DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

PALYNOLOGICAL INVESTIGATIONS AND FORAMINIFER CONTENTS OF THE EOCENE–MIOCENE DEPOSITS IN THE ÇARDAK–TOKÇA, BURDUR AND İNCESU AREAS, WESTERN ANATOLIA

by
Mehmet Serkan AKKİRAZ

August, 2008
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Ph.D. THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"PALYNOLOGICAL INVESTIGATIONS AND FORAMINIFER CONTENTS OF THE EOCENE–MIOCENE DEPOSITS IN THE ÇARDAK–TOKÇA, BURDUR AND İNCESU AREAS, WESTERN ANATOLIA"** completed by **MEHMET SERKAN AKKİRAZ** under supervision of **PROF. DR. FUNDA AKGÜN** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy.

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PALYNOLOGICAL INVESTIGATIONS AND FORAMINIFER CONTENTS OF THE EOCENE–MIOCENE DEPOSITS IN THE ÇARDAK–TOKÇA, BURDUR AND İNCESU AREAS, WESTERN ANATOLIA

ABSTRACT

This thesis explains the stratigraphical, palaeontological, palaeoenvironmental and palaeoclimatological significance of the Middle–Late Eocene Başçeşme (Çardak–Tokça Area) and Varsakyayla (Burdur Area) formations, the Early–"Middle" Oligocene Tokça (Çardak–Tokça Area) and İncesu (İncesu Area) formations and the Early Miocene Kavak and Aksu formations (Burdur Area). Many stratigraphical sections with various total thicknesses were measured from the Çardak–Tokça, Burdur and İncesu areas.

The coal–bearing Eocene sediments of the Çardak–Tokça and Burdur areas stratigraphically overlie the Lycian Nappes. The studied sequences are outcrops from the Başçeşme and Varsakyayla formations, which deposited in shallow marine to coastal environment without any stratigraphical break.

Diverse well–preserved palynomorph and foraminifer assemblages yield the Middle–Late Eocene age for the Başçeşme and Varsakyayla formations. In western Anatolia, mangrove elements *Spinizonocolpites* (*Nypa*) and *Psilatricolporites crassus* Van Der Hammen & Wymstra (*Pelliciera*) have been first recorded from these formations. The well–preserved foraminiferal data, along with corals, bivalves and gastropods, indicate that sedimentation ceased in the shallow–marine environment.

The Early–"Middle" Oligocene palynomorph and foraminifer assemblages have been obtained from the Tokça and İncesu formations. Palynological data indicate an Early–"Middle" Oligocene age for the Tokça and İncesu formations on the basis of abundance and presence stratigraphical marker species such as *Leiotriletes maxoides* Krutszsch ssp. m*aximus* (Pflug *in* Thomson & Pflug) Krutszsch, *Magnolipollis*

neogenicus ssp. *minor* Krutszsch, *Boehlensipollis hohli* Krutszsch, *Slowakipollis hippophaëoides* Krutszsch, *Triatriopollenites excelsus* (Potonié) Thomson & Pflug, *Plicapollis pseudoexcelsus* Krutszsch, *Plicatopollis hungaricus* Kedves, *Mediocolpopollis compactus* Krutszsch ssp. *ellenhausensis* Krutszsch, and *Caryapollenites simplex* (Potonié) Raatz ex Potonié. The presence of the dinoflagellate cysts in the samples indicates close proximity to a marine environment. The Early–"Middle" Oligocene age has also been proofed from benthic foraminifer assamblages obtained from the Üçtepeler reef member (Tokça Formation) and Delikarkası Formation (İncesu Area). The sediments of the Çardak–Tokça and İncesu areas were deposited during the Early–"Middle" Oligocene. Because of this, these sediments are older than the Thrace Basin and southwest Anatolian molasse basins (Kale–Tavas and Denizli molasse) which were deposited during the Late Oligocene–Early Miocene.

The Early Miocene palynomorph assemblages have been obtained from the Kavak and Aksu formations of the Burdur Area. The presence of *Leiotriletes maxoides* Krutszsch ssp. m*aximus* (Pflug *in* Thomson & Pflug) Krutszsch, *Dicolpopollis kockelii* Pflanzl, *Plicatopollis plicatus* (Potonié) Krutszsch, *P. hungaricus* Kedves and *Longapertites retipiliatus* Kar indicates an Aquitanian (Early Miocene) age. This age has been obtained from the marine foraminifers as well.

Within the scope of this thesis, on the basis of palynological and foraminifer data, palaeoenvironmental interpretations were made for the Middle–Late Eocene, Early–"Middle" Oligocene and Early Miocene. As a result, relying on these micropalaeontological data, marine regression and transgression for each age mentioned above were determined.

From the palaeoclimatic point of view, the mixture of temperate and tropical taxa indicating environments from the coast to the montane has been prevailed during the Middle–Late Eocene. The presence of warm Tethys waters permitted growing of the mangroves on western Anatolia during the Middle–Late Eocene.

The Early–“Middle” Oligocene continental temperature changes are documented by the record of the Tokça Formation (Çardak–Tokça Area) and İncesu Formation (İncesu Area) and indicate a cooling on the basis of palynological data and also isotopic works made by variours authors in the world.

An increase in the temperatures from the “Middle” Oligocene to Early Miocene is clear relying on the change of palaeoclimatic variations and increase in palaeotropical/arctotertiary ratio. The paleoclimatic data are consistent with isotopic works, too.

Keywords: Palynomorph, mangrove, foraminifer, palaeoclimate, palaeovegetation, Eocene, Oligocene

ÇARDAK-TOKÇA, BURDUR VE İNCESU ALANLARINDAKİ EOSEN-MİYOSEN TORTULLARININ PALİNOLOJİK İNCELEMELERİ VE FORAMİNİFER İÇERİKLERİ, BATI ANADOLU

ÖZ

Bu tez, Orta–Geç Eosen Başçeşme (Çardak–Tokça Alanı) ve Varsakyayla (Burdur Alanı) formasyonları, Erken–"Orta" Oligosen Tokça (Çardak–Tokça Alanı) ve İncesu (İncesu Alanı) formasyonları ve Erken Miyosen Kavak ve Aksu (Burdur Alanı) formasyonlarının stratigrafik, paleontolojik, paleoortamsal ve paleoiklimsel önemini açıklar. Çardak–Tokça, Burdur ve İncesu alanlarından çok sayıda farklı kalınlıklara sahip ölçülü kesitler alınmıştır.

Çardak–Tokça ve Burdur alanlarından kömürlü Eosen tortulları stratigrafik olarak Likya napları üstler. Çalışılan istifler, stratigrafik kesiklik olmaksızın, sığ deniz, kıyı ortamında çökelmiş Başçeşme ve Varsakyayla formasyonlarından yüzlekledir.

İyi korunmuş çeşitli palinomorf ve foraminifer toplulukları Başçeşme ve Varsakyayla formasyonlarının yaşını Orta–Geç Eosen olarak vermektedir. Batı Anadolu'da mangrove elementleri olan *Spinizonocolpites* (*Nypa*) ve *Psilatricolporites crassus* Van Der Hammen & Wymstra (*Pelliciera*) ilk kez bu formasyonlardan kaydedilmiştir. Mercan, bivalvia ve gastropodlu iyi korunmuş foraminifer verileri, tortulaşmanın sığ denizel ortamda son bulduğunu göstermektedir.

Erken–"Orta" Oligosen palinomorf ve foraminifer toplulukları Tokça ve İncesu formasyonlarından elde edilmiştir Palinolojik veriler, stratigrafik açıdan önemli olan *Leiotriletes maxoides* Krutszsch ssp. m*aximus* (Pflug *in* Thomson & Pflug) Krutszsch, *Magnolipollis neogenicus* ssp. *minor* Krutszsch, *Boehlensipollis hohli* Krutszsch, *Slowakipollis hippophaëoides* Krutszsch, *Triatriopollenites excelsus* (Potonié) Thomson & Pflug, *Plicapollis pseudoexcelsus* Krutszsch, *Plicatopollis hungaricus* Kedves, *Mediocolpopollis compactus* Krutszsch ssp. *ellenhausensis* Krutszsch, ve *Caryapollenites simplex* (Potonié) Raatz ex Potonié gibi türlerin

bolluğu ve varlığı dayanarak Erken–"Orta" Oligosen yaşını belirtmektedir. Örneklerdeki dinoflagelatların varlığı, denizel bir ortama yakınlığı tanımlamaktadır. Erken–"Orta" Oligosen yaşı, Üçtepeler resif üyesi (Tokça Formasyonu) ve Delikarkası Formasyonundan elde edilmiş olan bentik foraminifer topluluklarından da ispatlanmıştır. Çardak–Tokça and İncesu alanlarının tortulları, Erken–"Orta" Oligosen süresince çökelmiştir. Bu yüzden, Geç Oligosen–Erken Miyosen süresince çökelmiş olan Trakya ve güneybatı Anadolu molas havzalarından (Kale–Tavas ve Denizli molasları) daha yaşlıdır.

Erken Miyosen palinomorf toplulukları Kavak ve Aksu formasyonlarından elde edilmiştir. *Leiotriletes maxoides* Krutszsch ssp. m*aximus* (Pflug *in* Thomson & Pflug) Krutszsch, *Dicolpopollis kockelii* Pflanzl, *Plicatopollis plicatus* (Potonié) Krutszsch, *P. hungaricus* Kedves ve *Longapertites retipiliatus* Kar formlarının varlığı Akitaniyen (Erken Miyosen) yaşını tanımlamaktadır. Bu yaş aynı zamanda denizel foraminiferlerden de elde edilmiştir.

Bu tez kapsamında palinolojik ve foraminifer verilerine dayanarak Orta–Geç Eosen, Erken–"Orta" Oligosen ve Erken Miyosen için paleoortamsal yorumlamalar yapılmıştır. Sonuç olarak, bu mikropaleontolojik verilere dayalı yukarıda belirtilen her bir yaş için denizel transgresyon ve regresyonlar olduğu belirlenmiştir.

Paleoiklimsel açıdan, Orta–Geç Eosen süresince, kıyıdan dağ ortamını belirten ılıman ve tropikal taksanın karışımı ortaya çıkarılmıştır. Ilık Tetis sularının varlığı Orta–Geç Eosen süresince mangrov gelişimine izin vermiştir.

Erken–"Orta" Oligosen karasal iklimsel değişimleri, Tokça Formasyonu (Çardak–Tokça Alanı) ve İncesu Formasyonu (İncesu Alanı) elde edilmiştir ve palinolojik verilere ve dünyada farklı yazarlar tarafından yapılmış izotop çalışmalarına dayalı olarak bir soğumayı belirtmektedir.

Paleoiklimsel değişimler ve paleotropik/aktotersiyer oranındaki artışa başlı olarak, Orta Oligosen'den Erken Miyosen'e doğru bir sıcaklık artışı açıktır. Paleoiklimsel veriler izotop çalışmalarıyla da tutarlıdır.

Anahtar kelimeler: Palinomorf, mangrov, foraminifer, paleoiklim, paleovejetasyon, Eosen, Oligosen

CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Study Areas

The study areas include Tertiary sediments outcropping in different locations including an area between the north of Başçeşme Village, located northeastern part of Denizli city and Atabey town located on the northern part of Isparta city (Fig. 1. 1). These areas can be sequenced from west to east as the Çardak–Tokça, Burdur and İncesu areas.

The Çardak–Tokça Area is located on a wide area on the northern part of between Başçeşme village and Çardak town. The area is restricted to the north by Tokça village.

The Burdur Area is located on the wide area on the northern part of Lake Burdur. The study area is restricted by Başmakçı town in the west, by Lake Burdur in the south and by Aydoğmuş village in the north.

The İncesu Area include İncesu–İğdecik–Gümüşgün villages and Gönen–Atabey towns located to the north and northwest Isparta city in western Taurids, Lake District. Many sections have been measured from these Tertiary sediments.

The study areas can be reached by İzmir–Isparta highway. Small roads and well–stabilized gravel roads make transport easy to reach to towns and small villages located throughout the region.

1.2 Regional Geological Setting

The coal–bearing Tertiary areas outcropping in a wide area can be put into the following order from west to east: the Kale–Tavas, Denizli, Çardak–Tokça, Burdur, and İncesu, and northeast–southwest oriented areas which developed an imbricated basement, consisting of Mesozoic rocks of Lycian nappes, Bey Dağları Autochthon and Palaeocene–Eocene supra–allochthonus (Sözbilir, 2002) sediments. Lycian nappes and overlying supra–allochthonus sediments occupy a large area between Menderes Massif in the north and Bey Dağları in the east. Furthermore, the sediments belonging to Bey Dağları Autochthon are also observed around the area surrounding Isparta city.

The Palaeocene–Eocene supra–allochthonous sediments rest unconformably on the different tectonostratigraphic suites, such as the Lycian Nappes (Poisson, 1976; Özkaya, 1991; Şenel, 1991; Collins & Robertson, 1997, 1998, 1999), the Menderes Massif (Poisson, 1976; Özkaya, 1991; Özer et al. 2001), and the Bey Dağları carbonate platform (Özkaya, 1991; Collins & Robertson, 1998). The non–metamorphosed Palaeocene–Eocene supra–allochthonous sediments generally consist of turbiditic sandstone–mudstone alternations, coaly sandstones and mudstones, bioclastic and reefal limestone lenses, blocks of limestone and volcanic rocks. The supra–allochthonous sediments are separated from the basement rocks by a regional unconformity (Sözbilir, 2002).

On the other hand, tectonic development of the Oligocene and the Lower Miocene sediments which unconformably overlie the supra–allochthonous sediments, which has been interpreted regarded as the sediments piggy–back basins (Akgün et al., 2000; Sözbilir, 2002; Gürer & Yılmaz, 2002) or molasses basins (Koçyiğit, 1984; Göktaş et al., 1989; Yağmurlu, 1994; Akgün & Sözbilir, 2001; Sözbilir, 2005). These basins are accepted as sequences of continental and shallow marine sediments of transition between palaeotectonic and neotectonic periods in western Turkey (Koçyiğit, 1984). In these basins, sedimentary sequences are described by interdependence between tectonism and sedimentation, the latter of which involves fining–and coarsening–upward sedimentary cycles. In some places, the sequences include reefal limestones.

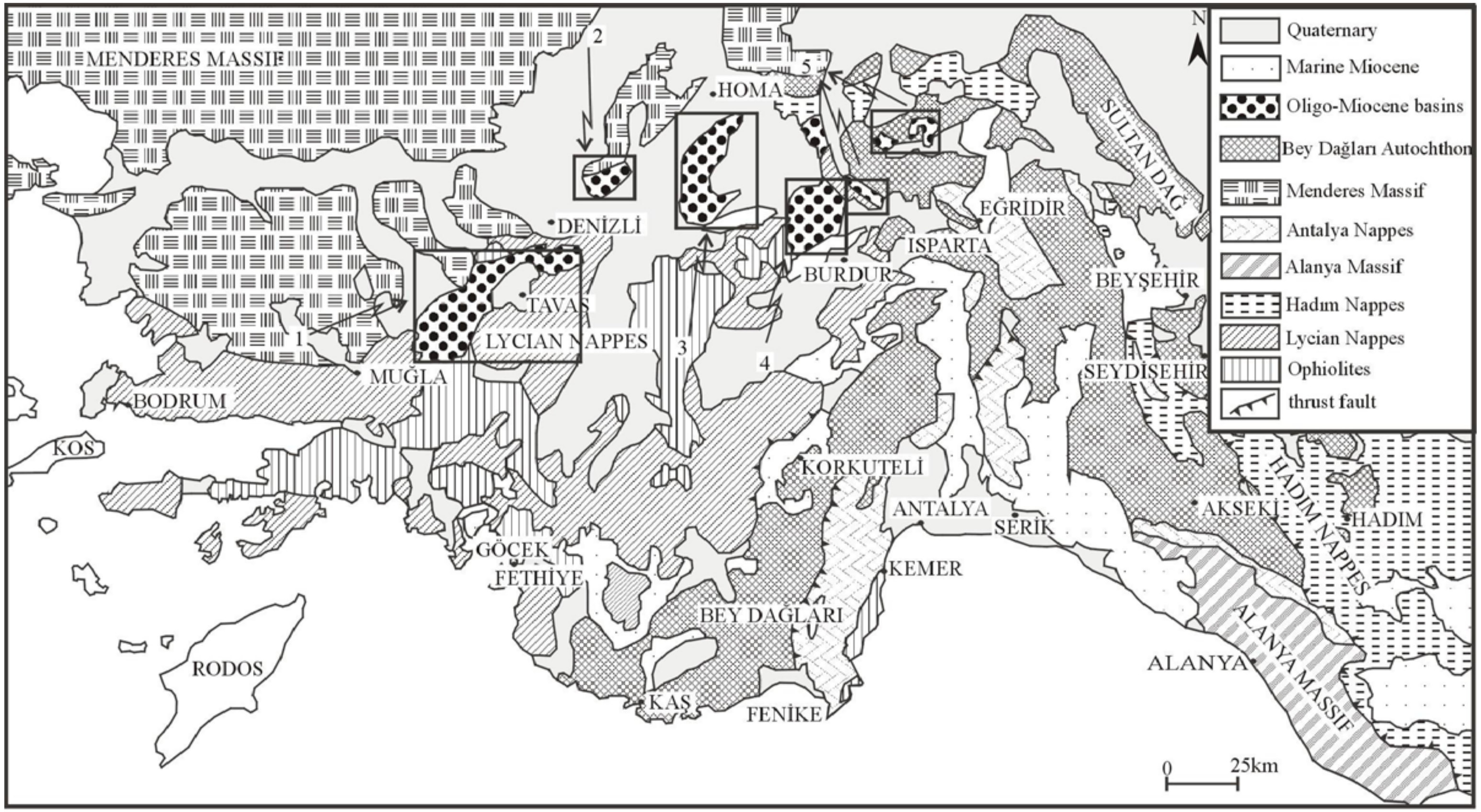


Figure 1.1 Simplified geological map of the Oligo-Miocene basins in SW Turkey showing five exposures of deposits.1) Kale-Tavas, 2) Denizli, 3) Çardak-Tokça, 4) Budur, 5) İncesu (modified from Gutnic, 1977; Akgün & Sözbilir, 2001).

1.3 Previous Studies

In this part, the sequences between Eocene and Miocene related with the studied areas have been prepared, and correlated with previous studies and herewith study.

Benda (1971a) and Benda & Meulenkamp (1990) studied the palynology of the coal-bearing Neogene sediments in southwest Anatolia, and separated seven palynological assemblages from bottom to top as Tokça, Kurbalık, Kale, Eskihisar, Yeni Eskihisar, Kızılhisar and Akça assemblages (Fig. 1. 2). According to Benda (1971a), Tokça sporomorph assemblage is Early Oligocene in age (Fig. 1. 2). However the number of the samples studied for the establishment of this sporomorph assemblage and also numerical data of relative frequencies of the individual taxon/or group of taxa were not given in his study. Instead, terms like "questionable", "single", "poor", "frequent" and "very frequent" were used in palynomorph distribution tables. The Chattian is represented by Kurbalık assemblage (Fig.1. 2).

The unpublished report of Göktaş et al. (1989) was the first comprehensive stratigraphic and palaeontological study of the Tertiary sediments of the Çardak–Tokça Area. The Başçeşme Formation was formerly subdivided into four members from bottom to top, the Dazlak, Beşparmak reef, Maden and Asar members. That study reported that the age of the Başçeşme Formation is Late Eocene (Priabonian) on the basis of unillustrated benthic foraminifers, mollusks and corals (Fig. 1. 2)

In the area, the Oligocene succession (Acıgöl Group) consists mainly of five major formations, from bottom to top Armutalanı, Çardak, Hayrettin, Tokça and Bozdağ formations (Fig. 1. 2). The coal–bearing Oligocene sediments are only represented by two major formations named as Hayrettin and Tokça. The authors suggested the "Middle"–Late Oligocene age for the Hayrettin Formation and the Late Oligocene age for the Tokça Formation on the basis of benthic foraminifers (Fig. 1. 2).

Şahbaz & Görmüş (1992) examined the stratigraphic and sedimentological properties of the conglomerates that crop out in the Çardak–Tokça Area, and recognized three different types of conglomerates belonging to the Eocene, Lower Oligocene and Oligocene, respectively (Fig. 1. 2).

Additionally, there are numerous studies on the Kale–Tavas and Denizli molasse basins to shed light on the stratigraphical and paleontological aspects of the stratigraphic sequences (Tchihatchef, 1869; Nebert, 1956; Becker–Platen, 1970; Luttig & Steffens, 1976; Gökçen, 1982; Hakyemez & Örçen, 1982; Hakyemez, 1989; Akgün & Sözbilir, 2001; Sözbilir, 2002; Gürer & Yılmaz, 2002; Sözbilir, 2005).

Gökçen (1982) suggested an Early Aquitanian age on the basis of ostracods and foraminifers of the N1 lithological zone, which was defined in the Yenişehir–Kale region.

Hakyemez & Örçen (1982) and Hakyemez (1989) studied the sediments between Mugla and Denizli and determined the age of the formation as the Late Oligocene based on the gastropods from the Mortuma Formation of the Kale–Tavas molasse Basin.

Recently, explanations of the tectonic setting and palynostratigraphy of the Kale–Tavas Basin have been presented by Yılmaz et al. (2000) and Akgün & Sözbilir (2001), respectively.

A detailed stratigraphical and palynostratigraphical study on the southwest Anatolian molasse basins (Kale–Tavas and Denizli molasse) was only made by Akgün & Sözbilir (2001) (Fig. 1. 2). The lowermost unit, the Karadere Formation is made up of alluvial-fan deposits with coal lenses. The same unit has previously been named as the Alanyurt Formation by Yılmaz et al. (2000). This unit unconformably overlies the Lycian Nappes and is conformably overlain by the Mortuma Formation (Fig. 1. 2), including braided and meandering river sediments with coal–bearing lagoonal sediments of Late Oligocene age (Hakyemez, 1989; Akgün & Sözbilir, 2001). The unconformably overlying Yenidere Formation is characterized by an extremely varied succession of terrestrial, limnic and marginal–marine deposits of Aquitanian age (Hakyemez, 1989).

From the palynological point of view, Akgün & Sözbilir (2001) distinguished two palynological assemblages. The first assemblage corresponds to the Late Oligocene and the second assemblage is the Early Miocene in age and it corresponds to Benda's Kurbalık assemblage (Fig. 1. 2). According to the authors, the molasse sedimentation in the Kale–Tavas and Denizli molasse basins took place in the Late Oligocene–Early Miocene time span (Fig. 1. 2).

Gürer & Yılmaz (2002) studied the geology of the Ören and surrounding areas, in SW Anatolia. According to the author, the Kale–Tavas Basin of Şengör & Yılmaz (1981) is the oldest basin of the region, and its sedimentary fill ranges from Upper Oligocene to Lower Miocene, as evidenced by gastropods, bivalves, palynomorphs and benthic foraminifers (Hakyemez, 1989; Akgün & Sözbilir, 2001). In the Oligocene and Early–Middle Miocene, the Kale–Tavas Basin fill consists of Gökçeören Formation, Akbük limestone, Gökbel conglomerates and Turgut Formation (Fig. 1. 2). On the other hand, the Ören Basin fill consists mainly of two rock units. The lower unit constitutes clastic rocks of Gökbel conglomerates. Upward in the succession, the conglomerates are replaced by sandstones of the Turgut Formation (Fig. 1. 2). The upper unit is a shale–marl–dominated, fine clastics succession having a number of lignite beds. The Sekköy Formation occurs at the top of the sequence (Fig. 1. 2).

Though numerous stratigraphical, palaeontological and tectonic studies have been made in Taurids so far, the studies made on Tertiary basins have been neglected or carried out by Mineral Research Exploration (M.T.A.) (Poisson, 1977; Yalçınkaya et al., 1986; Şenel, 1997a, 1997 b) (Fig. 1. 2).

Poisson (1977) studied in a wide area of Taurids and divided different Palaeogene and Neogene formations over the Lycian and Antalya nappes and Bey Dağları Authochthon.

Detailed stratigraphic study was made by Yalçınkaya et al. (1986) on the northern side of Lake Burdur, western Taurids. The basement rocks form serpentinized harzburgite, serpentine and gabbro indicating the tectonic melange and also olistostrome. Unconformably overlying Yavuzlar and Garipçe formations are mainly made up of neritic limestones and marls (Fig. 1. 2). The Hüyük Formation conformably overlies the Yavuzlar and Garipçe formations and consists of sandstone, mudstone alternation and neritic limestones.

In the area, Oligocene sedimentary succession (Acıgöl group) is made up of three major formations, from bottom to top, Küçükköy, Delikarkası and Ardıçlı formations (Fig. 1. 2). The Küçükköy Formation is laterally and vertically transitional with the Ardıçlı Formation and constitutes terrestrial sandstone, marl alternation. The Ardıçlı Formation is mainly made up of shallow marine conglomerates. Sandstones and mudstones also occur in the sequence. The Delikarkası Formation comprises the neritic nummulitic limestones.

The Oligocene sequence is unconformably overlain by the Aquitanian Atabey Formation that consists of reefal limestones. Unconformably overlying Burdigalian Ağlasun Formation includes black reefal limestone at the base, sandstone and mudstone alternation through the top.

Şenel (1997b) studied the geological properties surrounding Lake Burdur (Fig. 1. 2). According to the author, the Montian–Tanetian (Palaeocene) Mamatlar Formation occurs over the Lycian nappes and is mainly made up of algal limestones. The formation is unconformably overlain by the Lutetian?–Priabonian (Middle–Late Eocene) Varsakyayla Formation that consists of clastic and reefal limestones.

In the area, the Acıgöl group is made up of thick to massif conglomerates corresponding to the Ardıçlı Formation of Yalçınkaya et al. (1986), Delikarkası and Saraycık formations (Fig. 1. 2). The Saraycık Formation forms terrestrial sandstone and mudstone alternation. The Delikarkası Formation consists generally of medium to thick bedded reefal limestones, including shallow marine benthic foraminifers that indicate an Oligocene age.

The Aquitanian Kavak Formation that generally consists of reefal limestones comprising benthic foraminifer assemblage unconformably overlies the Acıgöl group. The unconformably overlying Aksu Formation is composed of conglomerates, and also sandstone and mudstone levels. The succession also includes gastropods, coral and bivalves.

Yağmurlu (1994) studied the tectono–sedimentary characteristics of the molasse type clastic sediments outcropping in northern Isparta, surrounding Gönen town, and divided it into two formations, from bottom to top, Kayıköy and İncesu formations (Fig. 1. 2). The Kayıköy Formation that is of turbiditic character is mainly composed of sandstone and shale alternation and also contains clayey and cherty interbeddings and conglomerate intercalations. The age of the formation is of Middle–Late Eocene on the basis of stratigraphic position of these sediments. The Oligocene İncesu Formation which consists mainly of medium to poorly sorted alluvial fan and fluvial deposits rests conformably on the Kayıköy Formation. Locally, muddy and blocky debris flows intercalations and coarsening upward sedimentary cycles occur in the Oligocene sequence.

Gutnic et al. (1979) searched the stratigraphical and tectonic aspects of tectonic units, located in northern Isparta. The Eocene flysch was described for the flysch sediments by the author (Fig. 1. 2). The Oligocene İncesu conglomerates, which are generally composed of coarse grained conglomerates, have unconformable boundary underlying Eocene flysch sediments.

Koçyiğit (1984) investigated tectono–stratigraphic characteristics of the Hoyran lake region (Isparta bend). At the base of the Lutetian Dereköy Formation, it has both laterally and vertically transitional Yukarıtırtır Formation which is mainly composed of shallow and deep marine carbonates. The most predominantly lithology comprising flysch facies that form coarse to fine grained sandstones including benthic foraminifer assemblage, indicates Lutetian. At the top of the formation, it has diverse boundary relations with older and younger units. For example, it is overthrusted by the internal Taurus ophiolitic melange (Fig. 1. 2), disconformity with the İncesu Formation and vertical passages the Almacık Formation that is made up of reefal limestone including benthic foraminifer assemblage which indicates a Priabonian (Late Eocene) age.

The İncesu Formation is mainly represented by a conglomerate that is of post orogenic molasse character. According to the author, the sediments of the formation seemed to be a limestone on account of calcite cement, and they were named as the Şablalı member, when its other parts are named as the Akçaköy member (Fig. 1. 2). The formation includes well–rounded Lutetian pebbles derived from the Dereköy Formation. Though the İncesu Formation is mostly sandy and lime cemented conglomerates, it also comprises of clay and marl including coal lenses. Researcher indicates the Early–“Middle” Oligocene age on the basis of benthic foraminifer assemblage (Fig. 1. 2). The succession is truncated by the Upper Miocene–Pliocene volcanics named as the Zendevi member of the Kızılcık Formation (Fig. 1. 2). The member is mainly made up of trachytes.

Sarıiz (1985) studied the geology of Keçiborlu surrounding, and distinguished the Eocene Dinar member and Isparta Formation (Fig. 1. 2). The Oligocene İncesu Formation rests over these units.

Karaman et al. (1989) investigated the geology of an area between Gönen and Atabey towns. The Lower–Middle Eocene flysch–like sediments were determined as the Kayıköy Formation. According to the authors, the Middle–Late Eocene Havdan member is generally made up of sandstones and the Delikarkası member that includes reefal limestones concordantly overlie the Kayıköy Formation (Fig. 1. 2). The relationship between Havdan and Delikarkası members is laterally and vertically transitional.

Aşık (1992) investigated the geology of an area surrounding Gümüşgün, Gönen and Atabey towns, located in north to northwest Isparta. Researcher distinguished the flysch–like sediments as the Kayıköy Formation which is truncated by volcanics named as the Baltaşı trachyandesite member (Fig. 1. 2). The Kayıköy Formation is covered by the moderately to poor sorted Oligocene Gönen conglomerates.

Görmüş & Özkul (1995) studied the stratigraphy of the area between Gönen–Atabey (Isparta) and Ağlasun (Burdur). According to the authors, the Middle Eocene Isparta flysch conformably overlies the pre–Eocene basement called the Koçtepe Formation. The sequence is generally composed of claystone, siltstone, sandstone and conglomerate alternation. Benthic and planktonic foraminifer assemblages obtained indicate the early–middle Lutetian. The Isparta flysch is laterally and vertically transitional with the overlying İncesu Formation which consists of variegated clastic sediments. Moreover, sandstones and locally mudstones with benthic foraminifers also occur in the sequence. The middle–late Lutetian age is proposed by the authors for the İncesu Formation (Fig. 1. 2). The succession is truncated by the Pliocene tuffs named as the Gölcük volcanics.

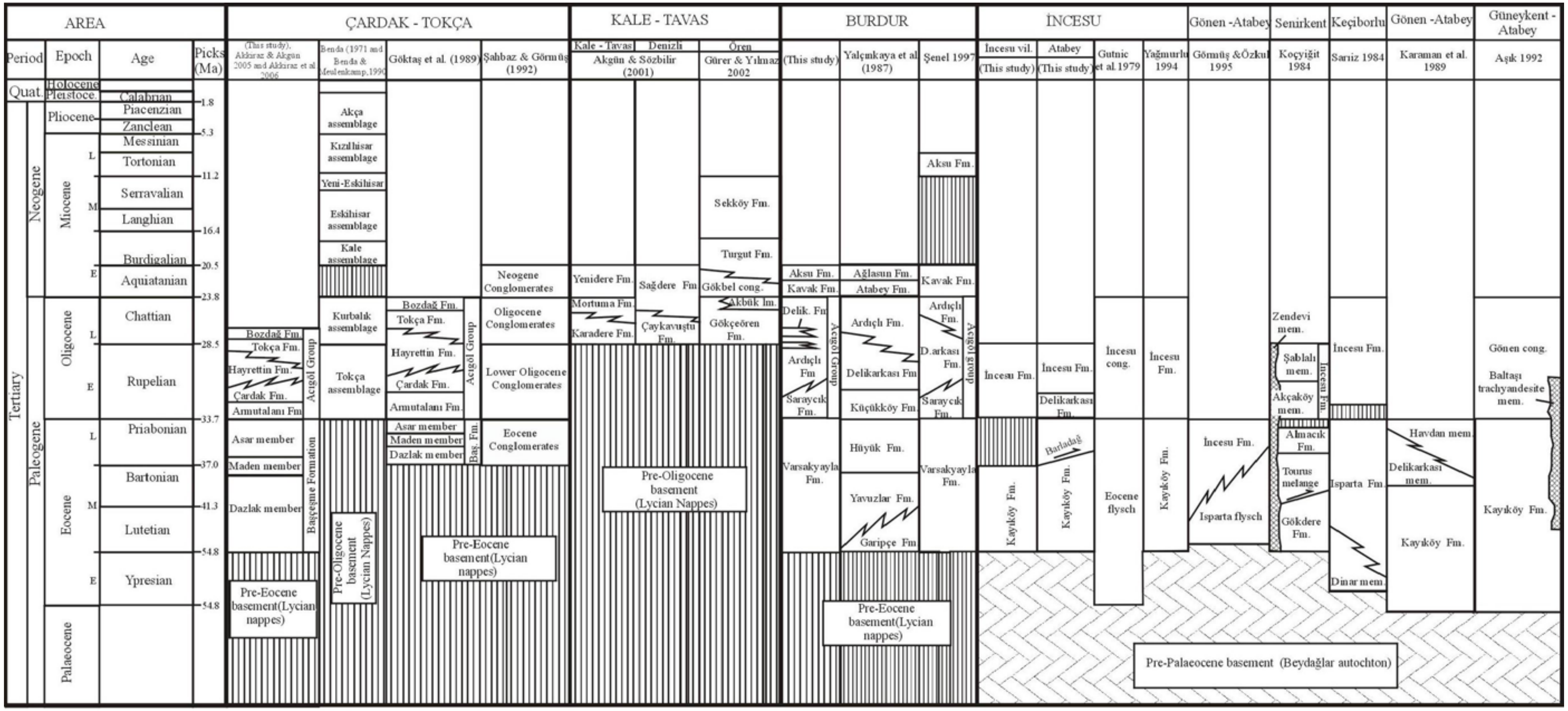


Figure 1.2 Correlation chart between the previous studies and herewith study.

1.4 Purpose and Scope

The geological studies have mainly been made in western Turkey to shed light on stratigraphic and tectonic problems so far (e.g. Nebert, 1961; Becker–Platen, 1970; Benda, 1971a, 1971b; Brunn et al., 1971; Gutnic et al., 1979; Şengör & Yılmaz, 1981; Koçyiğit, 1981, 1983, 1984, Öztürk, 1981; Ünal, 1981; Tüfekçi, 1984; Boray et al., 1985; Şenel, 1991; Şahbaz & Görmüş, 1992; Şahbaz & Görmüş, 1993; Yağmurlu, 1994; Robertson, 1993; Görmüş & Özkul, 1995; Yılmaz et al., 2000; Akgün & Sözbilir, 2001; Gürer & Yımaz, 2002; Sözbilir, 2002; Sözbilir, 2005).

However, micropaleontological studies on Tertiary formations of the Çardak–Tokça, Burdur and İncesu areas have been either neglected or carried out by Mineral Research of Exploration Institute (M.T.A.). For this reason, this thesis focuses on Tertiary sediments composed of both marine and coal–bearing lacustrine sediments.

The main objective of this thesis is to provide palynological and foraminiferal evidence from these areas, to obtain precise age, to ascertain depositional environments, to interpret qualitative palaeoclimatic conditions of these areas and also to analyze the similarities to and differences from correlative Tertiary basins.

1.5 Material and Methods

1.5.1 Material

During the field studies, detailed measured stratigraphic sections were taken from the Çardak–Tokça, Burdur and İncesu areas. Local geological mapping at 1/25.000 scale was carried out in the localities where the sections were measured.

A total of 402 palynological samples from the Eocene, Oligocene and Miocene sediments were taken from the Çardak–Tokça, Burdur and İncesu areas. The distrubition of these samples are categorised as follows: 93 of these samples from the Başçeşme Formation (Çardak–Tokça Area), 52 of these samples from Tokça

Formation (Çardak–Tokça Area), 5 samples from the Varsakyayla Formation (Burdur Area), 23 samples from the Kavak Formation (Burdur Area), 40 samples from the Aksu Formation (Burdur Area), 96 samples from the Kayıköy Formation (İncesu Area) and 93 samples from the İncesu Formation (İncesu Area).

Additionally, 208 samples were also taken for foraminiferal investigations. The number of the samples according to the areas are: 54 of these samples from the Başçeşme Formation (Çardak–Tokça Area), 19 samples from the Tokça Formation (Çardak–Tokça Area), 39 samples from the Varsakyayla Formation (Burdur Area), 31 samples from the Kavak Formation (Burdur Area), 11 samples from recristalized limestone lenses in the Ardıçlı Formation (Burdur Area), 8 samples from the nummulitic limestones and transition beds of the İncesu Area, 15 samples from the sandstones of the Kayıköy Formation (İncesu Area) 8 samples from the Cretaceous neritic and pelagic limestones in the İncesu Area and 23 samples from the Delikarkası Formation (İncesu Area).

1.5.2 Preparation Methods

Following techniques have been processed for palynological samples obtained from all stratigraphical sections for quantitative counting. Firstly, the samples were dried and crushed and about 10 mg. of sediment was shredded and placed in a plastic pot.

Palynological preparations were made from collected samples by using standard HCL and HF treatments followed by oxidation with Schulze's solution and KOH. The samples were treated by using concentrated 30 millilitres of 32 % HCL for one day to remove carbonates and disaggregate clay. After the material was washed four times in a centrifuge, the residue was processed with concentrated 30 millilitres of 38–40 % HF for two days. After the solution centrifuged three times, the material was prepared by using the Schulze's solution. The samples were mixed with 5 gr $KCLO_3$ and then 30 millilitres of 65 % nitric acid was added. The material was kept in the laboratory until it flushed. The solution was often controlled on the microscope whether it was ready or not. When the samples were prepared, they were washed three or five times until the water was reasonably cleaned. The residue was put into a glass tube and small amount of water was added. The solution was heated until 70 ^{0}C. 2 grams of KOH were added into the solution and then it was immediately centrifuged three times. The residue was placed into a small bottle and small amount of water was poured into it. Then 4–5 drops of alcohol was added into the bottle. The organic residue was screened through an 8 µm mesh screen and 2 and 7 slides per sample of the >8 µm fraction were prepared for transmitted light microscopy. Pollen counts were carried out at 400X using an Olympus microscope. Palynological counts range between 22 and 365 grains/specimen (Tables 4. 1, 4. 3, 4. 5, 4. 6, 4. 7, 4. 8).

Additionally, thin sections were prepared in order to determine the foraminifers. All species recorded in this study are illustrated in Appendix 1 and Appendix 2.

1.5.3 Method for the Reconstruction of Palaeoclimate

Palaeoclimate reconstructions of all fossil floras obtained from Başçeşme (Maden member), Tokça, Varsakyayla, Kavak, Aksu and İncesu formations are derived from the Coexistence Approach method (Mosbrugger & Utescher, 1997). The Coexistence Approach (CA) is a computer–aided technique for quantitative terrestrial climate reconstructions in Tertiary using plant fossils. It can be applied on all fossil floras (leaves, fruits and seeds, pollen, wood). Based on the assumption that the climatic requirements of Tertiary plant taxa are similar to those of their nearest living relatives (NLRs), the aim of the CA is to find climatic ranges in which a maximum number of NLRs of a given fossil flora can coexist (Fig. 1. 3). These coexistence intervals are considered as the best description of the palaeoclimatic situation, under which the fossil flora had lived (for detailed discussions see Mosbrugger & Utescher, 1997; Mosbrugger, 1999; Utescher et al., 2000).

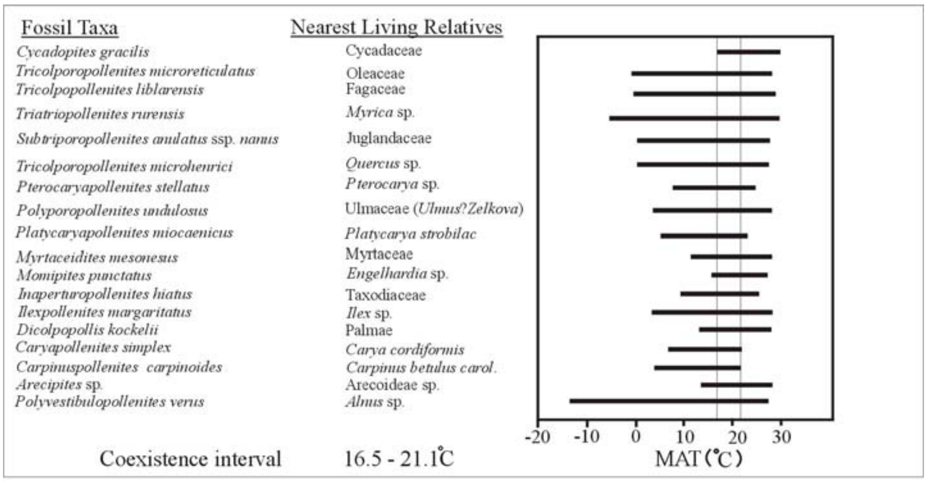


Figure 1. 3 The Coexistence Approach: Application on the flora of single sample number T-4 (see table 4.3 for the sample number).

The application of the CA is facilitated by computer programme CLIMSTAT and database PALAEOFLORA which includes NLRs of more than 2000 Tertiary plant taxa, together with their climatic requirements which are derived from meteorological stations located within the distribution of the taxa (see also information given on the web site www.palaeoflora.de).

Analyses took place with respect to four climatic parameters, e.g. mean annual temperature (MAT), temperature of the coldest month (CMT), temperature of the warmest month (WMT), and mean annual precipitation (MAP).

Typically the resolution and reliability of resulting coexistence intervals rise with the number of taxa included in the analysis and are relatively high in floras with 10 and more taxa for which climatic parameter are known.

The resolution of the calculated climate data varies with respect to parameter examined; it is the highest resolution for temperature related parameters (MAT, WMT, CMT) where it is generally in the range of 1 to 2 ^{o}C; results for MAP achieve a certainty of 100 to 200mm (see Mosbrugger & Utescher, 1997). Other precipitation parameters are less accurate, but notwithstanding may signify the whole trends (Mosbrugger, 1995; Mosbrugger & Utescher, 1997)

On the other hand, as indicated by Ivanov et al. (2002), the CA ivolves number uncertainties of sources of error: 1) Description of fossil taxa may be incorrect; 2) Allocation of a nearest living relative to a fossil taxon may be incorrect; 3) the climatic endurance of a nearest living relative may differ from the climatic tolerance of the corresponding fossil taxon. Additionally, the application of the CA to a fossil flora can also lead to two distinct coexistence intervals (Ivanov et al., 2002). This may be a conclusion from one or several factors mentioned above or it may be caused by a mixture of different floras standing for different climate situations.

1.5.4 Methods for the Reconstruction of Vegetation Type and Environment

Statistical methods can be useful tools for description and interpretation of results on the basis of large palynolgical data sets. Particularly, a combination of different statistical methods shows the potential to help managing these data (Kovach, 1989; Mosbrugger, 1995). In this study, we have analyzed palynofloras obtained from different formations using cluster analysis and Multi Dimensional Scaling (MDS) to obtain information about palaeovegetational and palaeoenvironmental developments for the formations. These methods were well exhibited and were already used positively in palaeobotany (e.g. Boulter & Hubbard, 1982; Hubbard & Boulter, 1983; Huhn et al., 1997). All statistical analyses were realized with the computer programme PAST developed by Ryan et al. (1995).

Cluster analysis used all unrefined data set to reveal possibly shrouded group structures that give a first approach on ecological similarities of the samples. Samples were grouped with respect to their resemblances in relative abundances of the occurring palynomorph groups. After applying several methods, most satisfactory results were attained with UPGMA (unweighted pair-groups) using different analytical methods.

CHAPTER TWO
STRATIGRAPHY

In this part, the stratigraphical properties of the Çardak–Tokça, Burdur and İncesu areas are described. Additionally, detailed stratigraphical measured–sections and cross–sections from investigated sediments are indicated. Lithological properties of the investigated sediments are described as well.

2.1 The Çardak–Tokça Area

2.1.1 Location of the Çardak–Tokça Area

The Çardak–Tokça Area is located in the northeast of Denizli where there is large Tertiary outcrops (Fig. 2. 1). Coal–bearing Eocene and Oligocene sediments of the Çardak–Tokça Area have been examined within the scope of this thesis. For this, our studies have focused on two parts, one of which is located at southwest of Çardak–Tokça Area including the Başçeşme Formation (Figs. 2. 1, 2 .3) and the other, Tokça Formation located at the north of the Çardak–Tokça Area (Figs. 2. 1, 2. 11).

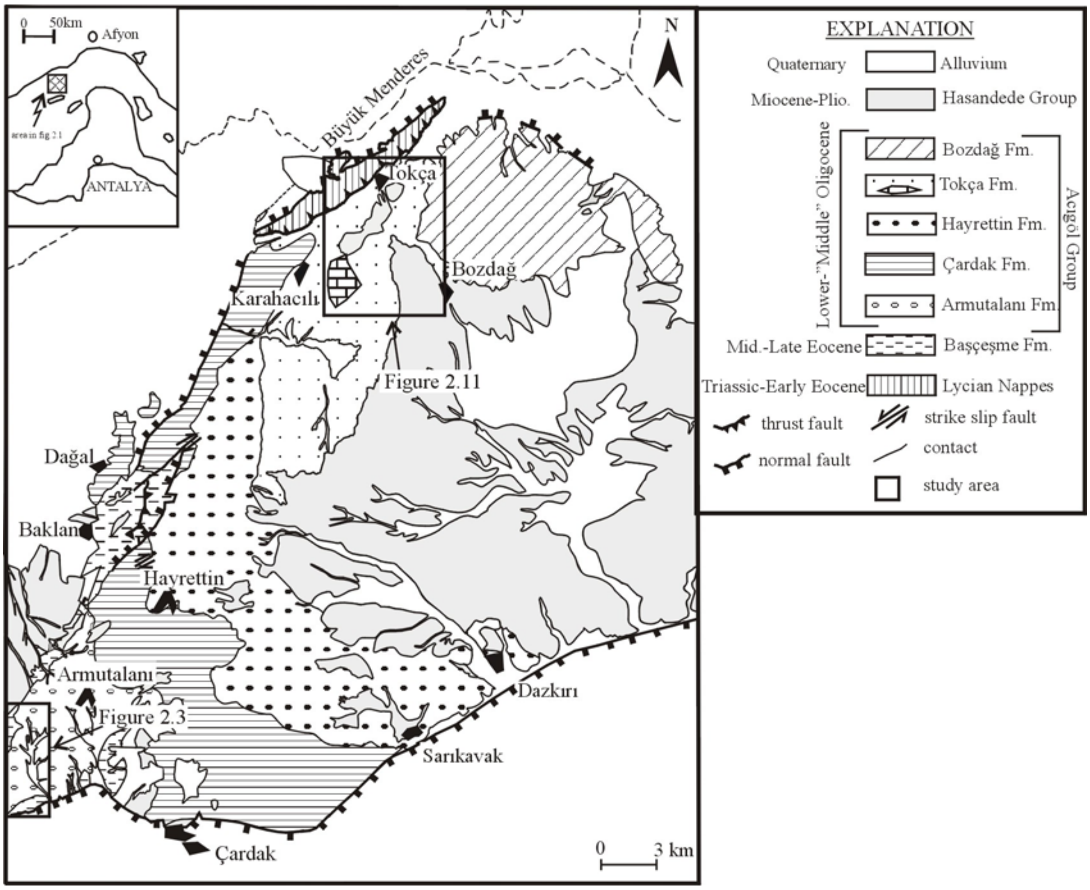


Figure 2. 1 Simplified geological map of the Çardak–Tokça Area (modified from Göktaş et al. 1989). See figure 1. 1 for location.

2.1.2 Stratigraphy

Tertiary sedimentary fill of the Çardak–Tokça Area can be divided into three parts, as supra–allochthonus sediments, Acıgöl group and neo-autochton cover units. In this area, pre–Eocene basement consists of the Triassic–Lower Eocene Lycian Nappes that are generally composed of metaconglomerate, metasandstone, recrystallized limestone, metavolcanites, dolomite, dolomitic limestones, ophiolitic–rocks, matrix and blocks (Göktaş et al., 1989; Şenel, 1997a). The Başçeşme Formation unconformably overlies the Lycian Nappes and deposited in alluvial–fan, shallow marine and beach environments (Fig. 2. 2).

The Oligocene Acıgöl group comprises five major formations (from bottom to top), the Armutalanı, Çardak, Hayrettin, Tokça and Bozdağ (Fig. 2. 2). The

Armutalanı Formation has about 800m total thickness that was deposited in a fan delta environment, and consists of ophiolite–derived conglomerate and mudstone alternation and unconformably overlies the Başçeşme Formation (Fig. 2. 2). The formation grades upward to the Çardak Formation which is made up of conglomerate, sandstone and mustone alternation and its maximum thickness is about 2000m (Fig. 2. 2). The conformably overlying Hayrettin Formation comprises sandstone and mudstone alternation with reefal limestone lenses and contains lignite horizons at the upper part. Its thickness reaches up to 1500m (Fig. 2. 2). Some gastropods, bivalves and bioturbations occur in the sandstones and mudstones. According to Şahbaz & Görmüş (1992), the Çardak and Hayrettin formations are channel deposits developed on the continental slope. The Hayrettin Formation has lateral and vertical transitional boundaries with the overlying Tokça Formation. The formation has a mudstone–dominated succession, including several lenses of coal and reefal carbonate lenses, which represent coastal, onshore and shallow marine environments (Fig. 2. 2). The total thickness of the formation is about 2000m (Fig. 2. 2). The Bozdağ Formation which is about 650m in thickness, constitutes the uppermost part of the Oligocene sequence, and consists mainly of conglomerate, sandstone, mudstone alternation including limestones. The formation was deposited in a coastal environment under terrestrial influence. The Acıgöl group is unconformably overlain by the Pliocene and Quaternary continental deposits (Fig. 2. 2).

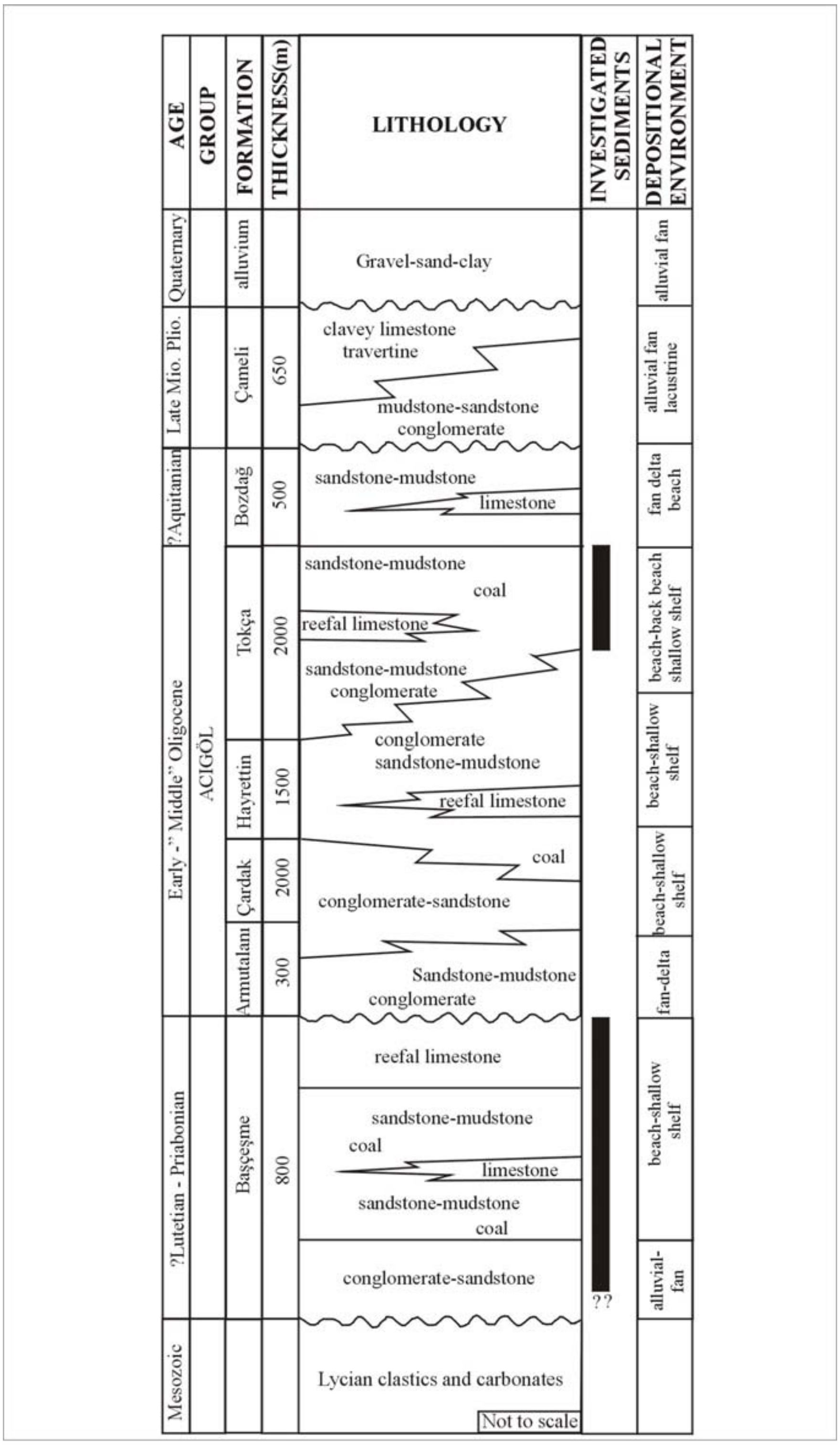


Figure 2. 2 Generalized lithostratigraphic columnar section of the Çardak–Tokça Area illustrating investigated sediments and inferred depositional environments of the formations (Modified from Şenel 1997a; Sözbilir, 2005).

2.1.3 Geological Setting of the Southwest Çardak–Tokça Area

In the area, the Middle–?Upper Eocene Başçeşme Formation, the Lower Oligocene Armutalanı Formation, Miocene and Quaternary sediments occur (Fig. 2. 3). The coal–bearing Eocene sediments of the Çardak–Tokça Area, which stratigraphically overlie the Lycian Nappes, are exposed in 35 km east of Denizli (Fig. 2. 3). The name of the Başçeşme Formation was taken from Başçeşme Village where it exposes well (Göktaş et al., 1989). In the area, the Başçeşme Formation was formerly subdivided into four members (from bottom to top), the Dazlak, Beşparmak reef, Maden and Asar members (Göktaş et al., 1989; Şenel 1997a). The studied sequences are outcrops of the Başçeşme Formation, deposited in shallow marine to coastal environment without any stratigraphical break. In the study area, the Dazlak, Maden and Asar members occur in the sequences (Figs. 2. 4a, 2. 5, 2. 6). Here, their lithological properties are briefly described, in ascending order.

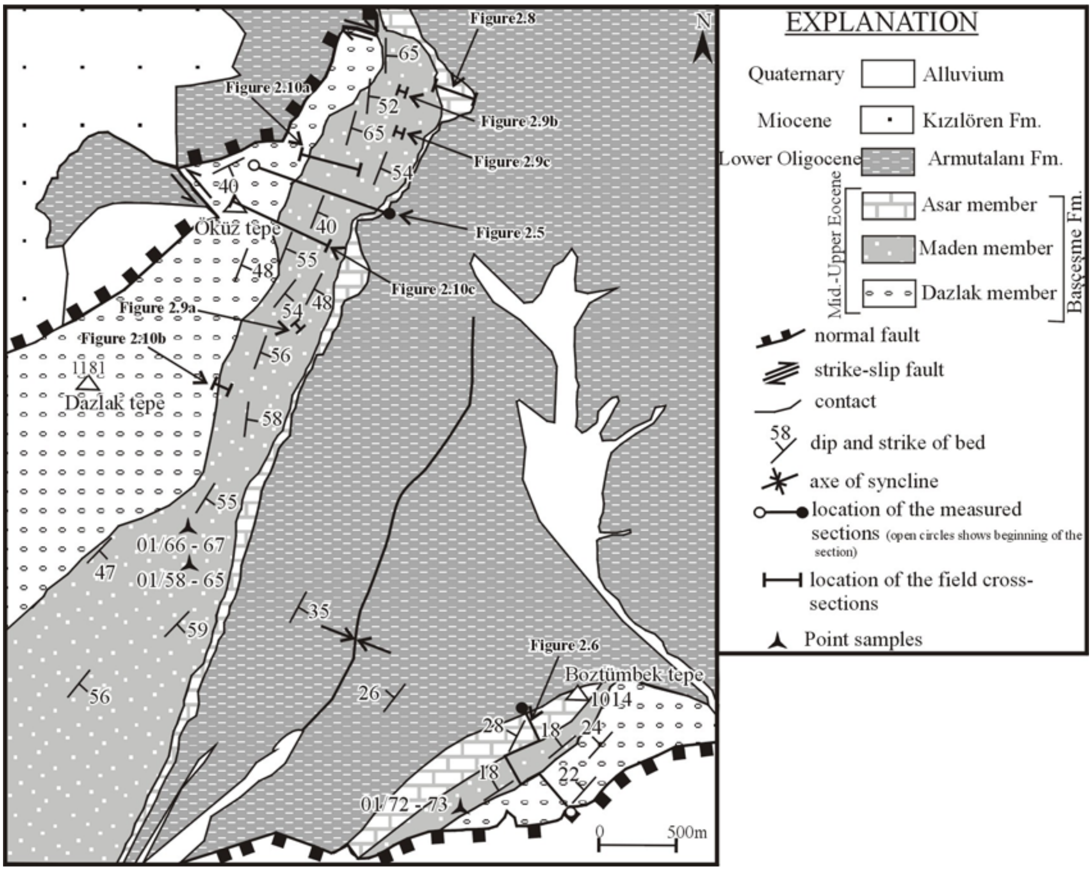


Figure 2. 3 Detailed geological map showing the north of Başçeşme Village. See figure 2. 1 for location. Location of measured sections and geological cross sections are indicated.

Figure 2. 4 Field photographs (a) from the Başçeşme Formation including the Dazlak, Maden and Asar members, also Early Oligocene Armutalanı Formation, (b) Field view showing a lower transitional boundary of the Maden member (Coordinates: 245127/93795).

The Dazlak member has been named after Dazlak Tepe where it exposes well (Göktaş et al., 1989) (Fig. 2. 2). The member is NE–SW oriented and exposes chiefly between Dazlak Tepe and Öküz Tepe (Fig. 2. 2). The Dazlak member, which is barren of microfossils, generally comprises a reddish and claret conglomerate and sandstone alternation in transgressive character (Figs. 2. 5, 2. 6). The conglomerates are coarse–grained and poorly sorted. Pebbles are between millimeters to 50cm in size. The most common components are black dolomites and serpentinezed ophiolits derived from the Lycian Nappes. Channel fills and bioturbation traces occur at some levels in the sandstones (Figs. 2. 5, 2. 7a). Additionally, planar and cross–bedded sandstones occur at some levels as well (Figs. 2. 5, 2. 6). Finning and coarsening–upward sequences are also observed. The thickness of the Dazlak member reduces from SW to NE (Fig. 2. 2). The Dazlak member was interpreted as alluvial–fan deposits by Şahbaz & Görmüş (1992). The lower contact of the Dazlak member is mostly tectonic or covered by younger units (Fig. 2. 2). However, the Eocene trangressive sequence unconfomably overlies the Lycian Nappes (Göktaş et al., 1989; Sözbilir, 2002)

The Maden member, which is NE–SW oriented, has been named after Maden Dere where it exposes well (Fig. 2. 2) (Göktaş et al., 1989). The Maden member, transitional with the underlying Dazlak member (Fig. 2. 4b), generally consists of yellowish sandstone, mudstone alternations and includes conglomerates and reefal limestone lenses (Figs. 2. 5, 2. 6). Cross bedding and ripple cross laminations occur at some levels of sandstones. The Maden member, deposited in intertidal environment, also contains coal seams and lenses (Fig. 2. 7b, c). Furthermore, shallow marine macrofossils–such as gastropods, bivalves, corals and bioclasts are abundant in the sandstones (Fig. 2. 7d, e).

The last member of the Eocene transgressive sequence is the Asar member, named after Asar Tepe located on the northern part and outside the study area. The member is also oriented from SW to NE (Fig. 2. 3) and generally comprises cream–coloured reefal limestones (Figs. 2. 5, 2. 6, 2. 8). In some places, the member includes conglomerate, sandstone, sandy limestone and mudstone (Figs. 2. 6, 2. 8). It has abundant macrofossils and microfossils, such as corals and benthic foraminifers,

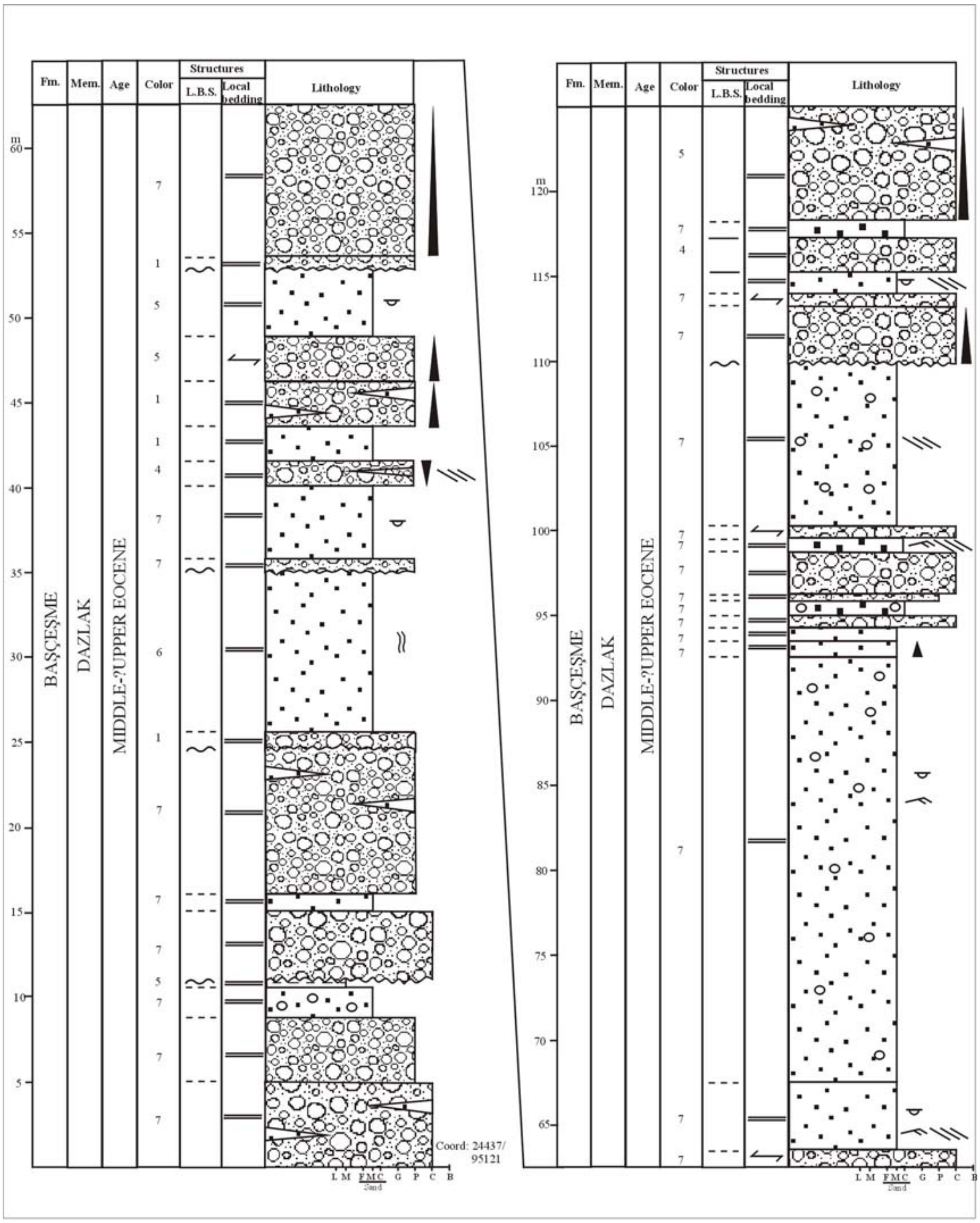
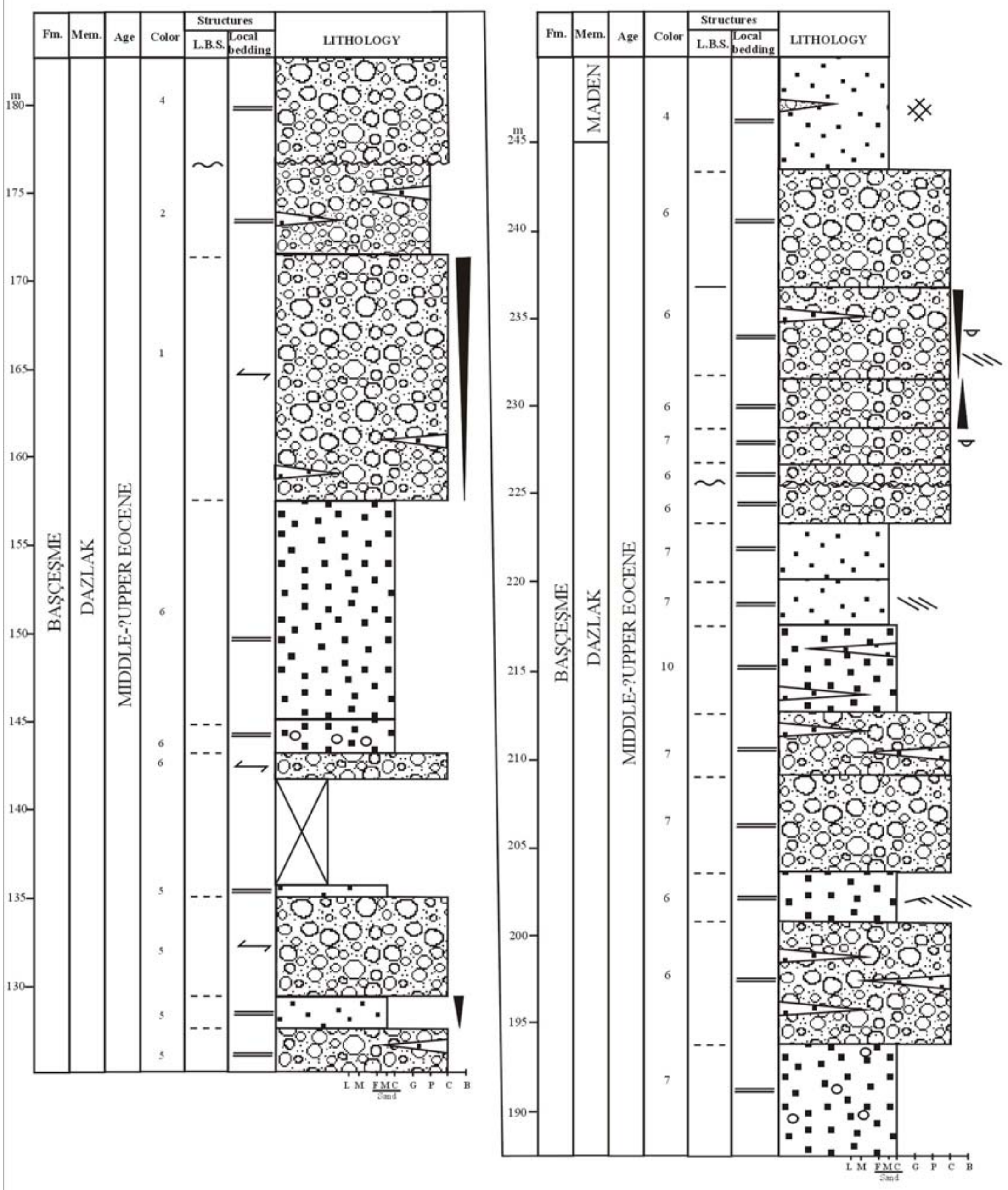


Figure 2. 5 Measured section of the Başçeşme Formation in the southeast of Öküz Tepe (see figure 2. 3 for location and figure 2. 58 for explanation).



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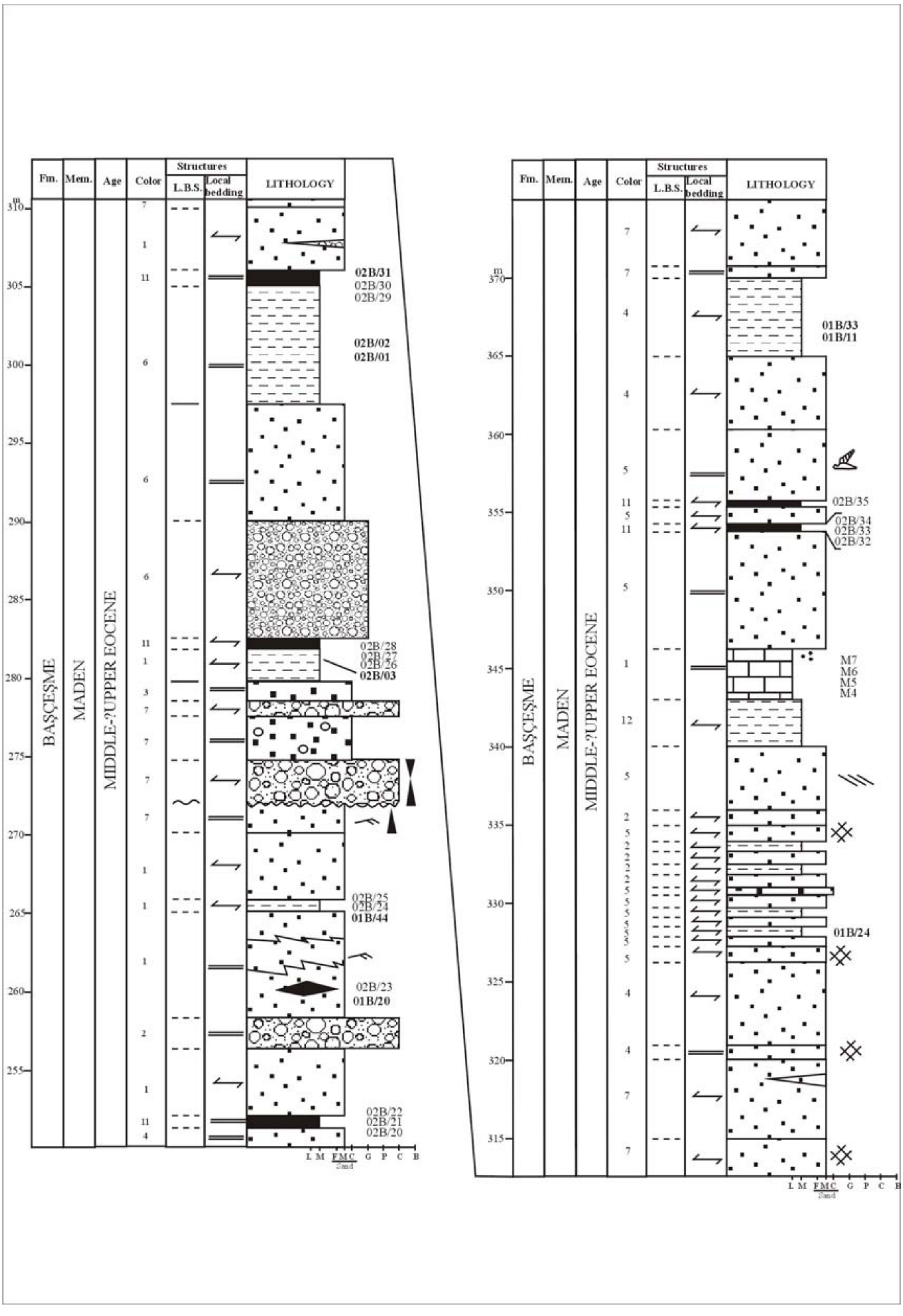

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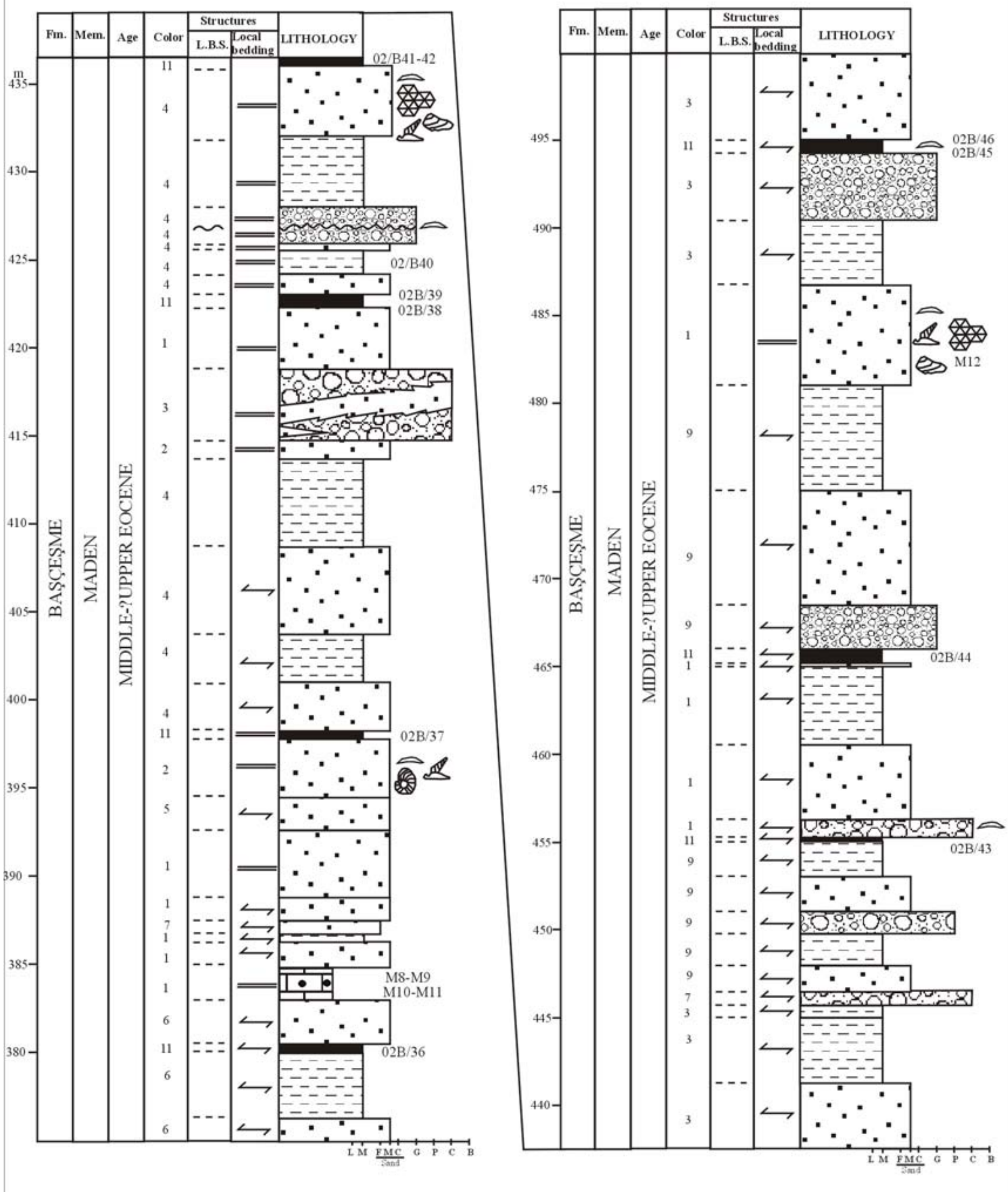

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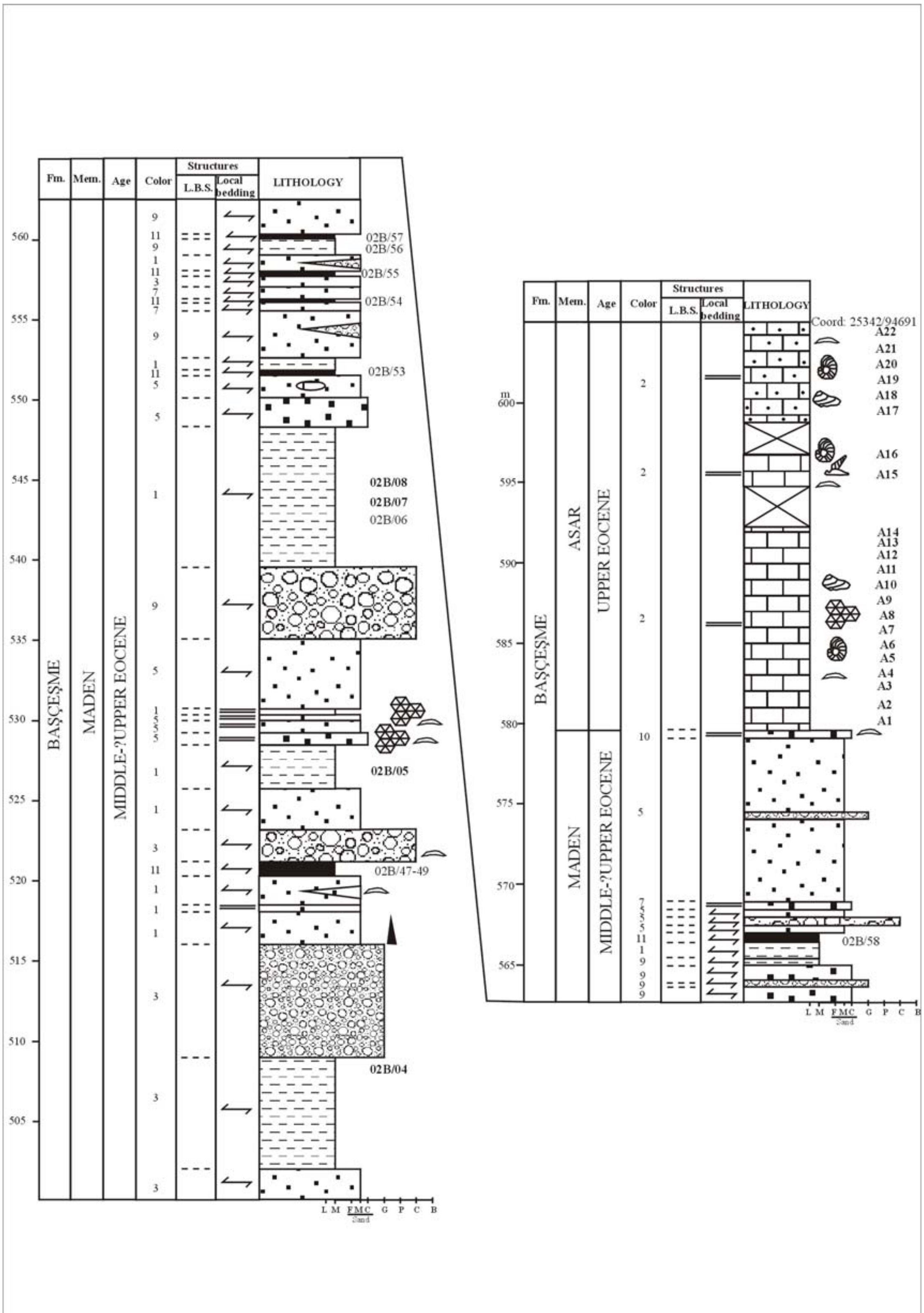

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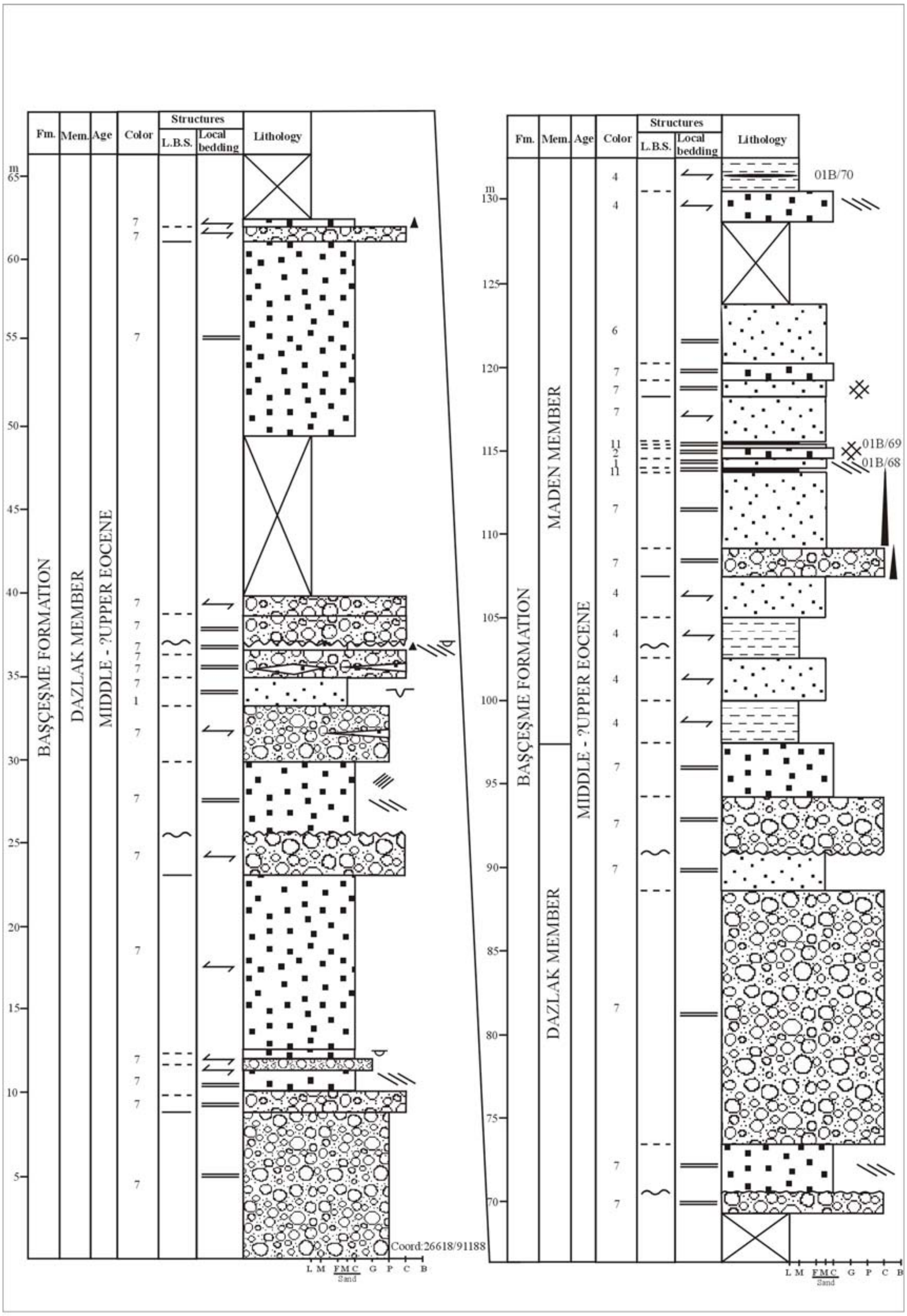
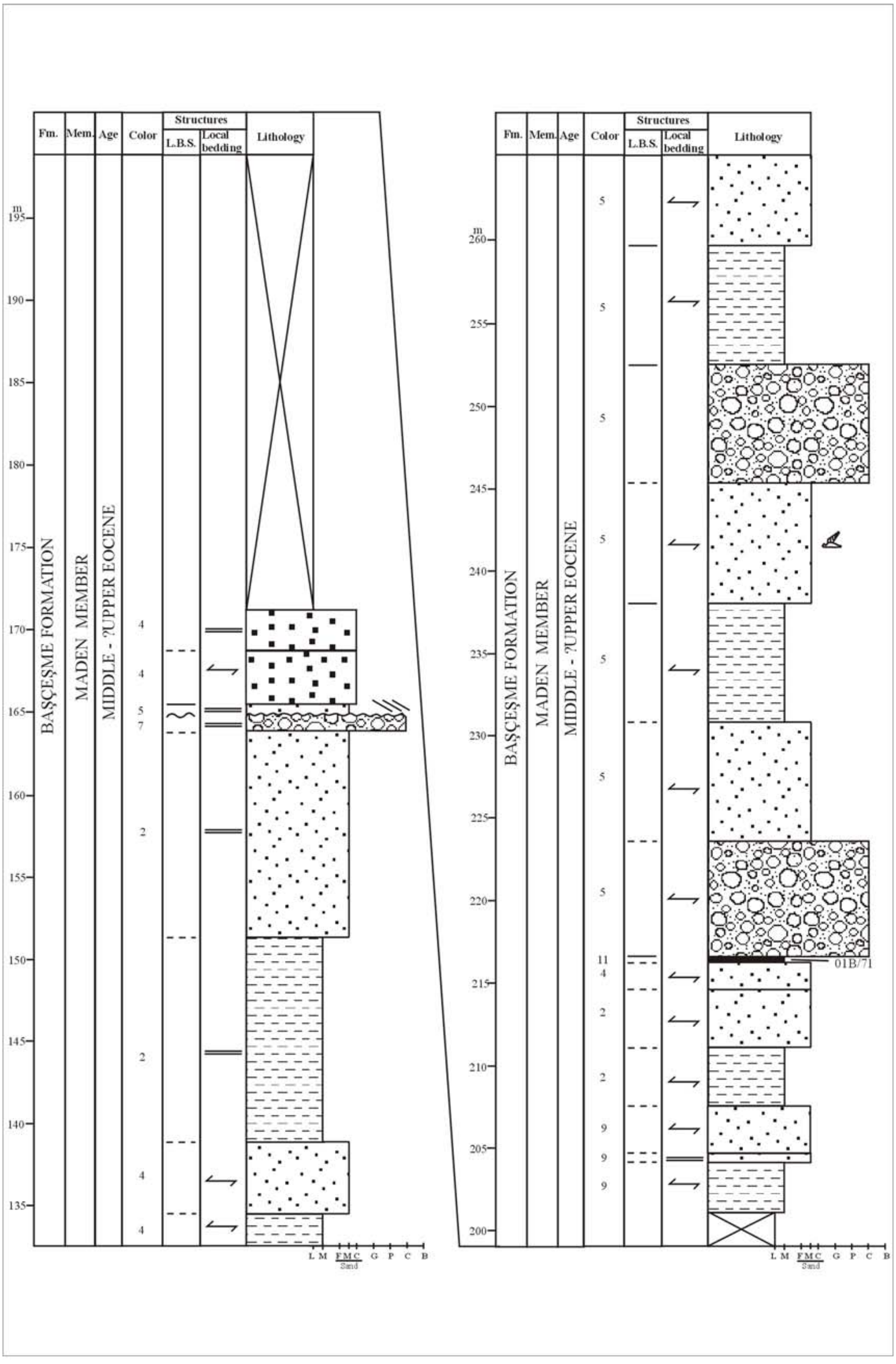


Figure 2. 6 Measured section of the Başçeşme Formation in the south of Boztümbek Tepe (see figure 2. 3 for location and figure 2. 58 for explanation).



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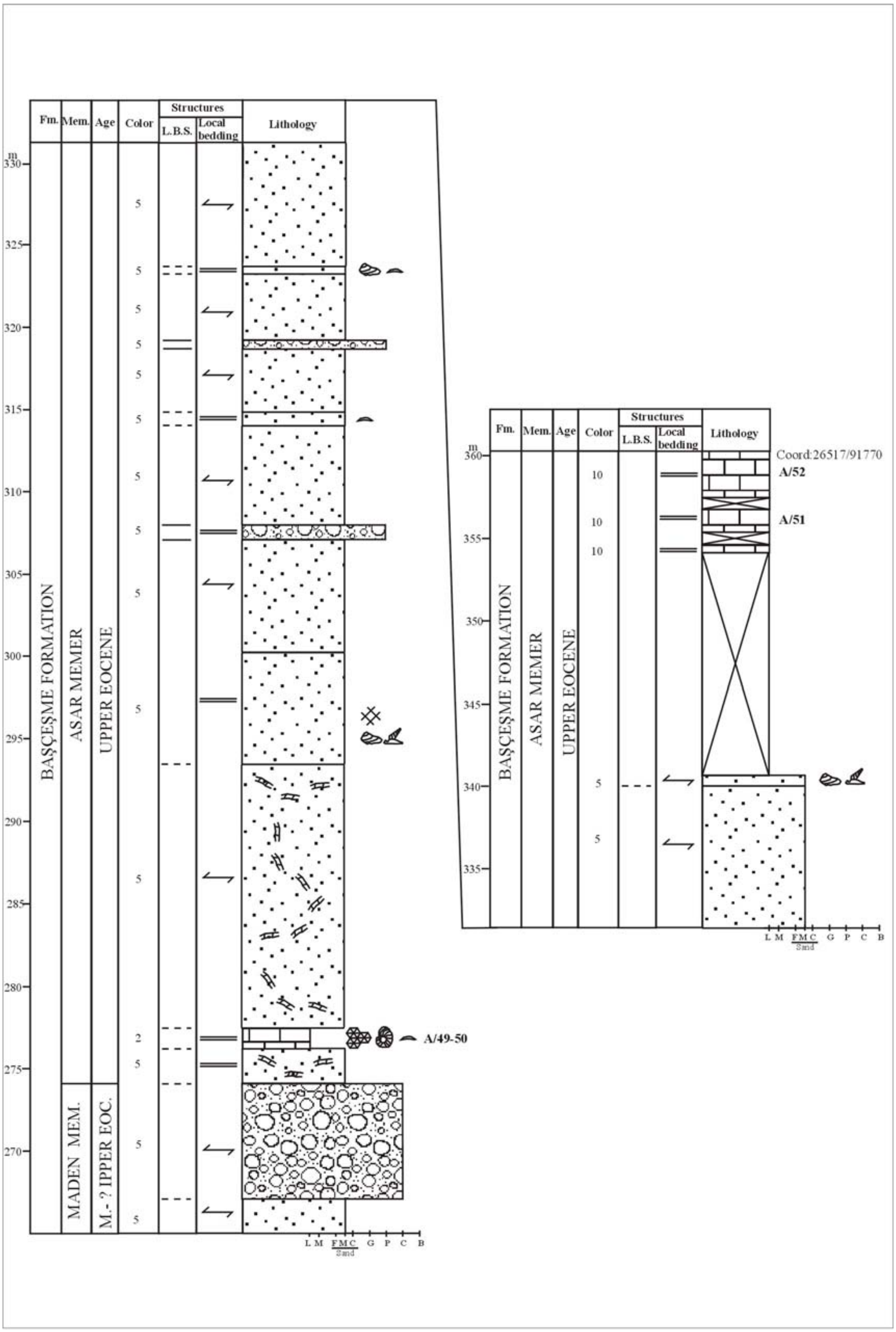


Figure 2.6 (continued)

Figure 2.7 Field photographs of the (a) biotubation traces in the Dazlak member (Coordinates: 24025/94375), (b) bivalves, gastropods and bioclasts in the Maden member (Coordinates: 25393/95688), (c) coral colony and gastropods in the Maden member (Coordinates: 25446/96040), (d) coal lense in the Maden member (Coordinates: 24505/93526), (e) coal seams in the Maden member. White arrows indicate the scale of the photos. Pencil is ~15cm long; Lens cap is ~50mm in diameter.

gastropods and bivalves. It was deposited in an intertidal environment, including an ecologic reef complex (Göktaş et al., 1989). The Lower–"Middle" Oligocene formations unconformably overlie the Asar member in the study area (Göktaş et al., 1989; Şenel 1997a; Şahbaz & Görmüş 1992; Sözbilir, 2002; Akkiraz & Akgün 2005). All of these units are overlain by the Miocene to Quaternary continental deposits (Koçyiğit 2005; Westaway et al., 2005; Sözbilir 2005) (Fig. 2. 2).

Two detailed stratigraphical sections with total thickness of 605m and 360m were measured from the Başçeşme Formation containing the Dazlak, Maden and Asar members (Figs. 2. 5, 2. 6). Besides, some geological cross–sections were also obtained from the Başçeşme Formation (Figs. 2. 8, 2. 9, 2. 10).

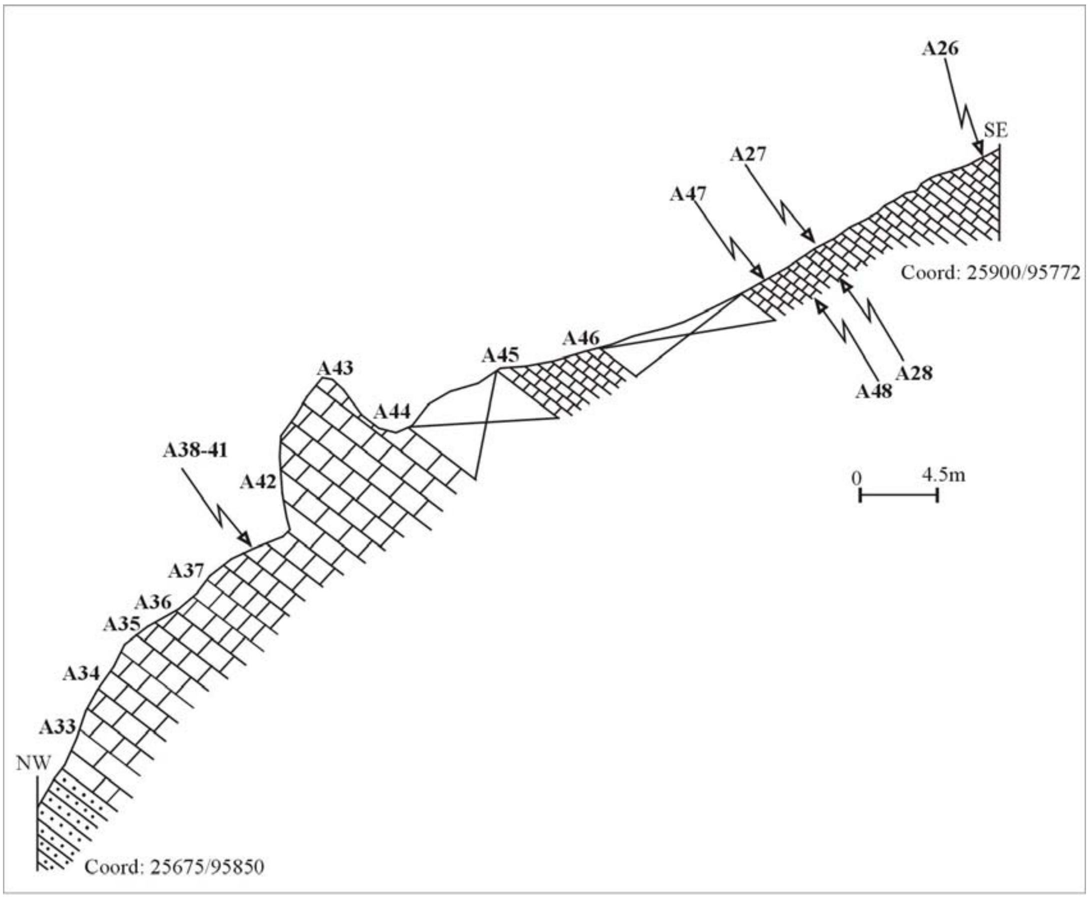


Figure 2. 8 Geological cross–section showing the variations in the Asar member (Başçeşme Formation). See figure 2. 3 for location and figure 2. 47 for explanations. Coordinates are indicated in the box.

A total of ninety–three clay, carbonaceous clay and lignite samples were collected from the Maden member, the only suitable lithologies for the palynological studies (Figs. 2. 3, 2. 5, 2. 6, 2. 9, 2. 10). Fifty–four samples were also taken from the sections for foraminiferal investigations from both the Maden and Asar members (Figs. 2. 5, 2. 6, 2. 8).

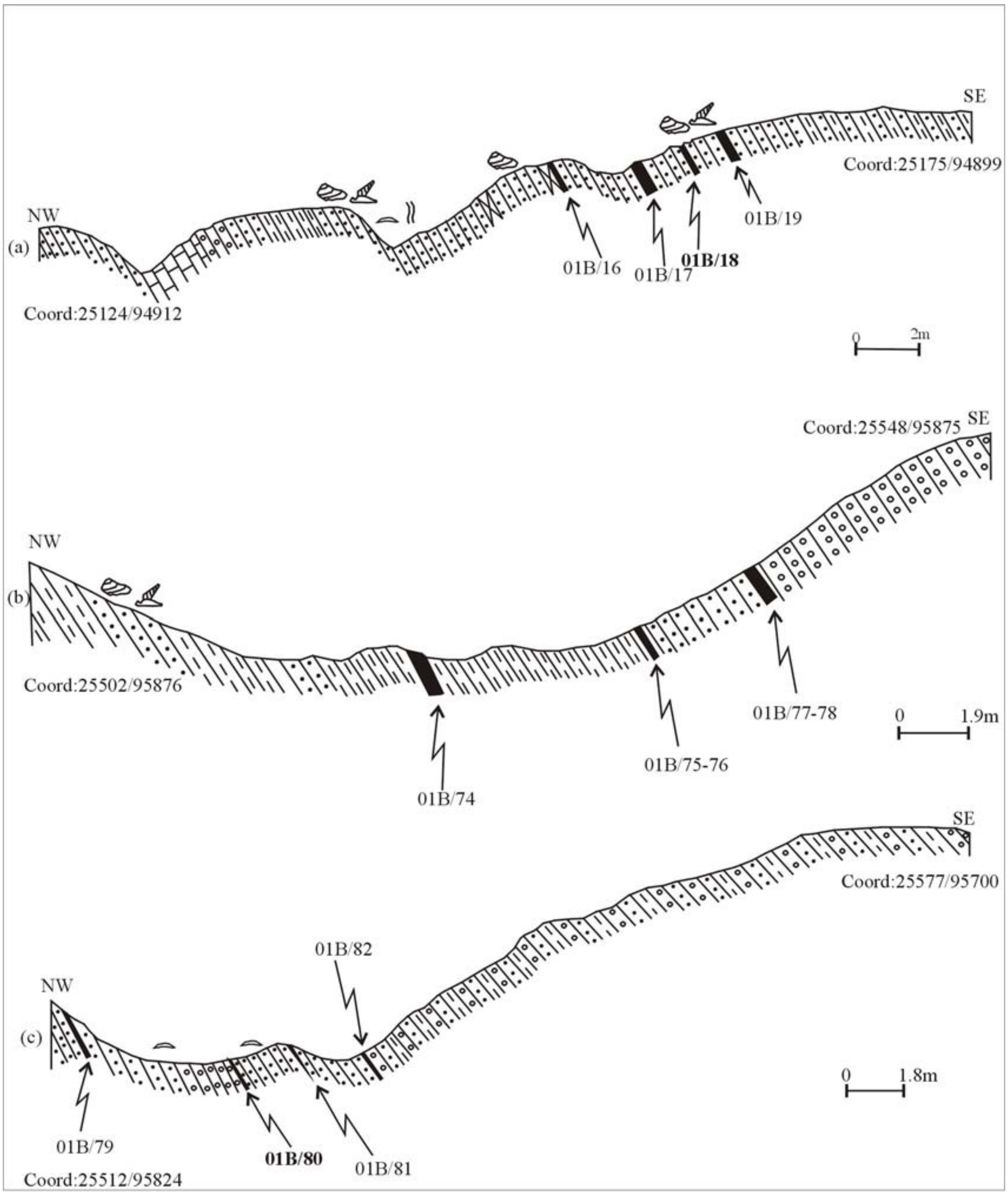


Figure 2. 9a-c. Geological cross–sections showing the samples from the Maden member (Başçeşme Formation). See figure 2. 3 for location and figure 2. 47 for explanation. Coordinates are indicated in box.

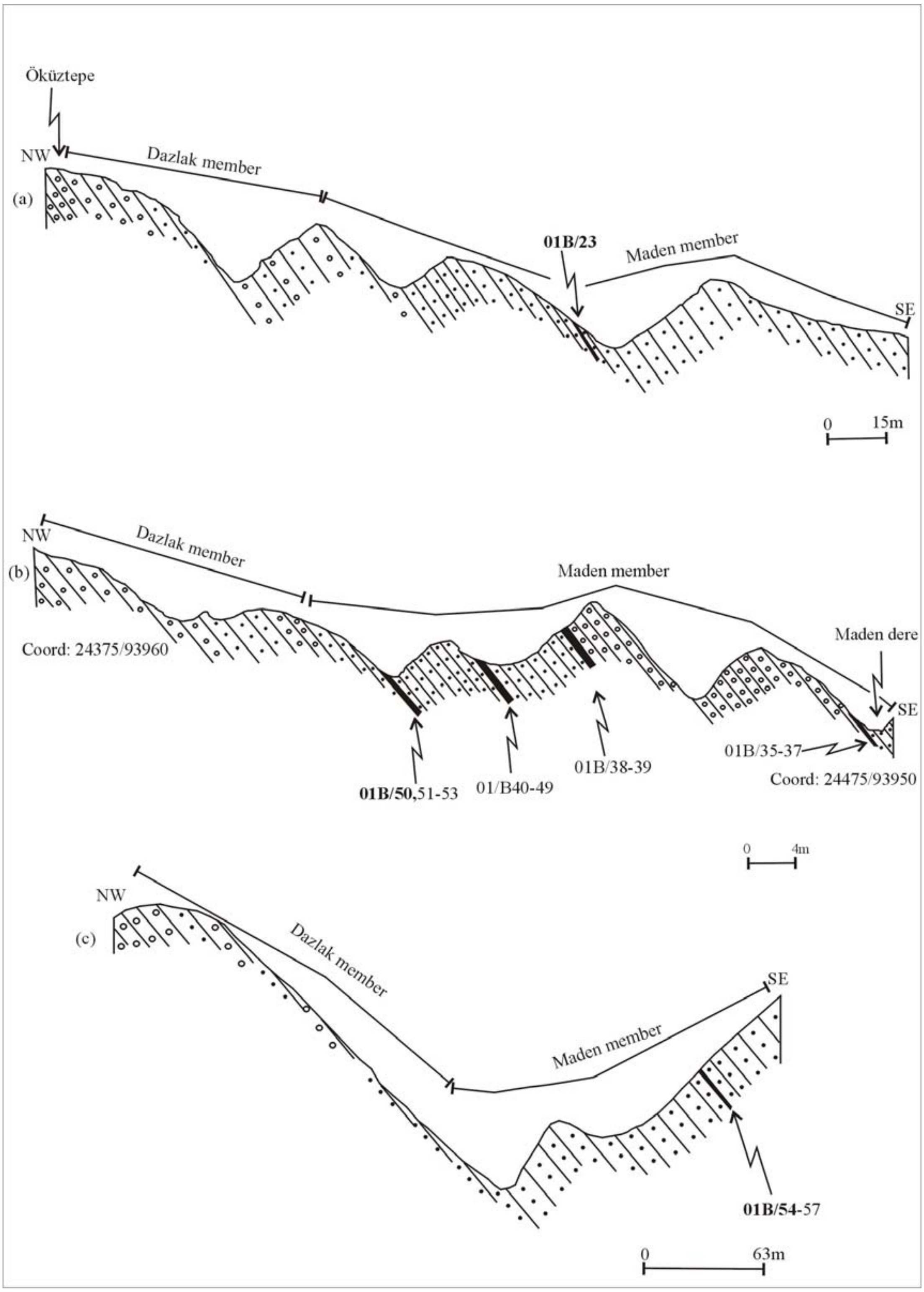


Figure 2. 10a-c. Geological cross-sections showing a transitional lower boundary of the Maden member (Başçeşme Formation). See figure 2. 3 for location figure 2. 47 for explanation. Coordinates of figure 2. 10b are indicated in the box.

2.1.4 Geological Setting of the Northern Çardak–Tokça Area

The study area includes a wide area surrounding Tokça Village (Fig. 2. 11). In the area, pre–Tertiary Lycian Nappes, Lower–"Middle" Oligocene Tokça Formation, Upper Oligocene Bozdağ Formation, Miocene–Pliocene lacustrine sediments and Quaternary alluvium occur. The Mesozoic carbonate rocks of the Lycian Nappes occur well at the Gedik Kaya and Bölük Kaya localities (Fig. 2. 11) and overthrust on the Tokça Formation (Figs. 2. 11, 2. 12a). Oligocene sediments observed in the surrounding area of Tokça Village consist of two major formations (from bottom to top), Tokça and Bozdağ.

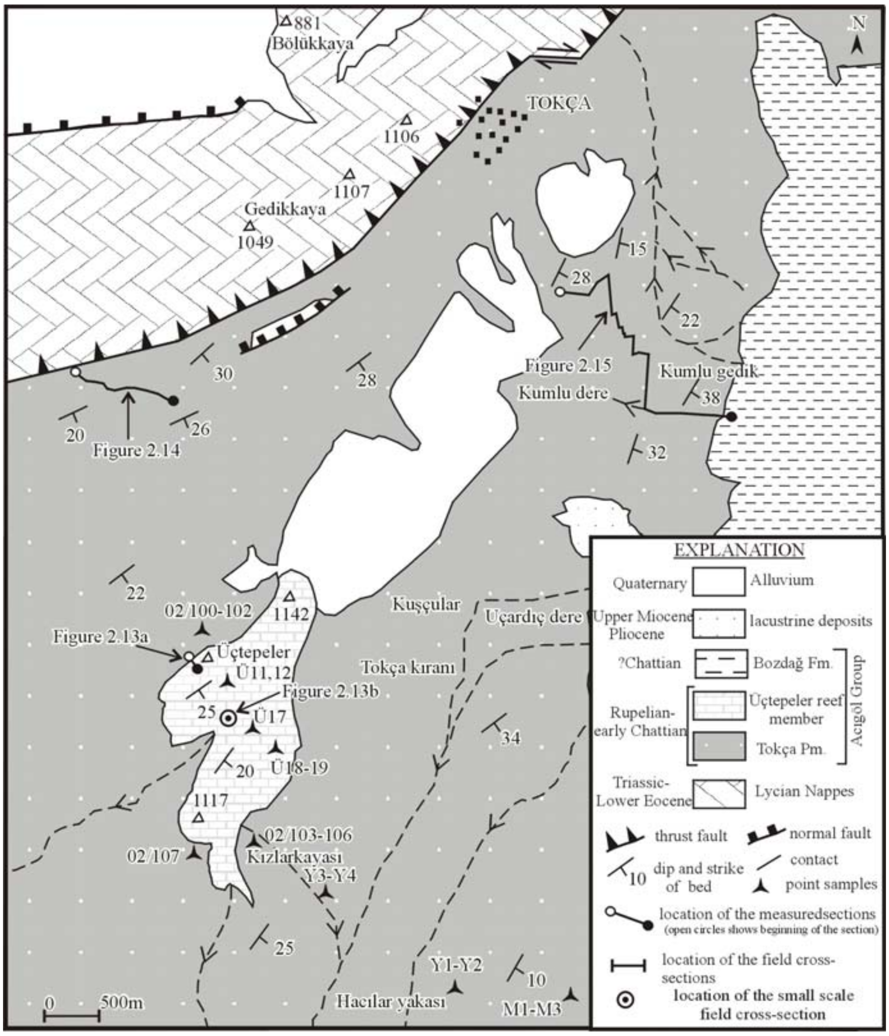


Figure 2. 11 Detailed geological map of Tokça Village and surroundings. See figure 2. 1for location. Location of measured sections, field cross-sections and point samples are indicated.

The Tokça Formation has been named after Tokça Village where it crops out well (Göktaş et al., 1989) (Fig. 2. 11). In the southwestern part of the investigated area, the formation is more widespread than in the north, and it exposes chiefly around Kızlarkayası, Hacılar Yakası, Tokça Kıranı, Kuşçular, Kumlugedik, Kumlu Dere (Fig. 2. 11).

The Üçtepeler reef member named after the Üçtepeler locality by Göktaş et al. (1989) occurs at the lower part of the Tokça Formation (Fig. 2. 11). According to Göktaş et al. (1989), the sequence of the Tokça Formation can be divided in two parts as the lower part of the Üçtepeler reef member and the upper part of the Üçtepeler reef member.

The Üçtepeler reef member is generally made up of cream–coloured sandstones and reefal limestones including a rich coral, bivalves, gastropods and benthic foraminifer assemblage (Figs. 2. 11, 2. 13b). The member also includes mudstones at some levels. The Üçtepeler reef member is a key level because its presence indicates the basic part of the Tokça lignites.

On the other hand, there are some differences between lower and upper sequences of the Üçtepeler reef member. The sequence of lower part is generally made up of conglomerate, sandstone, mudstone alternation (Fig. 2. 14). In some places, the sequence includes hematite concretions, channel fills and large scale cross–bedded sandstones (Fig. 2. 14). Additionally, plant debris and carbonized parts of plants occur in the mudstones.

The sequence of the upper part consists generally of sandstone, mudstone alternation, and forms the main thickness of the Tokça Formation which has about 1300m total thickness. Moreover, micritic limestones occur at some levels as well. In some places, sandstones, poorly cemented, have large scale planar bedding and cross stratification (Figs. 2. 12b, c; 2. 15). Unidentified leaf fossils and plant fragments have also been observed in the mudstones (Fig. 2. 15). Additionally, numerous thin coal seams, lenses and deformed gastropods occur in the sequence (Fig. 2. 15). The coal seams located at the lowest part of the sequence have economical importance and have also been processed by several coal companies.

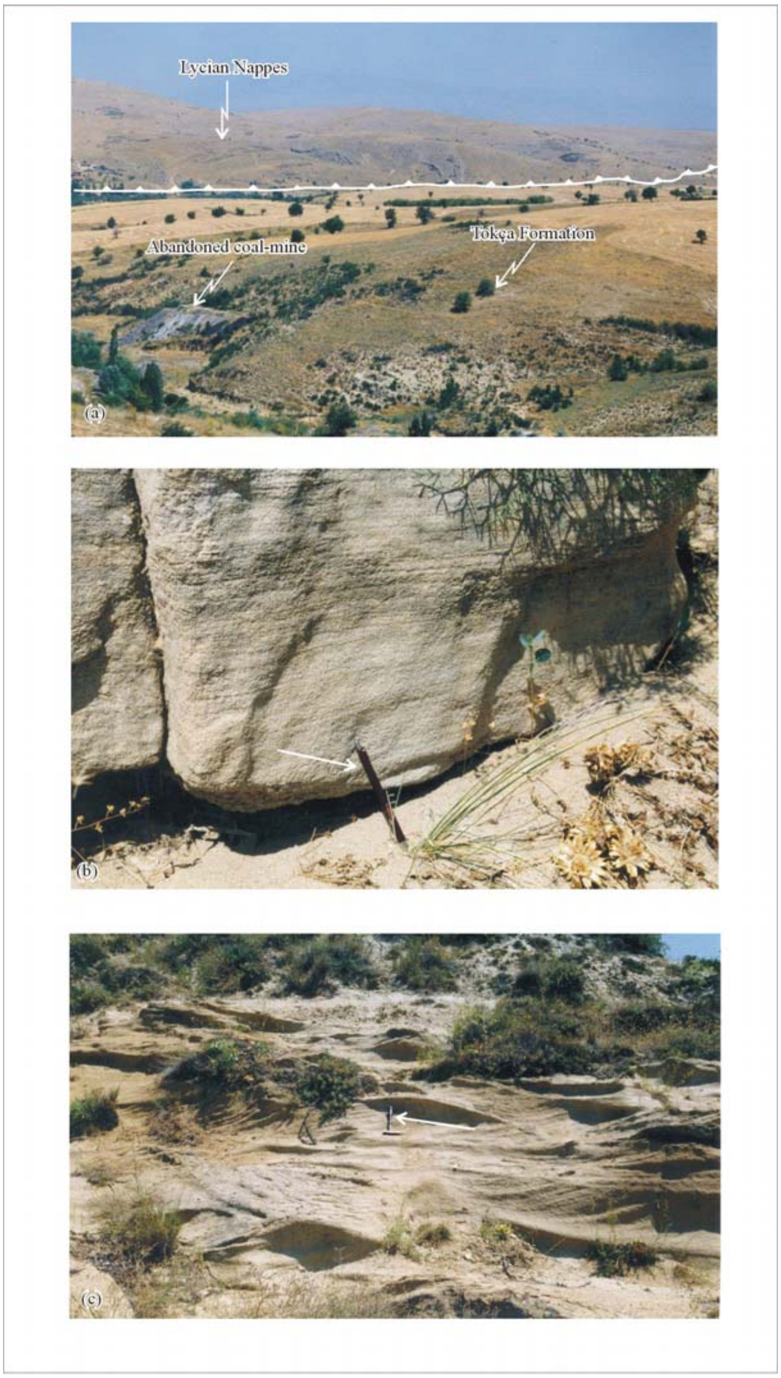


Figure 2. 12 Field photograps of (a) a thrust fault between Lycian Nappes and Tokça Formation, (b) planar laminae in sandstones (Coordinates: 45218/25790), (c) large-scale cross-stratification in the sandstones of the Tokça Formation (Coordinates: 45042/25711). Pencil in (b) is ~ 15cm long; hammer in (c) is ~ 34cm long.

The Tokça Formation was deposited in a coastal, onshore shallow marine environment. The relationship between the overlying Bozdağ Formation and the Tokça Formation is not clear (Göktaş et al., 1989).

The field studies have focused on three parts including the lower part of Üçtepeler reef member, Üçtepeler reef member and the upper part of the Üçtepeler reef member (Fig. 2. 11). Two detailed measured stratigraphical sections with 195m (Fig. 2. 14) and 915m total thickness (Fig. 2. 15) were taken from the lower and upper parts of the Üçtepeler reef member (Figs. 2. 11, 2. 14, 2. 15). Small scale stratigraphical and cross–sections were taken from the Üçtepeler reef member as well (Fig. 2. 13).

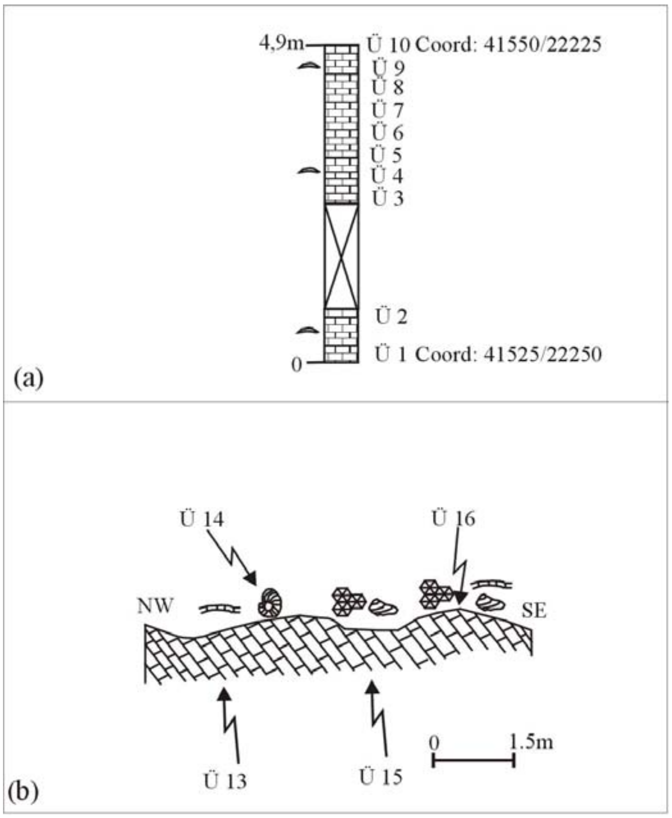


Figure 2. 13 (a) Measured section from the Üçtepeler reef member, (b) Geological cross–section from the Üçtepeler reef member (Coordinates: 41850/21625). Coordinates of figure 2.13a are indicated. See figure 2. 11 for location and figure 2. 47 for explanation.

Fifty–two palynological samples were collected from the lower and upper parts of the Üçtepeler reef member, also, nineteen samples from the Üçtepeler reef member for the foraminifer investigations.

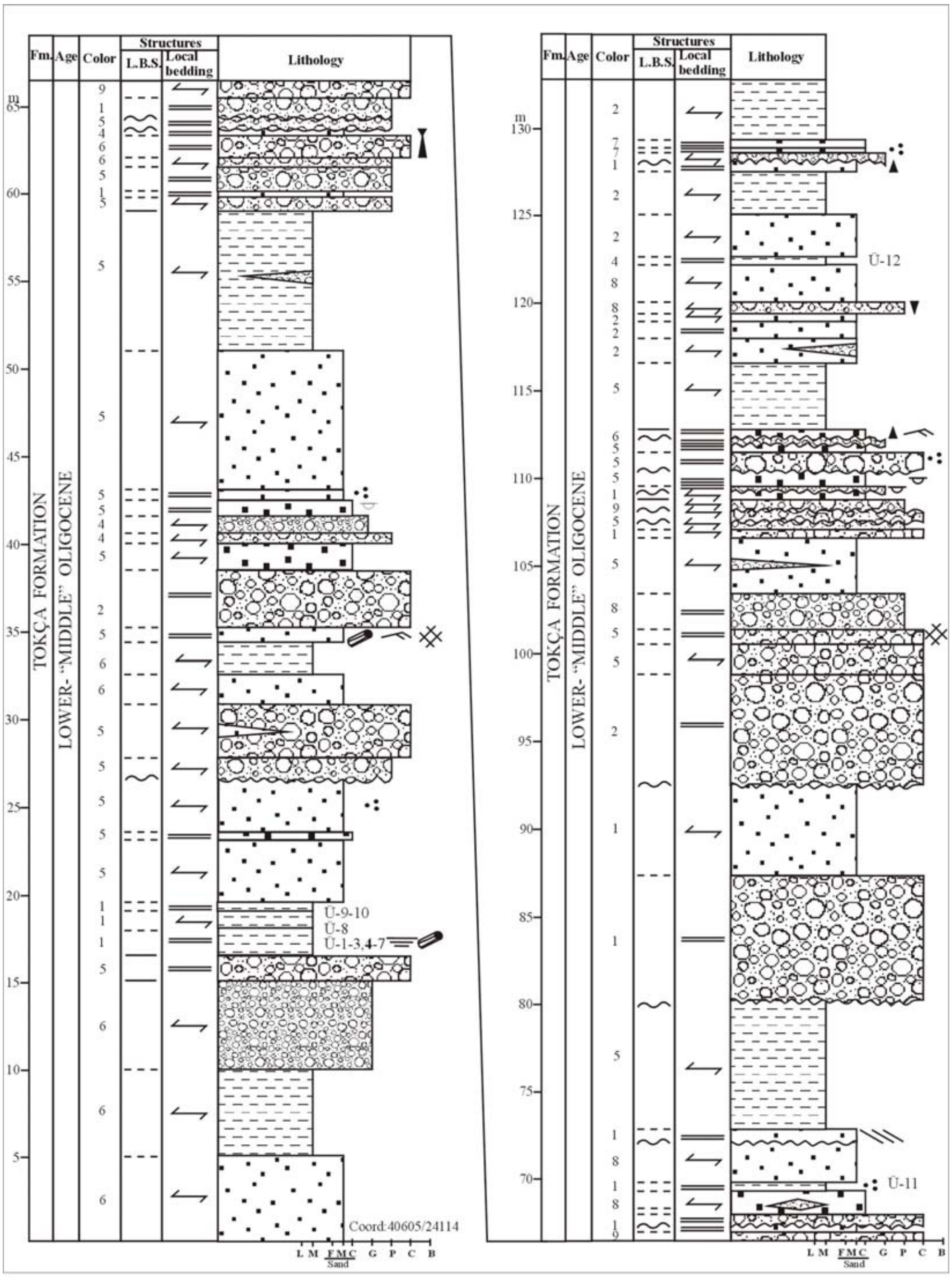


Figure 2. 14 Measured section of the Tokça Formation located at lower part of the Üçtepeler reef member in the southeastern part of Deliktaş Tepe (see figure 2. 11 for location and figure 2. 58 for explanation).

