphaeroidea* (Fleury), *Pseudonumm sopadensis* Drobne, *Helenalveolina rahaghii* Drobne and hyaline forms; *Redmondina hennigtoni* Hasson, *Thalmannita madrigaensis* Cushman and Bermudez, *Cuvillierina sireli* İnan have been recognized as the Selandian.

In the Eastern Pontides, the occurences of hyalin forms *Cuvillierina sireli* İnan and *Thalmannita* sp. correspond to the SBZ 2. Hyaline forms *Laffitteina erki* (Sirel), porcelene forms *Kayseriella decastroi* Sirel and *Ankaraella trochoidea* Sirel represent endemic taxa in Turkey.

The Shallow Benthic Foraminiferal Zonal (SBZ) Scheme (Serra-Kiel et al., 1998b) proposed for the Tethyan Paleogene is tested on Eastern Pontian material. It can not be applied to the Paleocene in the Eastern Pontides due to the presence of the large number of endemic taxa and variable stratigraphic ranges of some benthic foraminifera.

Benthic foraminifera (see Plates 1 and 2) identified in the Selandian of the Eastern Pontides: *Planorbulina cretae* (Marsson), *Rotalia perovalis* Terquem (Figure 4), *Idalina sinjarica* Grimsdale, *Laffitteina bibensis* Marie, *Mississippina binkhorsti* Reuss, *Anomalina* sp., *Eponides* sp., *Gyroidina* sp., *Spiroloculina* sp., *Lenticulina* sp., *Globigerinatheka* sp., *Globigerina* sp., *Valvulina* sp. , *Globotextularia* sp., *Textularia* sp. also occur in the Danian and Thanetian (see Figure 4).

The first appearance of *Laffitteina erki* (Sirel), *Rotalia trochidiformis* Lamarck, *Kathina selveri* Smout and *Cuvillierina sireli* İnan is in Selandian and they range up into the Thanetian. The ranges of *Kayseriella decastroi* Sirel , *Ankaraella trochoidea* Sirel and *Thalmannita* sp. are restricted to the Selandian (see Figure 4).

In the Eastern Pontides, the faunal assemblages, lithologic and microfacies properties of the Selandian units point to the dominance of shallow marine environmental conditions in the region during this time period.

CONCLUSIONS

First occurences of *Laffitteina erki* (Sirel), *Kathina selveri* Smout, *Rotalia trochidiformis* (Lamarck) and *Cuvillierina sireli* İnan, indicate the lower boundary of the Selandian. Local stratigraphic ranges of *Kayseriella decastroi* Sirel*, Ankaraella trochoidea* Sirel and *Thalmannita sp.* are restricted to the Selandian in the shallow water Paleocene outcrops of the northeastern Turkey.

