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

Türkiye’nin kuzeydoğusunun kesiminde Selândiyan (Üst Paleosen) benthic foraminifer toplulukları ve stratigrafik dağılımları

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ABSTRACT
In this study, benthic foraminiferal assemblages are determined in the Selândian 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 Selândian, but they also occur in the Thanetian. The local stratigraphical ranges of *Kayseriella decastroi* Sirel, *Ankaraella trochoidea* Sirel and *Thalmannita* sp. appear to be limited to the Selândian in the northeastern part of Turkey.

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

ÖZ

Anahtar Kelimeler: Benthic foraminifera, Selândiyan, stratigrafik dağılım, Üst Paleosen, kuzeydoğu Türkiye.

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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, 1985 and 1995).

The Paleogene stages were accepted by the International Subcommission on Paleogene Stratigraphy at the 28th 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 Yilmaz 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 Selandian 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., Epiondes 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-oxidized. This is interpreted here in as indication of an emergence period. The section continues with algal biosparites
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...
Idalina sinjarica Grimsdale, Rotalia trochodiformis (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 decastri 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...

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**Figure 2. Stratigraphic distribution 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, 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 Grimsdale, Laffitteina bibensis Marie, Laffitteina erki (Sirel) and Miliolidae have
also been recognized at this level. In this section (İnan et al., 2005), the first occurrence 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 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., *Quinqueloculina* sp. and *Miliolidae*. 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*.

In the Gölköy section (see Figure 1), the Selandian 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 this section, 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 Dieri, Massari and Radoicic, *Neomeris* (Neomeris) berouvalensis Steinmann, *Cymopolia elongata* Munier and Chalmas, *Furcoporella* sp., *Archaelia*thothamnium* sp., *Lithophyllum* sp., *Goniopora* sp.

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

Firstly, in SE Spain, oriental Betic Cordillera, Sierria Espuna area, an intermediate carbonated member contains benthic foraminifera such as *Cuvillierina sireli* İnan, *Miscellanea globularis* Rahaghi, *Planorbulina cretae* (Marsson), *Linarasia* sp., *Haddonia* sp., *Miliolidae* and *Textularidae*. 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 Drobné; porcelaneous forms *Periloculina* n.sp., *Globoflarina sphaeroidea* (Fleury), *Pseudonummm sopadensis* Drobné, *Helenalveolina rahaghi* Drobné 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 occurrences 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 Selandelier 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 Selandelier and they range up into the Thanetian. The ranges of *Kayseriella decastroi* Sirel, *Ankaraella trochoidea* Sirel and *Thalmannita* sp. are restricted to the Selandelier (see Figure 4).

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

**CONCLUSIONS**

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

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<th>Benthic Foraminifera</th>
<th>Lower Paleocene</th>
<th>Upper Paleocene</th>
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<td><em>Planorbulina cretae</em></td>
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<td>Anatoliella ozalpiensis</td>
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Figure 4. Composite stratigraphic distribution chart of some Selandelier benthic foraminifera of the shallow marine carbonate succession in the Eastern Pontides.

Şekil 4. Doğu Pontidlerde sığ denizel karbonat istiflerindeki Selandelier bentik foraminferlerinin birleştirilmiş stratigrafik dağılım tablosu.
ACKNOWLEDGEMENTS

The authors thank Kemal Taslı (Mersin University, Turkey) for his critics and comments.

REFERENCES


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 ekvatoriyaal kesit, Tecer kesiti (Yalakkaya), C11b, ekvatoriyaal kesit, Tecer kesiti (Körahmet), B8b, ekvatoriyaal kesit, B7a. (D, E) Idalina sinjarica Grimsdale, merkezi kesit, B13a, eksenel kesit, B7a, Tecer kesiti (Körahmet). (F, G) Kayseriella decastroi Sirel, ekvatoriyaal 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 planthoric 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, eksenel 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.