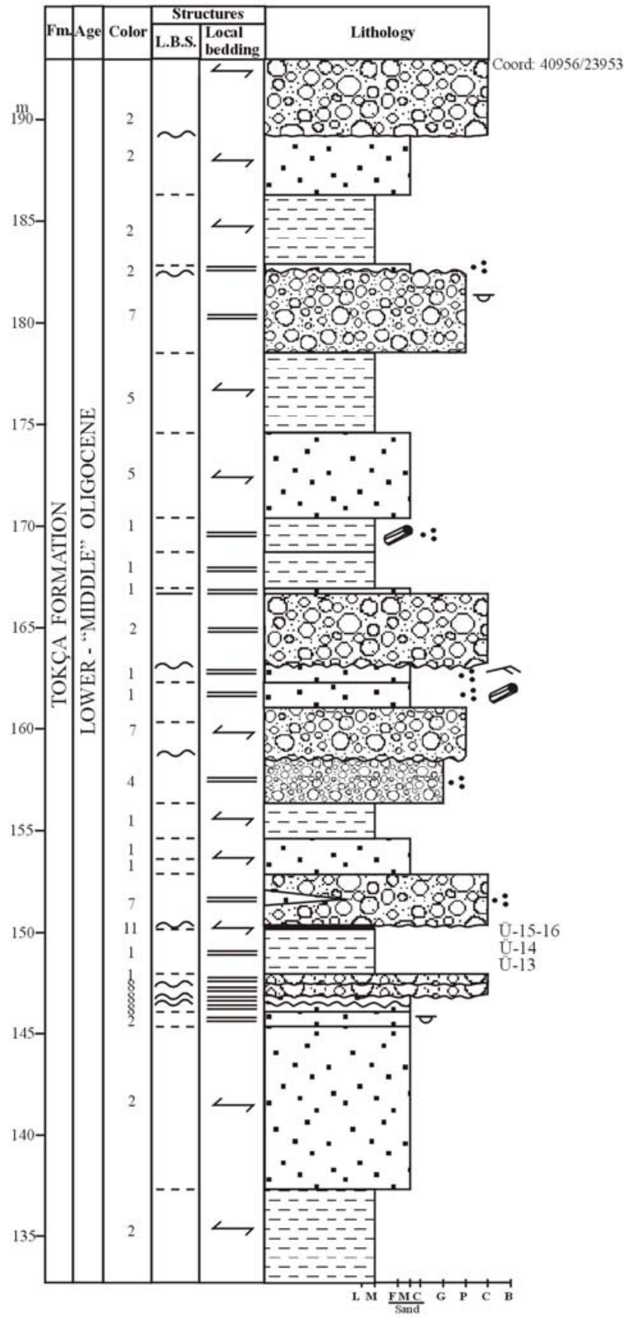


Figure 2.14 (continued)

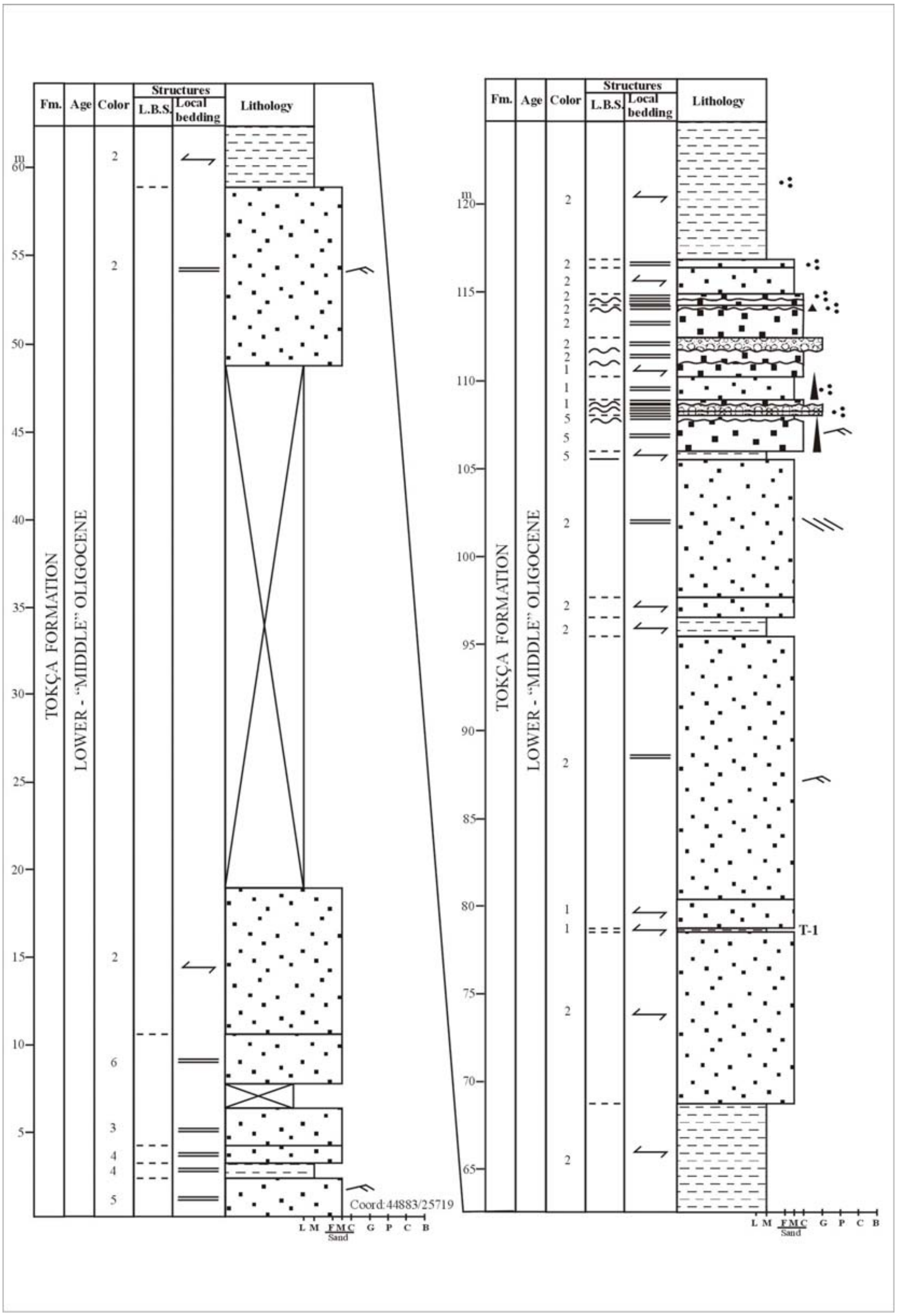


Figure 2. 15 Measured section of the Tokça Formation from the upper part of the Üçtepeler reef member in the southeast of Tokça Village (see figure 2. 11 for location and figure 2. 58 for explanation).

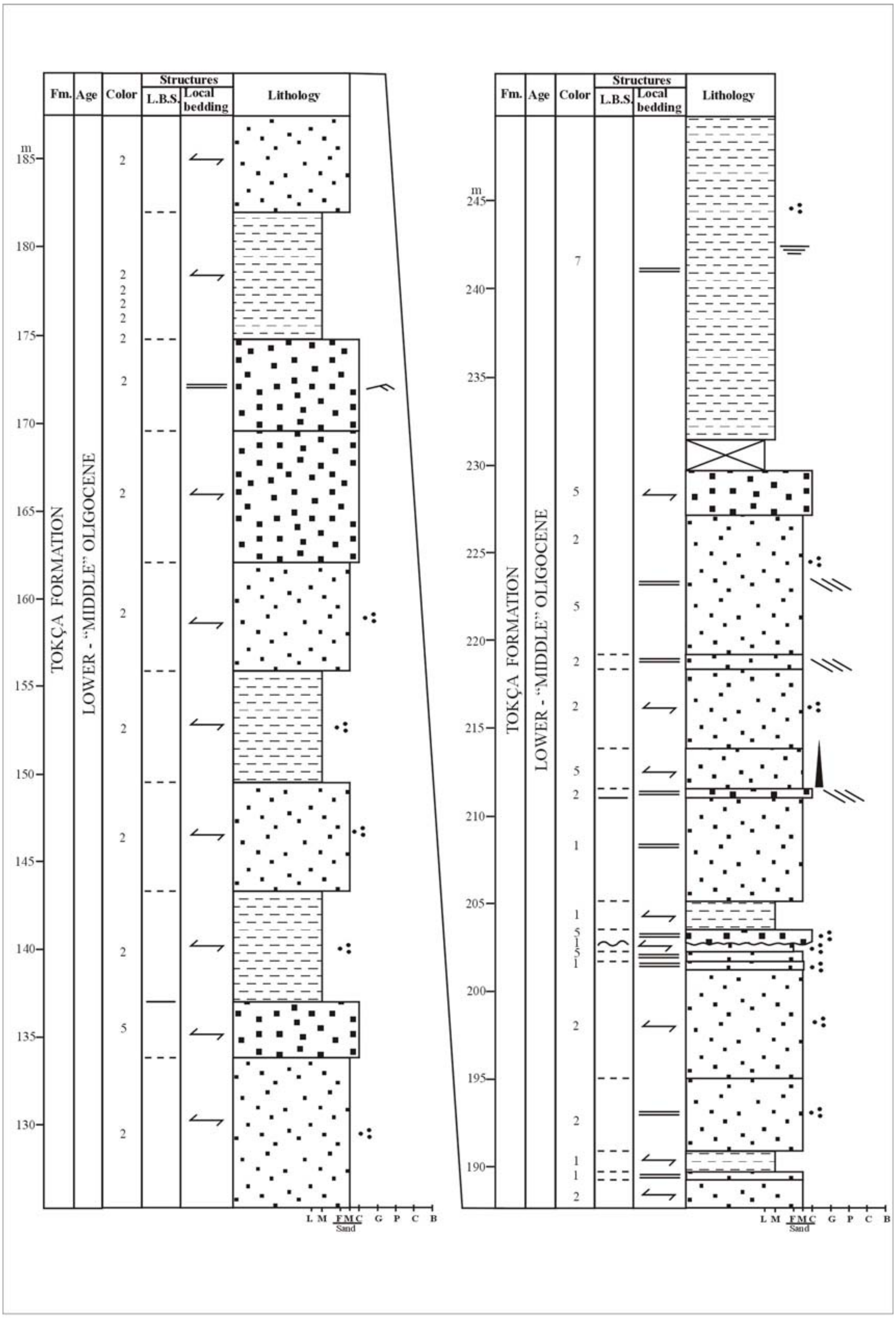
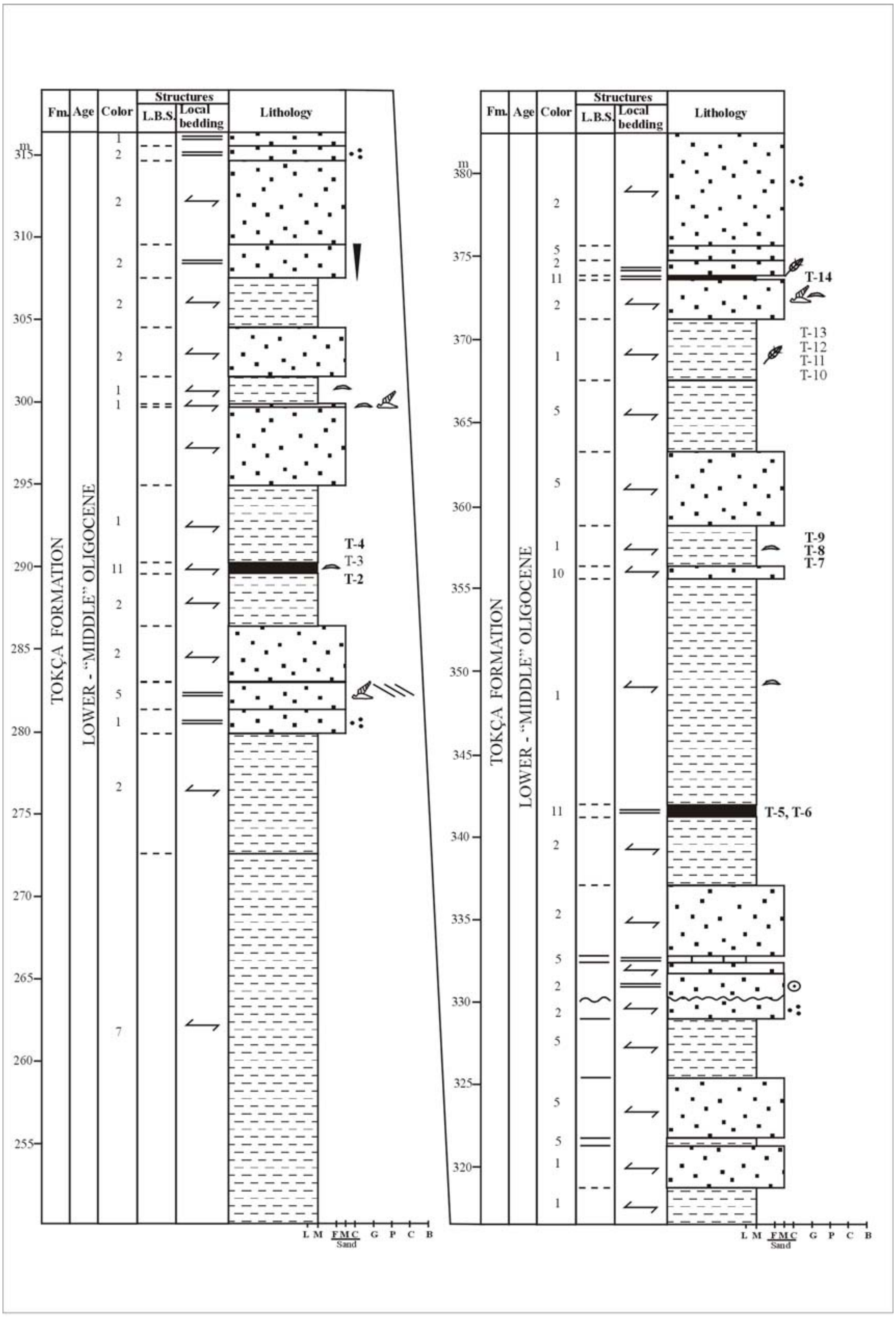


Figure 2.15 (continued)



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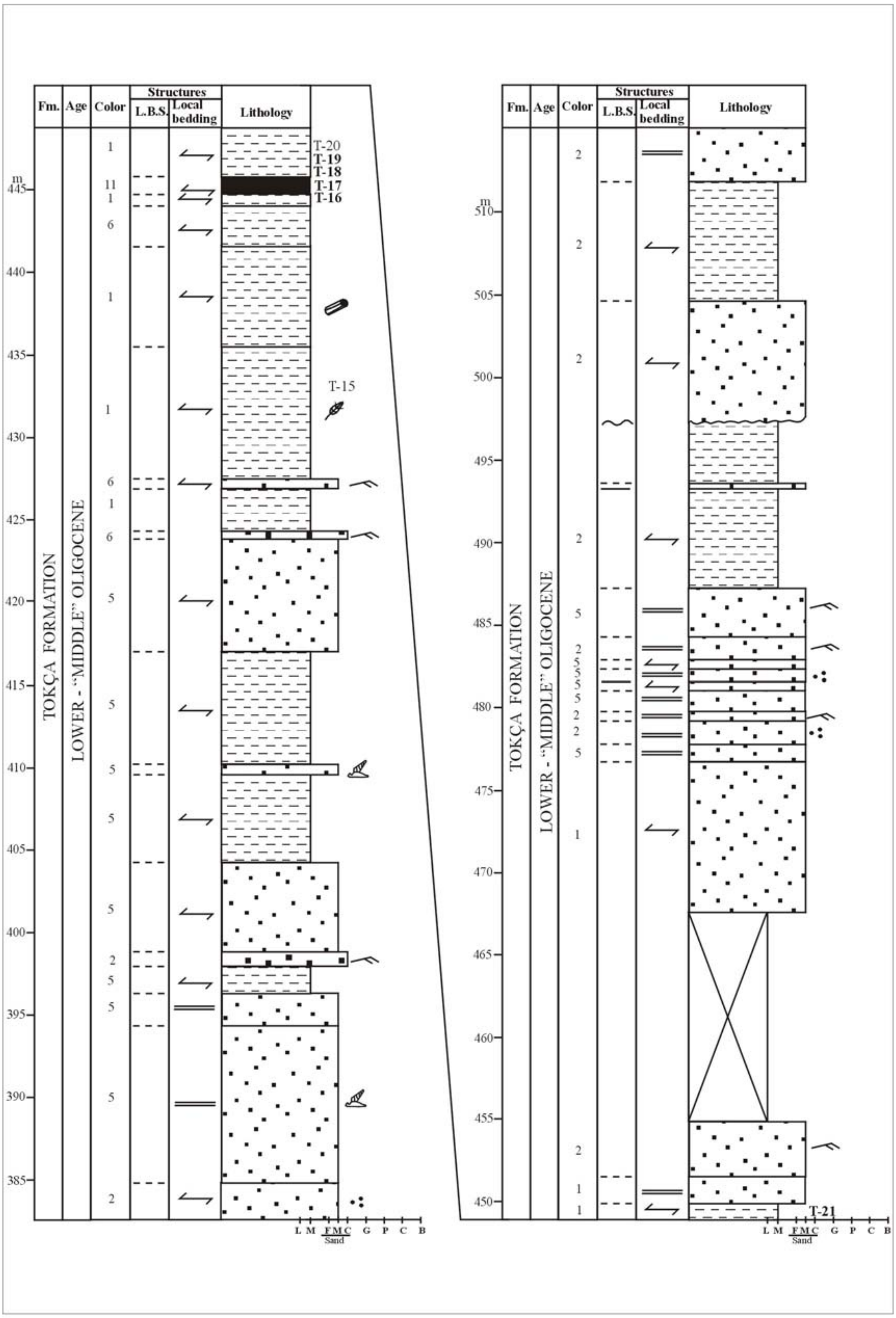

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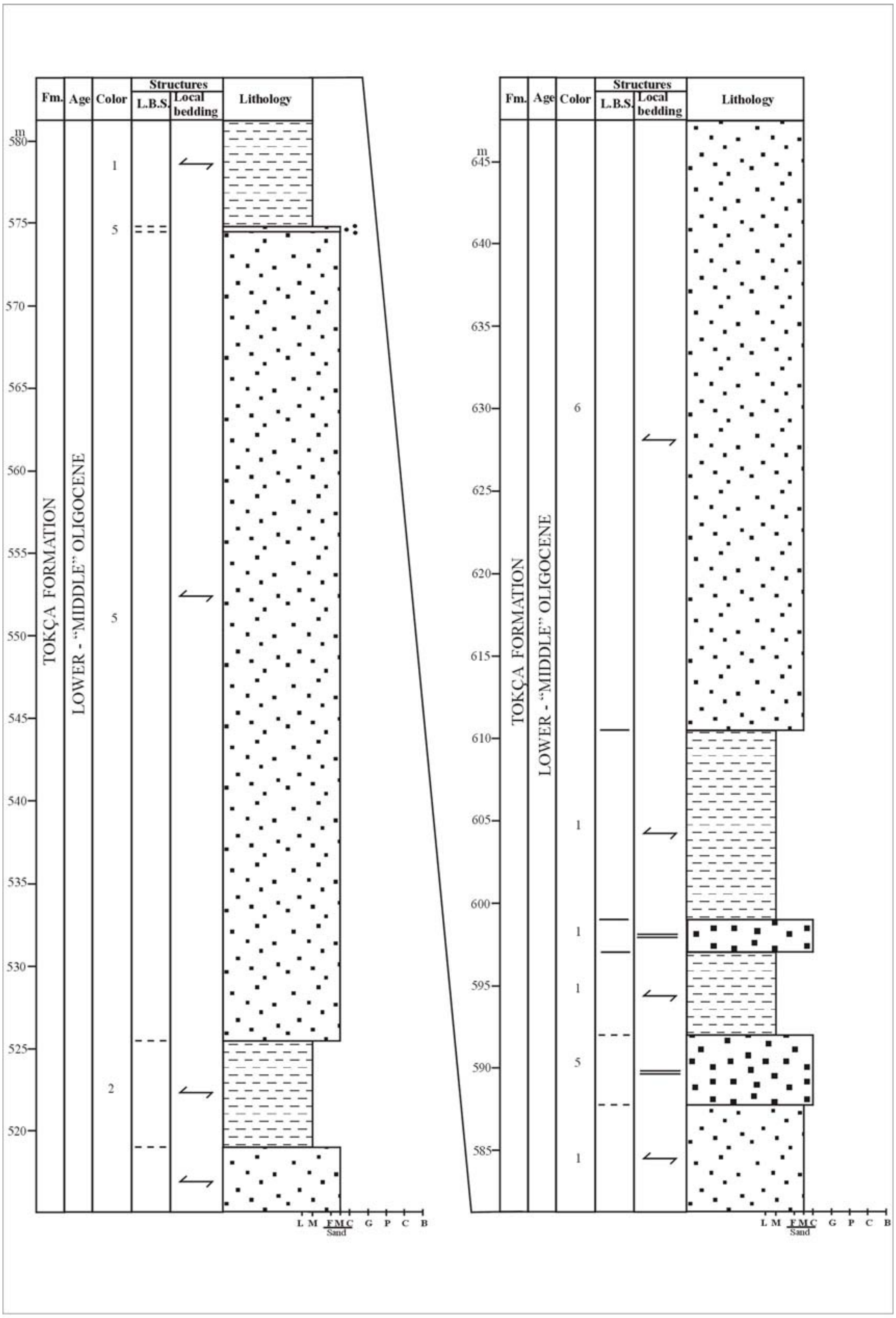

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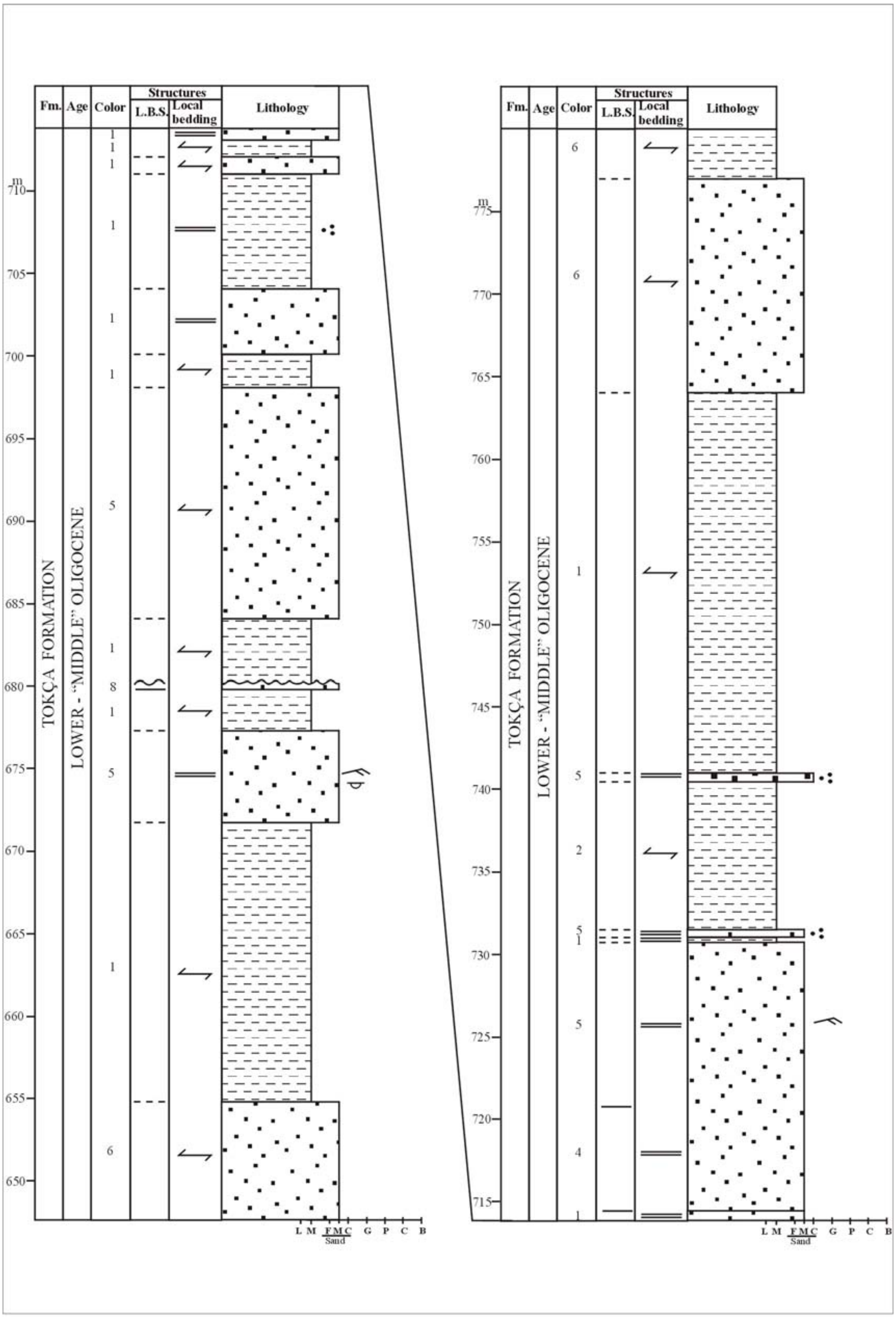

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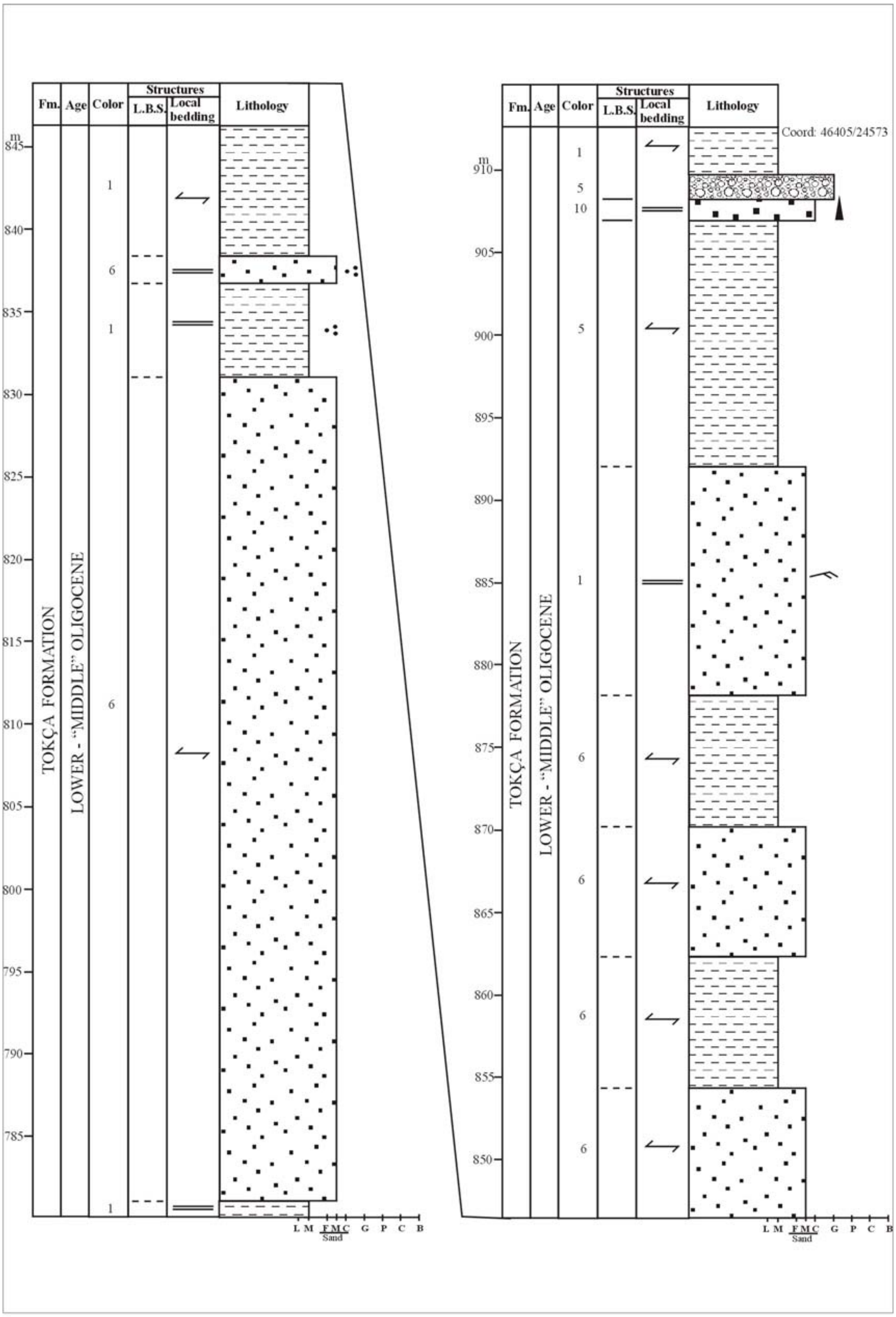


Figure 2.15 (continued)

2.2 The Burdur Area

2.2.1 Location of the Burdur **Area**

The NE–SW trending Burdur Area, located in the north of Lake Burdur, includes Mesozoic and Tertiary sediments in a wide area. To obtain the palynological samples from the area, field studies focused in the southwest part of the area, east of Başmakçı Village (Figs. 2. 16, 2. 18) and in the north of the area surrounding Kavak Village (Figs. 2. 16, 2. 22).

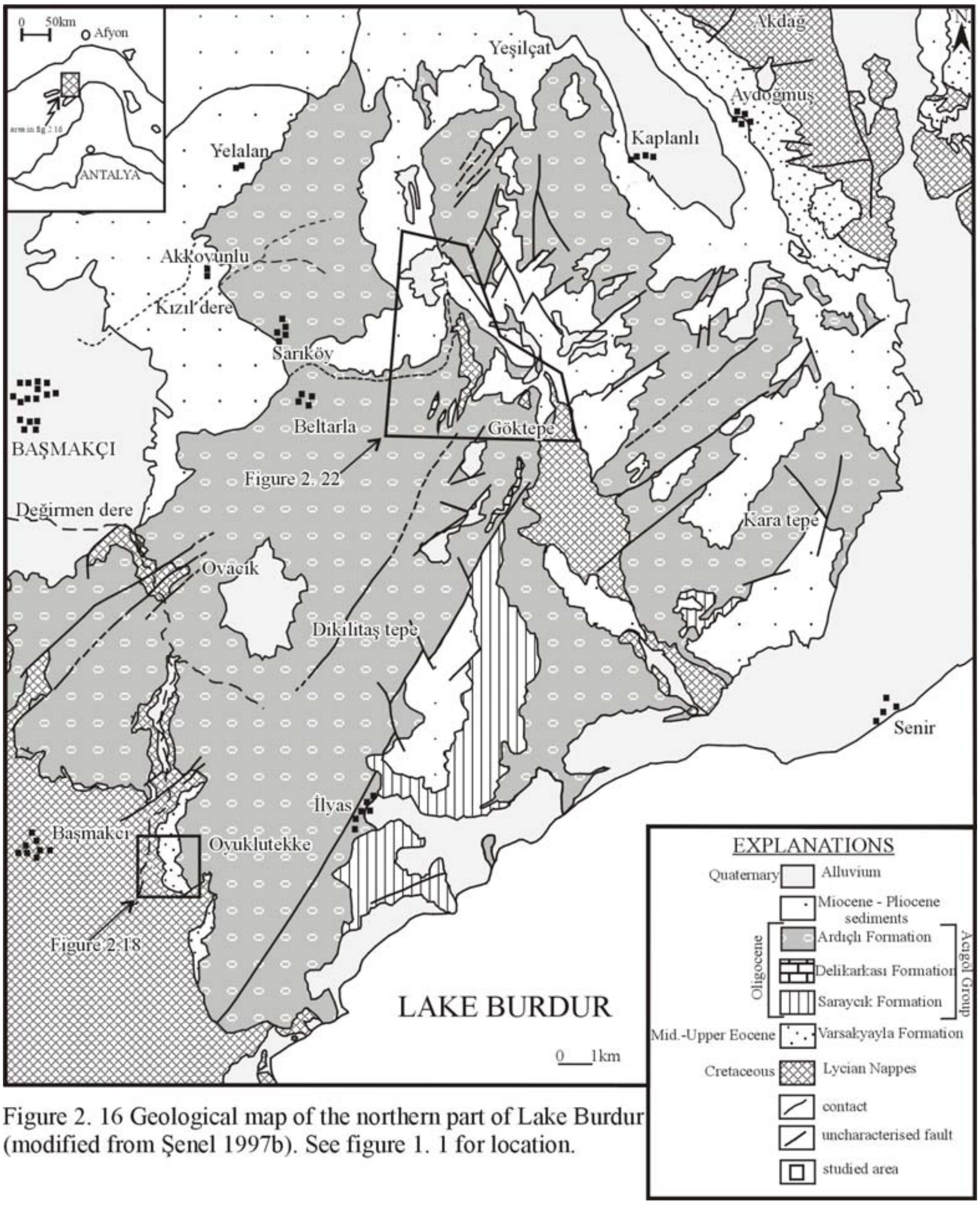


Figure 2. 16 Geological map of the northern part of Lake Burdur (modified from Şenel 1997b). See figure 1. 1 for location.

2.2.2 Stratigraphy

Tertiary sedimentary deposits of the Burdur Area can also be divided into supra–allochthonus sediments, Acıgöl group and neo–autochton cover units (Yalçınkaya et al., 1986; Şenel 1997b) (Fig. 2. 17). In the area, pre–Eocene basement is represented by ophiolitic melange and olistostrome of the Lycian Nappes (Poisson, 1977). The uncormably overlying Eocene Varsakyayla Formation is of about 270m in thickness (Fig. 2. 17) and generally consists of sandstone, mudstone, limestone alternation with coal, deposited in the beach shallow shelf environment. In the area, the Acıgöl Group attains its maximum thickness about 1650m and consists of two formations namely from bottom to top Saraycık and Ardıçlı formations.

The Oligocene Saraycık Formation named by Şenel (1997b) has about 150m total thickness, and is made up of sandstone and claystone, deposited in the terrestrial environment (Fig. 2. 17). The same unit has previously named as Küçükköy Formation by Yalçınkaya et al. (1986). The formation laterally and vertically grades into the Ardıçlı Formation, which is made up of thick polygenic conglomerates with recristalized limestone lenses, deposited in the shallow shelf environment under terrestrial influence (Şenel, 1997b) (Fig. 2.17). The formation has been named by Yalçınkaya et al. (1986) and its total thickness is about 1000–1500m (Fig. 2. 17).

The uncorfomably overlying Kavak Formation, has about 150m total thickness, as Şenel (1997b) stated, and is generally composed of conglomerate, sandstone, mudstone including coal and reefal limestone, deposited in the shallow shelf environment. The same unit was previously named as Atabey Formation by Yalçınkaya et al. (1986). The age of the formation is proposed to be of Aquitanian (Early Miocene) on the basis of benthic foraminifer and palynomorph assemblages (see chapter 4).

The Aksu Formation unconformably overlies the Kavak Formation. The formation generally consists of sandstone, mudstone with coals, deposited in shallow shelf environment. The formation has been named by Poisson (1977). The same unit was previously named as Gökdere Formation by Yalçınkaya et al. (1986). Its total thickness is about 1500m. Although the age of the Aksu Formation was accepted as the Tortonian (Late Miocene) by Yalçınkaya et al. (1986) and Şenel (1997b), an Aquitanian (Early Miocene) age is proposed based on the palynomorph assemblage (see chapter 4 for discussion).

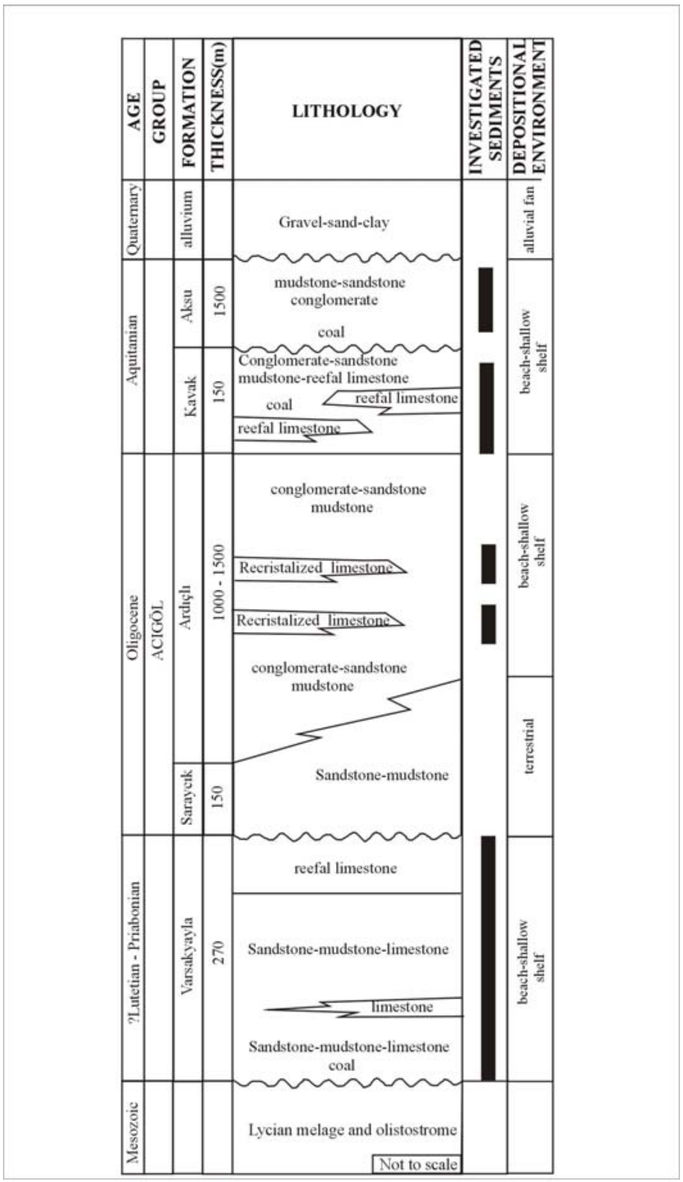


Figure 2. 17 Generalized lithostratigraphic columnar section of the Burdur Area illustrating investigated sediments and inferred depositional environments of formations (modified from Yalçınkaya et al. 1986; Şenel 1997b).

2.2.3 Geological Setting of the Southwest Burdur Area

The study area, located on the southwest of the Burdur Area, is situated in the north of Yukarıcimbili Village (Fig. 2. 18). In the area, pre–Eocene basement is represented by ophiolitic melange and olistostrome (Poisson, 1977) of Lycian Nappes, and mainly consists of serpentine, harzburgite, dunite and limestone blocks (Figs. 2. 18, 2. 19).

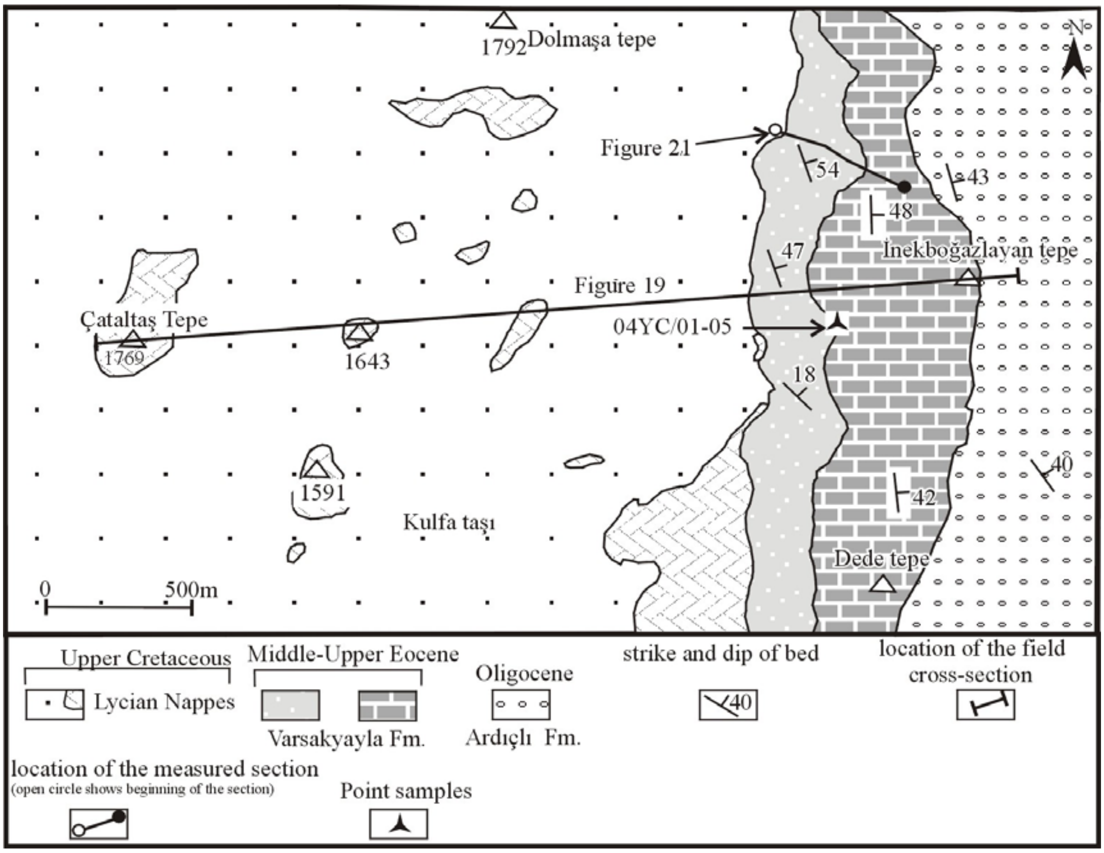


Figure 2. 18 Detailed geological map of northern part of Yukarıcimbili Village (north of Lake Burdur). See figure 2. 16 for location. Location of measured sections, geological sections and point samples are indicated.

The unconformably overlying Varsakyayla Formation was named by Poisson (1977) from Varsakyayla Village. The formation exposes well in this area and is mainly made up of conglomerate, sandstone, mudstone and reefal limestone (Figs. 2. 19, 2. 20). The lower part of the sequence consists of sandstone and mudstone alternation (Fig. 2. 21). Sandstones are generally greyish and comprise channel–fills, cross beddings, hematite concretions, plant debris and bioclasts at some parts (Fig. 2. 21).

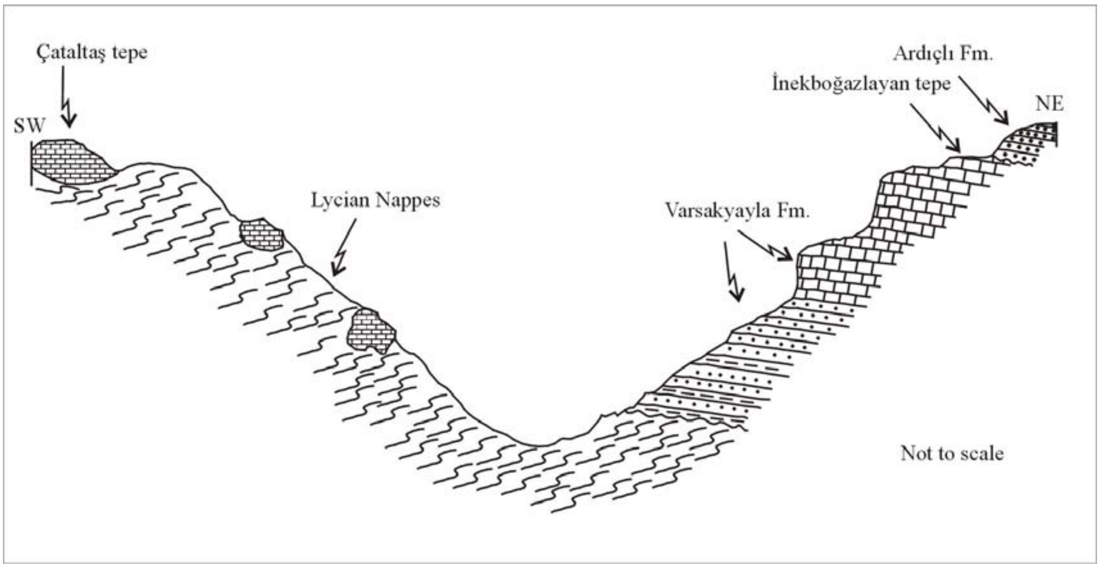


Figure 2. 19 Geological cross–section showing the unconformable lower boundaries of the Varsakyayla and Ardıçlı formations. See figure 2.18 for location and figure 2.47 for explanation.

Sandstones are considerably fractured in some places as well (Fig. 2. 21). The conglomerates, poorly sorted, derived from ophiolites occur through the upper part of the sequence (Fig. 2. 21). Additionally, bivalves and gatropod–bearing limestones also present in the sequence. The limestones including bivalves, gastropods, algae and benthic foraminifers are dominant through the upper part of the sequence. The formation was deposited in a shallow beach environment under terrestrial influence. In the area, the Oligocene Ardıçlı Formation that is generally composed of poorly sorted conglomerates unconformably overlies the Varsakyayla Formation (Figs. 2. 19, 2. 20). In this study, a detailed stratigraphical section with 275m total thickness was taken from the Varsakyayla Formation (Fig. 2. 21).

Totally, five samples for palynologic and thirty–nine samples for foraminifer investigations were collected from the Varsakyayla Formation (Figs. 2. 18, 2. 21).

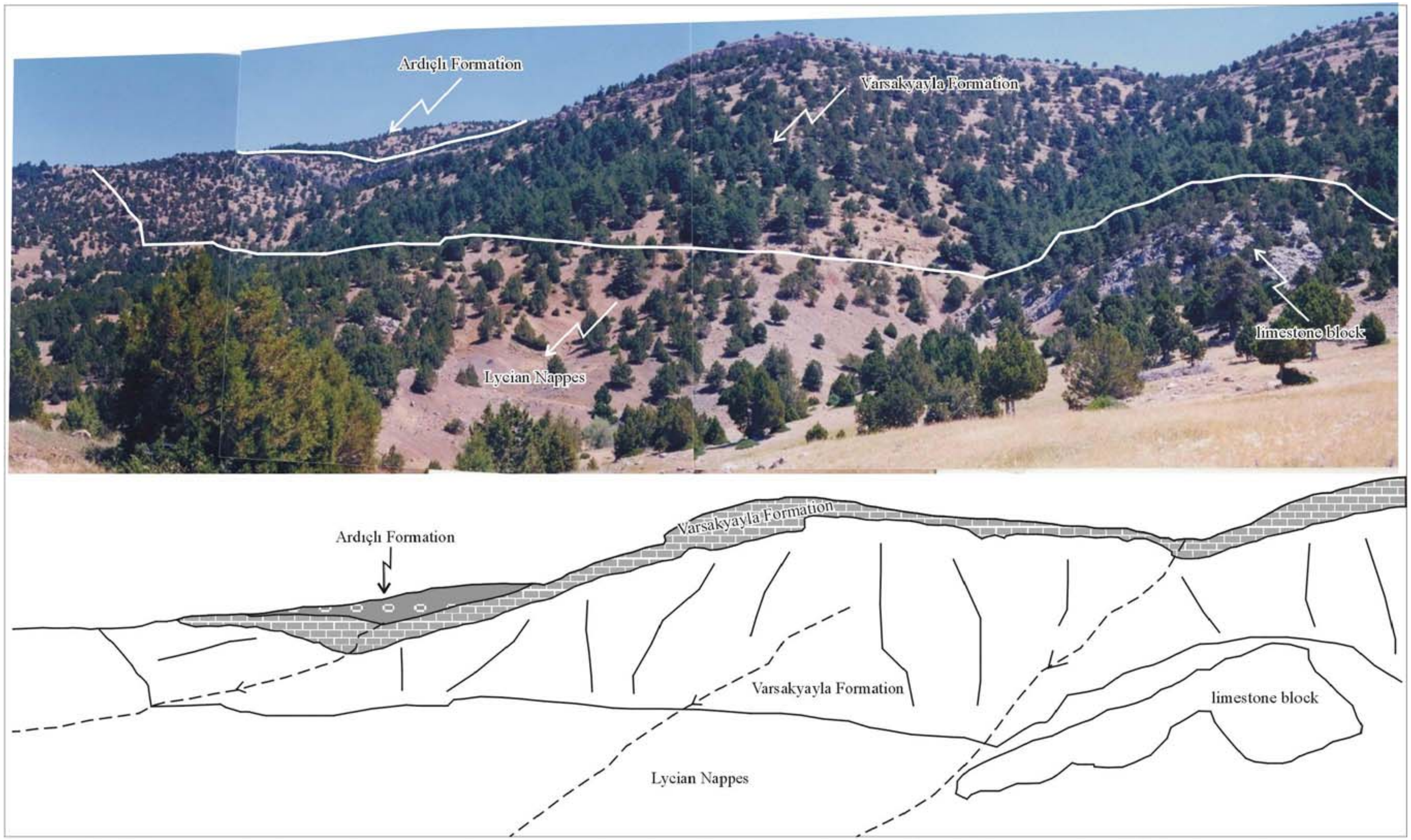


Figure 2. 20 Field photograph view showing an unconformable lower boundary of the Varsakyayla Formation with the underlying siliciclastic part of the Lycian Nappes.

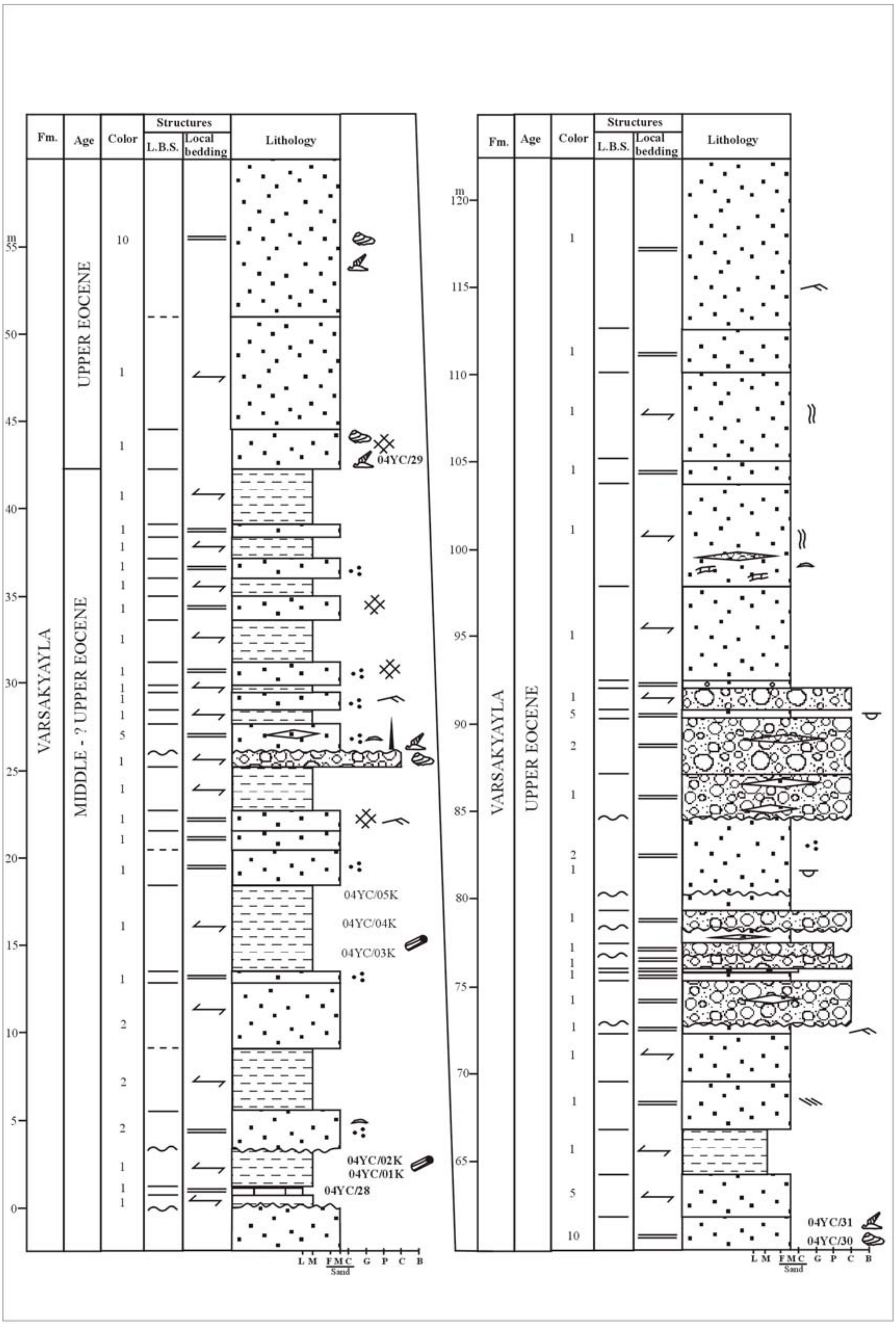


Figure 2. 21. Measured section of the Varsakyayla Formation from the north of Yukarıcimbili Village (see figure 2. 18 for location and figure 2. 58 for explanation).

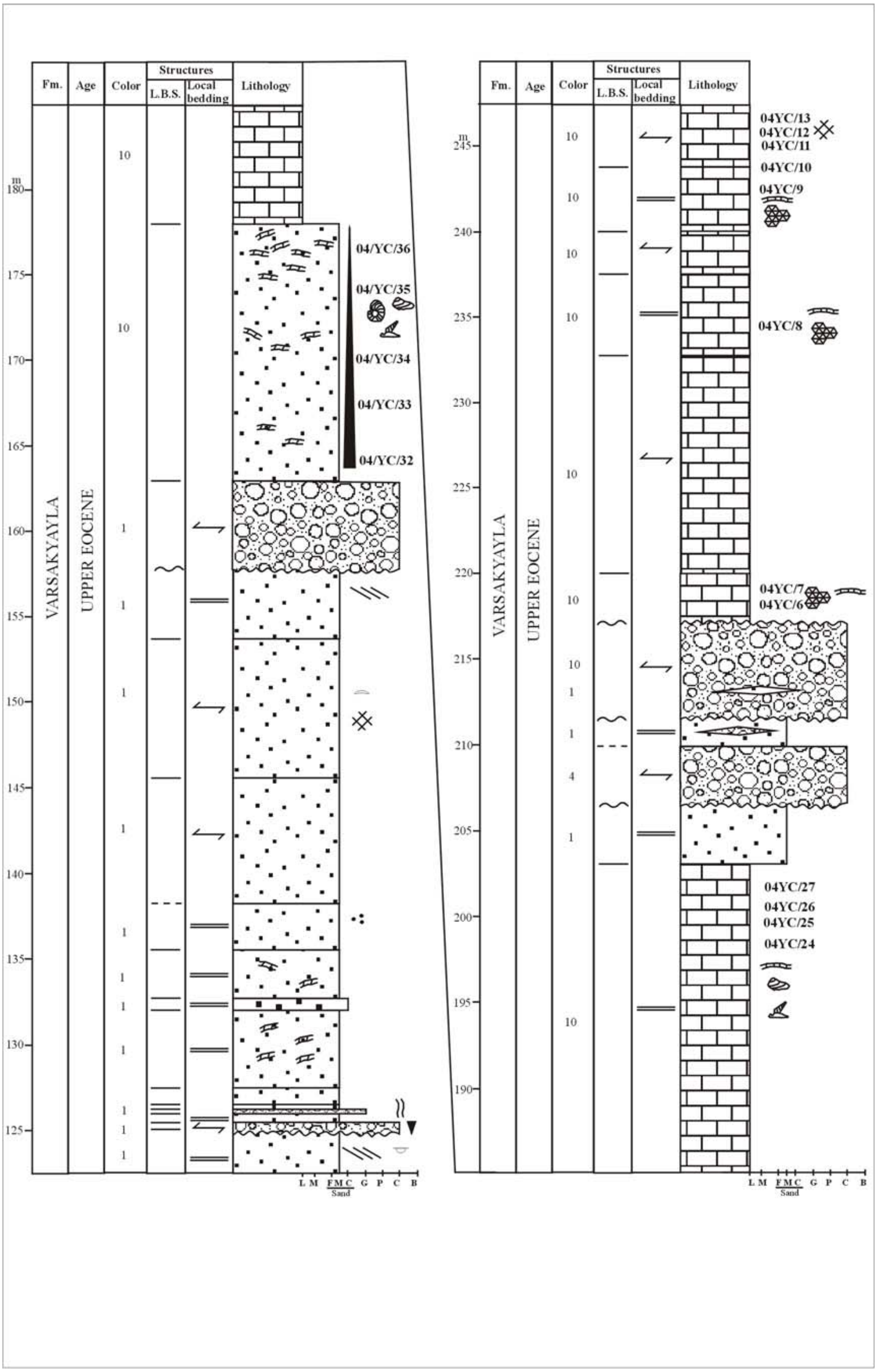


Figure 2. 21 (continued)

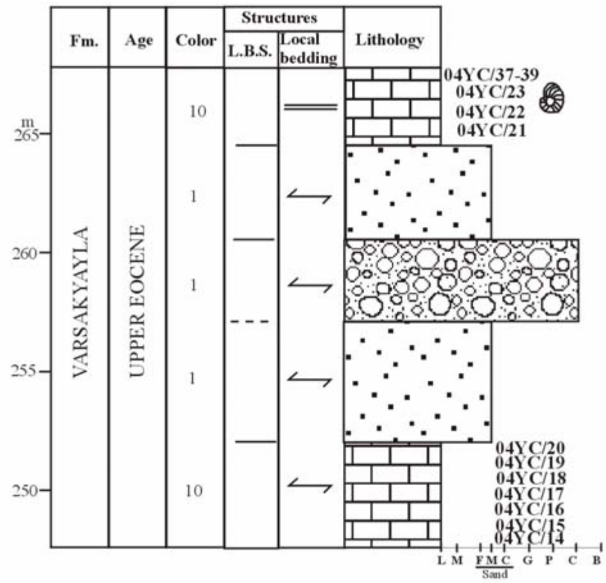


Figure 2. 21 (continued)

2.2.4 Geological Setting of the Northern Part of the Burdur Area

Field studies on northern part of the Burdur Area were carried out around the Kavak Village (Fig. 2. 22). In the area, the basement rocks consist of Mesozoic carbonates of the Lycian Nappes.

The Oligocene Ardıçlı Formation named by Yalçınkaya et al. (1986) from the Ardıçlı Village, located on the north edge of Lake Burdur, unconformably overlies the Lycian Nappes. It is mainly made up of shallow marine polygenic conglomerates, and includes recristalized shallow marines limestone lenses which are named as the Delikarkası Formation by Yalçınkaya et al. (1986) from the Delikarkası Tepe located in the southern part of Atabey. In the area, the Delikarkası Formation consists of thick–bedded recristalized limestone lenses. Strike–slip faultings occur at some parts of the lenses (Fig. 2. 23a).

The unconformably overlying Kavak Formation was named from the Kavak Village where the formation crops out well. The formation generally contains sandstone, mudstone including

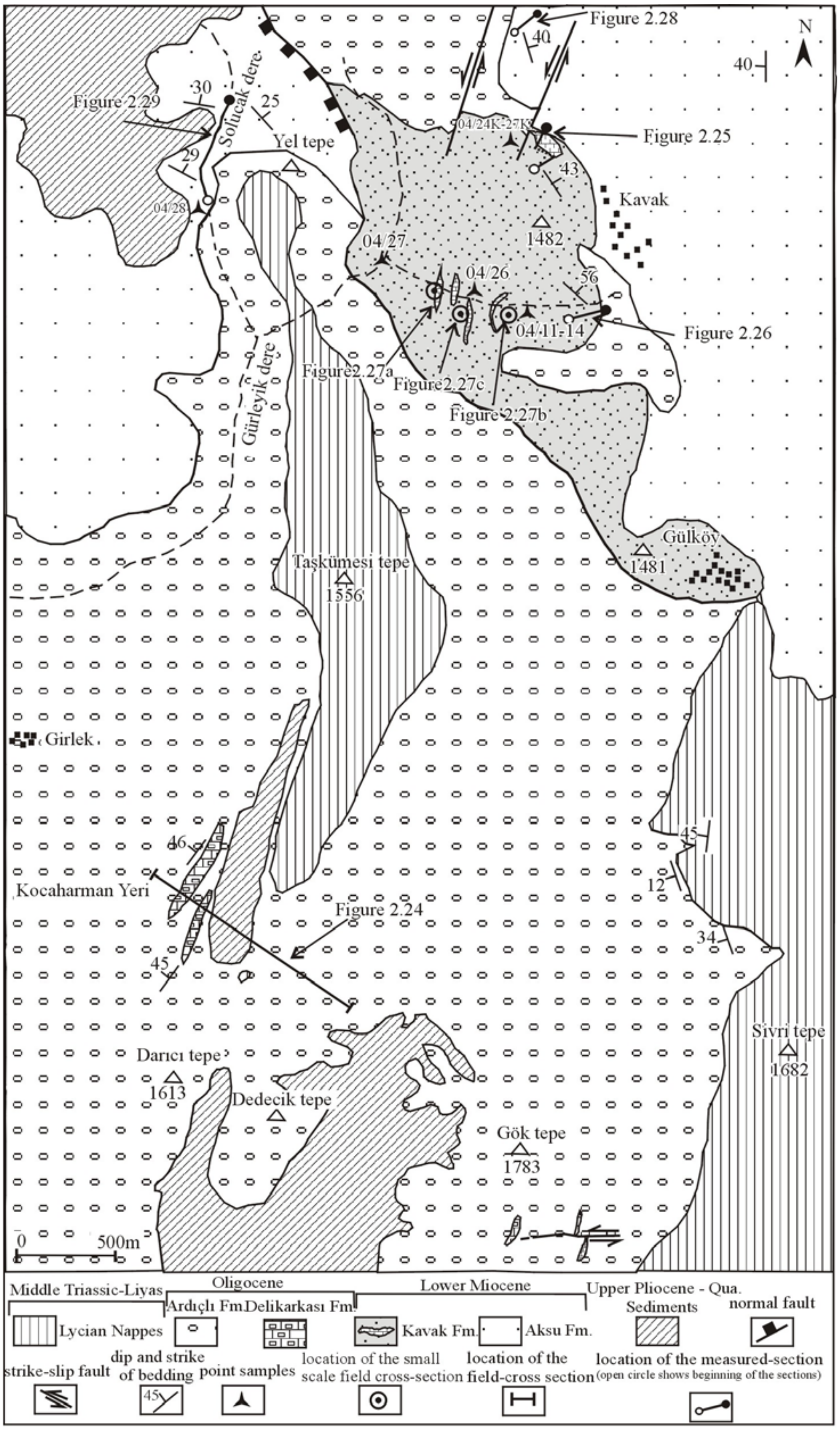


Figure 2. 22 Geological map of Kavak Village and surroundings. See figure 2. 16 for location. Location of geological cross–sections, measured sections and point samples are indicated.

deformed fossil fragments, coaly parts and reefal limestones comprising coral colony, gastropods, bivalves and a rich benthic foraminifer assemblage (Fig. 2. 23c) (Şenel, 1997b). Synsedimentary normal faults occur at some levels of the formation (Figs. 2. 23b). The Kavak Formation was deposited in a beach shallow–shelf environment (Şenel, 1997b).

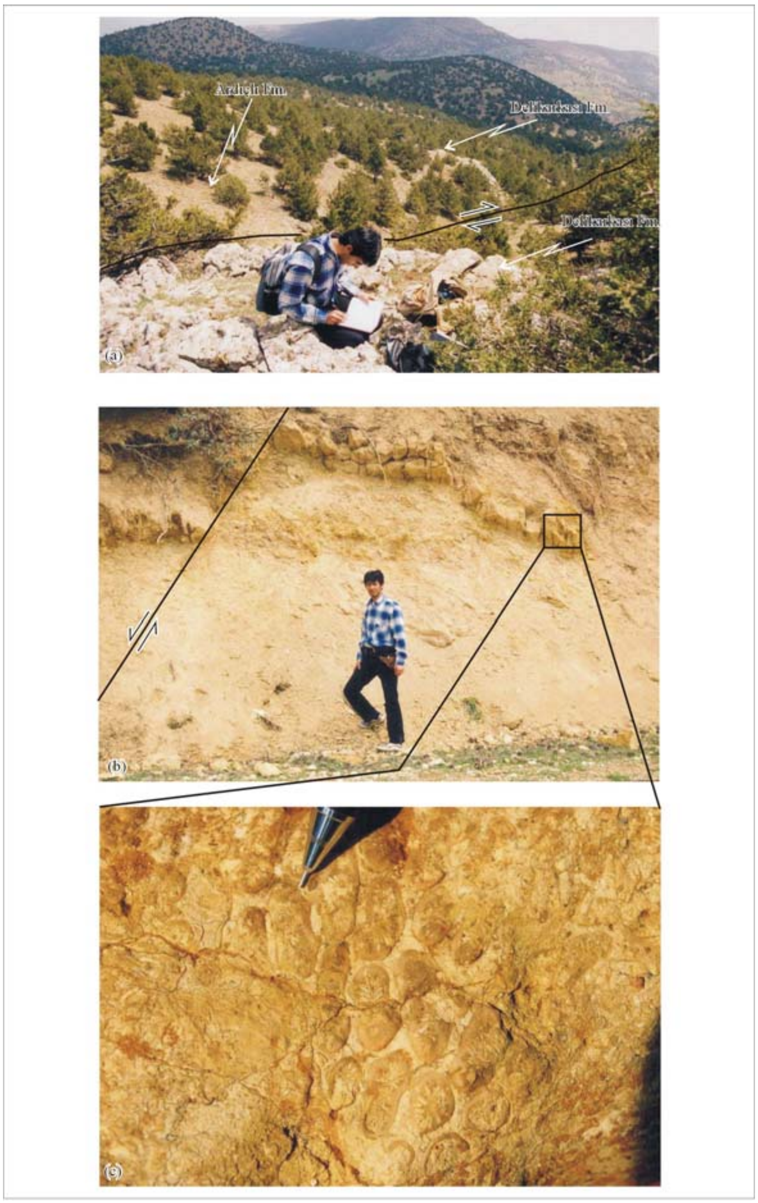


Figure 2. 23 Field photographs showing (a) a strike–slip fault in the Delikarkası Formation (Coordinates: 50950/95925), (b) synsedimentary normal fault in the Kavak Formation (Coordinates: 50780/01150), (c) close–up view of limestone including coral colony (Coordinates: 50780/01150).

The unconformably overlying Aksu Formation generally consists of conglomerate, sandstone and mudstone, deposited in a shallow marine environment under terrestrial influence. In some places, sandstones comprise bioturbation traces, hematites concretions, coral, gastropod, bioclast and coal seams and lenses. Pliocene–Quaternary alluvial sediments unconformably overlie the Aksu Formation.

A cross section was taken from the Ardıçlı Formation including the recristalized limestone lenses of the Delikarkası Formation (Fig. 2. 24). Two stratigraphical measured sections were taken from the Kavak Formation including shallow marine foraminifers and coals (Figs. 2. 25, 2. 26). Small scale cross sections were taken from the Kavak Formation as well (Fig. 2. 27). Additionally, two measured sections were also taken from the Aksu Formation (Figs. 2. 28, 2. 29).

Sixty–three samples were collected from the Kavak and Aksu formations for the purpose of palynological examination. Additionally, 42 samples were picked up from the Delikarkası and Kavak formations for the foraminifer investigation.

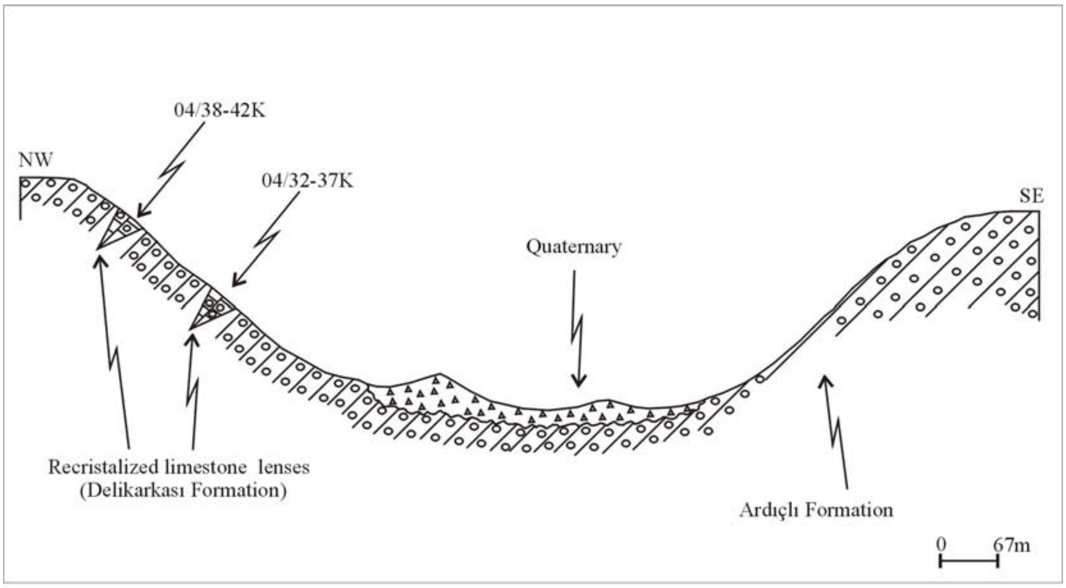


Figure 2. 24 Geological cross–section from the Oligocene Ardıçlı Formation including recristalized limestone lenses (Delikarkası Formation). See figure 2. 22 for section line figure 2. 47 for explanation.

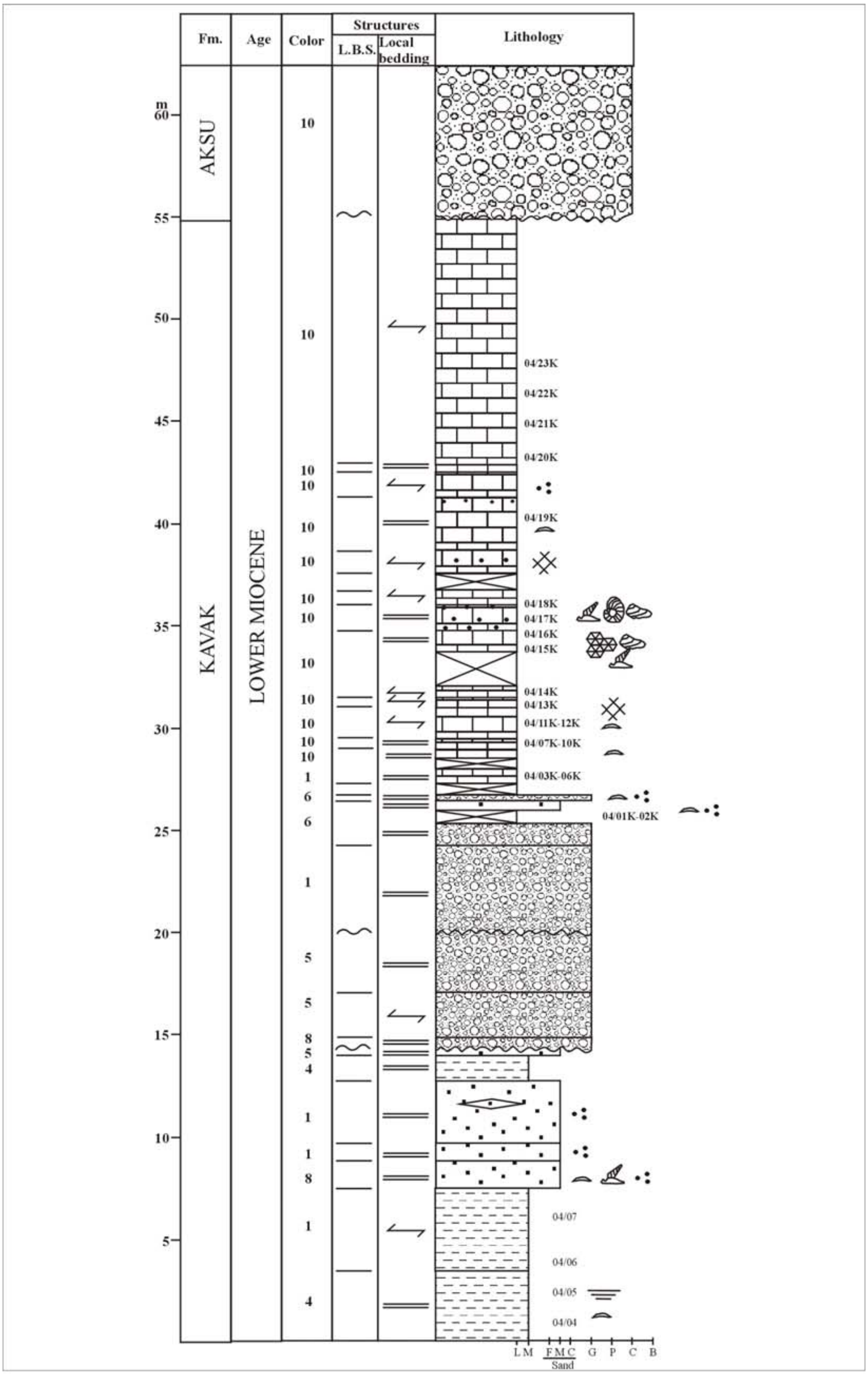


Figure 2. 25 Measured section of the Kavak Formation in the northwestern part of the Kavak Village (see figure 2. 22 for location and figure 2. 58 for explanation).

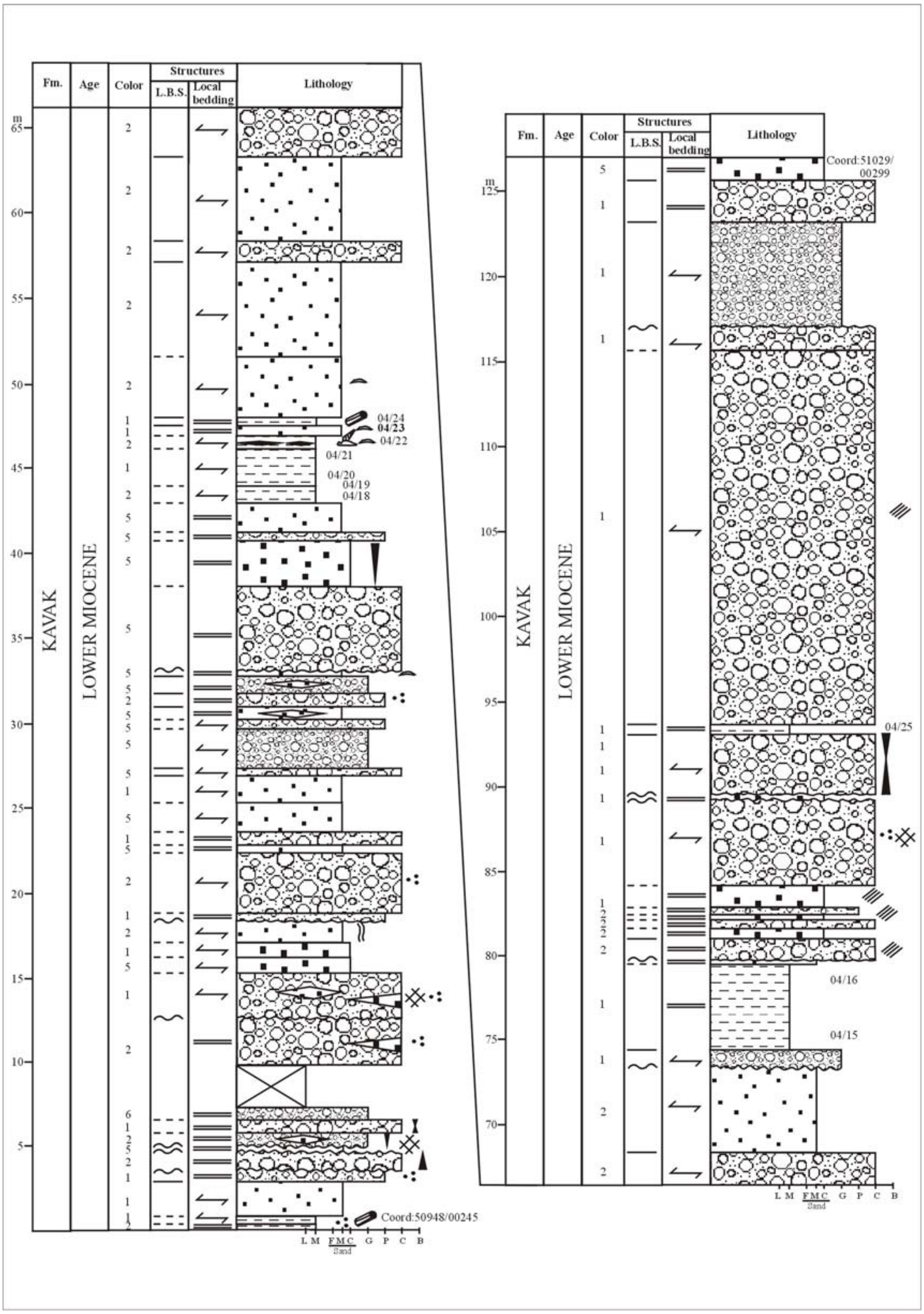


Figure 2. 26 Measured section of the Kavak Formation in the southeastern part of Kavak Village (see figure 2. 22 for location and figure 2. 58 for explanation).

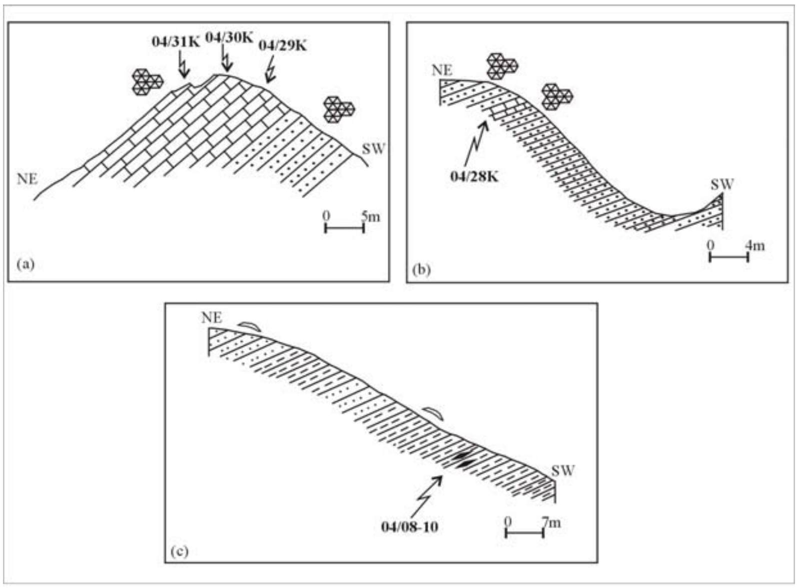


Figure 2. 27 Geological small cross–sections from the Kavak Formation. (a) Thick-bedded limestone including coral colony (Coordinates: 50242/00486), (b) medium to thick bedded sandstones with coral colony (Coordinates: 50500/00346), (c) coaly fine grained sediments (Coordinates: 50339/00380). See figure 2. 22 for location and figure 2. 47 for explanation.

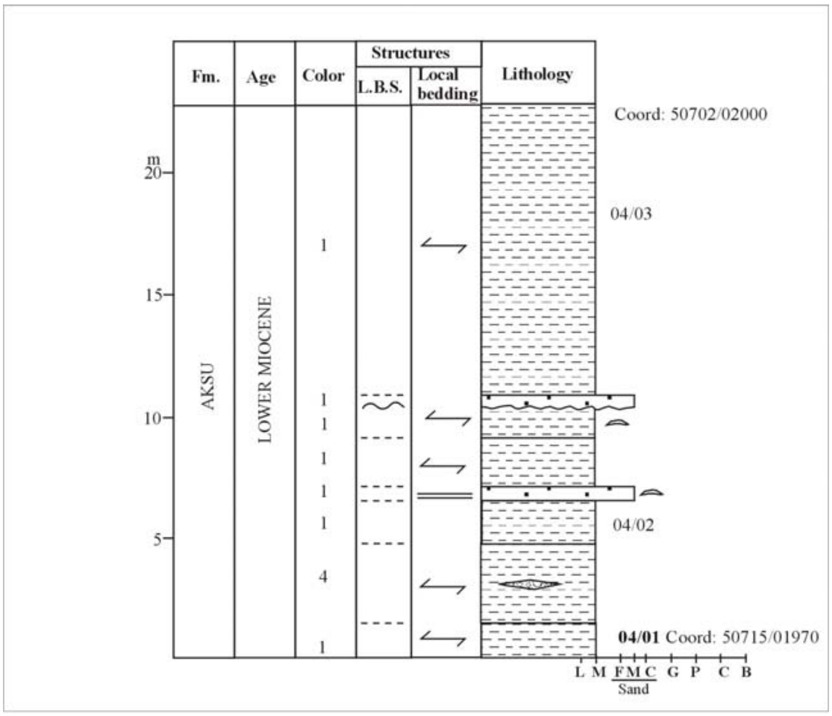


Figure 2. 28 Measured section of the Aksu Formation in the northwestern part of the Kavak Village (see figure 2. 22 for location and figure 2. 58 for explanation).

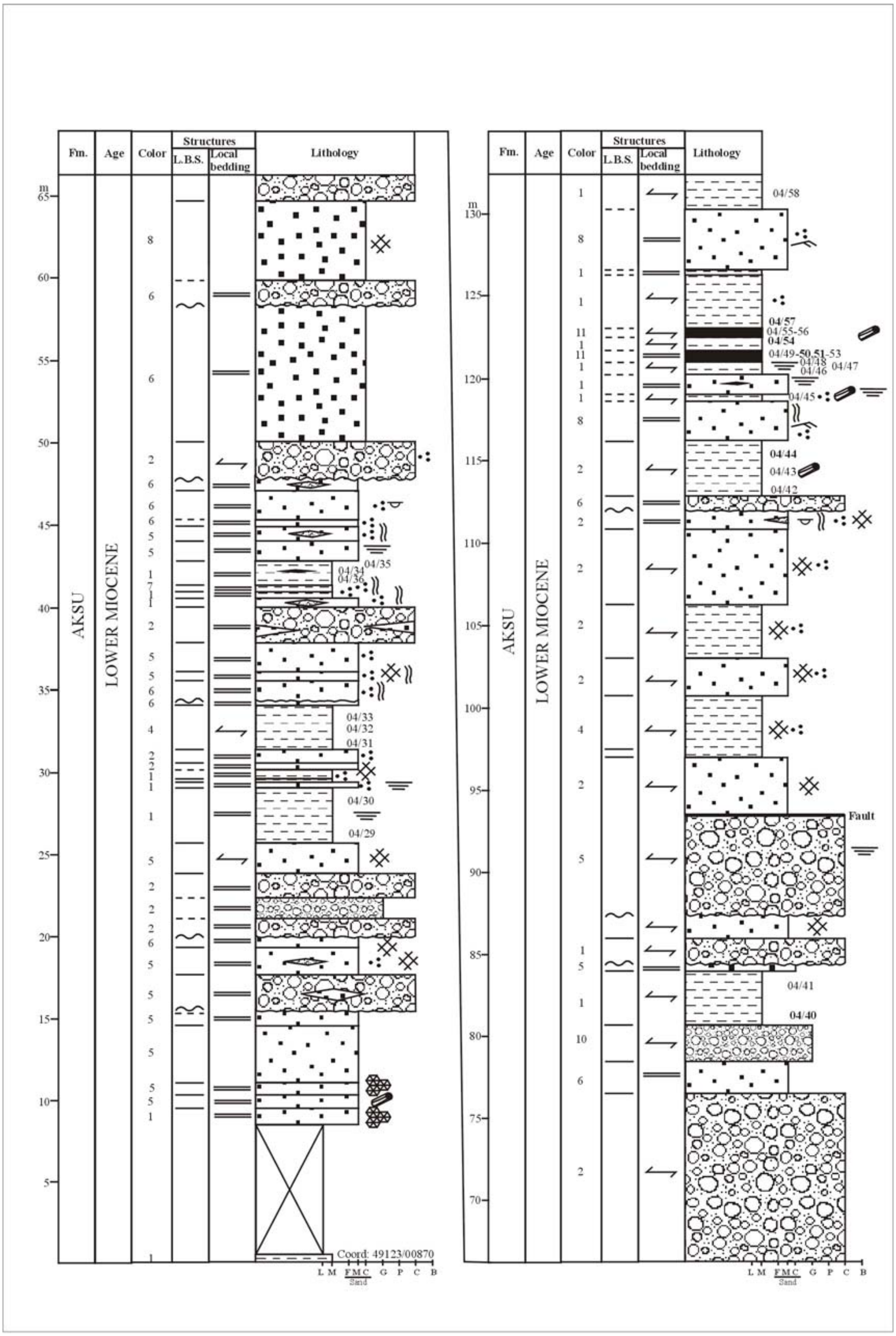


Figure 2. 29 Measured section of the Aksu Formation along Solucak Dere in west of Kavak Village (see figure 2. 22 for location and figure 2. 58 for explanation).

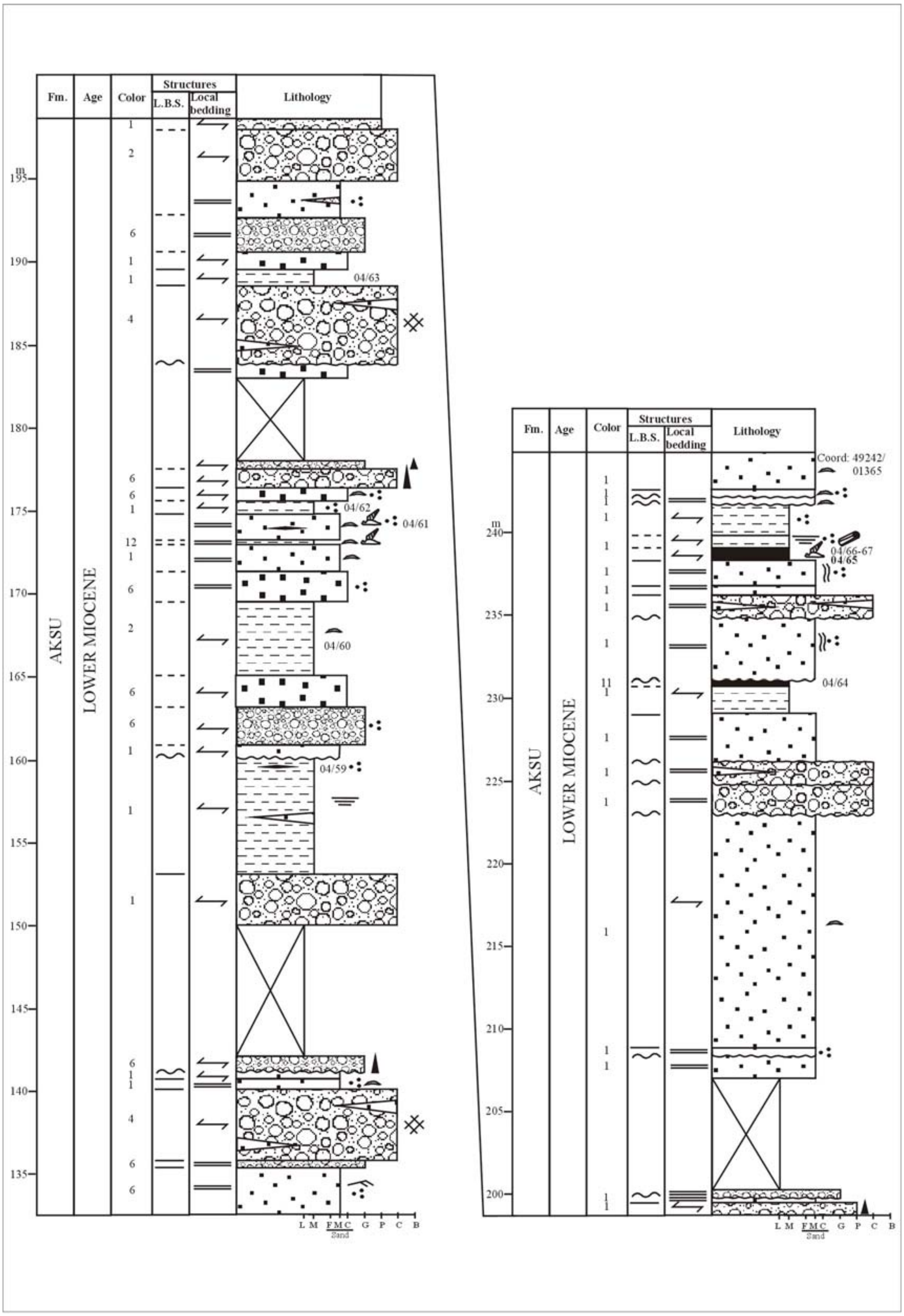


Figure 2. 29 (continued)

2.3 The İncesu Area

2.3.1 Location of the İncesu Area

The study area is situated in western part of the Isparta bends. Different tectonostratigraphic units, such as Bey Dağları Autochthon, Antalya Nappes and Lycian Nappes occur on Taurids (Fig. 2. 30). The Mesozoic autochthonous corbonate sequences were previously named as Geyikdağı unit by Özgül (1976) on Taurids, Bey Dağları carbonate platform by Poisson et al. (1984) on the Isparta bend and Hoyran neritic carbonate platform by Koçyiğit (1984) on the Hoyran lake region between Hoyran and Senirkent.

On the studied area, the Kırdağları, Barladağ and Isparta series belonging to the Bey Dağları Autochthon occur in the western part of Isparta bend (Gutnic, 1977) (Fig. 2. 30). The Kırdağları series crops out well in the northern part of İncesu Village (Fig. 2. 30). The Barladağ series occurs in the northern part of Gönen Town, eastern part of Kırdağları series, and overthrust on the allochthonous ophiolitic nappes also Eocene sediments (Fig. 2. 30). The Isparta series crops out well both on the northeastern and southwestern parts of Atabey Town (Fig. 2. 30). Additionally, ophiolitic Antalya Nappes have also been observed in internal part of the Isparta bend, and overthrust on the Isparta series of Bey Dağları Authocthon. Lycian Nappes overlie the western part of the bend (Fig. 2. 30).

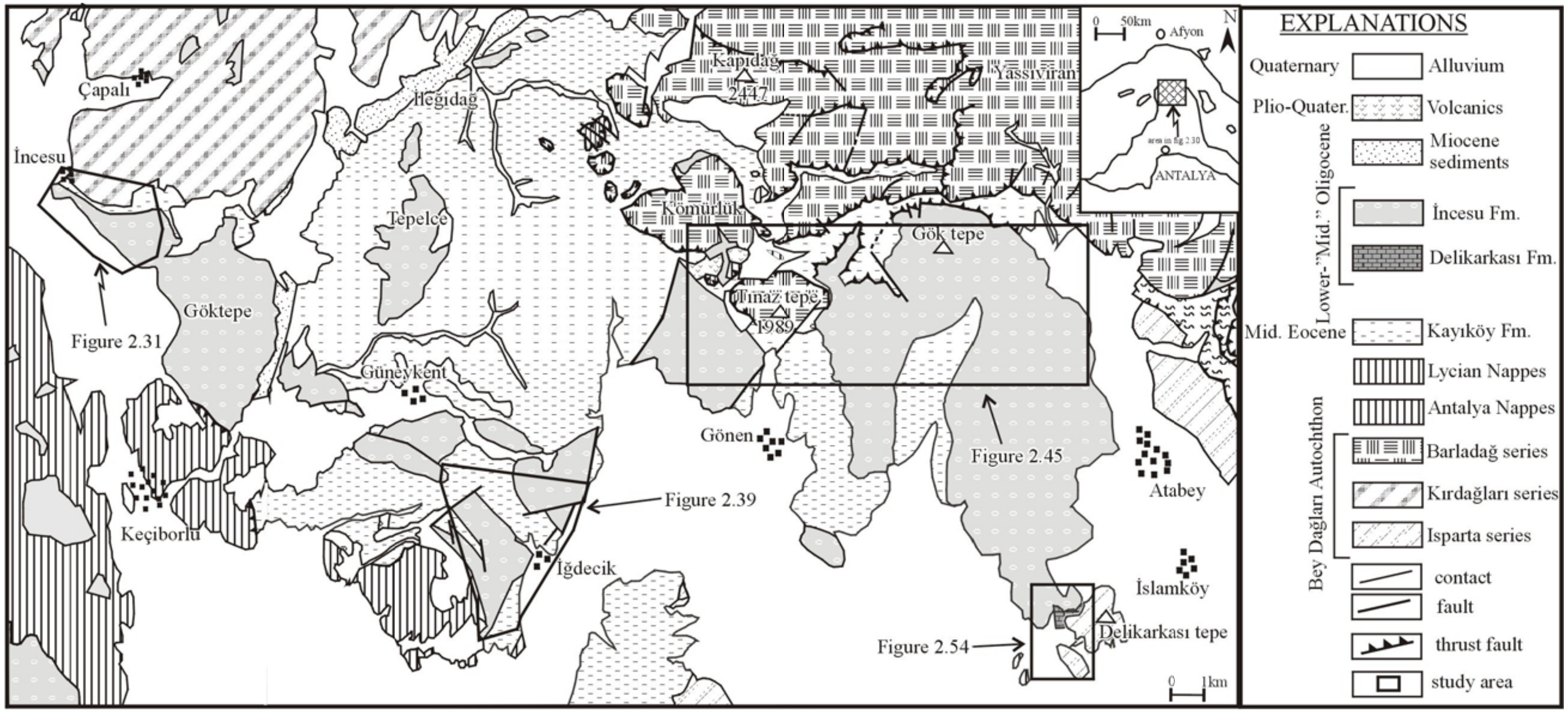


Figure 2.30 Simplified geological map of the northern part of Gönen Town (modified from Gutnic, 1977;Yağmurlu,1994). See figure 1.1 for location.

2.3.2 Stratigraphy

The field studies concentrated on four different areas indicated in Fig. 2. 30, and comprise İncesu–İğdecik villages and Gönen–Atabey towns, located at north and northwest of Isparta city in western Taurids, Lake District (Fig. 2. 30). In this part, a generalized columnar section has been created for the area including İncesu Village (Fig. 2. 32a). Additionally, a generalized columnar section has also been prepared for the surroundings of İğdecik, Gönen and Atabey.

2.3.2.1 Surrounding of İncesu Village

The sedimentary succession surrounding the İncesu Village can be divided into two parts as the Kırdağları serie belonging to the Beydağları autochton and neo–autochtonous sediments (Fig. 2. 31, 2. 32a).

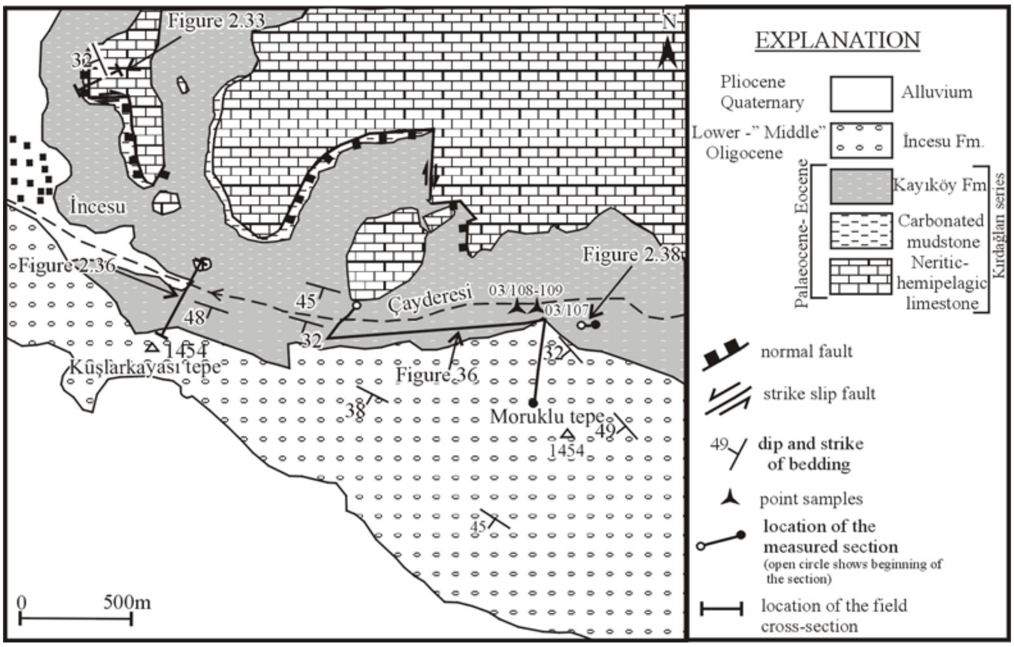


Figure 2. 31 Detailed geological map showing the east of İncesu Village. See figure 2. 30 for location. Location of measured section, geological cross-sections and point samples are indicated.

Gutnic (1977) studied the Taurids and distinguished the Jurassic–Cretaceous neritic limestones. Palaeocene–Eocene neritic and hemipelagic limestones conformably overlie Jurassic–Cretaceous neritic limestones (Gutnic, 1977). In the area, deep marine thin bedded carbonated mudstones conformably overlie the neritic and hemipegic limestones as well (Figs. 2. 31, 2. 32a, 2. 33).

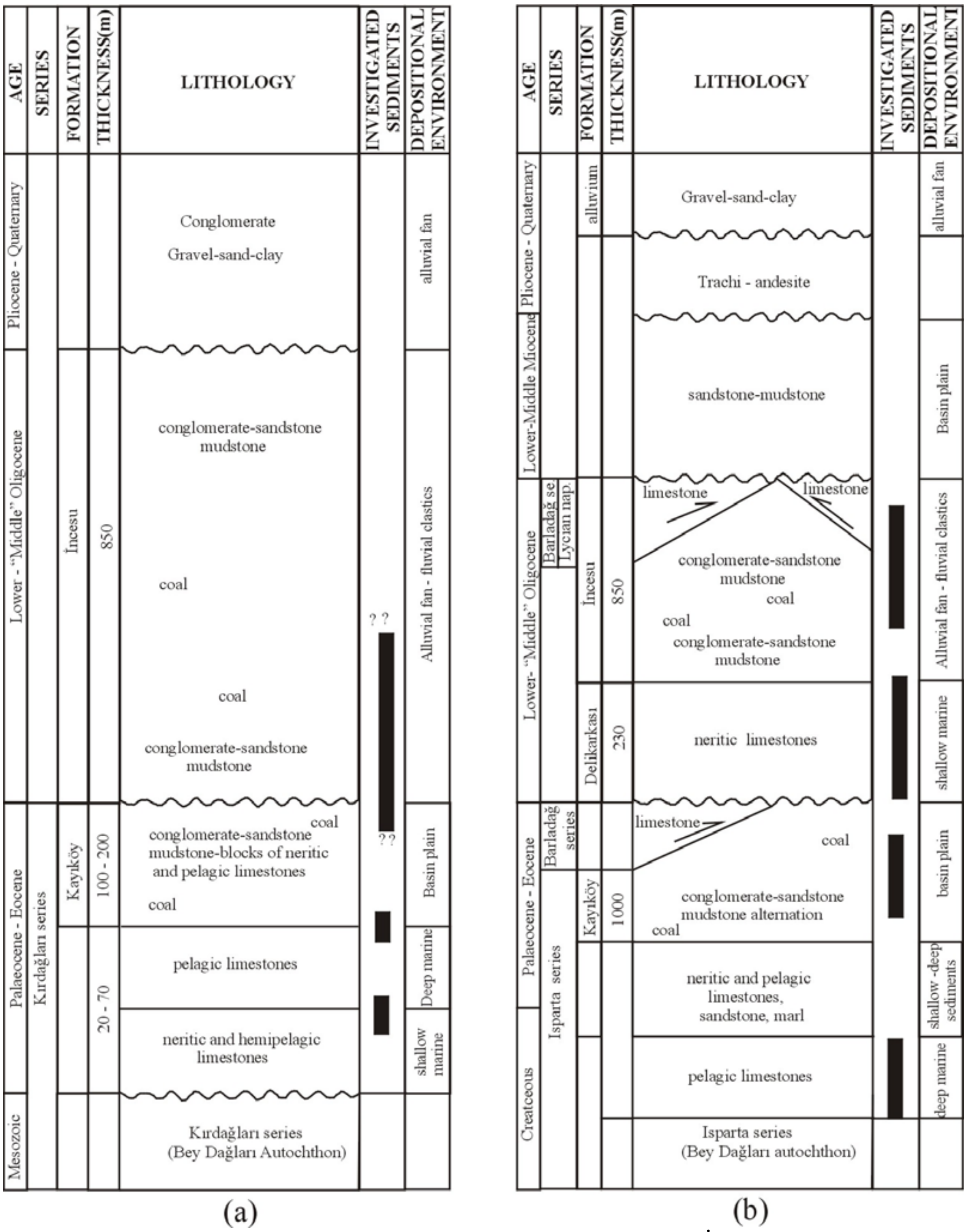


Figure 2. 32 Generalized lithostratigraphic columnar sections of the İncesu Area, investigated sediments and inferred depositional environments of the formations. (a) Surrounding of İncesu Village, (b) Surrounding of İğdecik, Gümüşgün villages, Gönen and Atabey towns (modified from Gutnic, 1977; Görmüş & Özkul, 1995;Yağmurlu, 1994).

The Kırdağları series comes to an end in the Middle Eocene Kayıköy Formation, named after Kayıköy Village, where it exposes well (Karaman et al., 1989). Its total thickness around Kayıköy Village is between 100–200m (Fig. 2. 32a). The formation consists generally of coal seams and lenses–bearing sandstone, mudstone alternation and limestone blocks derived from the Mesozoic rocks of the Kırdağları series (Fig. 2. 35). Additionally, the formation includes hematite concretions, bioturbations and bioclasts. The formation was deposited in the basin plain on the basis of flysh–like sediments (Yağmurlu, 1994; Görmüş & Özkul, 1995). The unconformably overlying Lower–"Middle" Oligocene İncesu Formation, named by Gutnic (1977) , is generally made up of thick to massive conglomerates and coaly sandstones, which were deposited in a alluvial–fan and fluvial environment (Figs. 2. 34, 2. 36). The total thickness of the formation outcropping in the north of Isparta is about 850m (Görmüş & Özkul, 1995). The Oligocene and Miocene deposits are accepted as the neo–autochthons by Gutnic (1977). These sediments are unconformably overlain by the Pliocene–Quaternary sediments and alluvium.

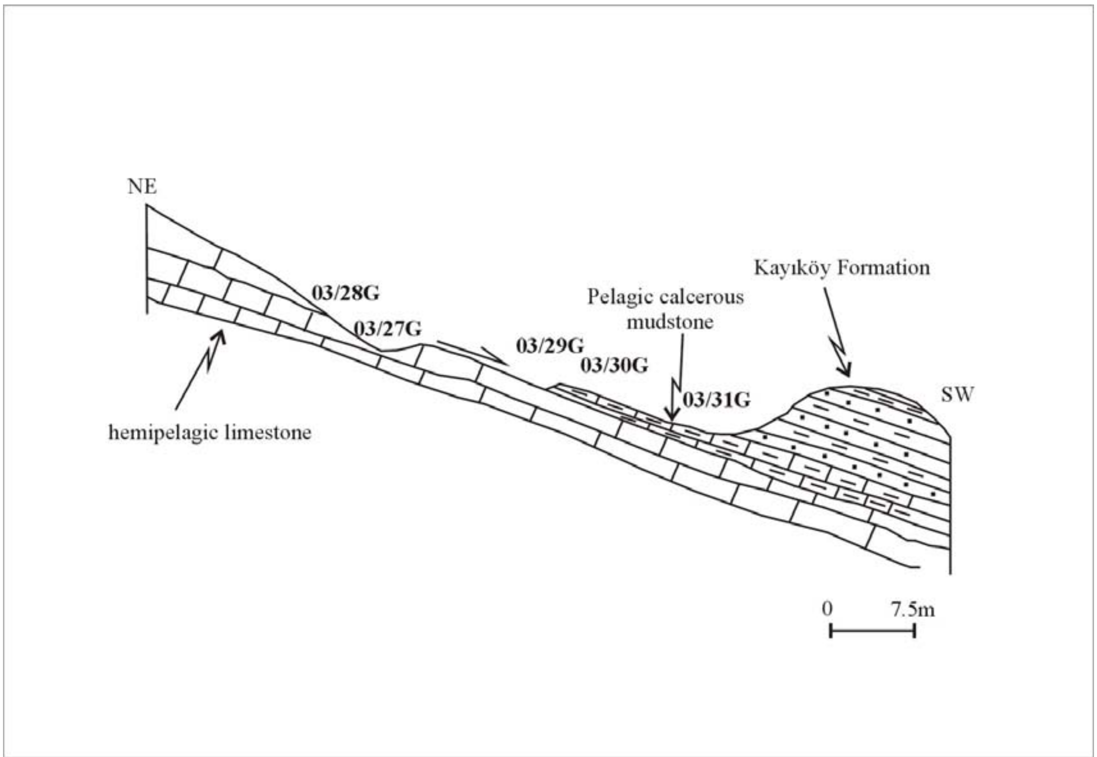


Figure 2. 33 Geological cross–section on the north of İncesu Village illustrating fault–bounded lower boundary of pelagic calcerous mudstones (Coordinates: 61681/13050). See figure 2. 31 for location and figure 2. 47 for explanation.

Figure 2. 34 Field photograph showing a disconformity at the lower boundary of İncesu Formation (Coordinates: 61162/12144).

A detailed measured section was taken from the coal–bearing Kayıköy and İncesu formations (Fig. 2. 37). Some cross–sections were taken from the neritic, hemipelagic and pelagic carbonated mudstones as well (Fig. 2. 33; 2. 36). In addition, a small–scale measured section was taken from the Kayıköy Formation along the Çay Dere (Fig. 2. 38).

Seventeen samples from the Kayıköy and five samples from the İncesu Formation were taken for palynological analysis. Also eight samples were taken for the foraminifer investigations from the neritic and pelagic limestones of the Kırdağları series.

Figure 2. 35a, b Field view of limestone blocks embedded in the matrix of turbiditic sandstone and mudstone alternation of the Kayıköy Formation.

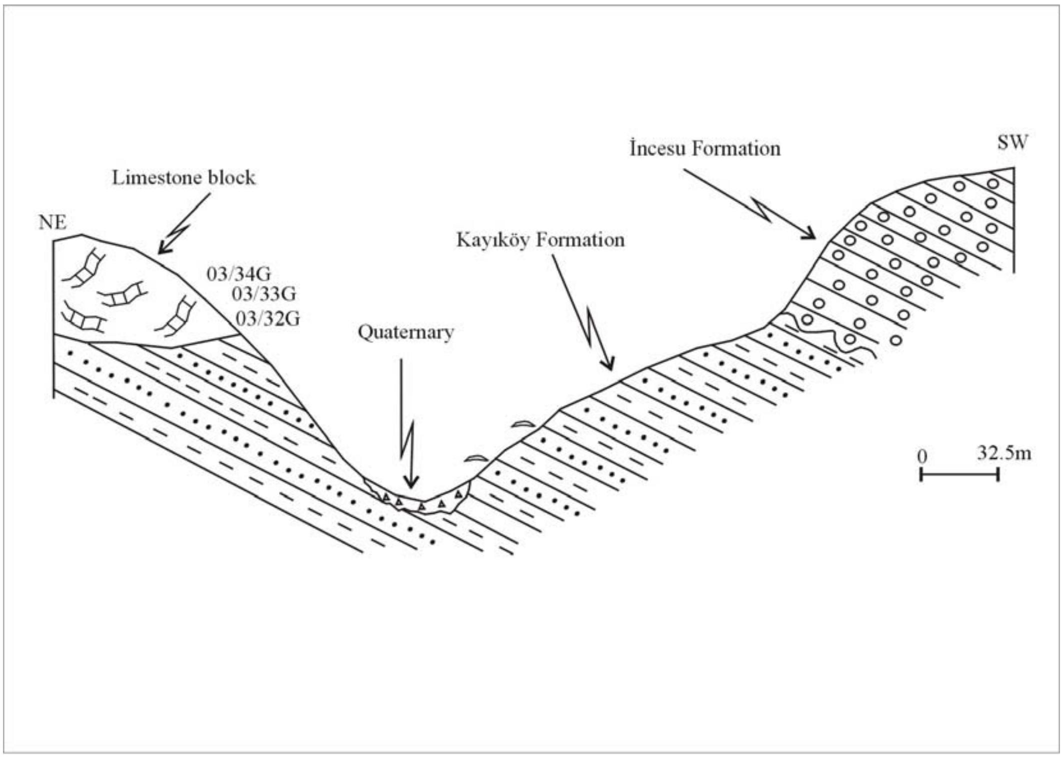


Figure 2. 36 Geological cross–section showing a disconfomity at the lower boundary of the İncesu Formation with the reefal limestone block of Bey Dağları Autochthon. See figure 2.31 for location and figure 2. 47 for explanation.

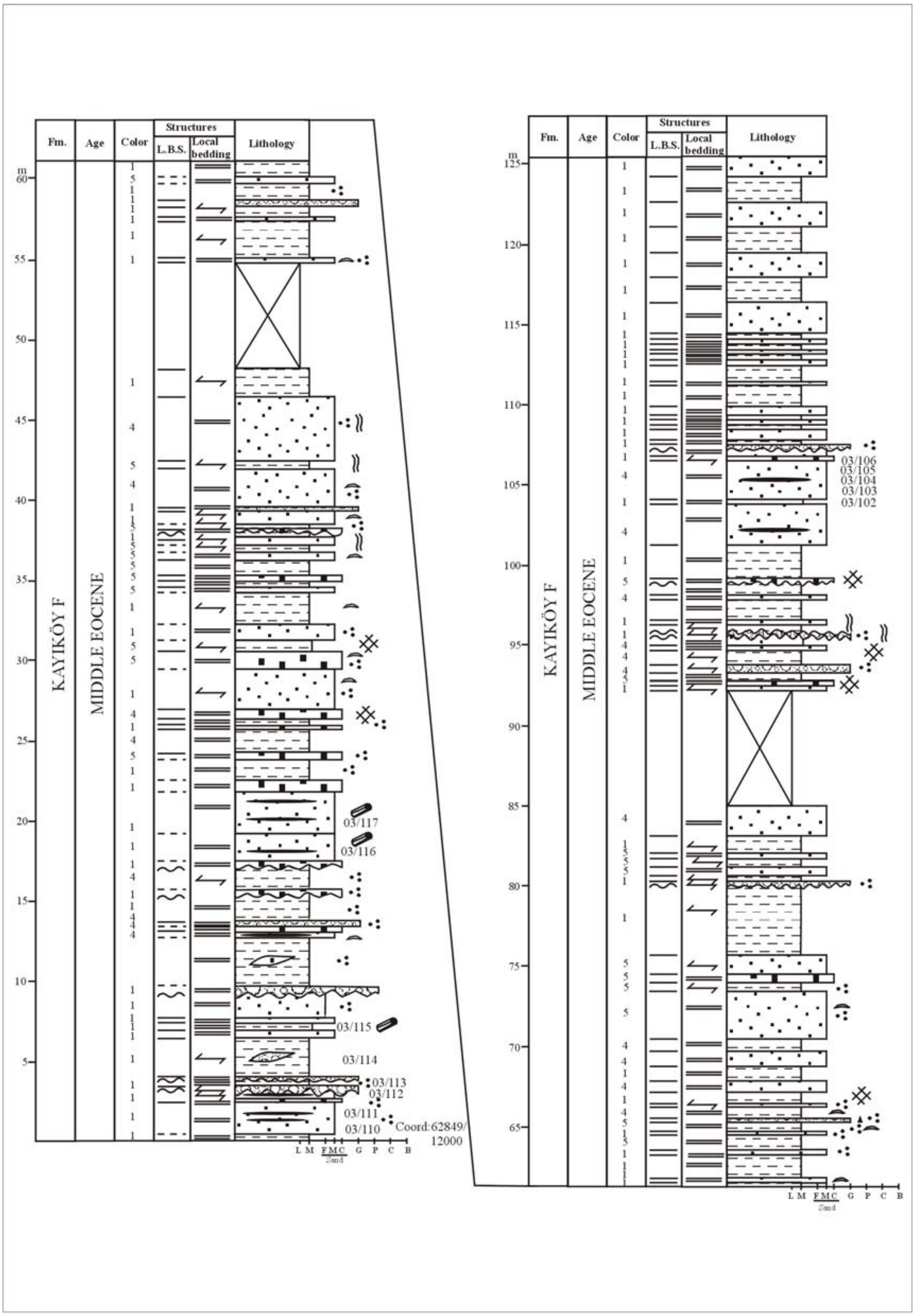


Figure 2. 37 Measured section of the İncesu Formation near the Oluk Çeşme in the southeast of the İncesu Village (see figure 2. 31 for location and figure 2. 58 for explanation).

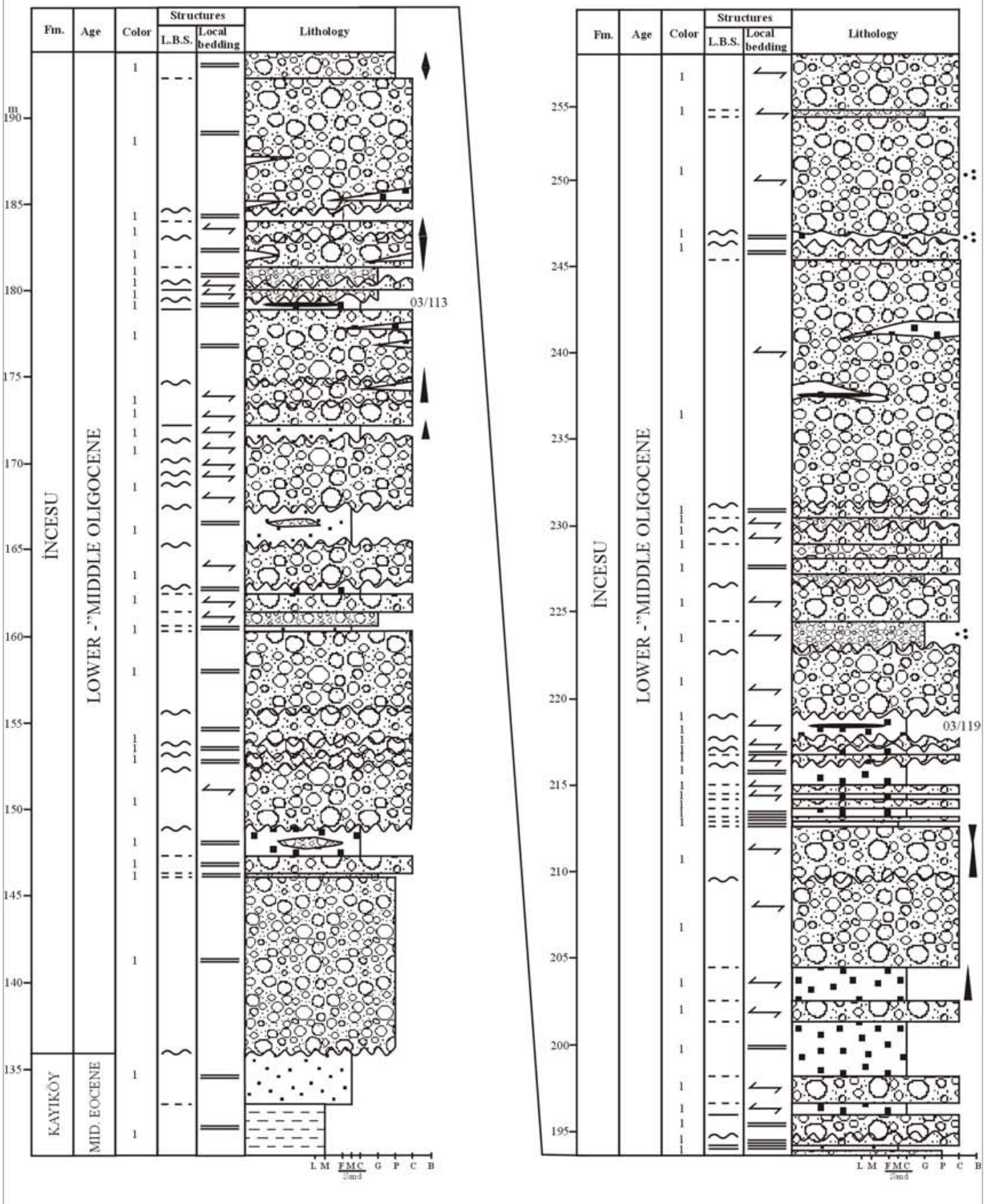


Figure 2. 37 (continued)

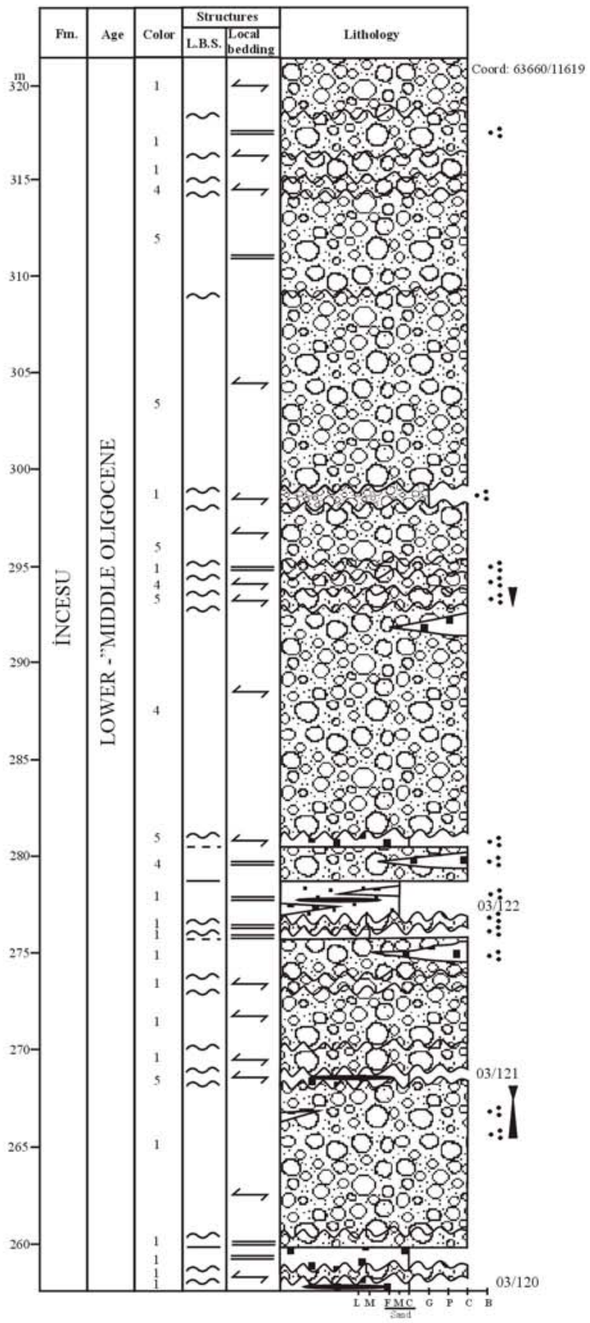


Figure 2. 37 (continued)

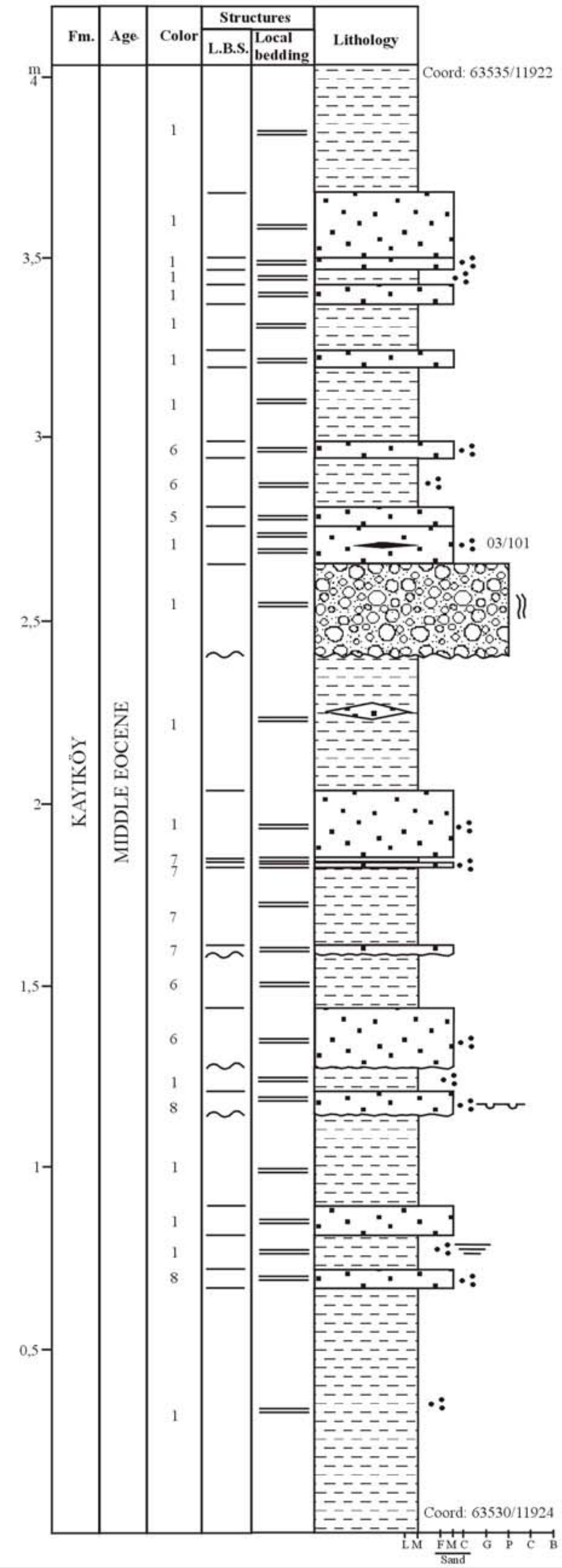


Figure 2. 38 Mesasured section of the Kayıköy Formation along the northeast of İncesu Village (see figure 2. 31 for location and figure 2. 58 for explanation).

2.3.2.2 Surrounding of Gönen and Atabey Towns

The sedimentary succession surrounding İğdecik and Gümüşgün villages and Gönen and Atabey towns can also be divided into two parts as the Isparta series belonging to the Bey Dağları Autochthon and neo–autochthonous sediments.

The Isparta serie consists of Cretaceous–Palaeocene neritic and pelagic limestones, Palaeocene–Lutetian reddish neritic and pelagic limestones (Gutnic, 1977), Middle Eocene Kayıköy Formation which is generally composed of conglomerate, sandstone, mudstone alternation in flysch like facies (Fig.2. 32b). In the area, the allochthonous and para–autochthonous Mesozoic carbonate rocks of the Barladağ series overthrust on the Kayıköy Formation (Fig. 2. 32b).

The Delikarkası Formation which is accepted as neo–autochthonous sediments occur at the basal part of Oligocene sequence (Gutnic, 1977). The Delikarkası Formation is mainly made up of fossilliferous neritic limestones and grades upward to the Early–"Middle" Oligocene İncesu Formation which was deposited in a alluvial–fan and fluviatile environments. Its total thickness is about 230m (Fig. 2. 32b). The allochthonous and para–autochthonous Mesozoic carbonate rocks of the Barladağ series and Lycian Nappes also overthrust on the İncesu Formation (Fig.2. 32b). The İncesu Formation is overlain by Lower–Middle Miocene sandstone–mudstone alternation in flysch facies. The Pliocene–Quaternary volcanics and alluvium unconformably overlie the sandstone, mudstone alternation.

In this part, the geological properties of the three areas indicated in fig.2. 30 are described.

2.3.2.2.1 Surrounding of İğdecik Village. The sediments outcropping in west of İğdecik and north of Gümüşgün consist of pre–Eocene Lycian Nappes, the Eocene Kayıköy Formation, Lower–"Middle" Oligocene İncesu Formation and Quaternary alluvium (Fig. 2. 39). The Middle Eocene Kayıköy Formation is mainly made up of medium to thick bedded and massif sandstones and conglomerates. Sandstones comprises hematite concretions, bioturbations, bioclasts, coal and also conglomerate lenses. Conglomerates, which are generally sorted moderately to poorly, derived from the basement rocks of serpentine, diabase and limestone.