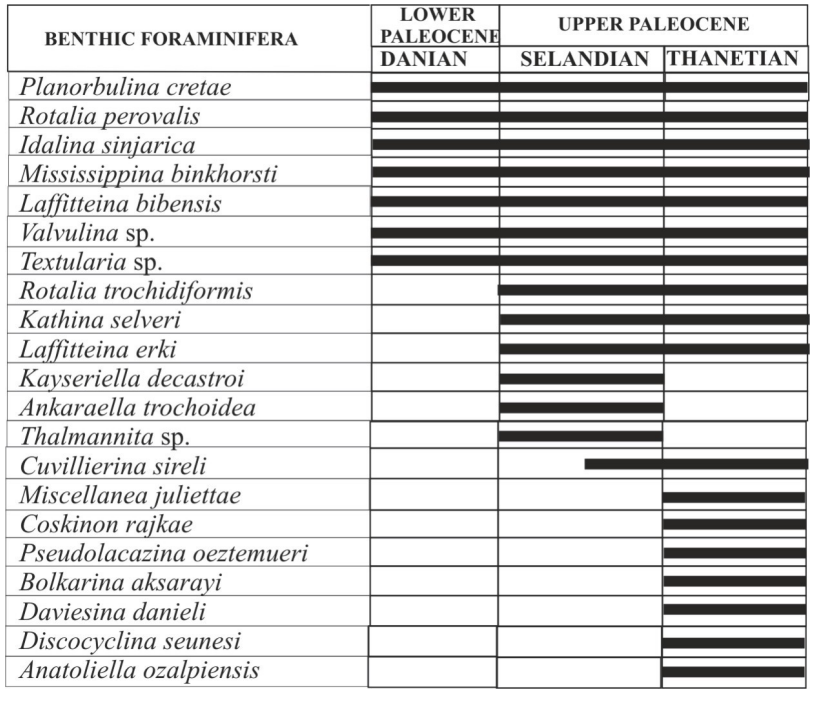

Figure 4. Composite stratigraphic distrubition chart of some Selandian benthic foraminifera of the shallow marine carbonate succession in the Eastern Pontides.
Şekil 4. Doğu Pontidlerde sığ denizel karbonat istiflerindeki Selandiyen bentik foraminferlerinin birleştirilmiş stratigrafik dağılım tablosu.

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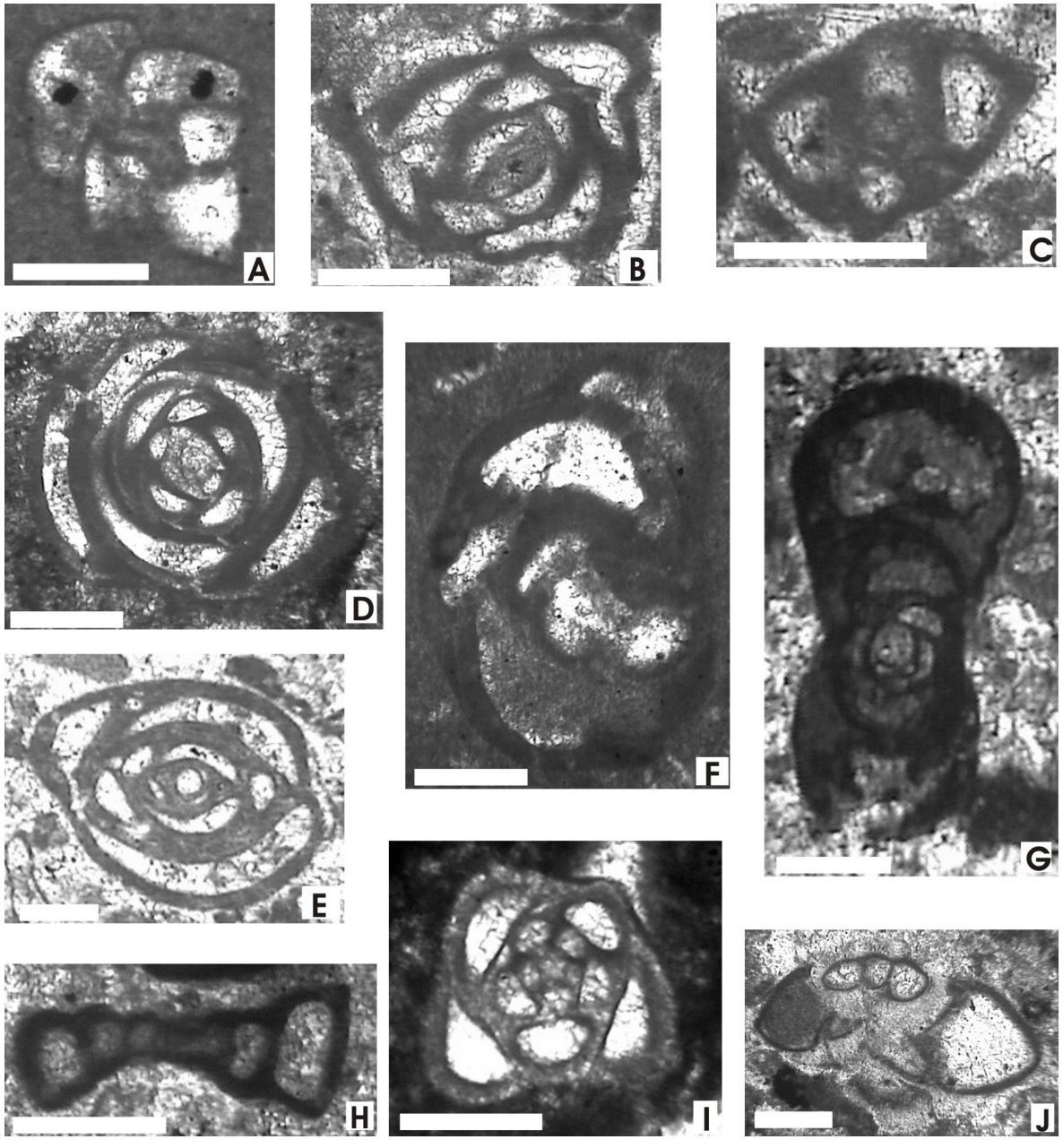