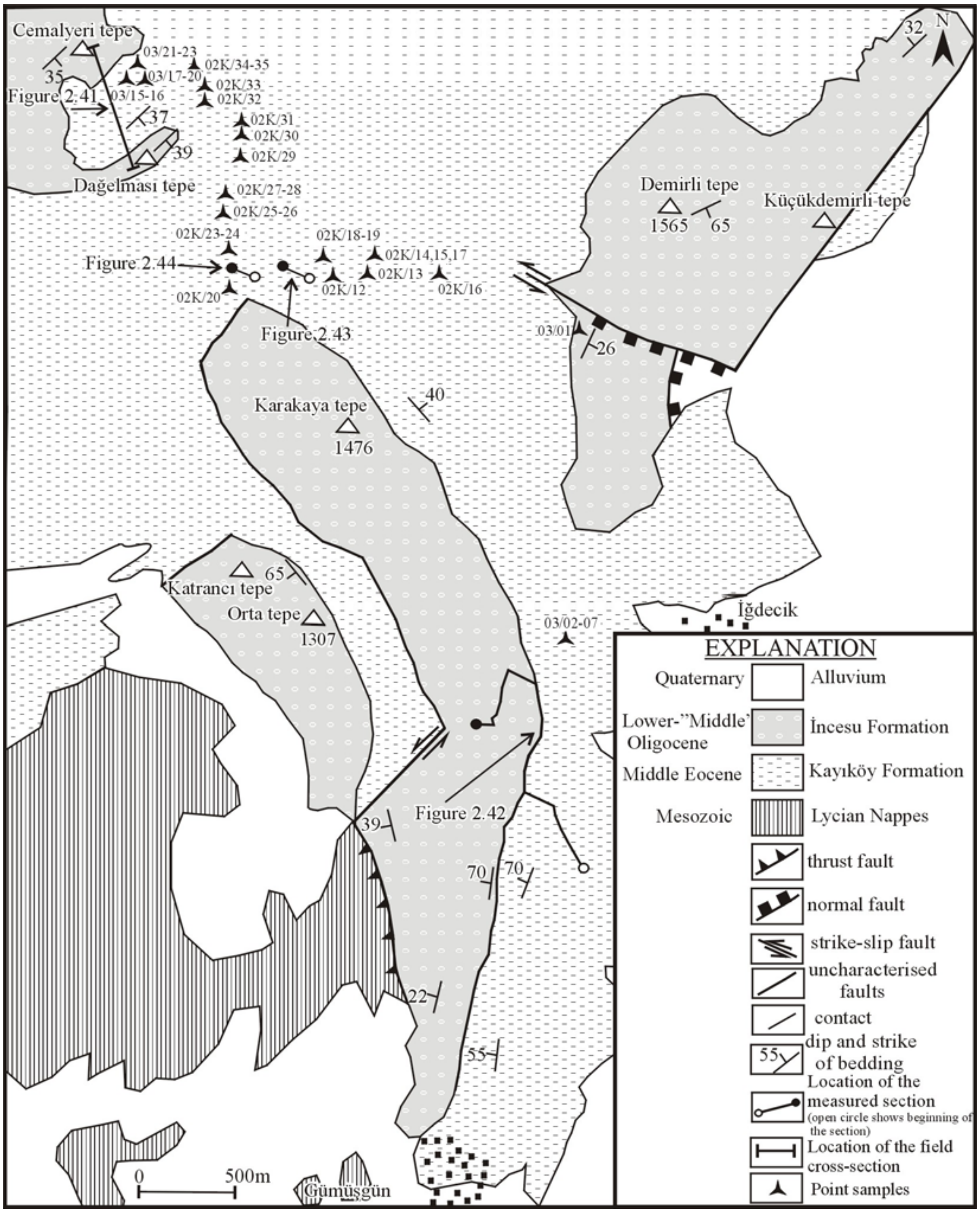


Figure 2. 39 Geological map of northern part of Gümüşgün Village. See figure 2. 30 for location. Location of measured sections, geological cross sections and point samples are indicated.

The formation also includes well–rounded pebbles of the Lutetian age derived from the basement rocks. The unconformably overlying İncesu Formation is mainly made up of pinkish and greyish conglomerate–sandstone alternation (Figs. 2. 40, 2. 41). The conglomerates are poorly sorted and main components of the conglomerates are chert, limestone, diabase and serpentine. Additionally, the Mesozoic carbonate rocks of the Lycian Nappes overthrust on the İncesu Formation in the northern part of Gümüşgün Village (Fig. 2. 39).

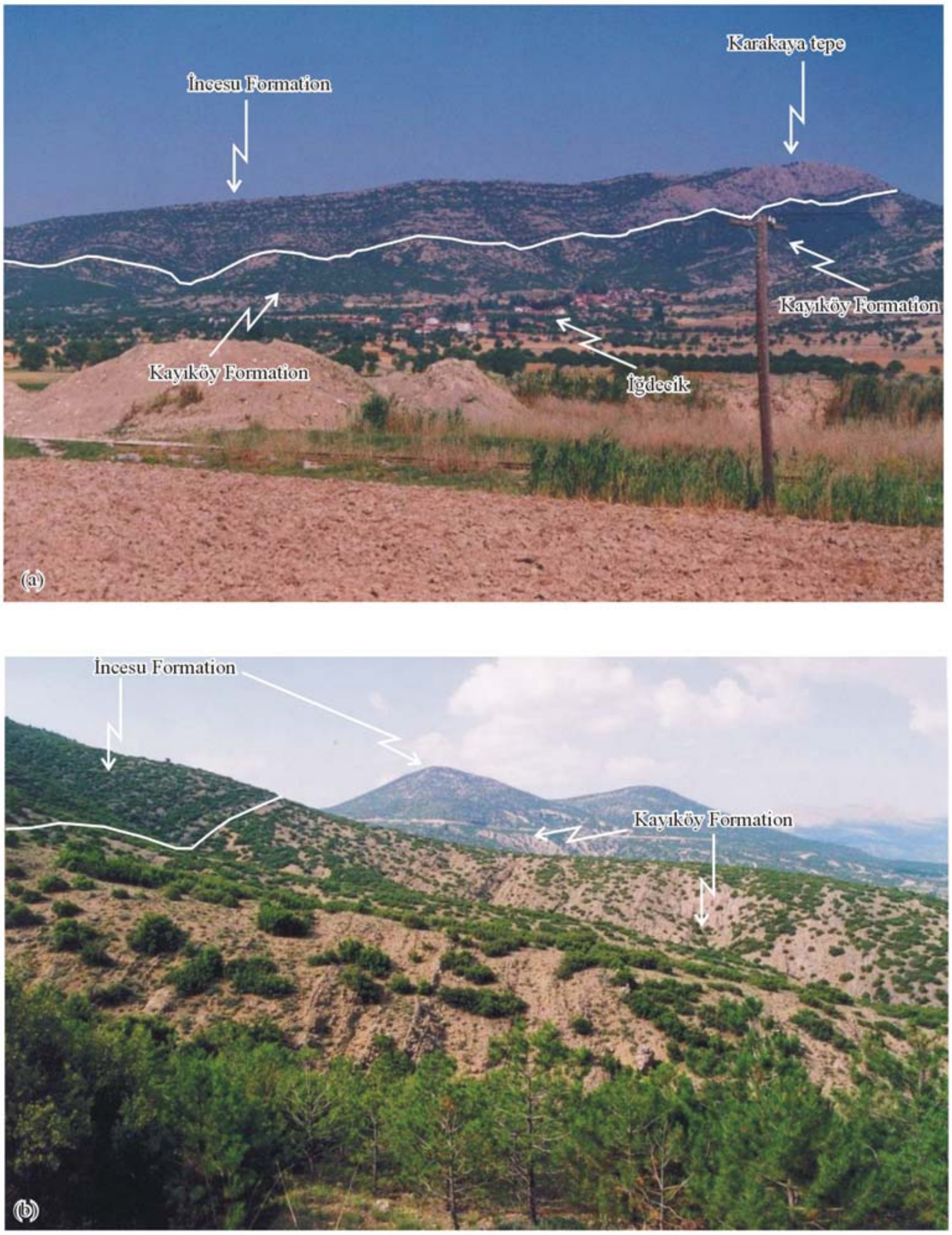


Figure 2. 40a,b Field photograph showing an unconformable lower boundary of the İncesu Formation.

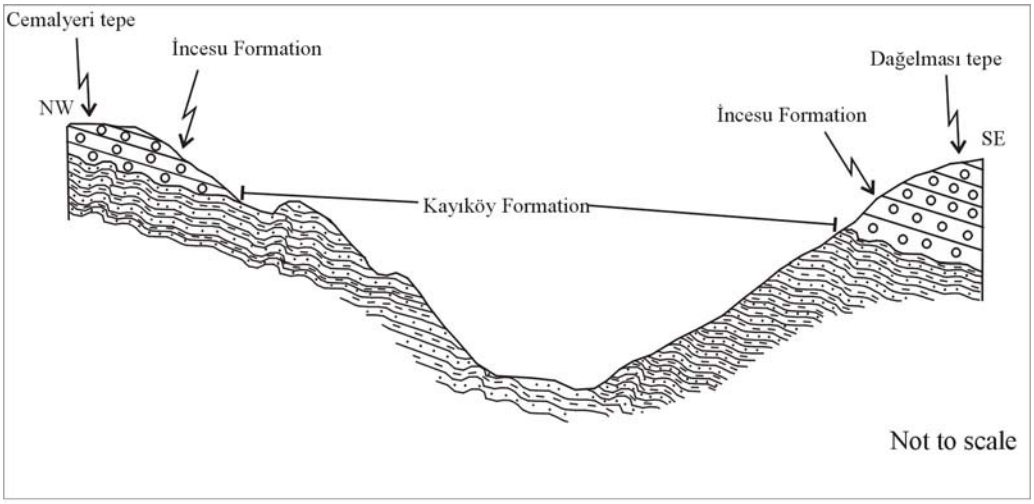


Figure 2. 41 Geological cross–section showing the unconformable lower boundary of the İncesu Formation with underlying turbiditic part of the Kayıköy Formation. See figure 2. 39 for location and figure 2. 47 for explanation.

During the field studies, a detailed measured stratigraphical section was taken from both Kayıköy and İncesu formations (Figs. 2.39, 2, 42). Two small–scaled measured sections were also taken from the Kayıköy Formation (Figs. 2. 43, 2. 44).

Forty–one samples for palynological investigations and four samples for foraminifer investigations were taken from the Kayıköy Formation.

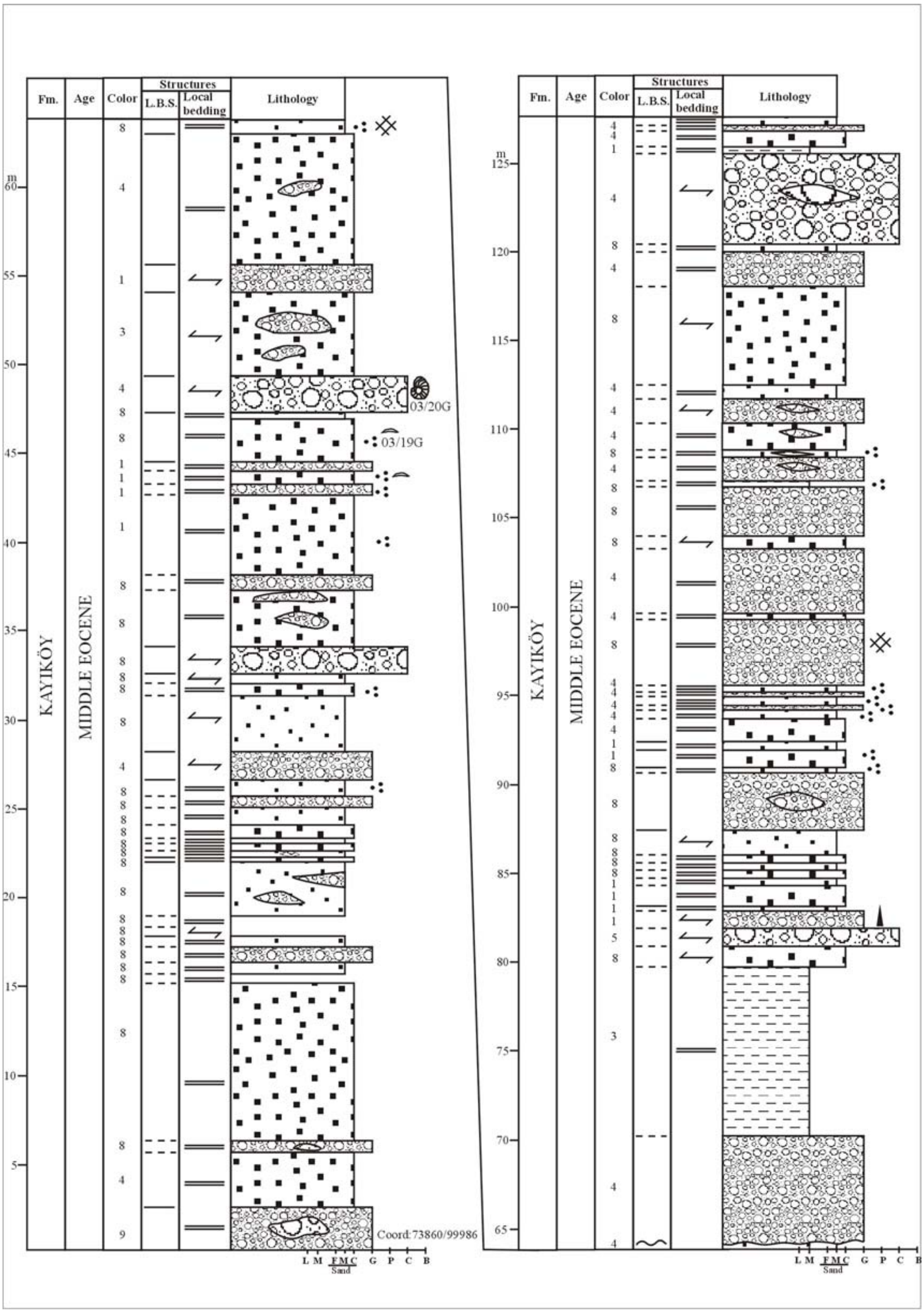


Figure 2. 42 Measured section of the Kayıköy and İncesu formations in the east of Karakaya Tepe (see figure 2. 39 for location and figure 2. 58 for explanation).

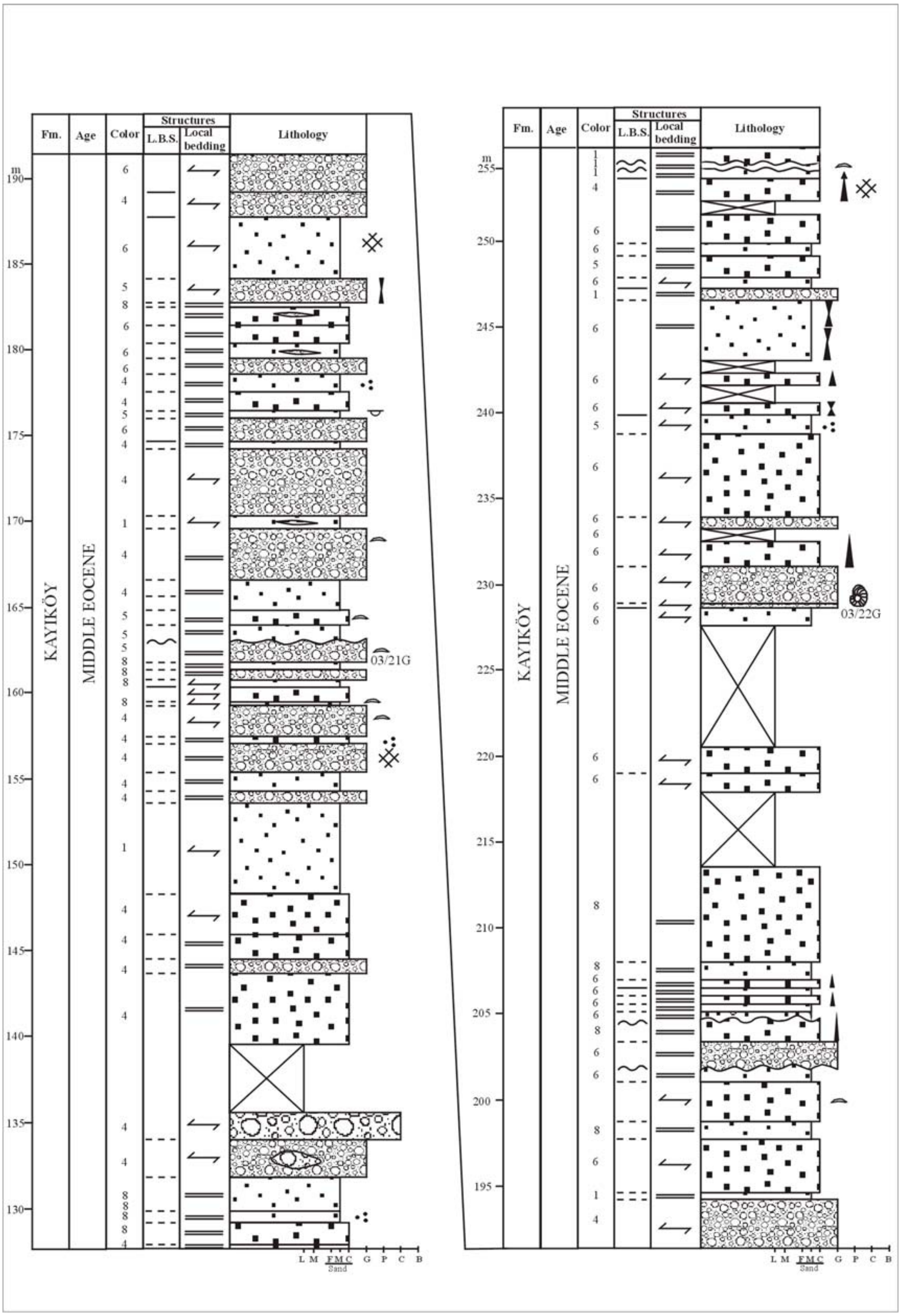


Figure 2. 42 (continued)

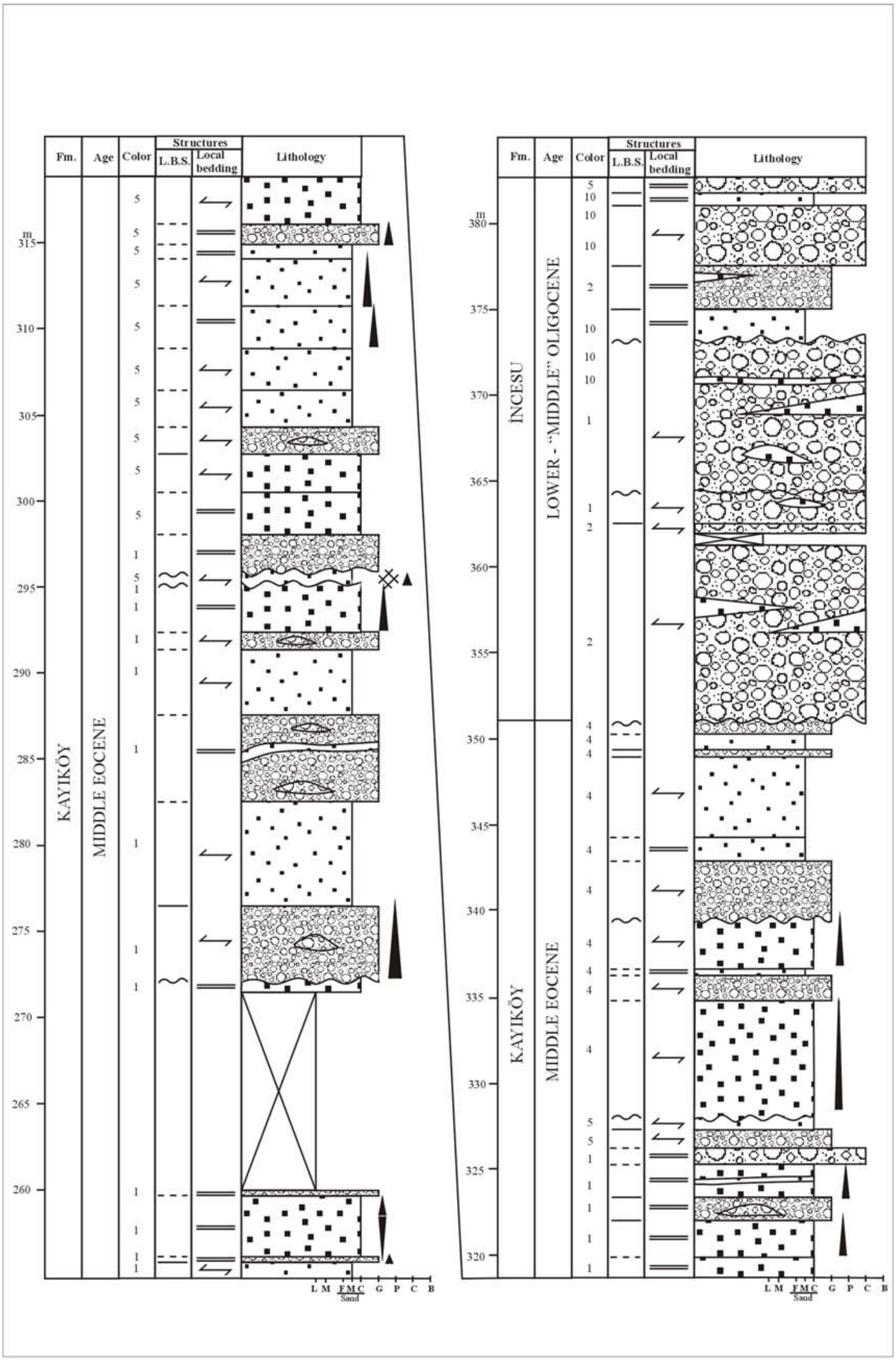


Figure 2. 42 (continued)

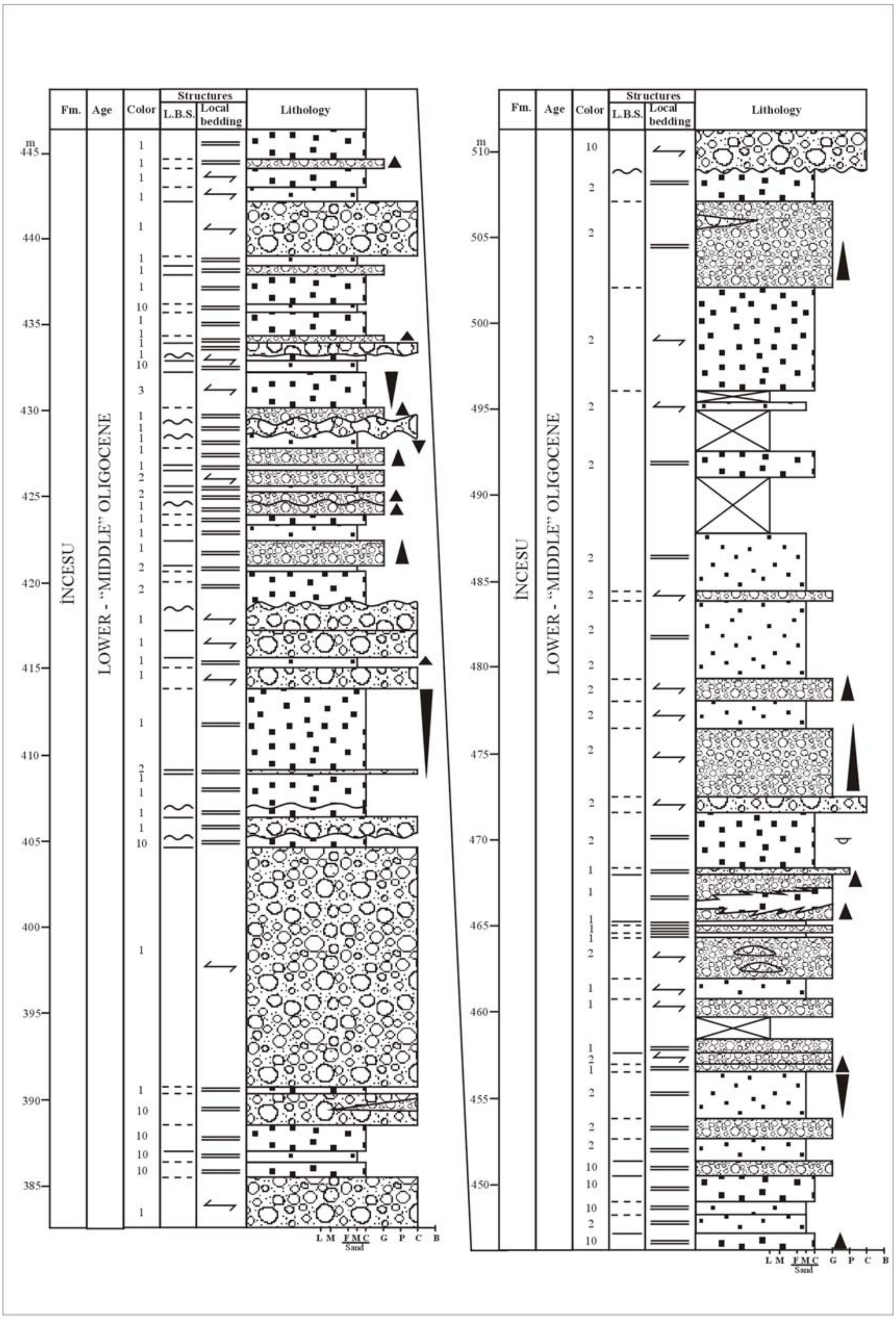


Figure 2. 42 (continued)

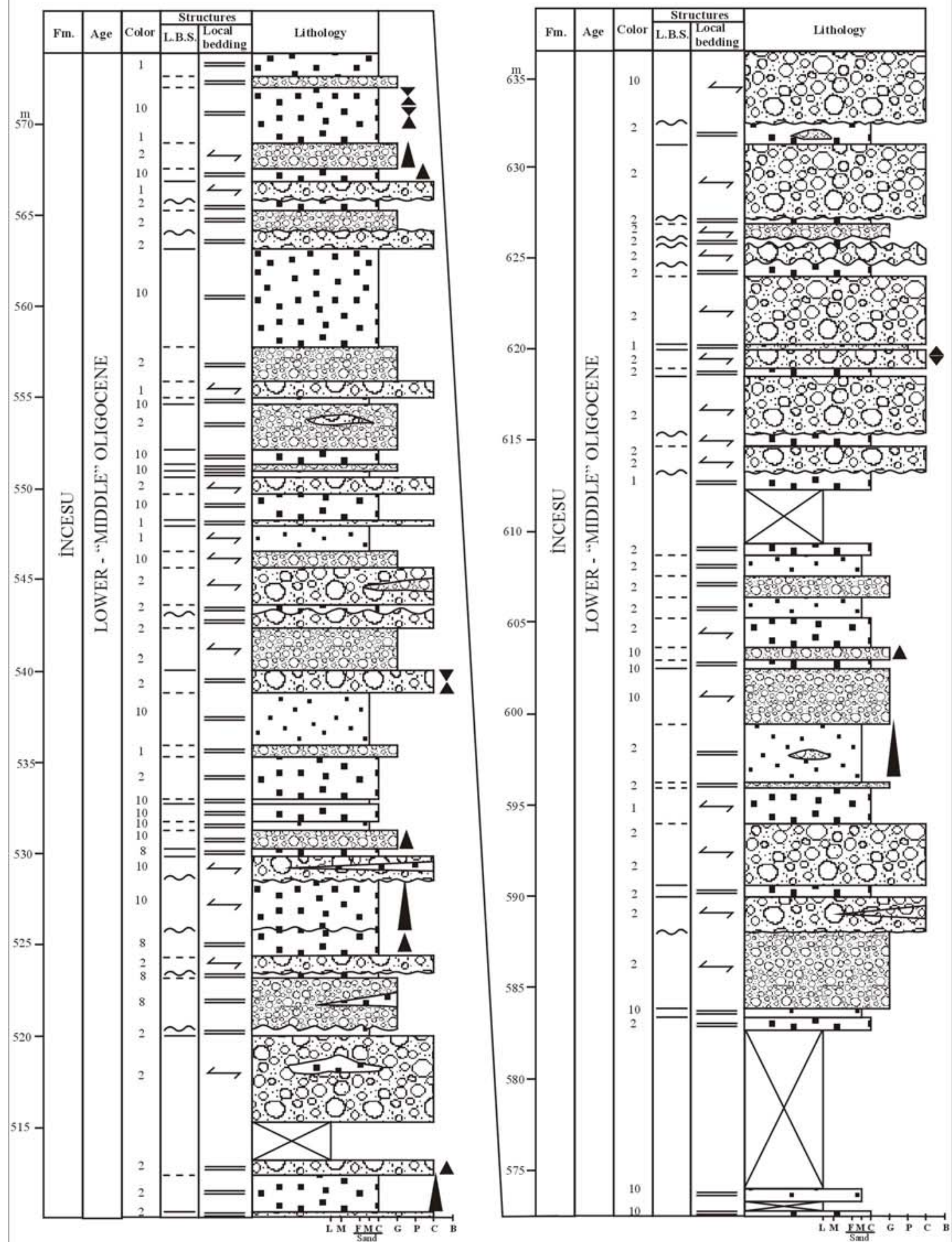
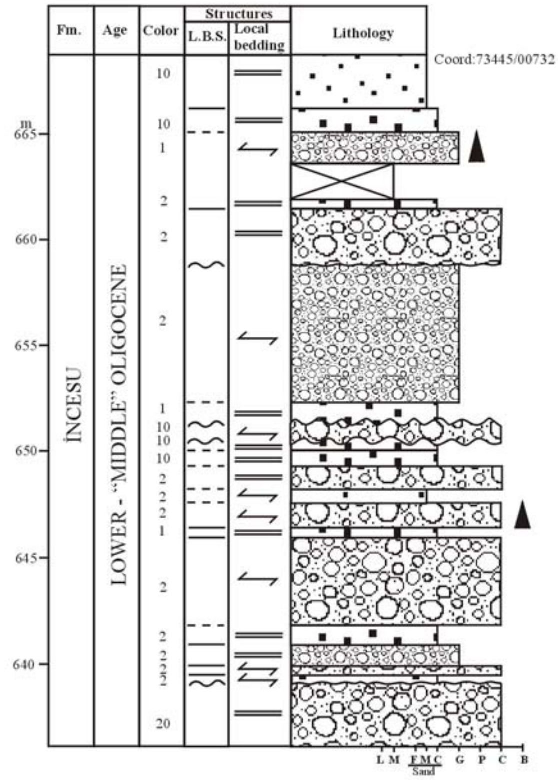


Figure 2. 42 (continued)



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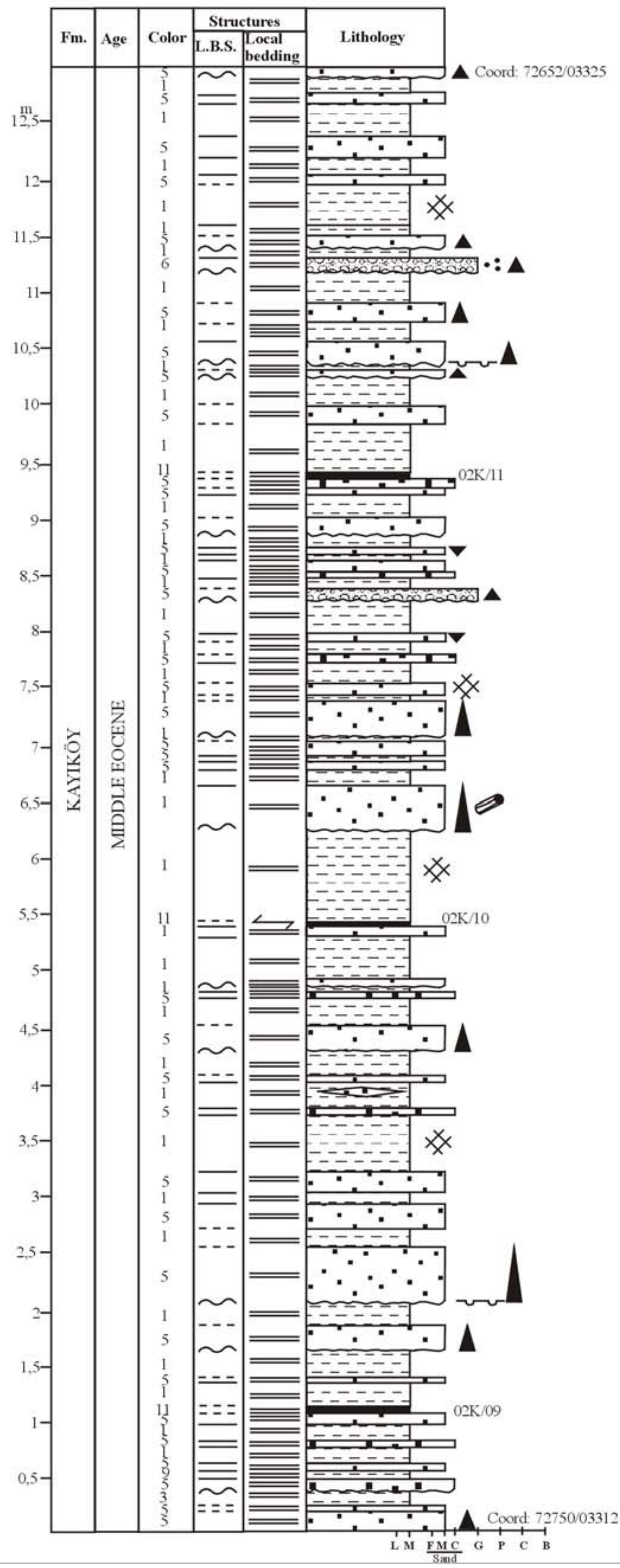

Figure 2. 43 Measured section of the Kayıköy Formation in the north of the Karakaya Tepe (northwest of Kırdağ Tepe) (see figure 2. 39 for location and figure 2. 58 for explanation).

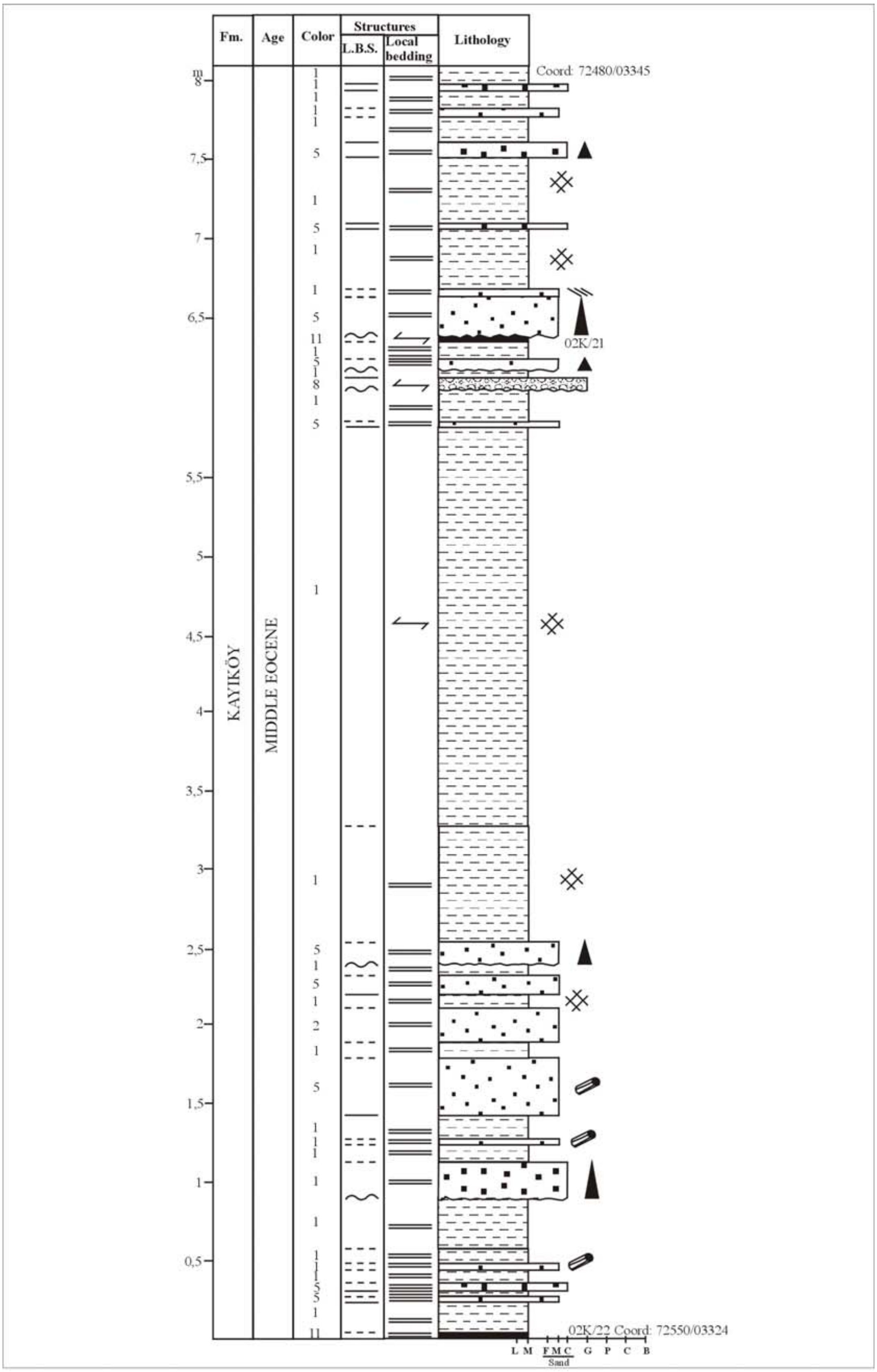

Figure 2. 44 Measured section of the Kayıköy Formation in the north of the Karakaya Tepe (see figure 2. 39 for location and figure 2. 58 for explanation).

2.3.2.2.2 North of Gönen Town. The Mesozoic carbonate rocks of Barladağ series belonging to the Bey Dağları Autochthon, Middle Eocene Kayıköy Formation, Lower–"Middle" Oligocene İncesu Formation, Pliocene–Quaternary volcanics and Quaternary alluvium present in the area (Fig. 2. 45). Pre–Eocene basement rocks crop out on Tınaz Tepe and Kömürlük Tepe (Fig. 2. 45) and overthrust on the Eocene Kayıköy Formation and Lower–"Middle" Oligocene İncesu Formation (Figs. 2. 45, 2. 46a). Further, the Kayıköy Formation overthrusts on the İncesu Formation as well (Fig. 2. 45).

The Kayıköy Formation outcropping in the northern part of Gönen Town consists of coarse–grained sediments, and is mainly represented by blockstone, conglomerate, coarse–and medium sized sandstone and locally mudstones (Fig.2. 47). Finning and coarsening upward sequences also occur. The most common components in the conglomerates and blockstones are chert, diabase, serpentine, grayish to dark limestones, laminated and intraformational limestones which are entirely angular, unsorted microscopic to 162cm in size. Blockstones are poorly sorted and include hematite concretions (Fig. 2. 49). Shallow marine fossils occur in the fine grained conglomerate, sandstone and mudstone. Besides, coal–lenses occur in the sandstones which include imbricated structures in some parts. Lower bedding structures and some bioturbations have also been observed in the sandstones (Fig. 2. 48a, b). Some parts of the Kayıköy Formation are folded (Fig. 2. 48c), and include debris flows deposits (Fig. 2. 48d). As the strike and dip of bedding planes of the Kayıköy and İncesu formations are more or less the same, there must be a disconformity between them. (Figs. 2. 46 b, c, d, 2. 47 a, b).

In the area, the İncesu Formation consists mainly of cream–coloured conglomerate, sandstone and grayish mudstone. Conglomerates resemble limestones at a first glance because of the calcite cement (Fig. 2. 48e). The most common components are well sorted and rounded cream–coloured limestones including the fossils at some parts (Fig. 2. 48e). The other components mainly consist of serpentine, diabase, sandstone. Fining and coarsening upwards also occur in the

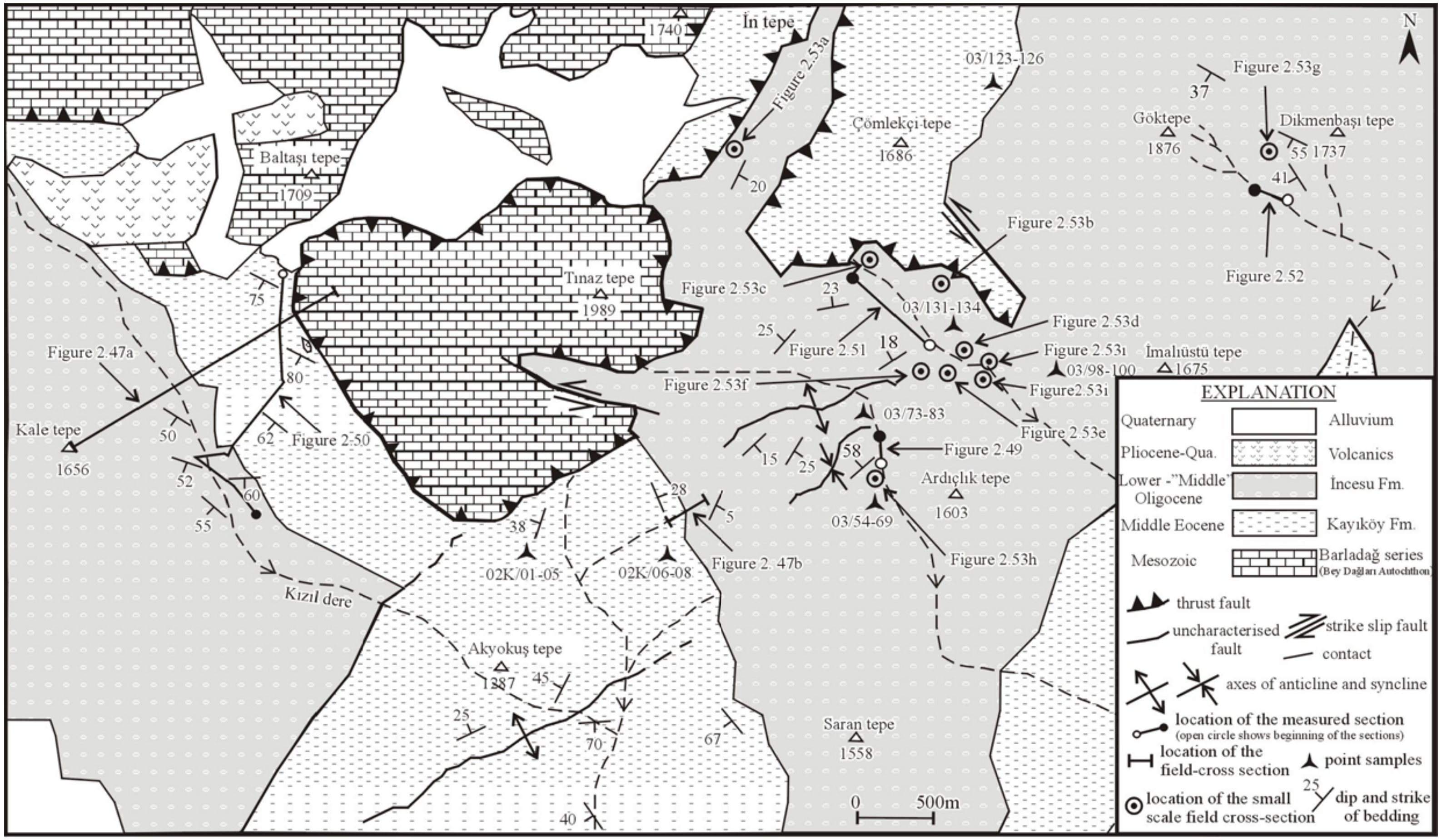

Figure 2. 45 Geological map of the north of Gönen Town. See figure 2.30 for location. Locations of measured sections and geologic cross-sections are indicated.

Figure 2. 46 Field photographs showing (a) a thrust fault boundary between the Barladağ serie and Kayıköy Formation, (b) an unconformable boundary between the Kayıköy Formation and overlying İncesu Formation (c) close–up view of the lower boundary of the İncesu Formation (d) closer–up view of the unconformable lower boundary of the İncesu Formation (Coordinates: 83475/07300 for figure 2. 46 b, c, d). The man is about 1.75cm tall.

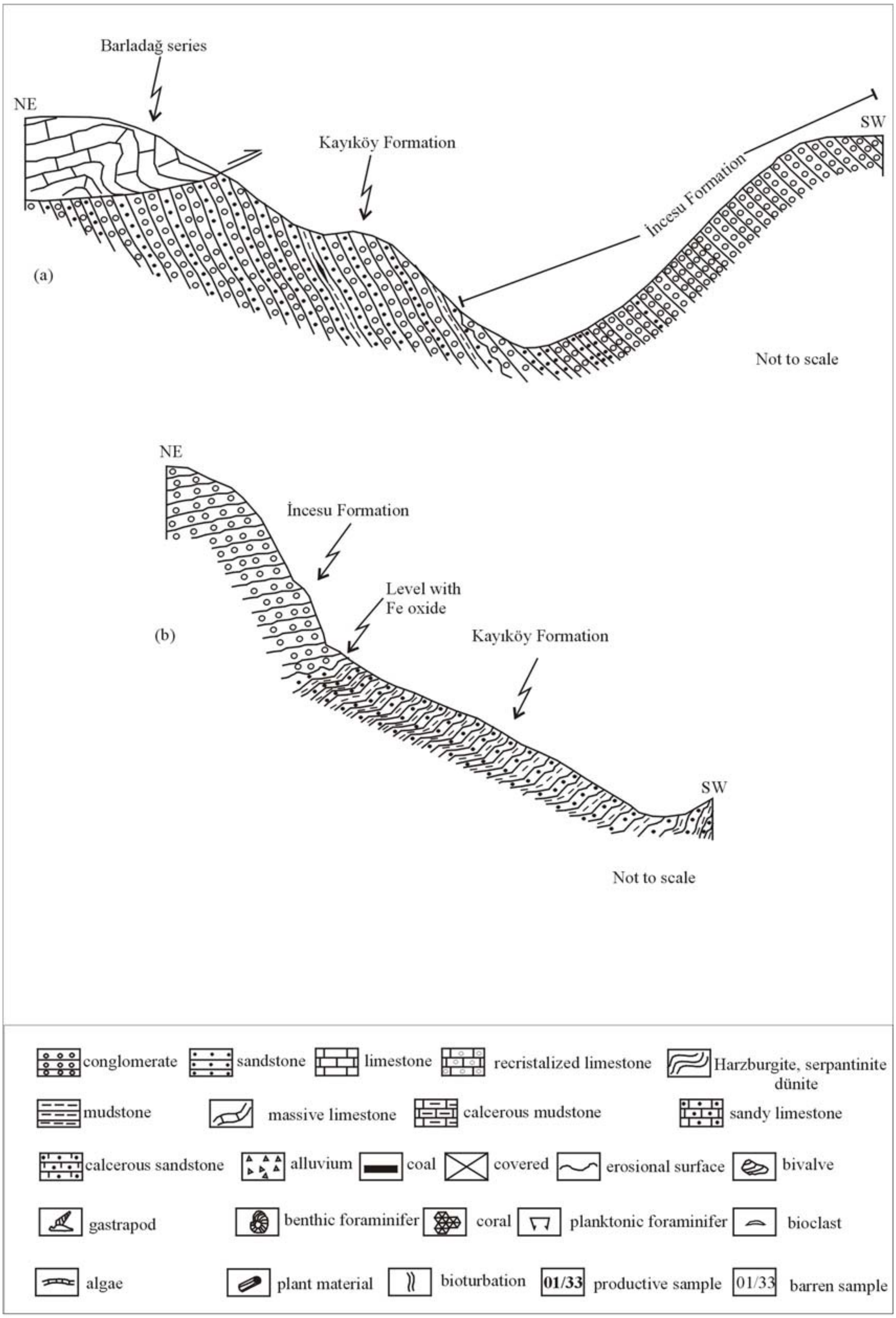

Figure 2. 47a, b Geological cross–sections showing the unconformable lower boundary of the İncesu Formation with overlying limestones of the Barladağ series belonging to the Bey Dağları Autochthon. Explanations of geological cross–sections are also indicated. See figure 2. 45 for locations of the geological–cross sections.

Figure 2. 48. Field photographs showing (a) lower bedding structures (Coordinates: 83475/07300), (b) sediment casts of burrows of various sizes (Coordinates: 82375/06832), (c) a folding (Coordinates: 82250/06050), (d) debris-flow deposits in the Kayıköy Formation (Coordinates: 72075/02975), (e) poorly sorted clast–supported conglomerates (Coordinates: 83775/07275), (e) small–scale cross stratification in the İncesu Formation (Coordinates: 84900/08850). Lens cap is 50mm in diameter. The man is about 1.75m tall.

sequence. In some place, channel fills occur in the sequence. Sandstones are bioturbated, lower bedding structures and cross bedded at some parts (Fig. 2. 48f). Greyish coaly mudstones occur at the lower part of the İncesu Formation.

In this part, three detailed measured sections were taken from the İncesu Formation (Figs. 2. 49, 2. 51, 2. 52). Additionally, a detailed measured section around 1100m with total thickness was taken from the western part of Tınaz Tepe including both Kayıköy and İncesu formations (Fig. 2. 50). Some geological cross sections were obtained from the İncesu Formation (Fig. 2. 53).

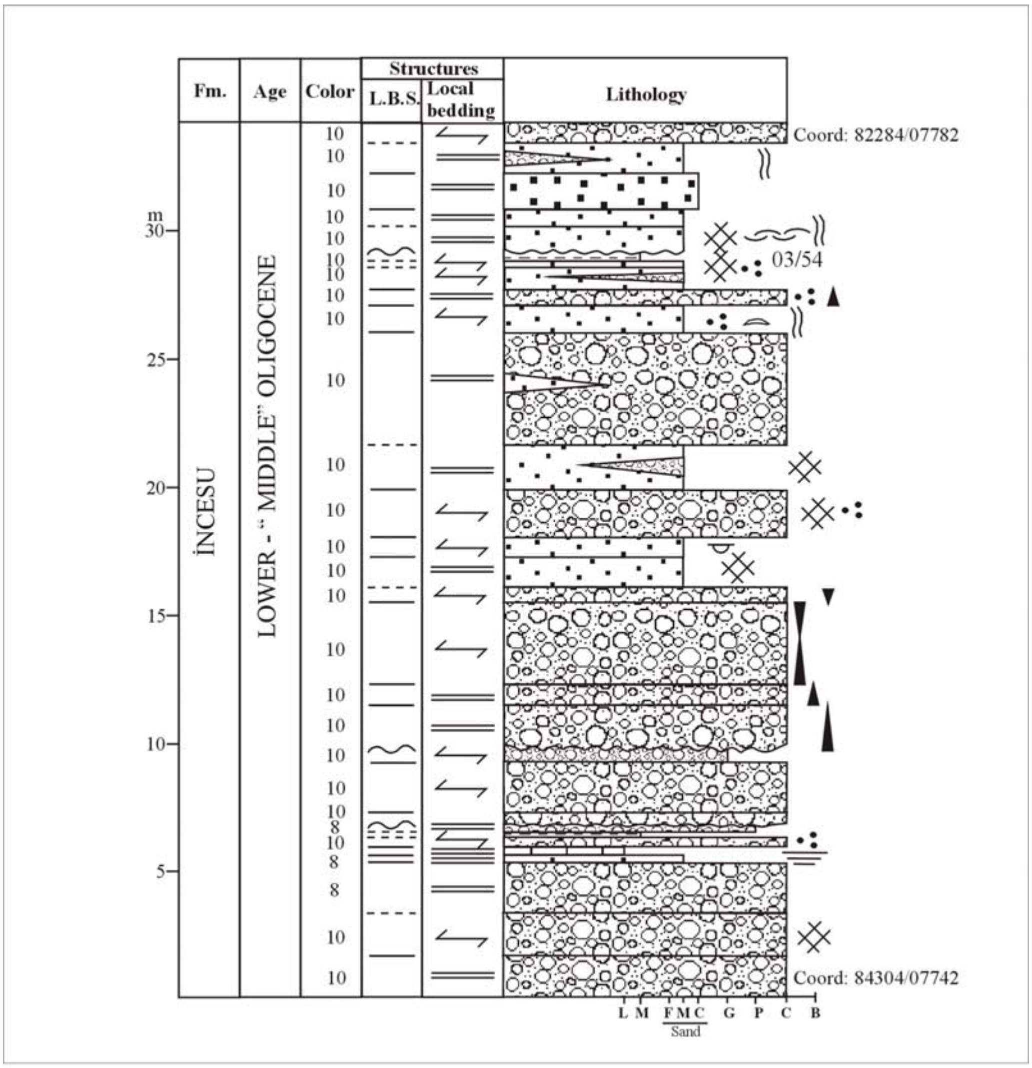

Figure 2. 49 Measured section of the İncesu Formation in northwest of Ardıçlık Tepe (see figure 2. 45 for location and figure 2. 58 for explanation).

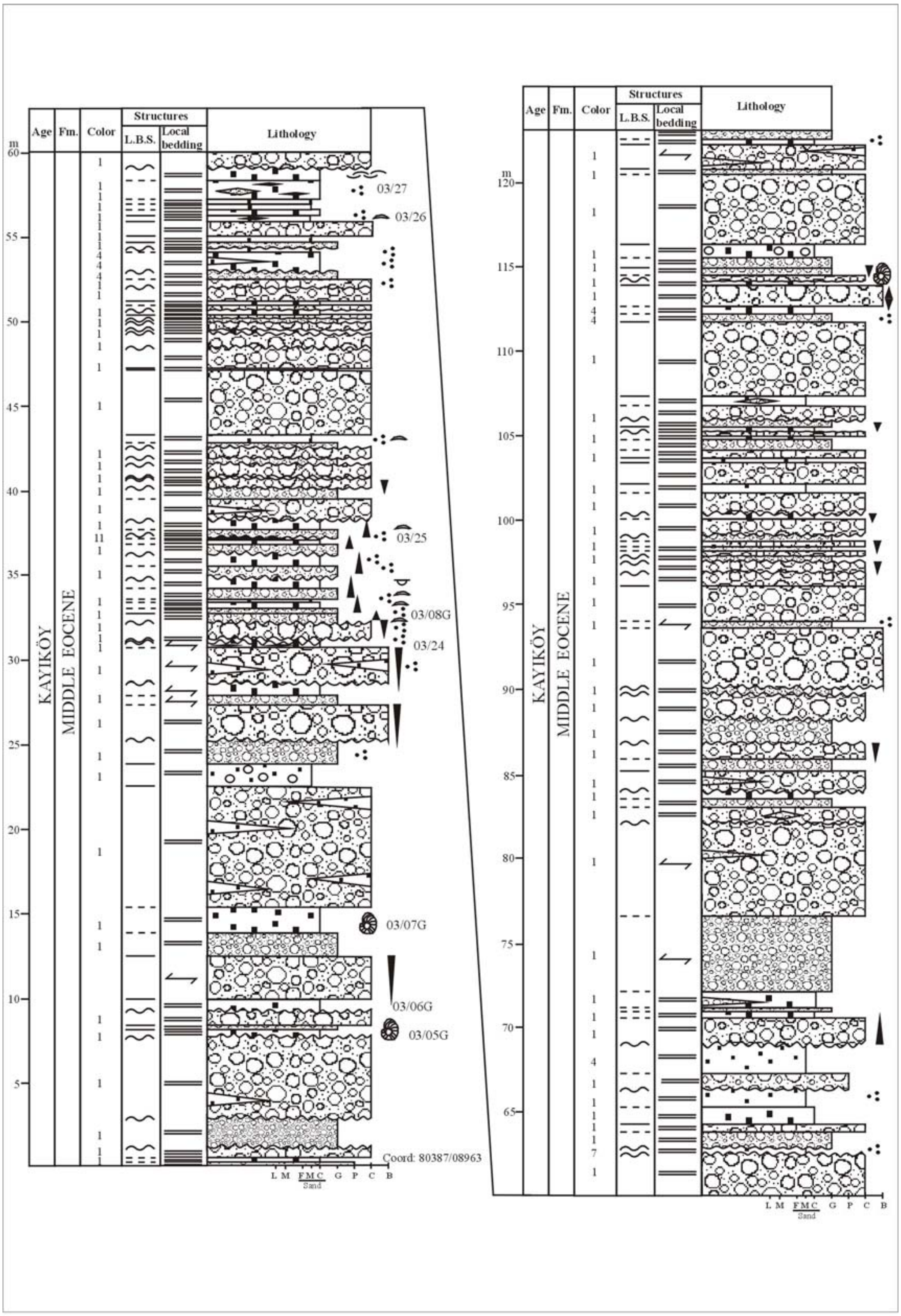

Figure 2. 50 Measured section of the Kayıköy and İncesu formations in the northeastern part of Kızıl Dere in north of Gönen Town (see figure 2. 45 for location and figure 2. 58 for explanation).

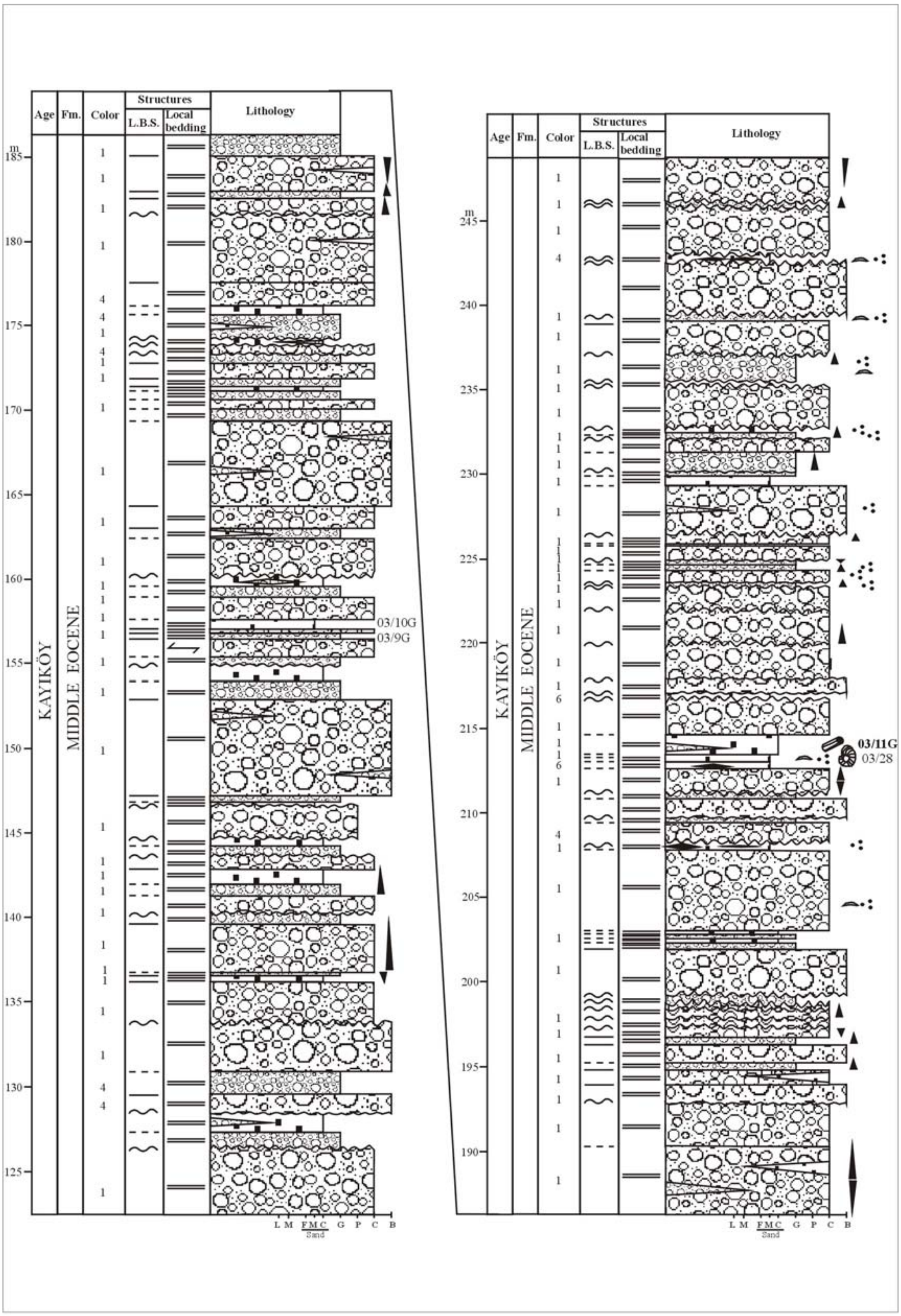

Figure 2. 50 (continued)

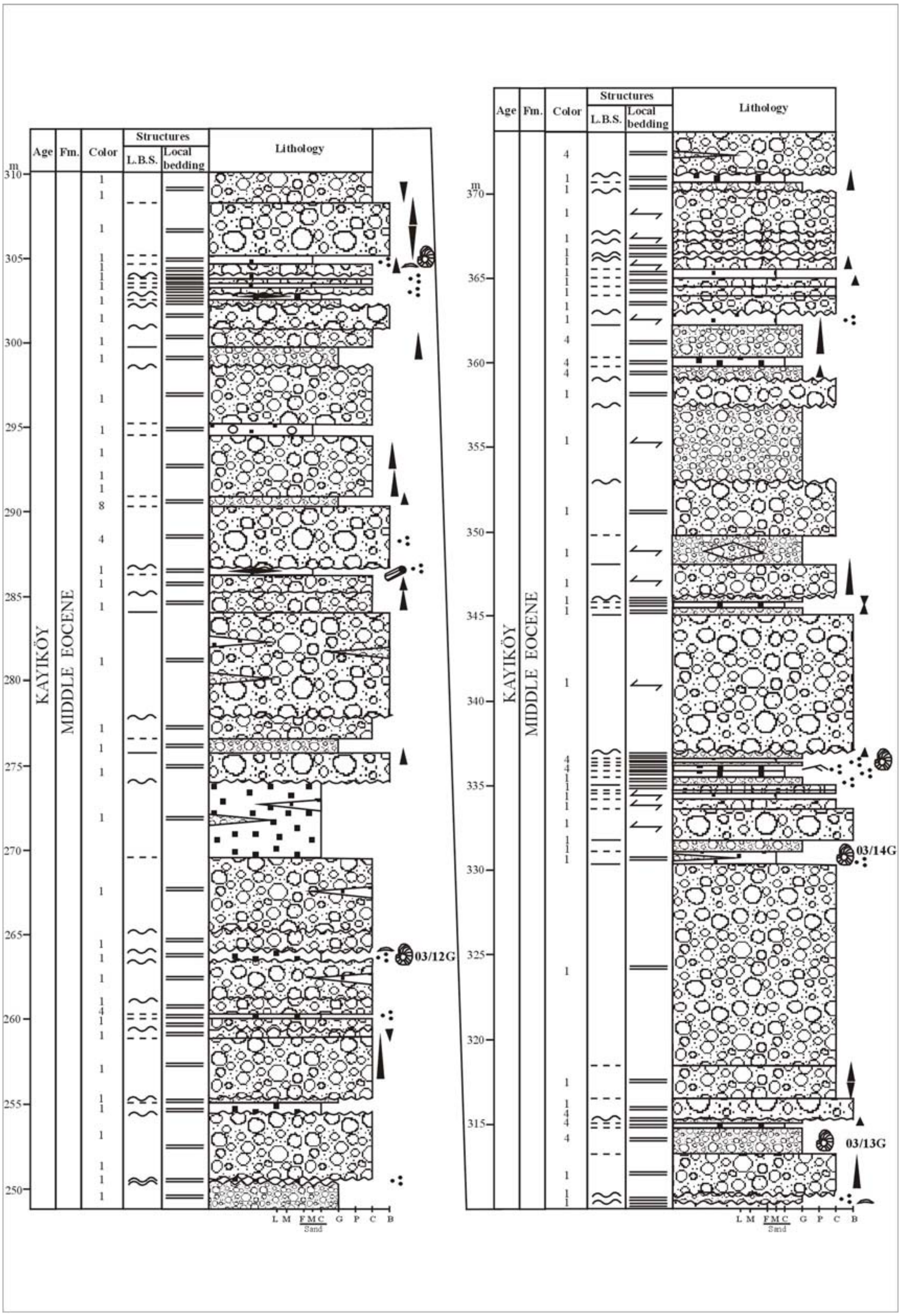

Figure 2. 50 (continued)

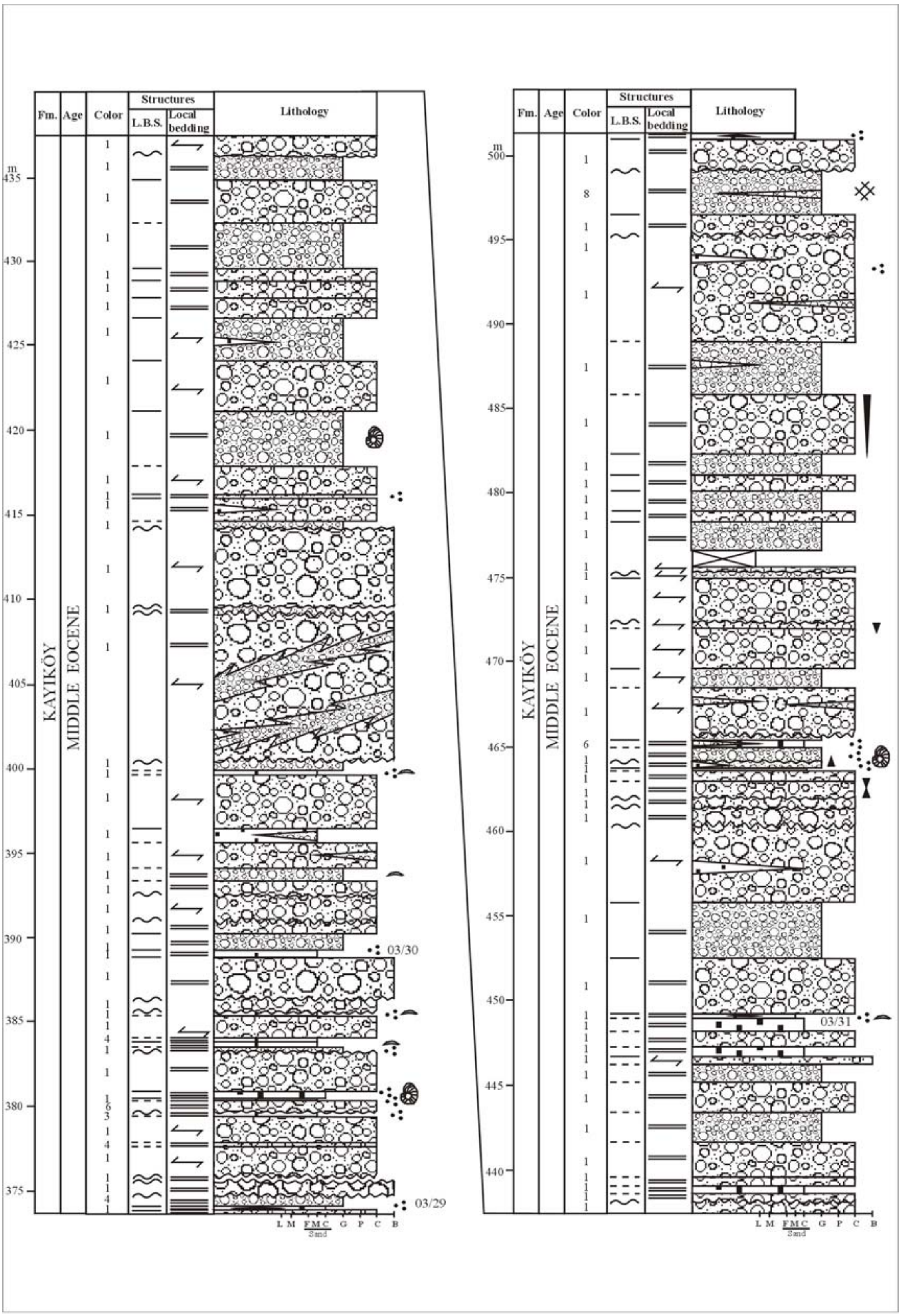

Figure 2. 50 (continued)

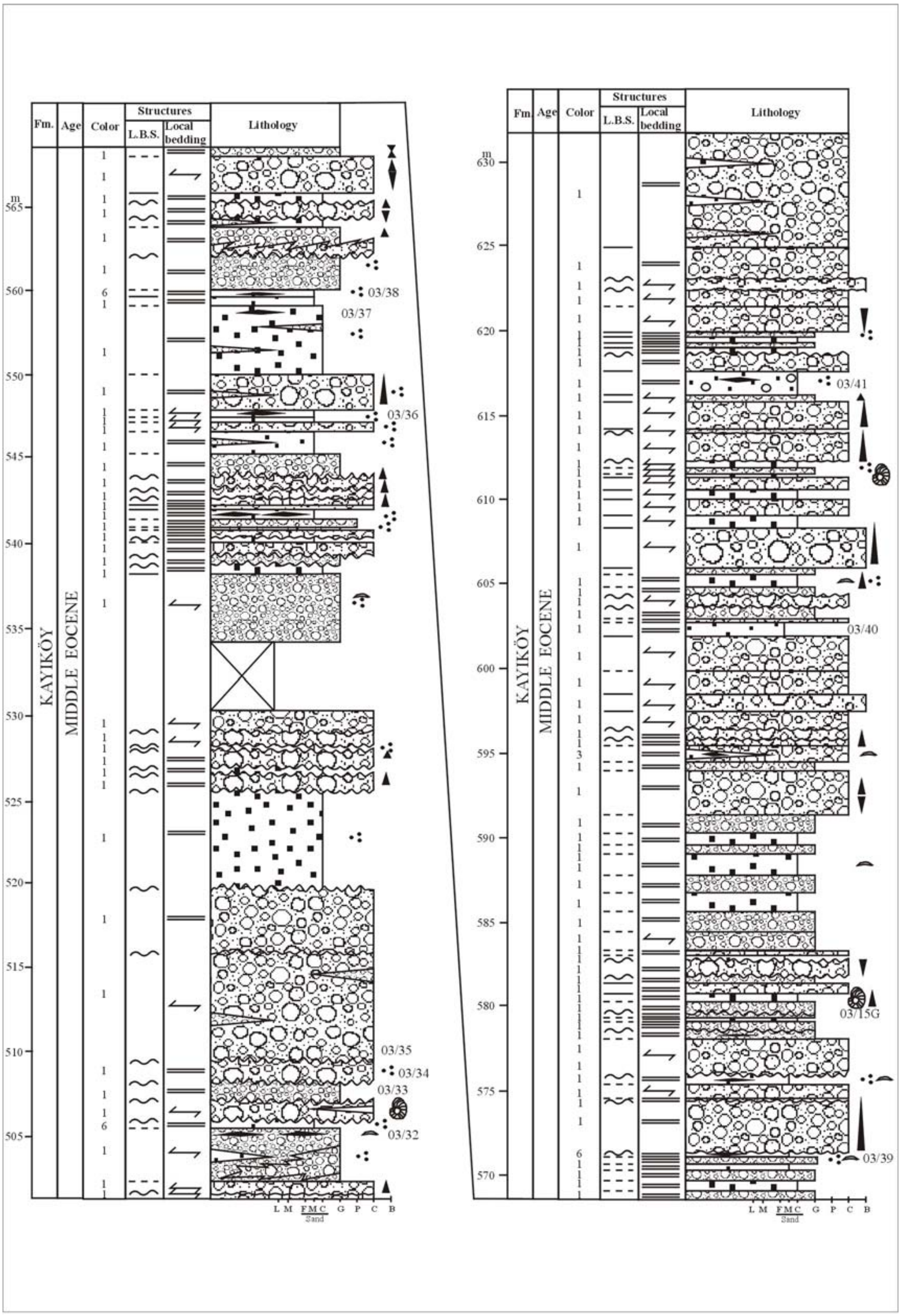

Figure 2. 50 (continued)

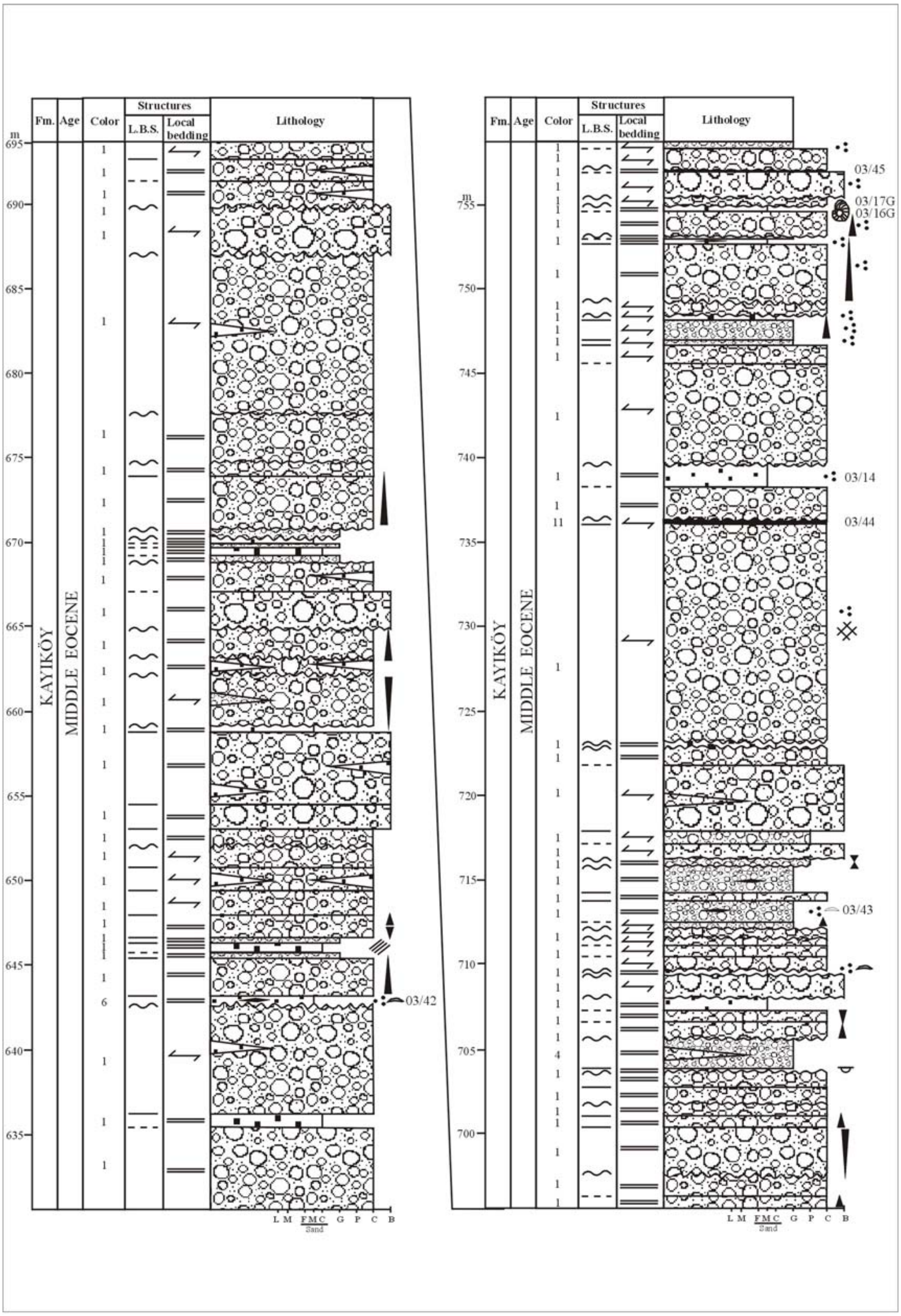

Figure 2. 50 (continued)

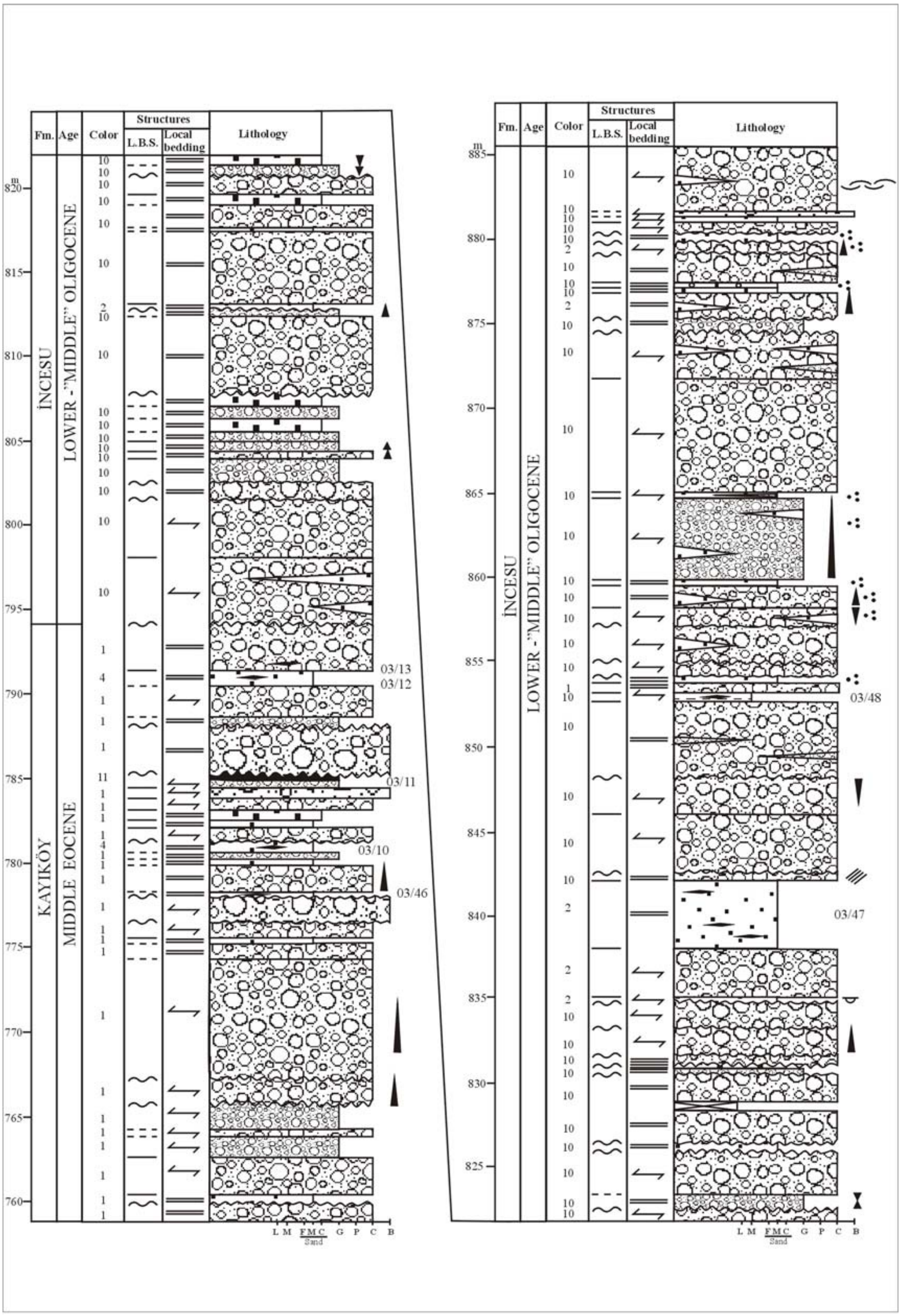

Figure 2. 50 (continued)

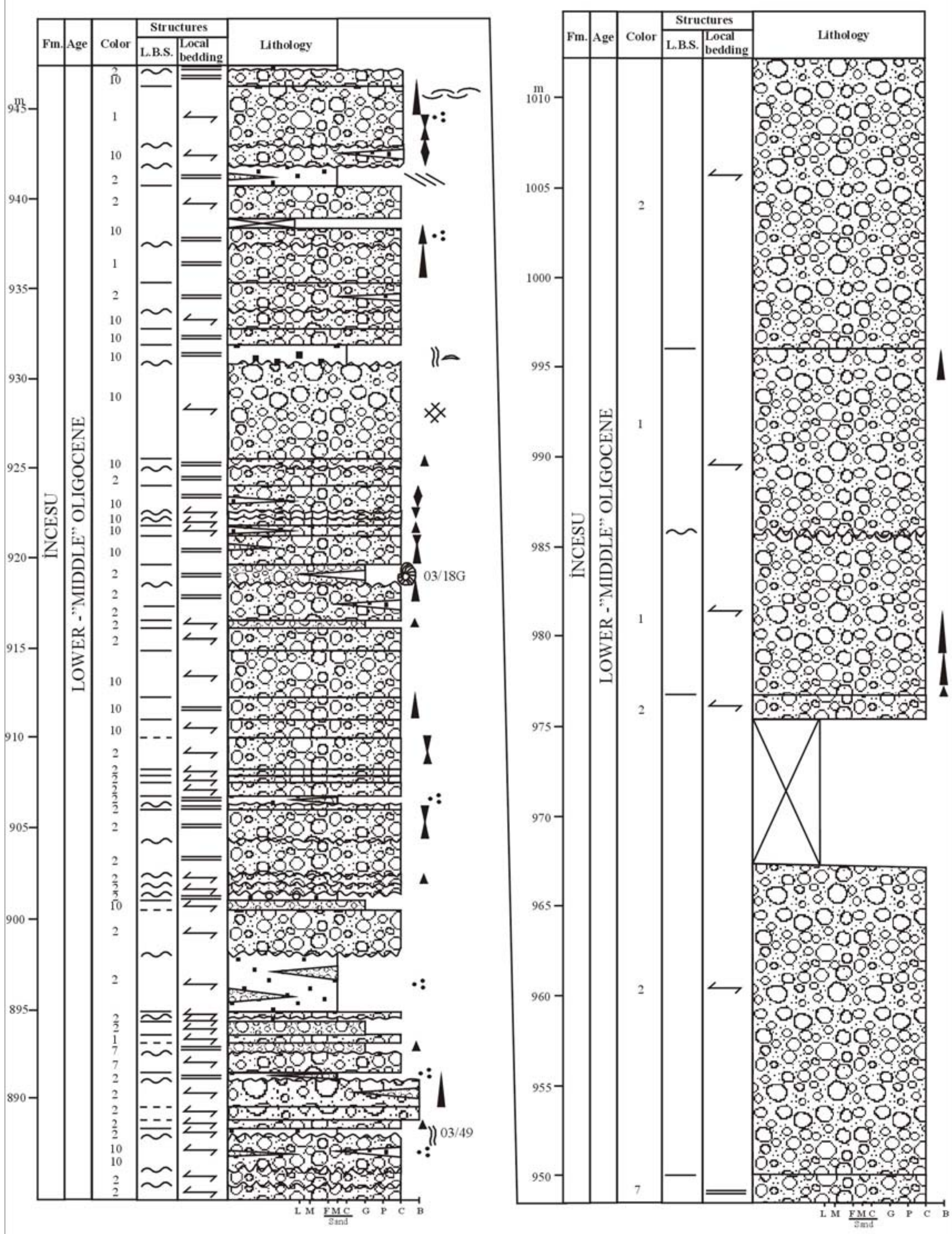

Figure 2. 50 (continued)

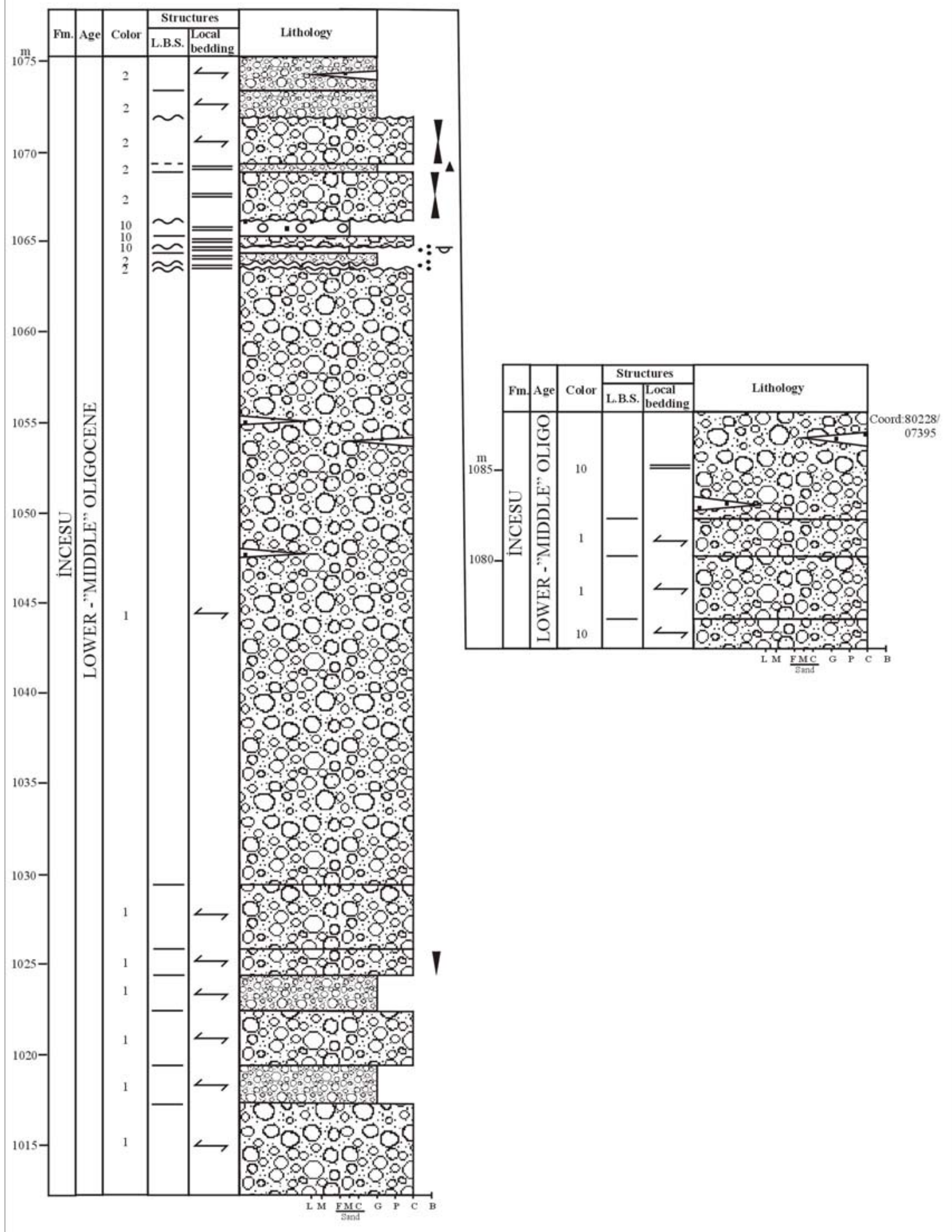

Figure 2. 50 (continued)

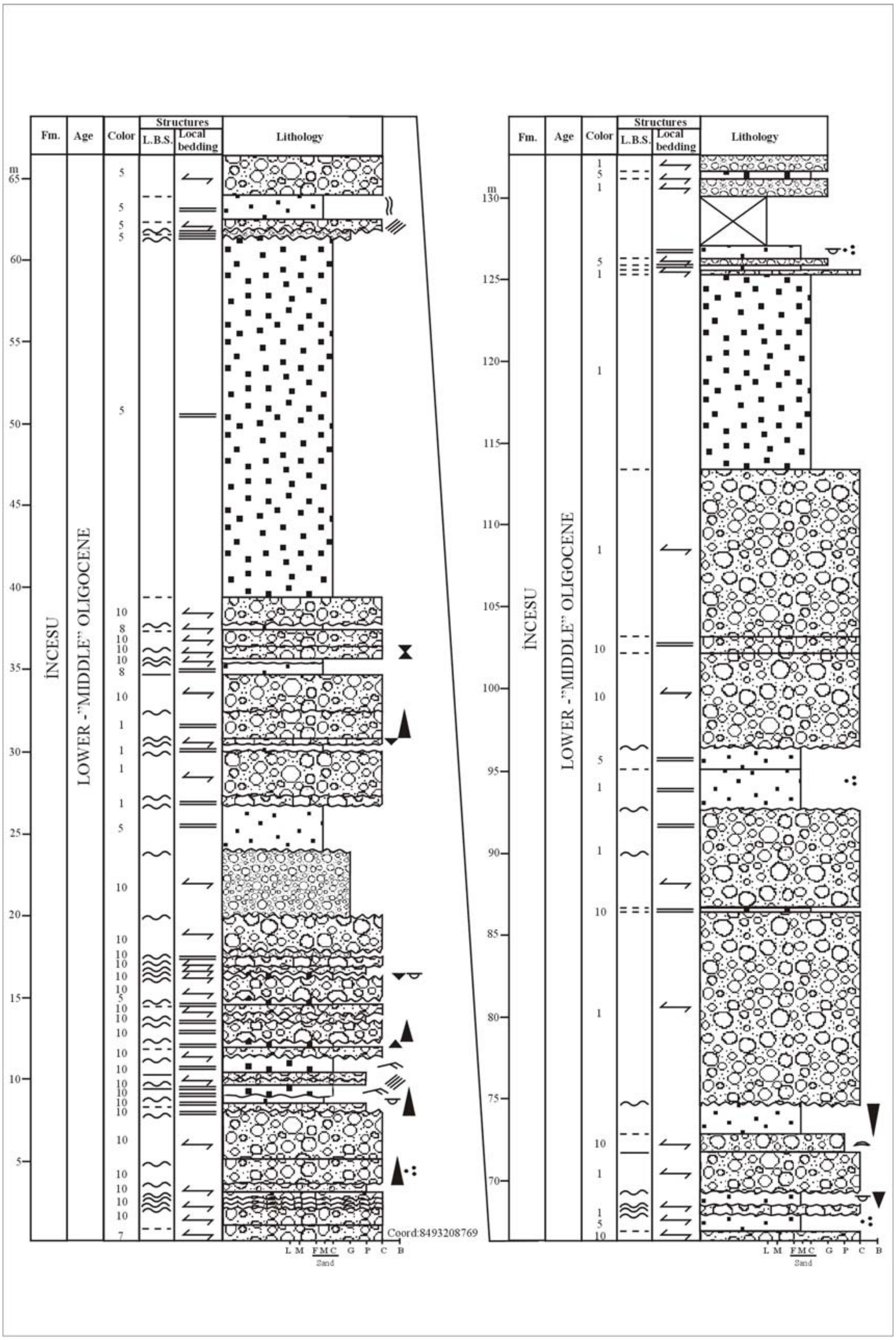

Figure 2. 51 Measured section of the İncesu Formation in the south of Çömlek Tepe in the north of Gönen Town (see figure 2. 45 for location and figure 2. 58 for explanation).

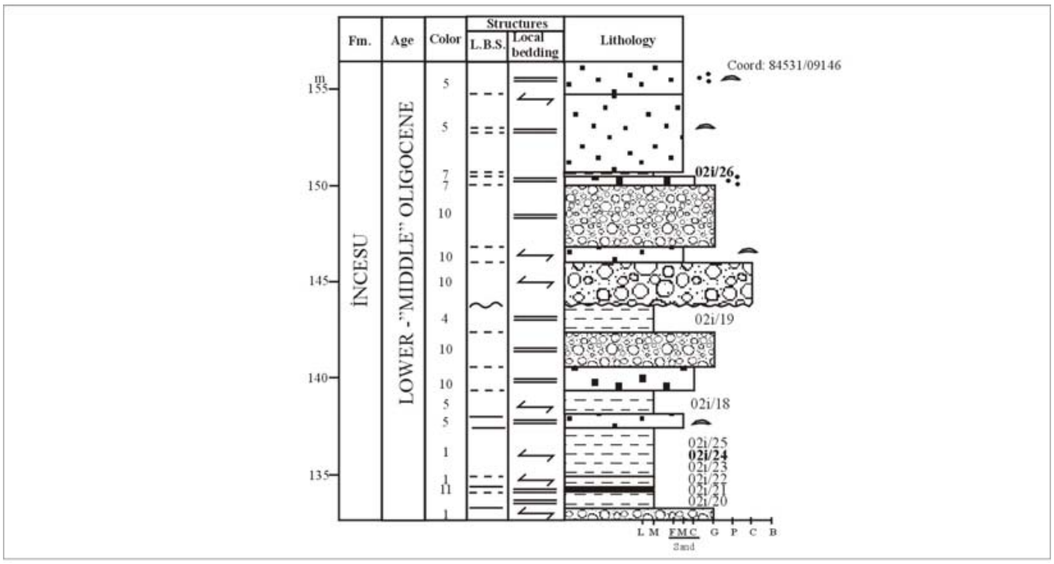

Figure 2. 51 (continued)

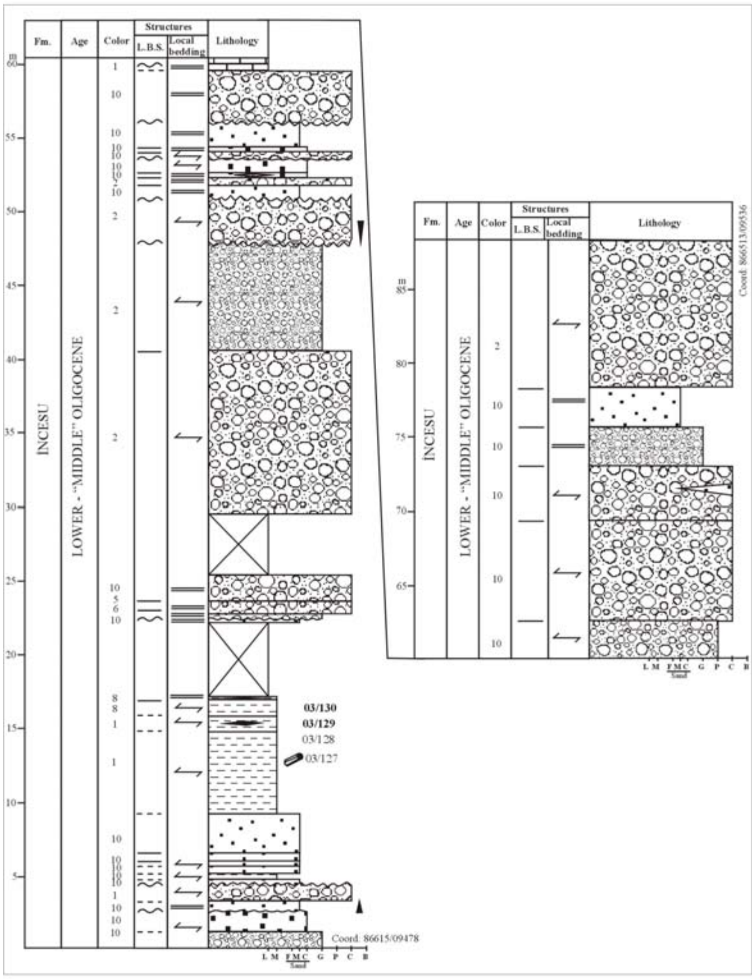

Figure 2. 52 Measured section of the İncesu Formation in the south of Dikmenbaşı Tepe (see figure 2. 45 for location and figure 2. 58 for explanation).

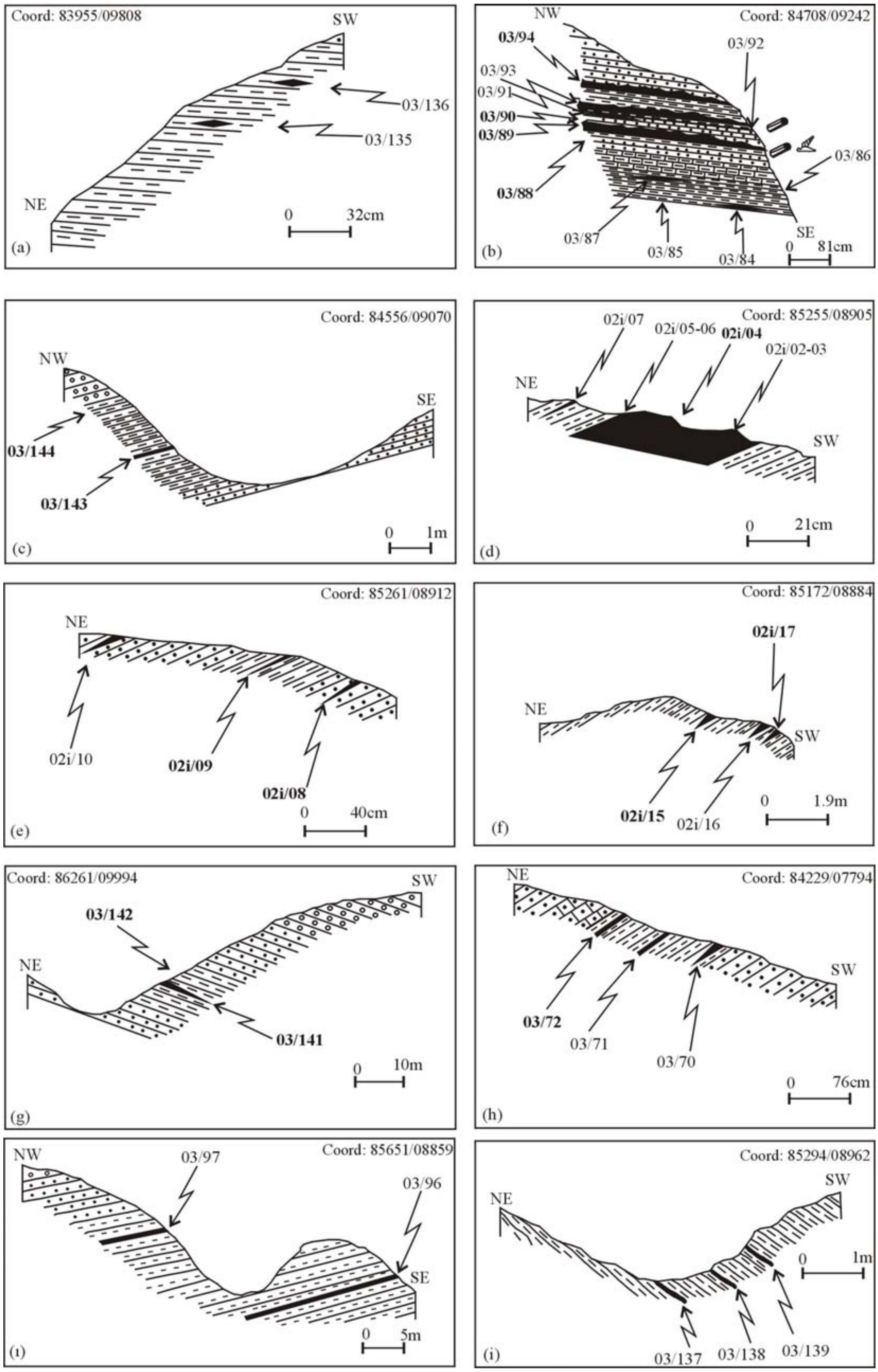

Figure 2. 53a-i Small scale geological cross-sections showing the sample numbers and lithological properties of the İncesu Formation. Coordinates are indicated in the boxes. See figure 2. 45 for locations of the sections and figure 2. 47 for explanation.

126 samples for palynological analysis and eleven samples for foraminifer investigations were systematically taken from the Kayıköy and İncesu formations.

2.3.2.2.3 Southern Part of Atabey Town. The last part of the İncesu Area includes the Delikarkası Tepe located in the SW of Atabey and İslamköy towns (Figs. 2. 30, 2. 54). In the area, basement rocks consist of Upper Cretaceous neritic and pelagic limestones of the Isparta series belonging to Bey Dağları Autochthon (Fig. 2. 54). Neritic limestones of the Isparta serie are generally thick bedded or massive. Pelagic limestones and carbonated mudstones observed in some restricted area are thin bedded and fractured. The Lower Oligocene Delikarkası Formation unconformably overlies the pelagic limestones and carbonated mudstones of the Isparta serie (Figs. 2. 55, 2. 56a, b). The name of the Delikarkası Formation was taken from the Delikarkası Tepe where it exposes well Yalçınkaya et al. (1986) (Fig. 2. 54). The formation is generally represented by shallow marine limestones and includes a rich benthic foraminifer assemblage (Fig. 2. 56c). In some places, the limestones are fractured (Fig. 2. 57). The İncesu Formation conformably overlies the Delikarkası Formation (Figs. 2. 55, 2. 56d).

A detailed section was measured from the neritic and pelagic carbonates of the Isparta series (Bey Dağları Autochthon) and Delikarkası Formation (Fig. 2. 57).

Eight samples from the neritic and pelagic limestones and twenty–three samples from the Delikarkası Formation were systematically collected (Fig. 2. 57).

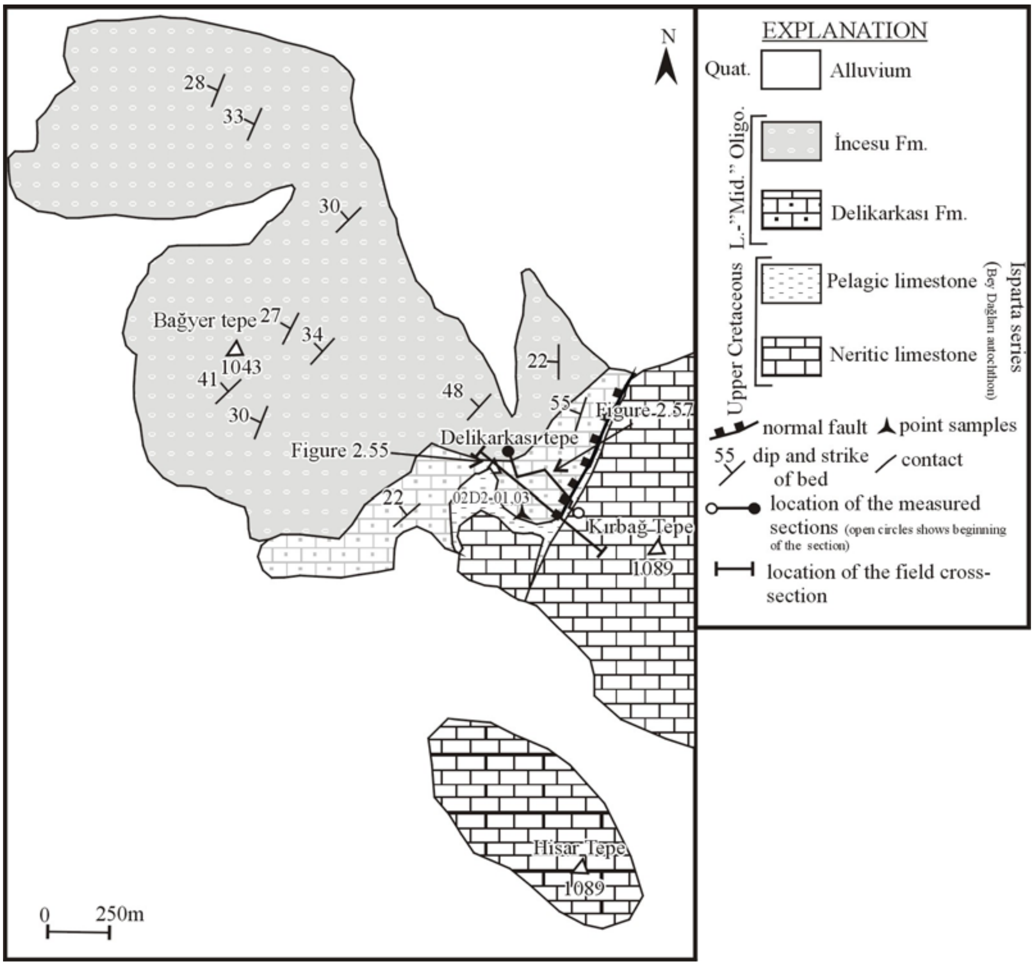

Figure 2. 54 Geological map of the southern part of Atabey Town. See figure 2. 30 for location. Location of measured section, geological cross-section and point samples are indicated.

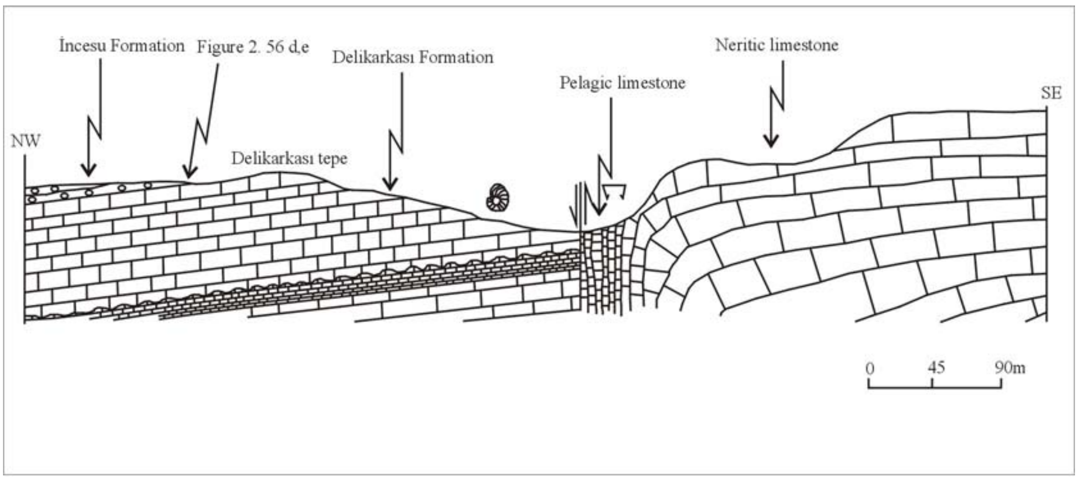

Figure 2. 55 Geological cross–section showing a fault–bounded boundary between Cretaceous limestones of the Isparta series (Bey Dağları Autochthon) and the overlying Lower Oligocene Delikarkası Formation (Modified from Gutnic, 1977). The section also shows a conformable upper boundary of Delikarkası Formation. See figure 2. 54 for location and figure 2. 47 for explanation.

Figure 2. 56 Field photographs showing (a) an unconformable lower boundary of the Delikarkası Formation, (b) fault–bounded lower boundary of the Delikarkası Formation with underlying pelagic limestones of Bey Dağları Autochthon, (c) Larger benthic foraminifers in the Delikarkası Formation (Coordinates: 90625/98825), (d, e) transitional boundary relationship between the Delikarkası and İncesu formations (Coordinates: 90480/99111). See figure 2. 47 for lithology explanations.

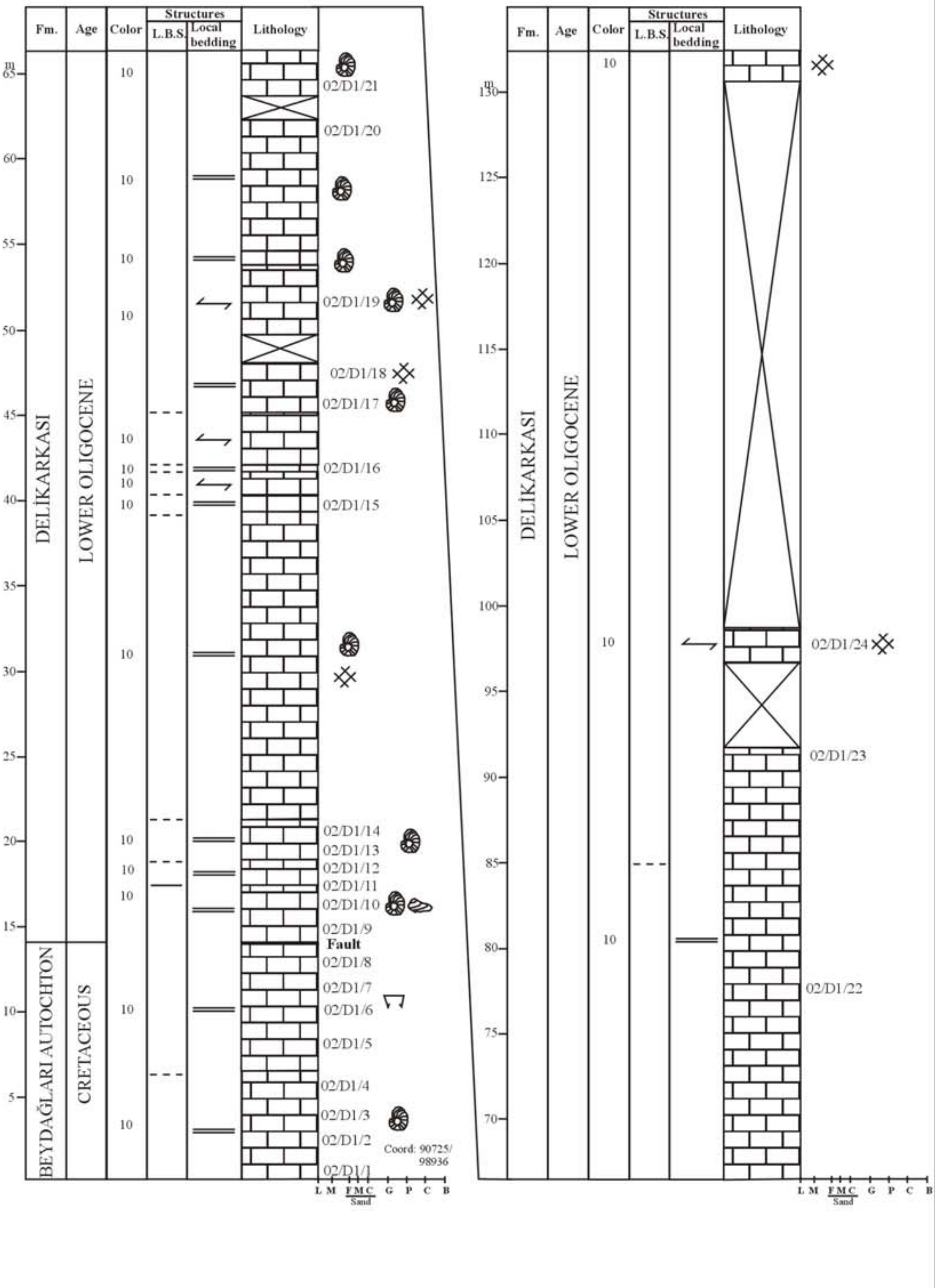

Figure 2.57 Measured section of the Delikarkası Formation surrounding the Delikarkası Tepe in the northwest of Kırdağ Tepe (see figure 2. 54 for location and figure 2. 58 for explanation).

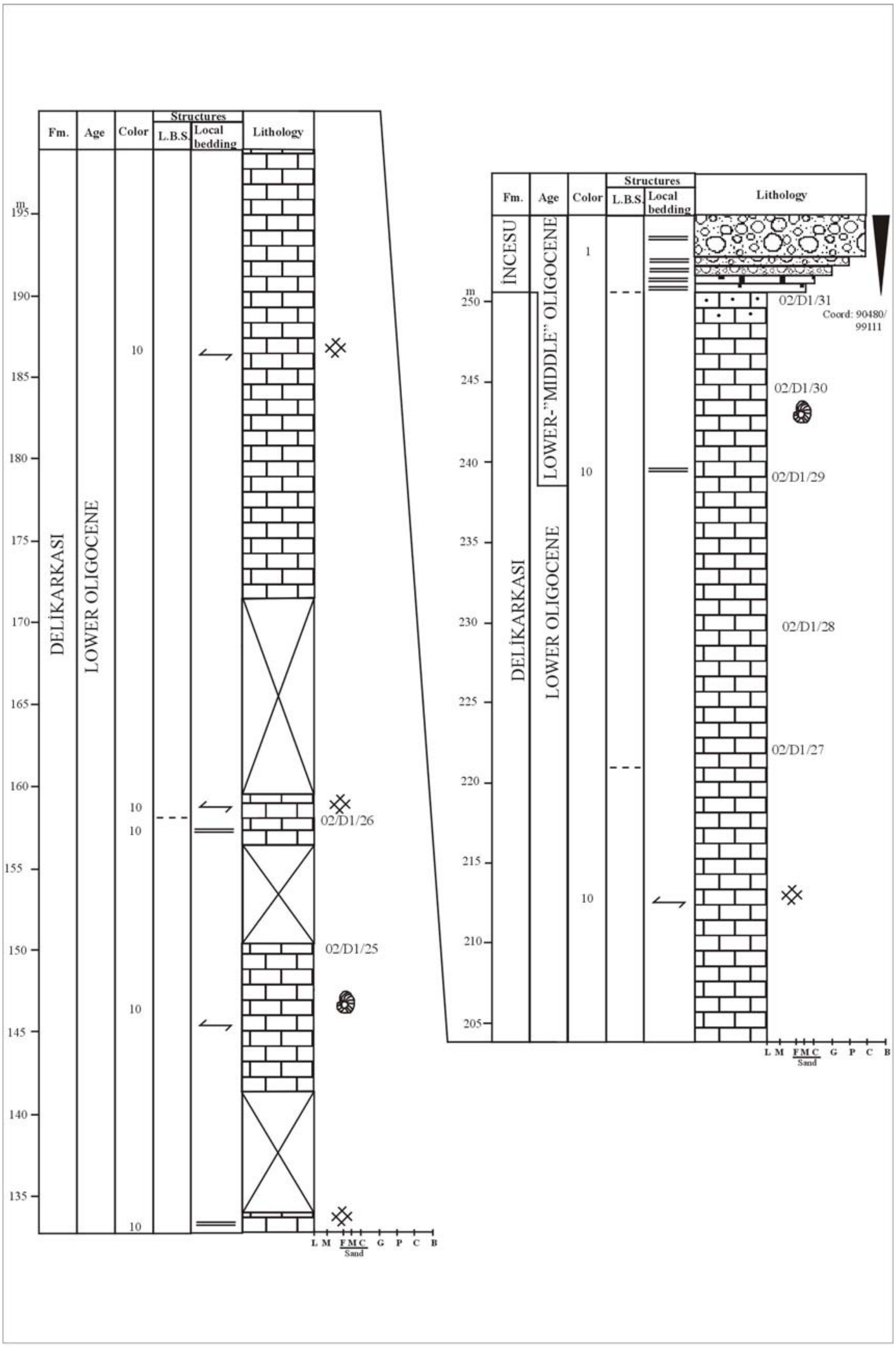

Figure 2. 57 (continued)

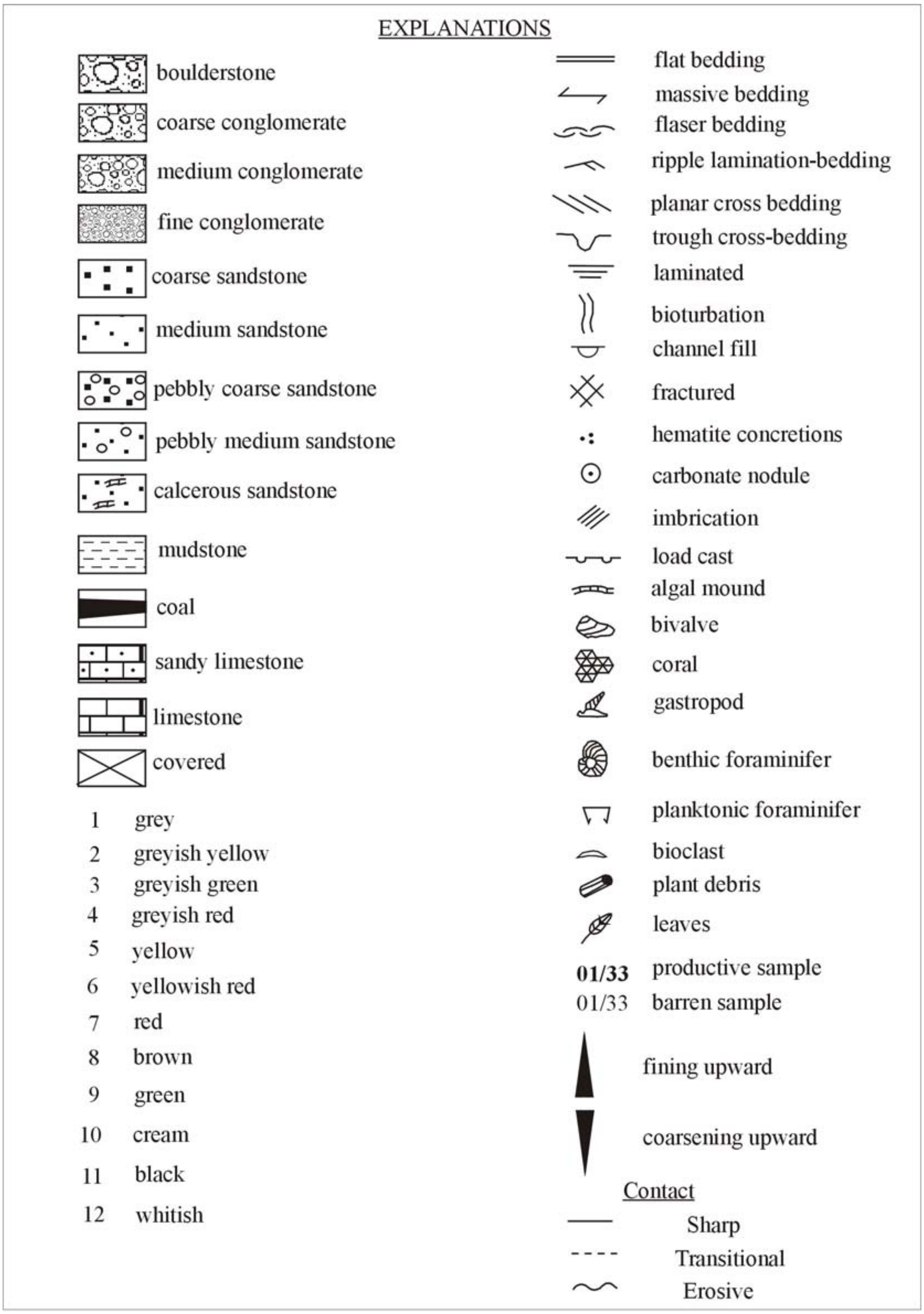

Figure 2. 58 Legend to logs in figs. 2. 6, 2. 7, 2. 13, 2. 14, 2. 21, 2. 25, 2. 26, 2. 28, 2. 29, 2. 36, 2. 37, 2. 42, 2. 43, 2. 44, 2. 49, 2. 50, 2. 51, 2. 52 and 2. 57.

CHAPTER THREE
SYSTEMATICS

3.1 Introduction

In the following a complete microflora is given. Totally 70 samples were counted of which, 18 samples from the Başçeşme Formation (Maden member), 17 samples from the Tokça Formation, 2 samples from the Varsakyayla Formation, 9 samples from the Aksu Formation, 5 samples from the Kavak Formation and 19 samples from the İncesu Formation. Most of the spores and pollen identified in this study are well known from the literature. Thomson & Pflug (1953)'s classification dominantly were used and also publications of Stuchlik et al. (2001), Thiele–Pfeiffer (1980, 1988) and Krutzsch to determine the spores. Additionally, taxonomy of dinoflagellate cysts and *Pediastrum* was also given on the following part. The maximum and minimum values, average values (ã) and number of measured individuals (n) were also indicated. For the spores, the ratio between trilete mark and spore radius are indicated. To determine the bisaccate pollen, dimension of the pollen have been measured. The stratigraphic ranges of the species have been given on the basis of previous Turkish, European and also other countries' literatures. All counting data are in the Tables 4. 1, 4. 3, 4. 5, 4. 6, 4. 7 and 4. 8. Additionally, all forms described here are shown in the plates on the Appendix 1. All slides are stored at Dokuz Eylül University, Department of Geological Engineering.

3.2 Systematics of Palynomorphs

Sporites POTONIÉ 1893

Triletes (REINSCH 1881) IBRAHIM 1933

Azonotrilete Microspores

Genus: *Leiotriletes* (NAUMOVA 1937) POTONIÉ & KREMP 1954

Type Species: *Leiotriletes sphaerotriangulus* (LOOSE 1932) POTONIÉ & KREMP 1954

(1) *Leiotriletes adriennis* (POTONIÉ & GELLETICH 1933) KRUTZSCH 1959
pl. 1, figs. 1–5

1933 *Punctati–sporites adriennis* sp. –POTONIÉ & GELLETICH, p. 521, pl. 2, fig. 14,15.

1951 *Lygodioisporites adriennis* POTONIÉ & GELLETICH –POTONIÉ, p.135–136, pl. 20, figs. 10, 11.

1954 *Laevigati adriennis* (POTONIÉ & GELLETICH) n. comb. –KRUTZSCH, p. 294–295, 310, pl. 4, fig. 1–4.

1959 *Leiotriletes adriennis* (POTONIÉ & GELLETICH) n. comb. subfsp. *adriennis* –KRUTZSCH, p. 57.

1994 *Leiotriletes adriennis* (POTONIÉ & GELLETICH) KRUTZSCH –ZIEMBIŃSKA –TWORZYDLO et al., pl. 2, fig. 6.

Dimensions: 48–60µm, ã = 53µm, (n = 116)

Description: Spores trilete, in polar view triangular with convex sides and widely rounded corners. Exine about 1µm thick. Arms of leasura straight, reaching 2/3 of radius. Labrum distinct.

Botanical affinity: *Acrostichum aureum*

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: According to Krutzsch (1962a), it occurred in Middle and Late Oligocene (late Chattian), and occasionally in Middle Miocene of Germany. Nakoman (1966a) reported it from Eocene Sorgun lignites. Konzálová (1973) mentions abundant occurrences in the Miocene sediments of Central Europe. Akyol (1980) reported the species from Middle–Upper Eocene sediments of Bayat (Çorum) lignites. Planderová (1991) pointed out that it occurs in Lower Miocene coal seams of Bohemia and Slovakia. Akgün & Sözbilir (2001) recorded the species from the Late Oligocene and Early Miocene of southwest Anatolian molasse deposits. Additionally, Akkiraz & Akgün (2005) also reported the species from the Lower Oligocene Çardak–Tokça Basin. According to Stuchlik et al. (2001), the range of species is from Middle Eocene to Early Miocene (Poland). Akkiraz et al. (accepted) have also recorded the species from Middle–?Upper Eocene sediments of the Çankırı Basin (central Anatolia).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Aksu Formation

(2) *Leiotriletes maxoides* KRUTZSCH 1962a ssp. *maximus* (PGLUG *in* THOMSON & PFLUG 1953) KRUTZSCH 1962a

pl. 1, figs. 6–11

1952 *Triradiato-sporites adriennis* (POTONIÉ) *maximus* PGLUG cf. *Lygodium* – MURRIGER & PFLUG, p. 57, 64, pl. 11, fig. 7.

1953 *Divisisporites maximus* n. sp. (PGLUG) –THOMSON & PFLUG, p. 52, pl. 1, figs. 57,58.

1959 *Leiotriletes maximus* (PFLUG) n. comb. –KRUTZSCH, p. 57.

1962a *Leiotriletes maxoides* (KRUTZSCH) *maximus* (PGLUG) KRUTZSCH – KRUTZSCH, p. 20, pl. 3, figs. 1–4.

Dimensions: 73–90 µm, ã = 80µm, (n = 49)

Description: Spores trilete, in polar view triangular with convex sides and widely rounded corners, exine more than 3µm thick. Arms of leasura straight, reaching 2/3 of radius. Labrum indistinct.

Botanical affinity: Family Lygodiaceae, the fossil spores are morphologically similar to spores of *Lygodium?*

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: According to Kedves (1961), the species occurred from the Sparnacien to Miocene of the Dorog Basin (France). In Germany, late Egerian (Krutzsch, 1962a). Nakoman (1966a) also indicated the presence of species from Eocene sediments of Sorgun area (Central Anatolia). According to Nakoman (1966b), the range of the species is from Eocene to Miocene of the Thrace Basin. Akyol (1971) reported its occurrence from Early Oligocene of Şile–İstanbul. It was recorded from Upper Oligocene and Lower Miocene sediments of western Poland (Ziembińska–Tworzydlo, 1974). Akyol (1980) mentions the species disappears after the upper most of "Middle" Oligocene (Bayat lignites). The species occurs in Early Eocene and Early Miocene of the Upper Rhine Graben (Nickel, 1996a). Further occurrences were obtained from the Oligocene and Miocene sediments of Poland (Stuchlik et al., 2001). Akgün (2002) reported the species from Middle–?Upper Eocene sediments of Çorum–Amasya area (central Anatolia). The species was also recorded from the Lower–"Middle" Oligocene Tokça Formation by Akkiraz & Akgün (2005). The species has also been described from Middle–?Upper Eocene sediments of the Çankırı–Çorum Basin by Akkiraz et al. (accepted).

Occurrences: Lower–"Middle Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(3) *Leiotriletes maxoides* KRUTZSCH 1962a ssp. *maxoides* KRUTZSCH 1962a

pl. 1, figs. 12–14

1953 *Lygodium- sporites adriennis* POTONIÉ & GELLETICH – HUNGER, p. 10, pl. 1, fig 21.

1953 *Laevigatosporites pseudomaximus* n. sp. –PFLUG & THOMSON *in* THOMSON & PFLUG, p. 54, pl. 2, fig. 21.

1961 *Leiotriletes dorogensis* (KEDVES) –KEDVES, pl. 4, fig. 14.

1962a *Leiotriletes maxoides maxoides* n. fsp. and subfsp. –KRUTZSCH, p. 18, pl. 2, figs. 1–5.

Dimensions: 55–72µm, ã = 63µm, (n = 385)

Description: Spores trilete, amb triangular to rounded–triangular with broadly rounded apices. The trilete mark is in most cases clearly recognizable. Exine up to 1.5 µm thick, Arms of leasura straight reaching 2/3 of radius. Labrum distinct.

Botanical affinity: Family Schizaeaceae; Genus probably *Lygodium*?

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: The species occurs in Middle and Late Oligocene and randomly in Middle Miocene of Germany (Krutzsch 1962a). Early and Middle Miocene of Hungary (Nagy 1985). It was reported from Middle–Late Oligocene of western Poland by Ziembińska–Tworzydlo (1974). According to Planderová (1991), the species occurs in the Ottnangian and Karpathian and disappears in the younger sediments of Slovakia. According to Lenz (2000), its range from is Middle Eocene to Miocene at Helmstedt, northern Germany. Stuchlik et al. (2001) indicated its occurrence from Middle Eocene to Middle Miocene of Poland.

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(4) *Leiotriletes maxoides* KRUTZSCH 1962a ssp. *minoris* KRUTZSCH 1962a

pl. 2, figs. 1–4

1962a *Leiotriletes maxoides* KRUTZSCH *minoris* n. subfsp. –KRUTZSCH, p. 16, pl. 1, figs. 1–8.

Dimensions: 45–55µm, ã = 48µm, (n = 98)

Description: Spores trilete, amb triangular to rounded–triangular with broadly rounded apices. The exine smooth. Arms of leasura reaching 2/3–4/5 of radius. Spore surface smooth or psilate.

Botanical affinity: Family Schizaeaceae; Genus probably *Lygodium*?

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: According to Krutzsch (1962a), the species occurs abundantly in Upper Oligocene and Lower Miocene coal deposits of Germany. It was described in the Egerian and Sarmation of Hungary (Nagy, 1985). Late Oligocene to Pliocene of Poland (Stuchlik et al., 2001).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene İncesu Formation; Lower Miocene Kavak and Aksu formations.

(5) *Leiotriletes triangulus* (MURRIGER & PFLUG 1952 ex KRUTZSCH 1959) KRUTZSCH 1962a

pl. 2, figs. 5–7

1952 *Triradiato-sporites neddeni* POTONIÉ ssp. *triangulus* PFLUG –MURRIGER & PFLUG, p. 57,pl. 2, fig. 5.

1953 *Concavisporites obtusangulus* POTONIÉ f. *minor* n. f. PFLUG –THOMSON & PFLUG, pl. 1, fig. 40.

1959 *Toroisporis* (*Toroisporis*) *triangulus* MURRIGER & PFLUG ex KRUTZSCH – KRUTZSCH, p. 91,92.

1962a *Leiotriletes triangulus* (MURRIGER & PFLUG ex KRUTZSCH) n. comb. – KRUTZSCH, p. 24, pl. 5, figs. 11–17.

1962a *Leiotriletes triangulatoides* n. fsp. – KRUTZSCH, p. 24, pl. 5, figs. 1–10.

Dimensions: 26–40 µm, ã = 38µm, (n = 30)

Description: Spores trilete, amb triangular with slightly convex sides, Exine thicker than 1 µm. Leasure arms reaching nearly a half of radius.

Remarks: It is in accordance with Krutzsch's (1962a) desription of species *Leiotriletes triangulatoides* included in the synonym list.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Previously recorded occurrences: The species occurs in Lower–Middle Miocene and ?Pliocene sediments of Germany (Krutzsch, 1962a). It was reported from "Middle" Oligocene sediments of western Poland by Ziembińska–Tworzydlo (1974). According to Nickel (1996a), it ranges from "Middle" Oligocene to Miocene of the Upper Rhine Graben. It was also reported from Middle Eocene of Messel (Thiele–Pfeiffer, 1988).

Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–"Middle Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(6) *Leiotriletes microlepioidites* KRUTZSCH 1962a

pl. 2, figs. 8–10

1962a *Leiotriletes microlepioidites* n. sp. –KRUTZSCH, p.30, pl. 8, figs. 1–18.

Dimensions: 25–31µm, ã = 25µm, (n = 20)

Description: Spores trilete, amb triangular with slightly concave side. Exine is about 1µm. Spore surface laevigate or psilate. Leasure arms sinusoidal, nearly reaching equator.

Botanical affinity: Family Dennstaedtiaceae; Genus probably *Microlepia*?

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: According to Krutzsch (1962a), the species occurs in Oligocene and Miocene of Germany. Stuchlik et al. (2001) mentions the range of species is from Late Oligocene to Pliocene in Poland.

Occurrences: Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Kavak and Aksu formations.

(7) *Leiotriletes microadriennis* KRUTZSCH 1959

pl. 2, figs. 11, 12

1959 *Leiotriletes microadriennis* n. sp. –KRUTZSCH, p. 61, pl. 1, figs. 3–7.

Dimensions: 30–40µm, ã = 30µm, (n = 60)

Description: Trilete spore with a triangular to roundish figure. Arms of leasura straight, reaching 2/3 to 4/5 of radius. Exine is about 1µm thick. Laevigate.

Botanical affinity: Family Schizaeaceae; Genus probably *Lygodium*?

Palaeofloristical element: Cosmopolitan

Previously recorded occurrences: Sittler (1965) recorded it from Early–"Middle" Oligocene of France. Nakoman (1966a) recorded the species in Eocene sediments of Yozgat–Sorgun area. Nakoman (1966b) mentions the occurrences of species may be observed up to Oligocene of the Thrace Basin. According to Krutzsch & Vanhoorne (1977), it occurs from Late Palaeocene to Late Eocene in Belgium. Nickel (1996a) mentions occurrences in the Rhine Graben from Late Palaeocene to Late Eocene. It was also recorded from Middle Miocene sediments of the Büyük Menderes Graben by Akgün & Akyol (1999). Akgün et al. (2000) illustrated the species from the Upper Miocene İncesu Formation of Central Anatolia. Akgün & Sözbilir (2001) and Akkiraz & Akgün (2005) reported it from Oligocene sediments of western Anatolian molasse basins (Kale–Tavas and Çardak–Tokça). Akgün (2002), Akgün et al. (2002) and Akkiraz et al. (accepted) indicate the presence of the species from Middle–?Upper Eocene sediments of the Çankırı Basin.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Aksu formation.

(8) *Leiotriletes wolffii* KRUTZSCH1962a ssp. *wolffii* KRUTZSCH 1962a

pl. 2, figs. 13–15

1962a *Leiotriletes wolffii wolffii* n. fsp. and subfsp. –KRUTZSCH, p. 26, pl. 6, figs. 1–14.

Dimensions: 40–45µm, ã = 45µm, (n = 111)
Description: Spores trilete, amb triangular with slightly concave sides. Spore surface smooth. Arms of leasura reaching 4/5–5/5 of radius.
Botanical affinity: Family Polypodiaceae; Genus probably *Microlepia*?
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: It occurs in the Hungarian Egerian to Sarmatian (Nagy, 1985). The range of species is from Late Eocene to Miocene of western Paratethys (Hochuli, 1978). Akgün (2002) reported the species from Middle–?Upper Eocene sediments of Çorum–Amasya area.
Occurrences: Middle–?Upper Eocene Başçeşme Formation; Lower–“Middle” Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(9) *Leiotriletes neddenioides* KRUTZSCH 1962a
pl. 2, figs. 16–18

1962a *Leiotriletes neddenioides* n. fsp. –KRUTZSCH, p. 32, pl. 9, figs. 1–15.

Dimensions: 35–48µm, ã = 38µm, (n = 27)
Description: Spores trilete, amb triangular with slightly concave sides. Exine is about 1 µm. Spore surface laevigate or psilate. Leasura arms straight nearly reaching equator.
Botanical affinity: Family Lygodiaceae? Cyatheaceae?
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: According to Krutzsch (1962a), the range of species is from Late Oligocene to Pliocene in Germany. Planderová (1990) mentions occurrences of species from Middle–Late Miocene in Carpathians. Nagy (1985) reported it from Middle Miocene to Pliocene of Hungary. Akgün (2002) recorded the species from Middle–?Upper Eocene sediments of Çorum–Amasya area.

Occurrences: Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(10) *Leiotriletes seidewitzensis* KRUTZSCH 1962a
pl. 2, fig. 19

1962a *Leiotriletes seidewitzensis* n. fsp. –KRUTZSCH, p. 30, pl. 8, figs. 19–24.

Dimensions: 33µm, ã = 33µm, (n = 3)
Description: Spore trilete, amb triangular with slightly concave sides and rounded apices. Exine is about 1µm thick. Leasura arms straight, reaching 3/4 length of spore radius.
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Previously recorded occurrences: It was recorded from Miocene sediments of Germany (Krutzsch, 1962a) and Hungarian Lower Miocene (Nagy, 1985). According to Stuchlik et al. (2001), the range of species is from Early to Middle Miocene in Poland. Akgün (2002) determines the presence of the species from Middle–?Upper Eocene sediments of Çorum–Amasya area.
Occurrences: Lower Miocene Aksu Formation.

(11) *Leiotriletes* sp. 1
pl. 2, fig. 20, 21

Dimensions: 23–28µm, ã = 25µm, (n = 4)
Description: Spores trilete, amb triangular with strongly concave sides and rounded apices. Leasura arms straight, reaching 3/4 length of spore radius.
Remarks: Only a few grains have been found and are similar to *Leiotriletes microlepioidites* Krutzsch 1962a, but seem to differ in having strongly concave sides without ornaments.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower Miocene Kavak Formation.

(12) *Leiotriletes* sp. 2

pl. 2, figs. 22, 23

Dimensions: 38–45µm ã = 40µm, (n = 3)

Description: Spores trilete, amb triangular with straight sides and more or less rounded apices. Leasura arms straight, reaching 3/4 length of spore radius.

Remarks: Only a few spore grains have been found and similar to *Leiotriletes neddenioides* Krutzsch 1962a and also *Leiotriletes wolffii* ssp. *wolffii* Krutzsch 1962a with respect to shape and size. However *Leiotriletes* sp. 2 has more or less straight sides.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Kavak Formation.

Genus: *Triplanosporites* PFLUG ex THOMSON & PFLUG 1953

Type Species: *Triplanosporites sinuosus* PFLUG 1952 ex THOMSON & PFLUG 1953

(13) *Triplanosporites microsinuosus* PFLANZL 1955

pl. 2, fig. 24

1955 *Triplanosporites microsinuosus* n. sp., *Triplanosporites sinuosus* ssp. *microsinuosus* n. subsp. PFLANZL & MURRIGER –PFLANZL, p. 27, pl. 5, figs. 12a, b, pl. 6, figs. 21a, b

Dimensions: 33µm (polar axis), 31 µm (equatorial diameter), (n = 1)

Description: Triplane trilete spore, outline in equatorial view nearly quadrangular, with rounded apices. Exine is about 2µm thick, near the proximal pole somewhat thicker. Spore surface laevigate.

Botanical affinity: Genus *Lygodium*?

Palaeofloristical element: Unknown

Previously recorded occurrences: Kedves (1967) reported the species from Eocene sediments of Paris region. Takahashi & Jux (1986) recorded the presence of species from Oligocene to Pliocene in Germany.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

(14) *Triplanosporites sinuosus* PFLUG 1952 ex THOMSON & PFLUG 1953
pl. 2, figs. 25, 26, pl. 3, fig. 1

1952 *Triplano-sporites sinuosus* n. sp. –PFLUG, p. 118, 136, pl. 6 fig. 3 and p. 113, 114 fig. 2

1953 *Triplanosporites sinuosus* (PFLUG ex THOMSON & PFLUG) –THOMSON & PFLUG, p. 53, pl.3, figs. 5–8.

Dimensions: 44–51 µm (polar axis), 40–45µm (equatorial diameter), ã = 50x45µm, (n = 15).

Description: Triplane trilete spore, outline in equatorial view nearly quadrangular, with distinctly rounded apices. Exine is about 2µm thick, near the proximal pole somewhat thicker. Spore surface laevigate and/or psilate.

Botanical affinity: Genus *Lygodium*?

Palaeofloristical element: Unknown

Previously recorded occurrences: It was reported from Palaeocene sediments of western Germany (Takahashi & Jux, 1986). According to Stuchlik et al. (2001), the species is common in Paleogene and Neogene sediments of Poland.

Occurrences: Lower–“Middle” Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(15) *Triplanosporites sinomaxoides* KRUTZSCH 1962a

pl. 3, fig. 2

1962a *Triplanosporites sinomaxoides* n. fsp. –KRUTZSCH, p. 40, pl. 13, figs. 1–6.

Dimensions: 64 µm (polar axis), 60 µm (equatorial diameter), (n = 1)

Description: Triplane trilete spore, leasura arms strongly straight. Exine is smooth 2–4µm thick. Spore surface laevigate.

Botanical affinity: Family Schizaeaceae; Genus *Lygodium*

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: According to Krutzsch (1962a), the species mainly occurs in Oligocene sediments of Germany. However, its occurrence was not surely proven in Upper Miocene and Pliocene sediments of northern Central Europe. It was reported from Middle Eocene to Upper Oligocene sediments of western Germany by Takahashi & Jux (1986).

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

Genus: *Punctatisporites* IBRAHİM 1933

Type Species: *Punctatisporites punctatus* (PFLUG *in* THOMSON & PFLUG 1953)

(16) *Punctatisporites punctatus* PFLUG *in* THOMSON & PFLUG 1953

pl. 3, fig. 3

1953 *Punctatisporites punctatus* n. sp. – PFLUG *in* THOMSON & PFLUG, p. 57, pl. 2, figs. 63–70.

Dimensions: 61µm (polar axis), 48 (equatorial axis), (n = 1)

Description: Trilete spore, amb almost triangular with more or less convex sides. Arms of leasura straight, reaching 2/3 to 4/5 of radius. Exine is about 1µm thick. Spore surface punctate.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Previously recorded occurrences: The species was rarely recorded from European Tertiary sediments (Thomson & Pflug, 1953).

Occurrences: Lower–"Middle" Oligocene İncesu Formation.

Genus: *Retitriletes* (VAN DER HAMMEN 1956 ex PIERCE 1961) emend. DÖRING, KRUTZSCH, MAI & SCHULZ 1963

Type Species: R*etitriletes globosus* PIERCE 1961

(17) *Retitriletes lusaticus* KRUTZSCH 1963a
pl. 3, fig. 4

1963a *Retitriletes lusaticus* n. fsp. –KRUTZSCH, p. 96, pl. 29, figs. 1–5.

Dimensions: 38µm, (n = 1)

Description: Spore trilete, amb circular. Exine is about 1–1,5µm. On distal face, reticulum strongly developed about 2 µm high, on proximal face, lumina more or less circular, about 6–8µm in diameter. Leasura arms indistinct.

Botanical affinity: Genus *Lycopodium*

Palaeofloristical element: Arctotertiary (cool temperate)

Previously recorded occurrences: It was recorded from "Middle" Oligocene sediments of western Poland (Ziembińska–Tworzydlo, 1974). According to Stuchlik et al. (2001), the range of species changes from Oligocene to Miocene.

Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(18) *Retitriletes* sp. 1

pl. 3, fig. 5

Dimensions: 30–45µm, ã = 40µm, (n = 7)

Description: Spores trilete, amb rounded triangular. Exine 1.5–2µm. Surfaces of proximal distal faces reticulate, reticulum with irregular, polygonar lumina about 7µm in diameter.

Remarks: Krutzsch (1962) described different kinds of *Retitriletes* species. Similar forms were described as a *Retitriletes* fsp. A which is notably similar to specimens obtained. However, *Retitriletes* fsp. A has not only more spherical forms but smaller size compare to our specimens.

Botanical affinity: The fossil pollen is similar morphologically to *Lycopodium*?

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu Formation.

Genus: *Baculatisporites* THOMSON & PFLUG 1953

Type Species: *Baculatisporites primarius* (WOLFF 1934) THOMSON & PFLUG 1953

(19) *Baculatisporites primarius* (WOLFF 1934) THOMSON & PFLUG 1953 ssp. *oligocaenicus* KRUTZSCH 1967a

pl. 3, fig. 6

1934 *Sporites primarius* n. sp. –WOLFF, p. 66, pl. 5, fig. 8.

1953 *Baculatisporites primarius* (WOLFF) n. comb. –THOMSON & PFLUG, p. 56, pl. 2, figs. 49–53.

1955 *Baculatisporites primarius* (WOLFF) –MURRIGER & PFLANZL, pl. 6, fig. 19.

1967a *Baculatisporites primarius* (WOLFF) –THOMSON & PFLUG 1953 ssp. *oligocaenicus* –KRUTZSCH, p. 60, pl. 12, figs. 1–6.

Dimensions: 65–70µm**,** ã = 70µm, (n = 5)

Description: Spores trilete, amb nearly circular. Leasura arms straight, reaching 1/2of the spore radius, bacula of various shape and size (up to 2µm high), densely placed.

Botanical affinity: Family Osmundaceae; Genus *Osmunda*

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: Krutzsch (1967) reported the species from Late Eocene to Early Miocene in Germany. In the Western Paratethys, the species occurs in Oligocene (Hochuli, 1978). According to Stuchlik et al. (2001), the range of species is between Late Oligocene and Pliocene in Poland. Akgün (2002) determines the species from Middle–?Upper Eocene sediments of Çorum–Amasya area.

Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–"Middle" Oligocene İncesu Formation.

(20) *Baculatisporites ovalis* KEDVES 1973

pl. 3, figs. 7, 8

1973 *Baculatisporites ovalis* n. sp. –KEDVES, p. 40, pl. 10, figs. 5, 6.

Dimensions: 40–50µm, ã = 50µm, (n = 3)

Description: Spore trilete, amb circular. Leasura arms straight. Spore surface densely placed bacula up to 2µm high.

Botanical affinity: Family Osmundaceae; Genus *Osmunda*

Palaeofloristical element: Palaeotropical–Arctotertiary

Previously recorded occurrences: According to Stuchlik et al. (2001), the range of species is between Paleogene and Middle Miocene in Poland.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu Formation.

(21) *Baculatisporites nanus* (WOLFE 1934) KRUTZSCH 1959

pl. 3, figs. 9–11

1934 *Sporites nanus* n. sp. –WOLFF, p. 66–67, pl. 5, fig. 9.

1959 *Baculatisporites nanus* (WOLFF) n. comb. –KRUTZSCH, p. 140.

Dimensions: 30–42µm, ã = 42µm, (n = 22)

Description: Spores trilete, amb circular. Leasura arms straight. Surface covered by densely placed bacula up to 1.5µm high and 1.5µm at their bases.

Botanical affinity: Family Osmundaceae; Genus *Osmunda*

Palaeofloristical element: Palaeotropical–Arctotertiary

Previously recorded occurrences: In Germany, the species occurs from “Middle” Oligocene to Miocene (Krutzsch, 1967a). According to Ashraf & Mosbrugger (1995), the species was recorded from “Middle” Oligocene and Pliocene sediments of Lower Rhine Embayment. Stratigraphic distribution of species was accepted from Late Oligocene to Pliocene by Stuchlik et al. (2001).

Occurrences: Lower–“Middle” Oligocene Tokça and İncesu formations.

(22) *Baculatisporites* sp. 1

pl. 3, fig. 12

Dimensions: 29–32µm, ã = 32µm (n = 5)

Description: Spore trilete, amb circular. Leasura arms straight. Spore surface densely placed bacula up to 2µm high.

Remarks: The specimen differs from the *Baculatisporites nanus* ssp. *gracilis* Krutzsch 1967 in having scarce ornaments and a clear leasura.

Botanical affinity: Family probably Osmundaceae?

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Cicatricosisporites* POTONIÉ & GELLETICH 1933

Type species: *Cicatricosisporites dorogensis* POTONIÉ & GELLETICH 1933

(23) *Cicatricosisporites* sp. 1

pl. 3, fig. 13

Dimensions: 37µm, (n =1)

Description: Spore trilete, amb triangular with broadly rounded apices. Exine 2µm thick. Spore surface with distinct, broad and undulate ridges about 3µm thick, ridges running to parallel to the sides of amb.

Remarks: Even the microscopic features point directly to the *Cicatricosisporites*, but identification down to species level is yet not possible because of bad preservation. Additionally, only a single spore grain has been observed.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Trilites* COOKSON 1947

Type Species: *Trilites tuberculiformis* COOKSON 1947

(24) *Trilites multivallatus* (PFLUG *in* THOMSON & PFLUG 1953) KRUTZSCH 1959

pl. 3, figs. 14, 15

1952 *Lygodium? spor. solidus* POTONIÉ –MEYER, p. 31, pl. I, fig. 7.

1953 *Corrugatisporites solidus* POTONIÉ *multivallatus* n. subsp. (PFLUG) – THOMSON & PFLUG, p. 35, pl. 2, figs. 37–40.

1959 *Trilites multivallatus* (PFLUG) n. comb. –KRUTZSCH, p. 149, Tab. 8.

Dimensions: 38–42µm, ã = 38µm, (n = 14)

Description: Spores trilete, amb triangular with slightly concave sides and rounded apices. Exine about 2–3µm thick, somewhat thicker on the apices. Surface covered with coarse verrucae about 3µm high. Leasura arms reaching 4/5 length of the spore radius.
Botanical affinity: Family Lygodiaceae; Genus *Lygodium*
Palaeofloristical element: Palaeotropical (subtropical)
Previously recorded occurrences: Krutzsch (1967a) mentions its occurrences in Upper Oligocene and Middle Miocene sediments of Germany. Chateauneuf (1980) mentions occurrences in upper Middle Eocene of the Paris Basin (France). Ashraf & Mosbrugger (1995) indicate the species from Early Oligocene to Pliocene in the Lower Rhine Embayment (NW Germany). According to Nickel (1996a), the species occurs from Lower Oligocene to Upper Miocene sediments of the Upper Rhine Graben. The range of species is indicated from Middle Eocene to Middle Miocene by Stuchlik et al. (2001). Akgün (2002) reported the presence of species from Middle–?Upper Eocene sediments of Çorum–Amasya area. It was also reported from southwest Anatolian molasse deposits by Akgün & Sözbilir (2001) and Akkiraz & Akgün (2005).
Occurrences: Lower–"Middle" Oligocene İncesu Formation

(25) *Trilites embriyonalis* KRUTZSCH 1967a
pl. 3, fig. 16

1967a *Trilites embriyonalis* n. fsp. –KRUTZSCH, p. 76, pl. 20, figs. 12–24.

Dimensions: 33–35µm, ã = 33µm, (n = 9)
Description: Spore trilete, amb triangular with clearly concave sides rounded apices. Spore surface corrugate sculpture sometimes running parallel to the spore sides. Leasura arms reaching 4/5 length of the spore radius.
Botanical affinity: Family Lygodiaceae
Palaeofloristical element: Unknown
Previously recorded occurrences: It was scarcely recorded in Miocene sediments of Germany (Krutzsch 1967a).

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(26) *Trilites* sp. 1
pl. 3, figs. 17, 18

Dimensions: 30–32µm, (n = 3)

Description: Spores trilete, amb triangular with straight or slightly concave sides rounded apices. Exine about 2µm (without sculpture elements). Spore surface rugulate with rugulae sometimes running parallel to the spore sides.

Remarks: The specimens obtained have a small sized, secondary folded and indistinct leasura arms.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Lower–“Middle” Oligocene Tokça and İncesu formations.

Genus: *Echinatisporis* KRUTZSCH 1959

Type Species: *Echinatisporis longechinatus* KRUTZSCH 1959

(27) *Echinatisporis miocenicus* KRUTZSCH & SONTAG *in* KRUTZSCH 1963b
pl. 3, figs. 19, 20

1963b *Echinatisporis miocenicus* n. fsp. (KRUTZSCH & SONTAG) –KRUTZSCH, p. 110, pl. 36, figs. 6–13.

Dimensions: 25–35µm, ã = 30µm, (n = 5)

Description: Spores trilete, amb triangular with slightly convex sides and rounded apices. Spore surface echinate, sculpture elements straight, about 6 µm long, with broad bases and acute tops.

Botanical affinity: Genus *Selaginella*.

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: It was recorded from Miocene sediments of Wackerdorf and Lausitz (Krutzsch, 1963b; Sontag, 1966). According to Planderová (1990), the species occurs in the Eggenburgian of Slovakia. Additionally, the species was recorded from Late Oligocene of central Paratethys (Hochuli, 1978).

Occurrences: Lower–“Middle” Oligocene İncesu Formation; Lower Miocene Kavak Formation.

(28) *Echinatisporis* ? *chattensis* KRUTZSCH 1963b

pl. 3, figs. 21–23

1963b *Echinatisporis* ? *chattensis* n. fsp. –KRUTZSCH, p. 104, pl.33, figs. 1–5.

Dimensions: 31–38µm, ã = 35µm, (n = 204)

Description: Spores trilete, amb circular. Exine about 2µm thick. Leasura arms indistinct. Spore surface covered by densely spaced spine–like elements of various shape and size, from conical with about 3–3.5µm basis diameter to baculate with 3µm basis diameter and about 8µm long. The tops of sculpture elements clavate somewhat flat and rounded, occasionally sharp.

Botanical affinity: Genus *Selaginella*

Palaeofloristical element: Palaeotropical–Arctotertiary

Previously recorded occurrences: Krutzsch (1963b) recorded the species from Upper Oligocene sediments of Middle Europe.

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(29) *Echinatisporis* sp. 1

pl. 3, fig. 24

Dimensions: 34µm, (n = 1)

Description: Spores trilete, amb more or less circular. Laesura indistinct. Spore surface covered by densely spaced spina up to 4µm long and about 3µm broad with rounded.

Botanical affinity: Family probably Selaginallaceae?

Remarks: Only a single grain has been recorded.

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Zonales (BENNIE & KIDSTON 1886) POTONIÉ 1956

Zonotrilete Microspores

Genus: *Polypodiaceoisporites* POTONIÉ 1956

Type Species*: Polypodiaceoisporites speciosus* (POTONIÉ 1934) POTONIÉ 1956

(30) *Polypodiaceoisporites* cf. *marxheimensis* (MURRIGER & PFLUG 1952 ex THOMSON & PFLUG 1953) KRUTZSCH 1959
pl. 3, fig. 25

1952 *Triradiato–sporites marxheimensis* n. sp. –MURRIGER & PFLUG, p.57, pl. 11, figs. 2–4.

1953 *Cingulatisporites marxheimensis* MURRIGER & PFLUG ex THOMSON & PFLUG, p. 58, pl. 1, figs. 13–15.

1959 *Polypodiaceoisporites marxheimensis* (MURRIGER & PFLUG) n. comb. – KRUTZSCH, p. 180.

Dimensions: 47–49µm ã = 48µm, (n = 4)

Description: Spore trilete, amb triangular with concave sides and rounded apices. Cingulum 6–7µm broad occasionally narrowed in some parts. Outer parts of cingulum slightly undulate. Leasura arms reaching 4/5 length of spore radius. Proximal face covered by big verrucae of irregular shape and size.

Remarks: The species obtained is similar to *Polypodiaceoisporites marxheimensis* (Mürriger & Pflug 1952 ex Thomson & Plug 1953) Krutzsch 1959, but smaller sized.

Botanical affinity: Shizaeaceae? Dicksoniaceae? Pteridaceae? Cyatheaceae?

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: Krutzsch (1967) reported the species from early Chattian in the Cyrenia beds. According to Planderová (1990), the species occurs mainly in Eocene sediments. It was also recorded from lower Badenian sediments of Hungary (Nagy, 1985).

Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(31) *Polypodiaceoisporites kedvesii* STUCHLIK *in* STUCHLIK et al. 2001
pl. 4, fig. 1

1969 non *Polypodiaceoisporites hamulatus* n. sp. –NAGY, p. 119, pl. 21, figs. 9, 10, text figure 22.

1973 *Polypodiaceoisporites hamulatus* n. sp. –KEDVES, p. 49, pl. 16, figs. 1, 2, text figure 9.

2001 *Polypodiaceoisporites kedvesii* (KEDVES) nom. nov. –STUCHLIK et al, p. 46, pl. 30, figs. 4a–d.

Dimensions: 39–40µm, ã = 40µm, (n = 7)

Description: Spores trilete, amb triangular with slightly convex sides and rounded apices. Cingulum of uniform breadth, up to 3µm wide. Exine up to 1µm thick. Leasure arms reaching 4/5 length of spore radius. Proximal face covered by regularly dispersed verrucae.

Remarks: *Polypodiaceoisporites hamulatus* was described a new species by Nagy (1969). The same was also given by Kedves (1973) to another type of spore. The name of species was changed as *Polypodiaceoisporites kedvesii* by Stuchlik et al. (2001).

Botanical affinity: Family Pteridaceae

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: According to Stuchlik et al. (2001) the range of species is between Middle Eocene and Middle Miocene in Poland.
Occurrences: Middle–?Upper Eocene Başçeşme Formation.

(32) *Polypodiaceoisporites gracillimus* NAGY 1963
pl. 4, fig. 2

1963 *Polypodiaceoisporites gracillimus* n. sp. –NAGY, p. 398, pl. 1, figs. 3–6.

Dimensions: 38µm, ã = 38µm, (n = 1)
Description: Spore trilete, with a narrow cingulum broadened on corners proximal face was covered by very small verrucae.
Botanical affinity: Family Pteridaceae
Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)
Previously recorded occurrences: The species occurs in marine or brackish water Oligocene and Miocene sediments of Germany (Krutzsch, 1967; Nickel, 1996a). The species was reported from Upper Oligocene–Lower Miocene sediments of southwest Anatolian molasse basins by Akgün & Sözbilir (2001). Akgün (2002) indicates the presence of species from Middle–?Upper Eocene sediments of Çorum–Amasya area.
Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(33) *Polypodiaceoisporites saxonicus* KRUTZSCH 1967a
pl. 4, figs. 3–5

1967a *Polypodiaceoisporites saxonicus* n. sp. –KRUTZSCH, p. 110, pl. 37, figs. 5–20.

Dimensions: 30–35µm, ã = 33 and 35µm, (n = 199)
Description: Spores trilete with cingulate, amb triangular with nearly straight sides and rounded apices. Cingulum broad, 3–4µm narrowing on the apices. Exine is about 2µm.

Leasura arms reaching nearly cingulum. On proximal surface, small verrucae, more densely placed near the leasura arms.

Botanical affinity: Family Pteridaceae; Genus *Pteris*

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: The species was reported from Late Eocene and Early Oligocene by Nickel (1996a). According to Stuchlik et al. (2001), the range of species is between Early Oligocene and Middle Miocene in Poland. Akgün (2002) and Akgün et al. (2002) determines the presence of species from Middle–?Upper Eocene sediments of the Çankırı Basin.

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations.

(34) *Polypodiaceoisporites muricinguliformis* NAGY 1969

pl. 4, fig. 6

1969 *Polypodiaceoisporites muricinguliformis* n. sp. –NAGY, p. 115, pl. 20, figs. 7,8.

Dimensions: 42µm, ã = 42µm, (n = 5)

Description: Spore trilete, amb triangular with slightly convex sides and rounded apices. Cingulum 6µm on the slightly convex sides, randomly slightly narrower on the apices. Cingulum margin slightly undulated. Leasura arms nearly reaching the cingulum, the proximal face loosely spaced verrucae.

Botanical affinity: Family Pteridaceae; Genus *Pteris*

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: According to Stuchlik et al. (2001), the range of species is between Early and Middle Miocene.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

(35) *Polypodiaceoisporites schoenewaldensis* KRUTZSCH 1967a

pl. 4, fig. 7

1967a *Polypodiaceoisporites schoenewaldensis* n. sp. –KRUTZSCH, p. 110, pl. 37, figs. 1–4.

Dimensions: 38µm, (n = 1)

Description: Spore trilete, amb triangular with slightly convex sides and rounded apices. Cingulum around 3µm and slightly convex sides. Leasura arms nearly reaching the cingulum. The proximal and distal face loosely spaced rugulae and/or corrugae.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Previously recorded occurrences: The species occurs in Oligocene sediments of Europe (Krutzsch, 1967a). It was recorded from Late Eocene and Early Oligocene by Nickel (1996a).

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(36) *Polypodiaceoisporites corrutoratus* NAGY 1985

pl. 4, figs. 8–10

1985 *Polypodiaceoisporites corrutoratus* n. sp. –NAGY, p. 96, pl. 27, figs. 14–16, pl. 28, figs. 1–6.

Dimensions: 42–45µm, ã = 42µm, (n = 12)

Description: Spore trilete, amb triangular with straight/slightly concave sides and rounded apices. Cingulum nearly of uniform breadth, up to 7µm wide and slightly undulated. Exine about 1µm thick. Leasura arms reaching 4/5 of spore radius.

Botanical affinity: Family Pteridaceae

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: Nagy (1985) mentions occurrences in the Lower and Middle Miocene of Hungary**.** The range of species is from Oligocene to Early Miocene (Stuchlik et al., 2001).

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(37) *Polypodiaceoisporites microconcavus* KRUTZSCH 1967a
pl. 4, fig. 11

1967a *Polypodiaceoisporites microconcavus* n. fsp. – KRUTZSCH, p. 114, pl. 39, figs. 18–32.

Dimensions: 20µm, ã = 20µm, (n = 5)
Description: Spore trilete, amb triangular with considerably concave sides and rounded apices. Cingulum imperceptible of uniform breadth up to 1 µm. Leasura arms reaching 4/5 length of spore radius.
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Previously recorded occurrences: According to Krutzsch (1967a), the species occurs in Oligocene and Miocene sediments.
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

(38) *Polypodiaceoisporites* sp. 1
pl. 4, fig. 12

Dimensions: 29µm, (n = 1)
Description: Spore trilete, amb triangular with strongly concave sides and rounded apices. Cingulum imperceptible nearly of uniform breadth, up to 1µm wide and strongly undulated. Exine about 1µm thick. Leasura arms reaching 4/5 of spore radius.
Remarks: Even the microscopic features point directly to the *Polypodiaceoisporites*, but identification down to species level is yet not possible.
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(39) *Polypodiaceoisporites* sp. 2
pl. 4, fig. 13

Dimensions: 41µm, (n = 1)
Description: Spore trilete, amb triangular with concave sides and rounded apices. Cingulum nearly of uniform breadth, up to 6.5µm wide and strongly undulated. Spore surface covered densely by big verrucae. Exine about 1µm thick. Leasura arms reaching 4/5 of spore radius.
Remarks: The size of this spore type is quite comparable with *P.kedvesii* Stuchlik et al., 2001, *P. muricinguliformis* Nagy 1969 and *P. corrutoratus* Nagy 1985, but relatively densely placed coarse ornaments.
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Monolete Spores IBRAHIM 1933

Genus: *Laevigatosporites* IBRAHIM 1933

Type Species: *Laevigatosporites vulgaris* (IBRAHIM 1932) IBRAHIM 1933

(40) *Laevigatosporites gracilis* WILSON & WEBSTER 1946
pl. 4, fig. 14

1946 *Laevigato-sporites gracilis* n. sp. –WILSON & WEBSTER, p. 273–274, fig. 4.

Dimensions: 22–30µm (equatorial diameter), 18–20µm (polar axis), ã = 30x20µm, (n = 32)
Description: Spores monolete, outline in equatorial view bean shaped. Amb almost ellipsoidal. Leasura about 15µm. Spore surface psilate.

Botanical affinity: Family Polypodiaceae

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: The range of species is between Early Oligocene to Early Pleistocene of Middle Europe (Krutzsch, 1967a). According to Planderová (1991), the species frequently occurred in Miocene sediments. The range of species is accepted between Early Oligocene and Pliocene by Stuchlik et al. (2001). It was recorded from Upper Oligocene–Lower Miocene sediments of southwest Anatolian molasse deposits by Akgün & Sözbilir (2001). Akgün (2002) also determined the species from Middle–Upper Eocene sediments of Çorum–Amasya area.

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations.

(41) *Laevigatosporites haardti* (POTONIÉ & VENITZ 1934) THOMSON & PFLUG 1953

pl. 4, figs. 15, 16

1934 *Sporites haardti* n. fsp. –POTONIÉ & VENITZ, p. 13, pl. 1, fig 13.

1953 *Laevigatosporites haardti* (POTONIÉ & VENITZ) n. comb. –THOMSON & PFLUG, p. 59, pl. 3, figs. 27–38.

Dimensions: 32–41 µm (equatorial diameter), 21–26µm (polar axis), ã = 38x26µm, (n = 797)

Description: Spores monolete, outline in equatorial view bean shaped. Amb nearly ellipsoidal. Leasura about 23–25µm. Spore surface psilate or laevigate.

Botanical affinity: Family Polypodiaceae

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: From Oligocene to Pliocene in Germany (Krutzsch 1967a). The species was recorded from Eocene, Oligocene and Miocene sediments of Turkey (e.g. Nakoman, 1964; Akyol, 1980; Akgün & Akyol, 1999; Akgün & Sözbilir 2001; Akgün 2002; Akkiraz & Akgün, 2005; Akkiraz et al., 2006; Sancay et al., 2006; Akkiraz et al., accepted).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu and Tokça formations; Lower Miocene Kavak and Aksu formations.

(42) *Laevigatosporites major* COOKSON 1947 ex KRUTZSCH 1959

1947 *Monolites major* n. sp. –COOKSON, p. 135, pl. 15, fig. 56.
1959 *Laevigatosporites major* (COOKSON) n. comb. –KRUTZSCH, p. 195.

Dimensions: 55µm (equatorial diameter), 35 µm (polar axis), (n = 1)
Description: Spore monolete, outline in equatorial view bean shaped. Amb nearly ellipsoidal. Leasura about 23–25µm. Spore surface psilate or laevigate.
Botanical affinity: Family Polypodiaceae
Palaeofloristical element: Palaeotropical–Arctotertiary
Previously recorded occurrences: Eocene–Pliocene (Stuchlik et al., 2001).
Occurrences: Lower–"Middle" Oligocene Tokça Formation.

Genus: *Verrucatosporites* THOMSON & PFLUG 1953

Type Species: *Verrucatosporites alienus* (POTONIÉ 1931d) THOMSON & PFLUG 1953

(43) *Verrucatosporites histiopteroides* KRUTZSCH 1962b
pl. 5, fig. 17

1962b *Verrucatosporites histiopteroides* n. fsp. –KRUTZSCH, p. 269, pl. 2, figs. 1–6.

Dimensions: 48µm (equatorial diameter), 30µm (polar axis), (n = 1)

Description: Spore monolete, outline in equatorial view bean shaped. Amb nearly ellipsoidal. Exine about 2–3µm, covered with closely spaced polygonal verrucae from 5 to 8µm in diameter and 3 to 5µm in high.

Botanical affinity: Family Davalliaceae

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: Krutzsch (1967a) indicates that the species occurs in "Middle" Oligocene and exists through the Pliocene of Germany. It was reported from Middle Miocene sediments of western Poland by Ziembińska–Tworzydlo (1974). According to Hochuli (1978), the species is observed from Late Oligocene to Early Miocene in the Central and Western Paratethys. Nickel (1996a) mentions the species occurs from "Middle" Oligocene to Late Oligocene in the Upper Rhine Graben. The range of species was given from Late Oligocene to Middle Miocene by Stuchlik et al. (2001).

Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(44) *Verrucatosporites favus* (POTONIÉ 1931c) THOMSON & PFLUG 1953
pl. 4, figs. 18–20

1931c *Polypodii*(?)*-sporonites favus* n. fsp. –POTONIÉ, p. 556, fig. 3.

1953 *Verrucatosporites* (*Polypodiispor.*) *favus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 60, pl. 3, figs.52–55 and pl. 4, figs. 1–4.

Dimensions: 41–58µm (equatorial diameter), 25–30 µm (polar axis), ã = 41x25µm, (n = 63)

Description: Spores monolete, outline in equatorial view bean shaped. Amb nearly ellipsoidal. Exine 2.5µm thick. Leasura up to 35–40µm. Spore surface spaced by flat verrucae about 3–5µm in diameter and about 3µm high.

Botanical affinity: Family Dennstaedtiaceae; Genus *Paesia*

Palaeofloristical element: Palaeotropical–Arctotertiary

Previously recorded occurrences: Nakoman (1966a) recorded the species in Eocene sediments of Sorgun lignites. Krutzsch (1967) mentions occurrences of the species in Middle Eocene–Pliocene of Middle Europe. Akyol (1971) found the species in Early Oligocene sediments of Şile–İstanbul (Turkey). Akyol (1980) also mentions that the species may be observed in Lower Miocene (Aquitanian) sediments of Bayat lignites. Akgün (2002), Akgün et al. (2002) and Akkiraz et al. (accepted) indicate the presence of species from Middle–?Upper Eocene sediments of the Çankırı Basin. The species was also determined Upper Oligocene and Miocene sediments of southwest Anatolian mollase basins by Akgün & Sözbilir (2001). Akkiraz & Akgün (2005) recorded the species from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin.
Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(45) *Verrucatosporites alienus* (POTONIÉ 1931c) THOMSON & PFLUG 1953
pl. 4, figs. 21–23

1931c *Sporites alienus* n. sp. –POTONIÉ, p. 556
1953 *Verrucatosporites alienus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p.60, pl. 3, figs. 47–48.

Dimensions: 42–57µm (equatorial diameter) 30–33 (polar axis), ã = 50x32µm, (n = 31)
Description: Spores monolete, outline in equatorial view bean shaped. Amb nearly ellipsoidal. Exine about 2µm. Spore surface covered with verrucae about 5–6µm in diameter and 3–4µm high.
Botanical affinity: Family Davalliaceae
Palaeofloristical element: Palaeotropical (subtropical)
Previously recorded occurrences: Nakoman (1966a) reported the species in Eocene of Sorgun lignites. According to Nakoman (1996b), the species is present from Middle Eocene to Early Miocene in the Thrace Basin. Krutzsch (1967) determines the presence of species from Late Eocene to Miocene of Europe. Akyol (1971) indicates the presence

of species in Lower Oligocene of Şile–İstanbul coals. Akgün et al. (2002) and recorded the species from Middle–?Upper Eocene sediments of the Çankırı Basin

Occurrences: Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Aksu Formation.

(46) *Verrucatosporites tenellis* (KRUTZSCH 1959) KRUTZSCH 1967a

1959 *Reticuloidosporites* (*Polypodiisporites*) *tenellis* n. sp. – KRUTZSCH, p. 218, pl. XLIV, fig. 486.

1967a *Verrucatosporites tenellis* (KRUTZSCH) n. comb. –KRUTZSCH, p. 190, pl. 71, figs. 4–19.

Dimensions: 37µm (equatorial diameter), 17µm (polar axis), (n = 1)

Description: Spores monolete, outline in equatorial view bean shaped. Amb nearly ellipsoidal. Exine about 1.5µm. Spore surface covered with densely spaced flat verrucae about 2µm in diameter.

Botanical affinity: Family Polypodiaceae?, Davalliaceae?

Palaeofloristical element: Palaeotropical–Arctotertiary

Previously recorded occurrences: The range of species is between Middle Eocene and Miocene of Poland (Stuchlik et al., 2001). The species has also been described from Middle–?Upper Eocene sediments of the Çorum–Amasya area and Çankırı Basin by Akgün (2002) and Akkiraz et al. (accepted), respectively.

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(47) *Verrucatosporites balticus* (KRUTZSCH 1962b) KRUTZSCH 1967a

pl. 5, fig. 1

1962b *Reticuloidesporites* (*Polypodiisporites*) *balticus* n. fsp. –KRUTZSCH, p. 269, 270, pl. 2, fig. 7–16.

1967a *Verrucatosporites balticus* (KRUTZSCH) n. comb. subfsp. *balticus* – KRUTZSCH, p. 177, pl. 65, figs. 6–8.

Dimensions: 37µm (equatorial diameter), 19 (polar axis), (n = 1)

Description: Spores monolete, outline in equatorial view bean shaped. Amb nearly ellipsoidal. Spore surface covered with densely spaced verrucae with rounded apices 3–4µm in diameter and 2–4µm high.

Botanical affinity: Family Polypodiaceae

Palaeofloristical element: Palaeotropical–Arctotertiary

Previously recorded occurrences: It was reported from Lower Miocene sediments of western Poland by Ziembińska–Tworzydlo (1974). The range of species is between Late Oligocene and Pliocene of Poland (Stuchlik et al., 2001).

Occurrences: Lower–"Middle" Oligocene Tokça Formation.

Pollenites POTONIÉ 1931c

Saccites ERDTMAN 1947

Genus: *Podocarpidites* COOKSON 1947 ex COUPER 1953

Type Species: *Podocarpidites ellipticus* COOKSON 1947

(48) *Podocarpidites libellus* (POTONIÉ 1931c) KRUTZSCH 1971

1931c *Pini*(?)*pollenites libellus* n. sp. –POTONIÉ, p. 5, text figure 33.

1971 *Podocarpidites libellus* (POTONIÉ) n. comb. –KRUTZSCH, p. 128, text figure 1–22.

Dimensions: Length: 45µm, Width: 30µm, (n = 1)

Description: Pollen grains bisaccate, corpus nearly circular. Sacci nearly circular in outline, double as big as corpus. Surface of sacci smooth, exine infrastucture alveolate.

Botanical affinity: Family Podocarpaceae, Genus *Podocarpus*

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: Nakoman (1966b) mentions the occurrences of the species in Tertiary sediments of the Thrace Basin. It is observed from"Middle" Oligocene to Miocene of the Middle Europe (Krutzsch, 1971). According to Stuchlik et al. (2002), the range of species is between Palaeogene and Middle Miocene of Poland. The species was described from Middle Miocene sediments of the Büyük Menderes Graben by Akgün & Akyol (1999).

Occurrences: Lower–"Middle" Oligocene İncesu Formation.

Genus: *Piceapollis* KRUTZSCH 1971

Type Species: *Piceapollis praemarianus* KRUTZSCH 1971

(49) *Piceapollis* sp 1.

pl. 5, fig. 2

Dimensions: Length: 63–81, Width: 44–57µm, ã = 70–55µm, (n = 9)

Description: Pollen grains bisaccate, corpus ellipsoidal. In equatorial view outline of pollen grain uniform. Proximal face nearly smooth, infrabaculate. Sacci semicircular in outline. Surface of sacci smooth, exine infrastucture alveolate.

Remarks: The specimens obtained belong to morphologically to the genus *Piceapollis*, but are not described this specific epithet.

Botanical affinity: Family probably Pinaceae?

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations.

Genus: *Pityosporites* SEWARD 1914

Type Species: *Pityosporites antarcticus* SEWARD 1914

(50) *Pityosporites microalatus* (POTONIÉ 1931b) THOMSON & PFLUG 1953
pl. 5, figs. 3–7

1931b *Piceae-pollenites microalatus* n. sp. –POTONIÉ, p. 5, text figure 34.
pp 1953 *Pityosporites microalatus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 67, pl. 5, figs. 47, 49, 51,57.

Dimensions: Length: 50–82µm, Width: 42–54µm, ã = 63–45µm, (n = 532)
Description: Pollen grains bisaccate, corpus rounded rhomboid in outline. Sacci nearly circular in outline. Surface of sacci reticulate.
Botanical affinity: Family Pinaceae; Genus *Pinus* "haploxylon" type
Palaeofloristical element: Arctotertiary
Previously recorded occurrences: According to Thomson & Pflug (1953) and Hochuli (1978), the species occurs from Eocene to Pliocene of Middle–East Europe. Nakoman (1966b) indicates that the species occurs from the Early Lias to all Tertiary of the Thrace Basin. Frederiksen (1980) recorded the species in Eocene sediments of North America. Chateauneuf (1980) mentions the species is present in Late Eocene–"Middle" Oligocene of France. According to Stuchlik et al. (2002), the species takes place from Cretaceous to Pliocene of Poland. The species was determined from the Eocene, Oligocene and Miocene basins of Turkey (e.g. Akyol, 1971; Batı, 1996; Akgün & Akyol, 1999; Akgün & Sözbilir, 2001; Akgün, 2002; Akgün et al., 2002; Akkiraz & Akgün, 2005; Akkiraz et al., 2006; Sancay et al., 2006; Akkiraz et al., accepted).
Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(51) *Pityosporites labdacus* (POTONIÉ 1931c) THOMSON & PFLUG 1953

pl. 5, figs. 8–10

1931c *Pollenites labdacus* n. sp. –POTONIÉ, p. 3, text figure 32.

1953 *Pityosporites labdacus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 68, pl. 5, figs. 60–61.

Dimensions: Length 57–85µm, Width: 22–44µm, ã = 71–32µm, (n = 87)

Description: Pollen grains bisaccate, corpus in outline ellipsoidal, sometimes more circular. In equatorial view outline of pollen grain tripartite with convex proximal face. Sacci nearly circular in outline and somewhat narrower than the breadth of corpus.

Botanical affinity: Family Pinaceae; Genus *Pinus* “sylvestris” type

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: Thomson & Pflug (1953) mention the species from Eocene to Pleistocene of the Middle Europe. The species was recorded from Oligocene and Miocene in all profiles, sometimes rich by Ziembińska–Tworzydlo (1974). The species was described from Middle Miocene sediments of the Büyük Menderes Graben by Akgün & Akyol (1999). According to Stuchlik et al. (2002), the species is present all Tertiary of Poland. Akkiraz & Akgün (2005) recorded the species from Lower–“Middle” Oligocene sediments of the Çardak–Tokça Basin. Akkiraz et al. (2006) also reported it from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin. The species was described from Oligocene and Miocene sediments of the Kars–Erzurum–Muş sub–basins by Sancay et al. (2006).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(52) *Pityosporites scopulipites* (WODEHOUSE 1933) KRUTZSCH 1971

pl. 5, figs. 11, 12

1933 *Pinus scopulipites* n. sp. –WODEHOUSE, p. 488, fig. 8.

1971 *Pityosporites scopulipites* (WODEHOUSE) n. comb. –KRUTZSCH, p. 72, pl. 10, figs. 10–21.

Dimensions: Length: 50–61µm, Width: 34–40µm, (n = 2)

Description: Pollen grains bisaccate. In equatorial view outline of pollen grain tripartite with convex proximal face. Sacci semicircular or more than semicircular in outline. Surface of sacci smooth, alveolate.

Botanical affinity: Family Pinaceae; Genus *Pinus*.

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: According to Stuchlik et al. (2002), the species occurs from Eocene to Middle Miocene of Poland.

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(53) *Pityosporites minitus* (ZAKLINSKAJA 1957) KRUTZSCH 1971

pl. 5, figs. 13, 14, pl. 6, fig. 1

1957 *Pinus minitus* n. sp. –ZAKLINSKAJA, p. 155–156, pl. 14, fig. 14.

1971 *Pityosporites minitus* (ZAKLINSKAJA) n. comb. –KRUTZSCH, p. 70, pl. 10, figs. 1–9.

Dimensions: Length: 38–46µm, Width: 32–38µm, ã = 42–38µm, (n = 4)

Description: Pollen grains bisaccate. In equatorial view outline of pollen grain tripartite. Surface of proximal face verrucate. Sacci semicircular in outline and smaller than the breadth of corpus. Surface of sacci smooth, alveolate.

Botanical affinity: Family Pinaceae; Genus *Pinus*

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: It was reported from Lower Miocene sediments of western Poland by Ziembińska–Tworzydlo (1974).

Occurrences: Lower–“Middle”Oligocene Tokça and İncesu formations.

(54) *Pityosporites* sp. 1

pl. 6, figs. 2, 3

Dimensions: Length: 50–62µm, Width: 30–45µm, ã = 59–43µm, (n = 3)

Description: Pollen grains bisaccate, in equatorial and polar view outline of pollen grains ellipsoidal. Surface of exine covered by densely spaced granulate and verrucate.

Remarks: The specimens obtained belong to morphologically to the genus *Pityosporites*, but are not described this specific epithet.

Botanical affinity: Family probably Pinaceae?

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Cathayapollis* RAATZ 1937 ex POTONIÉ 1958

Type Species: *Cathayapollis potoniei* SEWARD 1914

(55) *Cathayapollis krutzschii* (SIVAK 1976) ZIEMBIŃSKA–TWORZYDLO *in* STUCHLIK et al. 2002

pl. 6, fig. 4

1976 *Cathaya krutzschii* n. sp. –SIVAK, p. 268–270, pl. 11, figs. 1–10.

2002 *Cathayapollis krutzschii* (SIVAK) n. comb. –ZIEMBIŃSKA–TWORZYDLO *in* STUCHLIK et al. 2002, p. 16, pl. 13, figs. 1–4.

Dimensions: Length: 75µm, Width: 68µm, (n = 1)

Description: Pollen grain bisaccate. In polar view amb nearly uniform, corpus nearly circular. Sacci semicircular in outline. Surface of sacci smooth, exine infrastructure alveolate.

Botanical affinity: Genus *Cathaya*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: The species was described from Miocene and Pliocene sediments of Poland (Stuchlik et al., 2002). The range of species was given as Oligo–Miocene by Sivak (1976). It was recorded from the Egerian of southern Slovakia by Planderová (1990).

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(56) *Cathayapollis pulaënsis* (NAGY 1985) ZIEMBIŃSKA–TWORZYDLO *in* STUCHLIK et al. 2002

pl. 6, fig. 5

1985 *Cathaya puläensis* n. sp. –NAGY, p. 134, pl. 65, figs. 1–3.

2002 *Cathayapollis puläensis* (NAGY) n. comb. –ZIEMBIŃSKA–TWORZYDLO *in* STUCHLIK et al. 2002, p. 18, pl. 18, figs. 1–10.

Dimensions: Length: 47µm, Width: 32µm, (n = 1)

Description: Pollen grains bisaccate. In polar view amb sinusoidal, corpus ellipsoidal to nearly circular. On proximal face exine infrabaculate. Sacci nearly circular in outline. Line of saccus/corpus fastening slightly arcuate and attachment axis as long as the breadth of corpus in the attachment area. Surface of sacci smooth, exine infrastructure alveolate.

Botanical affinity: Genus *Cathaya*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: The species was described from Miocene and Pliocene sediments of Poland (Stuchlik et al., 2002).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

(57) *Cathayapollis* sp. 1

pl. 6, fig. 6

Dimensions: Length: 82µm, Width: 57µm, (n = 1)

Description: Pollen grains bisaccate. In polar view amb nearly uniform, corpus ellipsoidal. Sacci semicircular in outline. Surface of sacci smooth, exine alveolate.

Remarks: The specimens obtained belong to morphologically to the genus *Cathayapollis*, but are not described these specific epithet.

Botanical affinity: Genus probably *Cathaya*?

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Aksu Formation.

Genus: *Cedripites* WODEHOUSE 1933

Type Species: *Cedripites eocenicus* WODEHOUSE 1933

(58) *Cedripites* sp. 1

pl. 6, fig. 7

Dimensions: Length: 39µm, Width: 37µm, (n = 1)

Description: Pollen grains bisaccate. In equatorial outline amb nearly uniform, corpus ellipsoidal with convex proximal face. Proximal face rough, infrabaculate. Surface of sacci smooth, exine infrastructure alveolate with irregular shape.

Remarks: The specimen obtained is similar to genus the *Cedripites*, but are not described this specific epithet.

Botanical affinity: Genus probably *Cedrus*?

Palaeofloristical element: Unknown

Occurrences: Lower–"Middle" Oligocene İncesu Formation

Genus: *Abiespollenites* THIERGART 1937 ex POTONIÉ 1958

Type Species: *Abiespollenites absolutus* THIERGART 1937ex POTONIÉ 1958

(59) *Abiespollenites absolutus* THIERGART 1937 ex POTONIÉ 1958

pl. 6, fig. 8

1937 *Abies–pollenites absolutus* n. sp. –*Abies*–pollen –THIERGART, p. 306, pl. 24, fig. 6 (holotype).

1953 *Pityosporites absolutus* (THIERGART) n. comb. –THOMSON & PFLUG 1953, p. 68, pl. 5. fig. 64.

1958 *Abiespollenites absolutus* THIERGART *in* RAATZ –POTONIÉ, p. 63, pl. 8, figs. 77–79.

Dimensions: Length: 85–120µm, Width: 68–80µm, ã = 105x68µm, (n = 10)

Description: Pollen grains bisaccate. In polar view amb not uniform with clear differentiation of corpus and sacci part, forming sinusoidal line. Corpus ellipsoidal. Sacci nearly circular in outline as breadth as of corpus. Surface of sacci smooth or psilate, exine infrastructure alveolate.

Botanical affinity: The fossil pollen grain is similar to recent *Abies alba*

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: Krutzsch (1971) determined the species from Middle and Late Tertiary of the Middle Europe. According to Stuchlik et al. (2002), the species occurs in Miocene and Pliocene sediments of Poland. It was determined from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin by Akkiraz et al. (2006).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

(60) *Abiespollenites* sp. 1

pl. 6, fig. 9

Dimensions: Length: 95µm, Width: 77µm, (n = 1)

Description: Pollen grains bisaccate. In polar view amb uniform Corpus ellipsoidal. Sacci nearly circular in outline. Surface of sacci and corpus smooth exine infrastructure alveolate.

Remarks: The specimen obtained is similar to genus the *Abiespollenites*, but are not described it specific epithet.
Botanical affinity: Genus probably *Abies*?
Palaeofloristical element: Unknown
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Inaperturates THOMSON & PFLUG 1953

Genus: *Inaperturopollenites* THOMSON & PFLUG 1953

Type Species: *Inaperturopollenites dubius* (POTONIÉ & VENITZ 1934) PFLUG & THOMSON *in* THOMSON & PFLUG 1953

(61) *Inaperturopollenites dubius* (POTONIÉ & VENITZ 1934) THOMSON & PFLUG 1953
pl. 6, figs. 10, 11, pl. 7, figs. 1, 2

1934 *Pollenites magnus dubius* n. f. –POTONIÉ & VENITZ, p. 17, pl. 2, fig. 20–21.
1953 *Inaperturopollenites dubius* (POTONIÉ & VENITZ) n. comb. –THOMSON & PFLUG, p. 64, pl. 4, fig. 89 and pl. 5, figs. 1–13.

Dimensions: 25–40µm, ã = 37µm, (n = 353)
Description: In equatorial and polar view outline of pollen grains circular. On the distal face at the center of leptoma and sometimes small papilla. Exine about 2 µm thick.
Botanical affinity: Family Taxodiaceae
Palaeofloristical element: Arctotertiary (warm temperate)
Previously recorded occurrences: Thomson & Pflug (1953) recorded occurrences of the species from Palaeocene to Late Pliocene of the Middle Europe. Nakoman (1966a) indicated the species in Eocene sediments of Sorgun area. According to Nakoman (1966b), the species may be present all the Tertiary of the Thrace Basin. Akyol (1971)

reported the species in Lower Oligocene sediments of Şile–İstanbul. Akyol (1980) recorded the species from Middle–Upper Eocene Bayat (Çorum) lignites. Akgün & Akyol (1999) reported the species from Middle Miocene sediments of the Büyük Menderes Graben. Akkiraz & Akgün (2005) recorded fossil pollen grains from Lower–"Middle" Oligocene Tokça Formation. The species was described from Upper Oligocene sediments of the Kars–Erzurum–Muş sub–basins by Sancay et al. (2006). Akkiraz et al. (accepted) have also recorded the species from Middle–?Upper Eocene sediments of the Çankırı Basin.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu Formation; Lower Miocene Aksu Formation**.**

(62) *Inaperturopollenites hiatus* (POTONIÉ 1931b) PFLUG & THOMSON *in* THOMSON & PFLUG 1953

pl. 7, figs. 3–5

1931b *Pollenites hiatus* n. f. –POTONIÉ, p. 3, fig. 27.

1953 *Inaperturopollenites hiatus* (POTONIÉ) n. comb. –PFLUG & THOMSON *in* THOMSON & PFLUG, p. 65, pl. 5, figs. 14–20.

Dimensions: 25–40µm, ã = 30µm, (n = 19)

Description: Pollen grains round, generally cleaved "V" shape. The sculpture is smooth, fine–chagranate.

Botanical affinity: Family Taxodiaceae

Palaeofloristical element: Palaeotropical and Arctotertiary (subtropical to warm temperate)

Previously recorded occurrences: According to Snopková (1983), the species occurs in Middle Eocene and frequently in the Rupelian of Carpatians. Mohr (1984) mentioned the species from Eocene to Pliocene of Germany. The species was described from the Eocene, Oligocene and Miocene basins of Turkey (e.g. Nakoman, 1966a, 1966b; Akyol, 1971; Akgün & Akyol, 1999; Akgün, 2002; Akgün et al., 2002; Akkiraz & Akgün, 2005; Sancay et al., 2006; Akkiraz et al., accepted)

Occurrences: Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Aksu Formation.

(63) *Inaperturopollenites concedipites* (WODEHOUSE 1933) KRUTZSCH 1971
pl. 7, figs. 6–9

1933 *Cunninghamia concedipites* n. sp. –WODEHOUSE, p. 495, fig. 19.

1971 *Inaperturopollenites concedipites* (WODEHOUSE 1933) n. comb. –KRUTZSCH, p. 204, pl. 65, figs. 1–33.

Dimensions: 22–40µm, ã = 31µm, (n = 117)

Description: Pollen grains round, generally cleaved "V" shape. On distal the face in the centre a small leptoma. Surface of pollen exine microgranulate.

Botanical affinity: Family Taxodiaceae

Palaeofloristical element: Palaeotropical and Arctotertiary (subtropical to warm temperate)

Previously recorded occurrences: Krutzsch (1971) mentions the occurrence in Middle Eocene and Middle Miocene of Europe. The range of species was given from Middle Eocene to Late Miocene of Poland (Stuchlik et al., 2002). The species was determined from Upper Oligocene–Lower Miocene sediments of southwest Anatolian molasse deposits by Akgün & Sözbilir (2001). Akgün (2002), Akgün et al. (2002) and Akkiraz et al. (accepted) indicate the presence of species from Middle–?Upper Eocene sediments of Central Anatolia.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle"Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations

(64) *Inaperturopollenites magnus* (POTONIÉ 1934) THOMSON & PFLUG 1953
pl. 7, figs. 10–13

1934 *Pollenites magnus* n.sp. – POTONIÉ, p. 69, pl. 5, fig. 4.
1953 *Inaperturopollenites magnus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 64, pl. 4, figs. 83–88.

Dimensions: 51–75µm, ã = 58µm, (n = 9)
Description: Pollen grains large, round and spherical with mostly secondarily folded. Exine about 1 µm. Surface of pollen exine microgranulate smooth, chagrenat and without suggestion of a germinal aperture.
Botanical affinity: Family probably Pinaceae?; Genus probably *Pseudotsuga*?.
Palaeofloristical element: Unknown
Previously recorded occurrences: Thomson & Pflug (1953) mention occurrences of the species in "Middle"–"Late" Tertiary of the Middle Europe. The species was described from the Eocene, Oligocene and Miocene basins of Turkey (e.g. Nakoman 1966a; Akyol, 1971; Akgün & Akyol, 1999; Akgün & Sözbilir, 2001; Akgün et al., 2002; Akkiraz & Akgün, 2005; Sancay et al., 2006).
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle"Oligocene Tokça and İncesu formations.

(65) *Inaperturopollenites* sp. 1
pl. 7, fig. 14

Dimensions: 40–45µm, ã = 43µm, (n = 12)
Description: In equatorial and polar view outline of pollen grains circular. On the distal face at the center of small leptoma.
Remarks: Even the microscopic features point directly to the *Inaperturopollenites*, but identification down to species level is yet not possible because of bad preservation.
Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower – "Middle" Oligocene İncesu and Tokça formations

Genus: *Sequoiapollenites* THIERGART 1937

Type Species: *Sequoiapollenites polymorfosus* THIERGART 1937

(66) *Sequoiapollenites largus* (KREMP 1949) MANUM 1962
pl. 7, fig. 15

1949 cf. *Cryptomeria–Pollenites largus* n. sp. –KREMP, p. 58, pl. V, fig. 30.
1962 *Sequoiapollenites largus* (KREMP) n. comb. –MANUM, p. 43.

Dimensions: 37µm, (n = 1)

Description: Pollen grain ellipsoidal with mostly secondarily folded. Leptoma with straight papilla, 4.5 µm long and 4.5 broad at the basis.

Botanical affinity: Family Taxodiaceae; Genus probably *Cryptomeria*?.

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: It occurs in German Miocene (Krutzsch, 1971). It was also recorded from the Neogene Bohemian basins (Konzálová, 1973). The species occurred mostly in the Karpathian and lower Sarmatian of Carpathians (Planderová, 1990). According to Stuchlik et al. (2002), the range of species is between Oligocene and Miocene of Poland.

Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(67) *Sequoiapollenites polymorfosus* THIERGART 1937
pl. 7, figs. 16–19

1937 *Sequoia–pollenites poliformosus* n. sp. –THIERGART, p. 301–302, pl. 23, figs. 5–11.

1953 *Inaperturopollenites polyformosus* (THIERGART) n. comb. –THOMSON & PFLUG, p. 65, pl. 5, figs. 21–25.

1971 *Sequoiapollenites polyformosus* (THIERGART) –KRUTZSCH, p. 212, pl. 68, figs. 1–40, text–figure 13/86, tab. 13/86.

Dimensions: 22–31µm, ã = 25µm, (n = 16)

Description: Pollen grain ellipsoidal. On the distal face leptoma smooth, circular in outline, with curved papilla, 2.5 µm long and 3.5 µm at the basis.

Botanical affinity: Family Taxodiaceae; Genus *Sequoia*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: Nakoman (1966b) mentions that the species is mainly present from Oligocene to Pliocene of the Thrace Basin. Krutzsch (1971) also described it from "Middle" Oligocene to Pliocene of Germany. Miocene–Pliocene (Stuchlik et al., 2002). Akgün (2002) described the species from Middle–?Upper Eocene sediments of Çorum–Amasya area. Akgün & Akyol (1999) determined the species from Middle Miocene sediments of the Büyük Menderes Graben. Akkiraz et al. (2006) indicate the presence of the species from the Middle–?Upper Eocene Çardak–Tokça Basin. It was also described from Upper Oligocene sediments of the Kars–Erzurum–Muş sub–basins by Sancay et al. (2006).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Kavak Formation.

Monoporates NAUMOVA 1937 ex POTONIÉ 1960

Genus: *Sparganiaceaepollenites* THIERGART 1937

Type Species: *Sparganiaceaepollenites convexus* THIERGART 1937

(68) *Sparganiaceaepollenites polygonalis* THIERGART 1937

pl. 7, figs. 20–24

1937 *Sparganiaceae – pollenites* n. sp. –THIERGART, p. 307, pl. 24, fig. 11.

Dimensions: 20–25µm, ã = 23µm, (n = 90)

Description: Suboblate in outline. Outline of pore irregular, about 3–3.5 µm and lacking of annulus. Pollen surface having a sculpture composing of fine and baculate processes, about 0.3–0.5µm high forming reticulum.

Botanical affinity: Family Sparganiaceae; Genus *Sparganium*

Palaeofloristical element: Arctotertiary (temperate)

Previously recorded occurrences: Hochuli (1978) mentions the occurrences of the species in "Middle" Oligocene of the Western Paratethys and also Krutzsch (1970a) recorded the species in "Middle" Oligocene of Middle Europe. Akgün (2002) recorded the species from Middle–?Upper Eocene sediments of Çorum–Amasya area. The species was reported from Middle Miocene sediments of the Büyük Menderes Graben by Akgün & Akyol (1999). Akgün & Sözbilir (2001) described it from Upper Oligocene to Lower Miocene sediments of southwest Anatolian molasse basins. It was also described from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin by Akkiraz & Akyol (2005). Akkiraz et al. (2006) indicate the presence of species from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu and Tokça formations; Lower Miocene Aksu Formation.

(69) *Sparganiaceaepollenites neogenicus* KRUTZSCH 1970a

pl. 7, figs. 25, 26

1970a *Sparganiaceaepollenites neogenicus* n. sp. –KRUTZSCH, p. 82, pl. 13, figs. 1–6.

Dimensions: 27–29µm, ã = 29µm, (n = 51)

Description: Rounded in outline. Pores roundish, 3–4µm in diameter, without an annulus. Pollen surface having reticulate forming by dense baculate processes.

Botanical affinity: Family Sparganiaceae

Palaeofloristical element: Arctotertiary (temperate)

Previously recorded occurrences: Krutzsch (1970a) indicates that the species occurred from Oligocene to Pleistocene of Middle Europe. Ziembińska–Tworzydlo (1974) recorded the species from various horizons in Neogene of western Poland. Akgün (2002) recorded its presence from Middle–Upper Eocene sediments of Çorum–Amasya area. It was also determined from Middle Miocene sediments of the Büyük Menderes Graben by Akgün & Akyol (1999). Akkiraz & Akgün (2005) indicate the presence of species from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Lower–"Middle" Oligocene Tokça Formation.

Genus: *Aglaoreidia* ERDTMAN 1960 emend. FOWLER 1971

Type Species: *Aglaoreidia cyclops* ERDTMAN 1960

(70) *Aglaoreidia cyclops* (ERDTMAN 1960) FOWLER 1971
pl. 7, figs. 27a, b

1960 *Aglaoreidia cyclops* n. sp. –ERDTMAN, p. 47, pl. 1, figs. b–c
1971 *Aglaoreidia cyclops* (ERDTMAN) n. comb. –FOWLER, p. 140, pl. 1, figs. 3–4.

Dimensions: 40µm, (n = 1)

Description: Subprolate in outline. Pore round about 5µm in diameter, surrounded by annulus. Exine having a reticulate sculpture. Meshes varying in size, near pore larger and on the opposite side of pollen grain smaller.

Botanical affinity: Unknown

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: Hochuli (1978) mentions occurrences of the species from Lower Oligocene to “Middle” Oligocene of the Central and Western Paratethys. Chateauneuf (1980) recorded the species from Upper Eocene to uppermost Lower Oligocene of the Paris Basin. Chateauneuf et al. (1988) mention the species from Lower Oligocene to “Middle” Oligocene of France. According to Schuler (1988), the species occurred from Upper Eocene to Middle Oligocene of the Rhine Graben. It is characteristic form for Upper Eocene of England. Fowler (1988) and Nickel (1996) mentioned the species from Middle Eocene to “Middle” Oligocene of the Upper Rhine Graben. Akgün (2002) recorded the species from Middle–?Upper Eocene sediments of the Çorum–Amasya area. Akkiraz & Akgün (2005) determined the species from Lower–“Middle” Oligocene sediments of the Çardak–Tokça Basin.
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Graminidites* COOKSON 1947

Type Species: *Graminidites media* COOKSON 1947

(71) *Graminidites laevigatus* KRUTZSCH 1970a
pl. 7, fig. 28

1970a *Graminidites laevigatus* n. sp. –KRUTZSCH, p. 60, pl. 5. figs. 1–12.

Dimensions: 28–30µm, ã = 29µm, (n = 5)
Description: Spheroidal in equatorial outline. Pore round, about 2–2.5µm with a very distinct annulus about 2–2.5µm wide. Pollen surface laevigate to chagrenate.
Botanical affinity: Family possibly Gramineae?
Palaeofloristical element: Arctotertiary
Previously recorded occurrences: Krutzsch (1970a) described the species from Middle Miocene sediments of Middle Europe. The species was recorded from late Early Miocene–Middle Miocene of Karpathians (Planderová, 1990). It was also reported from

Middle Miocene sediments of the Soma Basin (western Anatolia) by Takahashi & Jux (1991).

Occurrences: Lower–"Middle" Oligocene Tokça İncesu formations.

Diporates (NAUMOVA 1937) POTONIÉ 1960

Genus: *Kopekipollenites* KEDVES 1974

Type species: *Kopekipollenites transdanubicus* KEDVES 1974

(72) *Kopekipollenites transdanubicus* KEDVES 1974
pl. 8, fig. 1

1974 *Kopekipollenites transdanubicus* n. fsp. –KEVDES, p.29, pl. 12, figs. 1–3.

Dimensions: 45µm, (n = 1)

Description: Pollen grain ellipsoidal or circular. The pores lie roughly in the centre of the pollen grain, subcircular or circular, about 5µm in diameter. Exine having small perforate.

Botanical affinity: Family Monocotyledonopsida

Palaeofloristical element: Unknown

Previously recorded occurrences: It was recorded from Lower–Middle Eocene sediments of northern Bakony Mountains by Kedves (1974). In Turkey, the species has first been described from Middle–?Upper Eocene Yoncalı Formation of central Anatolia by Akkiraz et al. (accepted).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Monocolpates IVERSEN & TROELS–SMITH 1950

Genus: *Longapertites* VAN HOEKEN KLINKENBERG 1964

Type Species: *Longapertites marginatus* VAN HOEKEN KLINKENBERG 1964

(73) *Longapertites punctatus* FREDERIKSEN 1994
pl. 8, figs. 2, 3

1994 *Longapertites punctatus* n. sp. –FREDERIKSEN, p. 122, pl. 3, figs. 7, 11–13.

Dimensions: Length: 34–47µm, Width: 21–38µm, ã = 35x22µm, (n = 2)
Description: Proximal face straight to gently arched, distal face strongly arched. Pollen surface distinctly punctate. Monosulcate, sulcus extends the full length of the distal face.
Botanical affinity: Family probably Arecaceae? Lepidocaryoidae?
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: It was described from Middle–Upper Palaeocene of Pakistan (Frederiksen, 1994). The species was recorded from Middle–Upper Eocene sediments of central Anatolia by Akgün (2002) (Yoncalı Formation). It has been determined from Middle–?Upper Eocene sediments of the Çankırı Basin by Akkiraz et al. (accepted).
Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(74) *Longapertites* cf. *punctatus* FREDERIKSEN 1994
pl. 8, fig. 4

Dimensions: Lenght: 58µm, Width: 28µm, (n = 1)
Remarks: The species obtained has similar properties of *Longapertites punctatus* Frederiksen 1994, but bigger sized.
Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(75) *Longapertites psilatus* FREDERIKSEN 1994
pl. 8, figs. 5–7

1994 *Longapertites psilatus* n. sp. –FREDERIKSEN, p. 122, pl. 3, figs. 8–10.

Dimensions: Length: 27–42µm, Width: 18–36µm, ã = 38x33µm, (n = 4)
Description: Poximal face flat to gently arched. Distal face strongly arched. Outline in polar view broadly oval. Monosulcate, sulcus extends the full length of distal side. The sulcus usually gapes open. The gape broader at the ends of grain than in the middle.
Botanical affinity: Family probably Arecaceae?, Lepidocaryoidae?
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: It was determined from Middle–Upper Palaeocene of Pakistan (Frederiksen 1994). Akgün (2002) documented the species from Middle–?Upper Eocene Yoncalı Formation of Çorum–Amasya area (central Anatolia). It has also been recorded from Middle–?Upper Eocene sediments of the Çankırı Basin by Akkiraz et al. (accepted).
Occurrences: Lower–“Middle” Oligocene İncesu Formation.

(76) *Longapertites discordis* FREDERIKSEN 1994
pl. 8, figs. 8–13

1994 *Longapertites discordis* n. sp. –FREDERIKSEN, p. 124, pl. 4, figs. 3–8.

Dimensions: Length: 43–52µm, Width: 32–38µm, ã = 50x35µm, (n = 59)
Description: In equatorial view, proximal face straight to gently arched, distal face tough arched. Monosulcate, sulcus extends the full length of distal face. Exine designed by reticulum, brochi round to polygonal to somewhat elongate. Brochi at ends of grain are much smaller.
Botanical affinity: Family probably Arecaceae?, Lepidocaryoidae?
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: The species was determined from Middle–Upper Palaeocene of Pakistan (Frederiksen, 1994). It was also recorded from Middle–?Upper Eocene sediments of central Anatolia by Akgün (2002) (Yoncalı Formation).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene Tokça and İncesu formations.

(77) *Longapertites retipilatus* KAR 1985
pl. 8, figs. 14,15

1985 *Longapertites retipilatus* n. sp. –KAR, p.120, pl. 22, fig. 9.

Dimensions: Length: 48–54µm, Width: 30–44µm, ã = 49x35µm, (n = 3)
Description: In equatorial view, proximal face straight to gently arched, distal face tough arched. Monosulcate, sulcus extends the full length of distal face. Exine designed by retipilate sculpture.
Remarks: The specimen obtained is small sized compared to the *Longapertites retipiliatus* Kar 1985.
Botanical affinity: Family probably Arecaceae?, Lepidocaryoidae?
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: It was recorded from Middle–Upper Palaeocene of Pakistan by Frederiksen (1994). It was also reported from ?Middle and Upper Eocene of southwestern India (Kar, 1985). Akkiraz et al. (accepted) have reported the species from Middle–?Upper Eocene sediments of the Çankırı Basin.
Occurrences: Lower–“Middle” Oligocene İncesu Formation; Lower Miocene Kavak Formation.

(78) *Longapertites* sp. 1
pl. 8, fig. 16

Dimensions: Length: 22µm, Width: 18µm, (n = 1)
Description: Small pollen grain, in the equatorial view, proximal face straight to gently arched, distal face strongly arched. Sulcus reaches the full length of distal face. Exine psilate or without ornaments.

Remarks: The specimen obtained is similar to the *Longapertites punctatus* Frederiksen 1994**,** but have no punctate sculpture**.**

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Psilamonocolpites* VAN DER HAMMEN & GARĆIA DE MUTIS 1966

Type Species: *Psilamonocolpites medius* (VAN DER HAMMEN 1954) VAN DER HAMMEN & GARĆIA DE MUTIS 1966

(79) *Psilamonocolpites* sp. 1

pl. 8, fig. 17

Dimensions: Length: 38µm, Width: 25 µm, (n = 1)

Description: Pollen grain roundly oval. Psilamonocalpate, colpus long and broader at the ends of margins. Exine having psilate to micropitted.

Remarks: The specimen obtained is similar to genus the *Psilamonocolpites*, but are not described these specific epithet because of bad preservation.

Botanical affinity: Family probably Arecaceae?

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Mauritiidites* VAN HOEKEN–KLINKENBERG 1964

Type Species: *Mauritiidites crassibaculatus* VAN HOEKEN–KLINKENBERG 1964

(80) *Mauritiidites franciscoi* (VAN DER HAMMEN 1956) HOEKEN–KLINKENBERG 1964

pl. 8, figs. 18a, b

1956 *Monocolpites franciscoi* n. sp. –VAN DER HAMMEN, p.105, fig. 2

1964 *Mauritiidites franciscoi* (VAN DER HAMMEN) n. comb. –HOEKEN–KLINKENBERG, p. 213.

Dimensions: Length: 30µm, Width: 18, (n = 1)

Description: Echinate, monosulcate pollen grains, with rooted spines. Amb ellipsoidal. Shape and size of spines are variable between 2–4µm in diameter.

Botanical affinity: Family Arecaceae; Genus *Mauritia*

Palaeofloristical element: Unknown

Previously recorded occurrences: It has known from Palaeocene and widespread all Tertairy in neotropical area (Venezuela) (Rull, 1998a).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Spinizonocolpites* MULLER 1968 emend. MULLER et al. 1987

Type Species: *Spinizonocolpites echinatus* MULLER 1968

(81) *Spinizonocolpites* sp. 1

pl. 8, figs. 19a, b

Dimensions: 43µm, (n = 2)

Description: Pollen grain ellipsoidal. Surface covered by densely echinae, about 3–5 µm. The conical echinae possesses blunt points and broader on the basis. Colpus about 24µm.

Remarks: The specimen obtained is similar to genus the *Spinizonocolpites*, but are not described these specific epithet because of bad preservation.

Botanical affinity: Genus probably *Nypa*?

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: *Nypa* type pollen were recorded the species from Middle Eocene sediments of southwest texas (Westgate & Gee, 1990). According to

Singh (1999), *Nypa* occur in Late Cretaceous and Eocene of India, but more diverse during Palaeocene. Different kinds of *Spinizonocolpites* species were determined from Middle–?Upper Eocene formations from central Anatolia (Akgün, 2002; Akgün et al., 2002; Akkiraz et al., 2006; Akkiraz et al., accepted).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Cycadopites* WODEHOUSE ex WILSON & WEBSTER 1946

Type Species: *Cycadopites follicularis* WILSON & WEBSTER 1946

(82) *Cycadopites gracilis* (WODEHOUSE 1933) KRUTZSCH 1970a
pl. 8, figs. 20–23

1970a *Cycadopites gracilis* n. sp. –KRUTZSCH, p. 94, pl. 18, figs. 1–3.

Dimensions: Length: 37–42µm, Width: 13–18µm, ã = 40x13µm, (n = 191)

Description: Pollen grains monosulcate, in polar view amb strongly ellipsoidal. Sulcus on the distal face in the pole area about 3µm broad. Exine psilate or laevigate.

Botanical affinity: Family Cycadaceae; Genus *Cycas*

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: Gorin (1975) recorded the species in Oligocene sediments of Grande Limagne (France). Akgün (2002) designated the species from Middle–?Upper Eocene sediments of Çorum–Amasya area. Akkiraz & Akgün (2005) and Akkiraz et al (2006) illustrated the species from Eocene and Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(83) *Cycadopites ?minimus* (COOKSON 1947) KRUTZSCH 1970a
pl. 9, figs. 1, 2

1970a *Cycadopites ?minimus* (COOKSON) n. comb. –KRUTZSCH, p. 95, pl. 18, figs 13,14.

Dimensions: Length: 18–21µm, Width: 12–13µm, ã = 20x12µm, (n = 16)
Description: Small monosulcate pollen grains, in polar view amb roundish ellipsoidal. Sulcus on the distal face in the pole area about 2µm broad. Exine psilate or laevigate.
Botanical affinity: Family Cycadaceae; Genus *Cycas*
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: Krutzsch (1970a) reported the species from Upper Oligocene and Middle Miocene sediments of Germany. Planderová (1991) documented it in the Egerian of west Carpatians. Akkiraz et al. (2006) indicate the presence of species from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin.
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations.

(84) *Cycadopites intrastructus* KRUTZSCH 1970a
pl. 9, figs. 3, 4

1970a *Cyacadopites intrastructus* n. sp. –KRUTZSCH, p. 92, pl.17, figs. 7–10.

Dimensions: Length: 42–52µm, Width: 19–22µm, ã = 46x22µm, (n = 10)
Description: Pollen grains monosulcate, in polar view amb strongly ellipsoidal. Sulcus on the distal face in the pole area about 2µm broad. Exine conspicuous psilate sculpture.
Botanical affinity: Family Cycadaceae; Genus *Ginkgo?, Cycas?*
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: Krutzsch (1970a) mentions occurrences in Pliocene and Pleistocene of Germany. Nagy (1985) recorded it in the lower Badenian of Danube

lowlands. It was also recorded in the Badenian and Sarmatian of Slovakia (Planderová (1991). Akgün (2002) determines the species from Middle–?Upper Eocene formations of Çorum–Amasya area. Akgün & Sözbilir (2001) illustrate the species from Upper Oligocene and Lower Miocene sediments of southwest Anatolian molasse deposits. Akkiraz et al. (2006) recorded the species from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower Miocene Aksu Formation.

(85) *Cycadopites lusaticus* KRUTZSCH 1970a
pl. 9, figs. 5, 6

1970a *Cycadopites lusaticus* n. sp. –KRUTZSCH, p. 92, pl. 17. figs. 1–3.

Dimensions: Length: 53–61µm, Width: 18–23µm, ã = 58x24µm, (n = 45)

Description: Pollen grains monosulcate, in polar view amb strongly ellipsoidal. Sulcus on the distal face in the pole area about 3µm broad. Exine conspicuous psilate sculpture.

Botanical affinity: Family Cycadaceae; Genus probably *Cycas*?

Palaeofloristical element: Unknown

Previously recorded occurrences: Krutzsch (1970a) mentions the occurrences of the species in the Middle Miocene of Germany. The species was designated from Upper Oligocene and Lower Miocene sediments of southwest Anatolian molasse basins by Akgün & Sözbilir (2001).

Occurrences: Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(86) *Cycadopites* sp. 1
pl. 9, fig. 7

Dimensions: Length: 38–40µm, Width: 8–10µm, ã = 38x8µm, (n = 23)

Description: Pollen grains monosulcate, in polar view amb varied from strongly ellipsoidal to roundish. Sulcus on the distal face in the pole area about 1–3 µm broad.
Remarks: The specimens obtained are small sized and similar to *Cycadopites* but are not described.
Botanical affinity: Family probably Cycadaceae?
Palaeofloristical element: Unknown
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“ Middle” Oligocene İncesu Formation.

Genus: *Arecipites* WODEHOUSE 1933

Type species: *Arecipites punctatus* WODEHOUSE 1933

(87) *Arecipites brandenburgensis* KRUTZSCH 1970a
pl. 9, figs. 8, 9

1970a *Arecipites brandenburgensis* n. sp. –KRUTZSCH, p. 106, pl. 22, figs. 8–16.

Dimensions: Length: 30µm, Width: 20–22 µm, ã = 30x22µm, (n = 3)
Description: Monocolpate (Monosulcate) pollen grain, amb oval. Colpus/Sulcus distinct, reaching both corners. Sculpture reticulate.
Botanical affinity: Family Arecoideae?, Palmae?
Palaeofloristical element: Unknown
Previously recorded occurrences: Krutzsch (1970a) mentions the occurrences from Oligocene and Miocene sediments of Germany. The species has been reported from Middle–?Upper Eocene sediments of the Çankırı Basin by Akkiraz et al. (accepted).
Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower Miocene Aksu Formation.

(88) *Arecipites* sp. 1
pl. 9, fig. 10

Dimensions: Length: 30µm, Width: 18µm, (n = 1)

Description: Monocolpate pollen grain, amb perprolate with rounded corners in polar view. Colpus distinct, slightly arched, reaching both corners. Structure baculate.

Remarks: The specimens obtained are small sized and similar to *Arecipites*, but are not described because of poor preservation.

Botanical affinity: Family Arecoideae?, Palmae?

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça Formation.

Genus: *Magnolipollenites* KRUTZSCH 1970a

Type Species: *Magnolipollis neogenicus* KRUTZSCH 1970a

(89) *Magnolipollis neogenicus* ssp. *minor* KRUTZSCH 1970a
pl. 9, figs. 11, 12

1970a *Magnolipollis neogenicus minor* n. subsp. –KRUTZSCH, p. 134, pl. 33, figs. 1–8.

Dimensions: Length: 38–44µm, Width: 25–30µm, ã = 42x30µm, (n = 14)

Description: Monosulcate pollen grains of subprolate in outline. Exine about 1µm thick with micropuncate sculpture.

Botanical affinity: Most likely the family Magnoliaceae?

Palaeofloristical element: Unknown

Previously recorded occurrences: According to Krutzsch (1970a), the species occurs from "Middle" Oligocene, Miocene and Pliocene sediments in Germany.

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations

Genus: *Monogemmites* KRUTZSCH 1970a

Type Species: *Monogemmites gemmatus* (COUPER 1960) KRUTZSCH 1970a

(90) *Monogemmites pseudosetarius* (WEYLAND & PFLUG 1957) KRUTZSCH 1970a

pl. 9, figs. 13–15

1957 *Inaperturopollenites pseudosetarius* n. sp. –WEYLAND & PFLUG, p. 103, pl. 22, fig. 29–31.

1970a *Monogemmites pseudosetarius* (WEYLAND & PFLUG) n. comb. –KRUTZSCH, p. 146, pl. 39, figs. 21–25.

Dimensions: 20–32µm, ã = 22µm, (n = 91)

Description: Pollen grains oval to roundish in outline and having monosulcate bursting. Loosely settled spinae like ornaments occupied all pollen body.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Previously recorded occurrence: Nakoman (1966a) mentions that an occurrence of the species was restricted in the Sannoisian (the lowest part of Oligocene) of the Thrace Basin. Krutzsch (1970a) reported occurrences of the species from Oligocene to Pliocene sediments of Middle Europe. Akgün et al. (2002) recorded the species from Middle–?Upper Eocene sediments of the Çankırı–Çorum Basin. The species was also illustrated from Middle Miocene sediments of the Büyük Menderes Graben by Akgün & Akyol (1999). Akkiraz & Akgün (2005) indicate the presence of species from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Lower–"Middle" Oligocene Tokça Formation

Dicolpates ERDTMAN 1947

Genus: *Dicolpopollis* PFLANZL 1956

Type Species: *Dicolpopollis kockelii* PFLANZL 1956

(91) *Dicolpopollis kockelii* PFLANZL 1956

pl. 9, figs. 16–22

1956 *Dicolpopollis kockelii* n. fsp. –PFLANZL, p. 241, pl. 16, figs. 9–12.

Dimensions: 18–26µm, ã = 20µm, (n = 16)

Description: Small dicolpate pollen grain with prominent reticulate sculpture. Amb irregularly elliptical or trapezoidal. Sulci are usually parallel to each other and sometimes converge or even touch to each other.

Botanical affinity: Family Palmae; Genus *Calamus*

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: Nakoman (1966a) recorded the species in Upper Oligocene sediments of the Thrace Basin. It is generally considered to range from Middle Eocene to "Middle" Oligocene of Germany (Krutzsch, 1967b). Akyol (1971) reported the species in Lower Oligocene of Şile–İstanbul (Turkey). According to Wilkinson et al. (1980), the species although not restricted to Oligocene, occurs only in northwest European Oligocene deposits. Chateauneuf et al. (1988) studied Paleogene sediments of the Paris Basin (France). They mention occurrences of the species from Upper Eocene to lower "Middle" Oligocene. Olliver–Pierre (1988) recorded the species from Lower Oligocene to "Middle" Oligocene of the Armorican Massif (France). Schuler (1988) indicates that the species occurrence from "Middle" Oligocene to Upper Oligocene of the Rhine Graben. According to Roche (1988), it is characteristic species of "Middle" Oligocene in Belgium. Ediger et al. (1990) studied the *Calamus*–like disulcate pollen grains and indicated the stratigraphic distribution of *Dicolpopollis* *kockelii*. According to authors, stratigraphic distribution of *Dicolpopollis kockelii* is low frequencies in Upper Eocene. It is represented by abundantly in Upper Oligocene and reduces to the Miocene. Akgün & Sözbilir (2001) reported the species in Upper Oligocene of southwest Anatolian molasse basins (Kale–Tavas and Denizli). At last Akkiraz & Akgün (2005) reported the species from Lower Oligocene Çardak–Tokça Basin.

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Aksu Formation.

Polyplicates ERDTMAN 1952

Genus: *Ephedripites* BOLCHOVITINA 1953

Type Species: *Ephedrepites mediolobatus* BOLCHOVITINA 1953

(92) *Ephedripites* sp. 1
pl. 9, fig. 23

Dimensions: 40–45µm, ã = 45µm, (n = 7)

Description: Polyplicate pollen grain. In equatorial view outline ellipsoidal with tapering pole areas. 8–10 plicae about 2–2.5 µm running meridionally reaching the poles.

Remarks: Although the specimens obtained are similar to the species *Ephedripites (Distachyapites) bernheidensis* Krutzsch 1961 with respect to size and morphology, it is not possible to describe it because of poor preservation.

Botanical affinity: Family probably Ephedraceae?

Palaeofloristical element: Unknown

Occurrences: Lower–"Middle" Oligocene İncesu Formation.

Braveaxones PFLUG *in* THOMSON & PFLUG 1953

Genus: *Plicapollis* PFLUG *in* THOMSON & PFLUG 1953

Type Species: *Plicapollis serta* PFLUG *in* THOMSON & PFLUG 1953

(93) *Plicapollis pseudoexcelsus* (KRUTZSCH 1957) KRUTZSCH 1961 ssp. *turgidus* PFLUG *in* THOMSON & PFLUG 1953
pl. 9, fig. 24

1953 *Triatriopollenites excelsus* (POTONIÉ) ssp. *turgidus* –PFLUG *in* THOMSON & PFLUG, p. 77, pl. 7, figs. 36–46.
1957 *Triatriopollenites pseudoexcelsus* n. fsp. –KRUTZSCH, p. 519, pl. VIII, figs. 31–37.
1961 *Plicapollis pseudoexcelsus* (KRUTZSCH 1957) n. comb. –KRUTZSCH, p. 304.

Dimensions: 16–20µm, ã = 18µm, (n = 18)
Description: Triporate pollen grains with drop-shaped annulus. Annulus develops abruptly from the thin exine and show a small appendix from outline. Exine is smooth. Plicae are characteristic.
Botanical affinity: Family probably Juglandaceae?
Palaeofloristical element: Unknown
Previously recorded occurrences: This form species occurs in Palaeocene and Upper Eocene and possibly in "Middle" Oligocene (Krutzsch, 1957; Góczán et al., 1967; Krutzsch & Vanhoorne, 1977; Hochuli, 1978; Thiele–Pfeiffer, 1988; Nickel, 1996a, 1996b; Lenz, 2001). Akgün (2002) recorded the species from Middle–?Upper Eocene sediments of Çorum–Amasya area.
Occurrences: Lower–"Middle" Oligocene İncesu Formation.

(94) *Plicapollis pseudoexcelsus* (KRUTZSCH 1957) KRUTZSCH 1961 ssp. *semiturgidus* PFLUG *in* THOMSON & PFLUG 1953
pl. 9, figs. 25, 26

1953 *Triatriopollenites excelsus* (POTONIÉ) ssp. *semiturgidus* –PFLUG *in* THOMSON & PFLUG, p. 77, pl. 7, figs. 57–58.
1957 *Triatriopollenites pseudoexcelsus* n. fsp. –KRUTZSCH, p. 519, pl. VIII, figs. 31–36.
1961 *Plicapollis pseudoexcelsus* (KRUTZSCH 1957) n. comb. –KRUTZSCH, p. 304.

Dimensions: 21–29µm, ã = 22µm, (n = 5)
Description: Triporate pollen grains. Amb triangular with convex sides. Three pores situated on each corner. More or less endoplicae. Exine smooth.
Botanical affinity: Family probably Juglandaceae?
Palaeofloristical element: Unknown
Previously recorded occurrences: See under (93) *Plicapollis pseudoexcelsus* ssp. *turgidus*.
Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–“Middle” Oligocene Tokça and İncesu formations.

(95) *Plicapollis* sp. 1
pl. 9, figs. 27, 28

Dimensions: 20–25µm, ã = 22µm, (n =4)
Description: Triporate pollen grains. Amb triangular with convex sides. Three pores situated on each corner with annulus, labrum. Imperceptible endoplicae.
Remarks: Even the microsrobic features point directly to the *Plicapollis*, but identification down to species level is yet not possible.
Botanical affinity: Family probably Juglandaceae?
Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Triatriopollenites* PFLUG *in* THOMSON & PFLUG 1953

Type Species: *Triatriopollenites rurensis* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

(96) *Triatriopollenites rurensis* THOMSON & PFLUG 1953
pl. 9, figs. 29–35

1953 *Triatriopollenites rurensis* n. sp. –THOMSON & PFLUG, p. 79, pl. 7, figs. 81–109.

Dimensions: 20–27µm, ã = 24µm, (n = 62)
Description: Triatrioporate pollen grains. Amb triangular with straight or slightly convex sides and rounded apices. Three pores situated on each corner with atrium, labrum and small annulus.
Botanical affinity: Family Myricaceae; Genus *Myrica*
Palaeofloristical element: Palaeotropical (subtropical)
Previously recorded occurrences: Thomson & Pflug (1953) mention occurrences of the species from Eocene to Pliocene of Middle Europe. The species was recorded from the Eocene, Oligocene and Miocene basins of Turkey (e.g. Nakoman, 1966a; Akyol, 1971; Batı, 1996; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün & Sözbilir, 2001; Akgün, 2002; Akgün et al., 2002).
Occurrences: Middle–?Upper Eocene Başçeşme and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations Lower Miocene Kavak and Aksu formations.

(97) *Triatriopollenites pseudorurensis* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

pl. 9, fig. 36, pl. 10. fig. 1

1953 *Triatriopollenites pseudorurensis* n. sp. (PFLUG & THOMSON) –THOMSON & PFLUG, p. 78–79, pl. 7, figs. 76–80.

Dimensions: 30–40µm, ã = 38µm, (n = 13)

Description: Triatrioporate pollen grains. Amb triangular with convex sides. Three pores situated on each corner with clear atrium and weakly developed tumescence.

Botanical affinity: Family Myricaceae; Genus *Myrica*

Palaeofloristical element: Subtropical–warm temperate

Previously recorded occurrences: Nakoman (1966a) also recorded the species in Eocene sediments of Sorgun lignites (central Anatolia). Moreover Nakoman (1966b) mentions occurrences of the species in Tertiary of the Thrace Basin (Turkey). Akyol (1980) reported the species in Eocene of Çorum–Bayat (Turkey). Batı (1996) reported the species from Upper Oligocene Thrace Basin. Akkiraz & Akgün (2005) determined the species form Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Lower –"Middle" Oligocene İncesu Formation.

(98) *Triatriopollenites bituitus* (POTONIÉ 1931a) THOMSON & PFLUG 1953

pl. 10, figs. 2–6

1931a *Pollenites bituitus* n. sp. –POTONIÉ, p. 332, pl. 11, fig. 17.

1953 *Triatriopollenites bituitus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 79, pl. 7, figs. 116–134.

Dimensions: 18–28µm, ã = 25µm, (n = 34)

Description: Triatrioporate pollen grains. Amb triangular with straight or slightly convex sides. Three pores situated on each corner with atrium and labrum.

Botanical affinity: Family Myricaceae; Genus *Myrica*

Palaeofloristical element: Palaeotropical (subtropical)

Previously recorded occurrences: From Eocene to Pliocene of the Middle Europe Thomson & Pflug (1953). In Turkey, the species was described from Eocene, Oligocene and Miocene sediments (e.g. Nakoman, 1966b; Akyol, 1971; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün et al., 2000; Akgün & Sözbilir, 2001; Akgün et al., 2002; Akkiraz & Akgün, 2005).

Occurrences: Middle–?Upper Eocene Başçeşme and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations. Lower Miocene Kavak Formation.

(99) *Triatriopollenites excelsus* (POTONIÉ 1931a) THOMSON & PFLUG 1953 ssp. *minor* PFLUG *in* THOMSON & PFLUG 1953

pl. 10, figs. 7–10

1953 *Triatriopollenites excelsu*s (POTONIÉ) n. comb. (b) subsp. *minor* subsp. PFLUG – THOMSON & PFLUG, p. 77, pl. 7, figs. 22–26.

Dimensions: 15–18µm, ã = 18µm, (n = 66)

Description: Triatrioporate pollen grains. Amb triangular with straight or slightly convex sides. Three pores situated on each corner with annulus. Annulus clearly prominent. Exine thin, Atrium visible.

Botanical affinity: Family Myricaceae

Palaeofloristical element: Subtropical–warm temperate

Previously recorded occurrences: The species was recorded from Palaeocene and Upper Eocene of Europe (Thomson & Pflug, 1953; Kedves, 1969, 1982; Gruas–Cavagnetto, 1978). Nickel (1996a) reported the subspecies from Upper Eocene of the Upper Rhine Graben. Akyol (1980) determined the species Middle–Upper Eocene Bayat lignites. Akgün et al. (2002) indicate its presence from Middle–?Upper Eocene sediments of the Çankırı Basin.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene Tokça and İncesu formations.

(100) *Triatriopollenites excelsus* (POTONIÉ 1931a) THOMSON & PFLUG 1953 ssp. *typicus* PFLUG *in* THOMSON & PFLUG 1953
pl. 10, figs. 11–16

1953 *Triatriopollenites excelsus* (POTONIÉ) n. comb. (b) subsp. *typicus* subsp. (PFLUG) –THOMSON & PFLUG, p. 77, pl. 7, figs. 27–31.

Dimensions: 22–30µm, ã = 22µm, (n = 54)
Description: Triatrioporate pollen grains. Amb triangular with straight with drop–shaped annulus. Annulus does not rise up prominent out of the outline. Exine smoothly to chagrenate.
Botanical affinity: Family Myricaceae
Palaeofloristical element: Subtropical–warm temperate
Previously recorded occurrences: See under (99) *Triatriopollenites excelsus* ssp. *minor*.
Occurrences: Middle–?Upper Eocene Başçeşme and Varsakyayla formations; Lower–“Middle” Oligocene İncesu Formation.

(101) *Triatriopollenites myricoides* (KREMP 1949) THOMSON & PFLUG 1953
pl. 10, figs. 17–20

1949 *Pollenites myricoides* n. sp. –KREMP, p. 64 and pl. 6, fig. 63
1953 *Triatriopollenites myricoides* (KREMP) n. comb. –THOMSON & PFLUG, p. 80, pl. 8, figs. 1–14.

Dimensions: 38–40µm, ã = 38µm, (n = 59)

Description: Triatrioporate pollen grains. Amb triangular with straight or slightly concave sides. Three pores situated on each corner with a prominent atrium and small labrum. Exine is chagrenate.

Botanical affinity: Family Myricaceae

Palaeofloristical element: Palaeotropical (subtropical)

Previously recorded occurrences: It was reported from Hungarian Oligocene (Rákosi 1973), in Miocene (the lower Ottnangian–Sarmatian) by Nagy (1969). It was recorded from Upper Eocene and Oligocene of Carpathians by Snopková (1980). According to Hochuli (1978), the species occurs in the Paleogene. Akgün & Akyol (1999) recorded the species from Middle Miocene sediments of the Büyük Menderes Graben. Akgün & Sözbilir (2001) illustrated the species from Upper Oligocene and Lower Miocene sediments of southwest Anatolian molasse basins.

Occurrences: Lower–"Middle" Oligocene Tokça Formation.

Genus: *Plicatopollis* KRUTZSCH 1962b

Type Species: *Plicatopollis plicatus* (POTONIÉ 1934) KRUTZSCH 1962b

(102) *Plicatopollis plicatus* (POTONIÉ 1934) KRUTZSCH 1962b
pl. 10, figs. 21–34

1934 *Pollenites plicatus* n. sp. –POTONIÉ, p. 55, pl. 2, fig. 19.

1953 *Triatriopollenites plicatus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 81, pl. 8, figs. 85–108.

1962b *Plicatopollis plicatus* (POTONIÉ) n. comb. –KRUTZSCH, p. 277, text figure 6.

Dimensions: 18–23µm, ã = 23µm, (n = 101)

Description: The species having a clear Endoplica. Annulus slightly developed or (in most cases) not visibly. Exine smooth and psilate.

Botanical affinity: Family Juglandaceae

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: The species occurred mostly in Eocene sediments of Europe (Thomson & Pflug, 1953; Krutzsch, 1957, 1970b; Nickel 1996a, 1996b). The species is most frequent in Middle Eocene sediments of Messel (Thilele–Pfeiffer, 1988). According to Knobloh et al. (1996), the species predominantly occurs in Eocene, reduces in Oligocene and Miocene of middle Europe. Akgün (2002) determined the species from Middle–?Upper Eocene sediments of Çorum–Amasya area. Akkiraz et al. (2006) also recorded the species from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Kavak and Aksu formations.

(103) *Plicatopollis hungaricus* KEDVES 1974

pl. 10, figs. 35, 36

1974 *Plicatopollis hungaricus* n. fsp. –KEDVES, p. 58, text figure 29 and pl. 19, figs. 13–18.

Dimensions: 27–30µm, ã = 28µm, (n = 4)

Description: Triangular in outline with convex sides. The species having a clear solution figure called plicae. Exine smooth and slightly punctate.

Botanical affinity: Probably ancient representative of the Juglandaceae?

Palaeofloristical element: Unknown

Previously recorded occurrences: Kedves (1974) recorded the species from Lower Eocene sediments of the Bakony Mountains (Hungary). According to Nickel (1996a), the range of species is similar to the range of *Plicatopollis plicatus* (Potonié 1934) Krutzsch 1962b. It was reported from the Oligocene sediments of Egypt by Kedves (1985).

Occurrences: Lower Miocene Kavak Formation.

(104) *Plicatopollis lunatus* KEDVES 1974
pl. 10, fig. 37, pl. 11, figs. 1–4

1974 *Plicatopollis lunatus* n. sp. –KEDVES, p. 57–58, fig. 28, pl. XIX, figs. 7–9 and 10–12.

Dimensions: 20–30 µm, ã = 25µm, (n = 37)

Description: Triporate pollen grains with convex outline. The pores are not prominent without annulus. The species having a characteristic endoplicae.

Botanical affinity: Family Juglandaceae

Palaeofloristical element: Unknown

Previously recorded occurrences: Similar forms were already recorded from Upper Palaeocene of Europe (Pflug, 1953). Kedves (1974) reported the species of Lower and Upper Eocene in the Bakony mountains. It was also reported from Middle Eocene sediments of Germany (Thiele–Pfeiffer, 1988; Nickel, 1996a). Akgün (2002) designated the species from Middle–?Upper Eocene sediments of Çorum–Amasya area. Akkiraz et al. (2006) also reported the species from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin. The species has also been reported from Middle–?Upper Eocene sediments of the Çankırı Basin by Akkiraz et al. (accepted).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations.

Genus: *Momipites* WODEHOUSE 1933

Type Species: *Momipites coryloidites* WODEHOUSE 1933

(105) *Momipites punctatus* (POTONIÉ 1931a) NAGY 1969
pl. 11, figs. 5–9

1931a *Pollenites coryphaeus punctatus* n. f. –POTONIÉ, p. 329, 332, pl. 2, figs. 7 and 11.

1969 *Momipites punctatus* (POTONIÉ) n. comb. –NAGY, p. 478, pl. LIV, figs. 9, 10.

Dimensions: 16–25µm, ã = 21µm, (n = 2079)

Description: Triporate pollen grains. Triangular in equatorial view with convex sides. Three small pores arranged angularly with a small atrium. Exine finely punctate.

Botanical affinity: Family Juglandaceae; Genus *Engelhardia*

Palaeofloristical element: Palaeotropical (subtropical)

Previously recorded occurrences: Most authors report occurrences in the Paleogene and mainly Lower and Middle Miocene (Konzálová, 1976a) of the Central Europe. It was reported from "Middle" Oligocene to Lower Miocene of the Western Paratethys (Hochuli, 1978). Snopková (1983) mentions sporadically occurrences in Upper Eocene and Oligocene of the Inner–Carpathian depressions. Nickel (1996a) recorded the species from Lower Eocene to Upper Miocene of the Upper Rhine Graben. It was recorded from Middle–?Upper Eocene sediments of Çorum–Amasya area by Akgün (2002). Akkiraz & Akgün (2005) indicate the presence of species from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Başeçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(106) *Momipites quietus* (POTONIÉ 1931c) NICHOLS 1973

pl. 11, figs. 10–12

1931c *Pollenites quietus* n. sp. –POTONIÉ, p. 556, text figure 13.

1953 *Triatriopollenites coryphaeus* ssp. *microcoryphaeus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 81, pl. 8, figs. 40?, 47, 48, 49, 56?

1973 *Momipites quietus* (POTONIÉ) n. comb. –NICHOLS, p. 107.

Dimensions: 12–15µm, ã = 15µm, (n = 162)

Description: Small triporate pollen grains. Triangular in equatorial view. Three small pores arranged angularly with a small atrium. It is easy to recognize due to characteristic form species.

Botanical affinity: Family Juglandaceae; Genus *Engelhardia*

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: According to Hochuli (1978), the species can be observed from Lower Palaeocene to Lower Miocene of Central and Western Paratethys. It was reorded from Lower Palaeocene to "Middle" Oligocene of the Upper Rhine Graben (Nickel, 1996a). The species was described from Eocene and Oligocene sediments of the Çardak–Tokça Basin (Akkiraz & Akgün, 2005; Akkiraz et al., 2006). It has been recorded from Middle–?Upper Eocene sediments of the Çankırı Basin by Akkiraz et al. (accepted).

Occurrences: Middle–?Upper Eocene Başeçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(107) *Momipites* sp. 1

pl. 11, fig. 13

Dimensions: 16–20µm, ã = 18µm, (n = 12)

Description: Triporate pollen grains. Triangular in equatorial view. Three pores situated on the equatorial corners, without atrium, annulus and labrum. Exine finely puntate to chagrenate.

Remarks: The species is similar to *Momipites punctatus* (Potonié 1931a) Nagy 1969 with respect to size, but *Momipites* sp. 1 has no annulus, labrum and atrium.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Triporopollenites* THOMSON & PFLUG 1953

Type Species: *Triporopollenites coryloides* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

(108) *Triporopollenites megagranifer* (POTONIÉ 1931a) THOMSON & PFLUG 1953
pl. 11, figs. 14, 15

1931a *Pollenites coryphaeus* subsp. *megagranifer* –POTONIÉ, p. 328, pl. 1, fig. 22.
1953 *Triporopollenites megagranifer* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 82, pl. 8, figs. 153–158.

Dimensions: 25–30µm, ã = 30µm, (n = 12)
Description: Triporate pollen grains. Amb triangular with convex sides**.** Three simple pores without annulus situated on each corner. Exine intragranulate structure.
Botanical affinity: Family probably Betulaceae
Palaeofloristical element: Unknown
Previously recorded occurrences: Thomson & Pflug (1953) indicate the species from Palaeocene to Upper Miocene of the Middle Europe. From Palaeocene to Lower Oligocene of the Thrace Basin (Nakoman, 1966b). It was determined from Middle–?Upper Eocene sediments of Çorum–Amasya area by Akgün (2002).
Occurrences: Lower–"Middle" Oligocene Tokça Formation.

(109) *Triporopollenites robustus* (MURRIGER & PFLUG 1951) PFLUG *in* THOMSON & PFLUG 1953
pl. 11, figs. 16, 17

1951 *Pollenites granifer robustus* n. subsp. –MURRIGER & PFLUG, p. 93, pl. 6, fig. 41.

1953 *Triporopollenites robustus* (MURRIGER & PFLUG) n. comb. (PFLUG) – THOMSON & PFLUG, p. 82, pl. 8, figs. 109–149.

Dimensions: 25–36µm ã = 30µm (n = 26)

Description: Triporate pollen grains. Amb triangular with slightly convex or rounded sides. Three pores situated on each corner arranged angularly, sometimes subequatorially. Pores round, annulus indistinct.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Previously recorded occurrences: It occurs commonly from Palaeocene to Upper Eocene and rarely in Miocene of the Middle Europe (Thomson & Pflug, 1953; Krutzsch & Vanhoorne, 1977). According to Nakoman (1966b), the species occurs in Lower Tertiary of the Thrace Basin. Akgün (2002) recorded the species from Middle–?Upper Eocene of Çorum–Amasya area. Akkiraz et al. (2006) described the species from Middle –?Upper Eocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle –?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations.

(110) *Triporopollenites* sp. 1

pl. 11, fig. 18

Dimensions: 20–22µm, ã = 20µm, (n = 10)

Description: Triporate pollen grains. Amb roundish triangular with strongly convex sides. Three pores situated on each corner arranged angularly. Pores round without annulus.

Remarks: Even the microsrobic features point directly to the *Triporopollenites*, but identification down to species level is yet not possible because of bad preservation.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Labrapollis* KRUTZSCH 1968

Type Species: *Labrapollis labraferus* (POTONIÉ 1931b) KRUTZSCH 1968

(111) *Labrapollis labraferus* (POTONIÉ 1931b) KRUTZSCH 1968
pl. 11, figs. 19, 20

1931b *Pollenites labraferus* n. sp. –POTONIÉ, p. 2, fig. 7.
1968 *Labrapollis labraferus* (POTONIÉ) n. comb. –KRUTZSCH, p. 62–63, pl. 1, figs. 1–12.

Dimensions: 17–20µm, ã = 18µm, (n = 4)
Description: Pollen grain roundish, weakly distinct pores and having plicae at the center of the pollen bodies. Exine about 2 µm thick.
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Previously recorded occurrences: The species occurs in Palaeocene and Eocene sediments of Europe (Krutzsch, 1957, 1968; Krutzsch &Vanhoorne, 1977; Lenz, 2005). The species was determined from Middle–?Upper Eocene sediments of Çorum–Amasya area by Akgün (2002).
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça Formation.

Genus: *Olaxipollis* KRUTZSCH 1962b

Type Species: *Olaxipollis matthesi* KRUTZSCH 1962b

(112) *Olaxipollis matthesi* KRUTZSCH 1962b
pl. 11, figs. 21, 22

1962b *Olaxipollis matthesi* n. sp. –KRUTZSCH, p. 277, pl. V, figs. 7–14.

Dimensions: 15–20µm, ã = 20µm, (n = 8)

Description: Triporate pollen grains with convex triangular in polar view. Pores without annulus, projecting and arranged angularly. Exine psilate.

Botanical affinity: Family Olacaceae, Genus probably *Olax*?

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: From Middle Eocene to Middle Miocene of Middle and East Europe (Krutzsch, 1962b; Ollivier–Pierre, 1980; Thiele–Pfeiffer, 1980). The species was described from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin (Akkiraz et al., 2006). It was recorded from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin as well by Akkiraz & Akgün (2005).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations.

Genus: *Trivestibulopollenites* PFLUG *in* THOMSON & PFLUG 1953

Type Species: *Trivestibulopollenites betuloides* PFLUG *in* THOMSON & PFLUG 1953

(113) *Trivestibulopollenites betuloides* PFLUG *in* THOMSON & PFLUG 1953
pl. 11, figs. 23–25

1953 *Trivestibulopollenites betuloides* n. sp. (PFLUG) –THOMSON & PFLUG, p. 85, pl. 9, figs. 25–34.

Dimensions: 18–25µm ã = 23µm, (n = 16)

Description: Triangular or rounded in equatorial outline. Three pores arranged angularly, having a vestibulum. Exine smooth.

Botanical affinity: Family Betulaceae; Genus *Betula*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: In Miocene and Pliocene of Middle Europe (Thomson & Pflug, 1953). Krutzsch (1958) indicates the presence of species in Middle Oligocene of Middle Europe. According to Nakoman (1966b), the species occurs all Tertiary of the Thrace Basin. Akkiraz & Akgün (2005) indicate the presence of species from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin. It was recorded from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin by Akkiraz et al. (2006).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations

Genus: *Caryapollenites* POTONIÉ 1960 ex RAATZ 1937 emend. KRUTZSCH 1961

Type species: *Caryapollenites simplex* POTONIÉ 1960 ex RAATZ 1937 emend. KRUTZSCH 1961

(114) *Caryapollenites simplex* (POTONIÉ 1931b) RAATZ ex POTONIÉ 1960
pl. 11, figs. 26–31

1931b *Pollenites simplex* n. sp. –POTONIÉ, p. 3, fig. 4.
1937 *Carya-pollenites simplex* (POTONIÉ) n. comb. –RAATZ, p. 19,pl. 1, fig. 6.
1960 *Caryapollenites simplex* (RAATZ) n. comb. –POTONIÉ, p. 123, pl. 7, fig. 162.

Dimensions: 30–45µm, ã = 38µm, (n = 416)

Description: Pollen grains of a typical round shape, usually having three simple subequatorial pores. The sculpture is microgranulate distributed regularly. Pores round, with 4–5µm in diameter.

Botanical affinity: Family Juglandaceae; Genus *Carya*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: Sporadical occurrences were recorded from Lower Miocene of North Bohemian coal basins by Konzálová (1976a). Hochuli (1978) mentions occurrences of the species from Lower Oligocene to Lower Miocene of Central and Western Paratethys. Chateauneuf (1980) reported the species from Lower Oligocene to Middle Oligocene of the Paris Basin (France). It is abundant in the Karpathian and Badenian of Hungarian Paratethys (Nagy, 1985). Its occurrences were reported from Lower Oligocene to Miocene of Belgium (Roche, 1988). Nickel (1996a) recorded the species from Lower Oligocene to Pliocene of the Upper Rhine Graben. In Turkey, the species occurs in Oligocene and Miocene deposits (e.g. Nakoman,1966b; Akyol; 1971; Batı, 1996; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün et al., 2000; Akgün & Sözbilir, 2001; Akgün, 2002; Akkiraz & Akgün, 2005; Sancay et al., 2006).

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

Genus: *Subtriporopollenites* THOMSON & PFLUG 1953

Type Species: *Subtriporopollenites anulatus* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

(115) *Subtriporopollenites anulatus* THOMSON & PFLUG 1953 ssp. *nanus* THOMSON & PFLUG 1953
pl. 11, figs. 32–34, pl. 12, fig. 1

1953 *Subtriporopollenites anulatus* n. sp. (THOMSON & PFLUG) (b) subsp. *nanus* (THOMSON & PFLUG) –THOMSON & PFLUG, p. 86, pl. 9, fig. 54–55.

Dimensions: 18–23µm, ã=23µm, (n = 46)

Description: Triporate pollen grains with nearly circular in outline and usually subequatorial pores. Exine smooth.

Botanical affinity: Family Juglandaceae; Genus probably *Carya*?

Palaeofloristical element: Subtropical–warm temperate

Previously recorded occurrences: Thomson & Pflug (1953) and Krutzsch & Vanhoorne (1977) indicate the species from Upper Palaeocene to Upper Eocene of Europe. Akyol (1980) recorded the species from Middle–Upper Eocene sediments of Bayat lignites. Akgün & Sözbilir (2001) recorded the species from Upper Oligocene sediments of southwest Anatolian molasse basins. Akgün (2002) and Akgün et al. (2002) determined the species from Middle–?Upper Eocene sediments of the Çankırı Basin. Akkiraz & Akgün (2005) illustrated the species from Lower–“Middle” Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–“Middle” Oligocene Tokça and İncesu formations.

(116) *Subtriporopollenites constans* PFLUG *in* THOMSON & PFLUG 1953

pl. 12, figs. 2, 3

1953 *Subtriporopollenites constans* n. sp. (PFLUG) –THOMSON & PFLUG, p. 87, pl. 9, figs. 78–89.

Dimensions: 22–29µm, ã = 24µm, (n = 8)

Description: Triporate pollen grains with nearly circular in outline and usually subequatorial pores. Exine rugulate or intrabaculate sculpture.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Previously recorded occurrences: Thomson & Pflug (1953) recorded the species from Palaeocene to Lower Oligocene of Middle Europe. Nakoman (1966b) mentions that the species occurred up to Oligocene. According to the Kedves (1970), the species occurs in Lower Eocene sediments of France. According to Akyol (1980), the species disappears after Upper Eocene. However, the author also indicates that the species can be observed in Lower Oligocene of the Thrace Basin. Akgün (2002) and Akgün et al. (2002) indicate the presence of species from Middle–?Upper Eocene sediments of the Çankırı Basin.

Akkiraz & Akgün (2005) reported the species from Lower–“Middle” Oligocene sediments of the Çardak–Tokça Basin. It was also indicated from Middle–Upper Eocene sediments of the Çardak–Tokça Basin by Akkiraz et al. (2006). It was determined from Middle–?Upper Eocene sediments of the Çankırı Basin by Akkiraz et al. (accepted).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene Tokça Formation.

Genus: *Celtipollenites* NAGY 1969

Type Species: *Celtipollenites komloensis* NAGY 1969

(117) *Celtipollenites intrastructurus* (KRUTZSCH & VANHOORNE 1977) THIELE–PFEIFFER 1980

pl. 12, fig. 4

1977 *Subtriporopollenites intrastructus* n. sp. –KRUTZSCH & VANHOORNE, p. 58–59, pl. 23, figs. 8–19.

1980 *Celtipollenites intrastructurus* (KRUTZSCH & VANHOORNE 1977) n. comb. –THIELE–PFEIFFER, p. 130 pl. 8, figs. 32–34.

Dimensions: 17–20µm, (n = 2)

Description: Triporate pollen grains with nearly circular in outline with three equatorially to subequatorially situated pores. Exine having intrapunctate sculpture. Pores are roundish to oval in shape, have a narrow annulus and about 2–2.5 µm large.

Botanical affinity: Family Ulmaceae; Genus *Celtis*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: The species is known from Palaeocene?, Lower Eocene and Lower Miocene sediments of Europe (Kedves, 1970; Krutzsch & Vanhoorne, 1977; Thiele–Pfeiffer, 1980; Lenz, 2005). Akgün (2002) indicates the presence of species from Middle–?Upper sediments of the Çorum–Amasya area.

Occurrences: Lower–“Middle” Oligocene Tokça Formation.

Genus *Intratriporopollenites* THOMSON & PFLUG 1953

Type Species: *Intratriporopollenites instructus* (POTONIÉ 1931c) THOMSON & PFLUG 1953

(118) *Intratriporopollenites instructus* (POTONIÉ 1931c) THOMSON & PFLUG 1953
pl. 12, fig. 5

1931c *Tiliae-pollenites instructus* n. sp. –POTONIÉ, p. 556, text figure 9.
1953 *Intratriporopollenites instructus* (POTONIÉ & VENITZ) n. comb. –THOMSON & PFLUG, p. 89, pl. 10, figs 16, 18–22.