PLATE 1. Benthic foraminifera of the Selandian in the Eastern Pontides.(A-C) Ankaraella trochoidea Sirel, centered equatorial section, Tecer sections (Yalakkaya), C11b, equatorial section, Tecer sections (Körahmet), B8b, equatorial section , B7a. (D, E) Idalina sinjarica Grimsdale, oblique section, B13a, axial section, B7a, Tecer sections (Körahmet). (F, G) Kayseriella decastroi Sirel, subequatorial section, Tecer sections (Yalakkaya), C11b, axial section, Tecer sections (Harmanyeri), H1. (H) Spiroloculina sp., centered axial section, Tecer sections (Harmanyeri), H1. (I) Quinqueloculina sp., oblique section, Tecer sections (Körahmet), B 7a. (J) Mississippina binkhorsti Reuss, axial section, Tecer sections (Körahmet), B 7a.

LEVHA 1. *Doğu Pontidlerde Selandiyen bentik foraminiferleri: (A-C) Ankaraella trochoidea Sirel, merkezi ekvatoryal kesit, Tecer kesiti (Yalakkaya), C11b, ekvatoryal kesit, Tecer kesiti (Körahmet), B8b, ekvatoryal kesit , B7a. (D, E) Idalina sinjarica Grimsdale, merkezi kesit, B13a, eksenel kesit, B7a, Tecer kesiti (Körahmet). (F, G) Kayseriella decastroi Sirel, ekvatoryale paralel kesit, Tecer kesiti (Yalakkaya), C11b, eksenel kesit, Tecer kesiti (Harmanyeri), H1. (H) Spiroloculina sp., eksenel kesit, Tecer kesiti (Harmanyeri), H1. (I) Quinqueloculina sp., merkezi section, Tecer kesiti (Körahmet), B 7a. (J) Mississippina binkhorsti Reuss, eksenel kesit, Tecer kesiti (Körahmet), B 7a.*