Dimensions: 35–38 µm, (n = 2)
Description: Pollen grains having a typical shape with triangular in outline. They have large pores with annulus. The outer part of exine extends around pores and forms a postvestibulum. Ectoexine with a reticulate sculpture composing of muri type processes about 0.5–1µm in diameter.
Botanical affinity: Family Tiliaceae; Genus *Tilia*
Palaeofloristical element: Arctotertiary (cool temperate)
Previously recorded occurrences: The species occurs during Tertiary of Middle Europe (Thomson & Pflug, 1953). The species is observed in Lower Tertiary of the Thrace Basin (Nakoman, 1966b). According to Planderová (1972), the species was more frequent in Lower–Middle Miocene than Sarmatian–Pliocene in Carpathians. Akgün & Akyol (1999) recorded the species from Middle Miocene sediments of the Büyük Menderes Graben. It was determined from Upper Miocene sediments of Sivas area by Akgün et al. (2000). Akkiraz & Akgün (2005) reported the presence of species from Lower–“Middle” Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Lower–"Middle Oligocene İncesu Formation; Lower Miocene Kavak Formation.

(119) *Intratriporopollenites insculptus* MAI 1961
pl. 12, fig. 6

1961 *Intratriporopollenites insculptus* n. sp. –MAI, p. 65, pl. XI, figs. 10–27.

Dimensions: 30µm, (n = 1)
Description: Pollen grain having a typical shapes with subspheroidal in outline. Pores surrounded by an annulus. Sculpture elements miroreticulate or granulate.
Botanical affinity: Family Tiliaceae, Subfamily Brownlowioideae
Palaeofloristical element: Arctotertiary (warm temperate)
Previously recorded occurrences: Mai (1961) reported occurrences till the end of Lower Miocene of central Europe. Oligocene–Lower Miocene of Europe (Thiele–Pfeiffer, 1980).
Occurrences: Lower Miocene Aksu Formation.

(120) *Intratriporopollenites indubitalibis* (POTONIÉ 1934) PFLUG & THOMSON *in* THOMSON & PFLUG 1953
pl. 12, figs. 7, 8

1934 *Pollenites indubitalis* n. sp. –POTONIÉ, p. 80, pl. 6, fig. 27.
1953 *Intratriporopollenites indubitalibis* (POTONIÉ) n. comb. (PFLUG & THOMSON) –THOMSON & PFLUG, p. 89, pl. 10, figs. 10–13.

Dimensions: 14–30 µm, ã = 15µm, (n = 2)
Description: Pollen grains having a typical shape with triangular in outline. Pores large with postvestibulum. Exine with reticulate sculpture.
Botanical affinity: Family Tiliaceae

Palaeofloristical element: Unknown

Previously recorded occurrence: The species occurred during Tertiary of Middle Europe (Thomson & Pflug, 1953). The species is observed in Lower Tertiary sediments of the Thrace Basin (Nakoman, 1966b). Akgün et al. (2002) determined the species from Middle–?Upper Eocene sediments of the Çankırı Basin. It was also recorded from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin by Akkiraz et al. (2006).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations.

Genus: *Compositoipollenites* POTONIÉ 1960

Type Species: *Compositoipollenites rhizophorus* (POTONIÉ 1934) POTONIÉ 1960

(121) *Compositoipollenites rhizophorus* (POTONIÉ 1934) POTONIÉ 1960 ssp. *burghasungensis* (MURRIGER & PFLUG 1952) MURRIGER & PFLUG *in* THOMSON & PFLUG 1953
pl. 12, figs. 9a, b

1934 *Pollenites rhizophorus* n. sp. –POTONIÉ, p. 94, pl. 6, fig. 32 and pl. 5, figs. 25, 26.
1952 *Triporato–pollenites burghasungensis* –MURRIGER & PFLUG, p. 60.
1953 *Intratriporopollenites rhizophorus* (POTONIÉ) n. comb. (b) subsp. *burghasungensis* (MURRIGER & PFLUG) n. comb. –THOMSON & PFLUG, p. 88, pl. 9, figs. 126–132 and pl. 10, figs. 1–6.
1960 *Compositoipollenites rhizophorus* POTONIÉ –POTONIÉ, p. 105, pl. 6, fig. 123.

Dimensions: 24µm, ã = 24µm, (n = 2)

Description: Pollen grains triporate. However, pores are not clearly recognized. Amb triangular with slightly convex sides and rounded apices. Exine having loosely situated spinae like ornament about 2µm base and 2.5µm high in diameter.

Botanical affinity: Family Icacinaceae

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: Thomson & Pflug (1953) recorded the species from Upper Palaeocene to Upper Eocene of the Middle Europe. Gruas–Cavagnetto (1968) mentioned the species from Lower Eocene to Upper Eocene of the Paris Basin. Kedves (1970) reported the species from Upper Palaeocene to Lower Eocene of Paris region. Nickel (1996a) mentions the occurrences from Upper Palaeocene to Upper Eocene of the Upper Rhine Graben. Akgün (2002) and Akkiraz et al. (accepted) indicate the presence of species from Middle–?Upper Eocene sediments of the Çankırı Basin. Akkiraz & Akgün (2005) recorded its presence from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Varsakyayla Formation.

Genus: *Polyporopollenites* PFLUG *in* THOMSON & PFLUG 1953

Type Species: *Polyporopollenites undulosus* (WOLFF 1934) THOMSON & PFLUG 1953

(122) *Polyporopollenites undulosus* (WOLFF 1934) THOMSON & PFLUG 1953
pl. 12, figs. 10–14

1934 *Ulmi–pollenites undulosus* n. sp. –WOLFF, p. 75, pl. 5, fig. 25.

1953 *Polyporopollenites undulosus* (WOLFF) n. comb. –THOMSON & PFLUG, p. 91, pl. 10, figs. 52–58.

Dimensions: 30–38 µm, ã = 38µm, (n = 53)

Description: Four to five porates pollen grain. Amb roundish. Exine having strongly rugulate sculpture.

Botanical affinity: Family Ulmaceae; Genus *Ulmus*?, *Zelkova*?

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: Krutzsch (1957) mentions occurrences of the species from Upper Palaeocene to recent of Middle Europe. From uppermost Middle

Eocene to “Middle” Oligocene of the Paris Basin (Chateauneuf, 1980). In Turkey, the species occurs all Tertiary (e.g. Nakoman, 1966b; Akyol, 1971; Batı, 1996; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün et al., 2000; Akgün & Sözbilir, 2001; Akgün, 2002; Akkiraz & Akgün, 2005; Akkiraz et al., 2006; Sancay et al., 2006).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Aksu Formation.

Genus: *Carpinuspollenites* NAGY 1969

Type Species: *Carpinuspollenites carpinoides* (PFLUG *in* THOMSON & PFLUG 1953) NAGY 1969

(123) *Carpinuspollenites carpinoides* (PFLUG *in* THOMSON & PFLUG 1953) NAGY 1969
pl. 12, figs. 15–19

1953 *Polyporopolllenites carpinoides* n. sp. (PFLUG) –THOMSON & PFLUG, p. 92, pl. 10, figs. 79–83.

1969 *Carpinuspollenites carpinoides* (PFLUG) n. comb. –NAGY, p. 458, pl. LII, fig. 8.

Dimensions: 30–40µm, ã = 38µm, (n = 18)

Description: Three to five porate pollen grains with annulus and labrum and without atrium. Exine thinly infrapunctate.

Botanical affinity: Family Betulaceae; Genus *Carpinus*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: The species occurs in Middle and Late Tertiary formations of Middle Europe (Thomson & Pflug, 1953). It was recorded from the Eocene, Oligocene and Miocene basins of Turkey (e.g. Nakoman, 1966b; Akgün & Sözbilir, 2001; Akgün, 2002; Akkiraz & Akgün, 2005; Akkiraz et al., 2006).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Aksu Formation.

Genus: *Pterocaryapollenites* THIERGART 1937 ex POTONIÉ 1960

Type species: *Pterocaryapollenites stellatus* (POTONIÉ 1931d) THIERGART 1937

(124) *Pterocaryapollenites stellatus* (POTONIÉ 1931d) THIERGART 1937
pl. 12, figs. 20–22

1931d *Pollenites stellatus* n. sp. –POTONIÉ, p. 28, pl. 2, fig. V 47b.
1937 *Pterocaryapollenites stellatus* (POTONIÉ) n. comb. –THIERGART, p. 311, pl. 24, fig. 19.

Dimensions: 30–38µm, ã = 38µm, (n = 10)
Description: Polyporate pollen grains angularly straight sides in outline, usually having five pores lain equatorially with weak annulus. Exine chagrenate to punctate.
Botanical affinity: Family Juglandaceae; Genus *Pterocarya*
Palaeofloristical element: Arctotertiary (warm temperate)
Previously recorded occurrences: Thomson & Pflug (1953) mention the occurrences of the species from Middle Eocene to Pleistocene of Middle Europe. Hochuli (1978) reported the species in “Middle” Oligocene of Central and Western Paratethys. The species occurs all Tertiary sediments of Turkey (e.g. Nakoman, 1966b; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün & Sözbilir, 2001; Akkiraz & Akgün, 2005; Sancay et al., 2006).
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene İncesu Formation; Lower Miocene Aksu Formation.

Genus: *Polyvestibulopollenites* PFLUG *in* THOMSON & PFLUG 1953

Type Species: *Polyvestibulopollenites verus* ((POTONIÉ 1931a) THOMSON & PFLUG 1953

(125) *Polyvestibulopollenites verus* (POTONIÉ 1931a) THOMSON & PFLUG 1953 pl. 12, figs. 23–28

1931a *Pollenites verus* n. sp. –POTONIÉ, p. 329, pl. 2, fig. 40.
1934 *Alni–pollenites verus* POTONIÉ –POTONIÉ, p. 58, pl. II, figs. 13, 17, 18, 25, 26.
1953 *Polyvestibulopollenites verus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 90, pl. 10, figs. 62–76.

Dimensions: 25–30µm, ã = 25µm, (n = 23)
Description: Pollen having generally five, rarely four pores, characteristic arcus connected pores. Exine smooth.
Botanical affinity: Family Betulaceae; Genus *Alnus*
Palaeofloristical element: Arctotertiary (warm temperate)
Previously recorded occurrences: From Eocene to Pliocene of Middle Europe Thomson & Pflug (1953). The species was determined from the Eocene, Oligocene and Miocene basins of Turkey (e.g. Nakoman, 1966b; Batı, 1996; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akkiraz & Akgün, 2005; Akgün & Sözbilir, 2001; Akkiraz et al., 2006; Sancay et al., 2006).
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

Genus: *Reevesiapollis* KRUTZSCH 1970c

Type Species: *Reevesiapollis triangulus* (MAMCZAR 1960) KRUTZSCH 1970c

(126) *Reevesiapollis triangulus* (MAMCZAR 1960) KRUTZSCH 1970c

pl. 12, fig. 29

1960 *Pollenites triangulus* n. sp. –MAMCZAR, p. 220, pl. 14, fig. 202.

1970c *Reevesiapollis triangulus* (MAMCZAR) n. comb. –KRUTZSCH, p. 374, pl. V, figs. 19–34, pl. VI, figs. 1–11, 19–41, pl. VII, figs. 1–44, pl. VIII, figs. 1–21.

Dimensions: 18–20 µm, (n = 2)

Description: Four porate pollen grains spheroidal or polygonal in outline. Exine having reticulate sculpture. Pores large, round and obvious.

Botanical affinity: Family Sterculiaceae; Genus *Reevesia*

Palaeofloristical element: Palaeotropical (subtropical)

Previously recorded occurrences: Nagy (1985) recorded the species from the Egerian to Pliocene in Hungary. According to Krutzsch (1970c), the range of species is from Palaeocene to Pliocene. It was recorded from Middle–?Upper Eocene sediments of Çorum–Amasya area by Akgün (2002).

Occurrences: Lower–“Middle” Oligocene İncesu Formation; Lower Miocene Kavak Formation**.**

Genus: *Pentapollenites* KRUTZSCH 1957

Type Species: *Pentapollenites pentangulus* (PFLUG *in* THOMSON & PFLUG 1953) KRUTZSCH, 1958a

(127) *Pentapollenites pentangulus* (PFLUG *in* THOMSON & PFLUG 1953) KRUTZSCH 1957

pl. 12, figs. 30, 31

1953 *Periporopollenites pentangulus* n. sp. (PFLUG) –THOMSON & PFLUG, p. 112, pl. 15, figs. 62–64.

1957 *Pentapollenites pentangulus* (PFLUG) n. comb. –KRUTZSCH, p. 520, pl. X, figs. 5–7.

Dimensions: 18–20µm, ã =18µm, (n = 4)
Description: Form of the *Pentapollenites* with more or less punctate structure. Outline convex triangular to concave rhombically.
Botanical affinity: Family Elaeagnaceae? Simarubaceae?
Palaeofloristical element: Unknown
Previously recorded occurrences: From Middle Eocene to Lower Oligocene of the Paris Basin (Chateauneuf, 1980). Nagy (1985) mentions occurrences in the Egerian, Ottnangian and lower Badenian of Hungary. According to Nickel (1996a), the species occurred from Palaeocene to "Middle" Oligocene of the Upper Rhine Graben. The species was determined from Lower–"Middle" Oligocene and Middle–?Upper Eocene sediments by Akkiraz & Akgün (2005) and Akkiraz et al. (2006), respectively.
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Aksu Formation.

Genus: *Cupaniëidites* COOKSON & PIKE 1954

Type species: *Cupaniëidites major* COOKSON & PIKE 1954

(128) *Cupaniëïdites eucalyptoides* KRUTZSCH 1962b
pl. 13, figs. 1, 2

1962b *Cupaneïdites eucalyptoides* n. fsp. –KRUTZSCH, p.271, pl. 3, figs. 11–17.

Dimensions: 18–24µm, (n = 3)
Description: Pollen grains triangular in outline with strongly concave sides. Syncolporate pollen with "Y" mark strongly clear. Exine micropunctate or psilate sculpture.

Botanical affinity: Myrtaceae?, Sapindaceae?

Palaeofloristical element: Unknown

Previously recorded occurrences: Cookson & Pike (1954) reported the species in Eocene sediments of Australia. Krutzsch (1962b) mentions occurrences of the species in "Middle" Oligocene of Germany. According to Konzalová (1976b, 1981), the species occurs during Tertiary. It is rarely observed in Upper Eocene sediments of the Paris Basin (Chateauneuf, 1980).

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations.

Genus: *Myrtaceidites* COOKSON & PIKE 1954

Type Species: *Myrtaceidites mesonesus* COOKSON & PIKE 1954

(129) *Myrtaceidites mesonesus* COOKSON & PIKE 1954
pl. 13, figs. 3–7

1954 *Myrtaceidites mesonesus* n. sp. –COOKSON & PIKE, p. 205/6, pl. 1, figs. 32–36.

Dimensions: 15–20µm, ã = 18µm, (n = 15)

Description: Pollen grains small to medium. Amb triangular to subtriangular, straight or slightly convex or concave sides. Parasyncolporate. Straight or curved, narrow or wide colpi with arci, enclosing developed polar area, called polar island, clearly or poorly definite. Exine psilate.

Botanical affinity: Family Myrtaceae

Palaeofloristical element: Unknown

Previously recorded occurrences: Cookson & Pike (1954) indicate the species from Eocene to Pliocene of Australia. Akkiraz et al. (2006) determined the species from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

Genus: *Syncolporites* VAN DER HAMMEN 1954 emend. ACEVEDO & ANZETOGUI 2001

Type species: *Syncolporites lisamae* VAN DER HAMMEN 1954

(130) *Syncolporites* sp. 1
pl. 13, figs. 8, 9

Dimensions: 17–20µm, (n = 2)
Description: Pollen grain syncolporate, angulaperturate, amb triangular more or less convex sides. Long, straight or curved, narrow or wide colpi, joined at the poles. Polar island absent. Pores without fastigium.
Remarks: Even the microsrobic features point directly to the *Syncolporites*, but identification down to species level is yet not possible because of bad preservation.
Botanical affinity: Family probably Myrtaceae?
Palaeofloristical element: Unknown
Occurrences: Lower–“Middle”Oligocene Tokça Formation; Lower Miocene Aksu Formation.

Genus: *Boehlensipollis* KRUTZSCH 1962b

Type Species: *Boehlensipollis hohli* KRUTZSCH 1962b

(131) *Boehlensipollis hohli* KRUTZSCH 1962b
pl. 13, figs. 10a, b

1962b *Boehlensipollis hohli* n. sp. –KRUTZSCH, p. 272, pl. 3, figs. 18–20.

Dimensions: 41µm, (n = 1)

Description: Pollen grain heterosyncolporate, angulaperturate, amb triangular strongly concave sides, corner narrowly rounded. Pollen having a sinuous exocolpi. Exine punctate or chagrenate sculpture.

Botanical affinity: Family Eleagnaceae

Palaeofloristical element: Palaeotropical

Previously recorded occurrences: Hochuli (1978) recorded the species from Lower and "Middle" Oligocene of Central and Western Paratethys. According to Wilkinson et al. (1980), the species was restricted to Oligocene sediments of the Lough Neagh Clays. Frederiksen (1980) reported the species from Middle Eocene to Lower Oligocene of South Carolina (America). Gorin (1975), Chateauneuf (1980) and Olliver–Pierre (1988) studied palynology in France. They mention occurrences of the species from Lower to "Middle" Oligocene. According to Schuler (1988), the species is characteristic for "Middle" Oligocene of the Rhine Graben. Roche (1988) mentions that the species is characteristic form for the "Middle" Oligocene of Belgium. From Lower Oligocene to "Middle" Oligocene of the Upper Rhine Graben (Nickel, 1996a). Schalke (1988) recorded the species in "Middle" Oligocene of Netherlands. It was also described from Lower Oligocene sediments of Çorum–Amasya area by Akgün (2002). Akkiraz & Akgün (2005) determined the species from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin.

Occurrences: Lower–"Middle" Oligocene İncesu Formation

Genus: *Slowakipollis* KRUTZSCH 1962b

Type Species: *Slowakipollis cechovici* (PACLTOVA 1958) KRUTZSCH 1962b

(132) *Slowakipollis hippophäeoides* KRUTZSCH 1962b

pl. 13, figs. 11a, b

1962b *Slowakipollis hipophäeoides* n. sp.–KRUTZSCH, p. 273, pl.4, figs. 1–15.

1972 *Slowakipollis hipophäeoides* KRUTZSCH –PLANDEROVA, p. 249, pl. 31, figs. 10–13.

1978 *Slowakipollis hipophäeoides* KRUTZSCH –HOCHULI, p. 74, pl. 10, fig. 22a,b.

1980 *Slowakipollis hipophäeoides* KRUTZSCH –CHATEAUNEUF, p. 125, pl. 16, fig. 11.

1984 *Slowakipollis hipophäeoides* KRUTZSCH –KIRCHNER, p. 115, pl. 6, fig 7a,b.

Dimensions: 30µm, (n = 1)

Description: Pollen grain syncolporate, angulaperturate, amb triangular more or less concave sides, corner narrowly rounded. Pores having drop–shaped annulus. Exine psilate.

Botanical affinity: Family Eleagnaceae; Genus *Hippophäe*

Palaeofloristical element: Unknown

Previously recorded occurrences: According to Hochuli (1978), the species occurred from “Middle” Oligocene to Lower Miocene of the Central and Western Paratethys. Kirchner (1984) recorded the species from Upper Oligocene to Pliocene of Southern Bavarian. Roche (1988) recorded the species in “Middle” Oligocene of Belgium. It is observed in “Middle” Oligocene sediments of Netherlands (Schalke, 1988). According to Schuler (1988), it occurred Lower and “Middle” Oligocene of the Rhine Graben. Hottenrott (2002) indicates its presence from the Lower Oligocene sediments of the Eisenberg Basin. Akkiraz & Akgün (2005) indicate the presence of species from Lower–“Middle” Oligocene sediments of the Çardak–Tokça Basin. Sancay et al. (2006) recorded the species from Lower Oligocene sediments of the Kars–Erzurum–Muş sub–basins.

Occurrences: Lower–“Middle” Oligocene İncesu Formation.

Longaxones PFLUG *in* THOMSON & PFLUG

Genus: *Tricolpopollenites* THOMSON & PFLUG 1953

Type Species: *Tricolpopollenites parmularius* (POTONIÉ 1934) THOMSON & PFLUG 1953

(133) *Tricolpopollenites henrici* (POTONIÉ 1931a) THOMSON & PFLUG 1953
pl. 13, figs. 12–15

1931a *Pollenites henrici* n. sp. –POTONIÉ, p.332, pl. 2, fig. 19.
1952 *Quercoidites henrici* POTONIÉ –MEYER, p. 41, pl. Pl. 3, fig. 19.
1953 *Tricolpopollenites microhenrici* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 95, pl. 11, figs. 62–110.

Dimensions: Polar axis: 30–50µm, Equatorial axis: 18–25, ã = 38x 18µm, (n = 9)
Description: Large tricolpate pollen grains. Outline elliptical or prolate to subprolate in equatorial view. Three colpi run from pole to pole.
Botanical affinity: Family Fagaceae; Genus *Quercus*
Palaeofloristical element: Subtropical–warm temperate
Previously recorded occurrences: Abundant in Paleogene, mainly in Oligocene sediments of Europe (Thomson & Pflug, 1953). The species occurs all Tertiary period of Turkey (e.g. Akyol, 1980; Akgün & Akyol, 1999; Akgün & Sözbilir, 2001; Akgün et al., 2002; Akkiraz & Akgün, 2005; Sancay et al., 2006).
Occurrences: Middle–?Upper EoceneVarsakyayla Formation; Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak Formation.

(134) *Tricolpopollenites densus* PFLUG *in* THOMSON & PFLUG 1953
pl. 13, figs. 16–21

1953 *Tricolpopollenites densus* n. sp. (PFLUG) –THOMSON & PFLUG, p. 96, pl. 11, figs. 55–58.

Dimensions: Polar axis: 20–26µm, Equatorial axis: 15–20, ã = 20x 17µm, (n = 68)
Description: Tricolpate polen grains. Outline elliptical or prolate spheroidal in equatorial view. Three colpi run from pole to pole. Exine psilate or finely granulate.
Botanical affinity: Family Fagaceae; Genus *Quercus*
Palaeofloristical element: Arctotertiary (warm temperate)
Previously recorded occurrences: Chateauneuf (1980) recorded the species from upper most Eocene to Lower–"Middle" Oligocene of the Paris Basin. The species occurs all Tertiary period of Turkey (e.g. Nakoman, 1966b; Akyol, 1971; Akgün et al., 2000; Akgün & Sözbilir, 2001).
Occurrences: Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Kavak and Aksu formations.

(135) *Tricolpopollenites liblarensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953 ssp. *fallax* (POTONIÉ 1934) THOMSON & PFLUG 1953
pl. 13, figs. 22–27

1934 *Pollenites fallax* n. sp. –POTONIÉ, p. 70, pl. 3, fig. 10.
1953 *Tricolporopollenites liblarensis* (THOMSON) n. comb. (b) subsp. *fallax* (THOMSON) n. comb. –THOMSON & PFLUG, p. 97, pl. 11, figs. 133–151.

Dimensions: Polar axis: 10–18µm, Equatorial axis: 5–13µm, ã = 18x10µm, (n = 179)
Description: Small tricolpate polen grains. Amb perprolate in equatorial view. Three colpi run from pole to pole. Exine psilate.
Botanical affinity: Family probably Fagaceae?
Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: Thomson & Pflug (1953) report occurrences of the species from Eocene to Miocene of Middle Europe. Nakoman (1966b) indicates that the species occurred in Lower Tertiary of the Thrace Basin. The species occurs all Tertiary period of Turkey (e.g. Akyol, 1971; Akyol, 1980; Akgün & Akyol, 1999; Akgün & Sözbilir, 2001).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(136) *Tricolpopollenites liblarensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953 ssp. *liblarensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953

pl. 13, figs. 28–34

1950 *Cupuliferoidae-poll. liblarensis* n. sp. –THOMSON *in* POTONIÉ, THOMSON & THIERGART, p. 55, pl. B, figs. 26, 27.

1953 *Tricolporopollenites liblarensis* (THOMSON) n. comb. (a) subsp. *liblarensis* (THOMSON) n. comb. –THOMSON & PFLUG, p. 96, pl. 11, figs. 111–132.

Dimensions: Polar axis: 18–25µm, Equatorial axis: 10–14µm, ã = 20x14µm, (n = 90)

Descriptions: Tricolpate pollen grains. Amb long–elliptical or perprolate in equatorial view. Three colpi run from pole to pole. Exine psilate.

Botanical affinity: Family probably Fagaceae?

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: See under (135) *Tricolpopollenites liblarensis* ssp. *fallax*.

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Kavak and Aksu formations.

(137) *Tricolpopollenites microhenrici* (POTONIÉ 1931d) THOMSON & PFLUG 1953

pl. 13, figs. 35–42

1931d *Pollenites microhenrici* n. sp. –POTONIÉ, p. 26, pl. 1, V 19c.

1953 *Tricolpopollenites microhenrici* (POTONIÉ) n. comb.–THOMSON & PFLUG, p. 96, pl. 11, figs. 62–110.

Dimensions: Polar axis: 20–29µm, Equatorial axis: 18–20µm, ã = 24x18µm, (n = 194)

Description: Tricolpate pollen grains. Amb elliptical or prolate in equatorial view. Three colpi strong, running almost paralel toward to apices and converging to the poles. Exine psilate or fine granulate.

Botanical affinity: Family Fagaceae; Genus *Quercus*

Palaeofloristical element: Palaeotropical–Arctotertiary (warm temperate)

Previously recorded occurrences: Thomson & Pflug (1953) mention occurrences of the species from Eocene to Pliocene of Middle Europe. The species occurs all Tertiary period of Turkey (e.g. Akyol, 1971; Akyol, 1980; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün et al., 2000; Akkiraz et al., 2006).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(138) *Tricolpopollenites asper* THOMSON & PFLUG 1953

pl. 13, fig. 43

1953 *Tricolpopollenites asper* n. sp. PFLUG &THOMSON –THOMSON & PFLUG, p. 96, pl. 11, figs. 43–49.

Dimensions: Polar axis: 25–35 µm, Equatorial axis: 15–20µm, ã = 25x20µm, (n = 4)

Description: Tricolpate pollen grains. Amb oval in equatorial view. Three colpi running paralel toward to apices. Exine chagrenate.

Botanical affinity: Family Fagaceae; Genus *Quercus*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: According to Thomson & Pflug (1953), the species occurs during Palaeocene and Pliocene of Germany. The species was recorded from Tertiary sediments of Turkey (Akyol, 1980; Akgün & Akyol, 1999; Akgün, 2002; Akgün et al., 2002; Akkiraz et al., 2006).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations.

(139) *Tricolpopollenites parmularius* (POTONIÉ 1934) THOMSON & PGLUG 1953
pl. 13, fig. 44

1934 *Pollenites parmularius* n. sp. –POTONIÉ, p. 52, pl. 2, Fig. 7(?), pl. 6, Fig. 11.
1951 *Cornaceoipollenites parmularius* n. sp. –POTONIÉ, pl. 21, fig.145.
1953 *Tricolpopollenites parmularius* (POTONIÉ) n. comb. –THOMSON & PGLUG, p.97, pl. 11, figs. 152–162.

Dimensions: Polar axis: 24–28µm, Equatorial axis: 16–20µm, ã = 24x18µm, (n = 4)

Description: Tricolpate pollen grains. Amb prolate in equatorial view. Three colpi strong, running almost parallel toward to apices. Exine psilate.

Botanical affinity: Family Fagaceae? or Eucommiaceae?;Genus probably *Eucomminia?*

Palaeofloristical element: Unknown

Previously recorded occurrences: Abundant in Paleogene, mainly in Oligocene (Thomson & Pflug, 1953). The species occurs all Tertiary period of Turkey (Nakoman, 1966b; Akgün & Akyol, 1999; Akgün, 2002; Akkiraz et al., 2006).

Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Aksu Formation.

(140) *Tricolpopollenites retiformis* THOMSON & PFLUG 1953
pl. 13, figs. 45–47, pl. 14, figs. 1–4

1953 *Tricolpopollenites retiformis* n. sp. –THOMSON & PFLUG, p. 97, pl. 11, figs. 59–61.

Dimensions: Polar axis: 14–22µm, Equatorial axis: 7–14µm, ã = 22x10µm, (n = 197)
Description: Small tricolpate pollen grains. Amb elliptical or prolate in equatorial view. Three colpi run from pole to pole. Lumina of reticulum about 1µm, muri baculate about 1µm high.
Botanical affinity: Family Saliaceae; Genus *Salix/Platanus*
Palaeofloristical element: Arctotertiary (warm temperate)
Previously recorded occurrences: The species occurs from Upper Palaeocene to recent of Middle Europe (Thomson & Pflug, 1953). The species was recorded from Tertiary sediments of Turkey (e.g. Nakoman, 1966b; Akyol, 1980; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün & Sözbilir, 2001; Akgün, 2002; Akgün et al., 2002).
Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

Genus: *Retitricolpites* (VAN DER HAMMEN 1956) PIERCE 1961

Type Species: *Retitricolpites ornatus* (VAN DER HAMMEN 1956) PIERCE 1961

(141) *Retitricolpites* sp. 1
pl. 14, figs. 5–7

Dimensions: Polar axis: 39–45µm, Equatorial axis: 30–34µm, ã = 38x25µm, (n = 13)

Description: Large tricolpate pollen grains. Amb prolate or prolate spheroidal in equatorial view. Three colpi run from pole to pole. Lumina of reticulum about 1–1.5µm, muri baculate about 1µm high.

Remarks: Even the microscopic features point directly to the *Retitricolpites*, but identification down to species level is yet not possible because of bad preservation.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations.

Genus: *Aceripollenites* NAGY 1969

Type Species: *Aceripollenites rotundus* NAGY 1969

(142) *Aceripollenites striatus* (PFLUG 1959) THIELE–PFEIFFER 1980
pl. 14, fig. 8

1959 *Tricolpo-pollenites striatus* n. sp. –PFLUG, p. 155, pl. 16, figs. 13–14.

1980 *Aceripollenites striatus* (PFLUG) n. comb. –THIELE–PFEIFFER, p. 115, pl. 11, figs. 22–25.

Dimensions: Polar axis: 28µm, Equatorial axis: 22µm, (n = 1)

Description: Tricolpate pollen grain. Amb prolate or prolate spheroidal in equatorial view. Three colpi strong, running from pole to pole. Exine having striate ornamentation.

Botanical affinity: Family Aceraceae; Genus *Acer*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: All Tertiary (Thiele–Pfeiffer, 1980)

Occurrences: Lower Miocene Kavak Formation.

Genus: *Polycolpites* COUPER 1953

Type Species: *Polycolpites clavatus* COUPER 1953

(143) *Polycolpites speciosus* DUTTA & SAH 1970
pl. 14, fig. 9

1970 *Polycolpites speciosus* n. sp. –DUTTA & SAH, p. 36, pl. 6, figs. 24–25.

Dimensions: Polar axis: 23–26µm, Equatorial axis: 18–20µm, ã = 24–18µm, (n = 2)
Description: 6–zonicolpate pollen grain. Amb prolate in equatorial view. Colpi run from pole to pole. Exine having finely granulate.
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Previously recorded occurrences: Dutta & Sah (1970) mention occurrences of the species in Lower Eocene substratum of Shillong Plateau (India). The species was determined from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Basin by Akkiraz & Akgün (2005).
Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça Formation.

Genus: *Tricolporopollenites* THOMSON & PFLUG 1953

Type Species: *Tricolporopollenites dolium* (POTONIÉ 1931d) THOMSON & PFLUG 1953

(144) *Tricolporopollenites euphorii* (POTONIÉ 1931a) THOMSON & PFLUG 1953
pl. 14, figs. 10–12

1931a *Pollenites euphorii* n. sp. –POTONIÉ, p. 328, pl. 1, figs. 12, 28.

1953 *Tricolporopollenites euphorii* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 102, pl. 12, figs. 133–140.

Dimensions: Polar axis: 25–28µm, Equatorial axis: 18–20µm, ã = 25x18µm, (n = 3)
Description: Tricolporate pollen grains. Amb rounded–oval or prolate in equatorial view. Three colpi running almost towards the apices. Equatorial pores roundish. Exine psilate.
Botanical affinity: Family Araliaceae
Palaeofloristical element: Palaeotropical (subtropical)
Previously recorded occurrences: Thomson & Pflug (1953) mention occurrences of the species from Lower Eocene to Pliocene of the Middle Europe. The species also occurs all Tertiary period of Turkey (Akgün, 2002; Karayiğit et al., 1999).
Occurrences: Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Kavak Formation.

(145) *Tricolporopollenites cingulum* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *fusus* (POTONIÉ 1931a) THOMSON & PFLUG 1953
pl. 14, figs. 13–21

1931d *Pollenites cingulum* n. sp. –POTONIÉ, p. 26, pl. I, V 60d, V 61c, V 60a and V 48b.
1931a *Pollenites fusus* n. sp. –POTONIÉ, p. 4 and 8, pl. 1, fig. 13.
1953 *Tricolporopollenites cingulum* (POTONIÉ) n. comb. (a) subsp. *fusus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 100, pl. 12, figs. 15–27.

Dimensions: Polar axis: 22–28µm, Equatorial axis: 9–17µm, ã = 22x14µm, (n = 130)
Description: Tricolporate pollen grains. Amb long elliptical or perprolate in equatorial view. Three colpi running towards the apices. Equatorial pores roundish or lalongate.
Botanical affinity: Genus *Trigonabalanus*
Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: Thomson & Pflug (1953) mention abundantly occurrences during Late Paleogene. The species was recorded from Tertiary sediments of Turkey (e.g. Nakoman, 1966a, 1966b; Akyol, 1971; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün et al., 2000; Akgün, 2002; Akgün et al., 2002; Akkiraz & Akgün, 2005; Akkiraz et al., 2006).
Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(146) *Tricolporopollenites cingulum* (POTONIÉ 1931d) THOMSON & PFLUG 1953
ssp. *pusillus* (POTONIÉ 1934) THOMSON & PFLUG 1953
pl. 14, figs. 22–29

1931d *Pollenites cingulum* n. sp. –POTONIÉ, p. 26, pls. I, V 46c, V 46b and V 46a.
1934 *Pollenites quisqualis pusillus* –POTONIÉ, p. 71, p. 3, fig. 21.
1953 *Tricolporopollenites cingulum* (POTONIÉ) n. comb. (b) subsp. *pusillus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 100, pl. 12, figs. 28–41.

Dimensions: Polar axis: 18–22µm, Equatorial axis: 10–16µm, ã = 21x11µm, (n = 361)
Description: Tricolporate pollen grains. Amb long elliptical or perprolate in equatorial view. Three colpi running towards the apices. Equatorial pores roundish or lalongate.
Botanical affinity: Family Fagaceae; Genus *Castanea*, *Castanopsis*, *Lithocarpus*, *Pasania*.
Palaeofloristical element: Palaeotropical **(**Subtropical)–Arctotertiary (warm temperate)
Previously recorded occurrences: See under (145) *Tricolporopollenites cingulum* ssp. *fusus*.
Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(147) *Tricolporopollenites cingulum* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *oviformis* (POTONIÉ 1931a) THOMSON & PFLUG 1953

pl. 14, figs. 30–37

1931d *Pollenites cingulum* n .sp. –POTONIÉ, p. 26, pl. 1, figs. V 46a–V 46c.

1931a *Pollenites oviformis* n. sp. –POTONIÉ, p. 328 and 332, pl. 1, fig. 20.

1953 *Tricolporopollenites cingulum* (POTONIÉ.) n. comb. (c) subsp. *oviformis* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 100, pl. 12, figs. 42–49.

Dimensions: Polar axis: 7–18µm, Equatorial axis: 5–14µm, ã = 7x5µm, (n = 568)

Description: Small tricolporate pollen grains. Amb prolate or prolate spheroidal in equatorial view. Three strong colpi run from pole to pole. Equatorial pores roundish. Exine psilate.

Botanical affinity: Family Fagaceae; Genus *Castanea*, *Castanopsis*, *Lithocarpus, Pasania*.

Palaeofloristical element: Palaeotropical **(**Subtropical)–Arctotertiary (warm temperate)

Previously recorded occurrences: See under (145) *Tricolporopollenites cingulum* ssp. *fusus*.

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(148) *Tricolporopollenites megaexactus* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *brühlensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953

pl. 14, figs. 38–46

1931d *Pollenites megaexactus* n. sp. –POTONIÉ, p. 26, pl. 1, V 42b.

1950 *Pollenites cingulum brühlensis* n. sp. –THOMSON *in* POTONIÉ, THOMSON & THIERGART, p. 56, pl. B, figs. 32 and 33.

1953 *Tricolporopollenites megaexactus* (POTONIÉ) n. comb. (a) subsp. *brühlensis* (THOMSON) n. comb. –THOMSON & PFLUG, p. 100 and 101, pl. 12, figs. 50–57 and figs. 65–80.

Dimensions: Polar axis: 16–23µm, Equatorial axis: 10–18µm, ã = 22x16µm, (n = 120)
Description: Pollen grains tricolporate, widely subprolate in equatorial view. Three colpi radially symmetrical and converging at the apices. Pores oval. Exine psilate.
Botanical affinity: Family Cyrillaceae
Palaeofloristical element: Palaeotropical (subtropical)
Previously recorded occurrences: Thomson & Pflug (1953) recorded the species from Lower Eocene and Pliocene sediments of Middle Europe. The species occurs all Tertiary period of Turkey (e.g. Nakoman, 1966b; Akyol, 1971; Akyol, 1980; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün et al., 2000; Akgün, 2002; Akgün et al., 2002; Akkiraz & Akgün, 2005; Akkiraz et al., 2006).
Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Kavak and Aksu formations.

(149) *Tricolporopollenites megaexactus* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *exactus* (POTONIÉ 1931d) THOMSON & PFLUG 1953
pl. 14, figs. 47–53

1931d *Pollenites megaexactus* n. sp. –POTONIÉ, p. 26, pl. 1, fig. V 42b.
1931d *Pollenites exactus* n.sp. –POTONIÉ, p. 26, pl. 1, fig. V 49b.
1953 *Tricolporopollenites megaexactus* (R. POT.) n. comb. (b) subsp. *exactus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 100 and 101, pl. 12, figs. 87–92.

Dimensions: Polar axis: 8–16µm, Equatorial axis: 7–17µm, ã = 16x14µm, (n = 70)

Description: Small tricolporate pollen grains. Amb subprolate. Three distinct colpi radially symmetrical. Pores roundish. Exine psilate.

Botanical affinity: Family Cyrillaceae

Palaeofloristical element: Palaeotropical **(**Subtropical)–Arctotertiary (warm temperate)

Previously recorded occurrences: Ashraf & Mosbrugger (1995) mention occurrences of the species from Middle Eocene to Pliocene of the Lower Rhine Embayment (NW Germany.

Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Kavak and Aksu formations.

(150) *Tricolporopollenites pseudocingulum* (POTONIÉ 1931a) THOMSON & PFLUG 1953

pl. 15, figs. 1–4

1931a *Pollenites pseudocingulum* n. sp. –POTONIÉ, p. 332, 328, pl. 1, figs. 2–4, 19, 24, 26, 27.

1953 *Tricolporopollenites pseudocingulum* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 99, pl. 12, figs. 96–111.

Dimensions: Polar axis: 25–30µm, Equatorial axis: 20–28µm, ã = 28x23µm, (n = 14)

Description: Tricolporate pollen grains. Amb widely subprolate in equatorial view. Three colpi strong, radially symmetrical and converging at the apices. Pores oval, elongate meridionally. Exine psilate and granulate.

Botanical affinity: Family Anacardiaceae; Genus *Rhus*

Palaeofloristical element: Palaeotropical (subtropical)

Previously recorded occurrences: Thomson & Pflug (1953) suggested its ranges from Palaeocene to Pliocene of Middle Europe. The species occurs all Tertiary period of Turkey (Nakoman, 1966b; Batı, 1996; Akgün & Akyol, 1999; Akgün et al., 2002; Akkiraz & Akgün, 2005; Akkiraz et al., 2006).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(151) *Tricolporopollenites marcodurensis* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

pl. 15, figs. 5, 6

1953 *Tricolporopollenites marcodurensis* n. sp. (PFLUG & THOMSON) –THOMSON & PFLUG, p. 103, pl. 13, figs. 5–9.

Dimensions: Polar axis: 38–43µm, Equatorial axis: 30–35µm, ã = 43x32µm, (n = 8)
Description: Large tricolporate pollen grains. Amb subprolate in equatorial view. Three large and strong colpi run from pole to pole. Exine intrabaculate.
Botanical affinity: Family Vitaceae; Genus *Ciccus*
Palaeofloristical element: Paleotropical
Previously recorded occurrences: Nickel (1996a) indicates the species from Lower Eocene to Upper Miocene of the Upper Rhine Graben. In Turkey, the species occurs all Tertiary (e.g. Akgün, 2002; Akkiraz & Akgün, 2005)
Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Aksu Formation.

(152) *Tricolporopollenites genuinus* (POTONIÉ 1934) THOMSON & PFLUG 1953

pl. 15, figs. 7, 8

1934 *Pollenites genuinus* n. sp. –POTONIÉ, p. 95, pl. 5, figs. 22, 30, 31, 32, 34 and pl. 6. fig. 34.

1953 *Tricolporopollenites genuinus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p.105, pl. 13, figs. 69–85.

Dimensions: Polar axis: 35–40m, Equatorial axis: 22–25µm, ã = 32x23µm, (n = 4)

Description: Large tricolporate pollen grains. Amb subprolate in equatorial view. Three large and strong colpi run from pole to pole. Exine rugulate or reticulate sculpture. Muri about 2µm in diameter.

Botanical affinity: Family Cupuliferae

Palaeofloristical element: Unknown

Previously recorded occurrence: Nakoman (1966b) mentions that the species occurs in Lower Tertiary of the Thrace Basin. Gruas–Cavagnetto (1968) mentions that the species occurred from the Danian to Pliocene of the Paris Basin.

Occurrences: Lower–"Middle" Oligocene Tokça Formation.

(153) *Tricolporopollenites microreticulatus* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

pl. 15, figs. 9–13

1953 *Tricolporopollenites microreticulatus* n. sp. (PFLUG & THOMSON) – THOMSON & PFLUG, p. 106, pl. 14, figs. 27–42.

Dimensions: Polar axis: 18–30µm, Equatorial axis: 17–22µm, ã = 22x18µm, (n = 133)

Description: Small tricolporate pollen grains. Amb prolate or perprolate**.** Three colpi conspicuous, running almost parallel towards the apices and converging to the poles. Exine densely reticulate. Muri baculate. Lumina of reticulum less than 1µm.

Botanical affinity: Family Oleaceae; Genus *Olea*, *Fraxinus*, *Ligustrum*

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: Thomson & Pflug (1953) record the species from Palaeocene to Pliocene of Middle–East Europe. The species occurs all Tertiary sediments of Turkey (e.g. Nakoman, 1966b; Akyol, 1980; Akgün & Akyol, 1999 Karayiğit et al., 1999; Akgün et al., 2000; Akgün & Sözbilir, 2001; Akgün et al., 2002; Akkiraz et al., 2006).

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(154) *Tricolporopollenites oleoides* KRUTZSCH & VANHOORNE 1977
pl. 15, fig. 14

1977 *Tricolporopollenites oleoides* n. sp. –KRUTZSCH & VANHOORNE, p. 79, pl. 33, figs. 21–25.

Dimensions: Polar axis: 26µm, Equatorial axis: 23µm, (n = 1)
Description: Tricolporate pollen grains. Amb subprolate in equatorial view. Three large colpi run from pole to pole. Exine densely coarse reticulate. Muri baculate. Strong reticulum about 2–2.5µm in diameter.
Botanical affinity: Family Oleaceae
Palaeofloristical element: Unknown
Previously recorded occurrences: It was reported from Middle–Upper Eocene of the Paris Basin by Chateauneuf (1980). It was also recorded from Middle–?Upper Eocene Yoncalı Formation in central Anatolia (Akgün 2002).
Occurrences: Middle–?Upper Eocene Varsakyayla Formation.

(155) *Tricolporopollenites edmundii* (POTONIÉ 1931d) THOMSON & PFLUG 1953
pl. 15, figs. 15, 16

1931d *Pollenites edmundi* n. sp. –POTONIÉ, p. 26, pl. 1, V53e, V52a, V53a.
1953 *Tricolporopollenites edmundii* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 101, pl. 12, figs. 125–132.

Dimensions: Polar axis: 38–39µm, Equatorial axis: 20–30µm, (n = 3)

Description: Tricolporate pollen grains. Amb prolate or subprolate in equatorial view. Three thick colpi having large and vigorous fastigium. Exine intrabaculate sculpture.

Botanical affinity: Family Mastixiaceae

Palaeofloristical element: Palaeotropical (subtropical)

Previously recorded occurrences: Nagy (1985) reported occurrences in the Eggenburgian and lower Pannonian of Hungary. Upper Oligocene to Middle Miocene (Thomson & Pflug, 1953; Krutzsch, 1957). According to Nakoman (1966b), the species occurs in Tertiary sediments of Turkey. It was recorded from Middle Miocene sediments of Akhisar (Çıtak) lignites by Akgün & Akyol (1987).

Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(156) *Tricolporopollenites pacatus* PFLUG *in* THOMSON & PFLUG 1953
pl. 15, figs. 17–19

1953 *Tricolporopollenites pacatus* n. sp. (PFLUG) –THOMSON & PFLUG, p. 99, pl. 12, figs. 118–121.

Dimensions: Polar axis: 25–32µm, Equatorial axis: 15–19µm, ã = 26x17µm, (n = 5)

Description: Tricolporate pollen grains. Amb subprolate in equatorial view. Three thick colpi run from pole to pole. Exine psilate.

Botanical affinity: Family Simarubaceae

Palaeofloristical element: Unknown

Previously recorded occurrences: According to Kedves (1963), occurrences of the species from Lower Eocene to Upper Eocene of Hungary. The species occurs in Eocene, Oligocene and Miocene sediments of Turkey (Nakoman, 1966b; Akgün & Akyol, 1999; Karayiğit et al., 1999; Akgün, 2002; Akgün et al., 2002).

Occurrences: Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

(157) *Tricolporopollenites villensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953
pl. 16, figs. 20–24

1950 *Tricolporopollenites cingulum* ssp. *villensis* n. subsp. –POTONIÉ, THOMSON & THIERGART, p. 55, pl. B, figs. 28–29.
1953 *Tricolporopollenites villensis* (POTONIÉ, THOMSON & THIERGART) n. comb. –THOMSON & PFLUG, p. 99, pl. 12, figs. 5–14.

Dimensions: Polar axis: 25–28µm, Equatorial axis:16–20µm, ã = 25x18µm, (n = 38)
Description: Tricolporate pollen grains. Amb prolate in equatorial view. Three colpi strong, running almost toward to apices. Exine psilate.
Botanical affinity: Family Cupuliferae
Palaeofloristical element: Unknown
Previously recorded occurrences: Thomson & Pflug (1953) reported the species in Middle Eocene and Miocene sediments of Middle Europe. The species occurs in Tertiary sediments of Turkey (Akyol, 1980; Karayiğit et al., 1999; Akgün, 2002).
Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower Miocene Kavak and Aksu formations.

(158) *Tricolporopollenites solé de portai* KEDVES 1965
pl. 16, fig. 25

1965 *Tricolpopollenites solé de portai* n. sp. –KEDVES, p. 34 pl. VI, figs. 4–5.

Dimensions: Polar axis: 23µm, Equatorial axis: 16µm, (n = 1)
Description: Tricolporate pollen grains. Amb prolate or subprolate in equatorial view. Three colpi running to from pole to pole. Exine having typical striate sculpture.
Botanical affinity: Family Fabaceae?, Rosaceae?, Anacardiaceae?
Palaeofloristical element: Unknown

Previously recorded occurrences: It was reorded from Oligocene and Early Miocene of western Paratethys (Hochuli, 1978) The species was recorded from Middle–?Upper Eocene Yoncalı Formation (central Anatolia) by Akgün (2002).
Occurrences: Middle–?Upper Eocene Varsakyayla Formation.

(159) *Tricolporopollenites baculoferus* PFLUG *in* THOMSON & PFLUG 1953
pl. 15, fig. 26

1953 *Tricolporopollenites baculoferus* n. sp. (PFLUG) –THOMSON & PFLUG, p. 105, pl. 14, figs. 1–8.

Dimensions: Polar axis: 35µm, Equatorial axis: 26µm, (n = 1)
Description: Large tricolporate pollen grains. Amb prolate or prolate spheroidal in equatorial view. Three thick colpi conspicuous run from pole to pole. Exine baculate about 2–3µm in diameter.
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Previously recorded occurrences: From Lower Eocene to Upper Eocene of Hungary (Kedves, 1963). Akgün & Akyol (1987) reported the species from Middle Miocene sediments of Akhisar (Çıtak) lignites.
Occurrences: Lower Miocene Aksu Formation.

(160) *Tricolporopollenites satzveyensis* PFLUG *in* THOMSON & PFLUG 1953
pl. 15, fig. 27

1953 *Tricolporopollenites satzveyensis* n. sp. (PFLUG) –THOMSON & PFLUG, p. 103, pl. 13, figs. 10–13.

Dimensions: Polar axis: 36–38µm, Equatorial axis: 25–28µm, (n = 2)

Description: Large tricolporate pollen grains. Amb subprolate in equatorial view. Three thick strong colpi, running towards the apices. Structure intrabaculate. Pores large deep elongate meridionally.

Botanical affinity: Family probably Araliaceae?

Palaeofloristical element: Unknown

Previously recorded occurrences: It was sporadically reported from Lower–Middle Miocene of western Poland by Ziembińska–Tworzydlo (1974). The species was mainly recorded from Middle Miocene sediments of Turkey (Akgün & Akyol, 1987).

Occurrences: Lower Miocene Aksu Formation.

(161) *Tricolporopollenites kruschi* (POTONIÉ 1931b) THOMSON & PFLUG 1953 ssp. *pseudolaesus* (POTONIÉ 1931b) THOMSON & PFLUG 1953

pl. 15, figs.28–30

1931b *Pollenites kruschi* n. sp. –POTONIÉ, p. 3, fig. 16.

1953 *Tricolporopollenites kruschi* ssp. *pseudolaesus* (POTONIÉ) n. comb. –THOMSON & PFLUG, p. 104, pl. 13, figs. 47–63.

Dimensions: Equatorial axis: 25–28µm, ã = 25µm (n = 7)

Description: Tricolporate pollen grains. Amb circular in polar view. Colpi extending to poles. Pores circular. Exine reticulate.

Botanical affinity: Family Nyssaceae

Palaeofloristical element: Arctotertiary (warm temperate)

Previously recorded occurrences: Thomson & Pflug (1953) reported the species from Lower Eocene to Miocene of the Middle Europe. The species has been recorded from Tertiary sediments of Turkey (e.g. Akyol, 1971; Akgün & Akyol, 1987; Akyol & Akgün, 1990; Batı, 1996; Akgün & Sözbilir, 2001; Akgün, 2002; Akkiraz & Akgün, 2005).

Occurrences: Middle–?Upper Eocene Varsakyayla Formation; Lower–"Middle" Oligocene Tokça Formation; Lower Miocene Aksu Formation.

Genus: *Retitricolporites* (VAN DER HAMMEN 1956) VAN DER HAMMEN & WIJMSTRA 1964

Type Species: *Retitricolporites normalis* (VAN DER HAMMEN 1956) VAN DER HAMMEN & WIJMSTRA 1964

(162) *Retitricolporites* sp. 1

pl. 16, fig. 1, 2

Dimensions: Polar axis: 32–40µm, Equatorial axis: 25–30µm, ã = 40x28µm, (n = 15)
Description: Tricolporate pollen grains. Amb prolate in equatorial view. Three large colpi run from pole to pole. Exine densely coarse reticulate. Muri baculate. Strong reticulum about 2µm in diameter.
Remarks: Even the microscopic features point directly to the *Retitricolporites*, but identification down to species level is yet not possible because of bad preservation
Botanical affinity: Unknown
Palaeofloristical element: Unknown
Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) Formation; Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Aksu Formation.

Genus: *Psilatricolporites* VAN DER HAMMEN 1956 ex VAN DER HAMMEN & WYMSTRA 1964

Type species: *Psilatricolporites inornatus* (VAN DER HAMMEN 1954) PIERCE 1961

(163) *Psilatricolporites crassus* VAN DER HAMMEN & WYMSTRA 1964

pl. 16, figs. 3–8

1964 *Psilatricolporites crassus* n. sp. –VAN DER HAMMEN & WYMSTRA, p. 237, pl. 1, figs. 1–4.

Dimensions: Polar axis: 30–45 µm, Equatorial axis: 35–55µm, ã = 43x30µm, (n = 1733)

Description: Large tricolporate pollen grains, colpi medium sized, pole elongate, sculpturing and thickness of the wall extremely variable.

Botanical affinity: Genus *Pelliciera*

Palaeofloristical element: Palaeotropical

Previously recorded occurrence: Hammen & Wymstra (1964) reported the presence of *Psilatricolporites crassus* in Oligocene and Miocene sediments of Guyana. The species has also been found in Oligocene and Miocene sediments of Chiapas, Mexico (Langenheim et al., 1967), in Eocene sediments of Jamaica and Panama (Graham, 1977). Akgün (2002) and Akkiraz et al. (2006) also suggested the presence of *Psilatricolporites crassus* from the Middle–?Upper Eocene Yoncalı Formation (central Anatolia) and Başçeşme Formation (western Anatolia), respectively.

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations.

(164) *Psilatricolporites* cf. *costatus* DUEÑAS 1980

pl. 16, fig. 9

1980 *Psilatricolporites costatus* n. sp. –DUEÑAS, p. 319, pl. 3, figs. 9–10.

Dimensions: Polar axis: 27µm, Equatorial axis: 23µm (n = 1)

Description: Pollen grain tricolporate. Amb sub–spheroidal in equatorial view. Three thick distinct costae colpi running from pole to pole. Exine psilate.

Remarks: The specimens obtained small sized compare to *Psilatricolporites costatus* Dueñas 1980

Botanical affinity: Genus *Pelliciera*

Palaeofloristical element: Unknown

Previously recorded occurrence: Dueñas (1980) reported the presence of the species from Oligocene and Miocene sediments of northern Colombia.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Genus: *Ilexpollenites* THIERGART 1937 ex POTONIÉ 1960

Type species: *Ilexpollenites iliacus* (POTONIÉ 1931c) POTONIÉ 1960

(165) *Ilexpollenites margaritatus* (POTONIÉ 1931a) THIERGART 1937 ex POTONIÉ 1960 pl. 16, figs. 10,11

1931a *Pollenites margaritatus* n. sp. –POTONIÉ, p. 332 and pl. I, figs. 32 and 33.
1934 *Pollenites margaritatus* (POTONIÉ) –POTONIÉ, p 73, pl. 3, fig. 25
1937 *Ilex-pollenites margaritatus* (POTONIÉ) –THIERGART, p. 321, pl. 25, figs. 27–29.
1960 *Ilexpollenites margaritatus* (POTONIÉ) THIERGART –POTONIÉ, p. 99.

Dimensions: Polar axis: 18–29µm, Equatorial axis: 15–22µm, ã = 26x20µm, (n = 15)
Description: Tricolporate pollen grains. Amb prolate or prolate spheroidal in equatorial view. Three colpi conspicuous and running from pole to pole. Exine clavate.
Botanical affinity: Family Aquifoliaceae; Genus *Ilex*
Palaeofloristical element: Arctotertiary
Previously recorded occurrences: The species was determined from Tertiary sediments of Turkey (e.g. Nakoman, 1966b; Akyol, 1971; Akyol, 1980; Akgün & Akyol 1999; Karayiğit et al., 1999; Akgün & Sözbilir, 2001; Akgün et al., 2002).
Occurrences: Lower–“Middle” Oligocene Tokça and İncesu formations.

(166) *Ilexpollenites iliacus* (POTONIÉ 1931c) THIERGART 1937 ex POTONIÉ 1960 pl. 16, fig. 12

1931c *Pollenites iliacus* n. sp. –POTONIÉ, p. 556, fig.5.
1937 *Ilex-pollenites iliacus* (POTONIÉ) –THIERGART, p. 321, pl. 25, fig. 30.
1960 *Ilexpollenites iliacus* (POTONIÉ) THIERGART –POTONIÉ, p. 99.

Dimensions: Polar axis: 25µm, Equatorial axis: 22µm, (n = 1)

Description: Tricolporate pollen grains. Amb prolate spheroidal in equatorial view. Three colpi conspicuous and running from pole to pole. Exine coarse clavate.

Botanical affinity: Family Aquifoliaceae; Genus *Ilex*

Palaeofloristical element: Arctotertiary

Previously recorded occurrences: Thomson & Pflug (1953) mentions occurrences of the species from Lower Eocene to recent of Middle Europe. The species occurs in Tertiary sediments of Turkey (Nakoman, 1966b; Akyol, 1971; Akkiraz & Akgün, 2005).

Occurrences: Lower–“Middle” Oligocene Tokça Formation.

Genus: *Umbelliferaepollenites* KIRCHNER 1984

Type species: *Umbelliferaepollenites peissenbergensis* KIRCHNER 1984

(167) *Umbelliferaepollenites peissenbergensis* KIRCHNER 1984
pl. 16, fig. 13

1984 *Umbelliferaepollenites peissenbergensis* n. sp. –KIRCHNER, p. 125, pl. 8, fig.7.

Dimensions: Polar axis: 20µm, Equatorial axis: 10µm, (n = 1)

Description: Tricolporate pollen grains. Amb prolate with well rounded apices in equatorial view. Exine psilate. Pores lalongate.

Botanical affinity: Family Umbelliferae

Palaeofloristical element: Unknown

Previously recorded occurrences: According to Kirchner (1984), the range of species is from Late Oligocene to Middle Miocene of Middle Europe.

Occurrences: Lower Miocene Aksu Formation.

Genus: *Tetracolporopollenites* THOMSON & PFLUG 1953

Type Species: *Tetracolporopollenites sapatoides* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

(168) *Tetracolporopollenites sapotoides* PFLUG & THOMSON *in* THOMSON & PFLUG 1953
pl. 16, fig. 14

1953 *Tetracolporopollenites sapotoides* n. sp. (PFLUG & THOMSON) –THOMSON & PFLUG, p. 110, pl. 15, figs. 6–12.

Dimensions: Polar axis: 33µm, Equatorial axis: 22µm, (n = 1)
Description: Tetracolporate pollen grains. Amb prolate and rounded apices in equatorial view. Large pores about 4–5 µm and lalongate. Exine psilate.
Botanical affinity: Family Sapotaceae
Palaeofloristical element: Palaeotropical
Previously recorded occurrences: The range of species is from Eocene to Miocene of Middle Europe (Thomson & Pflug, 1953). The species occurs in Tertiary sediments of Turkey (Nakoman, 1966b; Akgün et al., 1986; Batı, 1996; Akgün et al., 2002).
Occurrences: Lower Miocene Aksu Formation.

(169) *Tetracolporopollenites obscurus* PFLUG & THOMSON *in* THOMSON & PFLUG 1953 pl. 16, figs. 15–18

1953 *Tetracolporopollenites obscurus* n. sp. (PFLUG & THOMSON) –THOMSON & PFLUG, p. 108, pl. 14, figs. 86–99 and 102–108.

Dimensions: Polar axis: 25–28µm, Equatorial axis: 18–23µm, ã = 25x20µm, (n = 14)

Description: Tetracolporate pollen grains. Amb prolate and rounded apices in equatorial view. Colpi strong run parallel from pole to pole. Pores are small about 2µm. Exine psilate and fine granulate.

Botanical affinity: Family Sapotaceae

Palaeofloristical element: Palaeotropical

Previously recorded occurrence: According to Thomson & Pflug (1953), the species occurs in Lower–Middle Tertiary of Middle Europe. The species has been found in Tertiary sediments of Turkey (Batı, 1996; Akgün & Akyol, 1999; Akgün & Sözbilir, 2001; Akgün et al., 2002; Akkiraz & Akgün, 2005).

Occurrences: Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(170) *Tetracolporopollenites biconus* PFLUG *in* THOMSON & PFLUG 1953
pl. 16, fig. 19

1953 *Tetracolporopollenites biconus* n. sp. (PFLUG) –THOMSON & PFLUG, p. 109, pl. 15, figs. 1–3.

Dimensions: Polar axis: 18–20µm, Equatorial axis: 12–14µm, (n = 2)

Description: Small tetracolporate pollen grains. Amp prolate in equatorial view. Colpi distinct run from pole to pole and converging the apices. Pores lalongate. Exine psilate.

Botanical affinity: Family Sapotaceae

Palaeofloristical element: Palaeotropical

Previously recorded occurrence: Nagy (1969) mentions occurrences in the Egerian and lower Badenian of Hungary. The species was recorded from the Eocene, Oligocene and Miocene basins of Turkey (Akyol, 1980; Akgün & Sözbilir, 2001; Akgün et al., 2002; Akkiraz & Akgün, 2005).

Occurrences: Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Aksu Formation.

(171) *Tetracolporopollenites microrhombus* PFLUG *in* THOMSON & PFLUG 1953
pl. 16, figs. 20–22

1953 *Tetracolporopollenites microrhombus* n. sp. (PFLUG) –THOMSON & PFLUG, p. 109, pl. 15, figs. 22–25.

Dimensions: Polar axis: 20–23µm, Equatorial axis: 16–19µm, ã = 20x18µm, (n = 6)
Description: Tetracolporate pollen grains. Amb prolate in equatorial view. Colpi distinct run from pole to pole and converging the apices. Pores lalongate. Exine psilate.
Botanical affinity: Family Sapotaceae
Palaeofloristical element: Palaeotropical
Previously recorded occurrence: In Paleogene of Middle Europe (Thomson & Pflug, 1953). The species occurs in Tertiary sediments of Turkey (e.g. Akyol, 1980; Akgün & Akyol, 1999; Akgün & Sözbilir, 2001).
Occurrences: Lower Miocene Aksu Formation.

Periporates POTONIÉ 1970

Genus: *Chenopodipollis* KRUTZSCH 1966

Type Species: *Chenopodipollis multiplex* (WEYLAND & PFLUG 1957) KRUTZSCH 1966

(172) *Chenopodipollis multiplex* (WEYLAND & PFLUG 1957) KRUTZSCH 1966
pl. 16, figs. 23, 24

1957 *Periporopollenites multiplex* n. sp. –WEYLAND & PFLUG, p. 103, pl. 22, figs. 18–19.
1966 *Chenopodipollis multiplex* (WEYLAND & PFLUG) n. comb. –KRUTZSCH, p. 35, pl. 7, figs. 22–25.

Dimensions: 15–22µm, ã=22µm, (n = 8)

Description: Periporate pollen grains in round shape. Many openings situated on pollen surface. The openings are round. Exine finely spinulate.

Botanical affinity: Family Chenopodiaceae

Palaeofloristical element: Arctotertiary

Previously recorded occurrence: According to Planderova (1991), the range of species is between Oligocene and Miocene of Slovak Central Paratethys. The species was determined from Middle–?Upper Eocene sediments of the Çardak–Tokça Basin by Akkiraz et al. (2006).

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene Tokça and İncesu formations; Lower Miocene Aksu Formation.

Genus: *Periporopollenites* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

Type Species: *Periporopollenites stigmosus* (POTONIÉ 1931a) THOMSON & PFLUG 1953

(173) *Periporopollenites multiporatus* PFLUG & THOMSON *in* THOMSON & PFLUG 1953

pl. 16, fig. 25

1953 *Periporopollenites multiporatus* n. sp**.** (PFLUG & THOMSON) **–**THOMSON & PFLUG, p.111, pl. 15, fig. 17.

Dimensions: 22µm, (n = 1)

Description: Periporate pollen grains in round shape. Many openings situated on pollen surface. The openings are round about 1.5µm in diameter.

Botanical affinity: Family Chenopodiaceae

Palaeofloristical element: Unknown

Previously recorded occurrence: The species has mainly been determined from Miocene sediments of Turkey (Akgün et al., 1986; Akgün & Akyol, 1987; Akyol & Akgün, 1990; Akgün & Akyol, 1999; Akgün et al., 2000; Sancay et al., 2006).
Occurrences: Lower Miocene Aksu Formation.

(174) *Periporopollenites* sp. 1 (thallictrum type)
pl. 17, figs. 26, 27

Dimensions: 15µm, ã=15µm, (n = 4)
Description: Small periporate pollen grains in round shape. Many openings situated on pollen surface. The openings are round. Exine finely spinulate.
Botanical affinity: Family Chenopodiaceae
Palaeofloristical element: Cosmopolitan
Occurrences: Lower–"Middle" Oligocene Tokça Formation.

Genus: *Nowemprojectus* CHOI 1984

Type species: *Novemprojectus tumanganicus* (BOLOTNIKOVA 1973) FREDERIKSEN et al. 2002

(175) *Novemprojectus tumanganicus* (BOLOTNIKOVA 1973) FREDERIKSEN et al. 2002
pl. 16, figs. 28, 29, pl. 17, figs. 1–4

1973 *Aquilapollenites tumanganicus* n. sp. –BOLOTNIKOVA, p. 99–100, pl. 25, figs. 1–3.
2002 *Nowemprojectus tumanganicus* (BOLOTNIKOVA) n. comb. – FREDERIKSEN et al., p. 82–86, pl. 6, figs. 5–7.

Dimensions: Polar axis: 38–40µm, equatorial axis: 32–36 µm, ã = 38x36µm, (n = 8)

Description: Tripojectate pollen grains having three distinctly small flaps or horizontal projections at each pole. Spines at the poles about 1.5 µm long.

Botanical affinity: Unknown

Palaeofloristical element: Unknown

Previously recorded occurrences: It was originally described as *Aquilapollenites tumanganicus* Bolotnikova 1973 from Palaeocene of western coast of the sea of the Japan by Bolotnikova (1973). It was also recorded from Palaeocene Mackenzie delta region by Staplin (1976). On the other hand, the range of Bolotnikova (1979) shows *Nowemprojectus tumanganicus* in eastern Siberia as ranging throughout Palaeocene and being scarcely present in Lower to Middle Eocene. According to Frederiksen et al. (2002), the species occurs in Eocene sediments evidenced from on the North Slope of Alaska.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member).

Botanical affinities of palynomorphs in systematic part

(1)	*Leiotriletes adriennis* (POTONIÉ & GELLETICH 1933) KRUTZSCH 1959	(*Acrostichum aureum*)
(2)	*Leiotriletes maxoides* KRUTZSCH 1962a ssp. *maximus* (PGLUG *in* THOMSON & PFLUG 1953) KRUTZSCH 1962a	(Lygodiaceae; *Lygodium*?)
(3)	*Leiotriletes maxoides* KRUTZSCH 1962a ssp. *maxoides* KRUTZSCH 1962a	(Schizaeaceae; *Lygodium*?)
(4)	*Leiotriletes maxoides* KRUTZSCH 1962a ssp. *minoris* KRUTZSCH 1962a	(Schizaeaceae; *Lygodium*?)
(5)	*Leiotriletes triangulus* (MURRIGER & PFLUG 1952 ex KRUTZSCH 1959) KRUTZSCH 1962a	(Unknown)
(6)	*Leiotriletes microlepioidites* KRUTZSCH 1962a	(Dennstaedtiaceae; *Microlepia*?)
(7)	*Leiotriletes microadriennis* KRUTZSCH 1959	(Schizaeaceae; *Lygodium*?)
(8)	*Leiotriletes wolffii* KRUTZSCH1962a ssp. *wolffii* KRUTZSCH 1962a	(Polypodiaceae; *Microlepia*?)
(9)	*Leiotriletes neddenioides* KRUTZSCH 1962a	(Lygodiaceae?, Cyatheaceae?)
(10)	*Leiotriletes seidewitzensis* KRUTZSCH 1962a	(Unknown)
(11)	*Leiotriletes* sp. 1	(Unknown)
(12)	*Leiotriletes* sp. 2	(Unknown)

(13)	*Triplanosporites microsinuosus* PFLANZL 1955	(*Lygodium*?)
(14)	*Triplanosporites sinuosus* PFLUG 1952 ex THOMSON & PFLUG 1953	(*Lygodium*?)
(15)	*Triplanosporites sinomaxoides* KRUTZSCH 1962a	(Schizaeaceae; *Lygodium*?)
(16)	*Punctatisporites punctatus* PFLUG *in* THOMSON & PFLUG 1953	(Unknown)
(17)	*Retitriletes lusaticus* KRUTZSCH 1963a	(*Lycopodium*)
(18)	*Retitriletes* sp 1.	(Unknown)
(19)	*Baculatisporites primarius* (WOLFF 1934) THOMSON & PFLUG 1953 ssp. *oligocaenicus* KRUTZSCH 1967	(Osmundaceae; *Osmunda*)
(20)	*Baculatisporites ovalis* KEDVES 1973	(Osmundaceae; *Osmunda*)
(21)	*Baculatisporites nanus* (WOLFE 1934) KRUTZSCH 1959	(Osmundaceae; *Osmunda*)
(22)	*Baculatisporites* sp 1	(Osmundaceae?)
(23)	*Cicatricosisporites* sp. 1	(Unknown)
(24)	*Trilites multivallatus* (PFLUG *in* THOMSON & PFLUG 1953) KRUTZSCH 1959	(Lygodiaceae; *Lygodium*)
(25)	*Trilites embriyonalis* KRUTZSCH 1967a	(Lygodiaceae)
(26)	*Trilites* sp. 1	(Unknown)
(27)	*Echinatisporis miocenicus* KRUTZSCH & SONTAG *in* KRUTZSCH 1963b	(*Selaginella*)
(28)	*Echinatisporis* ? *chattensis* KRUTZSCH 1963b	(*Selaginella*)
(29)	*Echinatisporis* sp. 1	(Selaginellaceae?)
(30)	*Polypodiaceoisporites* cf. *marxheimensis* (MURRIGER & PFLUG 1952 ex THOMSON & PFLUG 1953) KRUTZSCH 1959	(Shizaeaceae? Dicksoniaceae? Pteridaceae? Cyatheaeceae?)
(31)	*Polypodiaceoisporites kedvesii* STUCHLIK *in* STUCHLIK et al. 2001	(Pteridaceae)
(32)	*Polypodiaceoisporites gracillimus* NAGY 1963	(Pteridaceae)
(33)	*Polypodiaceoisporites saxonicus* KRUTZSCH 1967a	(Pteridaceae; *Pteris*)
(34)	*Polypodiaceoisporites muricinguliformis* NAGY 1969	(Pteridaceae; *Pteris*)
(35)	*Polypodiaceoisporites schoenewaldensis* KRUTZSCH 1967a	(Unknown)
(36)	*Polypodiaceoisporites corrutoratus* NAGY 1985	(Pteridaceae)
(37)	*Polypodiaceoisporites microconcavus* KRUTZSCH 1967a	(Unknown)
(38)	*Polypodiaceoisporites* sp. 1	(Unknown)
(39)	*Polypodiaceoisporites* sp. 2	(Unknown)
(40)	*Laevigatosporites gracilis* WILSON & WEBSTER 1946	(Polypodiaceae)
(41)	*Laevigatosporites haardti* (POTONIÉ & VENITZ 1934)	(Polypodiaceae)

	THOMSON & PFLUG 1953	
(42)	*Laevigatosporites major* COOKSON ex KRUTZSCH 1959	(Polypodiaceae)
(43)	*Verrucatosporites histiopteroides* KRUTZSCH 1962b	(Polypodiaceae; *Histiopteris* (*Pteris*) *incisa*)
(44)	*Verrucatosporites favus* (POTONIÉ 1931c) THOMSON & PFLUG 1953	(Dennstaedtiaceae; *Paesia*)
(45)	*Verrucatosporites alienus* (POTONIÉ 1931c) THOMSON & PFLUG 1953	(Davalliaceae)
(46)	*Verrucatosporites tenellis* (KRUTZSCH 1959) KRUTZSCH 1967a	(Polypodiaceae?, Davalliaceae?)
(47)	*Verrucatosporites balticus* (KRUTZSCH 1962b) KRUTZSCH 1967a	(Polypodiaceae)
(48)	*Podocarpidites libellus* (POTONIÉ 1931c) KRUTZSCH 1971	(Podocarpaceae; *Podocarpus*)
(49)	*Piceapollis* sp. 1	(Pinaceae?)
(50)	*Pityosporites microalatus* (POTONIÉ 1931b) THOMSON & PFLUG 1953	(Pinaceae; *Pinus* "haploxylon" type)
(51)	*Pityosporites labdacus* (POTONIÉ 1931c) THOMSON & PFLUG 1953	(Pinaceae; *Pinus* "sylvestris" type)
(52)	*Pityosporites scopulipites* (WODEHOUSE 1933) KRUTZSCH 1971	(Pinaceae; *Pinus*)
(53)	*Pityosporites minitus* (ZAKLINSKAJA 1957) KRUTZSCH 1971	(Pinaceae; *Pinus*)
(54)	*Pityosporites* sp. 1	(Pinaceae?)
(55)	*Cathayapollis krutzschii* (SIVAK 1976) ZIEMBIŃSKA–TWORZYDLO *in* STUCHLIK et al. 2002	(*Cathaya*)
(56)	*Cathayapollis pulaënsis* (NAGY 1985) ZIEMBIŃSKA–TWORZYDLO *in* STUCHLIK et al. 2002	(*Cathaya*)
(57)	*Cathayapollis* sp. 1	(*Cathaya*?)
(58)	*Cedripites* sp. 1	(*Cedrus*?)
(59)	*Abiespollenites absolutus* THIERGART ex POTONIÉ 1958	(*Abies alba*)
(60)	*Abiespollenites* sp. 1	(*Abies*?)
(61)	*Inaperturopollenites dubius* (POTONIÉ & VENITZ 1934) THOMSON & PFLUG 1953	(Taxodiaceae)
(62)	*Inaperturopollenites hiatus* (POTONIÉ 1931b) PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Taxodiaceae)
(63)	*Inaperturopollenites concedipites* (WODEHOUSE 1933) KRUTZSCH 1971	(Taxodiaceae)

(64)	*Inaperturopollenites magnus* (POTONIÉ 1934) THOMSON & PFLUG 1953	(Pinaceae?, *Pseudotsuga*?)
(65)	*Inaperturopollenites* sp. 1	(Unknown)
(66)	*Sequoiapollenites largus* (KREMP 1949) MANUM 1962	(Taxodiaceae; *Cryptomeria*?)
(67)	*Sequoiapollenites polymorfosus* THIERGART 1937	(Taxodiaceae; *Sequoia*)
(68)	*Sparganiaceaepollenites polygonalis* THIERGART 1937	(Sparganiaceae; *Sparganium*)
(69)	*Sparganiaceaepollenites neogenicus* KRUTZSCH 1970a	(Sparganiaceae)
(70)	*Aglaoreidia cyclops* (ERDTMAN 1960) FOWLER 1971	(Unknown)
(71)	*Graminidites laevigatus* KRUTZSCH 1970a	(Gramineae?)
(72)	*Kopekipollenites transdanubicus* KEDVES 1974	(Monocotyledonopsida)
(73)	*Longapertites punctatus* FREDERIKSEN 1994	(Arecaceae?,Lepidocaryoidae?)
(74)	*Longapertites* cf. *punctatus* FREDERIKSEN 1994	(Arecaceae?,Lepidocaryoidae?)
(75)	*Longapertites psilatus* FREDERIKSEN 1994	(Arecaceae?,Lepidocaryoidae?)
(76)	*Longapertites discordis* FREDERIKSEN 1994	(Arecaceae?,Lepidocaryoidae?)
(77)	*Longapertites retipilatus* KAR 1985	(Arecaceae?,Lepidocaryoidae?)
(78)	*Longapertites* sp. 1	(Unknown)
(79)	*Psilamonocolpites* sp. 1	(Arecaceae?)
(80)	*Mauritiidites franciscoi* (VAN DER HAMMEN 1956) HOEKEN–KLINKENBERG 1964	(Arecaceae; *Mauritia*)
(81)	*Spinizonocolpites* sp. 1	(*Nypa*?)
(82)	*Cycadopites gracilis* (WODEHOUSE 1933) KRUTZSCH 1970a	(Cycadaceae; *Cycas*)
(83)	*Cycadopites* ?*minimus* (COOKSON 1947) KRUTZSCH 1970a	(Cycadaceae; *Cycas*)
(84)	*Cycadopites intrastructus* KRUTZSCH 1970a	(Cycadaceae; *Ginkgo?, Cycas?*)
(85)	*Cycadopites lusaticus* KRUTZSCH 1970a	(Cycadaceae; *Cycas*?)
(86)	*Cycadopites* sp. 1	(Cycadaceae?)
(87)	*Arecipites brandenburgensis* KRUTZSCH 1970a	(Arecoideae?,Palmae?)
(88)	*Arecipites* sp. 1	(Arecoideae?,Palmae?)
(89)	*Magnolipollis neogenicus* ssp. *minor* KRUTZSCH 1970a	(Magnoliaceae?)
(90)	*Monogemmites pseudosetarius* (WEYLAND & PFLUG 1957) KRUTZSCH 1970a	(Unknown)
(91)	*Dicolpopollis kockelii* PFLANZL 1956	(Palmae; *Calamus*)
(92)	*Ephedripites* sp. 1	(Ephedraceae?)
(93)	*Plicapollis pseudoexcelsus* (KRUTZSCH 1957) KRUTZSCH 1961 ssp. *turgidus* PFLUG *in* THOMSON & PFLUG 1953	(Juglandaceae?)
(94)	*Plicapollis pseudoexcelsus* (KRUTZSCH 1957) KRUTZSCH	(Juglandaceae?)

	1961 ssp. *semiturgidus* PFLUG *in* THOMSON & PFLUG 1953	
(95)	*Plicapollis* sp. 1	(Juglandaceae?)
(96)	*Triatriopollenites rurensis* THOMSON & PFLUG 1953	(Myricaceae; *Myrica*)
(97)	*Triatriopollenites pseudorurensis* PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Myricaceae; *Myrica*)
(98)	*Triatriopollenites bituitus* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(Myricaceae; *Myrica*)
(99)	*Triatriopollenites excelsus* (POTONIÉ 1931a) THOMSON & PFLUG 1953 ssp. *minor* PFLUG *in* THOMSON & PFLUG 1953	(Myricaceae)
(100)	*Triatriopollenites excelsus* (POTONIÉ 1931a) THOMSON & PFLUG 1953 ssp. *typicus* PFLUG *in* THOMPSON & PFLUG 1953	(Myricaceae)
(101)	*Triatriopollenites myricoides* (KREMP 1949) THOMSON & PFLUG 1953	(Myricaceae)
(102)	*Plicatopollis plicatus* (POTONIÉ 1934) KRUTZSCH 1962b	(Juglandaceae)
(103)	*Plicatopollis hungaricus* KEDVES 1974	(Juglandaceae?)
(104)	*Plicatopollis lunatus* KEDVES 1974	(Juglandaceae)
(105)	*Momipites punctatus* (POTONIÉ 1931a) NAGY 1969	(Juglandaceae; *Engelhardia*)
(106)	*Momipites quietus* (POTONIÉ 1931c) NICHOLS 1973	(Juglandaceae; *Engelhardia*)
(107)	*Momipites* sp. 1	(Unknown)
(108)	*Triporopollenites megagranifer* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(Betulaceae)
(109)	*Triporopollenites robustus* (MURRIGER & PFLUG 1951) PFLUG *in* THOMSON & PFLUG 1953	(Unknown)
(110)	*Triporopollenites* sp. 1	(Unknown)
(111)	*Labrapollis labraferus* (POTONIÉ 1931b) KRUTZSCH 1968	(Unknown)
(112)	*Olaxipollis matthesi* KRUTZSCH 1962b	(Olacaceae; *Olax*?)
(113)	*Trivestibulopollenites betuloides* PFLUG *in* THOMSON & PFLUG 1953	(Betulaceae; *Betula*)
(114)	*Caryapollenites simplex* (POTONIÉ 1931b) RAATZ ex POTONIÉ 1960	(Juglandaceae; *Carya*)
(115)	*Subtriporopollenites anulatus* THOMSON & PFLUG 1953 ssp. *nanus* THOMSON & PFLUG 1953	(Juglandaceae; *Carya*?)
(116)	*Subtriporopollenites constans* PFLUG *in* THOMSON & PFLUG 1953	(Unknown)

(117)	*Celtipollenites intrastructurus* (KRUTZSCH & VANHOORNE 1977) THIELE–PFEIFFER 1980	(Ulmaceae; *Celtis*)
(118)	*Intratriporopollenites instructus* (POTONIÉ 1931c) THOMSON & PFLUG 1953	(Tiliaceae; *Tilia*)
(119)	*Intratriporopollenites insculptus* MAI 1961	(Tiliaceae)
(120)	*Intratriporopollenites indubitalibis* (POTONIÉ 1934) PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Tiliaceae)
(121)	*Compositoipollenites rhizophorus* (POTONIÉ 1934) POTONIÉ 1960 ssp. *burghasungensis* (MURRIGER & PFLUG 1952) MURRIGER & PFLUG *in* THOMSON & PFLUG 1953	(Icacinaceae)
(122)	*Polyporopollenites undulosus* (WOLFF 1934) THOMSON & PFLUG 1953	(Ulmaceae; *Ulmus*?, *Zelkova*?)
(123)	*Carpinuspollenites carpinoides* (PFLUG *in* THOMSON & PFLUG 1953) NAGY 1969	(Betulaceae; *Carpinus*)
(124)	*Pterocaryapollenites stellatus* (POTONIÉ 1931d) THIERGART 1937	(Juglandaceae; *Pterocarya*)
(125)	*Polyvestibulopollenites verus* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(Betulaceae; *Alnus*)
(126)	*Reevesiapollis triangulus* (MAMCZAR 1960) KRUTZSCH 1970c	(Sterculiaceae; *Reevesia*)
(127)	*Pentapollenites pentangulus* (PFLUG *in* THOMSON & PFLUG 1953) KRUTZSCH 1957	(Elaeagnaceae? Simarubaceae?)
(128)	*Cupaneïdites eucalyptoides* KRUTZSCH 1962b	(Myrtaceae?, Sapindaceae?)
(129)	*Myrtaceidites mesonesus* COOKSON & PIKE 1954	(Myrtaceae)
(130)	*Syncolporites* sp. 1	(Myrtaceae?)
(131)	*Boehlensipollis hohli* KRUTZSCH 1962b	(Elaeagnaceae)
(132)	*Slowakipollis hippophäeoides* KRUTZSCH 1962b	(Elaeagnaceae; *Hippophäe*)
(133)	*Tricolpopollenites henrici* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(Fagaceae; *Quercus*)
(134)	*Tricolpopollenites densus* PFLUG *in* THOMSON & PFLUG 1953	(Fagaceae; *Quercus*)
(135)	*Tricolpopollenites liblarensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953 ssp. *fallax* (POTONIÉ 1934) THOMSON & PFLUG 1953	(Fagaceae?)
(136)	*Tricolpopollenites liblarensis* (THOMSON *in* POTONIÉ,	(Fagaceae?)

	THOMSON & THIERGART 1950) THOMSON & PFLUG 1953 ssp. *liblarensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953	
(137)	*Tricolpopollenites microhenrici* (POTONIÉ 1931d) THOMSON & PFLUG 1953	(Fagaceae; *Quercus*)
(138)	*Tricolpopollenites asper* THOMSON & PFLUG 1953	(Fagaceae; *Quercus*)
(139)	*Tricolpopollenites parmularius* (POTONIÉ 1934) THOMSON & PGLUG 1953	(Fagaceae? Eucommiaceae?; *Eucomminia?*)
(140)	*Tricolpopollenites retiformis* THOMSON & PFLUG 1953	(Saliaceae; *Salix/Platanus*)
(141)	*Retricolpites* sp. 1	(Unknown)
(142)	*Aceripollenites striatus* (PFLUG 1959)THIELE–PFEIFFER 1980	(Aceraceae; *Acer)*
(143)	*Polycolpites speciosus* DUTTA & SAH 1970	(Unknown)
(144)	*Tricolporopollenites euphorii* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(Araliaceae)
(145)	*Tricolporopollenites cingulum* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *fusus* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(*Trigonabalanus*)
(146)	*Tricolporopollenites cingulum* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *pusillus* (POTONIÉ 1934) THOMSON & PFLUG 1953	(Fagaceae; *Castanea*, *Castanopsis*, *Lithocarpus., Pasania*)
(147)	*Tricolporopollenites cingulum* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *oviformis* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(Fagaceae; *Castanea*, *Castanopsis*, *Lithocarpus., Pasania*)
(148)	*Tricolporopollenites megaexactus* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *brühlensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1959) THOMSON & PFLUG 1953	(Cyrillaceae)
(149)	*Tricolporopollenites megaexactus* (POTONIÉ 1931d) THOMSON & PFLUG 1953 ssp. *exactus* (POTONIÉ 1931d) THOMSON & PFLUG 1953	(Cyrillaceae)
(150)	*Tricolporopollenites pseudocingulum* (POTONIÉ 1931a) THOMSON & PFLUG 1953	(Anacardiaceae; *Rhus*)
(151)	*Tricolporopollenites marcodurensis* PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Vitaceae; *Ciccus*)
(152)	*Tricolporopollenites genuinus* (POTONIÉ 1934) THOMSON & PFLUG 1953	(Cupuliferae)

(153)	*Tricolporopollenites microreticulatus* PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Oleaceae; *Olea*, *Fraxinus*, *Ligustrum*)
(154)	*Tricolporopollenites oleoides* KRUTZSCH & VANHOORNE 1977	(Oleaceae)
(155)	*Tricolporopollenites edmundii* (POTONIÉ 1931d) THOMSON & PFLUG 1953	(Mastixiaceae)
(156)	*Tricolporopollenites pacatus* PFLUG *in* THOMSON & PFLUG 1953	(Simarubaceae)
(157)	*Tricolporopollenites villensis* (THOMSON *in* POTONIÉ, THOMSON & THIERGART 1950) THOMSON & PFLUG 1953	(Cupuliferae)
(158)	*Tricolporopollenites solé de portai* KEDVES 1965	(Fabaceae?,Rosaceae?, Anacardiaceae?)
(159)	*Tricolporopollenites baculoferus* PFLUG *in* THOMSON & PFLUG 1953	(Unknown)
(160)	*Tricolporopollenites satzveyensis* PFLUG *in* THOMSON & PFLUG 1953	(Araliaceae?)
(161)	*Tricolporopollenites kruschi* (POTONIÉ 1931b) THOMSON & PFLUG 1953 ssp. *pseudolaesus* (POTONIÉ 1931b) THOMSON & PFLUG 1953	(Nyssaceae)
(162)	*Retitricolporites* sp. 1	(Unknown)
(163)	*Psilatricolporites crassus* VAN DER HAMMEN & WYMSTRA 1964	(*Pelliciera*)
(164)	*Psilatricolporites* cf. *costatus* DUEÑAS 1980	(*Pelliciera*)
(165)	*Ilexpollenites margaritatus* (POTONIÉ 1931a) THIERGART 1937 ex POTONIÉ 1960	(Aquifoliaceae; *Ilex*)
(166)	*Ilexpollenites iliacus* (POTONIÉ 1931a) THIERGART 1937 ex POTONIÉ 1960	(Aquifoliaceae; *Ilex*)
(167)	*Umbelliferaepollenites peissenbergensis* KIRCHNER 1984	(Umbelliferae)
(168)	*Tetracolporopollenites sapotoides* PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Sapotaceae)
(169)	*Tetracolporopollenites obscurus* PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Sapotaceae)
(170)	*Tetracolporopollenites biconus* PFLUG *in* THOMSON & PFLUG 1953	(Sapotaceae)
(171)	*Tetracolporopollenites microrhombus* PFLUG *in* THOMSON & PFLUG 1953	(Sapotaceae)

(172)	*Chenopodipollis multiplex* (WEYLAND & PFLUG 1957) KRUTZSCH 1966	(Chenopodiaceae)
(173)	*Periporopollenites multiporatus* PFLUG & THOMSON *in* THOMSON & PFLUG 1953	(Chenopodiaceae)
(174)	*Periporopollenites* sp. 1 (thallictrum type)	(Chenopodiaceae)
(175)	*Nowemprojectus tumanganicus* (BOLOTNIKOVA) FREDERIKSEN et al. 2002	(Unknown)

Organic Walled Green Algae

Division Clorophyta PASHER 1914

Class Chlorophyceae KÜTZING 1849

Genus: *Botryococcus* KÜTZING 1849

Botryococcus braunii KÜTZING 1849

pl. 17, figs. 5–7

1849 *Botryococcus braunii* n. sp. – KÜTZING, p. 892.

Dimensions: 50–100µm, ã = 76µm, (n =158)

Description: Most diverse cauliflower–like cell colonies irregular shape and variable size composed of aggregates of ellipsoidal and spherical cells arranged radially.

Affinity: Family Botryococcaceae

Occurrences: Lower–“Middle” Oligocene Tokça and İncesu formations.

Genus *Pediastrum* MEYEN 1829

Pediastrum boryanum (TURPIN 1828) MENEGHINI 1840

pl. 17, figs. 8–11

Dimensions: 30–62µm, ã = 30µm, (n = 4)

Description: Flat, plate like circular or disc–shaped colonies. The size and shape of the individual cells nearly same. The length of the processes and the depth of incision in between variable.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member); Lower–"Middle" Oligocene İncesu Formation.

Pediastrum duplex MEYEN 1829

pl. 17, figs. 12

Dimensions: 44µm, (n = 1)

Description: Marginal cells rather short gradually taper processes and perforations of the cenobia sometimes small.

Occurrences: Middle–?Upper Eocene Başçeşme Formation (Maden member)

Division Dinoflagellata (BÜTSCHLI 1885) FENSOME et al. 1993

Class Dinophyceae FRITSCH 1929

Genus *Cleistopheridium* DAVEY, DOWNIE, SARJEANT & WILLIAMS 1966

Type Species: *Cleistopheridium diversispinosum* DAVEY et al. 1966

Cleistopheridium sp.

pl. 18, figs. 1–5,

Dimensions: 45–62µm (length of processes about 7–12µm), ã = 62 µm, (n = 6)

Description: The body is oval. The processes relatively long, hollow, erect. The number of processes present is more than thirty. The surface of central body and processes is smooth.

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–"Middle" Oligocene İncesu Formation; Lower Miocene Kavak and Aksu formations.

Genus: *Apectodinium* (COSTA & DOWNIE 1976) LENTIN &WIILIAMS 1977

Type Species: *Apectodinium homomorphum* (DEFLANDRE & COOKSON 1955) LENTIN &WIILIAMS 1977

Apectodinium sp.
pl. 18, fig. 6

Dimensions: 48 µm (length of processes about 6–8µm), (n = 1)
Description: The body is subspherical. The processes are short, erect or curved and commonly expanded distally. Some processes may be wider than the others. The surface of central body and processes is smooth.
Occurrences: Lower–"Middle" Oligocene İncesu Formation.

Genus *Homotrybilium* DAVEY & WILLIAMS 1966

Type Species: *Homotrybilium tenuispinosum* DAVEY & WILLIAMS 1966

Homotrybilium sp.
pl. 18, fig. 7

Dimensions: 51µm (length of processes about 10µm), (n = 1)
Description: The central body is spherical. The processes are simple, erect, tubular expanded and open distally serrate margin. The surface of central body and processes is smooth.
Occurrences: Middle–?Upper Eocene Başçeşme Formation.

Genus: *Cordosphaeridium* (KLUMP 1953) MORGENROTH 1968

Type Species: *Cordosphaeridium inodes* (KLUMP 1953) MORGENROTH 1968

Cordosphaeridium sp.
pl. 18, fig. 8

Dimensions: 40 µm (lenght of processes about 10µm), ã = 40µm, (n = 2)
Description: The central body is spherical. The processes are simple, tubular expanded and open distally serrate margin. The surface of central body and processes is smooth.
Occurrences: Middle–?Upper Eocene Varsakyayla Formation.

Dinoflagellate spp.
pl. 18, figs. 9–12

Occurrences: Middle–?Upper Eocene Başçeşme (Maden member) and Varsakyayla formations; Lower–“Middle” Oligocene Tokça and İncesu formations; Lower Miocene Kavak and Aksu formations.

CHAPTER FOUR
BIOSTRATIGRAPHY

In this chapter, biostratigraphical results are presented on the basis of palynomorph and foraminifer (larger benthic and planktonic) assemblages. The stratigraphical positions of productive samples obtained from all areas and their contents are indicated. Besides, palynological conclusions obtained are correlated with previous palynological results attained from the other parts of Turkey.

4.1 Çardak–Tokça Area

4.1.1 The Başçeşme Formation

4.1.1.1 Palynological Assemblage and Age

In this section, the age of the palynological assemblage of the Maden member (Başçeşme Formation) is discussed. There is no fossil record in the Dazlak member located at the bottom of the Başçeşme Formation owing to its coarse–grained, clastic nature. All palynological outcrop samples were obtained from the Maden member (Fig. 4. 1a). Eighteen of 101 samples investigated for their pollen content contain spores and gymnosperm and angiosperm pollen grains, which are fairly well preserved (Fig. 4. 1a, Table 4. 1). The flora is characterized by 61 taxa and is here recorded (Table 4. 1). Forty–six spores and pollen taxa belonging to the pterodophytic spores (8), gymnosperm (5) and angiosperm pollen taxa (33) were obtained from the samples of the Maden member (Table 4. 1). The number of angiosperm pollen is always higher than spores and gymnosperms. Moreover, *Pediastrum boryanum* and *P. dublex*, and dinoflagellate cysts such as *Homotrybilium* sp. and *Cleistosphaeridium* sp. and poorly preserved undifferentiated dinoflagellate cysts were also observed. Statistical analyses yield a long list of stratigraphically unimportant, long-ranging taxa (Table 4. 1), but with a few index taxa, for which stratigraphic ranges are given in Table 4. 2.

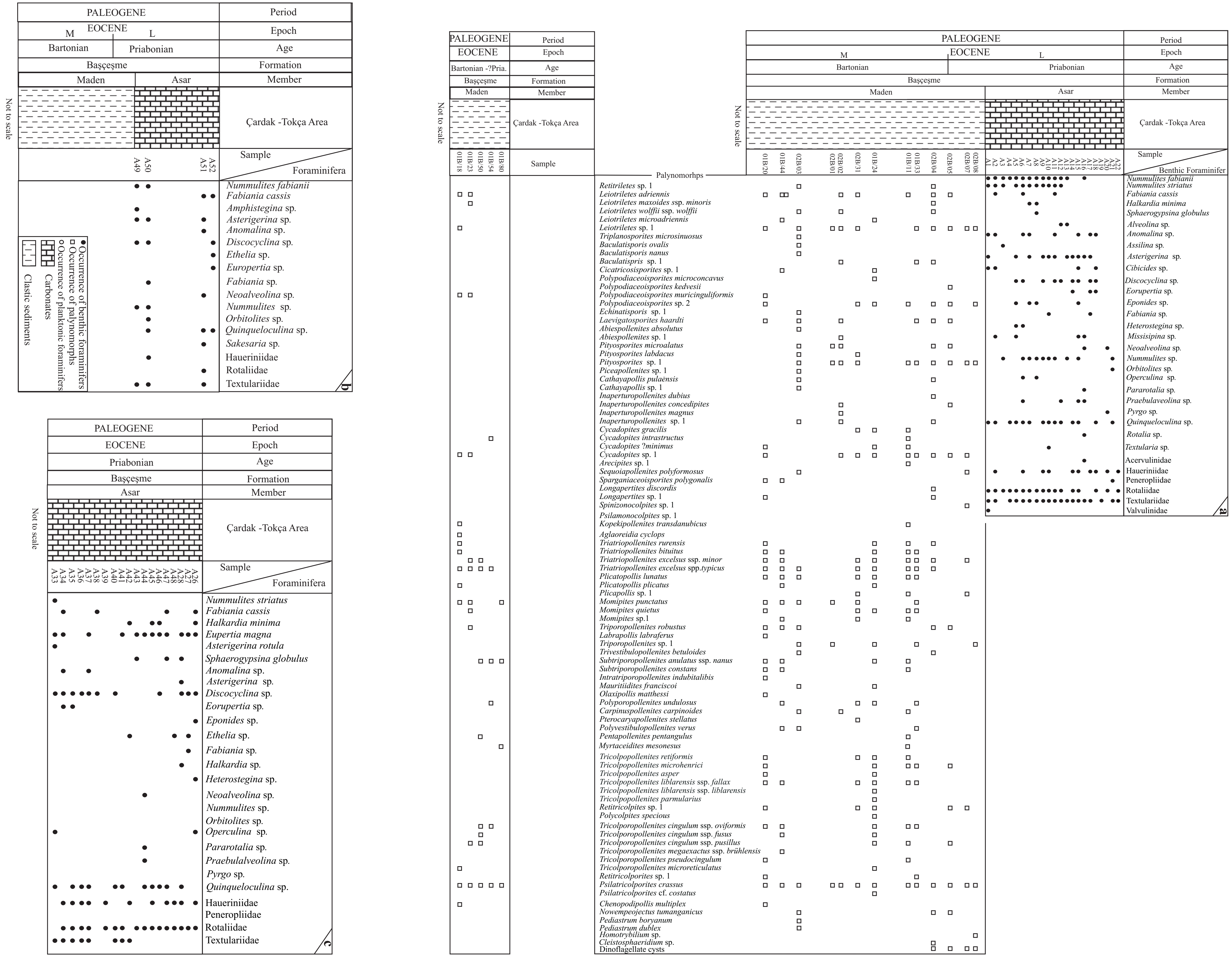

Figure 4.1. Occurrence of palynomorphs and benthic foraminifers in the Başçeşme Formation, (a) See figures.2.5, 2.9 and 2.10 for sample locations, (b) See figure 2. 6 for sample locations (c) benthic foraminifer contend of Asar member (see figure 2. 8 for sample locations).

Table 4. 1 Quantitative counting results of palynomorphs encountered in the Maden member (Başçeşme Formation) of the Çardak–Tokça Area.

		Palaeovegetation Types	Sample Numbers																	
SAMPLES			01B/20	01B/44	02B/03	02B/01	02B/02	02B/31	01B/24	01B/11	01B/33	02B/04	02B/05	02B/07	02B/08	01B/18	01B/23	01B/50	01B/54	01B/80
TAXA																				
SPORES																				
Retitriletes sp. 1	(?*Lycopodium*)	Swamp - Freshwater			2							3								
Leiotriletes adriennis	(*Acrostichum aureum*)	Back-Mangrove	8	2			5	3		1		3	12	34	8	9	4			
Leiotriletes maxoides ssp. *minoris*	(Schizaeaceae: ?*Lygodium*)	Swamp - Freswater										9					3			
Leiotriletes wolffii ssp. *wolffi*	(Polypodiaceae: ?*Microlepia*)	Swamp - Freswater			4	6	26					46								
Leiotriletes microadriennis	(Schizaeaceae: ?*Lygodium*)	Swamp - Freswater		1					1		1									
Leiotriletes sp. 1		Unknown				3														
Triplanosporites microsinuosus	(?*Lygodium*)	Swamp - Freshwater			1															
Baculatisporis ovalis	(Osmundaceae: *Osmunda*)	Swamp - Freshwater			1															
Baculatisporites nanus	(Osmundaceae: *Osmunda*)	Swamp - Freshwater			4															
Baculatisporites sp. 1	(?Osmundaceae)	Swamp - Freshwater					1				1	3								
Cicatricosisporites sp.1		Swamp - Freshwater		1																
Polypodiaceoisporites microconcavus		Swamp - Freshwater						2	3											
Polypodiaceoisporites kedvesii	(Pteridaceae)	Swamp - Freshwater								2		2	3							
Polypodiaceoisporites muricinguliformis	(Pteridaceae: *Pteris*)	Swamp - Freshwater	3												1	1				
Polypodiaceoisporites sp. 2		Unknown							1											
Echinatisporis sp. 1	(?Selaginellaceae)	Swamp - Freshwater			1															
Laevigatosporites haardti	(Polypodiaceae)	Swamp - Freshwater	2		5		1				2	1	1							
GYMNOSPERMOUS																				
Abiespollenites absolutus	(*Abies alba*)	Montane			10															
Abiespollenites sp. 1	(?*Abies*)	Montane					1													
Pityosporites microalatus	(Pinaceae: *Pinus* haploxylon type)	Montane			97	3	65			1	1	32	4	1	1					
Pityosporites labdacus	(Pinaceae: *Pinus* sylvestris type)	Montane			2			5												
Pityosporites sp. 1	(?Pinaceae)	Montane			1		2													
Piceapollenites sp.1	(?Pinaceae)	Montane			1															
Cathayapollis pulaensis	(*Cathaya*)	Montane			1							1								
Cathayapollis sp. 1	(?*Cathaya*)	Montane			1															
Inaperturopollenites dubius	(Taxodiaceae)	Swamp - Freshwater										14								
Inaperturopollenites concedipites	(Taxodiaceae)	Swamp - Freshwater			7		1						1							
Inaperturopollenites magnus	(?Pinaceae: ?*Pseudotsuga*)	Swamp - Freshwater					1													
Inaperturopollenites sp. 1		Unknown			7		2													
ANGIOSPERMOUS																				
MONOCOTYLEDONEAE																				
Cycadopites gracilis	(Cycadaceae: *Cycas*)	Lowland - Riparian						2	2	1										
Cycadopites intrasructus	(Cycadaceae: *Cycas*?, *Ginkgo*?)	Lowland - Riparian								1									1	
Cycadopites ?minimus	(Cycadaceae: *Cycas*)	Lowland - Riparian	1						2	2										
Cycadopites sp.1	(?Cycadaceae)	Lowland - Riparian	6				1	4	1	1	1	2	5	1						
Arecipites sp.1	(?Arecoideae, ?Palmae)	Back-Mangrove								1										
Sequoiapollenites polyformosus	(Taxodiaceae: *Sequoia*)	Lowland - Riparian			1									2						
Sparganiaceaepollenites polygonalis	(Sparganiaceae: *Sparganium*)	Swamp - Freshwater	1	1																
Longapertites discordis	(?Arecaceae, ?Lepidocaryoidae)	Back-Mangrove										2								
Longapertites sp. 1		Unknown	2									1								
Spinizonocolpites sp. 1	(?*Nypa*)	Mangrove												2						
Psilamonocolpites sp. 1	(?Arecaceae)	Mangrove														1				
Kopekipollenites transdanubicus	(Monocotyledonopsidae)	Unknown								1										
Aglaoreidia cyclops		Swamp - Freshwater														1				
DICOTYLEDONEAE																				
Triatriopollenites rurensis	(Myricaceae: *Myrica*)	Lowland - Riparian	2						1	1		1				1				
Triatriopollenites bituitus	(Myricaceae: *Myrica*)	Lowland - Riparian	1	1					1	1	1					1				
Triatriopollenites excelsus ssp. *minor*	(Myricaceae)	Lowland - Riparian	16	14				2	4		4	1		1			2	3		
Triatriopollenites excelsus ssp. *typicus*	(Myricaceae)	Lowland - Riparian	7	7	1			2	6	5	3	4				2	4	3	2	
Plicatopollis lunatus	(Juglandaceae)	Lowland - Riparian	3	3	6			1	1	1	1									
Plicatopollis plicatus	(Juglandaceae)	Lowland - Riparian		5					2							1				
Plicapollis sp. 1	(?Juglandaceae)	Unknown						2		1				1						
Momipites punctatus	(Juglandaceae: *Engelhardia*)	Lowland - Riparian	9	6	5	1		3			1					1	1			1
Momipites quietus	(Juglandaceae: *Engelhardia*)	Lowland - Riparian	2					1	1	1	1						1			
Momipites sp. 1		Unknown		3				4		5										
Triporopollenites robustus		Unknown	3	2	5							4	2				2			
Labrapollis labraferus		Unknown	1																	
Triporopollenites sp. 1					3	2			1		2				2					
Trivestibulopollenites betuloides	(Betulaceae: *Betula*)	Lowland - Riparian			6							3								
Subtriporopllenites anulatus ssp. *nanus*	(Juglandaceae: ?*Carya*)	Lowland - Riparian	3	6					2	2								1	2	2
Subtriporopollenites constans		Lowland - Riparian	1	2						1										
Intratriporopollenites indubitalibis	(Tiliaceae)	Lowland - Riparian	1																	
Mauritiidites franciscoi	(Arecaceae: *Mauritia*)	Back-Mangrove			1				1											
Olaxipollis matthessi	(Olacaceae: ?*Olax*)	Unknown	1																	
Polyporopollenites undulosus	(Ulmaceae: ?*Ulmus*, ?*Zelkova*)	Lowland - Riparian		2				2	1		1								1	
Carpinuspollenites carpinoides	(Betulaceae: *Carpinus*)	Lowland - Riparian			1		1			1										
Pterocaryapollenites stellatus	(Juglandaceae: *Pterocarya*)	Lowland - Riparian						1												
Polyvestibulopollenites verus	(Betulaceae: *Alnus*)	Lowland - Riparian		1	2						1									
Pentapollenites pentangulus	(?Elaeagnaceae, ?Simarubaceae)	Unknown								1								1		
Myrtaceidites mesonesus	(Myrtaceae)	Lowland - Riparian								1										1
Tricolpopollenites liblarensis ssp. *fallax*	(?Fagaceae)	Montane	1	1				1	1	3	2									
Tricolpopollenites liblarensis ssp. *liblarensis*	(?Fagaceae)	Montane							1											
Tricolpopollenites microhenrici	(Fagaceae: *Quercus*)	Montane	4						4	12	5		1							
Tricolpopollenites asper	(Fagaceae: *Quercus*)	Montane	1						1											
Tricolpopollenites parmularius	(?Fagaceae, ?Eucommiaceae; ?*Eucomminia*)	Montane							1											
Tricolpopollenites retiformis	(Saliaceae: *Salix/Platanus*)	Montane	2					1	1	1										
Retitricolpites sp. 1		Unknown	2					1	3				1	1						
Polycolpites speciosus		Unknown							1											
Tricolporopollenites cingulum ssp. *oviformis*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)	Lowland - Riparian	1	6					1	1	1							2	2	
Tricolporopollenites cingulum ssp. *fusus*	(*Trigonobalanus*)	Lowland - Riparian		3					1									1		
Tricolporopollenites cingulum ssp. *pusillus*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)	Lowland - Riparian							1	1			1				1	4		
Tricolporopollenites megaexactus ssp. *brühlensis*	(Cyrillaceae)	Lowland - Riparian		2																
Tricolporopollenites pseudocingulum	(Anacardiaceae: *Rhus*)	Lowland - Riparian	1							1										
Tricolporopollenites microreticulatus	(Oleaceae: *Olea, Fraxinus, Ligustrum*)	Lowland - Riparian							1							2				
Retitricolporites sp. 1		Unknown	9								2									
Psilatricolporites crassus	(*Pelliciera*)	Mangrove	111	142	5	185	87	102	204	152	170	48	171	161	76	34	33	7	17	24
Psilatricolporites cf. *costatus*	(*Pelliciera*)	Mangrove							2											
Chenopodipollis multiplex	(Chenopodiaceae)	Herbaceous marsh	2													2				
Nowemprojectus tumanganicus		Unknown			5							2	1							
Pediastrum boryanum		Freshwater			2															
Pediastrum duplex		Freshwater			1															
INCERTAE CEDIS																				
Homotrybilium sp.		Marine			1										1					
Cleistosphaeridium sp.		Marine										1								
Undifferentiated dinoflagellate cysts		Marine											1	1	5					
Total			207	211	190	200	194	139	254	203	201	183	204	205	94	56	51	22	25	28

Table 4. 2 Previous age determinations of some forms found in the Başçeşme and Varsakyayla formations.

Fossil	Age	References
Leiotriletes adriennis	Middle Eocene–Middle Miocene	Stuchlik et al. (2001)
Leiotriletes wolffii ssp. *wolffii*	Late Eocene–Pliocene	Nickel (1996a); Stuchlik et al. (2001)
Aglaoreidia cyclops	Middle Eocene–"Middle" Oligocene Early–"Middle" Oligocene	Nickel (1996a) Roche (1988); Hochuli (1978); Ollivier - Pierre et al. (1993)
Spinizonocolpites Group	Eocene Middle Eocene–Early Oligocene	Vinken (1988) Elsik (1974); Frederiksen (1973)
Triatriopollenites excelsus	Paleocene–Late Eocene	Thomson & Pflug (1953); Kedves (1969, 1982); Akyol (1978) ;Gruas–Cavagnetto (1978); Nickel (1996a)
Plicatopollis lunatus	Eocene–"Middle" Oligocene Paleocene–Early Eocene Middle Eocene Late Paleocene–Eocene	Nickel (1996a) Frederiksen (1980) Thiele-Pfeifer (1988) Akgün (2002)
Subtriporopollenites anulatus ssp. *nanus*	Late Palaeocene–Late Eocene	Thomson & Pflug (1953); Krutzsch (1957, 1970b); Krutzsch & Vanhoorne (1977)
Subtriporopollenites constans	Palaeocene–Early Eocene Middle Eocene Middle Eocene–"Middle" Oligocene Palaeocene–Early Oligocene	Kedves (1970); Krutzsch & Vanhoorne (1977) Thiele-Pfeifer (1988) Krutzsch (1970b) Gruas–Cavagnetto (1978)
Nowemprojectus tumanganicus	Paleocene–Middle Eocene Eocene	Bolotnikova (1979) Frederiksen et al. (2002)
Compositoipollenites rhizophorus ssp. *burghasungensis*	Late Eocene	Thomson and Pflug, (1953); Gruas –Cavagnetto, (1968); Kedves, (1970); Nickel, (1996a)

Some of the characteristic Early Eocene taxa of Normapolles, such as *Basapollis*, *Interpollis* and *Urkutipollenites*, are poorly represented in Lower Eocene and do not occur in Middle Eocene at Hungarian localities (Kedves 1986). These pollen have never been recorded in the samples of the Maden member. The stratigraphic distributions of *Triatriopollenites excelsus*, *Subtriporopollenites anulatus* ssp. *nanus*, *Subtriporopollenites constans*, *Plicatopollis lunatus* and *Nowemprojectus tumanganicus* are restricted to Palaeocene and Eocene all over the world (Table 4. 2). *Nowemprojectus tumanganicus* is here recorded for the first time from Eocene sediments of Turkey (Tables 4. 1, 4. 2). Additionally, *Aglaoreidia cyclops* appears in the Middle Eocene and seems to have its last occurrence within or at the top of the "Middle" Oligocene. Thus, this species is not recorded in sediments older than the Middle Eocene (Nickel 1996a; Chateauneuf 1980; Hochuli 1978; Vinken 1988).

In addition to the taxa mentioned above, mangrove and back-mangrove elements such as *Psilatricolporites crassus* (*Pelliciera*), *Spinizonocolpites* group (*Nypa*), *Leiotriletes adriennis* (*Acrostichum aureum*) *Longapertites discordis* (?Arecaceae, ?Lepidocaryoidae) and *Mauritiidites franciscoi* (*Mauritia*) were first recorded in western Anatolia (Table 4. 1). According to Rull (1998a, 1999), the Early Eocene occurrence of *Psilatricolporites crassus* (*Pelliciera*) and *Spinizonocolpites echinatus* (*Nypa*) is always sparse as compared to Middle Eocene of the Venezuelan Maracibo Basin; that observation is consistent with the data of this study. Most European *Nypa* pollen appearances are in the Ypresian–Cuisian deposits of France (Gruas–Cavagnetto 1977), except for Spanish occurrences that range from the Cuisian to Early Lutetian (Haseldonckx 1972) in age. Cavagnetto & Anadón (1996) described complex mangrove–swamp elements, like *Nypa, Avicennia* and *Pelliciera* from the Middle Bartonian (Middle Eocene) of the eastern Ebro Basin (northern Spain). According to Riegel et al. (1999), the mangrove association is prevalent and diverse in the Middle Eocene seam group relative to the Lower Eocene seam group at Helmstedt, northern Germany. The oldest biodiversification age of the mangroves on the European sea–shores is Middle Eocene (Plaziat et al. 2001). Furthermore, though it is necessary to indicate that *Nypa* also occurs at present day ecology, in the Eocene, it associates with some characteristic taxa like *Plicatopollis lunatus*, *Triatriopollenites excelsus*, *Subtriporopollenites anulatus* ssp. *nanus* and *Subtriporopollenites constans*, *Aglaoreidia cyclops* and *Nowemprojectus tumanganicus*.

Based on the palynological data, the Maden member should have been deposited during the Middle–?Late Eocene period (Fig. 4. 1a).

4.1.1.2 Foraminiferal Data and Age Determination

Fifty–four samples were collected from both the Maden and Asar members of the Başçeşme Formation (Fig. 4. 1a, b, c). However, 45 samples were found to be micropalaeontologically productive; samples from the limestones of the Maden member are barren (the samples of M4–M11) (Fig. 2. 5). Sözbilir et al. (2001) studied the microfauna of the Eocene sediments cropping out in the southeastern part of the Baklan area, located on 10 km northeast of the study area.

These authors obtained well–preserved foraminiferal data from the Beşparmak reef member, which is conformably overlain by the Maden member. The well–preserved fauna comprises *Asterigerina rotula*, *Nummulites perforatus*, *Nummulites beaumonti*, *Fabiania cassis*, *Europertia magna*, *Chapmanina gassinensis*, *Halkardia minima*, *Silvestriella tedraedra*, *Rotalia* sp., *Globigerina* sp., *Operculina* sp., *Heterostsegina* sp., *Assilina* sp., *Gypsina* sp., *Planorbulina* sp., *Textularia* sp., *Discocyclina* sp., Hauerinidae, Rotaliidae and algae. A Bartonian (Middle Miocene) age was suggested by the authors, and it is in agreement with our palynological data for the Maden member (Başçeşme Formation).

In this study, samples collected from the Asar member are rich in benthic foraminifers (Fig. 4. 1a, b, c). A *Nummulites* assemblage, including *Nummulites fabianii* and *Nummulites striatus*, has been determined. In addition, *Fabiania cassis*, *Eorupertia magna*, *Halkyardia minima*, *Spahaerogypsina globulus Asterigerina rotula*, *Quinqueloculina* sp., *Asterigerina* sp., *Discocyclina* sp., *Cibicides* sp., *Heterostegina* sp., *Eponides* sp., *Amphistegina* sp., *Alveolina* sp., *Assilina* sp., *Halkardia* sp., *Nummulites* sp., *Operculina* sp., *Praebulalveolina* sp., *Eorupertia* sp., *Fabiania* sp., *Neoalveolina* sp., *Halkyardia* sp., *Anomalina* sp., *Mississippina* sp., *Pararotalia* sp., *Pyrgo* sp., *Rotalia* sp., *Sakesaria* sp. and *Orbitolites* sp. have also been recorded in the samples (Fig. 4. 1a, b, c). Acervulinidae, Hauerinidae, Peneropliidae Rotaliidae, Textulariidae, Valvuniidae, algae, bivalves, gastropods and echinoderms have been documented as well. The foraminiferal fauna suggests a Priabonian (Late Eocene) age, and indicates a carbonate–shelf depositional environment for the Asar member.

On the basis of foraminifer data, Sözbilir et al. (2001) suggested that the age of the Beşparmak reef member is Bartonian. In addition, a Bartonian–?Priabonian age has been suggested for the Maden member on the basis of palynostratigraphic data. Besides, A Priabonian age is assigned on the basis of well–constrained foraminiferal data from the Asar member. In summary, the Beşparmak reef, Maden and Asar members were deposited during Bartonian–?Priabonian time in the study area.

However, it is difficult to interpret the age of the Dazlak member, which is located at the base of the
Başçeşme Formation, due to the lack of fossils. According to Şenel (1997a), Eocene sedimentation in the Çardak–Tokça Area began in the Late Lutetian, an age which may be accepted doubtfully for the Dazlak member.

4.1.2 The Tokça Formation

4.1.2.1 Palynological Assemblage and Age

In this part, the age of the Tokça Formation is indicated. As stated in the chapter 2, clastic sequence of the Tokça Formation can be divided into two parts, lower part of Üçtepeler reef member and upper part of the Üçtepeler reef member. Sixteen samples were taken from the lower part of the Üçtepeler reef member (Fig. 2. 14). Since the samples poorly preserved, only one sample could be counted (Fig. 4. 2, Table 4. 3). Pterodophytic spores are stood for by a high percentage (33%). However, their diversity is very poor and represented by only three genera, such as *Leiotriletes*, *Polypodiaceoisporites* and *Laevigatosporites*. Nevertheless, both diversity and abundance of tricolpate and tricolporate pollen grains is also stood for low percentage (Table 4. 3). The percentage of *Pityosporites microalatus* (23%) *Momipites punctatus* (~14) and *Caryapollenites simplex* (11%) is relatively high. *Triatriopollenites excelsus*, *Plicatopollis plicatus* and *P. hungaricus* which generally indicates the lower Tertiary forms the main points of the sample (Ütpl–4).

In contrast, thirty three samples were taken from the upper part of the Üçtepeler reef member (Figs 2. 11, 2. 15). Sixteen samples were suitable for the palynological examinations (Fig. 4. 2, Table 4. 3).

Palynological analysis contains spores, gymnosperm and angiosperm pollen grains, a few dinoflagellate cysts and freshwater *Botryococcus braunii* which are fairly well preserved (Table 4. 3). Palynological counts range between 98 and 356 grains/specimen (Table 4. 3). The palynomorph assemblage consists of ten spore species, seven gymnosperm pollen, and fifty angiosperm pollen (Table 4. 3).

The species of *Laevigatosporites haardti* (~19%), *Pityosporites microalatus* (~6%), *Caryapollenites simplex* (~3%) and *Momipites punctatus* (36%) occur very frequently (Table 4. 3).

Counting results indicate that abundantly occurring species except *Caryapollenites simplex* is not biostratigraphically important for the palynomorph assemblage defined in this study. Conversely, five pollen species recovered from the Tokça Formation have biostratigraphic significance according to the published literatures on Tertiary palynomorphs.

Table 4. 3. Quantitative counting results of palynomorphs encountered in the Tokça Formation of the Çardak–Tokça Area.

TAXA		Palaeovegetation Types	Sample Numbers																
SPORE			Utpl-4	02/103	02/104	02/105	T-2	T-4	T-5	T-6	T-7	T-8	T-9	T-14	T-16	T-17	T-18	T-19	T-21
Leiotriletes microadriennis	(Schizaeaceae: ?*Lygodium*)	Swamp - Freshwater	36									1							
Leiotriletes maxoides ssp. *maxoides*	(Schizaeaceae: ?*Lygodium*)					4									1				
Leiotriletes triangulus		Unknown	14																
Polypodiaceoisporites saxonicus	(Pteridaceae: *Pteris*)	Swamp - Freshwater	3											6					
Trilites sp. 1		Unknown												1					
Baculatisporites nanus	(Osmundaceae: *Osmunda*)	Swamp - Freshwater		1		10													
Laevigatosporites major	(Polypodiaceae)								1										
Laevigatosporites haardti	(Polypodiaceae)		3	136	94	130	56	2	127		2	6		67	1			2	6
Laevigatosporites gracilis	(Polypodiaceae)			5	8		2						2						
Verrucatosporites alienus	(Davalliaceae)			1															
Verrucatosporites balticus	(Polypodiaceae)														1				
GYMNOSPERM SACCAT																			
Pityosporites microalatus	(Pinaceae: *Pinus* haploxylon type)	Montane	38	6	5	1	15	16	22	19	15	27	2		6	2	20	11	3
Pityosporites labdacus	(Pinaceae: *Pinus* sylvestris type)								3	1		2		22	6			7	
Pityosporites minitus	(Pinaceae: *Pinus*)									2									
Cedripites sp. 1	(?*Cedrus*)														1				
Piceapollis sp. 1	(?Pinaceae)						2					3							
GYMNOSPERM NON-SACCAT																			
Inaperturopollenites dubius	(Taxodiaceae)	Swamp - Freshwater		2					4		9		22	1				6	
Inaperturopollenites concedipites	(Taxodiaceae)			4		5		4								1			
Inaperturopollenites magnus	(?Pinaceae: ?*Pseudotsuga*)											2							
Inaperturopollenites hiatus	(Taxodiaceae)						1		1		12	2							
ANGIOSPERM POLLEN																			
MONOCOTYLEDONEAE																			
Cycadopites gracilis	(Cycadaceae: *Cycas*)	Lowland - Riparian	4	7	1	1	5		12		3		28	2				7	
Cycadopites ?minimus	(Cycadaceae: *Cycas*)							3	1				3						
Magnoliaepollenites neogenicus ssp. *minor*	(?Magnoliaceae)	Unknown											4					1	
Monogemmites pseudosetarius		Lowland - Riparian							1		82	5		1	2				
Graminidites laevigatus	(?Gramineae)	Swamp - Freshwater							3										
Sparganiaceaepollenites polygonalis	(Sparganiaceae: *Sparganium*)						4	21	4		13	33						4	
Sparganiaceaepollenites neogenicus	(Sparganiaceae)		1					7	5		10	27						1	
Dicolpopollis kockelii	(Palmae: *Calamus*)							1					1						
Longapertites discordis	(?Arecaceae, ?Lepidocaryoidae)	Back - Mangrove					2					1							
DICOTYLEDONEAE																			
Triatriopollenites rurensis	(Myricaceae: *Myrica*)	Lowland - Riparian	1	1	2	1	1	3	1		3	6	1		1	1	4	1	
Triatriopollenites myricoides	(Myricaceae)												59						
Triatriopollenites bituitus	(Myricaceae: *Myrica*)					2		1		1	1	1		2			2		
Triatriopollenites excelsus ssp. *minor*	(Myricaceae)		5			1				1	1				1		1		
Plicatopollis plicatus	(Juglandaceae)		6												1			2	
Plicatopollis hungaricus	(?Juglandaceae)		1					2											
Momipites punctatus	(Juglandaceae: *Engelhardia*)		23	21	21	11	118	205	77	137	41	143	20	57	122	49	108	94	73
Momipites quietus	(Juglandaceae: *Engelhardia*)			3		1	7	10	5	10	5		7	1	7	9	2	18	4
Triporopollenites robustus						1					1			1					4
Labrapollis labraferus		Unknown						1				1		1					
Triporopollenites megagranifer	(Betulaceae)	Lowland - Riparian																12	
Olaxipollis matthesii	(Olacaceae: ?*Olax*)	Unknown				4										1			
Trivestibulopollenites betuloides	(Betulaceae)	Lowland - Riparian														5		1	
Caryapollenites simplex	(Juglandaceae: *Carya*)		19	1	2	5	18	9		3	3	5	2	7	13	3	10	16	4
Subtriporopollenites anulatus ssp. *nanus*	(Juglandaceae: ?*Carya*)							7	5		2	3				2	1	5	
Subtriporopollenites constans				2			2												
Celtipollenites intrastructus	(Ulmaceae: *Celtis*)			2															
Polyporopollenites undulosus	(Ulmaceae: ?*Ulmus*,?*Zelkova*)		1				2	2			13	7			2	1	1	2	
Carpinuspollenites carpinoides	(Betulaceae: *Carpinus*)							1			5	3	1					2	
Polyvestibulopollenites verus	(Betulaceae: *Alnus*)					2		2		1			1				1		
Cupanieidites eucalyptoides	(?Myrtaceae, ?Sapindaceae)										1								
Myrtaceidites mesonesus	(Myrtaceae)							1			3			1		1		1	1
Syncolporites sp. 1	(?Myrtaceae)	Unknown																	1
Tricolpopollenites henrici	(Fagaceae: *Quercus*)	Montane						1						1	1				
Tricolpopollenites densus	(Fagaceae: *Quercus*)			3	1	2	3	4	3	2	6	4	1	1		4	3	10	1
Tricolpopollenites liblarensis ssp. *liblarensis*	(?Fagaceae)					3			1			4	1	1	4	1	7	1	
Tricolpopollenites liblarensis ssp. *fallax*	(?Fagaceae)		1		1		6	14		10	1		1	3	12	8	11	6	11
Tricolpopollenites microhenrici	(Fagaceae;*Quercus*)		1	2		1	4	4	4	3	2	4	3		5	3	3	7	1
Tricolpopollenites parmularius	(?Fagaceae, ?Eucommiaceae: *Eucomminia*)												1						
Tricolpopollenites retiformis	(Saliaceae: *Salix/Platanus*)			7	2	6	9	1	4	7	7	4		6	2	2	2	12	2
Retitricolpites sp. 1		Unknown							1			1						1	
Polycolpites speciosus												1							
Tricolporopollenites pseudocingulum	(Anacardiaceae: *Rhus*)	Lowland - Riparian											1						
Tricolporopollenites cingulum ssp. *oviformis*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)			4	2		20	14	5	4	1	6	3	1	5	3	10	9	6
Tricolporopollenites cingulum ssp. *fusus*	(*Trigonobalanus*)						2												2
Tricolporopollenites cingulum ssp. *pusillus*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)		6			1	5	6		3			1	4				1	2
Tricolporopollenites marcodurensis	(Vitaceae: *Cissus*)	Unknown				1													
Tricolporopollenites megaexactus ssp. *exactus*	(Cyrillaceae)	Lowland - Riparian	2	2	3		2	3		4	1	1					1	1	2
Tricolporopollenites megaexactus ssp. *brühlensis*	(Cyrillaceae)			1	4	2	2	2	2			5	1	2			3	1	
Tricolporopollenites microreticulatus	(Oleaceae: *Olea, Fraxinus, Ligustrum*)			2	3	1	2	5	1	4	5	8	1	2	2	1	5	14	1
Tricolporopollenites genuinus	(Cupuliferae)	Unknown						1					3						
Tricolporopollenites kruschi ssp. *pseudolaesus*	(Nyssaceae)	Swamp - Freshwater			1	1							2						
Tricolporopollenites pacatus	(Simarubaceae)	Lowland - Riparian										1							
Tricolporopollenites euphorii	(Araliaceae)															1			
Retitricolporites sp. 1		Unknown						1				1	1						
Ilexpollenites margaritatus	(Aquifoliaceae: *Ilex*)	Lowland - Riparian						1				2	1					1	
Ilexpollenites iliacus	(Aquifoliaceae: *Ilex*)							1											
Chenopodipollis multiplex	(Chenopodiaceae)	Herbaceous marsh								1									
Periporopollenites sp. 1 (thallictrum type)	(Chenopodiaceae)										1							3	
Botryococcus braunii	(Botryococcaceae)	Freshwater							1		40	1					7	15	
INCERTAE CEDIS																			
Undifferentiated dinoflagellate cysts		Marine									1				1			1	
Total			165	213	150	197	290	356	294	213	290	321	174	191	199	98	202	276	124

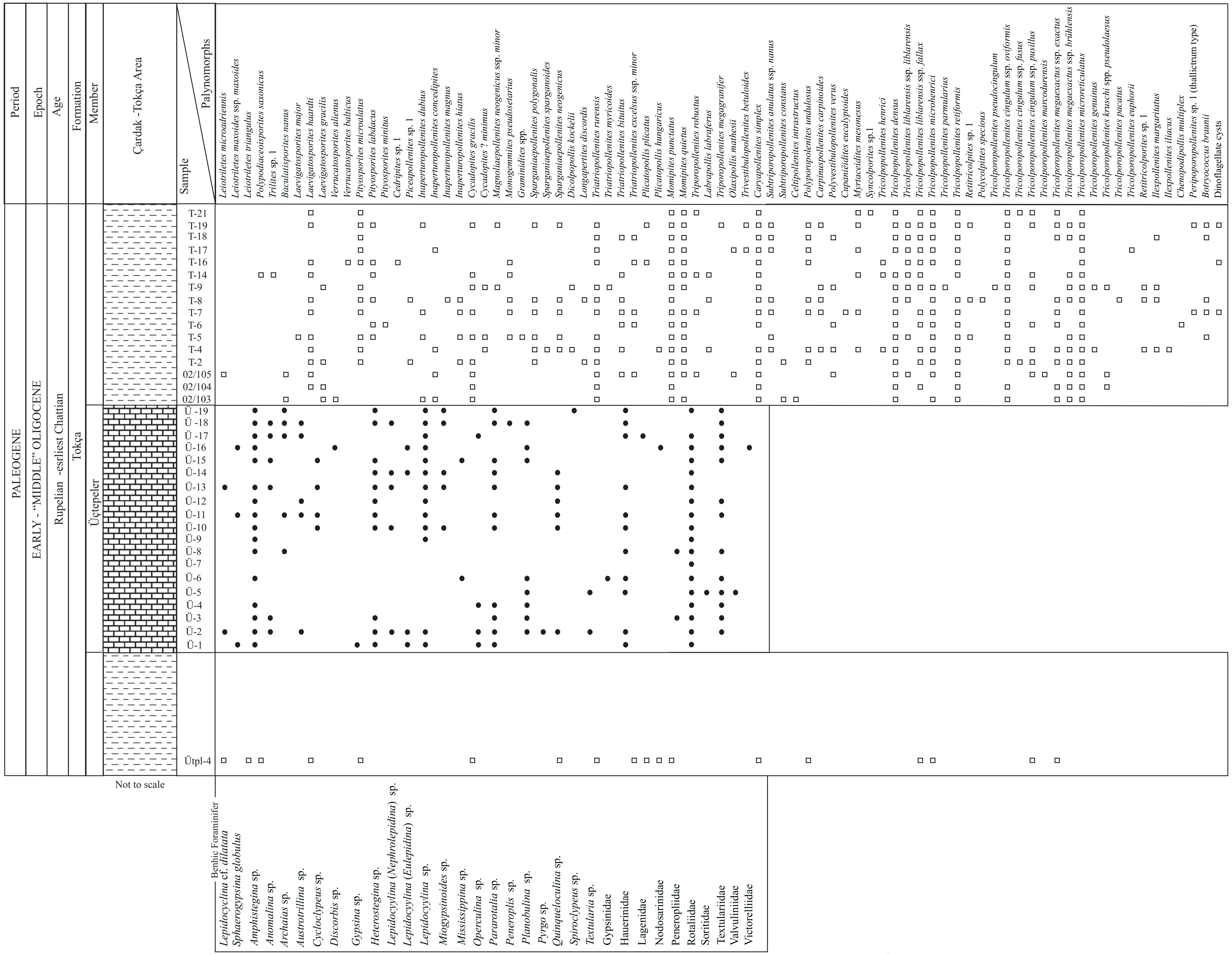

Figure 4.2 Occurrence of palynomorphs, and benthic foraminifers in the Tokça Formation. See figs. 2.11 and 2.13 locations of the samples in the Üçtepeler reef member. See figs.2.11, 2.14 and 2.15 for locations of the samples in the Tokça Formation. See fig. 4.1 for explanation.

The range of biostratigraphically important species like *Dicolpopollis kockelii*, *Caryapollenites simplex*, *Plicatopollis hungaricus*, and *Magnolipollis neogenicus* ssp. *minor* recovered from the Turkish Oligocene basins are given in (Table 4. 4).

Dicolpopollis kockelii Pflanz, 1956 is generally found in the Oligocene sediments in Turkey. According to Nakoman (1966a), the species occur in the Lower Tertiary sediments of the Thrace Basin. Akyol (1971) determined the species from the Early Oligocene of Şile (İstanbul). Ediger et al. (1990) reported that, although *Dicolpopollis* is frequently found in the Eocene–Oligocene rocks all over the world, *D. kockelii* forms an acme zone in the Upper Oligocene (Chattian) rocks in the northern Thrace Basin. Akgün & Sözbilir (2001) reported the occurrence of the species from Late Oligocene and Early Miocene of southwest Anatolian molasse basins. In spite of the fact that the genus *Dicolpopollis* is not restricted to the Oligocene, it is regularly found in the Oligocene deposits of Northwest Europe (Boulter & Craig, 1979; Wilkinson et al., 1980). It was also recorded from the Oligocene of North India (Salujha et al., 1974).

Caryapollenites simplex (Potonié & Venitz, 1934) Thomson & Pflug, 1953 was reported for the first time in the Early Oligocene of Ağaçlı (Istanbul) lignites by Nakoman (1968). Hochuli (1978); Gruas–Cavagnetto (1988); Schuler (1988); Roche (1988); Nickel (1996a) determined the species from the Early Oligocene–Miocene deposits of different localities of Europe. The species was reported from the Early Oligocene–"Middle" Oligocene of the Paris Basin by Chateauneuf (1980).

Subtriporopollenites constans Pflug *in* Thomson & Pflug 1953 was described from Early Tertiary in Europe (Thomson & Pflug 1953). It occurs frequently in Palaeocene and Lower Eocene sediments of Europe (Krutzsch, 1970c; Krutzsch & Vanhoorne, 1977; Kedves, 1982). It also occurs in Late Eocene and possibly "Middle" Oligocene (Krutzsch, 1957; 1961; 1970c). According to Lenz (2000), the range of species is between Palaeocene and "Middle" Oligocene. Akgün (2002) and Akgün et al. (2002) indicate the presence of species from Middle–?Upper Eocene sediments of the Çankırı Basin. Akkiraz & Akgün (2005) determined the species from Lower–"Middle" Oligocene sediments of the Çardak–Tokça Area. Besides, it was recorded from Middle–Upper Eocene sediments of the Çardak–Tokça Area by Akkiraz et al. (2006). It was determined from Middle–?Upper Eocene sediments of the Çankırı Basin by Akkiraz et al. (accepted).

Magnolipollis neogenicus ssp. *minor* Krutzsch 1970a was determined from "Middle" Oligocene, Miocene and Pliocene sediments of Germany (Table 4. 4). The species *Magnolipollis neogenicus* Krutzsch 1970a was mostly described from the Miocene sediments of Europe (Ziembińska–Tworzydlo et al. 1994; Planderova, 1990).

Table 4. 4 Previous age determinations of some forms found in the Oligocene basins.

Fossil	Age	References
Aglaoreidia cyclops	Middle Eocene – "Middle" Oligocene Early – "Middle" Oligocene Late Eocene – Early Oligocene	Nickel, (1996a) Roche, (1988); Hochuli, (1978); Ollivier - Pierre et al., (1993) Chateauneuf, (1980)
Dicolpopollis kockelii	Early Tertiary Late Eocene – Early Oligocene Early Oligocene Early – "Middle" Oligocene Late Oligocene	Nakoman, (1966a) Chateauneuf, (1980), Akyol, (1971); Ollivier - Pierre , (1980) Roche, (1988) Von Der Brelie, (1988)
Compositoipollenites rhizophorus ssp. *burghasungensis*	Late Eocene	Thomson and Pflug, (1953); Gruas –Cavagnetto, (1968); Kedves, (1970); Nickel, (1996a)
Intratriporopollenites instructus	Early Oligocene – Late Oligocene Early Oligocene – Miocene Late Oligocene	Schuler, (1988); Roche, (1988) Wilkinson & Boulter, (1980) Von Der Brelie, (1988)
Magnolipolliss neogenicus ssp. *minor*	"Middle" Oligocene – Pliocene	Krtzsch, (1970a)
Caryapollenites simplex	Early – "Middle" Oligocene Early Oligocene – Miocene	Chateauneuf, (1980) Hochuli, (1978); Roche, (1988); Schuler, (1988); Nickel, (1996a)
Plicatopollis hungaricus	Early Eocene Eocene Oligocene	Kedves, (1974) Nickel, (1996a) Kedves, (1985)
Extratriporopollenites pompeckji	Early Tertiary	Thomson & Pflug, (1953)
Slowakipollis hippophaëoides	Oligocene Early – "Middle" Oligocene	Gorin, (1975) Chateauneuf, (1980)
Boehlensipolis hohli	Early – "Middle" Oligocene "Middle" Oligocene	Gorin, (1975); Chateauneuf, (1980); Ollivier - Pierre et al., (1993); Hochuli, (1978), Schalke, (1988); Roche, (1988); Boulter & Craig, (1979)
Pentapollenites pentangulus	Paleocene – "Middle" Oligocene Middle Eocene – "Middle" Oligocene	Nickel, (1996a) Chateauneuf, (1980)
Gothanipollis sp.	Middle Eocene Early Eocene – Early Oligocene Oligocene	Fairchild & Elsik, (1969) Tschudy, (1973) Boulter & Craig, (1979); Wilkinson & Boulter, (1980); Wilkinson et al., (1980)
Mediocolpopollis compactus ssp. *ellenhausensis*	Late Eocene Late Eocene – "Middle" Oligocene "Middle" Oligocene Late Oligocene	Hochuli, (1978) Nickel, (1996a) Boulter & Craig, (1979) Krutzsch, (1959)

Plicatopollis hungaricus Kedves 1974 was described from the Lower Eocene sediments of Bakony Mountains (Hungary). The species was also determined from the Eocene sediments of the Upper Rhine Graben by Nickel (1996a). Conversely, Kedves (1985) reported low frequency of species from the Oligocene sediments of Egypt. Only a single grain was recorded from the Tokça Formation in this study (Table 4. 3).

Additionally, Akkiraz & Akgün (2005) obtained some stratigraphical marker species from the samples of upper part of Üçtepeler reef member (Table 4. 4). Their ranges were given in ascending order:

Boehlensipollis hohli Krutzsch, 1962b is a stratigraphic marker for Early–“Middle” Oligocene of France (Gorin, 1975; Chateauneuf, 1972, 1980; Ollivier–Pierre et al., 1993) and has similar range in Central and Western Paratethys (Hochuli, 1978). The species has been found from the “Middle” Oligocene in Belgium (Roche, 1988) and in Netherlands (Schalke, 1988). The species has also been found in the “Middle” Oligocene strata of the Bristol Channel (Boulter & Craig, 1979). The species has not been recorded from Late Oligocene of the Thrace Basin and southwest Anatolian molasse basins (Nakoman, 1968; Akgün & Sözbilir, 2001), whereas occurrence of the species has been reported from Early Oligocene of the Osmanoğlu Formation in the Çankırı–Çorum Basin by Akgün (2002).

Slowakipollis hippophaëoides Krutzsch, 1962b is other important species for the Oligocene. The Oligocene age from the Grande Limagne for this species is based on Gorin (1975)’s report. It also occurs in the Early–“Middle” Oligocene of the Paris Basin (Chateauneuf, 1980).

Aglaoreidia cyclops Erdtman, 1960 appears in the Middle Eocene and seems to have last occurrence within or top of “Middle” Oligocene. From this point of view, the species is not known later “Middle” Oligocene (Nickel, 1996a; Chateauneuf, 1980; Hochuli, 1978; Vinken, 1988).

Compositoipollenites rhizophorus Potonié, 1960 ssp. *burghasungensis* (Mürriger & Pflug, 1952) Mürriger & Pflug *in* Thomson & Pflug, 1953 reaches to Late Eocene and then disappears in Europe (Thomson & Pflug, 1953; Gruas-Cavagnetto, 1968; Kedves, 1970; Nickel, 1996a).

Mediocolpopollis compactus Krutzsch, 1959 ssp. *ellenhausensis* Krutzsch, 1970c was reported from Late Eocene of the Upper Rhine Graben by Nickel (1996a). The species was also determined from Late Eocene of Central and Western Paratethys by Hochuli (1978). It was found in Late Oligocene of western part of the British Isles (Wilkinson & Boulter, 1980) and in "Middle" Oligocene of the Bristol Channel sediments (Boulter & Craig, 1979).

Pentapollenites pentangulus (Pflug *in* Thomson & Pflug, 1953) Krutzsch, 1958 was reported from the Middle Eocene–Early Oligocene of the Paris Basin by Chateauneuf (1980). It has a Palaeocene to "Middle" Oligocene range in the Upper Rhine Graben (Nickel, 1996a).

Intratriporopollenites instructus (Potonié, 1931c) Thomson & Pflug, 1953 was generally found from Early Oligocene to Miocene of Europe (Wilkinson & Boulter, 1980). But it is rare in the "Middle" Oligocene (Mai, 1961; Krutzsch, 1967b).

Besides, *Leiotriletes microadriennis*, *Leiotriletes maxoides* ssp. *maximus*, *Leiotriletes adriennis*, *Verrucatosporites scutulum*, *Verrucatosporites alienus*, *Verrucatosporites favus* found in the Eocene–Oligocene are observed in the palynomorph assemblage of Akkiraz & Akgün (2005).

The species of *S. hippophaëoides*, *A. cyclops*, *C. rhizophorus* ssp. *burghasungensis*, *P. pentangulus* and *M. compactus* ssp. *ellenhausensis* have not been recorded from the other Turkish Oligocene basins up to now. Finally, the stratigraphic distribution of the taxa mentioned above and some spores such as *Leiotriletes*, *Verrucatosporites*, *Baculatisporites* and *Polypodiaceoisporites* indicates that Tokça lignites are of Early–"Middle" Oligocene age.

4.1.2.2 Foraminiferal Data and Age Determination

Nineteen samples were taken from the Üçtepeler reef member (Figs. 2. 11, 2. 13). As indicated in figure 4. 2, almost all samples include a rich bentonic foraminifer assemblage. The age of the Üçtepeler reef member is Rupelian–?Chattian (Early–?Late Oligocene) on the basis of *Lepidocyclina* (*Eulepidina*) *dilatata* d'Arciach, *Miogypsinoides* sp. (primitive forms), *Austrotrillina* sp. and *Cycloclypeus* sp. (Fig. 4. 2).

From palaeoenvironmental point of view, it can be said that forereef facies including *Lepidocyclina* sp. and *Heterostegina* sp. assemblage and patch reef facies with corals occurred during the deposition of Üçtepeler reef member.

According to Göktaş et al. (1989), the coral assemblage comprising, including *Phyllocoenia* cf. *lucasiana*, *Cricocyathus* cf. *aanulatus*, *Montastraea inaequalis*, *Stylophora* cf. *microstyla*, *Cyathamorpha gregoria Astrocoenia* cf. *laminosa*, *Agathiphyllia rochettina*, *Tarbellastraea organalis*, *Antillia cyclindroides*, *Michelottiphyllia* sp., *Siderofungia* sp., *Echinophora* sp., *Meandrina* sp., *Antiguastraea* sp., and *Porites* sp., indicates a "Middle" Oligocene age for the Tokça Formation. The benthic foraminiferal association of the formation is made up of *Lepidocyclina* cf. *dilatata*, *Lepidocyclina* sp., *Nummulites intermedius*, *Nummulites* cf. *vascus*, *Operculina* sp., *Pararotalia* sp., *Quinqueloculina* sp., *Ditrupa* sp., *Heterostegina* sp. and *Gypsina* sp., and suggest a Late Oligocene age. The Late Oligocene age was used by the authors.

All in all, the present state of knowledge on the basis of palynomorph and benthic foraminifer contents states that the sedimentation of the Tokça Formation began in Early–"Middle" Oligocene.

4.2 The Burdur Area

4.2.1 The Varsakyayla Formation

4.2.1.1 Palynological Assemblage and Age

Five palynological samples were collected from the clastic part of the Varsakyayla Formation (Fig. 2. 21). However, only two samples were suitable for palynological counting (Fig. 4. 3, Table 4. 5). Due to the low diversity and relative percentages of the species, 175 pollen grains for one sample and 164 pollen grains for the other one could be counted (Table 4. 5). In total, thirty–seven spore pollen species were determined. Only two spore species *Leiotriletes triangulus* and *Baculatisporites primarius* ssp. *oligocaenicus* were counted (Table 4. 5). The angiosperm pollen average is always higher than spores and gymnosperm. The pollen species *Plicatopollis plicatus* (~13%), *Momipites punctatus* (~10%) *Momipites quietus* (8%), *Tricolpopollenites retiformis* (15%) and *Tricolpopollenites liblarensis* (8%) are stood for high percentages. The other angiosperms are comparatively represented by lower percentages (1–3%). Additionally, marine *Cleistosphaeridium* sp. and *Cordosphaeridium* sp., and undifferentiated dinoflagellate cysts were also described from the samples (Fig. 4. 3, Table 4. 5).

As indicated in the palynomorph assemblage of the Maden member (Başçeşme Formation), the characteristic Early Eocene taxa Normapolles, such as *Basopollis*, *Interpollis* and *Urkutipollenites* do not occur in the Varsakyayla Formation.

According to Riegel et al. (1999), the variety of Normapolles is higher in the Early Eocene than in Middle Eocene. Normapolles have not been recorded from the Middle–?Late Eocene coal occurrences of central Anatolia by Akyol (1980), Akgün (2002) and Akgün et al. (2002). Besides, the species of *Plicatopollis lunatus*, *Triatriopollenites excelsus*, *Subtriporopollenites anulatus* ssp. *nanus* and *Compositoipollenites rhizophorus* ssp. *burghasungensis* generally observed in Eocene sediments were also determined in the Varsakyayla Formation (Table 4. 2). The age of the clastic part of the Varsakyayla Formation is of Middle–?Late Eocene based on presence of stratigraphical marker species in Table 4. 2.

Table 4. 5 Quantitative counting results of palynomorphs encountered in the Varsakyayla Formation of the Burdur Area.

TAXA		Palaeovegetation Types	Sample numbers	
SPORE			04/YC01	04/YC02
Leiotriletes triangulus		Unknown		1
Baculatisporites primarius ssp. *oligocaeinus*	(Osmundaceae: *Osmunda*)	Swamp - Freshwater	2	
GYMNOSPERMOUS				
Pityosporites microalatus	(Pinaceae: *Pinus* haploxylon type)	Montane	11	4
ANGIOSPERMOUS				
MONOCOTYLEDONEAE				
Arecipites brandenburgensis	(?Arecoideae, ?Palmae)	Back - Mangrove	1	
DICOTYLEDONEAE				
Triatriopollenites rurensis	(Myricaceae: *Myrica*)			3
Triatriopollenites bituitus	(Myricaceae: *Myrica*)		1	
Triatriopollenites excelsus ssp.*typicus*	(Myricaceae)			1
Plicatopollis lunatus	(Juglandaceae)			2
Plicatopollis plicatus	(Juglandaceae)		18	25
Momipites punctatus	(Juglandaceae: *Engelhardia*)	Lowland - Riparian	14	18
Momipites quietus	(Juglandaceae: *Engelhardia*)		12	15
Subtriporopollenites anulatus ssp. *nanus*	(Juglandaceae: ?*Carya*)		2	
Intratriporopollenites indubitalibis	(Tiliaceae)		1	
Compositoipollenites rhizophorus ssp. *burghasungensis*	(Icacinaceae)		1	1
Polyporopollenites undulosus	(Ulmaceae: *Ulmus*)			1
Tricolpopollenites retiformis	(Saliaceae: *Salix/Platanus*)		29	24
Tricolpopollenites microhenrici	(Fagaceae: *Quercus*)		4	3
Tricolpopollenites parmularius	(?Fagaceae, ?Eucommiaceae: ?*Eucomminia*)		1	
Tricolpopollenites henrici	(Fagaceae: *Quercus*)	Montane	1	
Tricolpopollenites liblarensis ssp. *liblarensis*	(?Fagaceae)		9	21
Tricolpopollenites liblarensis ssp. *fallax*	(?Fagaceae)		17	7
Tricolporopollenites asper	(Fagaceae: *Quercus*)		2	
Tricolporopollenites pseudocingulum	(Anacardiaceae: *Rhus*)			1
Tricolporopollenites cingulum ssp. *oviformis*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)	Lowland - Riparian	11	5
Tricolporopollenites cingulum ssp. *fusus*	(*Trigonabalanus*)		7	2
Tricolporopollenites cingulum ssp. *pusillus*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)		3	2
Tricolporopollenites marcodurensis	(Vitaceae: *Cissus*)	Unknown		1
Tricolporopollenites megaexactus ssp. *exactus*	(Cyrillaceae)		2	3
Tricolporopollenites megaexactus ssp. *brühlensis*	(Cyrillaceae)		10	7
Tricolporopollenites edmundi	(Mastixiaceae)	Lowland - Riparian		1
Tricolporopollenites microreticulatus	(Oleaceae: *Olea, Fraxinus, Ligustrum*)		6	5
Tricolporopollenites oleoides	(Oleaceae)		1	
Tricolporopollenites villensis	(Cupuliferae)			2
Tricolporopollenites solé de portai	(?Fabaceae, ?Rosaceae, ?Anacardiaceae)	Unknown		1
Tricolporopollenites kruschi ssp. *pseudolaesus*	(Nyssaceae)	Swamp - Freshwater		1
Psilatricolporites crassus	(*Pelliciera*)	Mangrove	2	2
Tetracolporopollenites obscurus	(Sapotaceae)	Lowland - Riparian	1	
INCERTAE CEDIS				
Cleistosphaeridium sp.			1	
Cordosphaeridium sp.		Shallow - marine	2	
Undifferentiated dinoflagellate cysts			3	4
Total			175	163

Furthermore, the palynomorph content of the two samples is similar to palynomorph content of the Maden member (Başçeşme Formation). Especially, mangrove element *Psilatricolporites crassus* (*Pelliciera*) represented by high percentages in the Maden member also occurs in the Varsakyayla Formation, as few grains (Table 4. 5). The clastic parts of the Varsakyayla Formation are well correlated with the Maden member (Başçeşme Formation) due to presence of stratigraphical marker species indicated in Table 4. 2.

Notwithstanding only two samples in the Varsakyayla Formation are productive concerning the palynomorph content. The palynomorph assemblage obtained is similar to the palynomorph content of the Maden member (Başçeşme Formation).

However, diversity of species obtained from the Varsakyayla Formation is poorer than the Maden member.

4.2.1.2 Foraminiferal Data and Age Determination

Thirty–nine samples were taken from the upper part of the Varsakyayla Formation (Figs. 2. 18, 2. 21). As stated in the figure 4. 3, thirty–seven samples were productive for the benthic foraminifer content (Fig. 4.3a, b). Haurinidae and Rotaliidae occur in roughly all samples (Fig. 4. 3a, b). Furthermore, *Nummulites fabianii*, *Halkyardia minima*, *Eorupertia magna* and *Sphaerogypsina globolus* were described as well (Fig. 4. 3). The presence of the *Nummulites fabianii* indicates the "Shallow Bentonic Zonation" of Serra–Kiel et al. (1998) who studied larger foraminiferal biostratigraphy of the Tethyan Palaeocene and Eocene, and corresponds to the Priabonian (Late Eocene). *Nummulites fabianii* primarily occur in the samples of 04YC/32–04YC/36, 04YC/24–04YC/25, 04YC/13–04YC/22 and 04YC/37–04YC/39 (Fig. 4. 3a). Samples between 04YC/06 and 04YC/12 have reefal character, and do not include *Nummulites* and *Discocyclina* because these kind of shallow marine environments are not suitable for their optimal living conditions. Samples between 04YC/29 and 04YC/31 signify the shelf lacustrine environment. Samples 04YC/32–04YC/36 and 04YC/25–04YC/27 indicate a carbonate shelf environment oriented by deeper marine conditions. Sample 04YC/24 indicates a reefal character. Samples between 04YC/06 and 04YC/11 determine a shallow shelf environment, while samples between 04YC/12 and 04YC/23 suggest a deep shelf environment. Sample 04YC/21 indicates a shallow marine environment. Samples between 04YC/37 and 04YC/39 suggest a carbonate shelf environment. Additionally, Anomaliniidae, Discorbiidae, Peneropliidae, Textulariidae and Valvuliniidae were also described from the samples (Figs. 4. 3a, b).

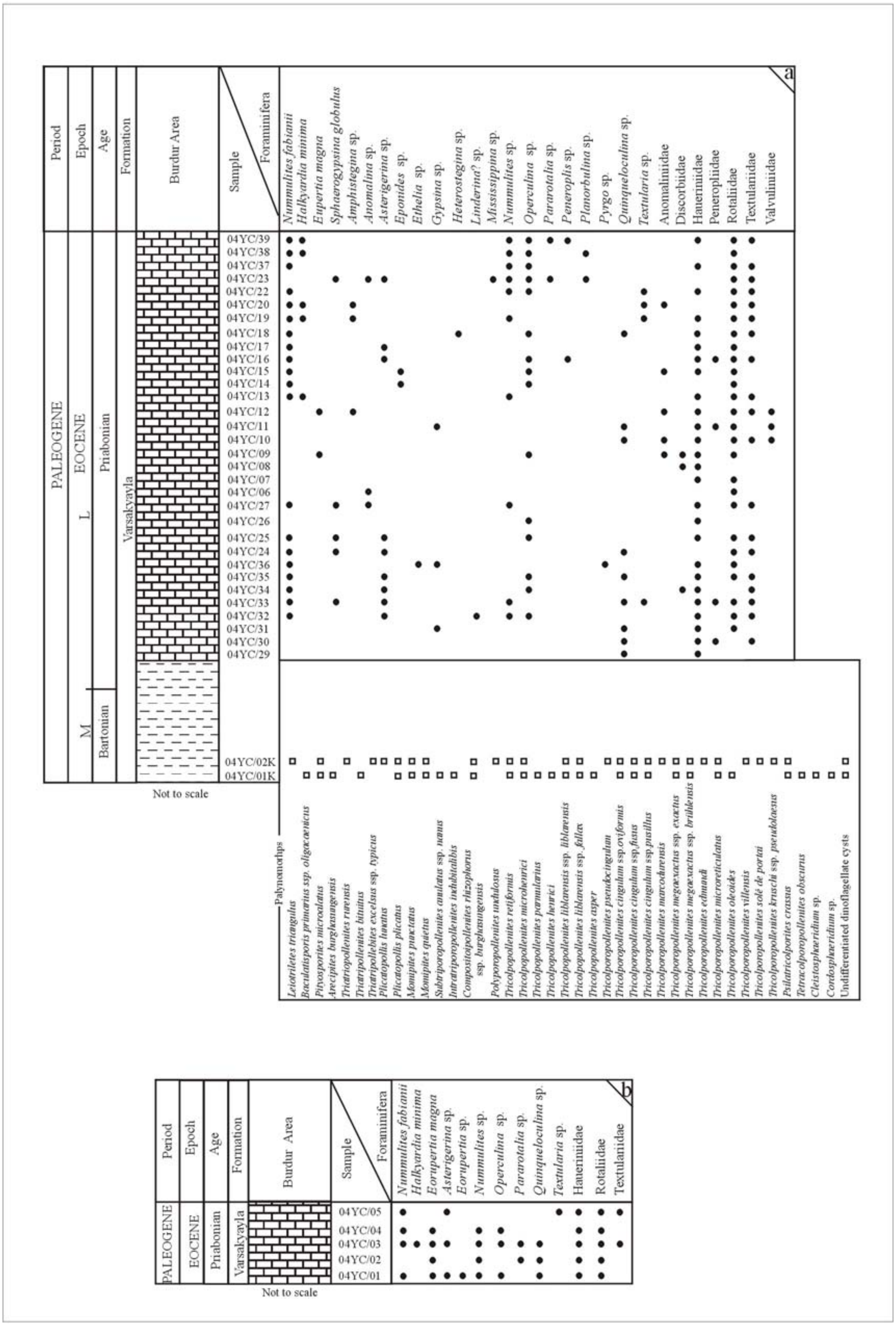

Figure 4. 3 Occurrence of palynomorphs and benthic foraminifers in the Varsakyayla Formation, (a) See figure 2. 20 for sample locations, (b) See figure 2. 18 for sample locations (See figure 4. 1 for explanation).

As a consequence, clastic parts of the Varsakyayla Formation can be well correlated with the Maden member (Başçeşme Formation) owing to the fact that both of them have similar palynomorph assemblages and biostratigraphic species. Further, limestones of the upper part of the Varsakyayla Formation can also be correlated with the Asar member (Başçeşme Formation) concerning their benthic foraminifer assemblages, which give a Priabonian (Late Eocene) age.

4.2.2 The Kavak Formation

4.2.2.1 Palynological Assemblage and Age

Twenty–three samples were taken from the Kavak Formation (Figs. 2. 22, 2. 25, 2. 26, 2. 27c). However, only five samples were suitable for palynological counting. The flora is represented by forty species and is here recorded (Fig. 4. 4, Table 4. 6). The number of angiosperm pollen is always higher than gymnosperm and spores (Table 4. 6). Palynological counts range between 94 and 198 grains/specimen (Table 4. 6). *Momipites punctatus* (30%), *Tricolpopollenites microhenrici* (3%) and *Tricolporopollenites cingulum* (8%) commonly present in Tertiary, occur very frequently in the palynomorph assemblage (Table 4. 6). However, from the biostratigraphical point of view, there is no importance of these species. If we think about that relative percentages and diversity of spore species were high during Oligocene, their percentages are represented by lower percentages in the palynomorph assemblage of the Kavak Formation (~1%). Conversely, *Momipites quietus* represented by high percentages in Eocene and Oligocene sediments occurs in low frequencies in the assemblage.

Table 4. 6 Quantitative counting results of palynomorphs encountered in the Kavak Formation of the Burdur Area.

TAXA		Palaeovegetation Types	Sample Numbers				
SPORES			04/08	04/09	04/10	04/27	04/23
Leiotriletes maxoides ssp. *maxoides*	(Schizaeaceae: ?*Lygodium*)	Swamp - Freshwater				3	18
Leiotriletes maxoides ssp. *minoris*	(Schizaeaceae: ?*Lygodium*)						2
Leiotriletes microadriennis	(Schizaeaceae: ?*Lygodium*)						1
Leiotriletes triangulus		Unknown		1	1	3	
Leiotriletes microlepioidites	(Dennstaedtiaceae: ?*Microlepia*)		4				
Leiotriletes sp. 1		Swamp - Freshwater					1
Polypodiaceoisporites saxonicus	(Pteridaceae: *Pteris*)					1	
Echinatisporis miocenicus	(*Selaginella*)					3	
Laevigatosporites haardti	(Polypodiaceae)		2	3	1		1
GYMNOSPERMOUS							
Pityosporites microalatus	(Pinaceae: *Pinus* haploxylon type)	Montane	5	5		2	6
Pityosporites labdacus	(Pinaceae: *Pinus* sylvestris type)				4	1	
ANGIOSPERMOUS							
MONOCOTYLEDONEAE							
Inaperturopollenites concedipites	(Taxodiaceae)	Swamp - Freshwater	3	7	12	7	8
Sequoiapollenites polyformosus	(Taxodiaceae: *Sequoia*)				1		
Cyacadopites gracilis	(Cycadaceae: *Cycas*)	Lowland -Riparian	2	3	3	2	3
Cyacadopites lusaticus	(Cycadaceae: ?*Cycas*)			2			
Longapertites retipiliatus	(?Arecaceae, ?Lepidocaryoidae)	Back - Mangrove		1			
DICOTYLEDONEAE							
Triatriopollenites rurensis	(Myricaceae: *Myrica*)	Lowland -Riparian		1	3	6	2
Triatriopollenites bituitus	(Myricaceae: *Myrica*)				1		
Plicatopollis plicatus	(Juglandaceae)		3	2	2	7	
Plicatopollis hungaricus	(?Juglandaceae)					1	
Momipites punctatus	(Juglandaceae: *Engelhardia*)		46	70	63	80	5
Momipites quietus	(Juglandaceae: *Engelhardia*)		5	11	2	3	1
Caryapollenites simplex	(Juglandaceae: *Carya*)		1	9	2	2	2
Intratriporopollenites instructus	(Tiliaceae: *Tilia*)					1	
Myrtaceidites mesonesus	(Myrtaceae)					1	1
Revesiapollis triangulus	(Sterculiaceae: *Reevesia*)				1		
Carpinuspollenites carpinoides	(Betulaceae: *Carpinus*)		1				
Polyvestibulopollenites verus	(Betulaceae: *Alnus*)		1		1		
Tricolpopollenites retiformis	(Saliaceae: *Salix/Platanus*)	Montane		1	7	2	1
Tricolpopollenites microhenrici	(Fagaceae: *Quercus*)		8	12	10	7	6
Tricolpopollenites densus	(Fagaceae: *Quercus*)			2	1		
Tricolpopollenites henrici	(Fagaceae: *Quercus*)		1			3	
Tricolpopollenites liblarensis ssp. *liblarensis*	(?Fagaceae)			5	4	4	2
Tricolpopollenites liblarensis ssp. *fallax*	(?Fagaceae)		2	5	5		6
Aceripollenites striatus	(Aceraceae: *Acer*)	Unknown			1		
Tricolporopollenites pseudocingulum	(Anacardiaceae: *Rhus*)	Lowland -Riparian	2		1	1	
Tricolporopollenites cingulum ssp. *oviformis*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)		17	21	42	22	15
Tricolporopollenites cingulum ssp. *fusus*	(*Trigonabalanus*)		3	4	7	6	3
Tricolporopollenites cingulum ssp. *pusillus*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)		9	10	14	14	3
Tricolporopollenites pacatus	(Simarubaceae)					2	
Tricolporopollenites megaexactus ssp. *exactus*	(Cyrillaceae)			6	2	1	4
Tricolporopollenites megaexactus ssp. *brühlensis*	(Cyrillaceae)		3	6	4	3	2
Tricolporopollenites microreticulatus	(Oleaceae: *Olea, Fraxinus, Ligustrum*)		1	2	1		1
Tricolporopollenites villensis	(Cupuliferae)		3	3		3	1
Tricolporopollenites euphorii	(Araliaceae)				1	1	
Tetracolporopollenites obscurus	(Sapotaceae)			1	1		
INCERTAE CEDIS							
Cleistosphaeridium sp.		Marine	1				
Undifferentiated dinoflagellate cysts			1	2		1	
Total			122	195	198	193	94

Furthermore, it is necessary to state that the species of Graminae, Chenopodiaceae, Compositae, Umbelliferae, which are represented by regular, low percentages in Middle Miocene of Anatolia, do not occur in the palynomorph assemblage of the Kavak Formation. Their percentages rise up to Upper Miocene and Pliocene. Consequently, the Kavak Formation should be older than Middle Miocene and is of Early Miocene (Aquitanian). Additionally, *Longapertites retipiliatus* and some plicoid forms like *Plicatopollis plicatus* and *Plicatollis hungaricus*, which regularly occur in Eocene and Oligocene, are also present in the samples of the Kavak Formation (Table 4. 6). *Cleistosphaeridium* sp. and undifferentiated dinoflagellate cysts indicating a marine influence were determined in the samples as well (Table 4. 6).

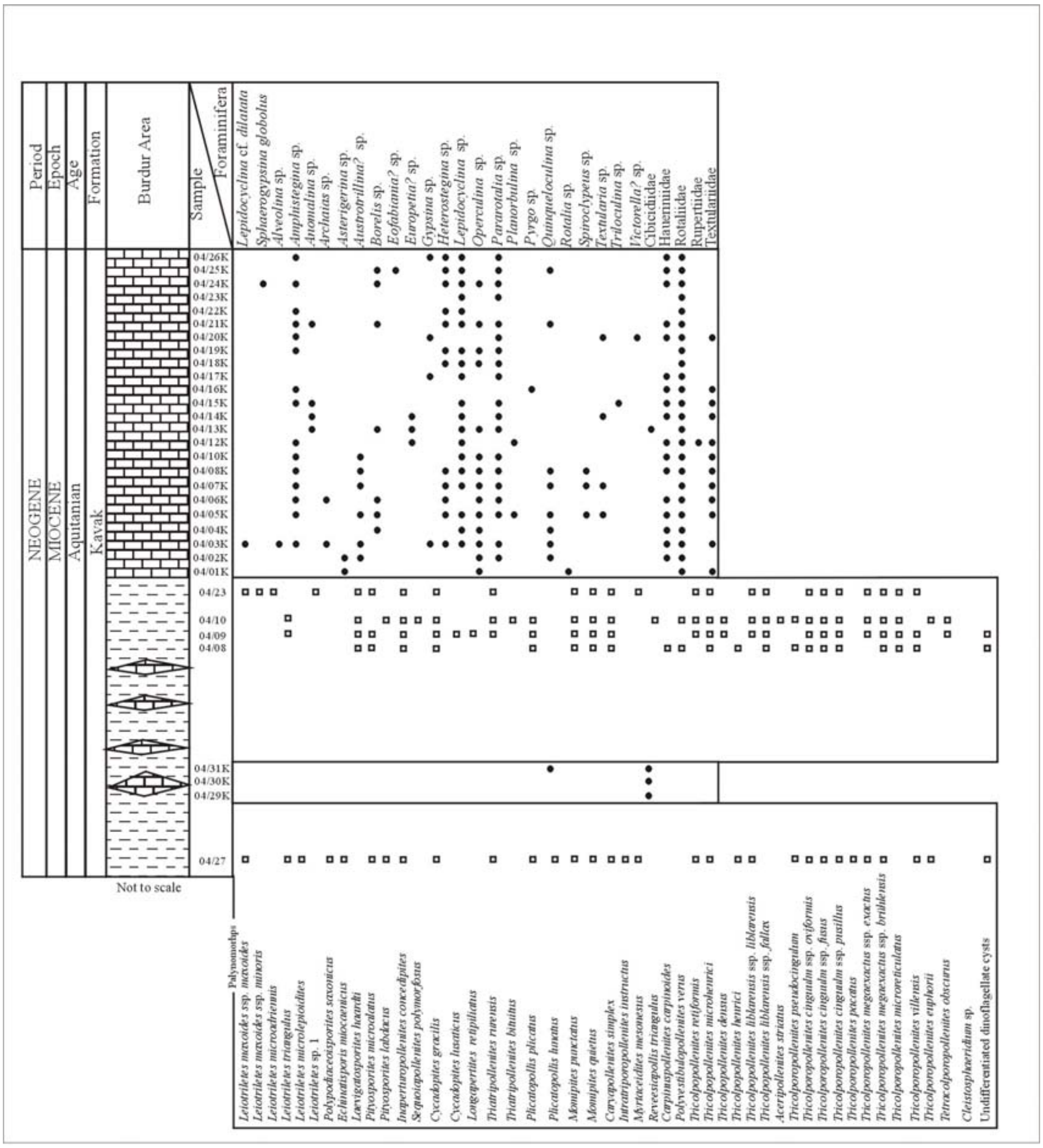

Figure 4. 4 Occurrence of palynomorphs and benthic foraminifers in the Kavak Formation (See figures 2. 22, 2. 25, 2. 26 and 2. 27 for locations of samples and figure 4. 1 for explanation).

4.2.2.2 Foraminiferal Data and Age Determination

Thirty–one foraminifer samples were taken from the Kavak Formation (Figs. 2. 25, 2. 27a, b). Nevertheless, twenty–six samples were productive with regard to foraminifer content (Fig. 4. 4). *Amphistegina* sp., *Heterostegina* sp., *Pararotalia* sp., Haurinidae and Rotaliidae occur nearly in all samples (Fig. 4. 4). The species of *Lepidocyclina* cf. *dilatata* and *Sphaerogypsina globolus* occur in the samples of 04/03K and 04/24K, respectively (Fig. 4. 4). On the basis of the foraminifer content of the samples and also *Lepidocyclina* cf. *dilatata*, the age of the Kavak Formation is of Early Miocene (Aquitanian) and this age is consistent with the palynological age obtained from the Kavak Formation. The genera *Archaias* sp. and *Austrotrillina* sp. occur together with *Lepidocyclina* cf. *dilatata* in these samples and their presence indicate a forereef environment. The absence of the Miogypsinoids in the samples shows that the age of the lower part of the formation should be of Aquitanian. The foraminifer samples were accumulated in a carbonate shelf environment oriented by open marine environment.

4.2.3 The Aksu Formation

4.2.3.1 Palynological Assemblage and Age

Forty samples were collected from the Aksu Formation (Figs. 2. 22, 2. 28, 2. 29). Only nine samples were productive for palynological counting (Fig. 4. 5, Table 4. 7). Palynological counts range between 22 and 304 grains/specimen (Table 4. 7). The flora is characterized by 58 species and is here recorded (Fig. 4. 5, Table 4. 7). The angiosperm count is always higher than gymnosperm and spores (Table 4. 7). Additionally, shallow marine *Cleistosphaeridium* sp. and poorly preserved dinoflagellate cysts were also recorded in the assemblage.

Different kinds of spore genus like *Leiotriletes*, *Polypodiaceoisporites*, *Verrucatosporites* and *Laevigatosporites* have been determined (Table 4. 7). Genus *Leiotriletes* are represented by variegated species (e. g. *L. maxoides*, *L.wolffii*), but their percentages change from sample to sample (Fig. 4. 5, Table 4. 7). The stratigraphically unimportant species of *Momipites punctatus* (11%), and *Tricolporopollenites cingulum* (~10%), which are observed during all Tertiary period, stood for high frequencies in the samples (Table 4. 7). On the other hand, the species *Momipites quietus* occurring frequently in the Eocene and Oligocene sediments is represented by low frequencies in the assemblage (Table 4. 7). The species *Leiotriletes maxoides* ssp. *maximus* and *Dicolpopollis kockelii*, which regularly occur in Eocene and Oligocene sediments of Turkey have been recorded only single grain in the 04A/57 sample (Table 4. 7). Their stratigraphic ranges are given below.

Table 4.7 Quantitative counting results of palynomorphs encountered in the Aksu Formation of the Burdur Area.

TAXA		Palaeovegetation Types	Sample Numbers								
SPORE			04A/40	04A/44	04A/50	04A/51	04A/54	04A/56	04A/57	04A/65	04A/01
Leiotriletes maxoides ssp. *maximus*	(Lygodiaceae: *?Lygodium*)					1			1		
Leiotriletes maxoides ssp. *maxoides*	(Schizaeaceae: *?Lygodium*)	Swamp - Freshwater	57	29	1		2	1	1	2	2
Leiotriletes maxoides ssp. *minoris*	(Schizaeaceae: *?Lygodium*)		56	13	5				5		
Leiotriletes wolffii ssp. *woffii*			26								
Leiotriletes triangulus		Unknown	8								
Leiotriletes seidewitzensis			3								
Leiotriletes neddenioides	(Lygodiaceae? Cyatheaceae?)		23	2							
Leiotriletes microlepioidites	Unknown	Swamp - Freshwater	9		1	1					
Leiotriletes microadriennis	(Schizaeaceae: *?Lygodium*)			19							
Leiotriletes adriennis	(*Acrostichum aureum*)	Back - Mangrove	9					13			
Leiotriletes sp. 2		Unknown	1								
Triplanosporites sinuosus	(*Lygodium*)		8	2							
Polypodiaceoisporites saxonicus					1			1	1		
Verrucatosporites alienus	(Davalliaceae)	Swamp - Freshwater									1
Laevigatosporites haardti	(Polypodiaceae)		22					1	3		
GYMNOSPERMOUS SACCATE											
Pityosporites microalatus	(Pinaceae: *Pinus* haploxylon)	Montane	1						5	1	11
Pityosporites labdacus	(Pinaceae: *Pinus* sylvestris)				1	1		2			
GYMNOSPERMOUS NON-SACCAT											
Inaperturopollenites dubius	(Taxodiaceae)				1					5	
Inaperturopollenites concedipites	(Taxodiaceae)	Swamp - Freshwater			7	12		2	5	17	2
Inaperturopollenites hiatus	(Taxodiaceae)								1	2	
Ephedripites sp. 1	(?Ephedraceae)	Herb		1							
ANGIOSPERMOUS											
MONOCOTYLEDONEAE											
Cycadopites gracilis	(Cycadaceae: *Cycas*)		18	3	1	3	2	1	1		
Cycadopites lusaticus	(Cycadaceae: *?Cycas*)	Lowland - Riparian	8	4					1		
Cycadopites intrastructus	(Cycadaceae: *Cycas?, Ginkgo?*)		5	2					1		
Arecipites brandenburgensis	(?Arecoideae, ?Palmae)	Back - Mangrove			2						
Sparganiaceaepollenites polygonalis	(Sparganiaceae: *Sparganium?, Typa?*)	Swamp - Freshwater						2			
Dicolpopollis kockelii	(Palmae: *Calamus*)		10			1		1	1		
DICOTYLEDONEAE											
Triatriopollenites rurensis	(Myricaceae: *Myrica*)		2			3		2	1		
Plicatopollis plicatus	(Juglandaceae)		2				1	6		1	1
Momipites punctatus	(Juglandaceae; *Engelhardia*)		11	1	20	19	5	38	40	17	6
Momipites quietus	(Juglandaceae; *Engelhardia*)		1		4	2		1	1	1	
Intratriporopollenites insculptus	(Tiliaceae)		1								
Caryapollenites simplex	(Juglandaceae: *Carya*)	Lowland - Riparian	2		3	1				1	2
Polyporopollenites undulosus	(Ulmaceae: *Ulmus?,Zelkova?*)									1	
Carpinuspollenites carpinoides	(Betulaceae: *Carpinus*)							1			
Pterocaryapollenites stellatus	(Juglandaceae: *Pterocarya*)					1					
Polyvestibulopollenites verus	(Betulaceae: *Alnus*)		1					3		2	
Myrtaceidites mesonesus	(Myrtaceae)							2			
Syncolporites sp. 1	(?Myrtaceae)	Unknown				1					
Tricolpopollenites densus	(Fagaceae: *Quercus*)		1		4	3	2	2	4	1	
Tricolpopollenites liblarensis ssp. *fallax*	(?Fagaceae)		2		2	3		4	7	8	5
Tricolpopollenites liblarensis ssp. *liblarensis*	(?Fagaceae)	Montane	1			3	1	8	7	1	
Tricolpopollenites microhenrici	(Fagaceae: *Quercus*)		5		6	12	1	12	9	13	1
Tricolpopollenites parmularius	(?Fagaceae, ?Eucommiaceae, *Eucomminia*)									1	
Tricolpopollenites retiformis	(Saliaceae: *Salix/Platanus*)				3			5	2	1	
Tricolporopollenites pseudocingulum	(Anacardiaceae: *Rhus*)				1			2	1	1	
Tricolporopollenites cingulum ssp. *oviformis*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)		4		48	46		19	23	60	3
Tricolporopollenites cingulum ssp. *fusus*	(*Trigonobalanus*)		3		16	15	3	18	16	9	
Tricolporopollenites cingulum ssp. *pusillus*	(Fagaceae: *Castanea,Castanopsis,Lithocarpus,Pasania*)		3	1	49	34	3	57	46	39	
Tricolporopollenites marcodurensis	(Vitaceae: *Cissus*)	Lowland - Riparian			1						
Tricolporopollenites megaexactus ssp. *exactus*	(Cyrillaceae)				3	5	1	5	3	9	
Tricolporopollenites megaexactus ssp. *brühlensis*	(Cyrillaceae)				10	3	1	25	11	8	
Tricolporopollenites microreticulatus	(Oleaceae: *Olea, Fraxinus, Ligustrum*)							1		1	
Tricolporopollenites villensis	(Cupuliferae)				8	6		4	7	1	
Tricolporopollenites baculoferus		Unknown						1			
Tricolporopollenites satzveyensis	(?Araliaceae)							1		1	
Tricolporopollenites pacatus	(Simarubaceae)	Lowland - Riparian			1						
Tricolporopollenites edmundi										1	
Tricolporopollenites kruschi ssp. *pseudolaesus*	(Nyssaceae)	Swamp - Freshwater						1		1	
Umbelliferaepollenites peissenbergensis	(Umbelliferae)	Herb			1						
Pentapollenites pentangulus	(?Elaeagnaceae, ?Simarubaceae)	Unknown				1					
Tetracolporopollenites microrhombus	(Sapotaceae)							2	3	1	
Tetracolporopollenites obscurus	(Sapotaceae)	Lowland - Riparian			1	2		1	1		1
Tetracolporopollenites sapotoides	(Sapotaceae)								1		
Tetracolporopollenites biconus	(Sapotaceae)									1	
Periporopollenites multiporatus	(Chenopodiaceae)	Herbaceous marsh								1	
Chenopodipollis multiplex	(Chenopodiaceae)			1							
INCERTAE CEDIS											
Cleistopheridium sp.		Marine			1				1		
Undifferentiated dinoflagellate cysts					1	1			1		2
Total			304	78	203	180	22	249	211	209	37

Leiotriletes maxoides Krutzsch 1962a ssp. *maximus* (Pflug *in* Thomson & Pflug 1953) Krutzsch 1962a generally occurs in the Oligocene sediments of Turkey (Akgün & Sözbilir 2001; Akkiraz & Akyol 2005). Its percentage decreases through Late Oligocene and Early Miocene. In this study, only a single grain was determined from a sample of the Aksu Formation.

Dicolpopollis kockelii Pflanzl 1956 is commonly found in the Oligocene sediments of Turkey (e.g. Nakoman, 1966b; Akyol, 1971; Ediger et al., 1990; Batı, 1996; Akgün & Sözbilir, 2001; Akkiraz & Akgün, 2005; Sancay et al., 2006). Though *Dicolpopollis* stood for high percentages in Eocene and Oligocene sediments all over the world, *Dicolpopollis* constitutes an acme zone in the Upper Oligocene sediments of the northern Thrace Basin (Ediger et al., 1990). Its percentage is also high in the Late Oligocene of SW Anatolian molasse sediments (average 7%), and suddenly decreases in the Early Miocene (average 0.8%). The abundance of *Dicolpopollis kockelii* is about 0.5 % in the palynomorph assemblage of the Aksu Formation, and consistent with the abundance of Akgün & Sözbilir's samples.

Additionally, some plicoid forms like *Plicatopollis plicatus* and *P. hungaricus*, which generally occur in Eocene and Oligocene, also occur in these samples defined in this study. Furthermore, as discussed in the palynomorph assemblage of the Kavak Formation, the species of Chenopodiaceae, Umbelliferae, Compositae and Graminae chiefly occur in Middle Miocene and their percentages rise up to Upper Miocene and Pliocene. A single grain of Umbelliferae and also Chenopodiaceae were recorded from the samples of the Aksu Formation, and this low percentage of these forms indicates that the Aksu Formation should be older than Middle Miocene.

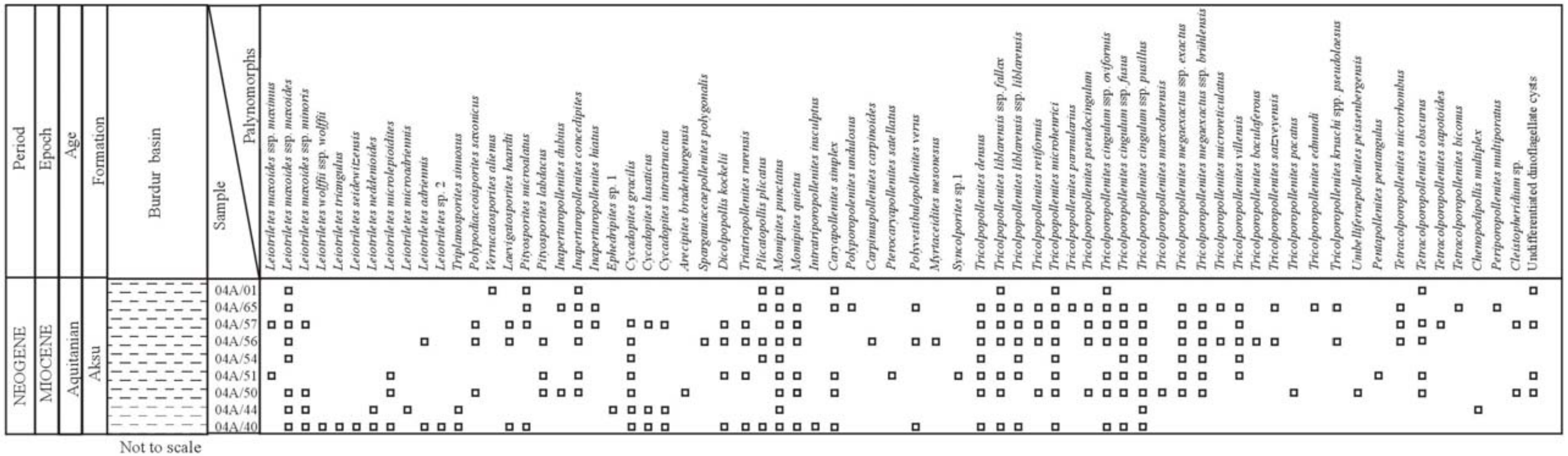

Figure 4. 5 Occurrence of palynomorphs in the Aksu Formation (See figs.2. 28 and 2. 29 for sample locations and fig.4. 1 for explanations).

Finally, the stratigraphic distribution of the taxa mentioned above determines that the Aksu Formation is of Early Miocene and is well correlated with the Kavak Formation. However, while the species *Leiotriletes maxoides* ssp. *maximus* and *Dicolpopollis kockelii* occur in low percentages in the Aksu Formation and they have not been recorded in the palynomorph assemblage of the Kavak Formation.

4.3 The İncesu Area

4.3.1 Surrounding of İncesu Village

4.3.1.1 Kırdağları Series

4.3.1.1.1 Foraminiferal Data and Age Determination. Eight samples were collected from the carbonate rocks of the Kırdağları serie outcropping surrounding İncesu Village (Figs. 2. 33, 2. 36). The samples between 03/32G and 03/34G include limited number of benthic foraminifers that indicate shallow marine characteristics (Fig. 4. 6). Samples 03/27G and 03/28G contain both shallow and deep marine foraminifers (Fig. 4. 6) (hemipelagic environment). Other samples indicated in figure 4. 6 completely determine the deep marine conditions owing to presence of pelagic foraminifera content. Based on the benthic foraminifer assemblage and also planktonic assemblage including *Acarinina* cf. *bulbrooki*, *Acarinina* sp. and *Globigerapsis* sp. suggest a middle–late Lutetian age (Middle Eocene).

The Kayıköy Formation, which was accumulated in flysch facies overlies those carbonates. Eighteen samples were taken from the Kayıköy Formation for the palynological analyses (Figs. 2. 31, 2. 37, 2. 38) All the samples obtained are barren due to poor preservation.

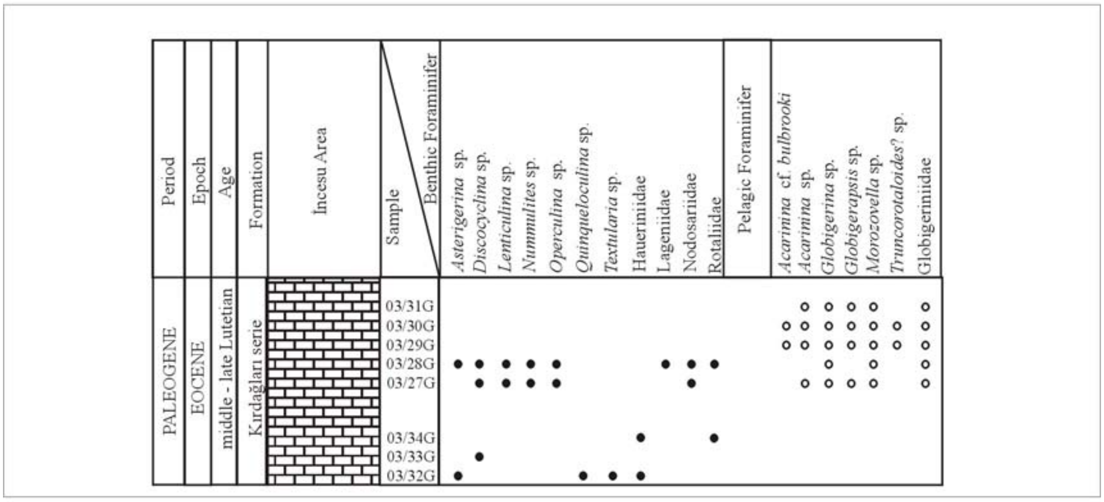

Figure 4. 6 Occurrence of benthic and pelagic foraminifers in the Kırdağları serie (See figures. 2. 33 and 2. 36 for sample locations and figure 4. 1 for explanations).

4.3.1.2 The İncesu Formation

Five samples were taken from the İncesu Formation for the palynological analyses (Fig. 2. 37). All the samples are barren owing to poor preservation.

4.3.2 Surrounding of Gönen and İğdecik

4.3.2.1 The Kayıköy Formation

4.3.2.1.1 Palynological Assemblage and Age. Seventy–eight samples were collected from the Kayıköy Formation (Figs. 2. 39, 2. 43, 2. 44, 2. 45, 2. 49) all of which are completely barren with respect to palynomorph content.

4.3.2.1.2 Foraminiferal Data and Age Determination. Four samples were taken from the section located to southern part of İğdecik Village (Fig. 2. 42). However, these samples were collected from the conglomerates including well–rounded pebbles of Lutetian age derived from the basement rocks.

Because of this, it is not possible to determine the exact time of accumulation of the Kayıköy Formation in this section.

Thirteen samples were taken from the Kayıköy Formation outcropping on the western part of Tınaztepe (Figs. 2. 45, 2. 49). The foraminifer content of twelve samples is indicated in figure 4. 7. Some samples also include planktonic foraminifers like *Globigerina* sp., and Globigerinidae. Taking the spread of *Nummulites* cf. *beaumonti* in the world into account, we can say that the age of the Kayıköy Formation is of Middle Eocene. From palaeoenvironmental point of view, the presence of clastic sediments and fossil fragments determine a flysch environment.

4.3.2.2 The İncesu Formation

4.3.2.2.1 Palynological Assemblage and Age. Eighty–eight samples collected from the İncesu Formation were processed and analyzed for palynomorphs. However, only nineteen samples were suitable for palynological counting (Fig. 4. 7, Table 4. 8). Nearly all samples containing well to fairly well preserved palynological assemblage including spores, gymnosperm saccate and non–saccate grains, angiosperms, dinoflagellate cysts and freshwater algae in relatively fluctuating abundances. Eighty–nine species that have been identified from the samples of the İncesu Formation are listed in both figure 4. 7 and Table 4. 8. Diversity of spores that have been observed in other palynomorph assemblages for now is not as rich as the İncesu Formation. Especially, lots of species belonging to *Leiotriletes* and *Polypodiaceoisporites* were determined (Table 4. 8). Additionally, it is necessary to indicate that the relative percentages of species in the samples vary from sample to sample. For instance, while *Echinatisporis* ?*chattensis* in 03i/142 sample is represented by high percentages (87%), it does not occur in other samples (Table 4. 8). If we want to give another example, when the relative percentages of *Tricolporopollenites cingulum* ssp. *oviformis* are about 27% in the sample of 02i/15 (Table 4. 8), it stands for either relatively low percentages or totally absent in other samples (Table 4. 8).

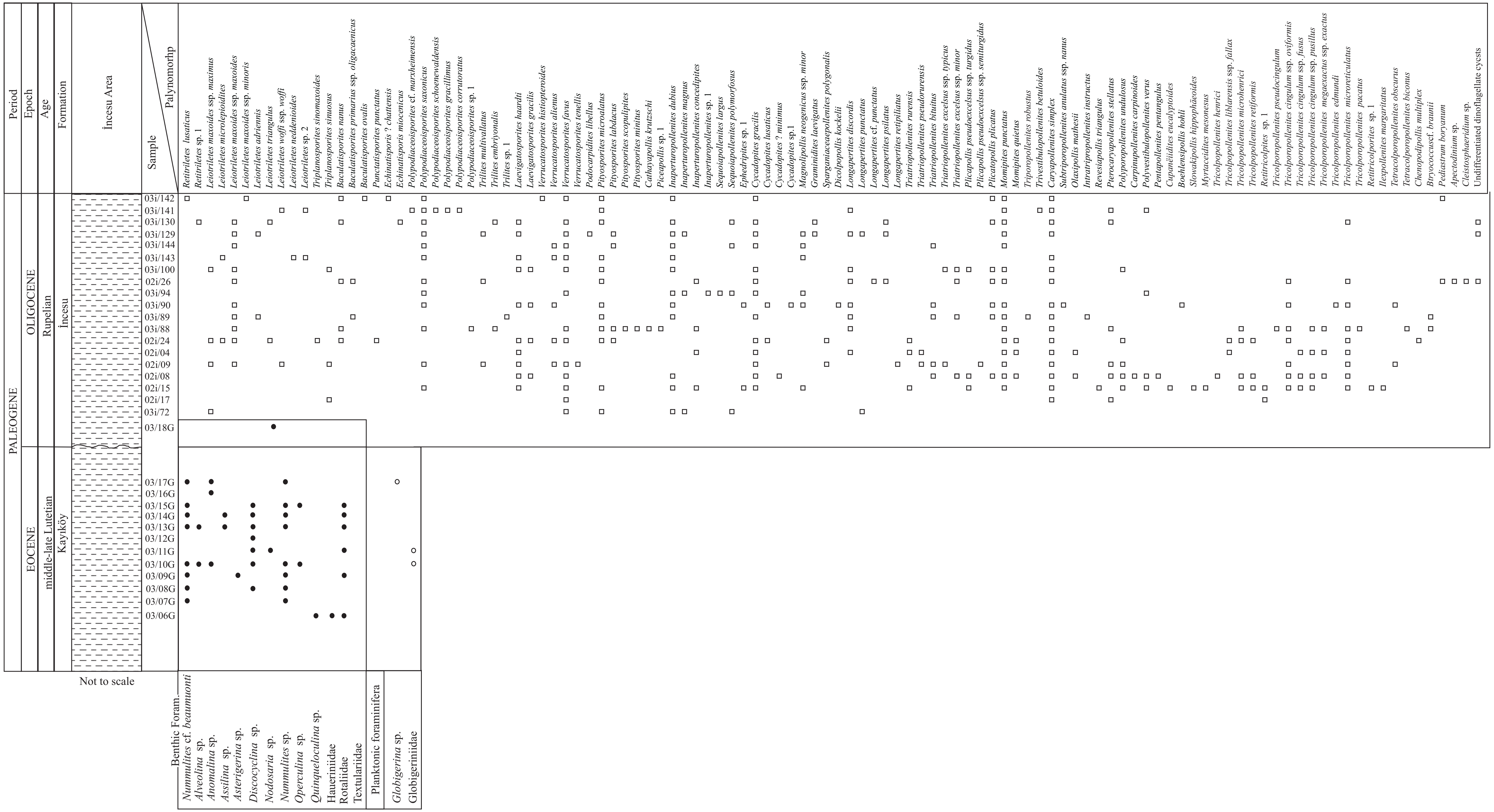

Figure 4.7. Occurrence of benthic and planktonic foraminifers in the Kayıköy Formation, palynomorphs and benthic foraminifers in the İncesu Formation. See figures.2. 41, 2. 42, 2. 43, 2. 44, 2. 45, 2. 47, 2. 49, 2. 50, 2. 51, 2. 52 and 2. 53 for sample locations. See figure 4. 1 for explanation.

Table 4. 8. Counting results (quantitative) of palynomorphs encountered in the İncesu Formation of the İncesu Area.

TAXA		Palaeovegetation Types	Sample Numbers																		
SPORE			03i/90	02i/24	02i/9	02i/4	02i/8	02i/15	02i/17	03i/88	03i/142	03i/143	02i/26	03i/141	03i/100	03i/94	03i/144	03i/72	03i/129	03i/130	03i/89
Retitriletes lusaticus	(*Lycopodium*)	Swamp - Freshwater									1										
Retitriletes sp.1		Unknown																		2	
Leiotriletes maxoides ssp. *maximus*	(Lygodiaceae: ?*Lygodium*)	Swamp - Freshwater		9	8										28			2			
Leiotriletes microlepioidites	(Dennstaedtiaceae: ?*Microlepia*)	Unknown		1								4									
Leiotriletes maxoides ssp. *maxoides*	(Schizaeaceae: ?*Lygodium*)	Swamp - Freshwater	14	40	60					8			7		61		3		30	19	22
Leiotriletes maxoides ssp. *minoris*	(Schizaeaceae: ?*Lygodium*)										5										
Leiotriletes adriennis	(*Acrostichum aureum*)	Back - Mangrove																	2		3
Leiotriletes triangulus		Unknown		1																1	
Leiotriletes wolffii ssp. *wolffii*	(Polypodiaceae: ?*Microlepia*)	Swamp - Freshwater			1									2							
Leiotriletes neddenioides	(Lygodiaceae? Cyatheaceae?)											2									
Leiotriletes sp. 2		Unknown										1		1							
Triplanosporites sinomaxoides	(Schizaeaceae: *Lygodium*)	Swamp - Freshwater		1																	
Triplanosporites sinuosus	(?*Lygodium*)				2				1						2						
Baculatisporites nanus	(Osmundaceae: *Osmunda*)			1						3	1		1							1	
Baculatisporites primarius ssp. *oligocaenicus*	(Osmundaceae: *Osmunda*)												1								2
Baculatisporites ovalis	(Osmundaceae: *Osmunda*)										2										
Puncatisporites punctatus				1																	
Echinatisporis ?*chattensis*	(*Selaginella*)										204										
Echinatisporites miocenicus	(*Selaginella*)																			2	
Polypodiaceoisporites cf. *marheimensis*														2							
Polypodiaceoisporites saxonicus	(Pteridaceae: *Pteris*)		1		2			1		7	4	1	5	144		1	7		9	2	
Polypodiaceoisporites schoenewaldensis														1							
Polypodiaceoisporites gracillimus	(Pteridaceae)													1							
Polypodiaceoisporites corrutoratus	(Pteridaceae)													12							
Polypodiaceoisporites sp. 1										1											
Trilites multivallatus	(Lygodiaceae: *Lygodium*)				1								1						11		
Trilites embriyonalis	(Lygodiaceae)									1										8	
Trilites sp. 1																					2
Laevigatosporites haardti	(Polypodiaceae)		1	14	12	72	6	1				1			10				2	1	
Laevigatosporites gracilis	(Polypodiaceae)		1	7			3								4						
Verrucatosporites histiopteroides	(Davalliaceae)										1										
Verrucatosporites alienus	(Davalliaceae)		1	1	6							17					4				
Verrucatosporites favus	(Dennstaedtiaceae: *Paesia*)			2	4		2	1	1	20	2	17			1	3	3	2	2	3	
Verrucatosporites tenellis	(?Polypodiaceae, ? Davalliaceae)				1																
GYMNOSPERM SACCAT																					
Podocarpidites libellus	(Podocarpaceae: *Podocarpus*)	Montane																	1		
Pityosporites microalatus	(Pinaceae: *Pinus* haploxylon type)		10	2				1		25	8	1	7	2	4			2		4	12
Pityosporites labdacus	(Pinaceae: *Pinus* sylvestris type)			1						1							21		7		
Pityosporites scopulipites	(Pinaceae: *Pinus*)									2											
Pityosporites minitus	(Pinaceae: *Pinus*)									2											
Cathayapollis krutzchii	(*Cathaya*)									1											
Piceapollis sp.1	(?Pinaceae)									3											
GYMNOSPERM NON SACCAT																					
Inaperturopollenites dubius	(Taxodiaceae)	Swamp - Freshwater	2				1	1			1	4			3	81	55	56	33	38	14
Inaperturopollenites magnus	(?Pinaceae: ?*Pseudotsuga*)															2		2	2		
Inaperturopollenites concedipites	(Taxodiaceae)					1		4		2			6								
Inaperturopollenites sp. 1		Unknown														1					
Sequoiapollenites largus	(Taxodiaceae: ?*Cryptomeria*)	Lowland - Riparian														1					
Sequoiapollenites polyformosus	(Taxodiaceae: *Sequoia*)															4	3	3		2	
Ephedripites sp. 1	(?Ephedraceae)	Herb	1					6													
ANGIOSPERM POLEN																					
MONOCOTYLEDONEAE																					
Cycadopites gracilis	(Cycadaceae: *Cycas*)	Lowland - Riparian		1	1	11	6	4			1		7		7	2	1		2	8	17
Cycadopites lusaticus	(Cycadaceae: ?*Cycas*)		23	7																	
Cycadopites ?*minimus*	(Cycadaceae: *Cycas*)						4														
Cycadopites sp.1	(?Cycadaceae)		1																		
Magnolipollis neogenicus ssp. *minor*	(?Magnoliaceae)	Unknown	4					1				2				1	4		2		
Graminidites laevigatus	(?Gramineae)	Herbaceous marsh																	1	1	
Sparganiaceaepollenites polygonalis	(Sparganiaceae: *Sparganium*)	Swamp - Freshwater		2	5																
Dicolpopollis kockelii	(Palmae; *Calamus*)		1																		
Longapertites discordis	(?Arecaceae, ?Lepidocaryoidae)	Back - Mangrove	1			2			1				7	20	13				8		2
Longapertites punctatus	(?Arecaceae, ?Lepidocaryoidae)																	1	1		
Longapertites cf. *punctatus*	(?Arecaceae, ?Lepidocaryoidae)												1								
Longapertites psilatus	(?Arecaceae, ?Lepidocaryoidae)												1						2	1	
Longapertites retipiliatus	(?Arecaceae, ?Lepidocaryoidae)				2																
DICOTYLEDONEAE																					
Triatriopollenites rurensis	(Myricaceae: *Myrica*)	Lowland - Riparian		2		2		2													
Triatriopollenites pseudorurensis	(Myricaceae: *Myrica*)				9	4															
Triatriopollenites bituitus	(Myricaceae: *Myrica*)		2		7		4										1				2
Triatriopollenites excelsus ssp. *typicus*	(Myricaceae)				2										5						
Triatriopollenites excelsus ssp. *minor*	(Myricaceae)						3						1		2						3
Plicapollis pseudoexcelsus ssp. *turgidus*	(?Juglandaceae)						3	5							10						
Plicapollis pseudoexcelsus ssp. *semiturgidus*	(?Juglandaceae)																				1
Plicatopollis plicatus	(Juglandaceae)		2				2				1		2		4					1	4
Momipites punctatus	(Juglandaceae; *Engelhardia*)		10	9	29	20	86	60		3	1		8	4	14		1	1	2	2	28
Momipites quietus	(Juglandaceae; *Engelhardia*)			1		1	5														
Triporopollenites robustus																					1
Trivestibulopollenites betuloides	(Betulaceae: *Betula*)													1							
Caryapollenites simplex	(Juglandaceae: *Carya*)		41	4	15	2	10	23	13	11	1	2	20	2	15				23	39	50
Subtriporopollenites anulatus ssp. *nanus*	(Juglandaceae: ?*Carya*)		1																		
Olaxipollis matthesi	(Olecaceae: ?*Olax*)	Unknown			1	1															
Intratriporopollenites instructus	(Tiliaceae: *Tilia*)	Lowland - Riparian																			1
Reevesiapollis triangulus	(Sterculiaceae: *Reevesia*)							1													
Pterocaryapollenites stellatus	(Juglandaceae: *Pterocarya*)				2		1		1	2				1						1	
Polyporopollenites undulosus	(Ulmaceae: *Ulmus* ?,*Zelkova* ?)			1	3		4	4							1						
Carpinuspollenites carpinoides	(Betulaceae: *Carpinus*)						1														
Polyvestibulopollenites verus	(Betulaceae: *Alnus*)						1	1					1	1							
Pentapollenites pentangulus	(?Elaeagnaceae, ?Simarubaceae)	Unknown					1														
Cupanieidites eucalyptoides	(?Myrtaceae, ?Sapindaceae)	Lowland - Riparian						2													
Boehlensipollis hohli	(Elaeagnaceae)		1																		
Slowakipollis hippophäeoides	(Elaeagnaceae: *Hippophäe*)							1													
Myrtaceidites mesonesus	(Myrtaceae)							1													
Tricolpopollenites henrici	(Fagaceae: *Quercus*)						1														
Tricolpopollenites liblarensis ssp. *fallax*	(?Fagaceae)	Montane				2		10													
Tricolpopollenites microhenrici	(Fagaceae: *Quercus*)					1	3	7		1											
Tricolpopollenites retiformis	(Saliaceae: *Salix*/*Platanus*)			2			9	33													
Retitricolpites sp. 1		Unknown						1	1												
Tricolporopollenites pseudocingulum	(Anacardiaceae: *Rhus*)	Lowland - Riparian								1											
Tricolporopollenites cingulum ssp. *oviformis*	(Fagaceae: *Castanea*,*Castanopsis*,*Lithocarpus*,*Pasania*)		2	3	6		13	98		2			1								
Tricolporopollenites cingulum ssp. *fusus*	(*Trigonabalanus*)					1	2	5													
Tricolporopollenites cingulum ssp. *pusillus*	(Fagaceae: *Castanea*,*Castanopsis*,*Lithocarpus*,*Pasania*)					9	2	22		1											4
Tricolporopollenites megaexactus ssp. *exactus*	(Cyrillaceae)					1	2			1											
Tricolporopollenites edmundi	(Mastixiaceae)		1																		
Tricolporopollenites microreticulatus	(Oleaceae: *Olea*, *Fraxinus*, *Ligustrum*)		2	1	9	4	13	23		1			1							1	
Tricolporopollenites pacatus	(Simarubaceae)									1											
Retitricolporites sp. 1		Unknown						1													
Ilexpollenites margaritatus	(Aquifoliaceae: *Ilex*)	Lowland - Riparian						10													
Tetracolporopollenites obscurus	(Sapotaceae)		1		4																
Tetracolporopollenites biconus	(Sapotaceae)									1											
Chenopodipollis multiplex	(Chenopodiaceae)	Herbaceous marsh		1				1													
Botryococcus braunii	Botryococcaceae	Freshwater								91											3
Pediastrum boryanum											1		1								
INCERTAE CEDIS																					
Apectodinium sp.		Marine								1											
Cleistosphaeridium sp.													1								
Undifferentiated dinoflagellate cysts													1						3	1	
Total			124	115	192	134	188	331	18	193	234	52	81	194	184	96	103	69	143	138	171

This variation in the relative abundances of the species can be attributable to different palaeovegetation types to the samples. Almost all samples include the species of *Caryapollenites simplex*, *Verrucatosporites alienus* and *Laevigatosporites haardti* (Table 4. 8).

Statistical analyses yield a long list of stratigraphically unimportant, long ranging taxa, but a small number of index taxa. These species are *Triatriopollenites excelsus*, *Plicapollis pseudoexcelsus*, *Dicolpopollis kockelii*, *Boehlensipollis hohli*, *Slowakipollis hippophaëoides*, *Intratriporopollenites instructus* and *Caryapollenites simplex*, of which stratigraphic ranges have been discussed in the palynomorph assemblage of the Tokça Formation. The data combined with the palynological results of Akkiraz & Akgün (2005) is given in Table 4. 4. Accordingly, on the basis of biostratigraphically important species indicated above, the age of the İncesu Formation is of Early–"Middle" Oligocene and well correlated with the age obtained from the palynomorph assemblage of the Tokça Formation.

4.3.3 Southern Part of Atabey Town

4.3.3.1 The Isparta Series

4.3.3.1.1 Foraminifer Data and Age Determination. Eight samples were taken from the carbonates of the Isparta series, which located on the southern part of Atabey town (Fig. 2. 57). The samples between 02D1/01 and 02D1/04 have neritic characteristics, and have not been examined in regard to foraminifer content. However, the other samples (02D1/05–02D1/08) were studied to give an age and make a prediction about palaeoenvironmetal conditions (Fig. 4. 8). The samples generally comprise species of *Globotruncana*, *Globotruncanita*, *Contusutruncana* and *Rodoturuncana*. Stratigraphic distribution of these species indicated in figure 4. 8 indicate that the age of the upper part of the Isparta series in this area is of the Kampanian–Maastrichtian. Pelagic conditions prevailed during the deposition of these samples.

4.3.3.2 The Delikarkası Formation

4.3.3.2.1 Foraminiferal Data and Age Determination. Twenty–three samples were collected from the Delikarkası Formation for foraminifer investigation (Figs. 2. 54, 2. 57). The samples include a rich benthic foraminifer assemblage (Fig. 4. 8). Almost all samples include *Amphistegina* sp., *Lepidocyclina* sp., *Pararotalia* sp., and Rotaliidae (Fig. 4. 8). Besides, *Nummulites intermedius*, *Nummulites vascus* and Eulepidin forms are also observed. The association suggests an Early Oligocene (Rupelian) age which is consistent with the palynological age obtained from the İncesu Formation.

From the palaeoenvironmental point of view, foraminiferal assemblage (mainly *Nummulites*) of the samples collected from the lower part of the sequence indicates a carbonate shelf environment (Fig. 4. 8). A shelf environment becomes dominant through the upper part of sequence on the basis of Haueriniidae and some algae. Additionally, it can be stated that a reefal environment also occur due to coral community in some samples. A dense *Microcodium* sp. assemblage observed towards the upper part of sequence defines a very shallow environment (Fig. 4. 8).

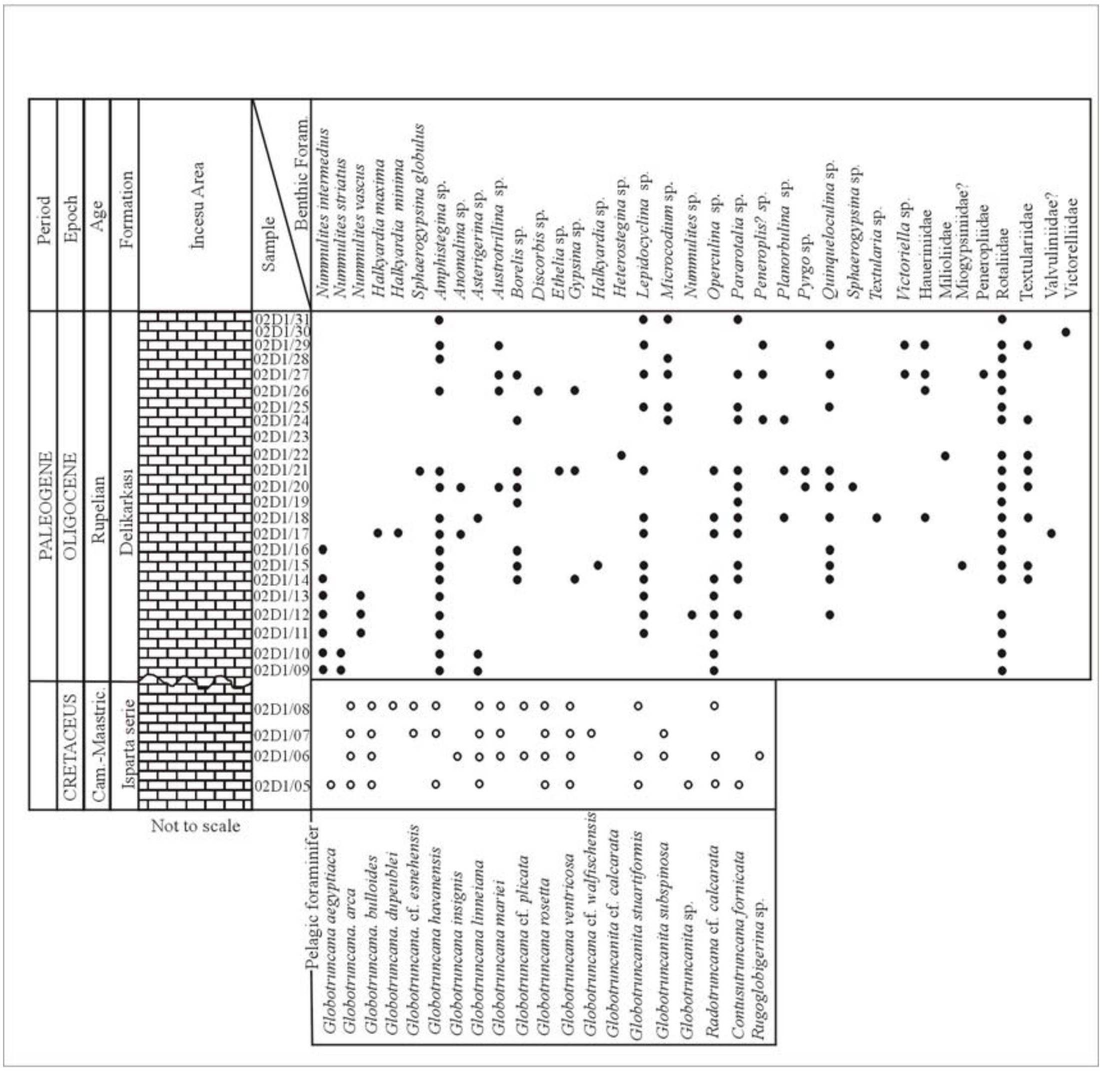

Figure 4. 8 Occurrence of planktonic foraminifers in the Isparta series and benthic foraminifers in the Delikarkası Formation (See figure 2. 57 for sample locations and figure 4. 1 for explanation).

4.4. Comparison of Palynological Data with Other Tertiary Basins in Turkey

4.4.1 Eocene

Palynological data obtained in this study is well correlated with the previous palynological studies carried out in the Turkish Eocene basins. Only limited palynological studies on the Eocene units have been made in the Yozgat and Çorum areas of central Anatolia up to now (Nakoman 1966a; Akyol 1980; Akgün et al. 2002; Akgün 2002; Akkiraz et al. accepted) (Table 4. 9).

The Turkish Eocene microflora was first examined in Central Anatolia (Sorgun lignites) by Nakoman (1966a). The species of *Laevigatosporites haardti*, *Verrucatosporites secundus*, *Leiotriletes microadriennis*, *Cicatricosisporites dorogensis*, *Inaperturopollenites dubius*, *Triatriopollenites excelsus*, *Triatriopollenites coryphaeus*, *Tricolporopollenites cingulum* stood for a high percentage in the assemblage (Table 4. 9). Additionally, it is necessary to indicate that the monolet spores are widespread in the assemblage. However, saccate pollen does not occur. The author accepted the age of the sediments in the Yozgat area (Sorgun lignites) as Early Eocene based on the presence of important biostratigraphic species such as *Laevigatosporites discordatus*, *Monocolpopollenites pseudodentatus*, *Monocolpopollenites tranquillus Triatriopollenites excelsus*, *Tetracolporopollenites biconus*, *Inaperturopollenites echinatus* and *Monocolpopollenites granulatus* (Table 4. 9).

Southwest Anatolian Eocene is characterized by presence of *Leiotriletes adriennis*, *Leiotriletes maxoides* ssp. *maximus*, *Baculatisporites gemmatus*, *Cingulatisporites macrospecious*, *Triporopollenites undulatus*, *Intratriporopollenites indubitalibis* and *Tricolporopollenites elongates* (Nakoman 1967).

Benda (1971a) suggested a different Eocene flora from the Nakoman's typical Eocene species. Depending on Benda (1971a), the species of *Concavisporites acutus*, *Triplanosporites tertiarius*, *Laevigatosporites ellipsoideus*, *Compositoipollenites rhizophorus* and *Monocolpopollenites zievelensis* are distinctive species for Turkish Eocene.

Akyol (1980) studied the palynological aspects of the Bayat lignites (nearby Çorum area of central Anatolia) (Table 4. 9). *Laevigatosporites haardti* is a dominant species in the palynomorph assemblage (~56%). While the relative percentages of *Laevigatosporites haardti* are reducing in the samples, the species *Leiotriletes adriennis* (~21%), *Cicatrisosisporites dorogensis* (~9%), *Triatriopollenites coryphaeus* (~15%) and *Tricolporopollenites cingulum* (~6%) participate in the palynomorph assemblage. The main spectacular point in the assemblage is that there is no saccate pollen like *Pityosporites microalatus* and *P. labdacus* (Table 4. 9). The author determined a rich flora, including biostratigraphically significance forms such as *Punctatosporites paleogenicus*, *Microfaveolatosporites pseudodentatus*, *Cicatricososporites pseudodorogensis*, *Cicatricososporites virgatus*, *Cicatricosisporites dorogensis*, *Concavisporites arugulatus*, *Concavisporites discites*, *Concavisporites acutus*, *Hamulatisporites hamulatis*, *Monocolpopollenites* (*Palmaepollenites*) *labiatus*, *Monocolpopollenites zievelensis*, *Subtriporopollenites constans*, *Subtriporopollenites intraconstans*, *Subtriporopollenites densiechinatus*, *Subtripropollenites rariechinatus*, *Leiotriletes maxoides* ssp. *maximus* and *Triatriopollenites excelsus*. A Middle–Late Eocene age is suggested on the basis of palynological data. According to Akyol (1980), Güngör (pers. commun.) recorded a rich gastropod fauna, which includes *Ampullina* aff. *grossa*, *Cerithium* (*Campanile*) *giganteum*, *Turitella* aff. *trempina*, *Assiminea* aff. *crassilabris*, *Melania* sp., *Ostrea* sp., and indicated a Lutetian (Middle Eocene) age.

Akyol (1980) compared the palynological results of Bayat lignites with the Nakoman's (1966a) data from Sorgun (Yozgat) area, and reached some inferences on palynological assemblages. These results are as follows:

- Dominance of monolete spores in both assemblages,
- As the relative percentages of *Laevigatosporites haardti* decrease, *Leiotriletes microadriennis*, *Cicatricosisporites dorogensis*, *Triatriopollenites coryphaeus* and *Tricolporopollenites cingulum* are participated in both assemblages.
- Absence of saccate pollen and presence of minor quantity of monocolpate and inaperturate pollen in the assemblages.

Moreover, Akyol (1980) also indicates the presence of some species which do not exist in the palynomorph assemblage of Sorgun area and absence of some species that totally occur in the palynomorph assemblage of Sorgun area. According to the author, this discrepancy is associated with palaeoecological conditions during accumulation of those coals.

Although Nakoman (1966a) and Akyol (1980) made out some biostratigraphically significant species for the Turkish Eocene, they did not document any of the mangrove species like *Psilatricolporites crassus* and *Spinizonocolpites* sp. 1 which have been determined in the present study (Başçeşme and Varsakyayla Formations) (Table 4. 9).

After those palynological studies at different localities in central Anatolia, Akgün et al. (2002), Akgün (2002) and Akkiraz et al. (accepted) obtained a rich species diversification (Table 4. 9). They also obtained new Eocene palynological data and suggested the presence of different kinds of mangrove and back–mangrove elements, like *Avicennia*, *Psilatricolporites* (*Pelliciera*), *Spinizonocolpites* (*Nypa*), *Mauritiidites franciscoi* (*Mauritia*) and *Leiotriletes adriennis* (*Acrostichum*) from the Middle–?Upper Eocene Yoncalı Formation in central Anatolia (Yozgat and Amasya areas) (Table 4. 9).

Akgün (2002) studied the palynological properties of coal–bearing Armutlu and Çeltek formations outcropping in the Çorum–Amasya area, and recorded the species *Leiotriletes microadriennis* (27%) and *Laevigatosporites haardti* (13%) abundantly (Table 4. 9). According to author, the choronostratigraphic range of various palynomorphs such as *Triatriopollenites excelsus*, *Baculatisporites gemmatus*, *Caryapollenites circulus*, *C. triangulus*, *Milfordia hungaricus*, *Plicapollis pseudoexcelsus*, *Proxapertites microreticulatus*, *P. operculatus*, *Labrapollis globosus*, *Plicatopollis lunatus*, *Trilites menatensis*, *Triporopollenites constatus*, *Compositoipollenites rhizophorus* ssp. *burghasungensis*, *C. minimus*, *Subtriporopollenites anulatus* ssp. *nanus*, *Echinatisporis hungaricus*, *Plicatopollis hungaricus*, *P. lunatus*, *Minorpollis* sp., *Trilites tertiarius*, *Microfovelatosporites pseudodentatus* and *Monocolpopollenites crassiexinus* are confined to Palaeocene and Eocene sediments of Turkey and Europe (Table 4. 9). Also, the species attributed to *Triporopollenites spackmanii*, *Toroisporites neddeni*, *Pentapollenites punctoides* and *Subtriporopollenites anulatus* ssp. *notus* recovered from these lignites are restricted to Middle Eocene deposits, and hence indicate that these lignites must be younger than the Early Eocene. The author also indicates that the presence of

Aglaoreidia cyclops, *Polypodiaceoisporites lusaticus*, *Pterocaryapollenites stellatus*, *Leiotriletes maxoides* ssp. *maximus* and *Periporopollenites stigmosus* collectively suggest that the age of these lignites should not be older than the Middle Eocene. The author recorded some mangrove and back–mangrove elements like *Longapertites*, *Proxapertites*, *Milfordia minima*, *M. hungaricus*, *Avicennia*, *Psilatricolporites crassus* and *Spinizonocolpites prominatus*. The author suggest that the age of the lignites outcropping Çorum–Amasya area is of Middle–?Late Eocene.

Despite the fact that the relative percentages of palynomorphs are different, the similarity between the palynomorph assemblage of Akgün (2002) and this study supports the reliability of the Middle–?Late Eocene assignment to the palynological assemblages of the Başçeşme (Maden member) and Varsakyayla formations. In addition, the presence of biostratigraphically important taxa such as *Aglaoreidia cyclops*, *Triatriopollenites excelsus*, *Plicatopollis lunatus*, *Subtriporopollenites constans* and *Subtriporopollenites anulatus* ssp. *nanus* in western and central Anatolia, it is also conspicuous that mangrove and back –mangrove elements like *Psilatricolporites crassus* and *Spinizoncolpites* sp. occur in the palynomorph assemblages of Akgün (2002) and this study (Başçeşme and Varsakyayla formations).

Akgün et al. (2002) studied the palynological aspects of coal–bearing Tertiary sediments outcropping in the Yozgat–Çiçekdağ area (Yoncalı Formation) located at southern part of the Çorum–Amasya area, and obtained a rich palynomorph assemblage (Table 4. 9). The species *Inaperturopollenites concedipites* (~14%), *Inaperturopollenites emmaensis* (~6%) and *Triatripollenites excelsus* (~6%) occur abundantly (Table 4. 9). The authors suggest a Middle–?Late Eocene for the Yoncalı Formation on the basis of *Concavisporites arugulatus*, *Ephedripites eosinipites*, *E. hungaricus*, *Spinizonocolpites*, *Triatriopollenites excelsus*, *Triporopollenites constatus*, *T. spackmanii*, *Compositoipollenites minimus*, *Subtriporopollenites anulatus* ssp. *nanus*, *S. anulatus* ssp. *notus*, *S. constans*, *Caryapollenites circulus*, *Porocolpopollenites vestibulum*, *Inaperturopollenites magnoporatus* and *Pistillipollenites mcgregorii* (Table 4. 9). Though diversity of mangrove elements occurring in the Çorum–Amasya area (Akgün 2002) is high, the mangrove element is only made up of genus *Spinizonocolpites*; *S. bulbospinosus*, *S. prominatus* and *S.* cf. *baculatus* (Table 4. 9). Because of the presence of similar biostratigraphically important taxa and mangrove elements in the palynomorph assemblages of the Başçeşme, Varsakyayla and Yoncalı formations, the correlation is possible between this study and Akgün et al. (2002).

After some palynological studies in different localities of central Anatolia (Nakoman 1966a; Akyol 1980; Akgün *et al*. 2002; Akgün 2002), a rich species diversification has been obtained from the Yozgat–Sorgun area by Akkiraz et al. (accepted).

According to Akkiraz et al. (accepted), commonly occurring species is principally made up of *Leiotriletes microadriennis* (~10%), *L. adriennis* (~6%), *Inaperturopollenites concedipites* (~9%), *I. dubius* (~9%), *Proxapertite*s sp. (5%), *Spinizonocolpites* (8%), *Plicapollis pseudoexcelsus* (11%), *Momipites punctatus* (8%), *Compositoipollenites rhizophorus* ssp. *burghasungensis* (7%) and *Tricolporopollenites undulatus* (15%) (Table 4. 9).

According to the authors, the species *Triatriopollenites excelsus*, *Caryapollenites circulus*, *Compositoipollenites minimus*, *Triporopollenites constatus*, *Plicatopollis lunatus*, *Anacolosidites* group, *Diporites iszkaszentgyörgyi* and *Monocolpopollenites crassiexinus* are restricted to the Palaeocene and Eocene sediments of Europe and Turkey (Table 4. 9). The presence of *Polypodiaceoisporites lusaticus, Echinatisporis longechinus* and *Leiotriletes maxoides* ssp. *maximus* indicates that the age of the Yoncalı lignites should not be older than the Middle Eocene. Besides, the species *Triporopollenites spackmanii*, *Pentapollenites punctoides, Concavisporites arugulatus* and *Celtipollenites laevigatus* are restricted to the Middle Eocene (Table 4. 9).

In addition to the taxa mentioned above, typical mangrove elements like *Spinizonocolpites* group, *Avicennia alba*–type, *Psilatricolporites crassus* and

Diporites iszkaszentgyörgyi, which has unknown botanical affinity, were firstly recorded in this study. The species of *Milfordia hungaricus*, *Kopekipollenites transdanubicus*, *Mauritiidites franciscoi* and *Diporites iszkaszentgyorgyi* have never been reported before in the Eocene sediments of central Anatolia (Table 4. 9).

On the basis of palynological assemblage, the age of the Yoncalı lignites should be of Middle–?Late Eocene in the Yozgat–Sorgun area and can be correlated with the other coal–bearing Turkish Eocene sediments in central Anatolia (Akyol 1980; Akgün *et al*. 2002; Akgün 2002). This age is also in accordance with the age obtained from benthic and planktonic foraminifera from the Yozgat area (Erdoğan et al., 1996).

If we want to compare the data between western and central Anatolian coal occurrences, the species *Spinizonocolpites echinatus*, *S. prominatus*, *S. baculatus*, *S. gemmatus*, *S. microgemmatus*, *S. bulbospinosus S.* cf. *wodehousei*, *S. indicus*, *S.* cf. *adamenteus* and *Spinizonocolpites* spp. were recorded in samples of the Yoncalı Formation (central Anatolia). In contrast, *Spinizonocolpites* sp. 1 has been determined as individual grains from the Maden member (western Anatolia) (sample 02B/07) and totally absent in the Varsakyayla Formation (Table 4. 9). In broad sense, diversification of pteridophytic spores, tricolpate and tricolporate pollen grains are high in the samples from the Yoncalı Formation (central Anatolia) compared to the Maden member (western Anatolia) and also Varsakyayla Formation. The species *Nowemprojectus tumanganicus* has been determined in samples of the Maden member (Table 4. 9), but does not occur in the Yoncalı Formation. The mangrove element *Psilatricolporites crassus* (*Pelliciera*) is abundant in almost all samples from the Maden member (54–90%); rarely exists in the Varsakyayla Formation (1%); is less abundant in samples from the Yoncalı Formation. Although the percentages of the mangrove elements are different in central and western Anatolian samples, the Middle–?Upper Eocene coal occurrences of central Anatolia can be correlated with the data of this study on the basis of the presence of mangrove elements. The difference in relative frequencies of the species is probably related with the palaeoecological factors which persisted during the deposition of these coals.

Besides, it is necessary to indicate that the species diversification obtained from the central Anatolian occurrences by Nakoman (1966a) in Sorgun area, Akyol (1980) in Bayat area, Akgün (2002) in Çorum–Amasya area, Akgün et al. (2002) in Yozgat–Çiçekdağ area and Akkiraz et al. (accepted) in Sorgun area is much more than species diversification acquired from both Başçeşme (Çardak–Tokça Area) and Varsakyayla (Burdur Area) formations.

Table 4. 9 The occurrence of spore and pollen species in the Çardak–Tokça and Burdur areas and in the comparable deposits of the other Turkish Eocene areas.

Area	**Çardak – Tokça**	**Burdur**	**Çiçekdağ Yozgat**	**Sorgun Yozgat**	**Corum – Amasya**	**Bayat Çorum**	**Sorgun Yozgat**
Age	**MIDDLE – ?LATE EOCENE**						**EARLY EOCENE**
	WESTERN ANATOLIA		**EASTERN ANATOLIA**				
Formation	**Başçeşme Fm.**	**Varsakyayla Fm.**	**Yoncalı Fm.**	**Yoncalı Fm.**	**Armutlu / Çeltek**		
	This study	**This study**	**Akgün et al. (2002)**	**Akkiraz et al. (accepted)**	**Akgün (2002)**	**Akyol (1980)**	**Nakoman (1966a)**
Retitriletes stellarius				+			
Leiotriletes microadriennis	+		+	++	++	+	++
Leiotriletes adriennis	+			++	+	+	
Leiotriletes triangulus		+					
Leiotriletes maxiodes ssp. *maximus*				+	+	+	+
Leiotriletes maxiodes ssp. *minoris*	+						
Leiotriletes wolffi ssp. *wolffi*	+				+		
Leiotriletes wolffi ssp. *brevis*					+		
Leiotriletes neddenioides					+		
Leiotriletes seidewitzensis					+		
Leiotriletes microsinuosoides					+		
Leiotriletes nominis						+	
Triplanosporites microsinuosus	+						
Deltoidisporites cf. *rotundus*					+		+
Deltoidisporites crassior							+
Deltoidisporites cf. *nominis*							+
Granulatisporites ikikaraensis							+
Punctatisporites tanndorfensis					+		
Punctatisporites gelletichi							+
Punctatisporites parvopunctatus						+	
Punctatisporites aquisgranensis						+	
Stereisporites steroides							+
Toroisporites neddeni					+		
Concavisporites pseudopartitus					+		
Concavisporites discites						+	
Concavisporites arugulatus			+	+		+	
Concavisporites acutus						+	+
Toroisporis minoris						+	
Echinatisporis triangulatus							+
Echinatisporis longechinus				+			
Echinatisporis faculeatus				+			
Echinatisporis minitus						+	
Echinatisporis hungaricus					+		
Echinatisporis erinaceus					+	+	+
Echinatisporis cf. *aculeatus*					+		
Echinatisporis cf. *spiculum*					+		
Reticulatisporites crassimus							+
Baculatisporites ovalis	+						
Baculatisporites nanus	+						
Baculatisporites quintus ssp. *quintus*					+		
Baculatisporites quintus ssp. *pseudoprimarius*					+		
Baculatisporites quintus ssp. *rugulatoides*					+		
Baculatisporites primarius ssp. *primarius*					+	+	
Baculatisporites primarius ssp. *major*			+	+	+		
Baculatisporites primarius ssp. *oligocaenicus*		+			+		
Baculatisporites gemmatus					+	+	+
Trilites solidus			+	+	+	+	
Trilites concavus						+	
Trilites multivallatus					+		
Trilites (*Ischyosporites*) *tertiarius*					+		
Trilites cf. *menatensis*					+		
Ischyosporites asolidus				+	+		
Ischyosporites foveosolidus				+	+		
Cicatricosisporites paradorogensis			+		+	+	
Cicatricosisporites dorogensis						++	++
Cingulatisporites gracilis							+

Cingulatisporites potoniei							+
Cingulatisporites vitiosus						+	+
Cingulatisporites compositus							+
Camarozonisporites sorgunensis							+
Hamulatisporis hamulatis						+	
Vedatisporites mükreminensis							+
Polypodiaceoisporites gracillimus ssp. *semiverrucatus*					+		
Polypodiaceoisporites saxonicus					+		
Polypodiaceoisporites marxheimensis			+				
Polypodiaceoisporites lusaticus				+	+		
Polypodiaceoisporites microconcavus	+						
Polypodiaceoisporites kedvesii	+						
Polypodiaceoisporites muricinguliformis	+						
Polypodiaceoisporites cf. *cyclocingulatus*					+		
Verrucingulatisporites undulatus				+			
Gleicheniidites simplex			+				
Cingulatisporites levispeciosus					+		
Undulatisporites concavus							+
Undulatisporites brevilaesuratus						+	
Leavigatosporites gracilis					+		
Leavigatosporites haardti	+		+	+	++	++	++
Laevigatosporites ovatus				+	+	+	
Leavigatosporites discordatus				+	+	+	+
Polypodiidites secundus ssp. *secundus*				+	+		
Polypodiidites lusaticus				+			
Punctatospoites paleogenicus						+	
Microfoveolatosporis pseudodentatus					+	+	
Echinosporis cf. *echinatus*					+		
Verrocosisporites cf. *rariverrucatus*			+				
Verrucatosporites favus ssp. *favus*				+	+	+	
Verrucatosporites favus ssp. *gracilis*					+		
Verrucatosporites tenellis				+	+		
Verrucatosporites favus ssp. *magnus*			+		+		
Verrucatosporites favus ssp. *pseudosecundus*					+		
Verrucatosporites cf. *alenius*			+				+
Verrucatosporites secundus						+	++
Verrucatosporites saalensis						+	+
Verrucatosporites afavus						+	+
Microfaveolatosporites retis							+
Microfaveolatosporites pseudodentatus						+	+
Microfaveolatosporites bayatensis							+
Cicatricososporites pseudodorogensis						+	
Cicatricososporites virgatus						+	
Pityosporites microalatus	++	++	+	+	+		
Pityosporites labdacus	+						
Cathayapollis pulaënsis	+						
Abiespollenites cf. *latisaccatus*					+		
Abiespollenites absolutus	+						
Sequoiapollenites polyformosus	+						
Inaperturopollenites magnus	+		+				
Inaperturopollenites hiatus			+	+			+
Inaperturopollenites dubius	+			++		+	++
Inaperturopollenites emmaensis			++				+
Inaperturopollenites concedipites	+		++	++	+		
Inaperturopollenites obscurus							+
Inaperturopollenites echinatus							+
Cupressacites cuspidataeformis					+		

Cupressacites bockwitzensiss				+			
Ephedripites claricristatatus			+				
Ephedripites hungaricus			+				
Ephedripites eosenipites			+				
Graminidites subtiliglobosus					+		
Graminidites laevigatus					+		
Milfordia minima					+		
Milfordia hungaricus				+	+		
Sparganiaceaepollenites polygonalis	+			+	+		
Sparganiaceaepollenites neogenicus					+		
Sparganiaceaepollenites magnoides					+		
Aglaoreidia cyclops	+				+		
Diporites iszkaszentgyoergyi				+			
Cycadopites intrastructus	+				+		
Cycadopites gracilis	+				+		
Cycadopites ?minimus	+						
Cycadopites tulipiferus					+		
Cycadopites kyushuensis					+		
Monocolpopollenites tranquillus				+	+		+
Monocolpopollenites areolatus							+
Monocolpopollenites fusus							+
Monocolpopollenites granulatus							+
Monocolpopollenites nymphoides							+
Monocolpopollenites crassiexinus				+	+		
Monocolpopollenites zievelensis				+		+	+
Monocolpopollenites (*Palmaepollenites*) *labiatus*						+	
Arecipites wiesaensis					+		
Arecipites papillosus					+		
Arecipites brandenburgensis				+			
Arecipites cf.*eopapillosus*					+		
Proxapertites microreticulatus				+	+		
Proxapertites granulatus					+		
Proxapertites operculatus					+		
Proxapertites sp.				++			
Longapertites triangulatus					+		
Longapertites punctatus				+	+		
Longapertites retipiliatus				+			
Longapertites indicus					+		
Longapertites cf. *psilatus*				+	+		
Longapertites hammenii					+		
Longapertites discordis	+				+		
Kopekipollenites transdanubicus	+			+			
Spinizonocolpites prominatus			+	+	+		
Spinizonocolpites cf. *wodehousei*				+			
Spinizonocolpites indicus				+			
Spinizonocolpites baculatus				+			
Spinizonocolpites cf. *adamenteus*				+			
Spinizonocolpites sp.				++			
Mauritiidites franciscoi	+			+			
Malvacipollis spinulosa				+			
Spinizonocolpites cf. *baculatus*			+				
Monogemmites pseudosetarius			+				
Monogemmites ovalis					+		
Olaxipollis matthessi	+						
Interpollis microsupplingensis				+			
Interpollis velum				+			
Minorpollis sp.					+		
Anacolosidites oculutus				+			
Plicapollis pseudoexcelsus			+	++	+		
Plicapollis cf. *conserta*				+			
Triatriopollenites excelsus	+	+	++	+	+	+	++
Triatripollenites intermedius				+			
rurensis, bituitus group	+	+	+	+	+	+	+
Triatriopollenites coryphaeus						++	++
Triatriopollenites globosus							+
Stephanoporopollenites anatolicus							+
Stephanoporopollenites hexaradiatus				+			

Plicatopollis plicatus	+	++		+	+	+	
Plicatopollis lunatus	+	+		+	+		
Plicatopollis hungaricus					+		
Momipites punctatus	+	++	+	++	+		
Momipites quietus	+	++	+	+	+		
Platycaryapollenites platycaryoides			+	+	+		
Platycaryapollenites miocaenicus			+	+	+		
Triporopollenites constatus			+	+	+		
Triporopollenites spackmanii			+	+	+		
Triporopollenites undulatus				+			
Triporopollenites robustus	+			+	+		
Triporopollenites megagranifer					+		
Labrapollis globosus					+		
Labrapollis labraferus	+			+		+	
Trivestibulopollenites betuloides	+						
Polyvestibulopollenites verus	+			+	+		
Celtipollenites intrastuructus					+		
Celtipollenites laevigatus				+	+		
Subtriporopollenites constans	+		+	+	+	+	
Subtriporopollenites facilis				+			
Subtriporopollenites intrastructurus				+			
Subtriporopollenites palaeogenicus			+				
Subtriporopollenites intraconstans			+	+	+	+	
Subtriporopollenites instructus			+				
Subtripollenites anulatus ssp. *nanus*	+	+	+	+	+	+	
Subtriporopollenites anulatus ssp. notus			+		+		
Subtriporopollenites magnoporatus				+	+		
Subtriporopollenites rariechinatus						+	
Subtriporopollenites densiechinatus						+	
Caryapollenites circulus			+	+	+		
Caryapollenites triangulus					+		
Compositoipollenites rizophorus ssp.*burghasungensis*		+	+	++	+		
Compositoipollenites minimus			+	+	+		
Compositoipollenites microechinatus				+			
Compositoipollenites medius				+			
Intratriporollenites indubitabilis	+	+	+		+		
Intratriporollenites magnoporatus			+				
Intratriporollenites instructus			+				
Carpinupollenites carpinoides	+						
Polyporopollenites undulosus	+	+	+		+		
Polyporopollenites polyanulus							+
Pterocaryapollenites stellatus	+				+		
Porocolpopollenites rotundus			+	+		+	+
Porocolpopollenites stereofornis			+				
Porocolpopollenites vestibulum			+				
Rhamnaceaepollenites triquetrius				+			
Mytaceidites mesonesus	+						
Pentapollenites pentangulus	+						
Pentapollenites cf. *punctoides*				+	+		
Striasyncolpites zworcardi				+			
Tricolpopollenites henrici		+	+	+	+	+	
Tricolpopollenites pudicus			+	+			
Tricolpopollenites asper	+	+	+	+	+	+	
Tricolpopollenites microhenrici	+	+	+	+	+	+	+
Tricolpopollenites densus			+	+	+	+	+
Tricolpopollenites retiformis	+	++	+	+	+	+	
Tricolpopollenites liblarensis	+	++	+	+	+	+	+
Tricolpopollenites parmularius	+	+		+	+		+
Tricolpites longicolpus					+	+	
Tricolpites levis						+	
Polycolpites speciosus	+						
Verrutricolpites cf.				+			

rotundiporis							
Striatricolpites catatumbus				+			
Polycolpites microputatus				+			
Polycolpites transdanubicus				+			
Pistilipollenites mcgregorii			+				
Tricolporopollenites villensis		+	+	+	+	+	+
Tricolporopollenites cingulum	+	++	+	+	+	++	++
Tricolporopollenites megaexactus	+	++	+	+	+	+	+
Tricolporopollenites undulatus				++			
Tricoporopollenites steinensis			+	+	+		+
Tricolporopollenites dolium					+		
Tricolporopollenites pseudocingulum	+	+	+	+			+
Tricolporopollenites pacatus			+	+	+		
Tricolporopollenites edmundi		+		+	+		
Tricolporopollenites euphorii				+	+		
Tricolporopollenites marcodurensis		+		+	+		
Tricolporopollenites kruschi		+	+	+	+	+	+
Tricolporopollenites baculaferus			+		+		
Psilatricolporites crassus	++	+		+	+		
Psilatricolporites cf. *costatus*	+						
Tricolporopollenites cf. *porasper*			+		+		
Tricolporopollenites microreticulatus	+	++	+	+	+	+	
Tricolporopollenites genuinus							+
Tricolporopollenites oleoides		+		+			
Ilexpollenites margaritatus			++	+		+	
Ilexpollenites propinguis				+			
Salixpollenites major				+			
Tricolporopollenites striatoides				+	+		
Tricolporopollenites striatopunctatus					+		
Tricolporopollenites sole-de-portai		+			+		
Avicennia type *alba*				+	+		
Avicennia type *marina*					+		
Tricolporopollenites messelensis				+	+		
Polygalacidites clarus				+			
Polycolporopollenites viesenensis				+			
Tetracolporopollenites biconus							+
Tetracolporopollenites obscurus		+	+	+	+		+
Tetracolporopollenites abditus			+		+	+	
Tetracolporopollenites microelipsus			+	+			
Tetracolporopollenites sapatoides			+				
Tetracolporopollenites manifestus			+		+		
Tetracolporopollenites perfectus							+
Tetracolporopollenites microrhombus						+	+
Tetracolporopollenites folliformis					+	+	
Chenopodipollis multiplex	+						
Periporopollenites multiporatus					+		
Nowemprojectus tumanganicus	+						
+ present in quantities up to 2% relative spore and pollen frequency, ++ present in quantities over 5%							

4.4.2 Early–"Middle" Oligocene

Palynological studies on Turkish Oligocene coals have mostly concentrated on the Thrace Basin. In contrast, there are few palynological studies on the Oligocene deposits in the rest of Turkey (Akyol, 1971; Batı, 1996; Nakoman, 1967; Akgün &

Sözbilir, 2001; Akkiraz & Akgün, 2005; Akgün, 2002; Sancay et al., 2006). This part deals with the differences and similarities of palynological assemblages of this study and previous contributions on Oligocene basins of Turkey.

Palynological assemblage obtained from the Tokça Formation is characterized by high percentages of *Laevigatosporites haardti* (37%), *Pityosporites microalatus* (12%), *Momipites punctatus* (86%) and *Caryapollenites simplex* (7%) (Table 4. 10). In addition, the palynological assemblage of the İncesu Formation is represented by high percentages of spore species such as *Leiotriletes maxoides* ssp. *maxoides* (~14%), *Echinatiporis* ?*chattensis* (~11%), *Polypodiaceoisporites* saxonicus (~10%) and *Laevigatosporites haardti* (6%) as well. Additionally, the pollen species *Inaperturopollenites dubius* (15%), *Momipites punctatus* (~15%) and *Caryapollenites simplex* (14%) occur very frequently.

Just as the palynomorph assemblages obtained from both İncesu (İncesu Area) and Tokça formations (Çardak–Tokça Area) are compared within the scope of this study, the main discrepancy is that the spore diversification in the palynomorph assemblage of the İncesu Formation is more than in the Tokça Formation (Table 4. 10). Furthermore, the relative percentages of common species are different. The other discrepancy is that the abundance of angiosperm pollen grains in Tokça Formation is higher than the İncesu Formation. Additionally, it is also necessary to indicate that the relative percentages of species change from sample to sample. For instance, *Longapertites discordis* are in low percentages in the Tokça Formation. *Longapertites* is present not only high species diversification but also abundance of species in the palynomorph assemblage of the İncesu Formation (Table 4. 10). Despite the fact that the number and diversification of species are different in both assemblages, these discrepancies can be dependent on palaeoecological conditions.

Conversely, Akkiraz & Akgün (2005) studied the palynology of coal–bearing Tokça Formation and determined high percentages of *Laevigatosporites haardti* (~8%), *Pityosporites microalatus* (8%), *Sparganiaceaepollenites neogenicus* (~6%), *Triatriopollenites coryphaeus* (15%) and *Tricolporopollenites microreticulatus* (9%)

(Table 4. 10). The authors also indicate that the biostratigraphically significant species like *Slowakipollis hippophaëoides*, *Intratriporopollenites instructus*, *Caryapollenites simplex*, *Mediocolpopollis compactus* ssp. *ellenhausensis*, *Aglaoreidia cyclops* and *Dicolpopollis kockelii* occur in low percentages in the assemblage (Table 4. 10).

If we combine the palynological data of Tokça and İncesu formations and also palynomorph assemblage of Akkiraz & Akgün (2005), there is a collective point in assemblages that contain biostratigraphically important species such as *Magnolipollis neogenicus* ssp. *minor Slowakipollis hippophaëoides*, *Boehlensipollis hohli*, *Intratriporopollenites instructus*, *Caryapollenites simplex* and *Dicolpopollis kockelii*. In addition to biostratigraphically important species, some plicoids species like *Plicatopollis plicatus* and *P. hunagricus* inherited from the Lower Tertiary also occur in the assemblages of Tokça and İncesu formations.

Moreover, the Tokça sporomorph assemblage was firstly demonstrated by Benda (1971a) from the Çardak–Tokça Area and his characteristic Early Oligocene sporomorph assemblage are shown in Table 4. 10. Benda (1971a) suggested that the Tokça sporomorph assemblage was characterized by the frequency of the species such as *Leiotriletes adriennis*, *Polypodiaceae*, *Verrucatosporites alienus*, *Inaperturopollenites incertus*, *I. emmaensis*, *I. dubius*, *I. magnus*, *I. hiatus*, *Monocolpopollenites tranquillus*, *Pityosporites microalatus*, *bituitus*, *rurensis* group, *Triatriopollenites coryphaeus*, *T. excelsus*, *Polyvestibulopollenites verus*, *Tricolpopollenites henrici*, *T. microhenrici*, *T. liblarensis*, *Tricolporopollenites megaexactus*, *T. pseudocingulum, T. cingulum* and *T. microreticulatus*. (Table 4. 10). However, the number of the samples studied for the establishment of this palynomorph assemblage and also numerical data of relative frequencies of the individual taxon/or group of taxa were not given in his study. Instead, terms like “questionable”, “single”, “poor”, “frequent” and “very frequent” were used in palynomorph distribution tables. Even though the Early Oligocene age defined in this study coincides with the age proposed by Benda (1971a), there are distinctions between palynomorph assemblage determined in this study and sporomorph assemblage of Benda (1971a). *Cicatricosisporites dorogensis*, *Corrugatisporites solidus*, *Inaperturopollenites emmaensis*, *Monocolpopollenites* species observed in the Early Oligocene Tokça sporomorph assemblage by Benda (1971a) and do not occur in the palynomorph assemblage of the Tokça Formation. On the other hand, if we combine the palynological data of the Tokça Formation defined in this study and Akkiraz & Akgün (2005), the species of *Magnolipollis neogenicus* ssp. *minor Dicolpopollis kockelii*, *Aglaoreidia cyclops*, *Plicatopollis plicatus*, *P. hungaricus Boehlensipollis hohli*, *Slowakipollis. hippophaëoides*, *P. pentangulus*, *C. rhizophorus* ssp. *burghasungensis*, *M. compactus* ssp. *ellenhausensis* and *I. instructus* that have biostratigraphical significance have been identified in the palynomorph assemblage of the Tokça Formation, but they do not take place in Benda's (1971a) Tokça sporomorph assemblage (Table 4. 10).

Akyol (1971) and Akgün (2002) studied the microfloras of the Early Oligocene basins in two different localities which are Şile (İstanbul) and Çankırı–Çorum, respectively (Table 4.10). The abundance of long ranging species has more or less similar to relative frequencies in Çankırı–Çorum, Şile and palynomorph assemblages obtained from the Tokça and İncesu formations. Akyol (1971) recorded high percentages of *Verrucatosporites favus* (~7%), *Pityosporites microalatus* (10%), *Triatripollenites rurensis* (~8%), *Triatriopollenites coryphaeus* (~32%), *Dicolpopollenites kockelii* (~13) and *Tricolporopollenites cingulum* (~11%) (Table 4. 10). Akyol (1971) and Akgün (2002) emphasized the importance of some species such as *Extratriporopollenites pompeckji*, *Plicatopollis lunatus*, *Plicapollis pseudoexcelsus*, *Triporopollenites robustus* and *Subtriporopollenites anulatus* ssp. *notus* ranging from Eocene to the Early Oligocene and suggested an Early Oligocene age for these two areas. *E. pompeckji* is only observed in the palynomorph assemblage of Akyol (1971). These species are not recorded in the palynomorph assemblages of the Tokça and İncesu formations (Table 4. 10). The species *Leiotriletes microadriennis*, *L. adriennis* and other index species of the Oligocene except *B. hohli* are found in our assemblage and do not occur in the Şile (İstanbul) coals and Çankırı–Çorum Basin. Akgün (2002) reported the presence of *B. hohli* and

Gothanipollis sp. in the Çankırı–Çorum Basin (Table 4.10) and suggests an Early Oligocene age.

Recently, Sancay et al. (2006) examined biostratigraphy of Oligocene and Miocene sediments outcropping in the Muş Basin (Eastern Anatolia) (Table 4. 10). To indicate the relative percentages of species, terms like “present”, “rare”, “common”, “abundant” and “super abundant” were used in palynomorph distribution tables. Early Oligocene palynoflora is commonly made up of the species of Compositae type pollen, *Inaperturopollenites hiatus*, *Magnastriatites howardi*, *Periporopollenites multiporatus*, *Pityosporites* spp. and Umbelliferae small types (less ornamented). The species of *Trilites multivallatus*, *Verrucatosporites favus, Caryapollenites simplex*, Umbelliferae, *Dicolpopollis kockelii*, *Slowakipollis hippophaëoides*, *Triatriopollenites* sp., *Reticulatisporites* sp., *Polyporopollenites undulosus*, *Saxosporis* sp., *Podocarpidites libellus*, *Mediocolpopollis compactus*, *Leiotriletes adriennis*, *Intratriporopollenites instructus*, *Ephedripites* sp., *Echinatisporis* sp., *Cingulatisporites* spp., *Cingulatisporites macrospecious* and *Cicatricosisporites* sp. also occur in the assemblage (Table 4. 10). The major distinction between the palynomorph assemblages obtained from the İncesu and Tokça formations and palynomorph assemblage of Sancay et al. (2006) is that open vegetation species like Compositae, Umbelliferae and Chenopodiaceae stands for high percentages in the palynomorph assemblage of them. However, it is interesting that there has been no palynological study indicating the abundance of open vegetation species obtained from Lower Oligocene sediments in Turkey up to now. As stated in the palynomorph content of the Kavak and Aksu formations, open vegetation species are observed in the Middle Miocene sediments and their percentages goes up to Pliocene and Pleistocene.