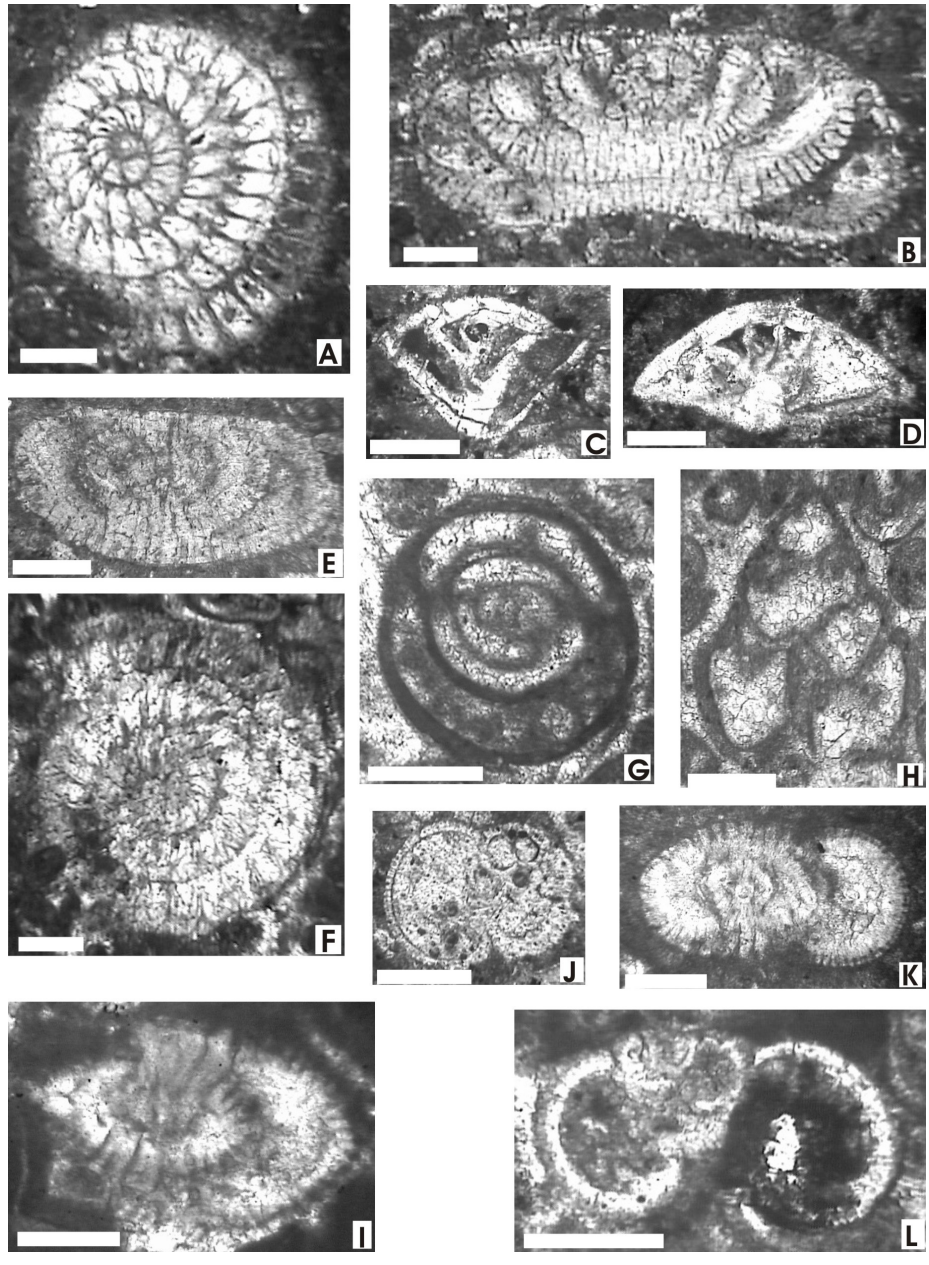

PLATE 2. Benthic and planthic foraminifera of the Selandian in the Eastern Pontides. (A, B) Laffitteina erki (Sirel), equatorial section, Gölköy section, Gk 10, axial section, Gölköy section, Gk 10, (C) Kathina selveri Smout, axial section, Çalköy section, Ç17 (D) Rotalia perovalis Terquem, axial section, Çalköy section, ÇK1. , (E, F) Laffitteina bibensis Marie axial section, Gölköy section, Gk10, equatorial section, Gölköy section, Gk10, (G) Pyrgo sp. axial section, Tecer sections (Körahmet), B 8b, (H) Valvulina sp., vertical section, Tecer sections (Körahmet), B8b. (I) Cuvillierina sireli İnan, axial section, Tecer sections (Körahmet), B 8a, (J) Globigerinatheka sp., axial section, Tecer section (Yalakkaya), C12b, (K) Thalmannita sp., Tecer sections (Körahmet), B 7b. (L) Globigerina sp., axial section, Tecer sections (Kabaktepe), 23.

LEVHA 2. *Doğu Pontidlerde Selandiyen bentik ve planktik foraminiferleri: (A, B) Laffitteina erki (Sirel), ekvatoryal kesit, Gölköy section, Gk 10, eksenel kesit, Gölköy section, Gk 10, (C) Kathina selveri Smout, eksenel kesit, Çalköy section, Ç17 (D) Rotalia perovalis Terquem, eksnel kesit, Çalköy kesiti, ÇK1. , (E, F) Laffitteina bibensis Marie eksenel kesit, Gölköy kesiti, Gk10, ekvatoryal kesit, Gölköy kesiti, Gk10, (G) Pyrgo sp. eksenel kesit, Tecer kesiti (Körahmet), B 8b, (H) Valvulina sp., boyuna kesit, Tecer kesiti (Körahmet), B8b. (I) Cuvillierina sireli İnan, eksenel kesit, Tecer kesiti (Körahmet), B 8a, (J) Globigerinatheka sp., eksenel kesit, Tecer kesiti (Yalakkaya), C12b, (K) Thalmannita sp., Tecer kesiti (Körahmet), B 7b. (L) Globigerina sp., eksenel kesit, Tecer kesiti (Kabaktepe), 23.*