However, biostratigraphically important species *Dicolpopollis kockelii*, *Caryapollenites simplex*, *Intratriporopollenites instructus*, *Mediocolpopollis compactus* and *Slowakipollis hippophaëoides* also occur in the assemblage but in low frequency. Their percentages can more or less be correlated with percentages occurring in the palynomorph assemblages of the İncesu and Tokça formations.

Additionally, although *Leiotriletes maxoides* ssp. *maximus* and species of *Longapertites* commonly occur in Eocene and Oligocene sediments of western and central Anatolian palynomorph assemblages, they are absent in the palynomorph assemblage of Sancay et al. (2006).

Table 4.10 The occurrence of spore and pollen species in the Çardak–Tokça and İncesu areas and in the comparable deposits of the other Turkish Oligocene basins (*indicates semi–quantitative distribution of palynomorphs).

	Çardak – Tokça Area			**İncesu Area**	**Çankırı – Çorum Basin**	**Kars–Erzurum–Muş Sub-basins**	**Şile (İstanbul)**	**Kars–Erzurum–Muş Sub-basins**	**Thrace Basin**		**Southwest Anatolian Molasse basins**
Age	**EARLY OLIGOCENE**							**LATE OLIGOCENE**			
	WESTERN ANATOLIA				**EASTERN ANATOLIA**		**NORTHERN ANATOLIA**	**EASTERN ANATOLIA**	**NORTHERN ANATOLIA**		**WESTERN ANATOLIA**
Association	***Benda, (1971a)**	**Akkiraz & Akgün, (2005)**	**This study (Tokça fm.)**	**This study (İncesu fm.)**	***Akgün, (2002)**	***Sancay et al. (2006)**	**Akyol, (1971)**	***Sancay et al. (2006)**	**Nakoman, (1968)**	**Batı, (1996)**	**Akgün & Sözbilir, (2001)**
Retitriletes lusaticus				+							
Reticulatisporites agatheous								+			
Lusatisporis perinatus								+			
Cingulatisporites macrospecious						+					
Leiotriletes adriennis	++	+		+		+		+		++	++
Leiotriletes microadriennis		+	+					+			++
Leiotriletes maxoides ssp. *maxoides*			+	++							
Leiotriletes maxoides ssp. *minoris*				+							
Leiotriletes maxoides ssp. *maximus*		+		+			+	+	+	+	+
Leiotrletes triangulus			+	+							
Leiotriletes wolffii ssp. *woflfii*				+							
Leiotriletes neddenioides	+			+							
Leiotriletes microlepioidites				+							
Triplanosporites sinomaxoides				+							
Stereisporites psilatus									+		
Triplanosporites sinuosus	+			+							
Polypodiaceoisporites saxonicus			+	++							
Polypodiaceoisporites marxheimensis				+							+
Polypodiaceoisporites schoenewaldensis				+							
Polypodiaceoisporites gracillimus				+							+
Polypodiaceoisporites seidewitzensis											+
Polypodiaceoisporites corrutoratus				+							
Polypodiaceae	++										
Trilites multivallatus				+		+					
Trilites solidus	+						+				
Trilites embriyonalis				+							
Baculatisporites nanus			+	+							
Baculatisporites primarius ssp. *oligacaenicus*				+							
Baculatisporites ovalis				+							
Baculatisporites gemmatus							+				+
Baculatisporites sileiensis							+				

Osmundaceae	+										
Echinatisporis ? *chattensis*				++							
Echinatisporis spinodigitalis							+				
Echinatisporites miocenicus				+							
Echinatisporites longechinus						+		+			
Magnastratites howardi						++		+			
Laevigatosporites major			+								
Laevigatosporites haardti		++	++	++		+	+		++	++	++
Laevigatosporites gracilis			+	+							
Verrucatosporites histiopteroides				+							
Verrucatosporites balticus			+								
Verrucatosporites favus	+	+		+		+	++	+	++	+	
Verrucatosporites alienus	++	+	+	+		+	+			+	
Verrucatosporites tenellis				+							
Verrucatosporites semiclavatus							+				
Verrucatosporites scutulum							+		+		
Verrucatosporites secundus									++		
Inaperturopollenites incertus	++										
Inaperturopollenites emmaensis	++						+		++	+	+
Inaperturopollenites dubius	++	+	+	++			+		++	+	
Inaperturopollenites concedipites			+	+							+
Inaperturopollenites magnus	++	+	+	+			+			+	+
Inaperturopollenites hiatus	++	+	+		++	++	+			+	
Monocolpopollenites tranquillus	++										+
Monocolpopollenites areolatus	+										
Sequoiapollenites largus				+							
Sequoiapollenites polymorfosus				+							
Ephedraceae type pollen				+							
Smilacipites setarius	+										
Pityosporites microalatus	++	++	++	+	++		++		++	+	+
Pityosporites scopulipites				+							
Pityosporites minitus				+							
Pityosporites labdacus			+	+							
Pityosporites minitus			+								
Pityosporites spp.						++					
Podocarpidites libellus				+		+					
Picea type pollen	+										
Cathayapollis krutzschii				+							
Monocolpopollenites areolatus	+										
Cycadopites gracilis			+	+							
Cycadopites ?*minimus*			+	+							
Cycadopites lusaticus				+							
Magnolipollis neogenicus ssp. *minor*			+	+							
Longapertites discordis			+	+							
Longapertites punctatus				+							

Longapertites psilatus				+							
Longapertites retipiliatus				+							
Monogemmites pseudosetarius			+								+
Momipites punctatus		++	++	++							
Momipites quietus			+	+							
Extratriporopollenites pompeckji							+				
Sparganiaceaepollenites		++	+	+	++					+	+
Graminidites laevigatus			+	+							
Gramineae	+									+	
Aglaoreidia cyclops		+									
Dicolpopollis kockelii		+	+	+		+	++		++	++	++
Compositae type pollen						++		++			
Umbelliferae type pollen						++		+			
bituitus, rurensis group	++	+	+	+			++		+	+	+
Triatriopollenites coryphaeus	++	++					++		++	+	+
Triatriopollenites excelsus	++		+	+	++						
Triatriopollenites pudicus										+	
Triatriopollenites myricoides			+								
Plicatopollis lunatus					+						
Plicatopollis plicatus			+	+							
Plicatopollis hungaricus			+								
Labrapollis labraferus			+								
Olaxipollis matthesii			+	+							
Plicapollis pseudoexcelsus			+	+	+						
Celtipollenites intrastructus			+								
Triporopollenites robustus			+	+	+						
Triporopollenites megagranifer			+								
Triporopollenites coryloides	+										
Trivestibulopollenites betuloides	+		+	+							
Caryapollenites simplex	+	+	++	++	+	+	+	+	+	+	+
Subtriporopollenites anulatus ssp. *notus*					+						
Subtriporopollenites anulatus ssp. *nanus*			+	+							
Subtriporopollenites constans			+								
Subtriporopollenites intraconstans											+
Revesiapollis triangulus				+							
Compositoipollenites rhizophorus ssp. *burghasungensis*		+									
Intratriporopollenites instructus	+	+		+	+	+			+		
Polyvestibulopollenites verus	++	+	+	+	+	+			+	+	+
Carpinuspollenites carpinoides			+	+							
Polyporopollenites undulosus	+		+	+		+	+			+	+
Pterocaryapollenites stellatus	+			+							+
Porocolpopollenites vesitbulum							+				+
Boehlensipollis hohli		+		+	+						
Slowakipollis hippophaëoides		+		+		+					
Myrtaceidites mesonesus			+	+							

Cupanëiidites eucalyptoides			+	+							
Gothanipollis sp.					+						
Pentapollenites pentangulus		+		+							
Tricolpopollenites microhenrici	++	+	+	+	+		+			+	+
Tricolpopollenites henrici	++		+	+							+
Tricolpopollenites retiformis	+		+	+							
Tricolpopollenites densus			+				+				
Tricolpopollenites parmularius			+								
Tricolpopollenites liblarensis	++	+	+	+			+		++		+
Tricolpopollenites asper	+										
Tricolpopollenites pudicus									+	+	
Tricolporollenites megaexactus	++	+	+	+	++		+		+		+
Tricolporopollenites pseudocingulum	++		+	+							
Tricolporopolenites cingulum	++	+	+	+	++		++		++	+	+
Tricolporopollenites microreticulatus	++	++	+	+	++		++				+
Tricolporopollenites genuinus			+								
Tricolpropollenites pacatus			+	+							+
Tricolporopolenites euphorii			+								
Tricolporopolenites edmundi				+							
Tricolporopollenites marcodurensis			+								
Tricolpoeopollenites villensis	+										
Tricolporopollenites dolium	+										
Nyssaceae type pollen			+								
Mediocolpopollis compactus ssp. *ellenhausensis*		+				+					
Ilexpollenites margaritatus			+	+			+				
Ilaxpollenites iliacus			+				+				
Tetracolporopollenites	+	+		+		+				+	+
Chenopodipollis multiplex			+	+							
Periporopollenites multiporatus						+		+			
Periporopollenites stigmosus								+			
Periporopollenites (thallictrum type)			+								
+ present in quantities up to 2% relative spore and pollen frequency, ++ present in quantities over 5%											

4.4.3 Late Oligocene

There are lots of palynological studies on the coal seams of the Thrace Basin (NW Turkey) (Nakoman, 1968; Ediger et al.; 1990; Elsik et al., 1990; Batı, 1996). The recent studies show that the age of the Thrace Basin is of Late Oligocene (Ediger et al., 1990; Elsik et al., 1990; Batı, 1996).

Nakoman (1968) studied the palynomorphs of four samples, called from old to young as A1 (lignitic marl), A2 (lignite), A3 (marl) and A4 (lignite) from the Ağaçlı (İstanbul) lignites. In the sample A1, the most occurring taxa generally consists of high percentages of *Triatriopollenites coryphaeus* (36%), *Laevigatosporites haardti* (20%), *Verrucatosporites favus* (8%) and *V. secundus* (5%) (Table 4. 10). The sample A2 is characterized by high percentages of *Tricolporopollenites cingulum* (22%), *Inaperturopollenites dubius* (12%), and *Laevigatosporites haardti* (8%). The sample A3 is represented by frequent occurrence of *Tricolporopollenites cingulum* (15%), *Dicolpopollis kockelii* (10%) and *Laevigatosporites haardti* (5%). Finallly, the A4 is characteristic with abundance of *Tricolporopollenites cingulum* (21%), *Pityosporites microalatus* (13%), *Triatriopollenites coryphaeus* (10%) (Table 4. 10). According to the author, the age of Ağaçlı lignites should be the latest Oligocene or Early Miocene. The main discrepancy between palynomorph assemblage of Nakoman (1968) and the palynomorph assemblage defined in this study is that the relative percentage of *D. kockelii* in the Ağaçlı lignites is higher than the palynomorph assemblages obtained from the Tokça and İncesu formations. Conversely, diversification of spore species defined in this study is much more than in the Ağaçlı lignites. It is also necessary to indicate that the stratigraphic marker species such as *Boehlensipollis hohli*, *Slowakipollis hippophaëoides*, *Plicatopollis plicatus* and *P. hungaricus* do not occur in the palynomorph assemblage of Nakoman (1968). Additionally, though some back–mangrove elements *Longapertites* inherited from the Early Tertiary occur in the palynomorph assemblages of the Tokça and İncesu formations, Nakoman (1968) did not record them in the Ağaçlı lignites.

Batı (1996) studied the palynostratigraphy and coal petrography of the Upper Oligocene lignites of the northern Thrace Basin. The author recorded high percentage of *Laevigatosporites haardti* (6%), *Leiotriletes adriennis* (6%) and *Dicolpopollis kockelii* (~5%) (Table 4. 10). Besides, the species *Baculatisporites gemmatus* (1.3%), *B. primarius* (1.5%), *Leiotriletes microadriennis* (1.3%), *Cingulatisporites macrospecious* (0.8%), *Echinatisporis bifurcus* (0.5%), *E. grandis* (0.5%), *Verrucatosporites favus* (0.2%), *V. alienus* (0.1%), *Inapeturopollenites dubius* (3%), *I magnus* (3%), *I. hiatus* (~2), *I. emmaensis* (~1%), *Monocolpopollenites tranquillus* (1%), *Triatriopollenites bituitus* (0.5%), *T. coryphaeus* (0.4%), *T. pudicus* (0.3%), *T. pseudorurensis* (0.2%), *Monoporopollenites gramineoides* (Gramineae) (0.4%) and *Polyporopollenites undulosus* (0.2%) also occur in the assemblage, but in minor quantities. According to the author, detailed statistical analysis on the palynomorph distributions revealed that there are two palynomorph assemblages in Late Oligocene, namely Zone 1 and Zone 2. The Zone 1 is characterized by absence of *Monoporopollenites* spp. and by frequent occurrence of *Anatolinites dongyingensis*, *Dicolpopollis kockelii*, *Polyvestibulopollenites verus* and spore species belonging to genera *Laevigatosporites*, *Leiotriletes* and *Baculatisporites*. The upper Zone 2 is characterized by first occurrence of *Monoporopollenites* spp. and most frequent occurrences of the taxa mentioned above.

According to the author, though the Zone 1 and Zone 2 are of Late Oligocene (Chattian) on the basis of palynological data, the Zone 2 is slightly younger than the Zone 1 and probably corresponds to the upper parts of Chattian. Remarkable point in this study is that the occurrence of *Dicolpopollis kockelii* in the assemblage is represented in high percentages (0.3–24.5%) and do not reach as Late Oligocene as in Early Oligocene and Early Miocene palynomorph assemblages defined in this study. What is more, it is necessary to indicate that the species belonging to genera *Longapertites* and also *Leiotriletes maxoides* ssp. *maximus*, *B. hohli*, *S. hippophaëoides*, *C. rhizophorus* ssp. *burghasungensis*, *Triatriopollenites excelsus*, *Plicatopollis plicatus* and *Plicapollis hungaricus* and *M. compactus* ssp. *ellenhausensis* occurred in the palynomorph assemblages of the Tokça and İncesu formations do not occur in the palynomorph assemblage of the northern Thrace Basin (Table 4. 10).

Akgün & Sözbilir (2001) examined the Late Oligocene–Early Miocene sporomorph assemblages of the southwest Anatolian molasse basins (Kale–Tavas and Denizli molasse) (Table 4. 10). The authors distinguished two different palynomorph assemblages by the qualitative and quantitative contents of the samples. The first palynomorph assemblage indicates Late Oligocene (Chattian) for the Kale–Tavas and Denizli molasse basins, and the second Early Miocene of the Denizli molasse basin. The similarity between palynomorph assemblage of the Thrace Basin and the first palynomorph assemblage of the southwest Anatolian molasse basins is noticeable on account of palynomorph content. Especially the abundance of *Dicolpopollis kockeli* reaches up to 20% in some samples of palynomorph assemblage of the Thrace Basin and in the first palynomorph assemblage of the southwest Anatolian molasse basins (Table 4. 10). But, *D. kockelii* is less frequent (0–1%) in this study. Dominant spore and pollen species of the Thrace coals and southwest Anatolian molasse coals are not stratigraphically important except *I. emmaensis* which is present in our samples. The diversity and abundance of the spores and other pollen species have more or less similar relative frequencies in the Thrace Basin and first palynomorph assemblage of the southwest Anatolian molasse basins. But index species for the Oligocene such as *B. hohli*, *S. hippophaëoides*, *A. cyclops*, *C. rhizophorus* ssp. *burghasungensis*, *M. compactus* ssp. *ellenhausensis* and *P. pentangulus* have not been reported from both the Thrace Basin and the southwest Anatolian molasse basins (Table 4. 10).

The Late Oligocene palynomorph content of Sancay et al. (2006) is similar to Early Oligocene palynomorph assemblage and is primarily represented by presence of *Cicatricosisporites* sp., *Ephedripites* sp., *Inaperturopollenites hiatus*., *Tricolpopollenites* spp., *Tricolporopolenites* spp. and Compositae type pollen (Table 4. 10). *Pityosporites* spp. is represented by high percentages in the assemblage (Table 4.10). Nevertheless, *Dicolpopollis kockelii* abundantly determined in Turkish Late Oligocene (Ediger et al., 1990; Batı, 1996; Akgün & Sözbilir, 2001) does not occur in the Late Oligocene palynomorph assemblage of Sancay et al. (2006). To briefly state, it is a problem whether *Dicolpopollis kockelii* formed an acme zone in the Turkish Late Oligocene or not. However, the authors also recorded *L. maxoides* ssp.

maximus and *Verrucatosporites* which have biostratigraphical significance for the Turkish Oligocene (Table 4. 10).

4.4.4 Miocene

As stated in the palynomorph contents and ages of the Kavak and Aksu formations, both formations are of Early Miocene (Aquitanian) and have similar palynomorph content. The species of *Momipites punctatus*, *Tricolporopollenites cingulum* and *Tricolporopollenites megaexactus* are abundantly recorded in both of the assemblages. Additionally, plicoid forms such as *Plicatopollis plicatus* and *Plicatopollis hungaricus* also occur in these assemblages. Just as *Arecipites brandenburgensis*, *Dicolpopollis kockelii*, *Polyporopollenites undulosus*, *Inaperturopollenites hiatus*, *Inaperturopollenites dubius*, *Umbelliferaepollenites peissenbergensis*, *Pentapollenites pentangulus* and different types of tetracolporate pollen occur in the palynormoph assemblage of the Aksu Formation, they do not occur in the palynomorph assemblage of the Kavak Formation (Table 4. 11). Besides, diversification of tricolporate pollen in the Aksu Formation is more than the Kavak Formation (Table. 4. 11).

Benda (1971a) studied the Neogene palynoflora of Turkey and subdivided it into seven sporomorph assemblages, namely, from bottom to top, Tokça, Kurbalık, Kale, Eskihisar, Yenieskihisar, Kızılhisar and Akça.

The Kurbalık sporomorph assemblage, which is Chattian–Aquitanian in age, generally consists of *Tricolpopollenites henrici*, *T. microhenrici*, *Tricolporopollenites megaexactus*, *T. exactus*, *myricoides–bituitus–rurensis* group and *microcoryphaeus–punctatus* group. Additionally, *Inaperturopollenites emmaensis* and *Tricolporopollenites microreticulatus* appear in the assemblage. The characteristic species for the Tokça sporomorph assemblage do not occur in the Kurbalık sporomorph assemblage. Though the age of the Kurbalık sporomorph assemblage was described as Chattian–Aquitanian by Benda (1971a), its age was revised as Late Oligocene by Benda & Meulenkamp (1990).

Also, Benda (1971a) firstly determined the Kale sporomorph assemblage and then proposed its age as the Burdigalian–Helvetian (Early Miocene–early Middle Miocene). The number of characteristic species that are made up of *microcoryphaeus–punctatus* and *myricoides–bituitus–rurensis* groups for the Chattian–Aquitanian declines in the Kurbalık sporomorph assemblage. Moreover, the species *Tricolporopollenites microreticulatus*, *Inaperturopollenites emmaensis* occur but in low percentages (Table 4. 11). However, the presence of *Castanae* group (*Cupuliferoipollenites pusillus* and *C. oviformis*), *Tricolporopollenites megaexactus* and *T. villensis* type, *euphorii–edmundi* group, inaperturate pollen and *Pinus* haploxylon group is also important for the Kale sporomorph assemblage. Besides, the species *Polyporopollenites undulosus*, *Pinus* silvestris group and *Nyssa* type pollen regularly occur in the Kale sporomorph assemblage. Despite the fact that the age of the Kale sporomorph assemblage was accepted as the Burdigalian–Helvetian by Benda (1971a), its age was revised as the early–middle Burdigalian by Benda & Meulenkamp (1990). The characteristic species indicated in the Kurbalık and Kale sporomorph assemblages have also been recorded in the palynomorph assemblages defined in this thesis. However, the species *Leiotriletes maxoides* ssp. *maximus*, *Dicolpopollis kockelii*, some plicoid forms like *Plicatopollis plicatus* and *Plicatopollis hungaricus*, which have biostratigraphic significance, and some marine dinoflagellate cysts are not present in the Kurbalık and Kale sporomorph assemblages of Benda (1971a) and Benda & Meulenkamp (1990).

As stated in the Late Oligocene of Akgün & Sözbilir (2001), they studied palynostratigraphy of the Kale–Tavas and Denizli molasse basins outcropping in southwest Anatolia. As indicated by authors, there are two palynomorph assemblages, the first palynomorph assemblage is of Late Oligocene and second one is of Early Miocene (Aquitanian). The species *Laevigatosporites haardti* (18%), *Sparganiaceaepollenites polygonalis* (7%), *Triatripollenites coryphaeus* (22%), *Tricolporopollenites megaexactus* (7%) stand for high percentages (9–18%) in the second palynomorph assemblage (Table 4. 11). *Dicolpopollis kockelii* inherited from the Late Oligocene was recorded in low percentage (1%) that is consistent with relative percentages of the Aksu Formation. Also, *Leiotriletes maxoides* ssp.

maximus regularly occurred in the Oligocene sediments has comparatively lower percentages (0.5%), and it is of low percentage in the Early Miocene Aksu Formation as well. Limited number of spore species was recorded by the authors. In addition, it is also useful to indicate that the spore diversification is confined to the Kavak and Aksu formations. Nevertheless, the species diversification belonging to angiosperms are rich. Additionally, just as plicoid forms such as *Plicatopollis plicatus* and *P. hungaricus* occur in the Kavak and Aksu formations, they do not occur in the southwest Anatolian molasse basins (Table 4. 11).

Pityosporites spp., *Cingulatisporites* sp., *Echinatisporis bifurcus* and Compositae type pollen occur abundantly in the Early Miocene (Aquitanian) palynomorph assemblage of Sancay et al. (2006) (Table 4. 11). The species represented by a low percentage in the Oligocene also occur in the Early Miocene (Aquitanian). With the distinction of Oligocene, Dipseceae and *Zonalopollenites* sp., which do not occur in the Kavak and Aksu formations are observed to have been present in the Early Miocene. In addition, it is essential that *Slowakipollis hippophaëoides* present in the Oligocene does not occur in the Early Miocene palynomorph assemblage. *Dicolpopollis kockelii* that is completely absent in the Late Oligocene occur in low percentages in the Early Miocene and is consistent with relative percentages of the Aksu Formation.

Akyol & Akgün (1990) studied the palynology of the Neogene sediments outcropping in Bigadiç, Kestelek, Emet, Kırka localities of the Bigadiç Basin, and distinguished two different sporomorph assemblages, namely lower and upper sporomorph assemblages. The lower sporomorph assemblage is constituted by high percentages of *Pityosporites microalatus* (~12%), *Laevigatosporites haardti* (8%), *Polyvestibulopollenites verus* (8%) and *Tricolporopollenites cingulum* (~9%) (Table 4. 11). Moreover, the species *Pityosporites labdacus* (1%), *Triatriopollenites coryphaeus* (1%), *Triatriopollenites rurensis* (~1%), *Triatriopollenites bituitus* (~1%), *Inaperturopollenites dubius* (~1%), *Inaperturopolenites hiatus* (~1%), *Triporopollenites simpliformis* (~1%), *Podocarpidites libellus* (~1%), *Polyporopollenites undulosus* (0–1%) and *Caryapollenites simplex* (0–1%) occur in low percentages (Table 4. 11). The genera *Cingulatisporites* sp. and *Gleicheniidites* sp. indicating early Tertiary also exist.

Further, the species *Monoporopollenites graminoides* (11%) and *Pityosporites microalatus* (8%) are abundantly represented in the upper sporomorph assemblage (Table 4. 11). In addition to presence of *Pityosporites microalatus* in all samples, just as the relative percentages of *Pityosporites microalatus* reduces, the species *Pityosporites labdacus* appear. Additionally, *Periporopollenites multiporatus* and *Tricolporopollenites cingulum* regularly occur in the samples, but in low percentages. The species *Triporopollenites labraferus*, *Triporopollenites simpliformis*, *Tricolpopollenites microhenrici*, *Tricolporopollenites microreticulatus*, *Tricolporopollenites microiliacus*, *Periporopollenites stigmosus*, *Ephedripites* and Compositae type pollen sporadically occur in some samples.

On the basis of palynomorphs indicated above, the age of lower palynomorph assemblage is of the Middle Miocene and upper palynomorph assemblage is of upper part of the Late Miocene.

In contrast, the age of the Bigadiç Basin has been reevaluated by Akgün et al. (2007), who interpreted the age as upper part of the Early Miocene compared with radiometric age dating made by Helvacı (1995) and Helvacı et al. (2004). Akgün et al. (2007) reexamined palynological properties of the Bigadiç sporomorph assemblage. Tricolpate (*Tricolpopollenites liblarensis*, *T. microhenrici*, *T. henrici*), tricolporate (*Tricolporollenites microreticulatus, T. iliacus*, *T. kruschi*, *T. cingulum*) pollen and some sporomorphs (*Verrucatosporites* sp., *Stereisporites* sp., *Echinatisporis* sp., *Cingulatisporites macrospeciosus*, *Gleicheniidites* sp.) belonging to the early Tertiary were observed at low frequency and high diversity in the Bigadiç sporomorph assemblage by Akyol & Akgün (1990). In addition, the abundance of Chenopodiaceae should be related with environmental conditions. However, the age of the Bigadiç Basin is still a matter of debate. Recent studies of Helvacı (1995) and Helvacı et al. (2004) show that the age of the Bigadiç Basin is the late Burdigalian on the basis of K/Ar analysis. For this reason, the age of the Bigadiç Basin was interpreted as latest Burdigalian by Akgün et al. (2007).

The relative percentages of the stratigraphically unimportant species can be correlated with percentages of palynomorphs acquired from the Kavak and Aksu formations. However, as previously indicated, *Dicolpopollis kockelii*, *Leiotriletes maxoides* ssp. *maximus*, plicoid forms and dinoflagellate cysts occurring in the palynomorph assemblages of the Kavak and Aksu formations are not present in the sporomorph assemblage of Akyol & Akgün (1990).

On the other hand, lots of palynological studies have been made on the Middle Miocene sediments of Turkey (e.g. Akgün et al. 1986; Akgün & Akyol, 1987; Akgün & Akyol, 1987; Akyol & Akgün, 1990; Gemici et al., 1991; Akgün et al. 1995). Some of these studies will be discussed below.

Akgün & Akyol (1987) studied the palynology of the Çıtak lignites (the Gördes Basin). The palynomorph assemblage is mainly characterized by high frequency of *Laeigatosporites haardti* and *Polyvestibulopollenites verus* (Table 4. 11). The species of *Pityosporites microalatus*, *Inaperturopollenites dubius*, *I. hiatus*, *I. incertus*, *Triporopollenites labraferus*, *Triatriopollenites microalatus*, *Tricolpopollenites densus*, *T. microhenrici*, *T. liblarensis*, *Tricolporopollenites cingulum* are represented by low percentages (Table 4. 11). According to the authors, commonly occurring species have mainly recorded in the Miocene sediments. Additionally, high percentages of Graminae, Umbelliferae, Compositae and Compositae that are sporadically occurring in the Çıtak lignites indicate Late Miocene and Pliocene. The age of the Çıtak lignites is of Middle Miocene relying on the absence of *Extratriporopollenites*, *Verrucatosporites*, *Toroisporis*, *Trilites*, *Cicatricosisporites*, *Corsinipollenites*, *Dicolpopollis*, *Laevigatosporites discordatus*, *L. ovatus*, *Monocolpopollenites areolatus* and *Inaperturopollenites emmaensis* inherited from “Early” Tertiary and low frequency of Gramineae. Although the relative percentages of commonly occurring species are more or less similar to both palynomorph assemblage of Çıtak liginites and palynomorph assemblages of the Kavak and Aksu

Formations, the species *Leiotriletes maxoides* ssp. *maximus*, *Longapertites retipiliatus*, *Dicolpopollis kockelii* and *Plicatopollis plicatus* and *P. hungaricus* inherited from Early Tertiary are totally absent in the palynomorph assemblage of the Çıtak lignites (Table 4. 11).

Gemici et al. (1991) examined micro and macro flora of the Soma area (Table 4. 11) and determined a rich leaf floras such as *Pinus*, *Sequoia*, *Taxodium*, *Glyptostrobus*, *Magnolia*, *Laurophyllum*, *Acer*, *Sapindus*, *Ziziphus*, *Zelkova*, *Ficus*, *Cercis*, *Myrica*, *Fagus*, *Populus*, *Salix*, *Castanea*, *Castanopsis*, *Quercus*, *Carya*, *Apocyanophyllum* and *Phagranites*. Furthermore, the palynomorph assemblage obtained consists mainly of species occurring in the Miocene sediments of Turkey (Table 4. 11). The authors accepted that the age of the Soma lignites is of Middle Miocene on the basis of leaf fossils and also palynomorph assemblage, which have no biostratigraphically important species for the Early Miocene.

Akgün & Akyol (1999) examined palynostratigraphy of coal–bearing Neogene deposits in the Büyük Menderes Graben of western Anatolia. Two different palynomorph assemblages were proposed by the authors. The first palynomorph assemblage is distinctly represented by high percentage of *Pityosporites microalatus* (11%), *Polyvestibulopollenites verus* (~17%) and *Tricolpopollenites microhenrici* (~7%) (Table 4. 11). The species *Laevigatosporites haardti*, *Sparganiaceaepollenites neogenicus*, *Triatriopollenites rurensis*, *Tricolpopollenites densus* and *Polyvestibulopollenites verus* abundantly occur in some samples. *Inaperturopollenites dubius*, *Tricolporollenites cingulum* and *Tricolporopollenites megaexactus* are represented by minor quantities. Additionally, *Triatriopollenites coryphaeus*, *Triporopollenites simpliformis* and *Caryapollenites simplex* occur irregularly and in low percentages. The species *Pityosporites labdacus*, *Monoporopollenites graminoides*, *Echigraminidites moravicus*, Compositae type pollen and *Periporopollenites multiporatus* sporadically occur. The authors mentioned that the first palynomorph assemblage is of early Middle Miocene and Middle Miocene. According to the authors, some forms such as *Pityosporites labdacus* (*Pinus* silvestris–type), Compositae type, Gramineae, *Periporopollenites* *stigmosus* (*Liquidambar*) and *Tsuga* were characterized by low percentages in the Middle Miocene and Late Miocene, and their percentages rose up to and throughout the Pliocene.

The major distinction between the first palynomorph assemblage and palynomorph assemblages obtained from the Kavak and Aksu formations is that just as *Leiotriletes maxoides* ssp. *maximus*, *Dicolpopollis kockelii*, some plicoid forms inherited from the “Lower” Tertiary occur in the Kavak and Aksu formations. These species do not occur in the first palynomorph assemblage of Akgün &Akyol (1999). Additionally, open vegetation species like Chenopodiaceae (*Periporopollenites multiporatus* and *Chenopodipollis multiplex*) have scarcely been recorded in the palynomorph assemblage of the Kavak Formation.

On the other hand, second palynomorph assemblage is characterized by high percentage of *Pityosporites microalatus* (5%) and *Polyvestibulopollenites verus* (~15%) (Table 4. 11). Additionally, the species *Inaperturopollenites dubius*, *Tricolpopollenites densus* and *Polyvestibulopollenites verus* occur abundantly in some samples. The species *Sparganiaceaepollenites polygonalis*, *Sparganiaceaepollenites neogenicus*, Compositae type pollen and *Periporopollenites multiporatus* occur in small quantities. According to the authors, the age of the second palynomorph assemblage is of late Middle Miocene–earliest Late Miocene on the basis of the presence of *Pityosporites labdacus* (*Pinus* silvestris type), Gramineae, Compositae and *Liquidambar*. On the other hand, as discussed in the palynomorph assemblages of the Kavak and Aksu formations, the species of *Periporopollenites multiporatus* (Chenopodiaceae), Umbelliferae, Compositae and *Monoporopollenites graminoides* (Graminae) are recorded here as individual grains.

Karayiğit et al. (1999) studied the coal quality, palynology and palaeoenvironmental properties of the Ilgın lignite. Angiosperms shrubs and trees constitute the main part of palynomorphical composition (average 40%). *Pityosporites microalatus* (6%), *Inaperturopollenites dubius* (7%), *Triatriopollenites coryphaeus* (~7%) and *Tricolpopollenites densus* (~6%) achieve relatively the highest abundance in percentage (Table 4. 11). The authors indicated a few herbaceous pollen taxa, *Monoporopollenites gramineoides* (Gramineae) and *Periporopollenites periporatus* (Table 4. 11). According to the authors, the relative percentage of these taxa in the Middle Miocene is quite low (2% to 3% maximum), reaching an equation of 10% in the Late Miocene and higher levels (20%minimum) in the Pliocene. It is also important that the ratio between *Pinus* haploxylon and *Pinus* sylvestris type pollen for the biostratigraphical subdivision in Turkey, Greece, Italy and Spain (Benda, 1971a, b; Benda & Meulenkamp, 1990). Depending on what authors stated, the relationship between the relative abundance of *Pinus* sylvestris and *Pinus* haploxylon in the latest Middle Miocene continues into younger strata with increasing predominance of *Pinus* silvestris over *Pinus* haploxylon type.

As a consequence, the age of the Ilgın lignites is of a Middle Miocene (equivalent of middle Serravallian) as discussed above. Though some spores such as *Baculatisporites primarius*, *Verrucosisporites* sp., *Verrucatosporites* sp. and *Cingulatisporites macrospecious* were determined in the Ilgın lignites and their presence is characteristic for age determination of Eocene and Oligocene sediments, the characteristic species like *Dicolpopollis kockelii*, *Leiotriletes maxoides* ssp. *maximus* and some plicoid forms were entirely not reported from the Ilgın lignites by authors (Table 4. 11).

Akgün et al. (2000) examined the palynology and mammal fauna from the Upper Miocene İncesu Formation at Düzyayla (Hafik–Sivas, Central Anatolia). Angiosperm pollen is represented by high percentages as compared with gymnosperms. In the assemblage, the species *Laevigatosporites haardti* (51%), Compositae type pollen (5%), *Periporopollenites multiporatus* (~6%) and *P. halifani* (~8) are characterized by high percentages (Table 4. 11). In spite of the fact that the relative percentages of arboreal plants such as *Tricolpopollenites densus, T. microhenrici* (*Quercus*) and *Tricolporopollenites cingulum* (*Castanea*) are in low percentages, the relative percentages of herbaceous pollen such as Graminae (*Monoporopollenites gramineoides*, *M. gramineus* and *Graminidites laevigatus*), Umbelliferae, Chenopodiaceae (*Periporopollenites multiporatus*), are high.

According to the authors, the sporomorph assemblage obtained is well correlated with "Kızılhisar sporomorph assemblage" (Becker–Platen, 1970; Benda, 1971a, b; Benda & Meulenkamp, 1990). Accordingly, the age of the sporomorph assemblage acquired from the İncesu Formation is of Late Miocene. The main discrepancy between the Early Miocene defined in this thesis and the Late Miocene is that just as some herbaceous species like Compositae, Chenopodiaceae and Umbelliferae abundantly occur in the Late Miocene İncesu Formation, the species of these genera are absent in the Early Miocene formations. However, only single grain of Umbelliferae was recorded from the palynomorph assemblage of the Aksu Formation.

Table 4.11 The occurrence of spore and pollen species in the Burdur Area and in the comparable deposits of the other Turkish Miocene basins (*indicates semi–quantitative distribution of palynomorphs).

	Burdur Area		**Denizli Area**		**Bigadiç Basin**	**Southwest Anatolian Molasse basins**	**Kars–Erzurum–Muş Sub-basins /Eastern Anatolia)**	**Ilgın lignites**	**Kırşehir Area**	**Büyük Menderes Graben**	**Gördes Basin**	**Soma Basin**	**Sivas (Hafik)**
Age	**EARLY MİOCENE**							**MIDDLE MİOCENE**					**LATE MIOCENE**
	WESTERN ANATOLIA						**EASTERN ANATOLIA**			**WESTERN ANATOLIA**			**EASTERN ANATOLIA**
Association	**This study (Kavak Fn.)**	**This study (Aksu Fn.)**	***Benda (1971a) (Kurbalık)**	***Benda (1971a) (Kale)**	**Akgün et al. (2007)**	**Akgün & Sözbilir, 2001**	***Sancay et al. (2006)**	**Karayiğit et al. (1999)**	**Akgün et. al. (1995)**	**Akgün & Akyol (1999)**	***Akgün & Akyol (1987)**	***Gemici et al. (1991)**	**Akgün et al. 2000**
Cicatricosisporites dorogensis			+	+									
Punctatisporites ellipsoideus											+		
Cingulatisporites macrospecious					+			+	+	+	+	+	
Cingulatisporites vitiosus											+		
Lusatisportes punctatus										+			
Leiotriletes microadriennis	+	+							+	+	+	+	+
Leiotriletes adriennis		+	+			+							
Leiotriletes pseudomaximus			+	+									
Leiotriletes maxoides ssp. *maxoides*	+	++											
Leiotriletes maxoides ssp. *minoris*	+	++											
Leiotriletes maxoides ssp. *maximus*		+				+							
Leiotrletes triangulus	+	+											
Leiotriletes wolffii ssp. *woflfii*		+											
Leiotriletes neddenioides		+	+	+									
Leiotriletes microlepioidites	+	+											
Leiotriletes seidewitzensis		+											
Gleichenia type									+		+		
Divisisporites divisus											+		
Triplanosporites sinuosus		+	+	+									
Polypodiaceoisporites saxonicus	+	+											
Polypodiaceae			+	+									
Trilites multivallatus							+						
Trilites solidus			+	+									
Stereisporites steroides										+			
Stereisporites sp.													+
Osmundaceae			+	+									
Baculatisporites primarius				+				+		+	+	+	
Baculatisporites gemmatus										+		+	
Baculatisporites microornatus											+		
Echinatisporis miocenicus	+												

Echinatisporis longechinus							+						
Echinatisporis bifurcus												+	
Echinatisporis grandis												+	
Laevigatosporites	+	+			++	+	+	+	++	+	++	+	++
Punctatosporites ellipsoides											+		
Verrucatosporites favus			+				+				+	+	
Verrucatosporites alienus		+	+									+	
Verrucatosporites scutulum										+			
Echinatosporites bifurcus							+						
Inaperturopollenites incertus			+								+		
Inaperturopollenites emmaensis			++	+									
Inaperturopollenites dubius		+	+	+				++	++	+	+	+	+
Inaperturopollenites concedipites	++	+				+							
Inaperturopollenites magnus			+	+					+	+			
Inaperturopollenites hiatus		+	+	+	+			+	+	+	+	+	+
Inaperturopollenites magnus									+			+	
Inaperturopollenites verrucosus												+	
Inaperturopollenites granulatus										+			
Inaperturopollenites granulosus									+				
Sciadopytspollenites serratus				+									
Monocolpopollenites tranquillus			+				+					+	+
Monocolpopollenites areolatus			+	+								+	
Sequoiapollenites polyformosus	+			+	+			+	+	+		+	
Ephedra type pollen		+							+	+			
Smilacipites setarius			+										
Arecipites brandenburgensis		+											
Arecipites fusus								+					
Arecipites zievelensis								+					
Pityosporites microalatus	+	+	++	++	++	+		++	++	++	++	++	+
Piceapollenites			+	+									
Pityosporites labdacus	+	+	+	+	+		+	+	+	+	+	+	+
Pityosporites absolutus								+	+		+		
Podocarpidites libellus					+		+	+		+	+		
Keteleeria type				+									
Cedripites cedroides											+		
Cathayapollis bağyakaensis						+		+					
Cycadopites gracilis	+	+											
Cycadopites minor								+					+
Cycadopites lusaticus	+	+											
Cycadopites intrastructus		+											
Cycadopites cycadoides													+
Longapertites retipiliatus	+												
Monogemmites pseudosetarius					+					+	+	+	+
Echigraminidites moravicus										+			
Momipites punctatus	++	++	++	+									
Momipites quietus	+	+											
Sparganiaceaepollenites		+				++				+			+
Monoporopollenites solaris											+		

Graminaeae			+	+	+		+	+	+	+	+	+	+
Cyperaceae			+	+									
Dicolpopollis kockelii		+				+	+						
Compositae type pollen									+				
Umbelliferae type pollen		+		+			+		+				
bituitus, rurensis group	+	+	++	+	+	+		+	+	+	+	+	+
Triatriopollenites coryphaeus					+	++	+	++	+	+	+	+	
Triatriopollenites concavus						+		+					
Triatriopollenites excelsus			+										
Triatriopollenites myricoides						+					+		
Plicatopollis plicatus	+	+				+				+	+	+	
Plicatopollis hungaricus	+												
Triatriopollenites arobaratus											+		
Platycaryapollenites miocaenicus						+							
Triporopollenites coryloides			+	+						+			
Triporopollenites simpliformis					+			+	+	+	+	+	
Triporopollenites megagranifer											+		
Triporopollenites robustus									+				
Triporopollenites vancompoi											+		
Labrapollis labraferus					+			+	+	+	+	+	
Corsinipollenites oculis ssp. *noctis*								+	+	+			
Trivestibulopollenites betuloides			+	+							+		
Ostryoipollenites rhenanus			+	+									
Caryapollenites simplex	+	+	+	+	+	+	+	+	+	+	+	+	+
Subtriporopollenites anulatus ssp. *nanus*					+	+							
Revesiapollis triangulus	+												
Intratriporopollenites instructus	+		+	+			+		+	+	+		+
Intratriporopollenites insculptus		+											
Polyvestibulopollenites verus	+	+	+	+	++			+	+	++	++	+	+
Carpinuspollenites carpinoides	+	+							+				
Polyporopollenites undulosus		+	+	+	+	+	+	+	++	+	+	+	+
Pterocaryapollenites stellatus		+	+	+			+	+		+	+	+	+
Porocolpopollenites vesitbulum						+				+	+		
Porocolpopollenites rotundus									+		+		
Myrtaceidites mesonesus	+	+											
Pentapollenites pentangulus		+											
Cupuliferaepollenites quisquallis			+	+									
cf. *Achantotricolpites intermedius*													+
Tricolpopollenites parmularius		+	+							+	+	+	
Aceripollenites striatus	+												
Tricolpopollenites microhenrici	++	++	++	++	+	+	+	++	+	++	+	++	+
Tricolpopollenites henrici	+		++	+	+	+			+	++	+	++	
Tricolpopollenites retiformis	+	+	+	+		+		+	+	+	+	+	+
Tricolpopollenites densus	+	+			+	+		++	++	++	+	++	+
Tricolpopollenites asper			+	+					+		+	+	
Tricolpopollenites liblarensis	+	+	+	+	+	+			+	+	+	+	+

Tricolpopollenites spinosus											+		
Tricolporollenites megaexactus	+	+	++	+	+	++		+	+	+	+	+	+
Tricolporopollenites pseudocingulum	+	+	+	+						+	+	+	+
Tricolporopolenites cingulum	++	++	++	+	++	+		+	+	+	+	+	+
Tricolporopollenites microreticulatus	+	+	++	+	+	+		+	+	+	+		
Tricolporopollenites villensis	+	+	+	+		+		+			+		
Tricolpropollenites pacatus	+	+				+		+	+	+	+	+	
Tricolporopolenites porasper						+			+	+	+	+	
Tricolporopolenites dolium			+	+						+			
Tricolporopollenites euphorii	+		+	+			+	+		+	+		
Tricolporopollenites edmundi		+	+	+							+		
Tricolporopollenites helmsteddensis										+	+		
Tricolporopollenites steinensis									+	+	+	+	
Tricolporopollenites genuinus									+	+			
Tricolporopollenites donatus													+
Tricolporopollenites baculoferus		+									+		
Tricolporopollenites satzveyensis		+										+	
Tricolporopollenites marcodurensis		+											
Tricolporopollenites eschweilerensis									+		+		
Tricolporopollenites irregulatus											+		
Nyssa type		+		+	+			+	+	+	+	+	
Rhuspollenites ornatus						+							
Ilexpollenites margaritatus						+		+	+	+			
Ilexpollenites iliacus					+						+	+	
Ilexpollenites microiliacus					+						+		
Mediocolpopollis compactus							+						
Tetracolporopollenites microrhombus		+			+	+				+			
Tetracolporopolenites abditus								+			+		
Tetracolporopollenites microellipsus						+		+		+	+	+	+
Tetracolporopollenites manifestus					+			+		+	+	+	
Tetracolporopollenites oblongus										+			
Tetracolporopollenites obscurus	+	+								+			
Tetracolporopollenites biconus		+											
Tetracolporopollenites sapotoides		+											
Tetracolporopollenites			+						+				
Chenopodiaceaepollenites multiplex		+											
Chenopodiaceae			+		++								
Juglans type				+									
Compositae type pollen				+						+			++
Periporopollenites stigmosus				+	+		+	+		+			+
Peripropollenites microporatus									+		+	+	
Peripropollenites perplexus													+
Peripropollenites granulatus													+
Periporopollenites halifani													++
Periporopollenites multiporatus		+			+		+		+	+	+		++
Peripropollenites multiporatus								+					
Periporopollenites sp.													+
+ present in quantities up to 2% relative spore and pollen frequency, ++ present in quantities over 5%													

CHAPTER FIVE
PALAEOENVIRONMENT AND PALAEOVEGETATION

In this part, to enable to reconstruct of the palaeoenvironmental and palaeovegetational conditions in the Çardak–Tokça, Burdur and İncesu areas, the palynological data set was subject to a two–step statistical analysis, namely cluster analysis and non–metric multi dimensional scaling (MDS) (see detailed explanations in chapter 1). Furthermore, Foraminifer data was also subject to statistical analysis to see the palaeoenviromental fluctuations in the areas. On the basis of palaeoenvironmental conditions, palaeogeographic data have also been presented.

5.1 Eocene

5.1.1 The Başçeşme Formation

The palynological assemblage of the Başçeşme Formation in the Çardak–Tokça Area is limited due to conditions of sedimentation, and exhibits some differences in the frequency of the same taxa in different samples (Table 4. 1). To reconstruct the palaeoenvironment during the deposition of the Başçeşme Formation, definite ecological marker taxa have been selected from the published literature. The ecological characteristics of the species have been grouped under generic headings, such as “mangroves” (*Nypa* and *Pelliciera*) and “fresh–water elements” (*Aglaoreidia cyclops*, Sparganiaceae and *Pediastrum* spp.) (See Table 4. 1 for detailed ecological requirements of taxa).

The rhizomatic palm *Nypa* is an ecological marker of mangrove vegetation (Germeraad et al. 1968; Jiménez 1984; Frederiksen 1985; Thanikaimoni 1987; Westgate & Gee 1990; Srivastava & Binda 1991; Graham 1995; Rull 1998a; Lenz & Riegel 2001). *Pelliciera* is another mangrove element (Jiménez 1984; Rull 1998a). According to Frederiksen (1985), *Aglaoreidia cyclops* was found to favour fresh–water habitats (e.g., *Azolla*, *Pediastrum*, *Botryococcus*, *Potamegaton*, *Sparganium* and *Typa*). Thus, the species was thought to have been produced by fresh–water habitats (Fowler 1971; Frederiksen 1985; Riegel et al.1999).

From the palaeovegetational point of view, the palaeocommunities and samples can be divided into two or three assemblages (Fig. 5. 1). In the palaeocommunities dendogram, assemblage 1 consists of mangroves, brackish–water elements and dinoflagellate cysts. Assemblage 2 includes fresh–water, lowland–riparian and montane elements (Fig. 5. 1). In the sample dendogram, assemblage A is characterized by a dominance of mangroves, brackish–water elements and low frequencies of dinoflagellate cysts and montane elements, corresponding to the palaeocommunity cluster 1 (Fig. 5. 1).

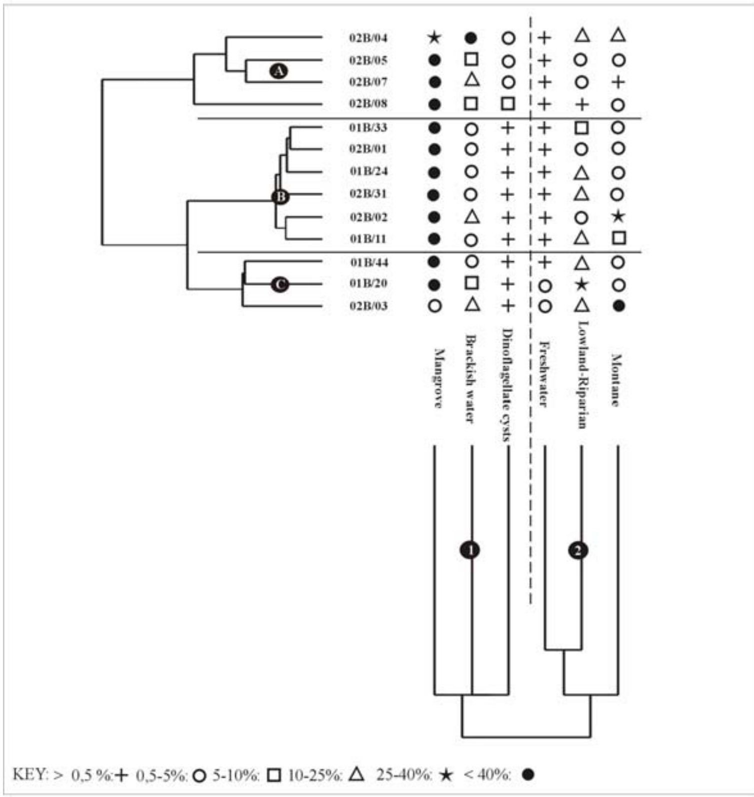

Figure 5. 1 Dendrograms for UPGMA cluster analysis of palaeocommunities (bottom) and samples (side), using Raup–Crick Index (See figure 2. 5 for the locations of the samples and table 4.1 for the relative percentages of species).

The samples of cluster A coincide with the samples taken from the upper part of the section. The presence of poorly preserved dinoflagellate cysts and the abundance of mangrove elements in these samples indicate close proximity to a marine environment (Figs.5. 1, 5. 3). The samples taken from the lower part of the section lack dinoflagellate cysts (Figs. 5. 1, 5. 3).

Sample cluster B is represented by the dominance of mangrove and the absence of fresh-water elements and dinoflagellate cysts. The lowland–riparian and montane elements in sample cluster B are higher than in cluster A (Figs. 5. 1, 5. 3).

The samples of cluster C were taken from the lowest part of the section and are represented by the presence of fresh-water elements, high frequencies of mangrove, lowland-riparian and montane elements, and the absence of dinoflagellate cysts (Figs. 5. 1, 5. 3), corresponding to cluster 2 in the palaeocommunity dendogram (Fig. 5. 3). There are low numbers of mangrove elements in sample cluster C as compared to clusters A and B (Fig. 5. 3).

All micropalaeontological samples have also been subjected to non-metric multidimensional scaling (MDS) using the Hamming distance method (Fig. 5. 2). The MDS shows results similar to those of the cluster analysis. The MDS of the samples (Figure 4) shows that groups identified in the cluster analysis have also been recognized this plot. The samples, which are situated at the positive part of the second axis, show a close proximity to marine environment based on the presence of marine samples (A1–A22); also, cluster A includes dinoflagellate cysts, mangroves and brackish–water elements (Figs. 5. 1, 5. 2). The samples at the negative part of the second axis indicate relatively a terrestrial condition.

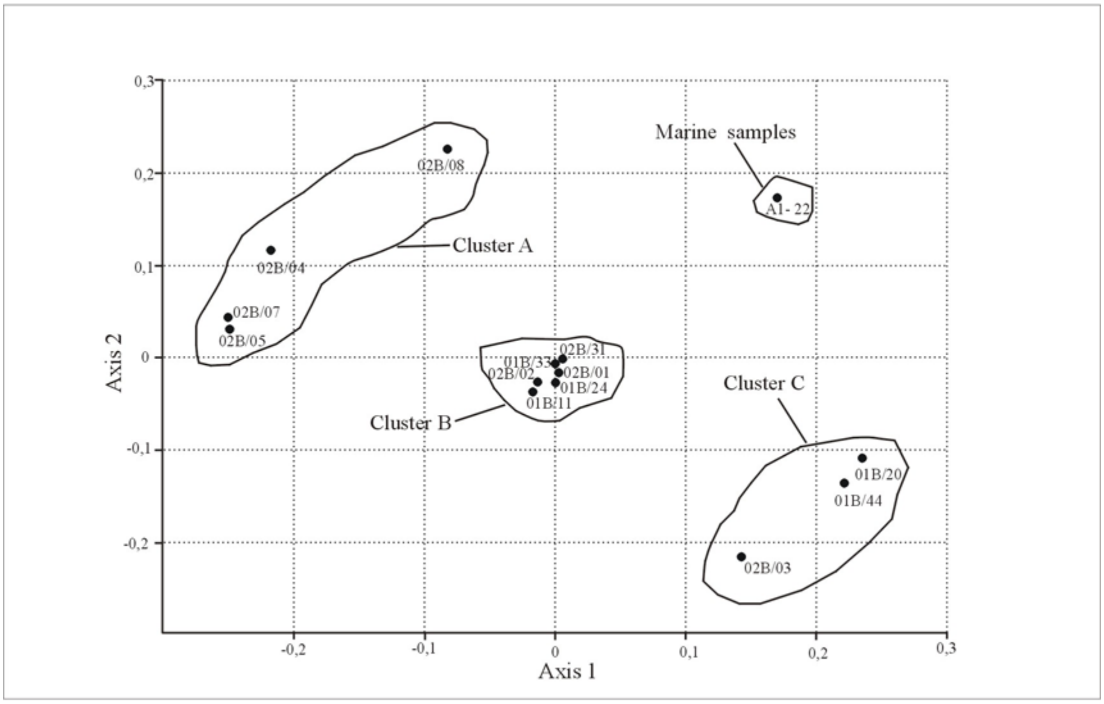

Figure 5. 2 Scattergram of taxa ordination, from a two–dimensional MDS using the Hamming distance. Stress = 0.3028 (See figure 2. 5 for the locations of the samples).

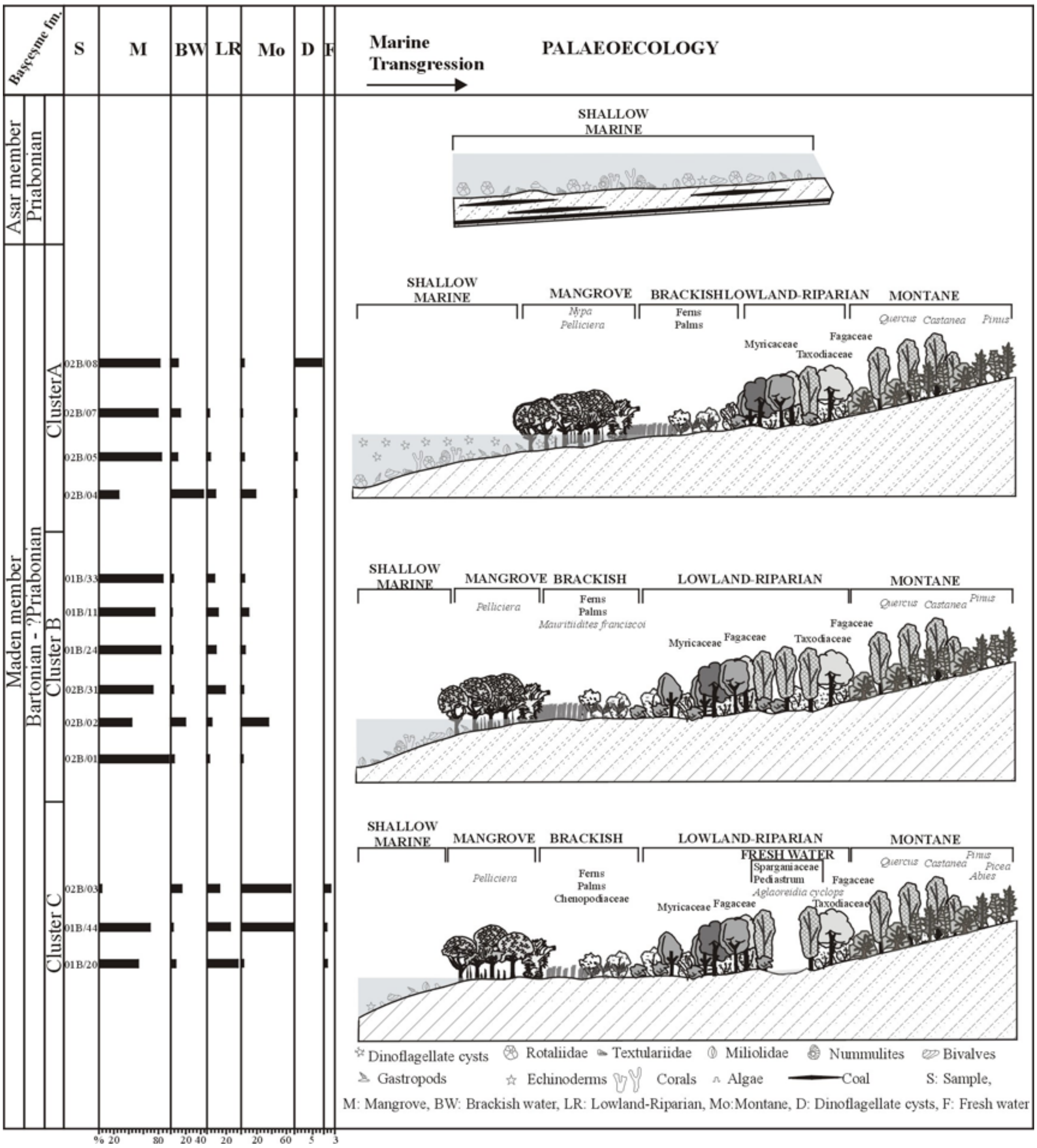

Figure 5. 3 Palaeoenvironmental reconstruction of the Çardak-Tokça Area (Western Anatolia) during the deposition of the coal–bearing Middle–Late Eocene Başçeşme Formation (for the Maden and Asar members).

Mangrove element *Pelliciera* (*Psilatricolporites crassus*) is found abundantly in all samples (Table 4. 1). According to Jiménez (1984), *Pelliciera* is more sensitive high soil salinity than other more widespread neotropical mangroves. It develops best on wet soils, shallowly inundated at high tides (Collins et al. 1977). It also thrives on firm, sandy slightly elevated soils which located in inter–channel areas (Fuch 1970; Jiménez 1984). *Nypa*, pollen of which is observed as individual grains in sample

02B/07, occurs in permanently brackish humid soil on the proximal fringes of mangrove fronts (Blasco 1977; Chapman 1976; Srivastava & Binda 1991) (Table 4. 1). The combination of *Psilamonocolpites* sp., *Mauritiidites franciscoi* (*Mauritia*) and *Leiotriletes adriennis* (*Acrostichum aureum*), which are back–mangrove swamps, have been observed as individual grains in some samples. Their presence in the Tertiary of Venezuela has been interpreted as representative of the wetlands behind mangroves near the limit of tidal influence (Rull 1992, 1997a, 1997b, 1998a, 1998b). A *Mauritia* palm forest associated with ferns indicates a zone of fresh-water (to locally brackish) swamps and marshes in the Eocene of Colombia (González-Guzmán 1967). The pollen of *Mauritia* grew back of the coastline (Van Der Hammen & Wijmstra 1964); its presence in the sediments is a reliable indicator of a warm tropical lowland environment flooded by fresh (sometimes oligohaline) waters (Rull 1998b). In addition, *Mauritiidites* may also be observed in more inland associations. The scarce presence of *Nowemprojectus tumanganicus* in samples 02B/03, 02B/04 and 02B/05 should be indicative of peaty substrates (Frederiksen et al. 2002) (Table 4. 1). The pollen of Chenopodiaceae may endure droughts in salt marshes (Fig. 5. 3).

Pteridophytic spores of Polypodiaceae, Schizaceae, Selaginellaceae, Lygodiaceae and *Osmunda* are dispersed in the samples, which indicate the prevalence of perennial water in the brackish-water palaeocommunity (Fig. 5. 3). The presence of *Sparganiaceaepollenites* (Sparganiaceae), *Pediastrum* spp. and *Aglaoreidia cyclops* in samples 02B/03, 01B/20 and 01B/44 corresponds to sample cluster C and may be considered as the fresh–water palaeocommunity (Figs. 5. 1, 5. 3). Almost all samples include lowland-riparian elements such as Juglandaceae, Betulaceae, *Engelhardia*, Fagaceae and Myrtaceae. Montane elements are represented by *Pinus*, *Abies*, *Picea*, *Cathaya*, *Quercus* and *Castanea* (Fig. 5. 3). The frequencies of lowland–riparian and montane elements and also the presence of fresh–water elements in palaeocommunity cluster 2 (which corresponds to the sample cluster C) may indicate low sea levels (Figs. 5. 1, 5. 2, 5. 3). The deposition of these samples in cluster C may have occurred in a non–marine, back–mangrove environment. The abundance of mangrove brackishwater elements and the presence of poorly preserved dinoflagellate cysts in sample cluster A indicate high sea levels (Figs 5. 1, 5. 3). Samples of clusters A and B must have been deposited in a mangrove environment (Fig. 5. 3).

In summary, it is clear that the Middle–Late Eocene transgression is recorded from cluster C to cluster A (Fig. 5. 3). The presence of marine limestones in the study area indicates that maximum sea–level conditions were attained during deposition of the Asar member (Fig. 5. 3). The marine transgression is also well documented by the presence of reefal limestones containing rich marine fossils, such as coral reefs, benthic foraminifers and echinoderms (Fig. 5. 3). In western Anatolia, there has been no study focusing on the Bartonian–Priabonian transgression. However, on a regional scale, the Palaeocene–Eocene successions of western Anatolia were probably associated with depressions (Sözbilir 2002).

5.1.2 The Varsakyayla Formation

As mentioned in chapters 1 and 4, only two samples were suitable with respect to palynological counting of the Varsakyayla Formation (Table 4. 5). Because of this, it is not possible to draw a picture of the palaeovegetational and palaeoenvironmental trend for each sample. On the other hand, it is possible to make an approximation for the palaeoenvironmental conditions of the Varsakyayla Formation based on the palynological assemblage.

For this reason, definite ecological marker taxa have been selected (See Table 4. 5 for detailed ecological requirements of taxa). Since the relative percentages of ecological groups on the basis of species obtained have been accounted, the relative percentages of ecological groups have been obtained like as shown in Table 5. 1. The ecological groups and also marine foraminifers obtained have been applied to mathematically cluster analysis and multi–dimensional scaling (MDS) (Table 5. 1, Figs. 5. 4, 5. 5).

Mangrove element is made up of *Psilaticolporites crassus* which is the pollen of the *Pelliciera* (1%), a mangrove forming tree now restricted to Central America (Graham, 1995). Back–mangrove elements *Arecipites brandenburgensis* also occur in the samples but in low percentages (Table 5. 1). Ferns like *Leiotriletes triangulus*, *Baculatisporites primarius* ssp. *oligocaenicus* also occur in the freshwater environment. Shallow marine fossils are represented by undifferentiated dinoflagellate cysts, *Cleistosphaeridium* sp. and *Cordosphaeridium* sp. (Fig. 5. 4). Lowland–riparian elements mainly consist of *Momipites quietus* (8%), *Plicatopollis plicatus* (12.9%), *Tricolporopollenites microreticulatus* (3.25%), *T. megaexactus* (2.75%), *T. cingulum* (3%) and *Momipites punctatus* (9.5%). Additionally, the species *Triatriopollenites rurensis*, *Triatriopollenites bituitus*, *Triatriopollenites excelsus*, *Plicatopollis plicatus*, *Intratriporopollenites instructus*, *Polyporopollenites undulosus*, *Tricolporopollenites pseudocingulum*, *Tricolporopollenites edmundi*, *Plicatopollis lunatus*, *Subtriporopollenites anulatus* ssp. *nanus*, *Compositoipollenites rhizophorus* ssp. *burghasungensis*, *Tricolpopollenites villensis* are represented in minor amounts. Moreover, montane elements are chiefly represented by *Pityosporites microalatus* (4. 4%), *Tricolpopollenites retiformis* (15.6%), *Tricolpopollenites liblarensis* (8%) and *Tricolpopollenites microhenrici* (2%). Swamp–freshwater element *Tricolporopollenites kruschi* ssp. *pseudolaesus* is represented in low frequency as well.

Table 5. 1 Average percentages of ecological groups in the Varsakyayla Formation (See Table 4. 5 number of species recorded).

Ecological groups	Swamp freshwater	Montane	Lowland-riparian	Mangrove	Back–Mangrove (Brackish water)	Dinoflagellate	Unknown
Relative percentages	1.183	39.234	52.478	1.185	0.286	1.71	3.924

In the cluster analysis, assemblage 1 consists of foraminifers (marine samples). Assemblage 2 contains lowland–riparian and montane elements (Fig. 5. 4). Assemblage 3 is made up of mangrove, back–mangrove, dinoflagellate cysts and swamp–freshwater elements (Figure 5. 4).

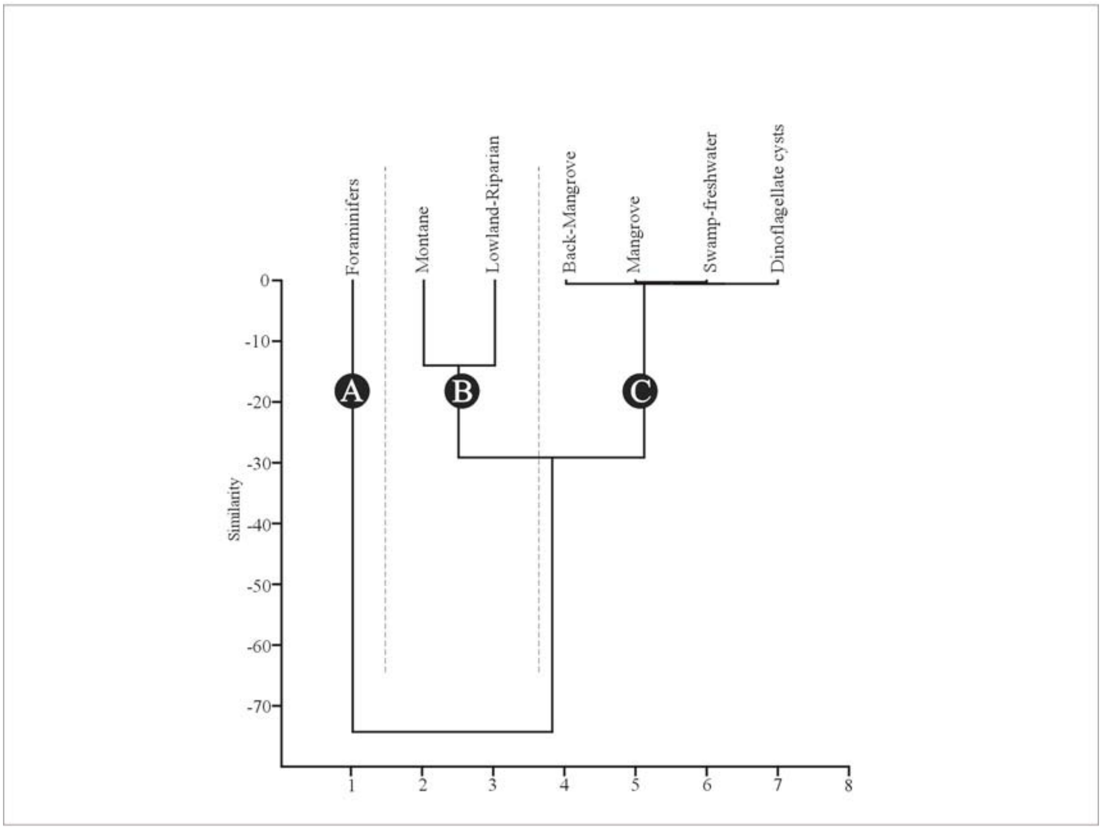

Figure 5. 4 Cluster analysis for ecological groups in the Varsakyayla Formation using Similarity index (See Table 5. 1 for the relative percentage of ecological groups).

All the micropalaeontological groups have also been applied to non–metric multidimensional scaling (MDS) using the Euclidean distance method (Fig. 5. 5). The MDS shows that the groups identified in the cluster analysis have also been recognized in this plot. The ecological groups, which are situated at the positive part of the second axis, show a relatively terrestrial environment which includes montane and lowland–riparian elements (cluster B). The ecological groups at the negative part of the second axis indicate close proximity to marine environment based on the presence of shallow marine foraminifers (cluster A). Also, cluster C includes dinoflagellate cysts, mangroves back–mangrove (brackish water) and swamp–freshwater elements (Figs. 5. 4, 5. 5).

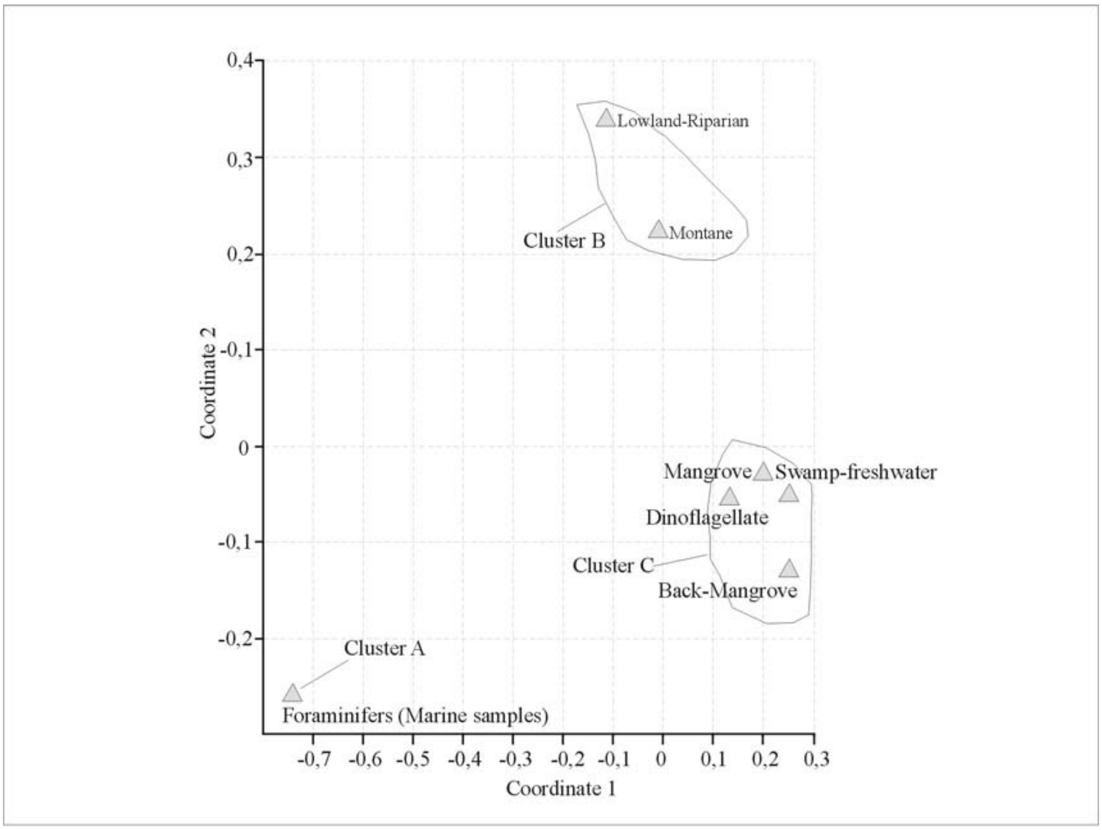

Figure 5. 5 Scattergram of the ecological groups ordination, from a two–dimensional MDS using the Euclidean distance. Stress = 0.212. The groups identified on the cluster analysis diagram are indicated as circled ecological groups.

As all palaeovegatational and foraminiferal data has been schematized, it is clear that Middle–Late Eocene transgression is also recorded from the Varsakyayla Formation (Fig. 5. 6). The presence of marine limestones at the top of Varsakyayla Formation in the study area indicates that maximum sea–level conditions were acquired during deposition of the Varsakyayla Formation (Fig. 5. 6). The marine transgression is also well documented by presence of reefal limestones containing rich marine fossils, such as coral reefs, benthic foraminifers and echinoderms (Fig. 5. 6). The carbonates in the Varsakyayla Formation can be well–correlated with the Asar member of the Başçeşme Formation.

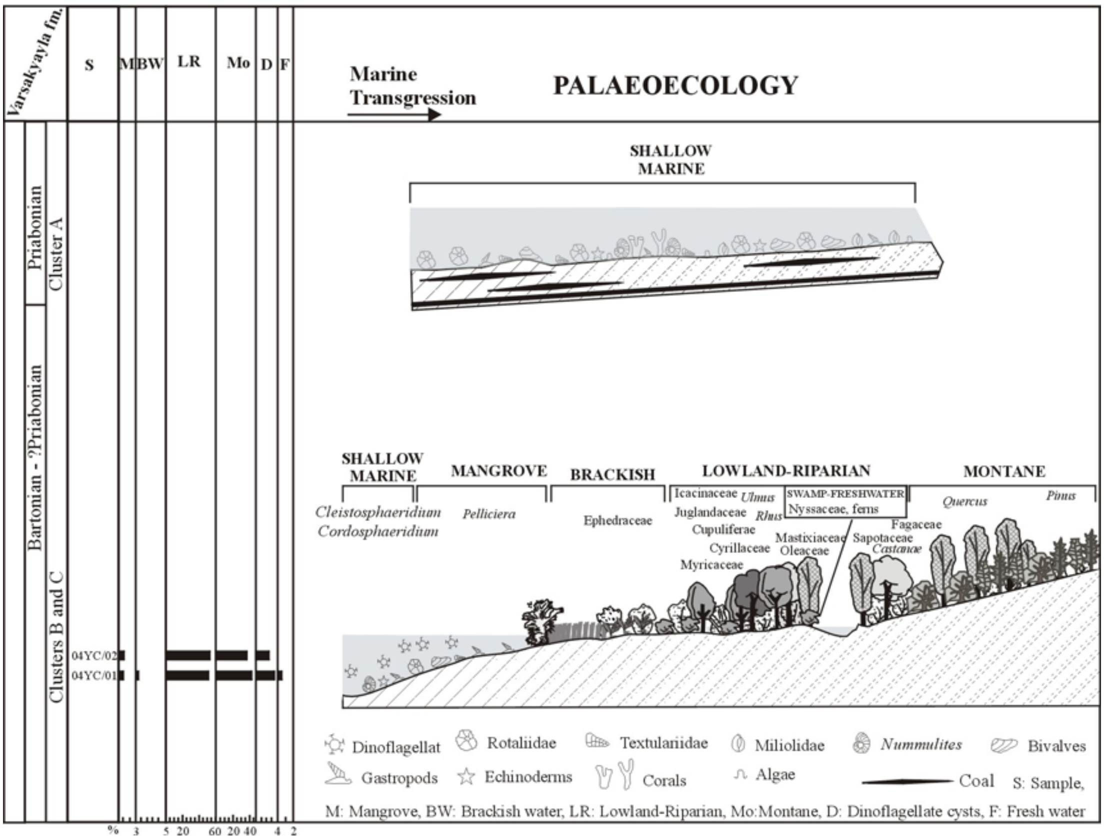

Figure 5. 6 Palaeoenvironmental reconstruction of the Burdur Area (Western Anatolia) during the deposition of the coal–bearing Middle–Late Eocene Varsakyayla Formation.

5.2 Early–"Middle" 0ligocene

5.2.1 The Tokça Formation

The main component of the palynological assemblage of the Tokça Formation is the lowland–riparian elements, which are represented by high percentages (~54%) (Table 5. 2). Swamp–freshwater and montane elements are also dominant components of the assemblage. Conversely, brackish water elements and dinoflagellate cysts are characterized by minor amounts (Table 5. 2). The lowland–riparian elements are represented by a high percentage of *Momipites punctatus* (~78%), *Caryapollenites simplex* (7%), *Tricolporopollenites cingulum* (~6%) (See Table 4. 3 for the number of species). Montane elements are characterized by a dominance of *Pityosporites microalatus* (~13%) and *Tricolpopollenites liblarensis*

(~4%). In contrast, swamp–freshwater elements are mainly made up of *Laevigatosporites haardti* (37%). The other minor elements have been presented under generic headings of palynomorphs such as Myricaceae, *Sali*x and Arecaceae.

Table 5. 2 Average percentages of the ecological groups in the Tokça Formation (See Table 4. 3 number of species recorded).

Ecological groups	Swamp freshwater	Montane	Lowland-riparian	Back –Mangrove (Brackish water)	Dinoflagellate	Unknown
Relative percentages	25.784	14.95	53.93	0.06	0.07	5.206

To reconstruct the palaeoenvironment of the Tokça Formation, the unweighted pair–group (UPGMA) Correlation matrix cluster analysis of palaeocommunities and samples defined all three assemblages (Fig. 5. 7).

In the palaeocommunity dendogram, assemblage A consists of swamp–freshwater elements (Fig. 5. 7). Assemblage B is made up of brackish water elements (back–mangrove environment) and marine dinoflagellate cysts. Assemblage C is represented by presence of lowland–riparian and montane elements.

In the sample dendogram, cluster A is characterized by a dominance of lowland–riparian and montane elements, low frequencies of dinoflagellate cysts and swamp–freshwater elements corresponding to the palaeocommunity cluster 2 (Fig. 5. 7). The presence of poorly preserved dinoflagellate cysts in cluster A defines close proximity of a marine environment. Sample cluster B is characterized by a dominance of swamp–freshwater and lowland–riparian elements, low percentage of montane elements and absence of dinoflagellate cysts corresponding to the cluster 1 (Fig. 5. 7). The swamp–freshwater elements in sample cluster B are higher than the ones in cluster A (Fig. 5. 7). The samples of cluster C are characterized by a predominance of swamp–freshwater elements, low frequencies of lowland–riparian and montane elements equivalent palaeocommunity cluster 3 (Fig. 5. 7).

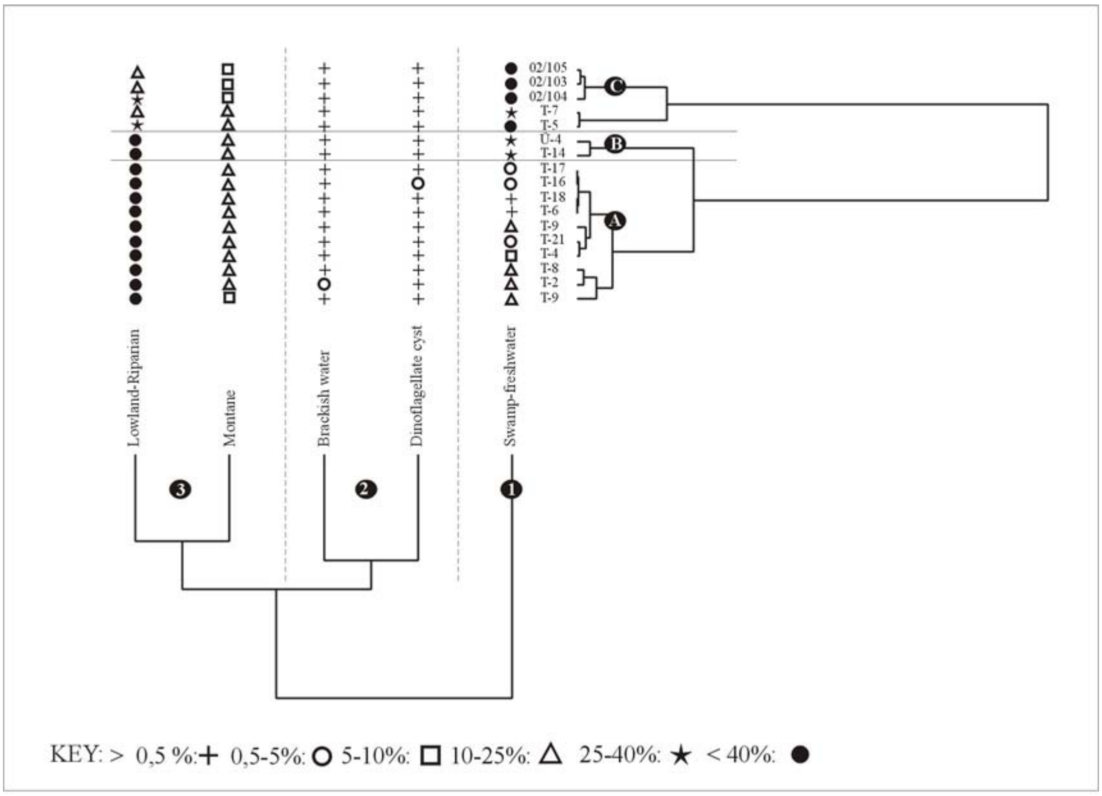

Figure 5. 7 Dendrograms for UPGMA cluster analysis of palaeocommunities (bottom) and samples (side), using Correlation matrix (See figures. 2. 11, 2. 14 and 2. 15 for the locations of the samples and table 4. 3 for the relative percentages of species).

Further, both samples and palaeocommunities have also been subject to non–metric multidimensional scaling (MDS), using the Euclidean distance method (Figs. 5. 8, 5. 9). The MDS of palaeocommunities (Fig. 5. 8) and samples (Fig. 5. 9) indicate that the groups identified in the cluster analysis have also been recognized in these plots. The palaeocommunities, which are located at the negative part of the first axis (cluster 2), show a close proximity of a marine environment because cluster 2 includes marine dinoflagellate cysts and also brackish water elements (Fig. 5. 8). The palaeocommunities at the positive part of the first axis define relatively terrestrial conditions (clusters 1 and 3).

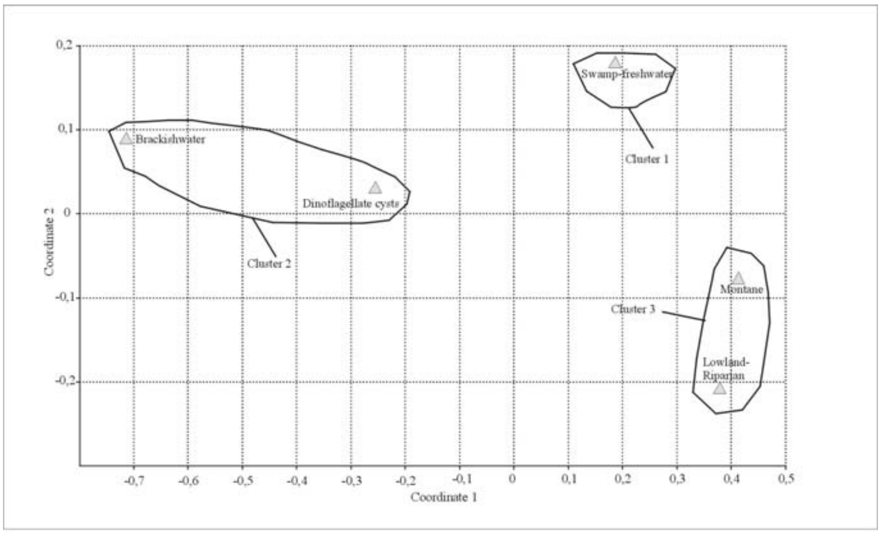

Figure 5. 8 Scattergram of ecological groups ordination, from a two–dimensional MDS using the Euclidean distance. Stress = 0.5096. Groups identified on the cluster analysis diagram are indicated as circled ecological groups.

The samples situated at the positive part of axis also indicate a close proximity of marine environment (cluster A) (Fig. 5. 9). However, the samples located at the negative part of second axis define more terrestrial conditions.

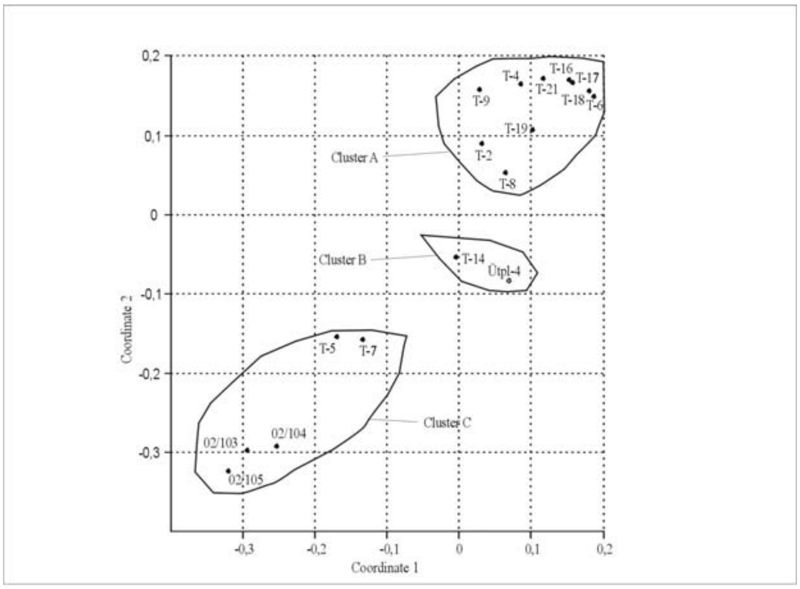

Figure 5. 9 Scattergram of samples ordination, from a two–dimensional MDS using the Euclidean distance. Stress = 0.005. Groups identified on the cluster analysis diagram are indicated as circled samples.

Although we have obtained both marine and terrestrial flora, it is not possible to determine a marine transgression or regression during the deposition of coals in the Tokça Formation. Because, for instance, sample T–2 obtained from the lower part of Tokça sequence (upper part of the Üçtepeler reef member) includes brackish water environment indicating a marine environment (Fig. 5. 10). In addition, the sample T–16 which is situated at the upper part of the Tokça sequence contains marine dinoflagellate cysts as well (Fig. 5. 10). On the other hand, the samples T–5 and T–7 which are located at the upper part of sample T–2 do not have any brackish water elements and dinoflagellates cysts, and indicate terrestrial conditions.

However, we can say that marine influence was effective during the deposition of the coals in the Tokça Formation. Also, the presence of marine limestones in the study area defines that maximum sea–level conditions were attained during the deposition of the Üçtepeler reef member that includes reefal limestones containing rich marine benthic biota like corals and benthic foraminifers (Fig. 5. 10).

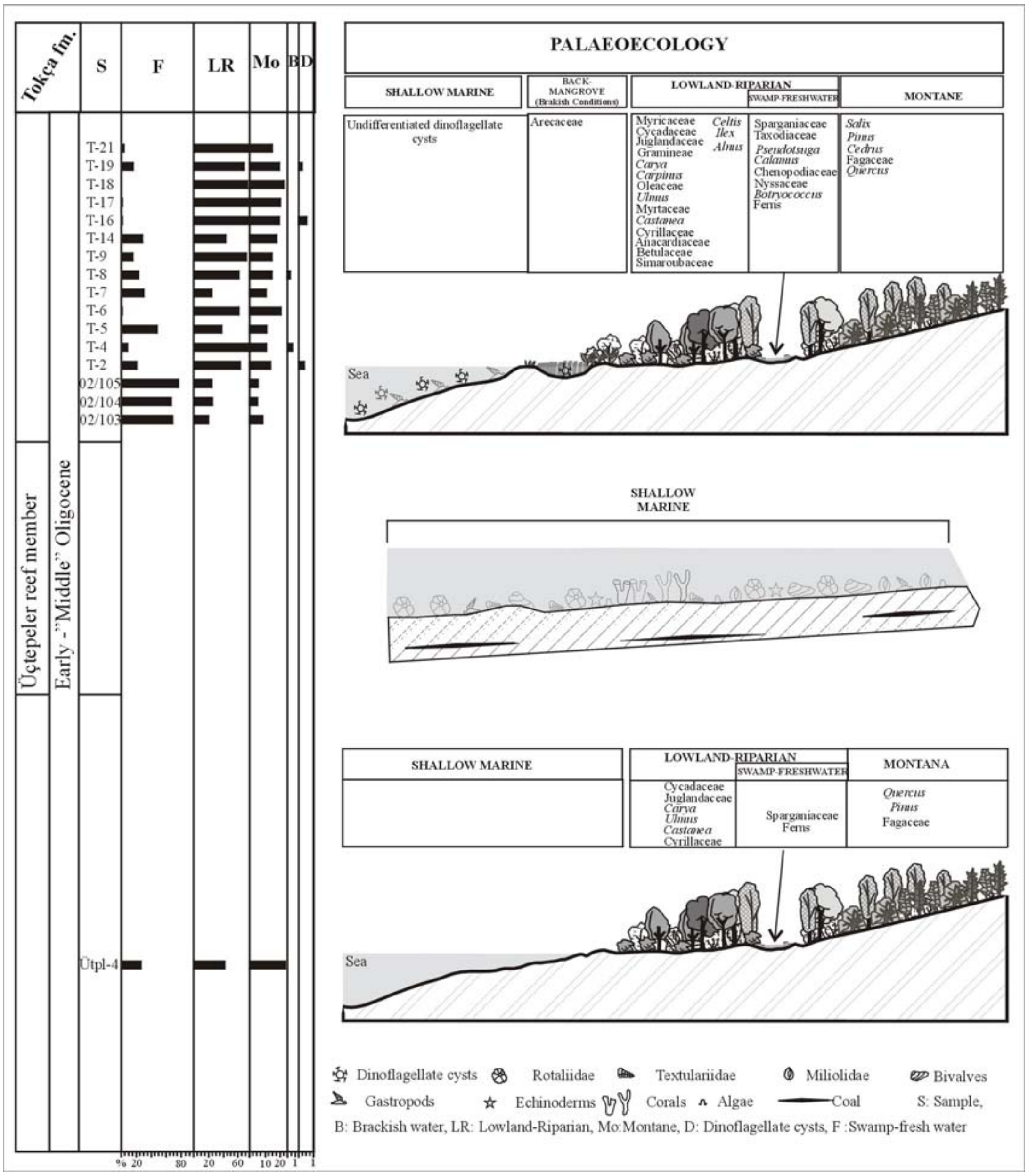

Figure 5. 10 Palaeoenvironmental reconstruction of the Çardak–Tokça Area (Western Anatolia) during the deposition of the coal–bearing Early–"Middle" Oligocene Tokça Formation.

5.2.2 The İncesu Formation

Nineteen samples were productive in the İncesu Formation with respect to palynomorph content. However, a sample (02i/17) was excluded because of low relative frequency of taxa (see Table 4. 8 for counting results). In the assemblage, main conspicuous point is that a rich spore species diversification including the swamp–freshwater elements has been recorded. Also, their numbers are high

(52.81%) when compared to the Early “Middle” Oligocene Tokça Formation (25. 784%) (Table 4. 8, Fig. 5. 2). The spores generally consist of high percentages of *Echinatisporis ?chattensis* (~11%), *Verrucatosporites favus* (3%), *Polypodiaceoisporites saxonicus* (~10%), *Laevigatosporites haardti* (6%), *Leiotriletes maxoides* ssp *maxoides* (~14%) (See Table 4. 8 for the number of species). Besides, lowland–riparian elements in the İncesu Formation are represented by low frequencies when compared to the Tokça Formation (Tables 5. 2, 5 .3). The lowland–riparian elements constitute a predominance of *Momipites punctatus* (~15%) and *Caryapollenites simplex* (14%). The percentages of dinoflagellate cysts and brackish water elements are low, but higher than the Tokça Formation (Tables 5. 2, 5. 3). As a result, the palaeocommunity types of the İncesu Formation indicate a close proximity of a marine environment analogized by the Tokça Formation which was also deposited in a terrestrial environment under marine influence.

Table 5. 3 Average percentages of ecological groups in the İncesu Formation (See Table 4. 8 number of species recorded).

Ecological groups	Swamp freshwater	Montane	Lowland-riparian	Back –Mangrove (Brackish water)	Dinoflagellate	Unknown
Relative percentages	52.81	11.15	28.7	2.55	0.32	4.47

On the other hand, for the reconstruction of palaeoenviroment, both samples and palaeocommunities have also been applied to cluster analysis and MDS (Figs. 5. 11, 5. 12, 5. 13). The unweighted pair–group (UPGMA) Chord distance Cluster Analysis of samples and palaeocommunities defined both of the assemblages (Fig. 5. 11).

In the palaeocommunity dendogram, assemblage 1 is made up of swamp–freshwater, lowland–riparian and montane elements (Fig. 5. 11). Assemblage 2 consists of brackish water elements and marine dinoflagellate cysts (Fig. 5. 11).

In the sample dendogram, cluster A is represented by a dominance of lowland riparian elements and low frequencies of swamp–freshwater elements corresponding to the palaeocommunity cluster 1 (Fig. 5. 11). The samples in cluster A also include low percentage of marine dinoflagellate cysts and brackish water elements. Sample cluster B which is the equivalent of cluster 2 is characterized by a predominance of swamp–freshwater elements and low percentage of lowland–riparian elements compared to cluster A (Fig. 5. 11). It also comprises dinoflagellate cysts, montane and brackish water elements which have more or less similar percentages.

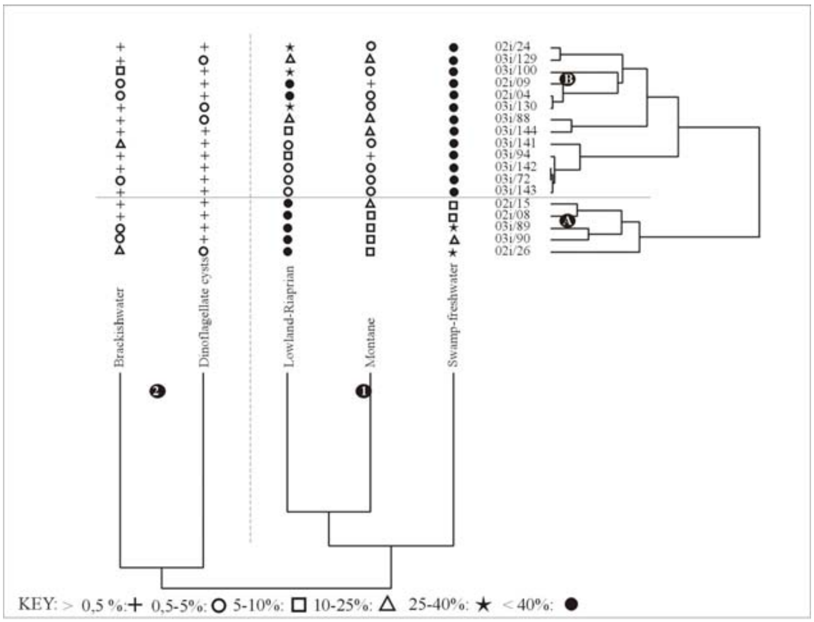

Figure 5. 11 Dendrograms for UPGMA cluster analysis of palaeocommunities (bottom) and samples (side), using Chord distance (See figs. 2. 45, 2. 52 and 2. 53 for the locations of the samples and table 4. 7 for the relative percentages of species).

Besides, samples and palaeocommunities have also been subjected to non–metric multidimensional scaling (MDS), using Euclidean distance method as well (Figs. 5. 12, 5. 13). The MDS has also given a result as in the cluster analysis.

The palaeocommunities that are situated at the positive part of second axis (cluster 1) determine terrestrial conditions when compared to the cluster 2 which are located at the negative side of second axis (Fig. 5. 12).

The samples located at the positive part of the second axis correspond to cluster A and indicate a relatively more marine conditions when compared to the samples that are situated at the negative part of the second axis (Fig. 5. 13).

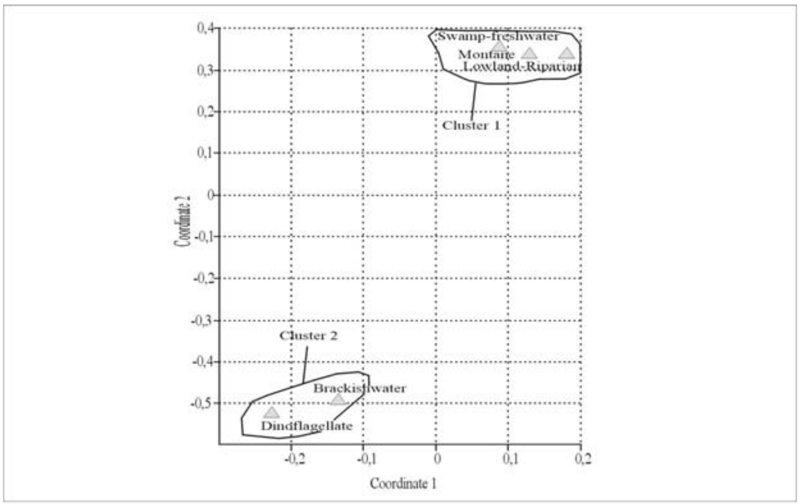

Figure 5. 12 Scattergram of ecological groups ordination, from a two–dimensional MDS using the Euclidean distance. Stress = 0.072. Groups identified on the cluster analysis diagram are indicated circled ecological groups.

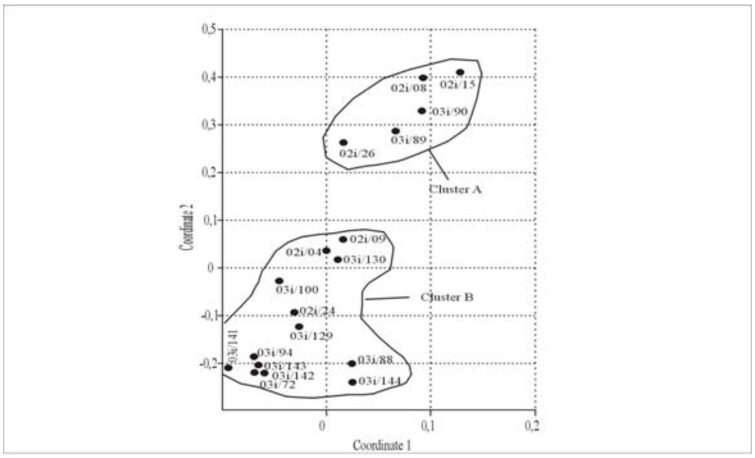

Figure 5. 13 Scattergram of samples ordination, from a two–dimensional MDS using the Euclideandistance. Stress = 0.053. Groups identified on the cluster analysis diagram are indicated as circled samples.

However, it should be indicated that the samples obtained from the İncesu Formation were deposited in a terrestrial condition under marine influence as evidenced by marine dinoflagellate cysts and brackish water elements in the clusters A and B (Figs. 5. 11, 5. 12, 5. 13). We can not infer any palaeoecological trend during the deposition of these coals because both the samples located at the lower and upper parts of the İncesu sequence include marine palynomorphs.

On the other hand, to present the palaeoenvironmental reconstruction during the Early–"Middle" Oligocene, we have combined both palynological data of the İncesu Formation and foraminifer data of the Delikarkası Formation (Fig. 5. 14). As indicated in the chapter 3, a rich benthic foraminifer assemblage has been obtained from the Early–"Middle" Oligocene Delikarkası Formation which is conformably overlain by the İncesu Formation (see chapter 2 for detailed explanations). All the micropalaeontological data indicate that an Early–"Middle" Oligocene regression occurred from the Delikarkası Formation to İncesu Formation. The regression is also well evidenced from the sedimentological data, including marine limestones of the Delikarkası Formation and overlying coal–bearing fluviatile sediments of the İncesu Formation. The regression was rooted from a structural high formed by the Barladağ series belonging to the Bey Dağları autochthon which was located to the north of the İncesu Formation (Yağmurlu, 1994). The presence of marine limestones in the Delikarkası Formation defines that the maximum sea–level conditions were achieved during that time.

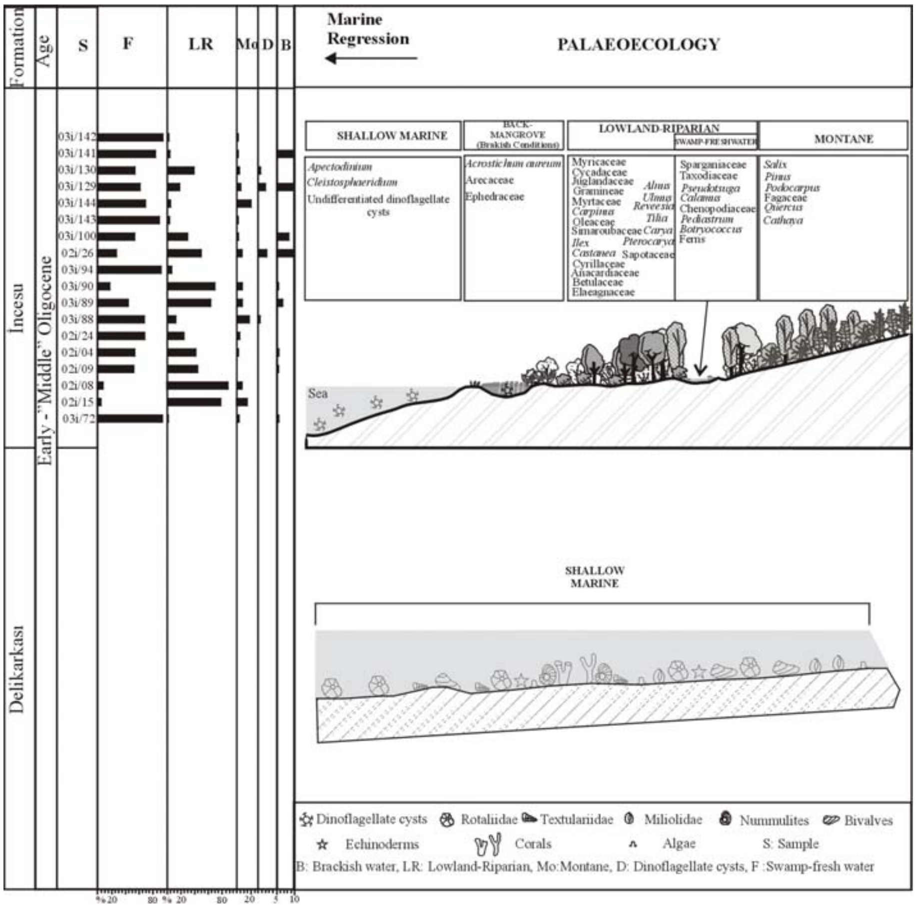

Figure 5. 14 Palaeoenvironmental reconstruction of the İncesu Area (Western Taurids) during the deposition of the coal–bearing Early–“Middle” Oligocene Delikarkası and İncesu formations.

5. 3 Early Miocene

5.3.1 The Kavak Formation

The palynological assemblage obtained is represented by low frequency of species diversification (Table 4. 6). Swamp–freshwater elements are represented by high abundance of *Inaperturopollenites dubius* (7%) (See Table 4. 6 for the numbers). Lowland–riparian elements consist mainly of *Momipites puntatus* (~53%) and *Tricolporopollenites cingulum* (~13%). Montane elements are made up of high percentages of *Tricolpopollenites microhenrici* (~9%). Back–magrove element *Longapertites retipiliatus* has been described as a individual grains. Besides, marine palynomorphs *Cleistosphaeridium* sp. and undifferentiated dinoflagellate cysts have scarcely been reported in the samples as well (Table 4. 6).

To reconstruct the palaeoenviroment, both samples and palaeocommunities have also been applied to cluster analysis and MDS (Figs. 5. 15, 5. 16, 5. 17). The unweighted pair–group (UPGMA) Bray Curtis measure Cluster Analysis of samples and palaeocommunities defined both of the assemblages (Fig. 5. 15).

In the palaeocommunity dendogram, assemblage 1 is made up of swamp–freshwater, lowland–riparian and montane elements (Fig. 5. 15). Assemblage 2 consists of brackish water elements and marine dinoflagellate cysts (Fig. 5. 15).

In the sample dendogram, cluster A is represented by a dominance of lowland riparian elements and swamp–freshwater elements and absence of dinoflagellate cysts and brackish water elements corresponding to the palaeocommunity cluster 1 (Fig. 5. 15). Sample cluster B which is the equivalent of cluster 2 is characterized by presence of dinoflagellate cysts and brackish water elements indicating a marine condition (Fig. 5. 15).

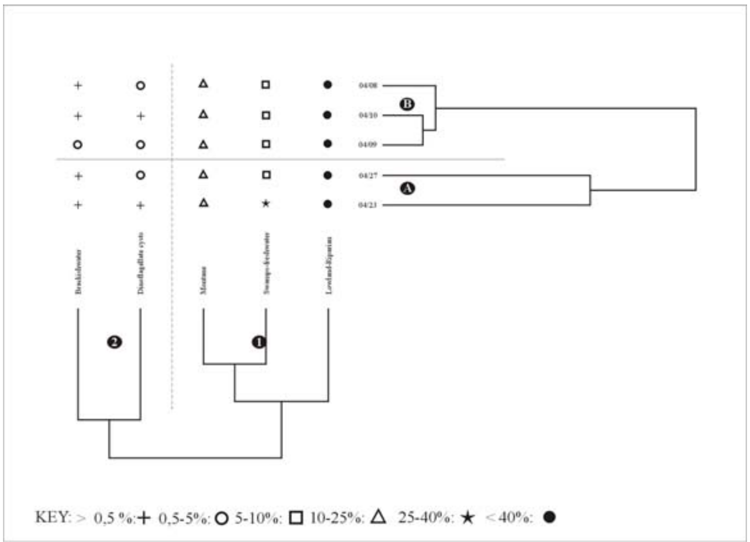

Figure 5. 15 Dendrograms for UPGMA cluster analysis of palaeocommunities (bottom) and samples (side), using Bray–Curtis measure (See figures. 2. 22, 2. 26 and 2. 27 for the locations of the samples and table 4. 6 for the relative percentages of species).

As well as cluster analysis, samples and palaeocommunities have also been applied to non–metric multidimensional scaling (MDS), and Euclidean distance method is used (Figs. 5. 16, 5. 17).

The palaeocommunities that are situated at the positive part of second axis (cluster 1) determine terrestrial conditions when compared to the cluster 2, which are located at the negative side of second axis (Fig. 5. 16).

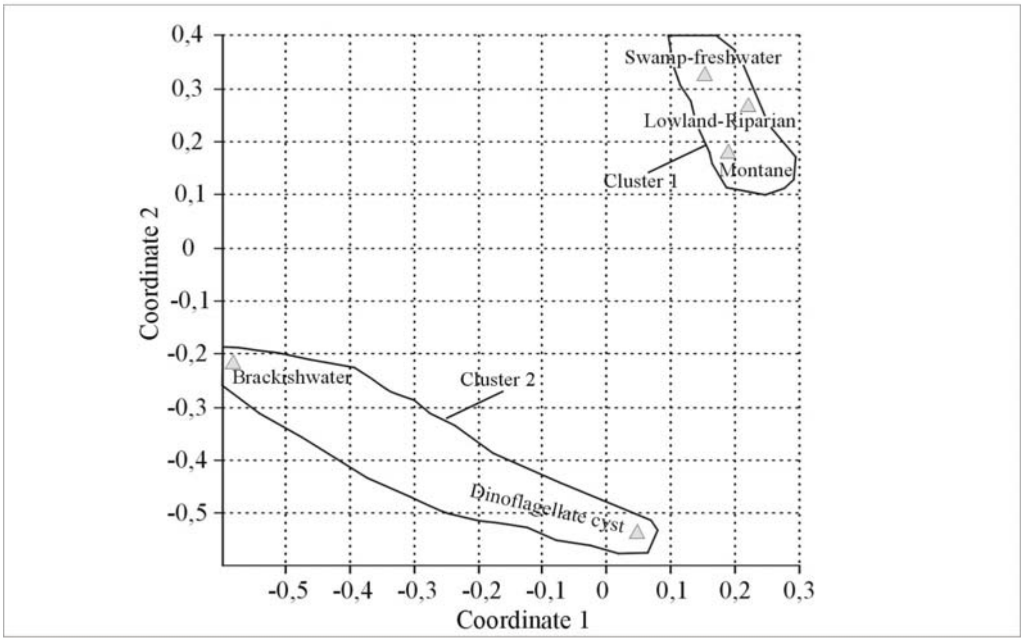

Figure 5. 16 Scattergram of ecological groups ordination, from a two–dimensional MDS using the Euclidean distance. Stress = 0.1974. Groups identified on the cluster analysis diagram are indicated as circled ecological groups.

The samples located at the positive part of second axis correspond to cluster A and indicate relatively more marine conditions when compared to the samples that are situated at the negative part of second axis (Fig. 5. 17).

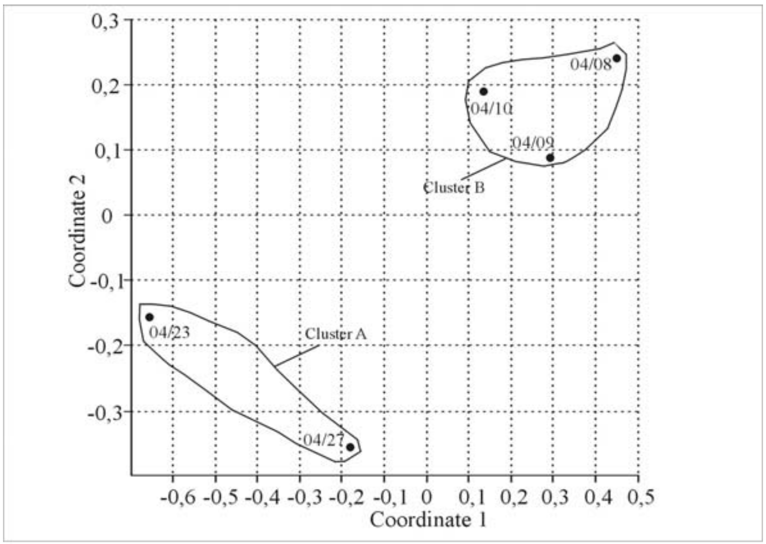

Figure 5. 17 Scattergram of samples ordination, from a two–dimensional MDS using the Euclidean distance. Stress = 0. Groups identified on the cluster analysis diagram are indicated circled samples.

As stated in chapter 3, the Kavak Formation includes well–preserved marine limestones containing benthic foraminifers, corals, gastropods and bivalves. The foraminifer data indicate that the levels where the samples obtained were accumulated in a carbonate shelf environment oriented open marine environment.

It is clear from the schematized palaeovegatational and foraminiferal data has been schematized, it is clear that the Early Miocene transgression is recorded from the Kavak Formation (Fig. 5. 18). The presence of marine limestones at the top of the Kavak Formation in the study area indicates that the maximum sea–level conditions were obtained during deposition of the Kavak Formation (Fig. 5. 18).

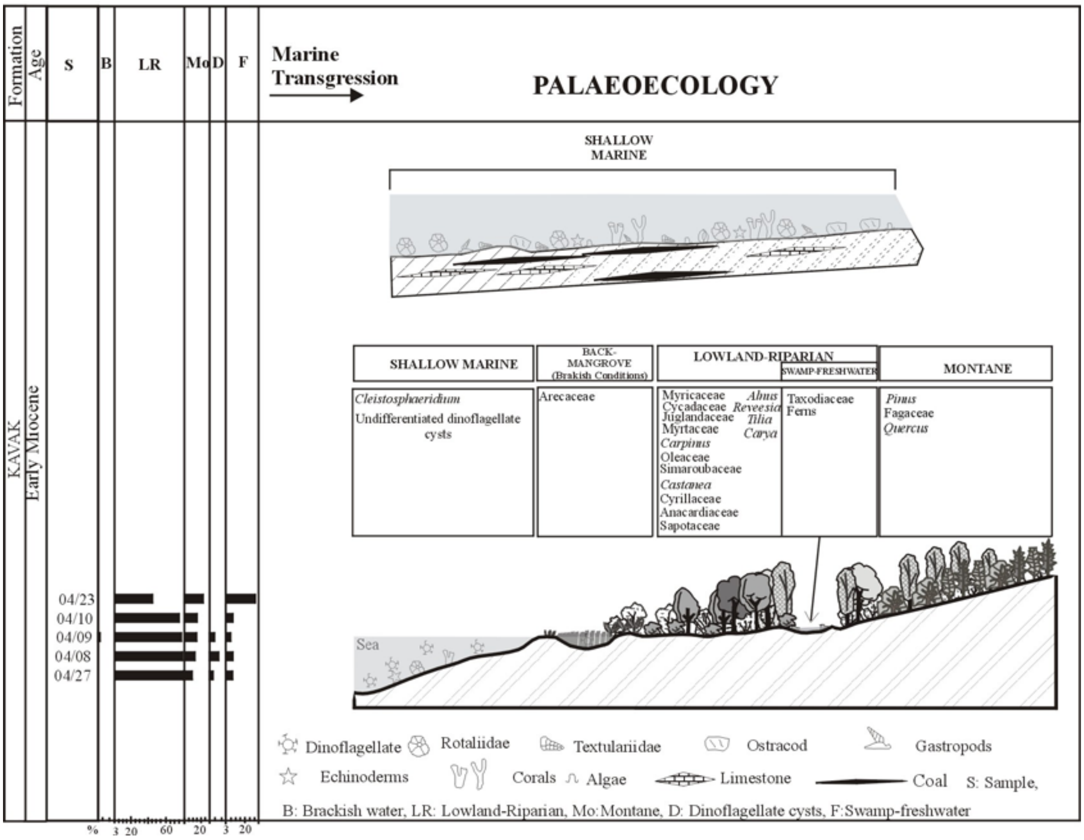

Figure 5. 18 Palaeoenvironmental reconstruction of the Burdur Area (Western Anatolia) during the deposition of the coal–bearing Early Miocene Kavak Formation.

5.3.2 The Aksu Formation

In the assemblage, the spores belonging to swamp–freshwater elements are mainly represented by different kinds of *Leiotriletes* genera (see Table 4. 7 for the numbers). Their relative percentages change from sample to sample. However, *Leiotriletes maxoides* is the major component of the spores and represented by high percentages (~10%). The swamp–freshwater elements mainly constitute *Inaperturopollenites concedipites* (5%). Additionally, the species *Triplanosporites sinuosus*, *Polypodiaceoisporites saxonicus*, *Verrucatosporites alienus* also occur in the assemblage (Table 4. 7). Back–mangrove elements are characterized by minor amounts of *Leiotriletes adriennis* and *Arecipites brandenburgensis*. The lowland–riparian elements generally consist of high abundances of *Momipites punctatus* (17%) and *Tricolporopollenites cingulum* (19%). Montane elements are characterized by a high percentage of *Tricolpopollenites microhenrici* (6.5%). Also, minor amount of shallow marine *Cleistosphaeridium* sp and undifferentiated dinoflagellate cysts has been recorded.

To reconstruct the palaeoenviroment, both samples and palaeocommunities based on the ecological requirements of taxa have been applied to cluster analysis (Figs. 5. 19). The unweighted pair–group (UPGMA) Simpson index Cluster Analysis of samples and palaeocommunities defined both two assemblages (Fig. 5. 19). The sample 04A/54 has been excluded because of low species diversification (Table 4. 7).

In the palaeocommunity dendogram, assemblage 1 is made up of swamp–freshwater, lowland–riparian, brackish water and montane elements (Fig. 5. 19). Assemblage 2 consists of marine dinoflagellate cysts (Fig. 5. 19).

In the sample dendogram, cluster A coincides with the samples taken from the upper part of the Aksu Formation, which is represented by a dominance of lowland–riparian and montane elements, presence of dinoflagellate cysts and absence of brackish water elements corresponding to the palaeocommunity cluster 2 (Fig. 5. 19). The presence of poorly preserved dinoflagellate cysts in the sample cluster A determines a high sea level (Figs. 5. 19, 5. 20).

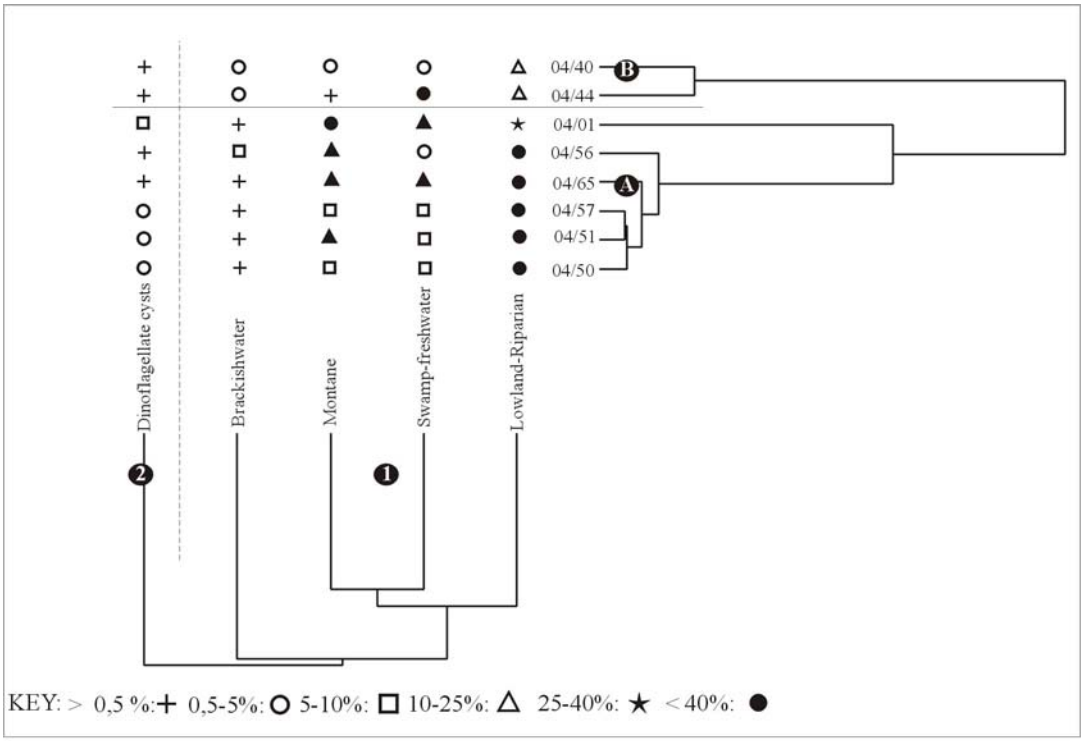

Figure 5.19 Dendrograms for UPGMA cluster analysis of palaeocommunities (bottom) and samples (side), using Bray–Curtis measure (See figures 2. 28, 2. 29 for the locations of the samples and table 4. 7 for the relative percentages of species).

The samples of cluster B which is equivalent of palaeocommunity cluster 1 were taken from the lower part of the Aksu Formation and are characterized by a predominance of swamp–freshwater elements, presence of brackish water elements and absence of marine dinoflagellate cysts (Fig. 5. 19). The palynomorph content of cluster B indicates more terrestrial condition when compared to cluster A. But these samples were accumulated under marine influence as well (Fig. 5. 20). To sum up, it is clear that the transgression is recorded from cluster B to cluster A (Fig. 5. 20).

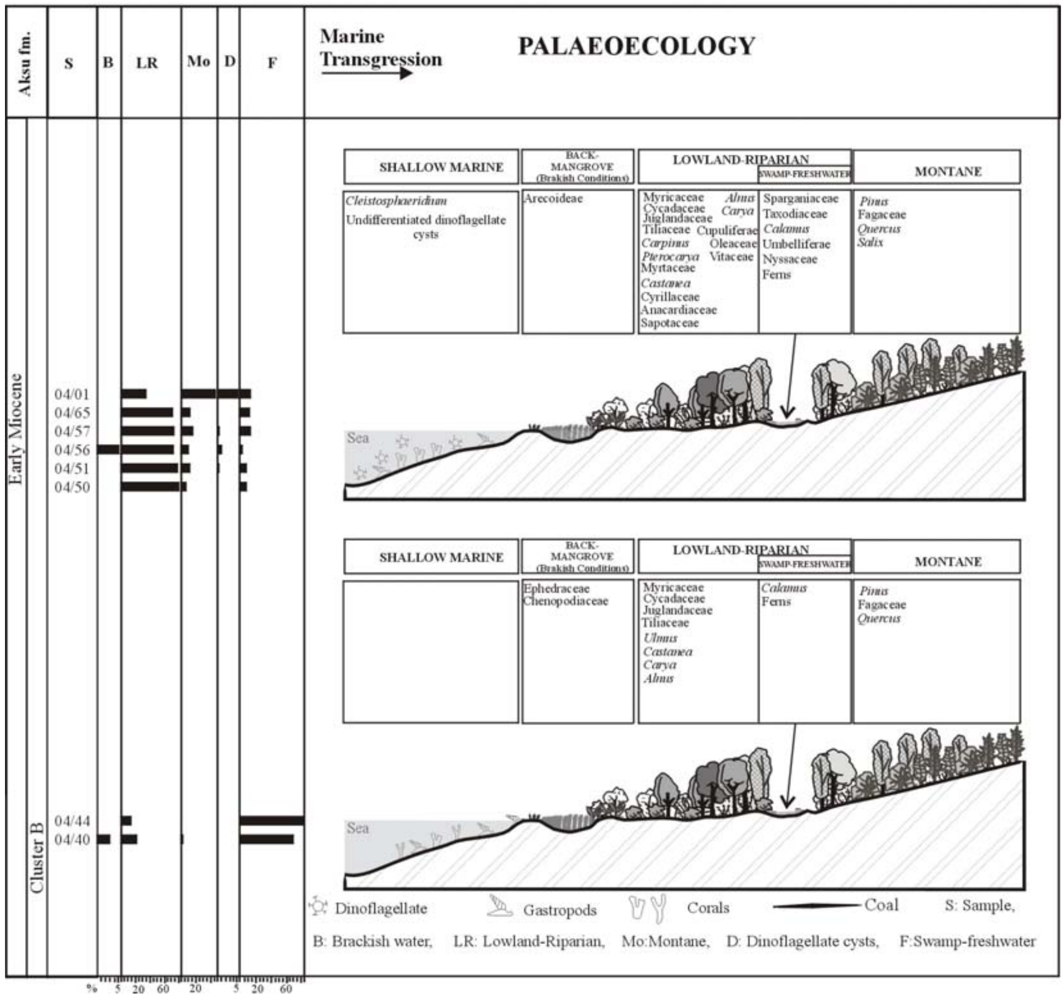

Figure 5. 20 Palaeoenvironmental reconstruction of the Burdur Area (Western Anatolia) during the deposition of the coal–bearing Early Miocene Aksu Formation.

5.4 Palaeogeography

In this part, we tried to make an approach to the Middle Eocene–Early Miocene palaeogeography of western Anatolia based on the palaeoenvironmental data.

During Middle Eocene, there was a broad connection between the Indian Ocean, Mediterranean and Paratethys seas (Meulenkamp & Sissingh, 2003) (Fig. 5. 21). The eastern part of the Arabian platform was covered by the sea during the Middle Eocene. In southwest Anatolia, the sequences include both shallow and deep shelf deposits, consisting of a mixture of clastics and carbonates. The presence of mangroves like *Spinizonocolpites* (*Nypa*) and *Psilatricolporites crassus* (*Pelliciera*) in western Anatolia indicates the Indian oceanic influence (Fig. 5. 21). Additionally, the presence of marine limestones located at the top of the Başçeşme (Asar member) and Varsakyayla formations determines warm climatic conditions. During the Middle–Late Eocene, the mangroves are widespread, which should be related to the absence of ice caps.

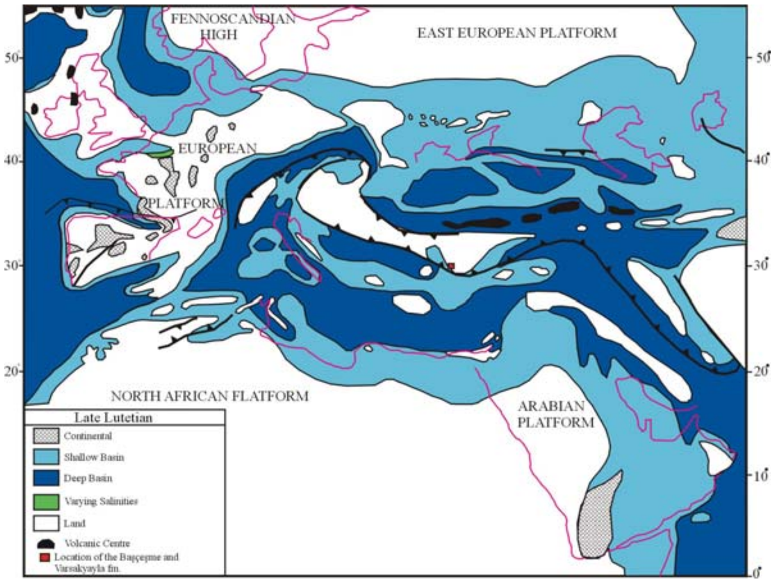

Figure 5. 21 Schematic palaeogeographic map for the late Lutetian, showing position of continental basins, shallow and deep marine basins and shallow and deep basins with salinities deviating from normal (modified from Meulenkamp et al., 2000; Meulenkamp & Sissingh, 2003). Heavy lines indicate important fault zones, filled triangles represent respectively thrusting and oceanic subduction.

In the Oligocene, the northern border of the marine environment was defined by a line connecting the cities of Denizli, Burdur and Isparta (Eğridir) according to Luttig & Steffens (1976). It indicates that the Çardak–Tokça, Burdur and İncesu areas were deposited in terrestrial environment under marine influence based on the presence of marine dinoflagellate cysts during the Early Oligocene (Fig. 5. 22). The marine influence was also recorded from the reefal limestones obtained from the Üçtepeler reef member (Çardak–Tokça Area) and Delikarkası Formation (İncesu Area). Coarse clastic materials at the base of the Çardak–Tokça and Burdur areas were derived from a structural high formed by ophiolitic materials. According to Gürer & Yılmaz, (2002), this structural high was located at the south of the Kale–Tavas Basin, named as Çardak–Tokça and Burdur areas through the east. On the other hand, the structural high is located at the northern part of the İncesu Formation. The palynomorph assemblage defined in this study is different from those of palynomorph assemblages of the Late Oligocene Thrace Basin and the Late Oligocene–Early Miocene Kale–Tavas Basin. Therefore sedimentation starts in the Early Oligocene in the Çardak–Tokça, Burdur and İncesu areas and they are older than these two basins.

The Oligocene record indicates, when compared with Eocene, that a major crisis took place at that time. It is reported from a brief cooling event related to oceanic changes and/or formation of Atlantic ice sheet evidenced by marine isotopic data from Zachos et al. (2001).

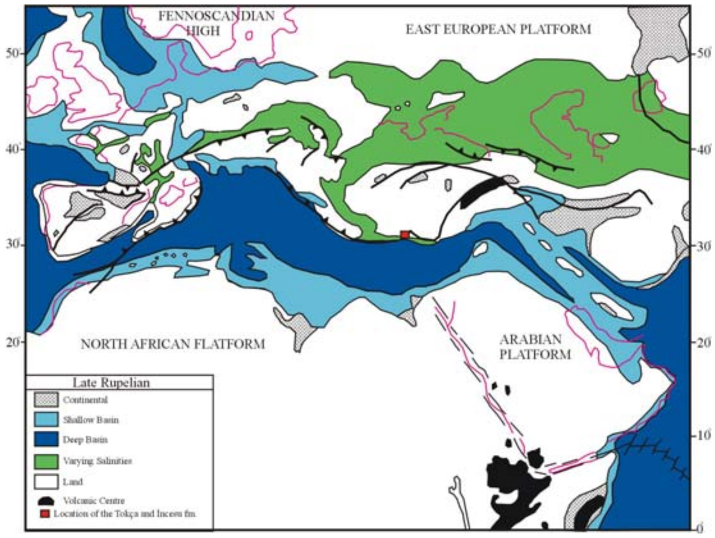

Figure 5. 22 Schematic palaeogeographic map for the late Rupelian, showing position of continental basins, shallow and deep marine basins and shallow and deep basins with salinities deviating from normal (modified from Meulenkamp et al., 2000; Meulenkamp & Sissingh, 2003). Heavy lines indicate important fault zones, filled triangles represent respectively thrusting and oceanic subduction.

The sea still located in the central parts of the Arabian Platform in the latest Early to earliest Middle Miocene and connected with the Mediterranean to the Indian ocean. (Fig. 5. 23). In the Early Miocene, the palaeogeography of Turkey was an erosional highland with fault bounded basins. The palaeovegetational data substantiate the uplift of Turkey in the late Aquitanian–late Burdigalian period (Fig. 5. 23). The Anatolian highlands decreased in elevation towards the east and south and descended to the Mediterranean. The Kavak and Aksu formations (Burdur Area) were deposited in the terrestrial environment under marine influence on the basis of marine palynomorphs. Furthermore, the deposition of widespread reefal limestones in Early Miocene of Turkey determines that warm climatic conditions prevailed during this time (Erol, 1981; Görür et al., 1995). According to Plaziat et al. (2001), the Early Miocene and especially the early Middle Miocene (Langhian) is the warmer period. The presence of widespread carbonate reefs is locally associated with impoverished mangroves along the northern Tethyan coasts : Spain and France (Bessedik, 1981, 1985; Bessedik & Cabrera, 1985). *Spinizonocolpites* (*Nypa*) is a common member of the eastern mangroves. It has also been recorded from the Late Oligocene–Early Miocene of the Biga Penninsula by Akkiraz et al. (2007) and enter the Mediterranean sea. It indicates that the Middle Eastern seaways still remained open until the end of the Middle Miocene (Fig. 5. 23).

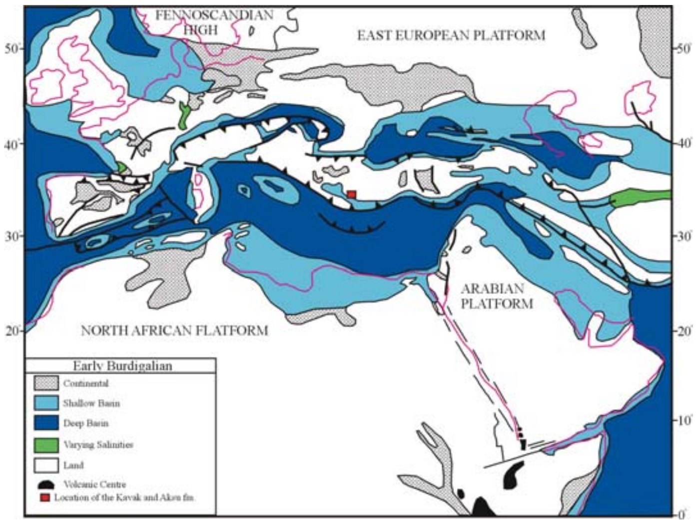

Figure 5. 23 Schematic palaeogeographic map for the early Burdigalian, showing position of continental basins, shallow and deep marine basins and shallow and deep basins with salinities deviating from normal (modified from Meulenkamp et al., 2000; Meulenkamp & Sissingh, 2003). Heavy lines indicate important fault zones, filled triangles represent respectively thrusting and oceanic subduction.

5.5 Palaeogeographic Data of Mangroves

On the basis of previous studies and the data of the present study, current and Eocene geographic distributions of mangrove elements *Nypa* and *Pelliciera* have been plotted on maps (Figure 5. 24). The pollen of *Nypa* (*Spinizonocolpites*) and *Pelliciera* (*Psilatricolporites crassus*), which were first recorded from Middle–?Upper Eocene deposits in central Anatolia (Yozgat and Amasya areas) by Akgün (2002) and Akgün et al. (2002), have been cited in chapter 3. *Nypa* was present on all continents during the Eocene but, at present, it only occurs in the Indo–Malaysian region (Figure 5. 21). Conversely, *Pelliciera* (*Psilatricolporites crassus*) occurred in the Caribbean area and on the Atlantic coasts of Guyana and Brazil during Eocene–Oligocene time (Rull 1998a). It was also recorded from the Middle–Late Eocene sediments of the Ebro Basin (northeast Spain) by Cavagnetto & Anadón (1995, 1996). Although its presence in Africa is uncertain during Eocene time, it has been reported from the Middle–?Upper Eocene sediments in both central (Yoncalı Formation) and western Anatolia (Başçeşme Formation) (Figure 5. 24). It was also reported from the Tertiary of the Guiana Basin (Van Der Hammen & Wijmstra 1964), and from the Early Miocene sediments of Panama (Graham 1977). According to Graham (1995), its presence persisted into the Quaternary Gulf/Caribbean region (Mexico, the Antilles, Central America, and northern South America). However, at present, *Pelliciera* (*Psilatricolporites crassus*) is observed in a restricted area of central and northern South America (Figure 5. 24). In this study, the present Atlantic mangrove (*Pelliciera*) and present Indo-Pacific mangrove (*Nypa*) elements have not been reported in western Anatolia. Their presence in the Middle–?Upper Eocene sediments of western and central Anatolia implies warm mid-latitude Tethys water. At the global scale, since the tropical Tethys free seaway was connected with the Palaeo-Atlantic and Indian oceans. The mangroves should have invaded southeastern Asian, African, North and South American and European shores.

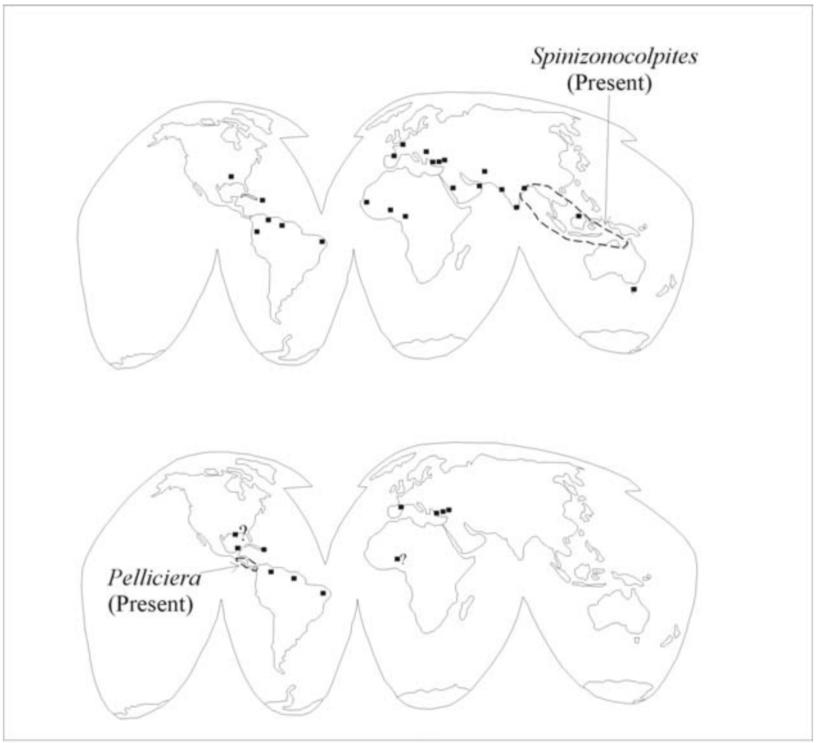

Figure 5. 24 Present (dashed areas) and Eocene (black squares) geographic distribution of *Spinizonocolpites* spp. (*Nypa*) and *Psilatricolporites crassus* (*Pelliciera*). After Germeraad et al. (1968), Muller (1981), Thanikaimoni et al. (1984), Frederiksen (1980, 1985, 1988, 1994), Thanikaimoni (1987), Westgate & Gee (1990), Srivastava & Binda (1991), Cavagnetto & Anadon (1995), Graham (1995), Nickel (1996), Pole & Macphail (1996), Rull (1998a,1999), El Beialy (1998), Riegel et al. (1999), Akgün (2002), Akgün et al. (2002), Akkiraz et al. (accepted).

CHAPTER SIX
PALAEOCLIMATE

Quantitative terrestrial palaeoclimatic analysis based on the palynological assemblages obtained from the Çardak–Tokça, Burdur and İncesu areas was carried out by the use of the Coexistence Approach proposed by Mosbrugger & Utescher (1997); this technique is based on the 'nearest living relative' philosophy, the assumption that climatic requirements of Tertiary plant taxa are similar to those of their living relatives (Mosbrugger & Utescher 1997) (See chapter 1 for detailed explanations).

As an additional climate proxy we determined all palynolofloras the relative proportion of palaeotropical (P) and arctotertiary (A) elements (Fig. 6. 2). Depending on classical definitions, (e.g. Mai, 1995) the term "arctotertiary elements" is used for plants which grew under temperate to warm–temperate climate and correspondingly occur today in the temperate zone. Conversely, "palaeotropical elements" are plants that have their present–day distribution mainly in the palaeotropic area (i. e. in the tropical regions of Asia and Africa). The palaeofloristic aspects of all species obtained have been presented in chapter 3.

6.1 Eocene

6.1.1 The Başçeşme Formation

To reconstruct the palaeoclimate of the Başçeşme Formation, mean annual temperature (MAT) was calculated. The palaeoclimatic reconstruction of the palynoflora of the Başçeşme Formation is based on a total of 19 taxa (Fig. 6. 1). The calculated coexistence interval results in a mean annual temperature (MAT) range mainly between 24.8 and 25 °C, but intervals between 17.2 and 21.1 °C also occur (Fig. 6. 1). Thus, two different mean annual temperatures (24.8–25 °C and 17.2–21.1 °C) have been obtained by applying the Coexistence Approach proposed by Mosbrugger & Utescher (1997). Possibly, diverse coexistence intervals indicate different plant communities growing under different climatic conditions on variegated relief (Ivanov et al. 2002). These two coexistence intervals indicate two plant communities that grow under different climatic conditions.

For this reason, Nix's (1982) terms megatherm and mesotherm are quite relevant. Nix (1982) recognized plant groups for characteristic temperature response models for Australia and New Guinea. The megatherm element is dominant where the mean annual air temperature exceeds 24 °C and corresponds to the environment of the mangrove association. The mesotherm element is dominant where mean annual air temperature ranges between 14 °C and 21 °C and coincides with the slope and montane–forest association.

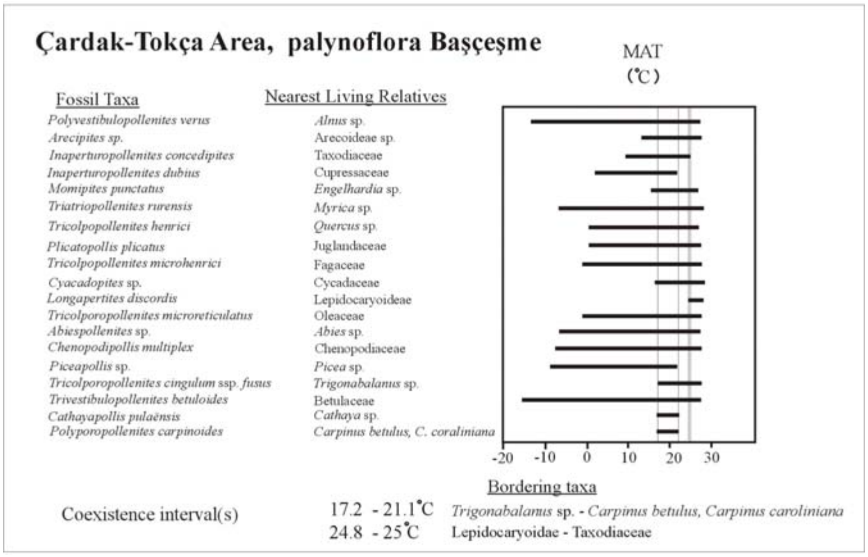

Figure 6. 1 Application of Coexistence Approach to the Başçeşme palynoflora in the Çardak–Tokça Area (Western Anatolia). The shaded box marks the climatic requirements of the taxa, the vertical lines delimit the widths of coexistence intervals (MAT: Mean annual temperature).

An intermediate zone is indicated as an area where the mean annual temperatures are lower than 24 °C but higher than 21 °C. The obtained climatic values correspond to the terminology of Nix (1982). Climatic conditions should be 24.8–25 °C near the coast, including the megathermal elements (mangrove association). The second MAT value (17.2–21.1 °C) corresponds to Nix's mesotherm zone. The intermediate zone is characterized by a temperature ranging between 21.1–24.8 °C. Nix (1982) used these terms to do away with the confusion that is usually associated with the use of tropical, subtropical and temperate, since these have both geographic and thermal connotations. On the other hand, according to Wolfe (1979), the moist tropical forests have an MAT higher than 25 °C; the 20–25 °C isotherms lie in the region of development for the paratropical forest; broad-leaf evergreen forests grow in a subtropical climate (13–20°C). The occurrence of *Nypa* pollen suggests that tropical to subtropical climatic conditions existed during deposition of the Başçeşme Formation. If the habitat requirements of *Nypa* during the Eocene were similar to those of extant *Nypa*, water temperatures must have been warmer than 24 °C. *Nypa* cannot survive in temperatures less than 20 °C (Fechner 1988). The species of *Nypa*, *Avicennia* and *Pelliciera* are among the megathermal taxa (Cavagnetto & Anadón 1995, 1996). Pole & Macphail (1996) studied the palaeogeography and palaeoecology of Eocene *Nypa* from Regatta Point, Tasmania. According to the authors, temperature is not the only factor restricting the dispersion of *Nypa* that determines monsoonal conditions or at least seasonal rain in Tasmania during the Eocene. *Psilatricolporites crassus* (*Pelliciera*) in particular has been recorded with great frequency in our samples as a megathermal species. The mangroves need the tropical and humid climate to develop (Frederiksen 1985; Westgate & Gee 1990).

In addition, the presence of the zooxanthellate coral fauna with larger foraminifera in the carbonate rocks indicates the tropical temperatures of the Tethys Sea. The zooxanthellate coral fauna and reef growth with larger foraminifera control the minimum sea–surface temperature (Schmiedl et al. 2002). Ediger et al. (1990) studied the palynological properties of Tertiary in the northern Thrace Basin (Northwestern Turkey), and discussed the palaeoclimate of the Eocene period. According to these authors, the increasing percentages of thermophilous elements, such as *Cyacadopites*, *Monocolpopollenites* and *Dicolpopollenites kalewensis*, indicate that the temperature was higher in the Oligocene than in the Eocene, probably resulting in a temperate climate in the Eocene and a subtropical climate in the Oligo–Miocene. However, they also noted that the Eocene part of the climate curve should be drawn with caution on the basis of previous palaeoclimatic studies (Wolfe 1978; Hochuli 1984).

Throughout the Eocene epoch, the climate of the Mediterranean region underwent fluctations (Aleksandrova et al. 1987). The Early Eocene is marked by some decrease in the mean annual temperatures in what is present–day Belgium, Germany and the East European platform, later succeeded in Europe by a warm tropical and subtropical climate (Buchardt 1978; Yasamanov, 1982). Palaeobotanical determinations of the Middle Eocene palaeoclimate (Gray, 1960; Dilcher 1973; Wolfe 1978; Upchurch & Wolfe 1987; Greenwood & Wing 1995) and of the Late Eocene palaeoclimate (Frederiksen 1980b; Wolfe 1992) for the northern Gulf Coast, U.S.A. are all winter–dry tropical to humid paratropical climates on lowlands, and most infer no freezing. Wolfe & Poore (1982) estimated that MAT in the Mississippi Embayment fluctuated between about 20^{o}C and 30^{o}C during the Middle–Late Eocene period and is consistent with this study because it lay at similar latitude. According to Roehler (1993), the climate is tropical to subtropical character in the Middle Eocene and becomes temperate in the Late Eocene of Green River Basin, Wyoming, Utah and Colorado. Mosbrugger *et al.* (2005) documented the warmest climate conditions in the Lutetian of Geiseltal flora (Weiselster Basin). The MAT ranges from 23 to 25^{o}C, MAP from 1000 to 1600mm and CMT from 17 to 21 ^{o}C. These results indicate virtually tropical climatic conditions. Frederiksen (1980a, 1980b) suggested a regime of winter–dry tropical climate on lowlands adjacent to the coastline and a marginal humid paratropical climate on the upper coastal plain. In conclusion, we have identified the presence of a mixture of subtropical/paratropical climatic zones, corresponding to an interval having mean annual temperatures between 17.2° and 25 °C, and from coast to montane environments. This climatic discrepancy is related to the effects of the tropical Tethys Sea on terrestrial environments.

Additionally, calculated P/A ratio is high in the Başçeşme Formation and this supports the reliability of warm climate conditions during the Middle–Late Eocene (Fig. 6. 2b). For the comparison of the continental and marine temperature variations, the global oxygen isotope records of Buchardt (1978), Yasamanov (1982) and Zachos et al. (2001) have been selected (Fig. 6. 2a, c). Buchardt (1978) indicated the palaeotemperature changes from the last 60 Ma in the North Sea area. Additionally, Yasamanov (1982) also determined the palaeotemperature changes from western Alpine Himalayan belt (central and southern regions of the East European platform, the Carpathians, the Crimea and Caucasus). Buchardt (1978) and Yasamanov (1982) show a cooler climate from tropical in Palaeocene and Eocene times to temperate in Miocene epoch (Fig. 6. 2a), over an area that embraced the high and middle latitudes of Eurasia. Zachos et al. (2001) provide the most recent synthesis of global climate change during the Cenozoic (Fig. 6. 2c). The isotope record and ocean water temperatures derived from the analysis of benthic and deep–sea foraminifers are on the basis of Deep Sea Drilling Project and Ocean Drilling Project sites (Fig. 6. 2c). Zachos et al. (2001) indicate a warm period in the Middle–Late Eocene (Fig. 6. 2c).

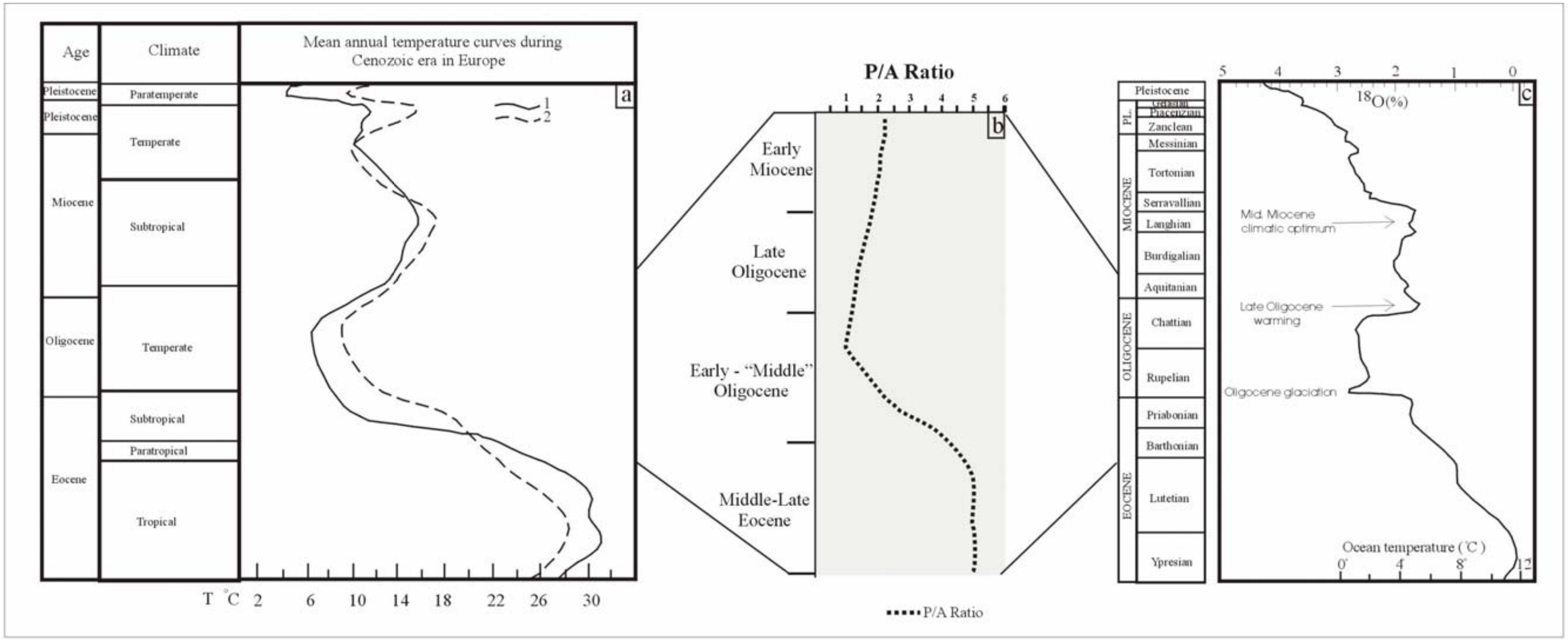

Figure 6. 2 (a) Early Cenozoic climate of Europe: 1) temperature of the North Sea (Buchardt, 1978); 2) temperature of central and southern regions of the East European platform, Carpathians, Crimea, Caucasus, Middle Asia and Kazakhstan (Yasamanov, 1982). (b) relative percentages of palaeotropical and arctotertiary elements derived from the samples of the Çardak-Tokça, Budur and İncesu basins. (c) Global marine oxygen isotope record of Zachos et al. (2001).

6.1.2 The Varsakyayla Formation

The palynoflora analyzed from the Varsakyayla Formation of Burdur Area includes 37 taxa, and the palaeoclimatic reconstruction is based on 16 taxa (Fig. 6. 3). The resulting coexistence interval for the MAT ranges from 17.2 to18.8^{o}C, and CMT and WMT as 9.6 to 13.1^{o}C and 25 to 27.7^{o}C, respectively. For the MAP, the CA values change from 1217 to 1613mm (Figure 6. 3). This indicates warm temperate and/or subtropical palaeoclimatic conditions under high rainfall. However, the mangrove element *Psilatricolporites crassus* (*Pelliciera*) also occurs in the palynoflora of the Varsakyayla Formation and needs a warm climatic conditions near the coast. The climatic data obtained from the MAT (17.2–18.8°C) corresponds to Nix’s mesotherm zone and determines slope or hinterland environment. Conversely, the resolution increases with the number of taxa included in the analysis. However, our palynoflora has poor species diversification and gives a low P/A ratio. Additionally, CMT values are high and indicate a warm climatic condition.

As indicated by Ivanov et al. (2002), the CA also involves number uncertainties of sources of error: 1) Description of fossil taxa may be incorrect; 2) Allocation of a nearest living relative to a fossil taxon may be incorrect; 3) the climatic endurance of a nearest living relative may differ from the climatic tolerance of the corresponding fossil taxon; 4) misidentification of a fossil taxon or poor modern climatic data. Because of these reasons, we have only obtained the climatic conditions of slope and montane environment. Additionally, as indicated in the climatic interpretation of the Başçeşme Formation, the presence of the zooxanthellate coral fauna with larger foraminifera in the carbonate rocks indicates the tropical temperatures of the Tethys Sea.

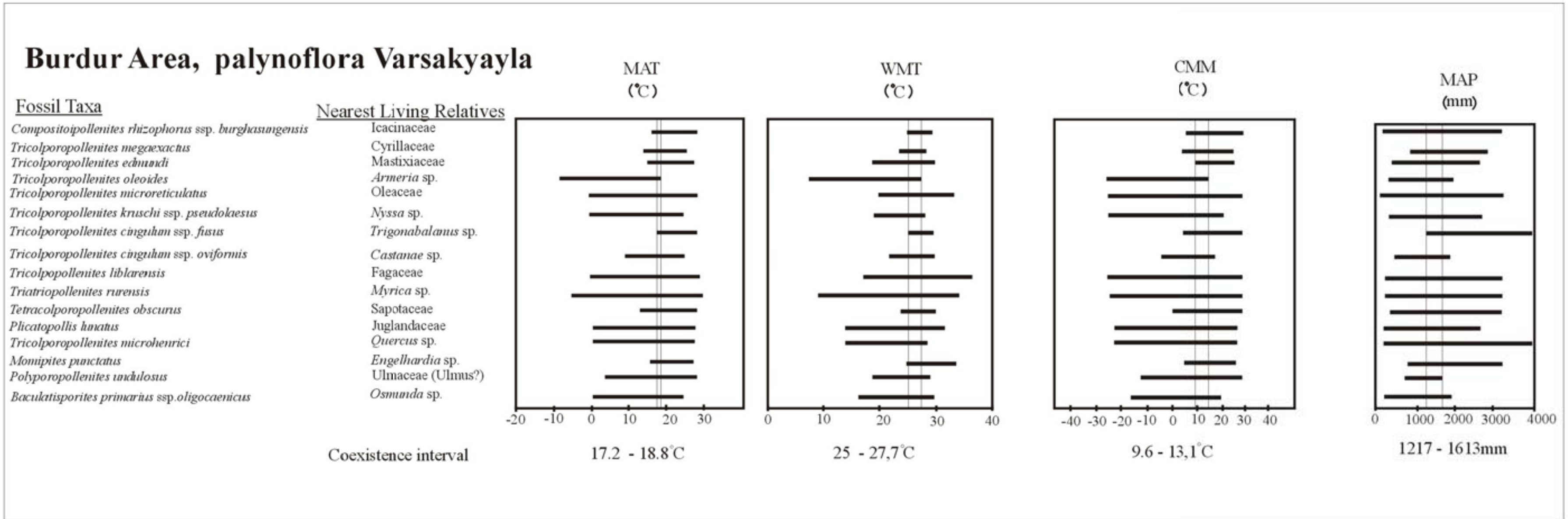

Figure 6. 3 Application of the Coexistence Approach to the Varsakyayla palynoflora in the Burdur Area. The shaded boxes mark the climatic requirements of the taxa, the vertical lines delimit the widths of the coexistence intervals (MAT: mean annual temperature, CMT: mean temperature of the coldest month, WMT: mean temperature of warmest month, MAP: mean annual precipitation).

6.2 Early–“Middle” Oligocene

6.2.1 The Tokça Formation

The palynoflora obtained from the Tokça Formation and also the palynological data of Akkiraz & Akgün (2005) have been applied to the CA method (Fig. 6. 4). The palaeoclimatic reconstruction of the Tokça palynoflora relies on a total of 35 taxa with known NLRs (Fig. 6. 4). The resulting coexistence interval for the MAT ranges from 17.2 to 17.4 °C. The intervals for the CMT and WMT are determined as ranging between 5.5 and 8.3 °C and 27.3 and 27.9 °C, respectively. For the MAP, the CA yields values between 1217 and 1355 mm (Fig. 6. 4). These climatic data indicate a subtropical condition under high rainfall. According to Mosbrugger et. al (2005), MAP did not change dramatically between Eocene and Late Miocene. On the other hand, continental climate changes of Central Europe during the last 45 million years are mainly characterized by decrease of CMT, of nearly 20°C between Eocene and Pliocene. The authors also indicate that the MAT and WMT did not undergo a significant change from Eocene to Pliocene. We have obtained 9.6 to 13.1^{o}C for the CMT from the Varsakyayla Formation (Fig. 6. 3) and 5.5 to 8.3 °C from the Tokça Formation (Fig. 6. 4). It is also necessary to indicate that the P/A ratio decreases from Eocene to Early–“Middle” Oligocene and indicates cooler climatic conditions when compared to the Middle–Late Eocene. Figure 6. 2b, c show that the major trends observed in marine records are clearly reflected by the continental curves of P/A ratio.

Tropical climatic conditions in the Eocene gave way to a subtropical–temperate climate with marked seasons in England, Belgium and France (Elsik, 1974; Gorin, 1975; Krutzsch & Vanhoorne, 1977; Hochuli, 1978; Chateauneuf, 1980; Ollivier-Pierre, 1980; Boulter & Hubbard, 1982; Collinson, 1992; Cavagnetto & Anadón, 1996). The results clearly show that there was a rapid decline in water temperature during the Oligocene (Buchardt 1978; Yasamanov 1982; Zachos et al. 2001) (Fig. 6. 2c). This decrease coincides with the global climatic changes of the Latdorfian–Rupelian event. The climate of the Gulf Coast was apparently tropical and more or less uniform from the Middle Eocene almost to the end of the Eocene. Then, the climate probably became cooler and perhaps drier very rapidly, and this regime persisted into the Early Oligocene (Wolfe & Hopkins, 1967; Elsik, 1974). A sudden increase in the frequency of modern *Quercus* pollen is recorded by Frederiksen (1991) both on Gulf Coast (Upper Priabonian) and in southern California (Lower Priabonian). Its frequency might be related to a climatic cooling. *Quercus* type pollen occurs in almost all samples of the Tokça Formation (See table 4. 3). At the boundary between Eocene and Oligocene the essential changing of plant and development of the subtropical flora took place in the basin of Middle and Upper Don (Shpul, 2002). The palynomorph assemblage defined in this study suggests subtropical climatic conditions and is consistent with the results of the previous studies related to climatic cooling.

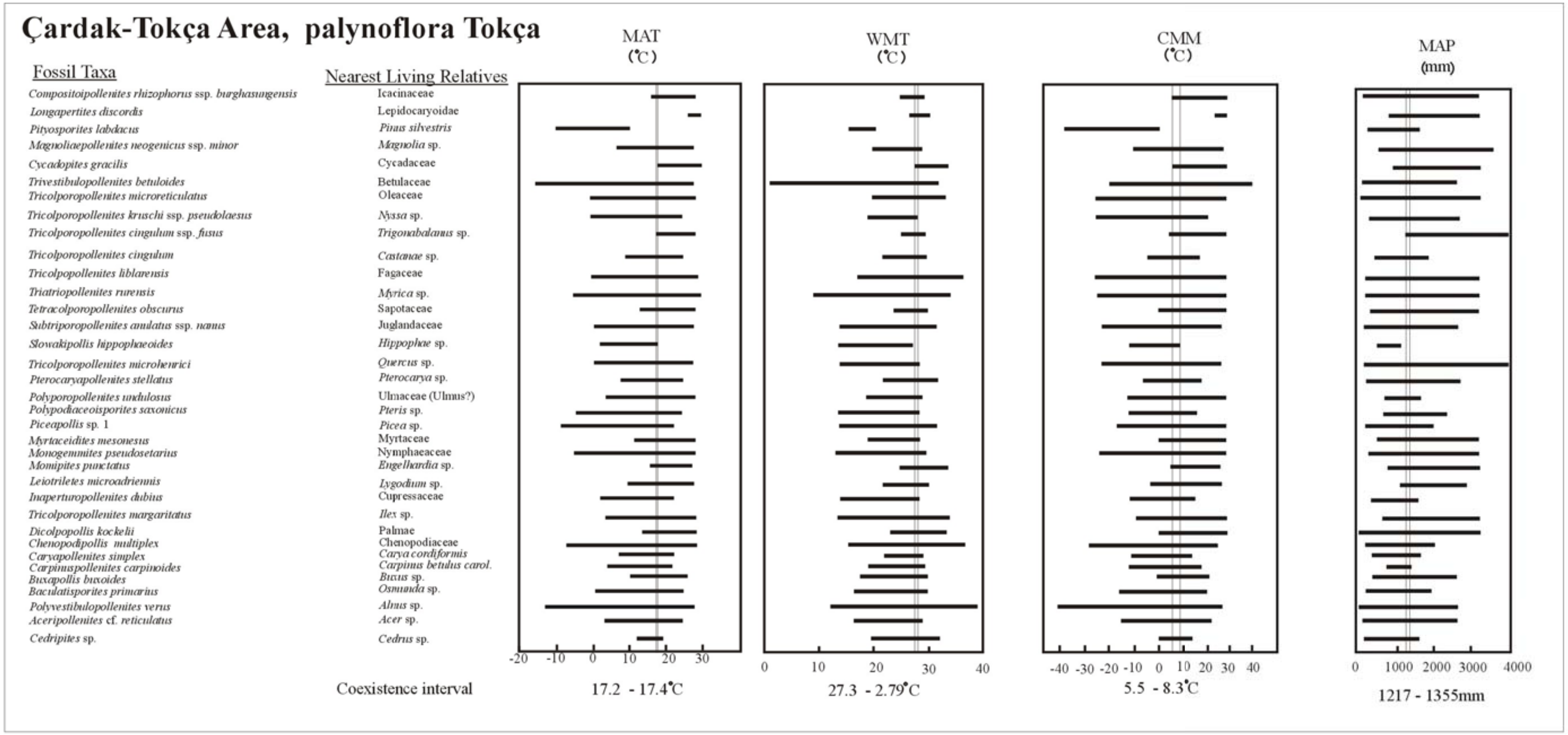

Figure 6. 4 Application of the Coexistence Approach to the Tokça palynoflora in the Çardak -Tokça Area. The shaded boxes mark the climatic requirements of the taxa, the vertical lines delimit the widths of the coexistence intervals (MAT: mean annual temperature, CMT: mean temperature of the coldest month, WMT: mean temperature of warmest month, MAP: mean annual precipitation).

6.2.2 The İncesu Formation

Eighty–nine species have been identified from the samples of the İncesu Formation. The palaeoclimatic reconstruction of the İncesu palynoflora relies on totally 34 taxa with known NLRs (Fig. 6. 5). The MAT calculated with the coexistence approach gives the interval of 17.2 to 17.4 °C with the borders of this range determined by *Trigonabalanus* and Hippophae. The CMT coexistence interval ranges mainly between 6.2–8.3 °C but intervals between 9.6 and 13.1^{o}C also occur. The coexistence interval of the WMT is 27.3 to 28.1°C determined by Cyacadaceae and Cupressaceae. The coexistence interval for the MAP is 1217 to 1355 mm, which is determined by *Trigonabalanus* and *Cathaya* (Fig. 6. 5). Possibly these two coexistence intervals for the CMT represent two plant communities which grow under different climatic conditions depending on variegated relief. The first coexistence interval may indicate the climatic conditions of slope and/or montane environments. The second coexistence interval is represented by lowlands. Here, it is important to keep in mind that mountain located at the northern part of the İncesu Formation existed near the basin. The presence of high mountains near the basin indicates more rainfall in the mountainous area. Additionally, the exclusion of Lepidocaryoidae, which forms an outlier with upper MAT and CMT requirements, leads to values mentioned above (Fig. 6. 5). Its presence in the assemblage indicates a warm condition on lowlands, especially on the back–mangrove environment. On the other hand, the presence of *Pinus* sylvestris type pollen suggests a cooler condition on montane environment (Fig. 6. 5). Thus, all the data indicate a subtropical climate during the deposition of the Early–"Middle" Oligocene İncesu Formation.

Increased amount of arctotertiary elements leads to a lower P/A ratio and indicates a cooler condition during the deposition of the Early–"Middle" Oligocene İncesu Formation (Fig. 6. 2b). However, the presence of larger foraminifers and also corals in the Delikarkası Formation located at the base of the Early Oligocene sequence suggests warmer–water temperatures. And, though reefs as prominent morphological structures were not observed, the coral fauna and larger foraminifers in the carbonates of the Delikarkası Formation indicate tropical climatic conditions during the beginning of the Early Oligocene. In contrast, palynoflora obtained from the İncesu Formation that conformably overlies the Delikarkası Formation provides mean annual temperatures of 17.2–17.4^{o}C that indicate cooler conditions. This climatic discrepancy is explained either by decreasing temperatures during the Early Oligocene or a warm surface water temperature with a current result in a differential climatic evolution of the marine and terrestrial environment. Additionally, according to Zachos et al. (2001), stable isotopes provided insight into ice volume changes and global climate fluctuations, their frequency and amplitudes indicating initial Antarctic glaciations during the Late Eocene and major ice volume increased in the earliest Oligocene (Fig. 6. 2c).

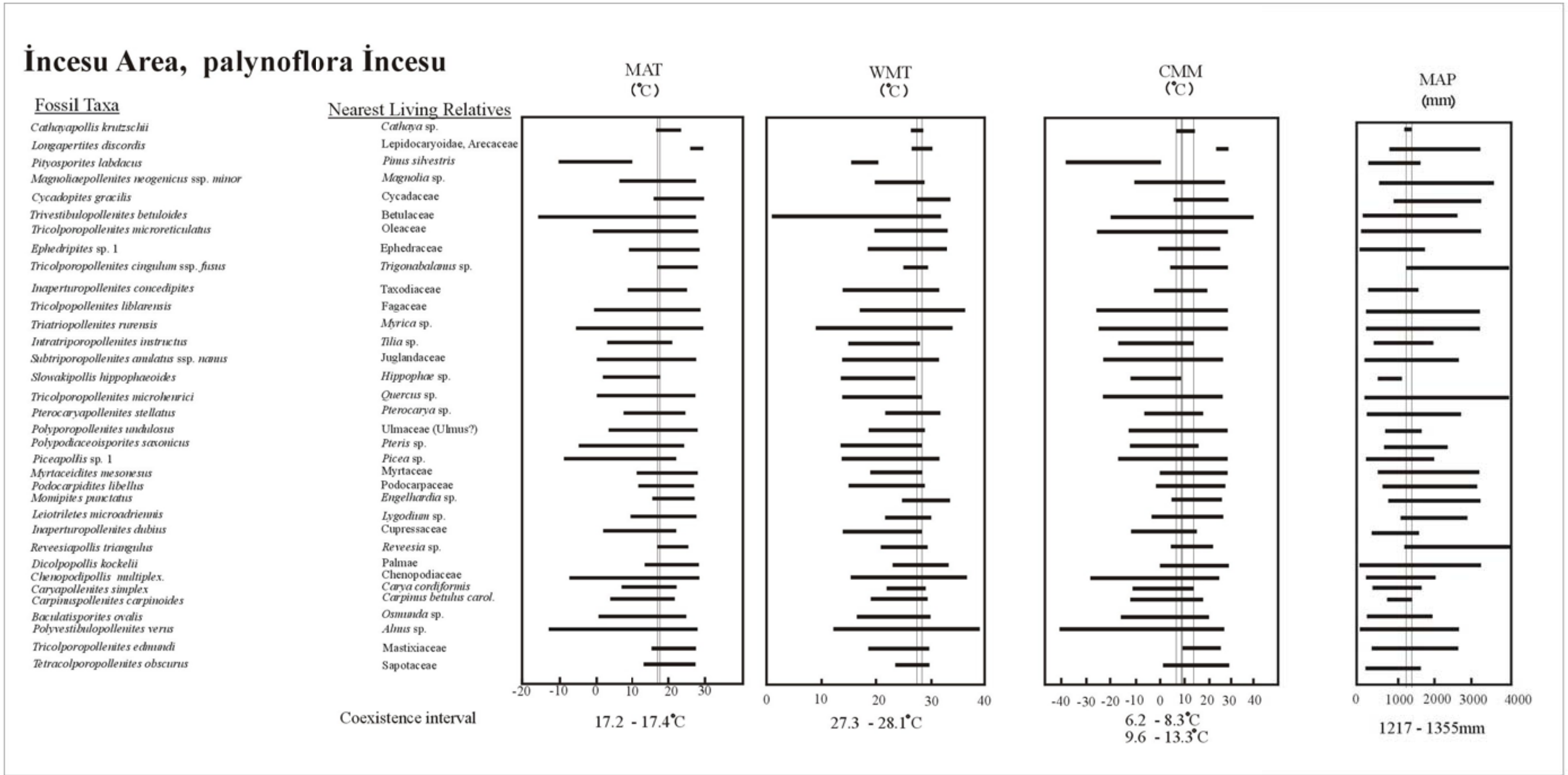

Figure 6. 5 Application of the Coexistence Approach to the İncesu palynoflora in the İncesu Area. The shaded boxes mark the climatic requirements of the taxa, the vertical lines delimit the widths of the coexistence intervals (MAT: mean annual temperature,CMT: mean temperature of the coldest month, WMT: mean temperature of warmest month, MAP: mean annual precipitation).

6.3 Early Miocene

6.3.1 The Kavak Formation

Forty species have been identified from the samples of the Kavak Formation. The palaeoclimatic reconstruction of the Kavak palynoflora relies on totally 17 taxa with known NLRs (Fig. 6. 6). The resulting coexistence interval for the MAT ranges from 17.2 to 20.8 °C with the borders of which range determined by *Trigonabalanus* and *Tilia*. The coexistence interval for the CMT from these data is between 5.5 and 13.3 °C determined by Cycadaceae and *Tilia*. The coexistence interval of the WMT is between 27.3 and 28.1 °C determined by Cycadaceae and *Myrica*. For the MAP, the CA yields values between 1217 and 1355 mm determined by *Carpinus* and *Trigonabalanus* (Fig. 6. 6). In the assemblage, the palaeotropical elements ferns like *Leiotriletes* occur frequently in some samples. In the canopy, Sapotaceae also occurs. Additionally, palaeotropical indicators such as *Momipites*, *Reevesiapollis triangulus*, *Tricolporopollenites euphorii*, *Tricolporopollenites megaexactus* ssp. *brühlensis*, *Tricolporopollenites pseudocingulum* also take place in the assemblage. Additionally, *Longapertites discordis* that indicates a warm condition and also lowland environment occurs sporadically in the assemblage.

On the other hand, the arctotertiary elements such as *Sequoiapollenites polyformosus*, *Plicatopollis plicatus*, *Caryapollenites simplex*, *Intratriporopollenites instructus*, *Carpinuspollenites carpinoides*, *Polyvestibulopollenites verus*, *Tricolpopollenites liblarensis*, *T. densus*, *Tricolporopollenites cingulum*, *T. microreticulatus*, *Aceripollenites striatus* probably lived on hills. Although the climate data obtained has wide ranges, the climate was subtropical under high rainfall. Because of this, the relative percentage of P/A ratio is calculated on the basis of palynological data set. Its ratio increases from Oligocene to Early Miocene (Fig. 6. 2b) and indicates a warm climate. These results are in accordance with the data obtained from isotope records (Buchardt 1978; Yasamanov 1982; Zachos et al. 2001) (Fig. 6. 2b, c)

According to Nagy (1990) and Planderová (1990), there was a warm subtropical climate during the Chattian and Aquitanian periods. It is observed that the temperature in the Aquitanian reached a warm condition because of increasing palaeotropical elements. However, a decrease in temperature was estimated during the middle–late Aquitanian as evidenced from Nagy (1990) in the Hungarian Miocene and Planderová (1990) in Eastern and Central Europe. In contrast, Hochuli (1978) from Austrian Molasse and Kirchner (1984) from Southern Bavarian Pitch Coal Mine recorded a warm phase during the early Aquitanian and it is consistent with the data obtained in this study. Additionally, Akgün et al. (2007) have recorded warm climate conditions in the Early Miocene of Turkey. It is also necessary to indicate that the Neogene period shows a general trend of climatic deterioration. This climate trend was punctuated by global warmth during the Middle Miocene known to be warmer than any other time during the Neogene, but general climate deterioration resumed in the Late Miocene.

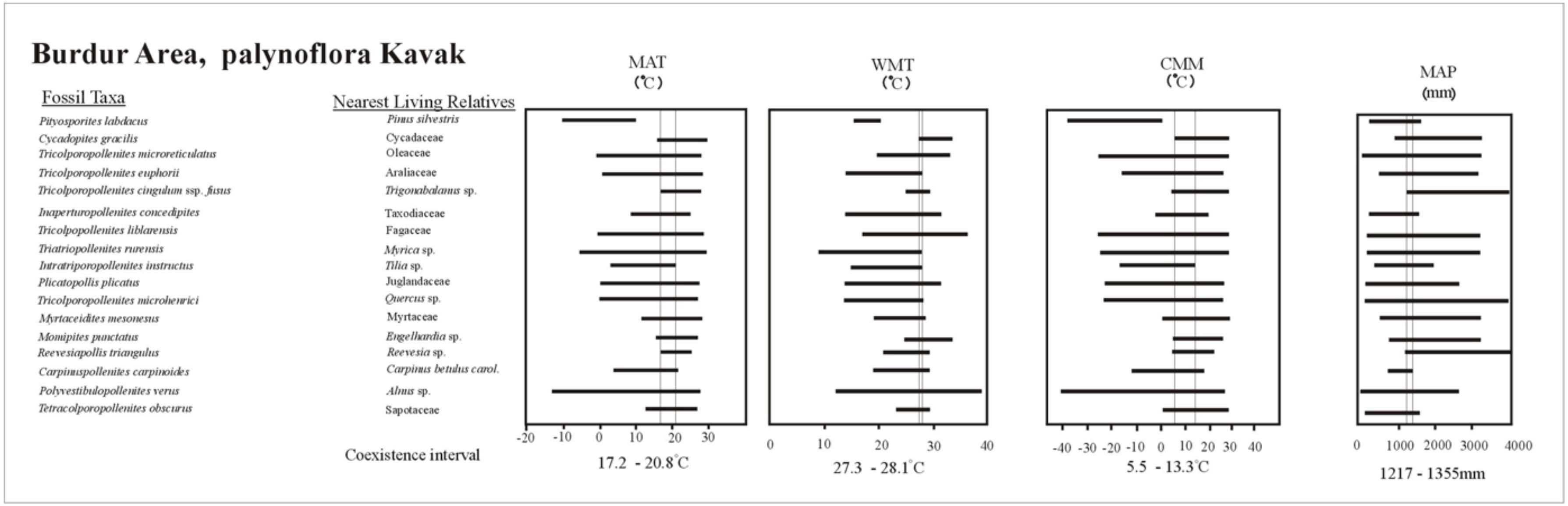

Figure 6. 6 Application of the Coexistence Approach to the Kavak palynoflora in the Burdur Area. The shaded boxes mark the climatic requirements of the taxa, the vertical lines delimit the widths of the coexistence intervals (MAT: mean annual temperature, CMT: mean temperature of the coldest month, WMT: mean temperature of warmest month, MAP: mean annual precipitation).

6.3.2 The Aksu Formation

The palynoflora contains a total of fifty–eight taxa, 25 of which were used for calculating the coexistence intervals (Fig. 6. 6). The calculated coexistence intervals result in a (MAT) range mainly between 21 and 21.1 °C. The borders of this range were determined by Brownlowidae and *Carpinus*. The coexistence interval for the CMT from these data is between 9.6 and 13.3 °C determined by Mastixiacae and *Carya*. The coexistence interval for the CMT from these data is between 27.3 and 27.9 °C determined by Cycadaceae and *Nyssa*. For the MAP, the CA yields values between 1217 and 1355 mm determined by *Trigonabalanus* and *Carpinus* (Fig. 6. 6). The obtained results indicate a warm subtropical climate under high rainfall. In the assemblage palaeotropical elements are mainly characterized by abundance of ferns like *Leiotriletes* and presence of *Verrucatosporites alienus* (See table 4. 7). The palaeotropical elements are also represented by occurrence of *Cyacadopites*, *Dicolpopollis kockelii*, *Triatriopollenites rurensis*, *Momipites*, *Tricolporopollenites marcodurensis*, *T. megaexactus* ssp. *brühlensis*, *T. edmundi* and *Tetracolporopollenites*. The arctotertiary elements are made up of *Caryapollenites simplex*, *Intratriporopollenites insculptus*, *Polyporopollenites undulosus*, *Carpinuspollenites carpinoides*, *Pterocaryapollenites stellatus*, *Polyvestibulopollenites verus*, *Tricolpopollenites densus*, *T. liblarensis*, *T. retiformis*, *Tricolporopollenites microreticulatus*, *T. kruschi* ssp. *pseudolaesus* and *Chenopodipollis multiplex* (See table 4.7 for the numbers). Additionally, increasing percentages of palaeotropical elements (*Leiotriletes*, *Momipites* and *Cycadopites*) and decreasing amount of arctotertiary elements are indicative of cooling climate. According to Mosbrugger et al. (2005), an overall trend of raising temperature is observed during Early Miocene persisted into the Middle Miocene.

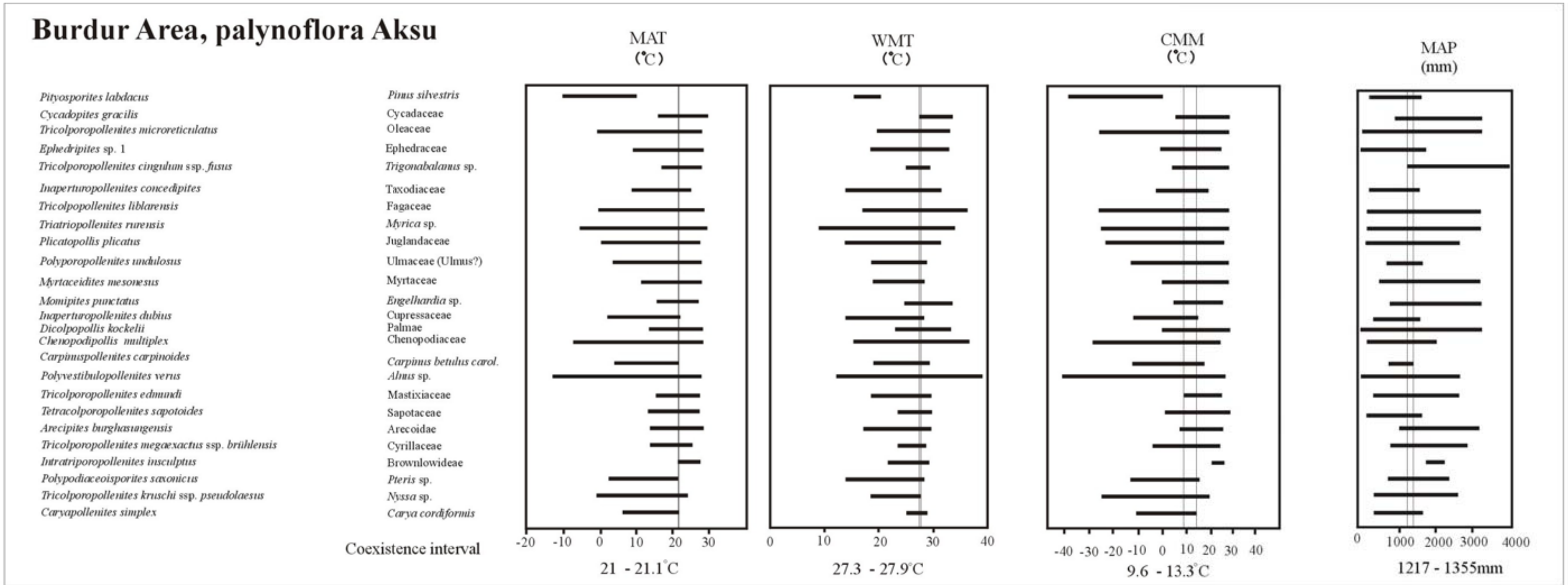

Figure 6. 7 Application of the Coexistence Approach to the Aksu palynoflora in the Burdur Area. The shaded boxes mark the climatic requirements of the taxa, the vertical lines delimit the widths of the coexistence intervals (MAT: mean annual temperature, CMT: mean temperature of the coldest month, WMT: mean temperature of warmest month, MAP: mean annual precipitation).

6.4 Summary of General Climatic Trends

In this part, general climatic trends have been interpreted from the Middle Eocene to end of the Early Miocene on the basis of climatic data obtained in this study and also previous studies made in other parts of Turkey (Fig. 6. 8). Apart from the palaeoclimatic results obtained from the Başçeşme,Varsakyayla, Tokça, İncesu, Kavak and Aksu formations, the Middle–?Late Eocene palaeoclimatic data have been acquired from the Çankırı–Çorum Basin by Akgün (2002), Akgün et al. (2002) and Akkiraz et al. (accepted). The latest Chattian (Late Oligocene) and the early Aquitanian (Early Miocene) palynomorph assemblages were determined from the Kale–Tavas Basin by Akgün & Sözbilir (2001). The palynomorph assemblages of the latest Burdigalian were described from the Bigadiç Basin in western Anatolia (Akyol & Akgün, 1990) and Samsun–Havza area in central Anatolia (Kayseri & Akgün, accepted). Akgün et al. (2007) have firstly made a palaeoclimatic reconstruction from the Late Oligocene to the Late Miocene of Turkey on the basis of the data mentioned above and also palynological and palaeobotanical data obtained from other parts of Turkey (e.g. Soma, Yatağan basins).

If we have a look at figure 6. 8, calculated coexistence intervals for the Middle–Late Eocene obtained from western (Başçeşme and Varsakyayla formations) and central Anatolia (Çankırı–Çorum Basin) give us two different values, around 18°C for the first and 25°C for the second. As discussed in the palaeoclimatic evolution of the Başçeşme Formation, different coexistence intervals indicate the existence of plant communities that grow under different climatic conditions and variegated relief (Ivanov et al. 2002). Additionally, temperature of the coldest month (CMT) obtained from the central Anatolia give us two different climatic values, 13°C for the first, 24°C for the second (Fig. 6. 8). These different values should also be connected with the palaeogeographic organisations.

During the Early Oligocene, mean annual temperature (MAT) is around 17°C obtained from the Tokça and İncesu formations (Fig. 6. 8). Moreover, temperature of the coldest month (CMT) is about 7°C. It is clear that there is a decrease in CMT and

MAT from the Middle Eocene to the Early Oligocene (Fig. 6. 8), whereas temperature of the warmest month (WMT) and mean annual precipitation (MAP) did not undergo a significant change from the Middle Eocene to the Early Oligocene. Though the P/A ratio is represented by high averages during the Middle–Late Eocene, its ratio is low in the Early Oligocene and consistent with the climatic results obtained here. The Early Oligocene cooling was recorded from Germany by Mosbrugger et al. (2005) and also oxygen isotopic works made by Zachos et al. (2001) (Fig. 6. 8).

From the Early Oligocene to the Early Miocene, an increase in the temperature is clear (Fig. 6. 8). Additionally, the P/A ratio increases from the Early Oligocene to the Early Miocene as well (Fig. 6. 2b). The obtained palaeoclimatic results are consistent with the previous isotopic works made by Zachos et al. (2001). According to Mosbrugger et al. (2005), the succeeding warm time span persisted into earlier part of the Serrevallian (Middle Miocene), and corresponds to the Middle Miocene Climatic Optimum that is globally observed as well (Fig. 6. 2c).

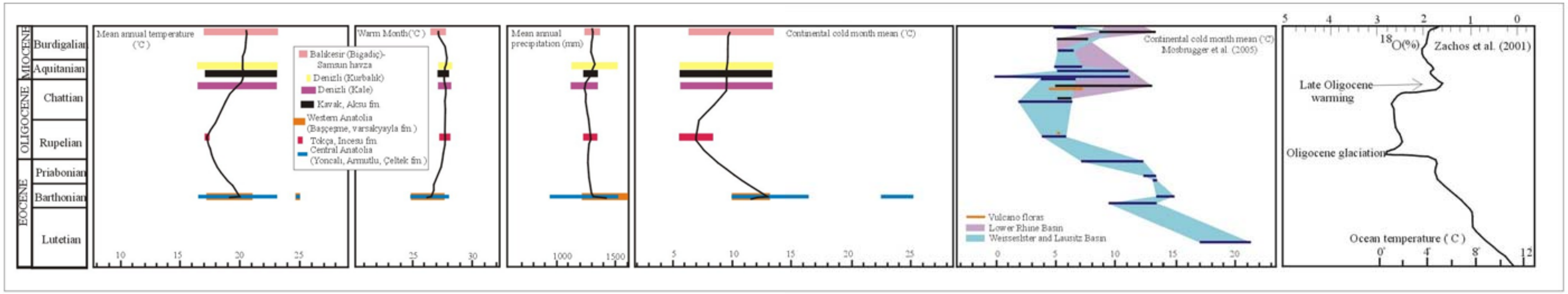

Figure 6. 8 Coexistence intervals and isotopic data derived from the samples between Middle Eocene and Early Miocene (data from Zachos et al. (2001); Akgün (2002) ;Akgün et al. (2002); Akkiraz et al. (accepted); Mosbrugger et al. (2005); Akgün et al. (2007) and herewith study).

CHAPTER SEVEN
CONCLUSIONS

Biostratigraphical Results

Coaly parts of the Başçeşme and Varsakyayla formations have been deposited during the Middle–?Late Eocene relying on the presence of stratigraphically important species like *Aglaoreidia cyclops*, *Triatriopollenites excelsus*, *Subtriporopollenites anulatus* ssp. *nanus*, *Subtriporopollenites constans*, *Plicatopollis lunatus, Compositoipollenites rhizophorus* ssp. *burghasungensis* and *Nowemprojectus tumanganicus*. In addition to biostratigraphical important species for the Middle–?Late Eocene, the mangrove elements *Psilatricolporites crassus* (*Pelliciera*), *Spinizonocolpites* group (*Nypa*), *Leiotriletes adriennis* (*Acrostichum aureum*) *Longapertites discordis* (?Arecaceae, ?Lepidocaryoidae) and *Mauritiidites franciscoi* (*Mauritia*) have firstly been recorded from the western Anatolian coal occurrences so far.

The foraminiferal fauna suggests a Priabonian (Late Eocene) age, and indicates a carbonate–shelf depositional environment for the Asar member (Başçeşme Formation) and carbonate levels located at top of the Varsakyayla Formation.

In conclusion, the palynological assemblages and foraminifer data obtained from the Başçeşme (Çardak–Tokça Area) and Varsakyayla (Burdur Area) formations indicate a Middle–Late Eocene age, and these formations are well correlated to each other with respect to palynologic and foraminifer data and also lithostratigraphic properties.

The palynomorph assemblage obtained from the Tokça Formation (Çardak–Tokça Area) and also the data of Akkiraz & Akgün (2005), chiefly consisted of stratigraphical marker species like *Magnolipollis neogenicus* ssp. *minor Boehlensipollis hohli*, *Slowakipollis hippophaëoides, Subtriporopollenites constans, Aglaoreidia cyclops*, *Dicolpopollis kockelii*, *Compositoipollenites rhizophorus* ssp.

burghasungensis, *Plicatopollis hungaricus, Mediocolpopollis compactus* ssp. *ellenhausensis, Pentapollenites pentangulus, Caryapollenites simplex* and *Intratriporopollenites instructus*, which indicate an Early–"Middle" Oligocene age. The Early–"Middle" Oligocene age is consistent with the results based on the previous palynological study of Benda (1971a).

On the other hand, the age of the Üçtepeler reef member (Tokça Formation) is Rupelian–?Chattian (Early–?Late Oligocene) on the basis of *Lepidocyclina* (*Eulepidina*) *dilatata*, *Miogypsinoides* sp. (primitive forms), *Austrotrillina* sp. and *Cycloclypeus* sp. Additonally, according to Göktaş et al (1989), although the age of the Tokça Formation is the "Middle" Oligocene on basis of the coral assemblage, they gave a Late Oligocene for the Tokça Formation relying on the content of benthic foraminifers such as *Lepidocyclina* cf *dilatata*, *Lepidocyclina* sp., *Nummulites intermedius*, *Nummulites* cf *vascus*, *Operculina* sp., *Pararotalia* sp., *Quinqueloculina* sp., *Ditrupa* sp., *Heterostegina* sp. and *Gypsina* sp., collected from the limestone lenses of the formation.

In conclusion, the present state of knowledge on the basis of palynomorph and benthic foraminifer contents points that the sedimentation of the Tokça Formation begins (Çardak–Tokça Area) in the Early–"Middle" Oligocene.

The Delikarkası Formation (İncesu Area) occurs at the basal part of the Oligocene seguence in the İncesu Area and has a rich benthic foraminifer assemblage. The presence of the *Nummulites intermedius*, *Nummulites vascus* and *Lepidocyclina* sp. indicates a Rupelian (Early Oligocene) age. Additionally, *Nummulites striatus* and *Halkardia minima* have also been recorded from the samples. The boundary relationship between the Delikarakası Formation and the overlying İncesu Formation is transitional.

Palynological data indicate an Early–"Middle" Oligocene age for the İncesu Formation (İncesu Area) on the basis of abundance and presence of *Slowakipollis hippophaëoides*, *Boehlensipollis hohli*, *Dicolpopollis kockelii Triatriopollenites* *excelsus*, *Plicapollis pseudoexcelsus*, *Caryapollenites* simplex, *Intratriporopollenites instructus*, *Leiotriletes maxoides* ssp. *maximus* and different kind of spore species such as *Leiotriletes*, *Verrucatosporites*, *Polypodiaceoisporites*. The Early–"Middle Oligocene Tokça Formation is well correlated with the İncesu Formation with respect to palynomorph content and also foraminifer data.

The palynomorph assemblages obtained from the Tokça Formation (Çardak–Tokça Area) and İncesu Formation (İncesu Area) are different from those of palynomorph assemblages of the Late Oligocene Thrace Basin and Late Oligocene–Early Miocene southwest Anatolian molasse basins (Kale–Tavas and Denizli) so that the Early–"Middle" Oligocene Çardak–Tokça and İncesu areas are older than these two basins.

An Early Miocene age has been acquired from the Kavak and Aksu formations (Burdur Area) on the basis of presence of biostratigraphically important species such as *Leiotriletes maxoides* ssp. *maximus*, *Dicolpopollis kockelii*, *Plicatopollis plicatus*, *P. hungaricus* and *Longapertites retipiliatus*. Additionally, foraminifer data obtained from the Kavak Formation indicate an Aquitanian (Early Miocene) age based on the presence of some foramifers such *Lepidocyclina* cf. *dilatata*, *Lepidocyclina* sp., *Gypsina* sp., *Sphaerogypsina globolus*, *Archaias* sp. *Austrotrillina* sp.

Palaeoenvironmental Results

The overall rise in sea level from the Bartonian to the Priabonian is indicated by the distribution of both microfaunal and palynological associations from the back–mangrove to shallow marine environment for the Maden member (the Başçeşme Formation). The lower part of the Maden member was deposited in a non–marine back mangrove environment. The palaeoenvironment changed from back mangrove to mangrove environment or front mangrove through the upper part of the Maden member and also through the shallow marine environment in the Asar member which includes the marine fossils. The sea level rise should be related to the basin subsidence as a result of tectonic development.

As all the palaeovegatational and foraminiferal data have been schematized, it is clear that the Middle–Late Eocene transgression is also recorded from the Varsakyayla Formation. The presence of marine limestones at the top of the Varsakyayla Formation in the study area indicates that the maximum sea–level conditions were acquired during deposition of the Varsakyayla Formation. The marine transgression is also well documented by presence of reefal limestones containing rich marine fossils, such as coral reefs, benthic foraminifers and echinoderms, and can be well correlated with the Asar member of the Başçeşme Formation.

During the Early–"Middle" Oligocene, the Tokça Formation (Çardak–Tokça Area) was deposited in a terrestrial environment under marine influence, because of the presence of marine dinoflagellate cysts and also a rich foraminifer assemblage acquired from the Üçtepeler reef member (Tokça Formation) that attained a maximum sea level.

In the İncesu Area, a rich bentonic foraminifer assemblage has been obtained from the Early–"Middle" Oligocene Delikarkası Formation which is conformably overlain by the İncesu Formation. The maximum sea level condition was realized during the deposition of the Delikarkası Formation which has well–preserved marine fauna; coral, foraminifer, echinoderms, bivalves. All the micropalaeontological data indicate that the Early–"Middle" Oligocene regression is reported from the Delikarkası Formation to the İncesu Formation. The regression is also well documented from sedimentological data, including marine limestones of the Delikarkası Formation and overlying coal–bearing fluviatile sediments of the İncesu Formation. The regression was sourced from a structural height formed by Barladağ series belonging to Bey Dağları Autochthon, which is located to the north of the İncesu Formation.

In the Early Miocene, the Kavak and Aksu formations (Burdur Area) were deposited in a terrestrial environment under marine influence as well. Foraminifer and palynological data collectively indicate a marine transgression during the deposition of the Kavak Formation. A marine transgression has also been recorded from the Aksu Formation.

Palaeoclimatic results

The mangrove taxa and coral fauna with larger foraminifera in the carbonates of the Başçeşme and Varsakyayla formations indicate tropical water temperatures during the Bartonian–Priabonian period. Palaeoclimatic conditions are characterized by 24.8–25^{0}C in the mangrove environment. The mean annual temperature is of 21.1–24.8^{0}C in the megatherm/mesotherm intermediate zone and 17.2–21.1^{o}C in mesotherm zone. Diverse coexistence intervals indicate plant communities that grow under different climatic conditions and variegated relief.

The circulation of the warm Tethys waters should have led to the growth of mangroves on central and western Anatolia during the Middle–Late Eocene.

Palaeoclimatic data obtained from the Early–"Middle" Oligocene Tokça (Çardak–Tokça Area) and İncesu (İncesu Area) formations indicate a cooling from the Middle Eocene to the Early Oligocene. This should be related to the fact that either Turkey's palaeogeographic position should have moved to north or Antarctic glaciations built up during the Early Oligocene. The cooling has also been reported from the low ratio of palaeotropical and arctoteriary elements, and isotopic works which were made on other parts of the world.

From the Early Oligocene to the Early Miocene, an increasing in temperature is clear. It has been evidenced by high P/A ratio, and isotopic works, as well.

REFERENCES

Acevedo, L. T., & Anzotegui, L. M. (2001). Fossil pollen of Myrtaceae in the Late Tertiary of Northeastern Argentina: Taxonomic Considerations. In D. K. Goodman & R. T. Clarke (Eds.). Proceedings of the IX International Palynological Congress, *American Association of Stratigraphic Palynologists Foundation*, 311-318.

Akgün, F., Alişan, C., & Akyol, E. (1986). A palynological approach to the Neogene stratigraphy of Soma area. *Geological Society of Turkey Bulletin*, *29*, 13-25.

Akgün, F., & Akyol, E. (1987). Palynological investigations of Akhisar (Çıtak) lignite. *Geological Society of Turkey Bulletin*, *30*, 35-50.

Akgün, F., Olgun, E., Kuşçu, İ., Toprak, V., & Göncüoğlu, M. C. (1995). Orta Anadolu kristalen kompleksinin "Oligo–Miyosen" örtüsünün stratigrafisi, çökelme ortamı ve gerçek yaşına ilişkin yeni bulgular. *Turkish Association of Petroleum Geologists Bulletin*, *6* (1), 51-68.

Akgün, F., & Akyol, E. (1999). Palynostratigraphy of the coal-bearing Neogene deposits Graben in Büyük Menderes Western Anatolia. *Geobios*, *32*(3), 367-383.

Akgün, F., Kaya, T., Forsten, A., & Atalay, Z. (2000). Biostratigraphic data (Mammalia and Palynology) from the Upper Miocene İncesu Formation at Düzyayla (Hafik Sivas, Central Anataloia). *Turkish Journal of Earth Sciences*, *9*, 57-67.

Akgün, F., & Sözbilir, H. (2001). A palynostratigraphic approach to the SW Anatolian molasse basin: Kale-Tavas molasse and Denizli molasses, *Geodinamica Acta*, *14*, 71-93.

Akgün, F. (2002). Stratigraphic and paleoenvironmental significance of Eocene palynomorphs of the Çorum-Amasya area in the central Anatolia, Turkey. *Acta Palaeontologica Sinica*, *41*, 576-591.

Akgün, F., Akay, E., & Erdoğan, B. (2002). Terrestrial to shallow marine deposition in central Anatolia: a palynological approach. *Turkish Journal of Earth Sciences*, *11*, 1-7.

Akgün, F., Kayseri, M. S., & Akkiraz, M. S. (2007). Palaeoclimatic evolution and vegetational changes during the Late Oligocene-Miocene period inWestern and Central Anatolia (Turkey). *Palaeogeography, Palaeoclimatology, Palaeoecology, 253*, 56-90.

Akkiraz, M. S., & Akgün, F. (2005). Palynology and age of the Early Oligocene units in Çardak–Tokça basin, southwest Anatolia: paleoecological implications. *Geobios, 38*, 283-299.

Akkiraz, M.S., Akgün, F., Örçen, S., Bruch, A. A., & Mosbrugger, V. (2006). Stratigraphic and Palaeoenvironmental Significance of Bartonian–Priabonian (Middle–Late Eocene) Microfossils from the Başçeşme Formation, Denizli Province, Western Anatolia. *Turkish Journal of Earth Science*, *15*, 155-180.

Akkiraz, M. S., Kayseri, F., & Akgün, F. (2007). Palaeoecology of Coal–Bearing Eocene Sediments in Central Anatolia (Turkey) Based on Quantitative Palynological Data. *Turkish Journal of earth Sciences*, (in press).

Akkiraz, M. S., Akgün, F,, Bozcu, F., Kapan–Yeşilyurt S., & Bozcu, A. (2007). Palynological record from the Late Oligocene and Miocene of Biga peninsula (NW Turkey), with emphasis on mangrove. *NECLIME (Neogene Climate Evolution of Eurasia) Annual Meeting*, p.1.

Ashraf, A. R., & Mosbrugger, V. (1995). Palynologie und Palynostratigraphie des Neogens der Niederrheinischen Bucht. *Palaeontographica Abteilung B Ionnides*, *235* (1-6), 61-173.

Aşık, A. (1992). Gümüşgün-Gönen-Atabey (Isparta) dolayının jeolojisi. Akdeniz Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, 41s.

Akyol, E. (1971). Microflore de l'Oigocene infériur récoltée dans un sondage pres d' Avcıkoru, Şile–İstanbul. *Pollen et Spores, 13* (1), 117-133.

Akyol, E. (1978). Stratigrafik palinoloji, kömür işletmeciliği ve bir örnek (Stratigraphic palynology, coal mining and a case study). *Jeoloji Mühendisliği Dergisi 6*, 31-38.

Akyol, E. (1980). Etude palynologique de l'Eocene de Bayat (Çorum–Turquie) et essai de correlation entre Karakaya et Emirşah. *Mineral Research and Exploration Institute of Turkey (MTA) Bulletin*, *91*, 39-53

Akyol, E., & Akgün, F. (1990). Bigadiç, Kestelek, Emet ve Kırka boratlı Neojen tortullarının palinolojisi ve karşılaştırılması. *Mineral Research and Exploration Institute of Turkey Bulletin*, *111*, 165-175.

Aleksandrova, A.N., Prozorov, Y.I., & Yasamanov, N.A. (1987). Climatic and floristic zonation of the Mediterranean region during the Early Cenozoic time. *International Geology Review*, 29, 503-514.

Batı, Z. (1996). Palynostratigraphy and Coal Petrography of the Upper Oligocene Lignites of the Northern Thrace Basin, NW Turkey. PhD Thesis, Middle East Technical University, Ankara, Turkey [unpublished].

Becker-Platen, J. D. (1970). Lithostratigraphische Untersuchungen im Känozoikum Südwest–Anatoliens. *Beihhefte zum Geologischen Jahrbuch, 97*, 1-244.

Benda, L. (1971a). Grundzüge einer pollenanalytischen Gliederung des türkischen Jungtertiärs (Känozoikum und Braunkohle der türkei. 4. *Beihhefte zum Geologischen Jahrbuch*, *113*, 1-46.

Benda, L. (1971b). Principles of the palynologic subdivision of the Turkish (Kanozoikum und Braunkohlen der Turkei-3.) *Newsletter Stratigraphy, 1*, 23-26.

Benda, L., & Meunlenkamp, J. E. (1990). Biostratigraphic correlations in the Eastern Mediterranean Neogene 9. Sporomorph associations and event stratigraphy the Eastern Mediterranean. *Newsletter Stratigraphy, 2*3, 1-10.

Bennie, J., & Kidston, R. (1886). On the occurrrence of spores in the Carboniferous Formation of Scotland. *Proceedings of the American Philosophical Society*, *9*, 82-117.

Bessedik, M. (1981). Une mangrove à *Avicennia* L. en Méditerannée occidentale au Miocène inférieur et moyen. Implications paléogéographiques. *Comptes rendus des séances de l'Académie des Sciences, Paris* 293, 469-472.

Bessedik, M., & Cabrera, L. (1985). Le couple récif-mangrove à San Pau d'Ordal, témoin du maximum transgressif en Méditerannée nord-occidentale (Burdigalien supérieur–Langhien inférieur). *Newsletter Stratigraphy*, *14*, 20-35.

Blasco, F. (1977). Outlines of ecology, botany and forestry of the mangals of the Indian subcontinent. In V. J. Chapman, (Ed.). Ecosystems of the World. *Wet Coastal Ecosystems*, *1*, 241-260.

Bolchovitina, N. G. (1953). Sporovo-pyl'tsevaya kharakteristika melovykh otlozheny tsentral nykh oblasti SSSR. (Spore pollen characteristic of the Cretaceous deposits in central of the USSR). *Trudy Inst. Geol. Nauk. 145* (61), 1-184.

Bolotnikova, M. D. (1973). *Aquilapollenites* Rouse pollen grains from the Paleocene deposits of the western coast of the Sea of Japan. *Academy of Sciences Viladivostok*, 98-104.

Bolotnikova, M. D. (1979). Spore-Pollen Complexes of Tertiary Deposits of the Western Coast of the Sea of Japan. 'Science' Publishing House, Moscow.

Boray, A., Şaroğlu, F., & Emre, Ö. (1985). Isparta büklümünün kuzey kesiminde doğu–batı daralması için bazı veriler. *Jeoloji Mühendisliği Dergisi*, *23*, 9-20.

Boulter, M. C., & Craig, D. L. (1979). A Middle Oligocene Pollen and Spore Assemblage from the Bristol Channel. *Review of Paleobotany and Palynology, 28*, 259-272.

Boulter, M. C., & Hubbard, R. N. L. B. (1982). Objective paleoecological and biostratigraphic interpretation of Tertiary palynological data by multivariate statistical analysis. *Palynology*, *6*, 55-68.

Brunn, H. J., Dumont, J. H., Gracianski, P. C., Gutnic, M., Juteau, T., Marcaoux, J., Monod, O., & Poisson, A. (1971). Outline of the geology of the Western Taurids. In A. S. (Ed.). Geology and history of Turkey. *Petrol Exploration Society Libya*. Tripoli. 225-255.

Buchardt, B. (1978). Oxygen isotope paleotemperatures from the Tertiary period in the North Sea area. *Nature, 275*, 121-123.

Bütschli, O. (1885). Ester Band. Protozoa. In H. G. Bronn's Klassen und Ordnungen des Thier–Reichs, *Wissenschaftlich dargestellt un Wort und Bild*. 865-1088.

Cavagnetto, C., & Anadón, P. (1995). Uno mangrove complexe dans le Bartonien du basin de le l'Ebre (Ne de l'Espagne). *Palaeontographica Abteilung B Ionnides 236***,** 147-165.

Cavagnetto, C., & Anadón, P. (1996). Preliminary palynological data on floristic and climatic changes during the Middle Eocene–Early Oligocene of the eastern Ebro Basin, northeast Spain. *Review of Palaeobotany and Palynology*, *92*, 281-305.

Chapman, V. J. (1976). Mangrove vegetation. J. Cramer, FL-9490 Vaduz, 447 pp.

Chateauneuf, J. J. (1972). Contribution à l'étude de l'Aquitanien. La coupe de Carry-le-Rouet (Bouches-du-Rhône, France). Ve Congrès du Néogène méditerranéen. Volume III, Étude palynologique. *Bulletin Bureau de Recherches Géologiques et Minières*, *4*, 59-65.

Chateauneuf, J. J. (1980). Palynostratigraphie et Paléoclimatologie de L' Eocene Supérieur et de L' Oligocene du Bassin de Paris. *Mémorie du Bureau de Recherches Géologiques et Minières*, *116* , 1-360.

Chateauneuf, J. J., Cavagnetto, C., Meyer, K. J., Sittler, C., & Pierre. O. (1988). Pollen and Spores (Compilation). In R. Vinken, (Ed.). The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, *100*, 288-320.

Choi, D. K. (1984). A new Eocene triprojectate pollen genus from the Canadian Arctic , *Nowemprojectus*. *Review Palaeobotany and Palynology*, *43*, 337-341.

Cookson, I. C. (1947). Plant microfossils from the Lignites of Kerguelen Archipelago. *British, Australian and New Zealand Antartic Research Expedition 1929-1931*, *2* (8), 127-142.

Cookson, I. C., & Pike, K. M. (1954). Some dicotyledonous pollen types from Cenozoic Deposits in the Australian Region. *Australian Journal of Botany*, *2*, 197-219.

Collins, J., Berkelhamer, R.C., & Mesler, M. (1977). Notes on the natural history of the mangrove *Pelliciera rhizophorae* Tr.& Pl., (Theaceae). *Bresnia*, *10/11*, 17-29.

Collins, A. S., & Robertson, A. H. F. (1997). The Lycian Melange, southwest Turkey: an emplaced accretionary complex. *Geology*, *25*, 255-258.

Collins, A. S,. & Robertson, A. H. F. (1998). Processes of Late Cretaceous to Late Miocene episodic thrust sheet translation in the Lycian Taurides, SW Turkey. *Journal of the Geological Society*, *155*, 759-772.

Collins, A. S., & Robertson, A. H. F. (1999). Evolution of the Lycian allochthon, western Turkey, as a north-facing Late Palaeozoic to Mesozoic rift and passive continental margin. *Geological Journal*, *34*, 107-138.

Collinson, M. E. (1992). Vegetational and floristic changes around the Eocene/Oligocene boundary in western and central Europe. In D. R., Prothero, & A. W., Berggren, (Eds.). Eocene–Oligocene Climatic and Biotic Evolution. *Princeton University Press, Princeton*, 437-450.

Costa, L. I., & Downie, C. (1976). The distribution of the dinoflagellate *Wetzeliella* in the Paleogene of northwestern Europe. *Palaeontology*, *19*, 591-614.

Couper, R. A. (1953). Upper Mesozoic and Caninozoic Spores and Pollen Grains from New Zealand. *New Zealand Geological Survey Paleontological Bulletin***,** *22*, 77pp.

Couper, R. A. (1960). New Zealand Mesozoic and Cainozoic Plant Microfossils. *Paleont. New Zealand Geological Survey Paleontological Bulletin, 32*, 1-87.

Davey, R. J., & Williams, G. L. (1966). The genus Hystrichosphaeridium and its allies. In R. J. Davey, C. Downie, W. A. S. Sarjeant, & G. L. Williams, (Eds.). Studies on Mesozoic and Cainozoic dinoflagellate cysts. *Bulletin of the British Museum* (*Natural History*) *Geology, Supplement*, *3*, 53-106.

Davey, R. J., Downie, C., Sarjeant, W. A. S., & Williams, G. L. (1966). Studies on Mesozoic and Cainozoic dinoflagellate cysts. *Bulletin of the British Museum* (*Natural History*) *Geology, Supplement*, *3*, 1-48.

Dilcher, D. L. (1973). A palaeoclimatic interpretation of the Eocene floras southeastern North America. In A. Graham, (Ed.). Vegetation and Vegetational History of Northern Latin America. *Elsevier Publishing Company*, 39-59.

Döring, H., Krutzsch, W., Mai, D., & Schulz, E. (1963). Diskussionsbeitrag zur sporengattung *Retitriletes*. In W. Krutzsch, Atlas der jungtertiären Sporen und Mikroplanktonformen des nördlichen Mitteleuropas. Lieferung, II, 8-18.

Dueñas, H. (1980). Palynology of Oligocene–Miocene strata of borehole Q-E-22, Planeta Rica, Northem Colombia. *Review Palaeobotany and Palynology*, *10*, 318-328.

Dutta, S. K., & Sah, S. C. D. (1970). Palyno–stratigraphy of the Tertiary sedimentary formations of Assam: *5.* Stratigraphy and Palynology of South Shillong Plateau. *Palaeontographica Abteilung B Ionnides*, *131*, 1-72.

Ediger, V. Ş., Batı, Z., & Alişan, C. (1990). Paleopalynology and Paleoecology of *Calamus* like Disulcate Pollen Grains. *Review of Paleobotany and Palynology*, *62*, 97-105.

Elsik, W. C. (1974). Characteristic Eocene palynomorphs of the Gulf Coast, U.S.A. *Palaeontographica Abteilung B Ionnides*, *149*, 90-111.

Elsik, W.C., Ediger, V.Ş., & Batı, Z. (1990). Fossil Fungal spore: *Anatolinites* gen. nov. *Palynology*, *14*, 91-103.

Erdtman, G. (1947). Suggestions for the Classifikation of Fossil and Recent Pollen Grains and Spores. *Svensk. Bot. Tidskr., 41*, 104-114.

Erdtman, G. (1952). Pollen morphology and plant taxonomy.Angiosperms. *Choronica Botanica*.

Erdtman, G. (1960). On three new genera of the Lower Headon Beds, Berkshire. *Botaniska Notiser*, *113*, 46-48.

Erdoğan, B., Akay, E., & Uğur, M. Ş. (1996). Geology of the Yozgat Region and Evolution of the Collisional Çankırı Basin. *International Geology Review*, *38*, 788-806.

Erol, O. (1981). Neotectonic and geomorphological evolution of Turkey. *Zeitschrift für Geomorphologie, Neue Folge, Supplement Band*, *40*, 193-211.

Fairchild, W. W., & Elsik, W. C. (1969). Characteristic palynomorphs of the lower Tertiary in the Gulf Coast. *Palaeontographica Abteilung B Ionnides*, *128*, 81-89.

Fechner, G. G. (1988). Selected Palynomorphs from the Lower to Middle Eocene of the South Atlas Border Zone (Morocco) and their Environmental Significance. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *65*, 73-79.

Fowler, K. (1971). A new species of Aglaoreidia from the Eocene of southern England. *Pollen et Spores*, *13*, 135-147.

Fowler, K. (1988). Pollen and spores (compilation). In R. Vinken, (Ed.). The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, *100*, 288-320.

Frederiksen, N. O. (1973). New mid–Tertiary spores and pollen grains from Mississipi and Alabama. *Tulane Studies in Geology and Paleontology*, *10*, 65-86.

Frederiksen, N. O. (1980). Sporomorphs from the Jackson Group (Upper Eocene) and Adjacent Strata of Mississipi and Western Alabama. *Geological Survey Professional Paper, 1084*, 1-75.

Frederiksen, N. O. (1985). Review of early Tertiary sporomorph palaeoecology. Amarican *Association of Stratigraphical Palynologists Contribution Series*, *19*, 1-92.

Frederiksen, N. O. (1988). Sporomorph biostratigraphy, floral changes, and paleoclimatology, Eocene and earliest Oligocene of the eastern Gulf Coast. *United States Geological Survey Professional Paper*, *144*8, 1-68.

Frederiksen, N. O. (1991). Pulses of Middle Eocene to earliest Oligocene climatic deterioration in Southern California and the Gulf Coast. *Palaios*, *6*, 564-571.

Frederiksen, N. O. (1994). Middle and Late Palaeocene angiosperm polen from Pakistan. *Palynology*, *18*, 91-137.

Frederiksen, N. O., Edwards, L. E., Ager, T.A., & Sheeehan, T. P. (2002). Palynology of Eocene strata in the Sagavanirktok and Canning formations on the North Slope of Alaska. *Palynology*, *26*, 59-93.

Fritsch, F. E. (1929). Evolutionary sequence and affinities among Protophyta. *Biol. Rev.*, *4*(2), 103-151.

Fuch, J. R. (1970). Ecological and Palynological notes on *Pelliciera rhizophorae*. *Acta Botanica Neerlandica*, *19*, 884-894.

Gemici, Y., Akyol, E., Akgün, F., & Seçmen, Ö. (1991). Soma kömür havzası fosil makro ve mikroflorası. *Maden Tetkik ve Arama Dergisi*, *11*, 161-178.

Germeraad, J. H., Hopping, C. A., & Müller, J. (1968). Palynology of Tertiary sediments from tropical areas. *Review of Palaeobotany and Palynology*, *6*, 189-348

Goczán, F., Groot, J. J., Krutzsch, W., & Pacltová, B. (1967). Die Gattungen des „Stemma Normapolles PFLUG 1953b" (Angiospermae). Neubeschreibungen und Revision europäischer Formen (Oberkreide bis Eozän). *Palaeontographica Abteilung B Ionnides*, *2*(3), 429-540.

González-Guzmán, A. E. (1967). A palynological Study on the Upper Los Cuervos and Mirador Formations (Lower and Middle Eocene, Tibu Area, Colombia). E. J. Brill, Leiden.

Gorin, G., (1975). Étude palynostratigraphique des sédiments paléogènes de la Grande Limagne. Bulletin Bureau *Recherches Géologiques et Minières, 3*, 147-181.

Göktaş, F., Çakmakoğlu, A., Tarı, E., Sütçü, Y. F., & Sarıkaya, H. (1989). Çivril-Çardak Arasının Jeolojisi (Geology of Çivril-Çardak Region]. *Mineral Research and Exploration Institute of Turkey (MTA) Report*, *8701*, 107pp.

Görmüş, M., & Özkul, M. (1995). Stratigraphy of Gönen–Atabey (Isparta) and Ağlasun (Burdur). *Science Institute of Süleyman Demirel University*, *1*(1), 43-64.

Görür, N., Şengör, A. M. C., Sakınç, M., Tüysüz, O., Akkok, R., Yiğitbaş, E., Oktay, F.Y., Barka, A., Sarıca, N., Ecevitoğlu, B., Demirbağ, E., Ersoy, S., Algan, O., Güneysu, C., & Aykol, A. (1995). Rift formation in the Gökova region, southwest Anatolia: implications for the opening of the Aegean Sea. *Geological Magazine*, *132* (6), 637-650.

Graham, A. (1977). New records of *Pelliciera* (Theaceae/Pelliceriaceae) in the Tertiary of the Caribbean. *Biotropica*, *9*, 48-52.

Graham, A. (1995). Diversification of Gula/Caribbean Mangrove Communities through Cenozoic time. *Biotropica*, 27, 20-27.

Gray, J. (1960). Temperate pollen genera in the Eocene (Claiborne) flora, Alabama. *Science*, *132,* 808-810.

Greenwood, D. R., & Wing, S. L. (1995). Eocene continental climates and latitudinal temperature gradients. *Geology*, *23*, 1044-1048.

Gruas-Cavagnetto, C. (1968). Étude palynologique des divers gisements du Sparnacien du Bassin de Paris. *Mémoire de la Société Géologique de France*, *110*, 1-144.

Gruas-Cavagnetto, C. (1977). Etude palynologique de l'Eocene du Bassin Anglo-Parisien. These de Doctorate d'Etat es Sciences Naturelles, Universite de Pierre Marie Curie VI, 287 pp.

Gruas-Cavagnetto, C. (1978). Étude palynologique de l'Eocéne du Bassin Anglo–Parisien. *Mémoire de la Société Géologique de France*, *131*, 1-64.

Gruas-Cavagnetto, C. (1988). Pollen and Spores (Compilation). In R. Vinken, (Ed.). The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, *100*, 288-320.

Gökçen, N. (1982). Denizli ve Muğla çevresi Neojen istifinin Ostrakod biyostratigrafisi.*Yerbilimleri*, *9*, 111-131.

Gutnic, M. (1977). Géologiqie du Taurus Pisidien au Nordd'Issparta (Turquie). *Trv. Lab., Geol. Hist. Univ., XI*. 130pp.

Gutnic, M., Monod, O., Poisson, A., & Dumond, J. F. (1979). Géologie des Taurids occidentales (Turquie). *Mem Geol. Soc. France*, *13*7, 112pp.

Gürer, Ö. F., & Yılmaz, F. (2002). Geology of the Ören and surrounding regions, SW Turkey, *Turkish Journal of Earth Science, 11*, 2-18.

Hakyemez, H.Y., & Örçen, S. (1982). Muğla Denizli arasındaki (GB Anadolu) Senozoyik yaşlı çökel kayaların sedimentolojik ve biyostratigrafik incelenmesi. *Mineral Research Exploration Institute*, (7311).

Hakyemez, H. Y. (1989). Kale–Kurbalık (GB Denizli) Bölgesindeki Senozoyik yaşlı Çökel Kayaların Jeolojisi ve Stratigrafisi. *Bulletin Mineral Research Exploration Institute, 109*, 9-21.

Haseldonckx, P. (1972). The presence of Nypa palm in Europe: a solved problem. *Geologie en Mijnbouw*, *51*, 645-650.

Helvacı, C. (1995). Stratigraphy, mineralogy, and genesis of the Bigadiç borate deposits, western Turkey. *Economic Geology*, *90*, 1237-1260.

Helvacı, C., Mordoğan, H., Çolak, M., & Gündoğan, İ. (2004). Presence and distribution of lithium in borate deposits and some recent lake waters of West–Central Turkey. *International Geology Review*, *46*, 177-190.

Hochuli, P. A. (1978). Palynologische untersuchungen im Oligosen der zentralen und westlichen Paratethys. *Beitrräge Paläontologie, Österreich*, *4*, 1-132.

Hochuli, P. A. (1984). Correlation of the Middle and Late Tertiary sporomorph assemblage. *Paléobiologie Continentale*, *14*, 301-314.

Hottenrott, M. (2002). Age Determinations of Palynological Assemblages from Lower Tertiary of the Eisenberg Basin (Northern Palatinat, Germany). *Acta Palaeontologica Sinica*, *4*1(4), 565-575.

Hubbard, R. N. L. B., & Boulter, M. C. (1983). Reconstruction of Palaeogene climate from palynological evidence. *Nature*, *301*, 147-150.

Huhn, B., Utescher, T., Ashraf, A. R., & Mosbrugger, V. (1997). The peat-forming vegetation in the Middle Miocene Lower Rhine Embayment, an analysis based on palynological data. *Meded. Ned. Inst. Toegep. Geowet.*, *58*, 211-218.

Hunger, R. (1953). Mikrobotanisch–stratigraphische Untersuchungen der Braunkohlen der südlichen Oberlausitz und die Pollenanalyse als Mittel zur Deutung der Flözgenese. *Freiberger Forschungshefte*, *C8*, 5-38.

Ivanov, D., Ashraf, A.R., Mosbrugger, V., & Palamarev, E. (2002). Palynological evidence for Miocene climate change in the Forecarpathian basin (Central Paratethys, NW Bulgaria). *Palaeogeography, Palaeoclimatology, Palaeoecology, 178*, 19-37.

Ibrahim, A. C. (1932). Beschreibung von Sporenformen aus Flöz Ägir.

Ibrahim, A. C. (1933). Sporenformen des Aegirhorizontes des Ruhrreviers. Dissertation *Technische,* 47 pp.

Iversen, J., & Troels-Smith, J. (1950). Pollenmorphologische Definitionen und Typen. *Danmarks Geologiske Undersøgelse*, *4* (8), 1-53.

Jiménez, J. A. (1984). A Hypothesis to Explain the Reduced Distribution of the Mangrove *Pelliciera rhizophorae* Tr. & Pl., *Biotropica*, *16*, 304-308.

Kar, R. K. (1985). The fossil flora of Kachchh –IV. Tertiary palynostratigraphy. *Palaeobotanist*, *34*, 1-280.

Karaman, M. E., Meriç, E., & Tansel İ. (1989). Gönen–Atabey arasındaki bölgenin jeolojisi. *Cumhuriyet Üniversitesi Mühendislik Fakültesi Dergisi*,

Karayiğit, A. İ., Akgün, F., Gayer , R. A., & Temel, A. (1999). Quality, Palynology, and Palaeoenvironmental Interpretation of the Ilgin Lignite, Turkey. *International Journal of Coal Geology*, *38*, 219-236.

Kayseri, M. S., & Akgün, F. (2007). Palynostratigraphic, Palaeovegetational and Palaeoclimatic Investigations on the Miocene Deposits in central Anatolia (Çorum Region and Sivas Basin). *Turkish Journal of Earth Sciences* (in press).

Kedves, M. (1961). Etudes palynologiques dans le bassin de Dorog. II. *Pollen et Spores*, *3(*1), 101-153.

Kedves, M. (1963). Stratigraphie palynologique des couches Eocènes de Hongrie. *Pollen et Spores, 1*, 149-159.

Kedves, M. (1965). Palynological Investigations on the Lower Eocene Layers in the surrounding Country of Iskaszentgyörgy. III. *Acta Biologica*, *11* (1-2), 33-50.

Kedves, M. (1967). Études palynologiques des couches du Tertiaire inférieure de la région Parisienne. I. Spores. *Pollen et Spores*, *9* (3): 521-552.

Kedves, M. (1969). Études palynologique des couches du Tertiaire inférieur de la region Parisienne. IV. Pollen des Normapolles. *Pollen et Spores*, *11*(2), 385-396.

Kedves, M. (1970). Etudes palynologiques des couches du Tertraire inferieur de la region Parisienne. *Pollen et Spores*, *12*, 83-97.

Kedves, M. (1973). Paleogene Fossil Sporomorphs of the Bakony Mountains. I. *Studia Biologica Hungarica*, *12*, 5-134.

Kedves, M. (1974). Paleogene Fossil Sporomorphs of the Bakony Mountains. II. *Studia Biologica Hungarica*, *13*, 1-124.

Kedves, M. (1982). Palynology of the Thanetion lagers of Ménat. *Palaeontographica Abteilung B Ionnides, 182*, 87-150.

Kedves, M. (1985). Etudes palynologiques sur les sediments prequaternaires de I'Egypte. Oligocene. *Revista Espaňola de Micropaleontología*, *8*(3), 333-346.

Kedves, M. (1986). Palaeogene fossil sporomorphs of the Bakony Mountains IV. *Studia Biologica Hungarica*, *21*, 120 pp.

Kirchner, M. (1984). Die Oberoligozäne Mikroflora des Südbayerischen Pechkohlenreviers. *Palaeontographica Abteilung B Ionnides*, *192*, 85-162.

Klump, B. (1953). Beitrag zur Kenttnis der Mikrofossilien des mittleren und oberen Eozän. *Palaeontographica Abteilung A Ionnides*, *103* (5/6), 377-406.

Knobloch, E., Konzálová, M., & Kvaček, Z. (1996). Die Obereozäne Flora der Staré Sedlo-Schichtenfolge in Böhmen (Mitteleuropa). *Rozpravy Českého Geologického ústavu, svacek*, *49*, 260 pp.

Koçyiğit, A. (1981). Isparta Büklümünde (Batı Toroslar) Toros karbonat platformunun evrimi. *Türkiye Jeoloji Kurumu Bülteni, 24* (2), 15-23.

Koçyiğit, A. (1983). Hoyran Gölü (Isparta Büklümü) dolayının tektoniği. *Türkiye Jeoloji Kurumu Bülteni, 26* (1), 1-10.

Koçyiğit, A. (1984). Tectono–stratigraphic characteristics of Hoyran Lake region (Isparta Bend). In O. Tekeli, & C. Göncüoğlu, (Eds.). *Geology of the Taurus belt*. 53-67.

Koçyiğit, A. (2005). The Denizli graben–horst system and the eastern limit of western Anatolian continental extension: basin fill, structure, deformational mode, throw amount and episodic evolutionary history, SW Turkey. *Geodinamica Acta*, *18*, 167-208.

Konzálová, M. (1973). Mikropaleontologický (palynologický) výzkum severoćeské hnedouhelni pánve. *MS. Archiv, Geol. Úst.ĆSAV*, Praha (manuskript).

Konzalová, M. (1976a). Micropaleontological Research of the Lower Miocene of Northern Bohemia. *Rozpravy ČSAV, Řada mat. a přirod*, *12*, 1-75.

Konzalová, M. (1976b). Paläobotanisch und stratigraphisch wichtige Sporomorphen aus dem Alttertiär NW–Böhmens, *Čas. Mineral. Geol., 21*, 71-75.

Konzalová, M. (1981). *Boehlensipollis* und andere Mikrofossilien des böhmischen Tertiärs (vulkanogene Schichtenfolge). *Sbor. Geol. Věd. Paleont., 24*, 135-162.

Kovach, W. L. (1989). Comparisons of multivariate analytical techniques for the use in pre Quaternary plant paleoecology. *Review of Palaeobotany and Palynology, 60*, 255-282.

Kremp, G. (1949). Pollenanalytische Untersuchung des miozänen Braunkohlenlagers von Konin an der Warthe. *Palaeontographica Abteilung B Ionnides*, *90*, 53-93.

Krutzsch, W. (1954). Bemerkungen zur Benennung und Klassifikation fossiler (insbesondere tertiärer) Pollen und Sporen. *Geologie*, *3*(3), 258-311.

Krutzsch, W. (1957). Sporen-und Pollengruppen aus der Oberkreide und dem Tertiär Mitteleuropas und ihre stratigraphische Verteilung. *Zeitschrift für Angewandte Geologie*, *3*, 509-548.

Krutzsch, W. (1958). Sporen und Pollengruppen aus der Oberkreide und dem Tertiär Mitteleuropas und ihre stratigraphische Verteilung. *Zeitschrift für angewandte Geologie, 3*(11/*12*), 519-548.

Krutzsch, W. (1959). Mikropaläontologie (sporenpaläontologische) Untersuchungen in der Braunkohle des Geiseltasles. I. Die Sporen und die Sporenartigen sowie die ehemals zu Sporites gestellten Formeinheiten der Sporae dispersae der mitteeozänen

Braunkohle des mittleren Geiseltales (Tagebau Neumark–West i. w. S.), unter Berücksichtigung und Revision weiterer Sporenformen aus der bisherigen Literatur. *Geologie*, *21/22*, 1-425.

Krutzsch, W. (1961). Beitrag zur Sporenpaläontologie der präoberoligozänen kontinentalen und marinen Te rtiärablagerungen Brandenburgs. *Ber. geol. Ges. DDR*, *5* (4), 290-343.

Krutzsch, W. (1962a). Atlas der mittel–und jungtertiären dispersen Sporen–und Pollen– sowie der Mikroplanktonformen des nördlichen Mitteleuropas. I. VEB Deutscher Verlag der Wissenchaften, Berlin.

Krutzsch, W. (1962b). Stratigraphisch bzw. botanisch wichtige neue Sporen und Pollenformen aus dem deutschen Tertiär. *Geologie, 11*(3), 263-307.

Krutzsch, W. (1963a). Atlas der mittel–und jungtertiären dispersen Sporen-und Pollen- sowie der Mikroplanktonformen des nördlichen Mitteleuropas. II. VEB Deutscher Verlag der Wissenchaften, Berlin.

Krutzsch, W. (1963b). Atlas der mittel-und jungtertiären dispersen Sporen–und Pollen– sowie der Mikroplanktonformen des nördlichen Mitteleuropas. III. VEB Deutscher Verlag der Wissenchaften, Berlin

Krutzsch, W. (1966). Zur Kenntnis der präquartären periporaten Pollenformen. *Geologie, 15* (55), 16-71.

Krutzsch, W. (1967a). Atlas der mittel- und jungtertiären dispersen Sporen- und Pollen- sowie der Mikroplanktonformen des nördlichen Mitteleuropas, Lieferg. 4 u. 5. Weitere azonotrilete (apiculate, murornate), zonotrilete, monolete und alete Sporenformen. 1-232.

Krutzsch, W. (1967b). Die stratigraphisch verwertbaren Sporen und Pollenformen des mitteleuropäischen Alttertiärs. *Geologisches Jahrbuch, 3*, 309-379.

Krutzsch, W. (1968). *Brosipollis* und *Labrapollis*, zwei neue Pollengenera aus dem Tertiär Mitteleuropas. *Review of Palaeobotany and Palynology*, *6*, 61-70.

Krutzsch, W. (1970a). Atlas der mittel-und jungtertiären dispersen Sporen-und Pollen sowie der Mikroplanktonformen des nördlichen Mitteleuropas. Lieferung VII: Monoporate,monolcolpate, longicolpate, und ephedroide (polyplicate) Pollenformen. 175pp.

Krutzsch, W. (1970b). Die stratigraphisch verwertbaren Sporen–und Pollenformen des mitteleuropäischen Alttertiärs. *Jb. Geol., 3*, 309-379.

Krutzsch, W. (1970c). *Reevsiapollis*, ein neues Pollengenus der Sterculiaceen aus dem mitteleuropäischen Tertiär. *Feddes Repert*., *81* (6-7), 371-384.

Krutzsch, W. (1971). Leferung. 6. Coniferenpollen (Saccites und „Inaperturates"). 1-234.

Krutzsch, W., & Vanhoorne, R. (1977). Die Pollenflora von Epinois und Loksbergen in Belgien. *Palaeontographica Abteilung B Ionnides*, *163*, 1-110.

Kützing, F. T. (1849). Species *Algarum*. 922pp.

Langenheim, J.H., Hackner, B.L., & Bartlett, A. (1967). Mangrove pollen at the depositional site of Oligo–Miocene amber from Chiapas, Mexico. *Harvard University Botanical Museum Leaflets*, *21*, 289-324.

Lentin, J. K., & Williams, G. L. (1977). Fossil dinoflagellates: index to genera and species. *Bedford Institute of Oceanography, 77*(8), 1-209.

Lenz, O. (2000). Paläoökologie eines Küstenmoores aus dem Eozän Mitteleuropas am Beispiel der Wulfersdorfer Flöze und deren Begleitschichten (Helmstedter Oberflözgruppe, Tagebau Helmstedt). *Doctoratal dissertation*, 228 pp.

Lenz, O. K., & Riegel, W. (2001). Isopollen maps as a tool for the reconstruction of a coastal swamp from the Middle Eocene at Helmstedt (northern Germany). *Facies*, *45*, 177-194.

Lenz, O. K. (2005). Palynologie und Paläoökologie eines Küstenmoores aus dem Mittleren Eozän Mitteleuropas–Die Wulfersdorfer Flözgruppe aus dem Tagebau Helmstedt, Niedersachsen. *Palaeontographica Abteilung B Ioannides*, *271*, 1-157.

Loose, F. (1932). Siehe in R. Potonie & İbrahim Cookson, I. C., & Pike, K. M. (1954). Some Dicotyledoneous Pollen Types from Cainozoic Deposits in the Australian Region. *Australian Journal of Botany*, *2* (2), 197-219.

Luttig, G., & Steffens, P. (1976). The paleogeographic atlas of Turkey from the Oligocene to the Pleistocene. *Bundesansalt für Geowissenchaften und Rohstoffe*, 1-64.

Mai, D. H. (1961). Über Eine fossile Tiliaceen-Blüte und tilioiden Pollen aus dem deutschen Tertiär. *Geologie*, *32*, 413-423.

Mai, D.H. (1995). Tertiäre Vegetationsgeschichte Europas. G. ischer, Jena, 563pp.

Mamczar, J. (1960). Standard Section of the Middle Miozän for Central Poland. *Inst. Geol. Biul.*, *157*, 138-222.

Manum, S. (1962). Studies in Tertiary flora of Spitsbergen with notes on Tertiary floras of Ellesmere Island, Greenland and Iceland. A palynological investigation. *Norsk Polar Institut*, *125*, 1-127.

Meneghini, G. (1840). Synopsis Desmidiacearum hucusque cognitarum. *Linnaea*, *14*, 201-240.

Meulenkamp, J.E., Sissingh, W. et al., (2000). Early to Middle Ypresian, late Lutetian, late Rupelian, early Burdigalian, early Langhian, late Tortonian, Piacenzian/Gelasian. In J. Dercourt, M. Gaetani, et al. (Eds.). *Atlas Peri-Tethys Palaeogeographical Maps*. CCGM/CGMW, Paris, maps 17-23.

Meulenkamp, J. E., & Sissingh W. (2003). Tertiary palaeogeography and tectonostratigraphic evolution of the Northern and Southern Peri-Tethys platforms and the intermediate domains of the African-Eurasian convergent plate boundary zone. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *196*, 209-228.

Meyen, F. I. F. (1829). Beobachtungen über einige niedrige Algenformen. *Nova Acta Leopoldina-Carolina Norimbergae*, *14*, 771-778.

Meyer, B. L. (1952). Mikrofloristische Untersuchungen an jungtertiären Braunkohlenbildungen im östlichen Bayern. *Dissertation Üniversity München*, 75 pp.

Mohr, B. A. R. (1984). Die Mikroflora der Obermiozänen bis unterpliozänen Deckschichten der rheinischen Braunkohle. *Palaeontographica Abteilung B Ioannides, 191*, 29-133.

Morgenroth, P. (1968). Zur Kenntnis der Dinoflagellaten und Hystrichosphaeridien des Danien. *Geologisches Jahrbuch, 86,* 533-578.

Mosbrugger, V. (1995). New methods and approaches in Tertiary palaeoenvironmental research. *Arbeit des Staatlichen Museums für Mineralogie und Geologie zu Dresden*, *41*, 41-52.

Mosbrugger, V., & Utescher, T. (1997). The coexistence approach-a method for quantitative reconstructions of Tertiary terrestrial paleoclimate data using plant fossils. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *134*, 61-86.

Mosbrugger, V. (1999). The nearest living relative method. In T. P. Jones, & N. P. Rowe (Eds.). Fossil Plant and Spores: Modern techniques. *Geological Society of London*, 261-265.

Mosbrugger, V., Utescher, T., & Dilcher, D. (2005). Cenozoic continental climatic evolution of Central Europe. *Proceedings of the National Academy of Sciences* (*PNAS*), *18*, 14964-14969.

Müller, J. (1968). Palynology of the Pedawan and Plateau Sandstone formations (Cretaceous–Eocene) in Sarawak, Malaysia. *Micropaleontology, 14* (1), 1-37.

Müller, J. (1981). Fossil pollen records of extant angiosperms. *The Botanical Review 47*, 1-142.

Müller, J., Dedigiacomo, E., & Van Erve, A. W. (1987). A palynological zonation for the Cretaceous, Tertiary, and Quaternary of northern South America. *American Association Stratigraphic Palynologists Contribution Series, 19*, 7-76.

Mürriger, F., & Pflug, H., (1951). Über die Altersstellung der Braunkohle von Burghasungen, Bezirk Kassl, auf Grund pollenanalytischer Untersuchungen und Verleiche mit anderen Braunkohlenvorkommen. *Notizblatt des Hessiches Landesamtes für Bodenforschung zu Wiesbaden*, *6*, 87-97.

Mürriger, F., & Pflug, H., (1952). Über eine palynologische Untersuchung des Braunkohlenlagers der Grubbe Emma bei Marxheim (Untermaingebiet). *Notizblatt des Hessiches Landesamtes für Bodenforschung zu Wiesbaden, 6* (3), 56-66.

Mürriger, F., & Pflanzl, G. (1955). Pollenanalytische Datierungen einiger hessischer Braunkohlen. *Notizblatt des Hessisches Landesamtes für Bodenforschung zu Wiesbaden*, *83*, 71-89.

Nagy, E. (1963). Spores et pollens nouveaux d'une coupe de la briqueterie d'Eger (Hongrie). *Pollen et Spores*, *19* (3), 361-389.

Nagy, E. (1969). Palynological Elaborations of the Miocene Layers of the Mecsek Mountains. *Annales Instituti Geologici Publici Hungarici*, *52* (2), 237-650.

Nagy, E. (1985). Sporomorphs of the Neogene in Hungary. *Geologica Hungarica Seria Palaeontologica*, *47*, 1-470.

Nagy, E. (1990). Palynological correlation of the Neogene of the Central Paratethys. *Geological Institute of Hungary,* 1-126.

Nakoman, E. (1964). Etude palynologiqe de quelques échantillons de lignite provenant du Bassin de Thrace (Turquie). *Annales de la Société Géologique du Nord*, *74*, 289-303.

Nakoman, E. (1966a) Eosen yaşlı Sorgun linyitlerinin sporopollinik etüdü. *Maden Tetkik ve Arama Enstitüsü Dergisi*, *67*, 69-88.

Nakoman, E. (1966b). Contribution á I'étude palynologique des formations tertiaires du bassin de Thrace. I. Etude qualitative. *Annales de la Société Géologique du Nord, 86*, 65-107.

Nakoman, E. (1967). Güneybatı Anadolu'nun Tersiyer mikroflorasında rastlanan bazı yeni formlar (New forms of Southwest Anatolian Tertiary microflora). *Mineral Research and Exploration Institute of Turkey (MTA) Bulletin*, *68*, 27-38.

Nakoman, E. (1968). Contribution à l'étude de la microflore tertiaire des lignites de Seyitömer (Turquie). *Pollen et Spores*, *10*, 521-556.

Naumova, S. N. (1937). Spores and Pollen from the USSR. *17. International Geology Congress*, 353-364.

Nebert, K. (1956). Denizli-Acıgöl merkezinin Jeolojisi, 1/100,000 ölçekli Denizli 105/1, 105/2 ve Isparta 106/1 paftalarının sahası içinde yapılan jeolojik harita çalısmaları hakkında rapor.*Maden Tetkik Arama Raporu*, (2509).

Nebert, K. (1961). Kale-Tavas bölgesine ait yeni müşahedeler. *Bulletin Mineral Research Exploration Institution, 57,* 57-64.

Nichols, D. J. (1973). North American and European Species of *Momipites* („*Engelhardtia"*) and related Genera. *Geoscience and Man*, *7*, 103-117.

Nickel, B. (1996a). Palynofazies und Palynostratigraphie der Pechelbronner Schichten im nördlichen Oberrheintalgraben. *Palaeontographica Abteilung B Ionnides*, *240*, 1-151.

Nickel, B. (1996b) Die mitteleozäne Mikroflora von Eckfeld bei Manderscheid/Eifel. *Mainzer Naturw Archiv*, *18*, 1-121.

Nix, H. A. (1982). Environmental determinations of biogeography and evolution in Terra Austuralis. In W. S., Barker, & P. J. M., Greenslade, (Eds.). *Evolution of the flora and fauna of Arid Australia*. Peacock Publication, 47-66.

Ollivier-Pierre, M. F. (1980). Étude palynologique (spores et pollens) de gisements paléogènes du Massif Amoricain. Stratigraphie et paléogéographie. *Mém. Soc. géol. minéral. Bretagne*, *25*, 1-239.

Ollivier–Pierre, M. F. (1988). Pollen and spores (compilation). In. R. Vinken, (Ed.). The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, *100*, 288-320.

Ollivier–Pierre, M. F., Maupin C., Esteoule–Choux, J., & Sittler, C. (1993). Transgression et paleoenvironnement. l'Oligocene en Bretagne. Sedimentologie, micropaleontologie palynologie et palynofacies du Rupelien du Bassin de Rennes. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *103*, 223-250.

Özer, S., Sözbilir, H., Özkar, İ., Toker, V., & Sarı, B. (2001). Stratigraphy of Upper Cretaceous-Palaeogene sequences in the southern and eastern Menderes Massif (western Turkey). *International Journal of Earth Sciences*, *89*, 852-866.

Özgül, N. (1976). Toroslarin bazi temel jeoloji özellikleri. *Geological Society of Turkey Bulletin*, *19*, 65-78.

Özkaya, I. (1991). Evolution of a Tertiary volcanogenic trough in SW Turkey-the Alakaya basin of the Lycian belt. *Geologische Rundschau*, *80*, 657-668.

Öztürk, A. (1981). Homa-Akdağ (Denizli) yöresinin stratigrafisi. *Türkiye Jeoloji Kurumu Bülteni, 24*, 1, 75-84.

Pascher, A. (1914). Die Süßwasserflora Deutschlands, Österreichs und der Schweiz. Bd. 2 (2. Aufl.) (Gustav Fischer) jena.

Pflanz, G. (1956). Das Alter der Braunkohlen des Meißners, der Flöze 2 und 3 des Hirschbergs und eines benachbarten Kohlenlagers bei Laudenbach. *Notizblatt des Hessiches Landesamtes für Bodenforschung zu Wiesbaden, 84*, 232-244.,

Pflug, H. (1952). Palynologie und Stratigraphie der Braunkohlen von Helmstedt. *Paläontologische Zeitschrift*, *26* (1/2), 112-137.

Pflug, H. (1953). Zur Entstehung und Entwicklung des angiospermiden Pollens in der Erdgeschichte. *Palaeontographica Abteilung B Ionnides*, *95*, 60-171.

Pflug, H. (1959). Beiträge zur Klimageschichte Islands. VIII. Sporenbilder aus Island und ihre stratigraphische Deutung. *Neues Jahrbuch für Geologie und Paläontologie*, *107*, 141-172.

Pierce, R. L. (1961). Lower Upper Cretaceous Plant Microfossils from Minnesota. *Üniv. of Minnesota. Geological Survey Bulletin, 42*, 86 pp.

Plaziat, J. C., Cavagnetto, C., Koeniguer, J. C., & Baltzer, F. (2001). History and biogeography of the mangrove ecosystem, based on a critical reassessment of the paleontological record. *Wetlands Ecology and Management*, *9*, 161-179.

Planderová, E. (1972). Pliocénne sporomorfy z oblasti Zȧpadných Karpát a ich stratigrafická interpretácia. Geol. Práce, Správy, 59. Geol Üst. D. Štúra.

Planderová, E. (1990). Miocene microflora of Slovak Central Paratethys and its biostratigraphical significance. *Dioniz Stur Institute of Geology*, Bratislawa, 144 pp.

Pole, M. S., & Macphail, M. K. (1996). Eocene *Nypa* from Regatta Point, Tasmania. *Review of Palaeobotany and Palynology*, *92*, 55-67.

Poisson, A. (1976). Essai d'interprétation d'une transversale Korkuteli-Denizli (Taurus ouest-anatolien-Turkuie). *Bulletin of the Geological Society of France, 2*, 499-509.

Poisson, A. (1977). Recherches géologiques dans les Taurides Occidentales (Turquie). These Doctorate d'Etat, Université Paris- Sud (Orsay), 795 pp.

Poisson, A., Akay, E., Dumont, J. F., & Uysal, Ş. (1984). The Isparta angle (western Taurids-Turkey): a Mesozoik paleorift : In O. Tekeli, & Göncüoğlu, M. C. (Eds.). *Geology of the Taurus Belt* : Proceedings Int. Sym., 11-26, Ankara.

Potonié, H. (1893). Die Flora des Rotliegenden von Thüringen. *Abh. Geol. Landesanst.* N. F., 9.

Potonié, R. (1931a). Zur Mikroskopie der Braunkohlen. Tertiäre Blüntenstaubformen. *Braunkohle*, *30* (16), 325-333.

Potonié, R. (1931b). Pollenformen aus tertiären Braunkohlen. *3. Jahrbuch der Preussischen Geologischen Landesanstalat*, *52*, 1-7.

Potonié, R. (1931c). Zur Mikroskopie der Braunkohlen. Tertiäre Sporen-und Blütenstaubformen. (4. Mitteilung). *Zeitschrift Braunkohle*, *30* (27), 554-556.

Potonié, R. (1931d). Pollenformen der miocänen Braunkohle (2. Mitteilung). *Sitz. Ber. Ges. Naturf. Fr.*, *1–3*, 24-29.

Potonié, R., & Gelletich, J. (1933). Über die Pteridophytensporen einer aozänen Braunkohle aus Dorog, Ungarn. *Sitz. Ber. Ges. Naturforsch. Freunde, 33*, 517-528.

Potonié, R. (1934). Zur Mikrobotanik des eozänen Humodils des Geiseltales. *Arbeiten aus dem Institut für Paläobotanik und Petrographie der Brennsteine*, *4*, 25-125.

Potonié, R., & Venitz, H. (1934). Zur Mikrobotanik des miozänen Humodils der niederrheinischen Bucht. *Arbeiten aus dem Institut für Paläobotanik und Petrographie der Brennsteine*, *5*, 5-58.

Potonié, R., Thomson, P. W., & Thiergart, F. (1950). Zur Nomenklatur und Klassifikation der neogenen Sporomophae (Pollen und Sporen). *Geologisches Jahrbuch, 65*, 35-69.

Potonié, R. (1951). Revision stratigraphisch wichtiger Sporo–morphen des mittel europäischen Tertiärs. *Palaeontographica Abteilung B Ionnides*, *91*(5–6), 131-151.

Potonié, R., & Kremp, G. (1954). Die Gattungen der paläzoichen Sporae dispersae und ihre Stratigraphie. *Geologisches Jahrbuch, 69*, 111-194.

Potonié, R. (1956). Synopsis der Gattungen der Sporae dispersae. I. Teil: Sporites. *Beihefte zum geologischen Jahrbuch*, *23*, 103pp.

Potonié, R. (1958). Synopsisder Gattungen der Sporae dispersae. II. Teil: Sporites (Nachträge), Saccites, Aletes, Praecolpates, Polyplicates, Monocolpates*. II. Beihefte zum Geologischen Jahrbuch*, *31***,** 1-114.

Potonié, R. (1960). Synopsis der Gattungen der Sporae dispersae. III Teil: Nachträge Sporites, Fortsetzung Pollenites. *Beihhefte zum Geologischen Jahrbuch*, 39, 1-189.

Potonié, R. (1970). Synopsis der Gattungen der Sporae dispersae. V. Teil: Nachträge zu allen Gruppen (Turmae). *Beihhefte zum Geologischen Jahrbuch*, *87*, 1-222.

Rákosi, L. (1973). A dorogi-medence paleogén kèpzödményeinek palinologiaja. *Annales Instituti Geologici Publici Hungarici, 55*(3), 497-575.

Raatz, G. V. (1937). Mikrabotanisch-stratigraphische Untersuchung der Braunkohle des Muskauer Bogens. *Abhadlungen der Preussischen Geologischen Landesanstalt Neue Folge*, *183*, 3-48.

Riegel, W., Bode, T., Hammer, J., Hammer-Schiemann, G., Lenz, O., & Wilde, V. (1999). The palaeoecology of the Lower and Middle Eocene at Helmstedt, northern Germany-a study in contrasts. *Acta Palaeobotanica Supplement*, *2*, 349-358.

Reinsch, P. F. (1881). Neue Untersuchungen über die Mikrostruktur der Steinkohle des Carbon, der Dryas und Trias: Beiträge zur Aufhellung des Ursprungs und der Zusammensetzung dieser Mineralkörper, sowie zur Kenntniss des einfachsten Pflanzenlebens der Vorwelt. Weigel.

Robertson, A. H. F. (1993). Mesozoic-tertiary sediments and tectonic evolution of Neotethyan carbonate platforms, margins and small oceanic basins in the Antalya Complex, southwest Turkey. *Spec. Publ. Int. Ass. Sediment*, *20*, 415-465.

Roche, E. (1988). Pollen and Spores (Compilation). In. R. Vinken (Ed), The Northwest European Tertiary Basin. *Geologisches Jahrbuch, 100*, 288-320.

Roehler H. W. (1993). Eocene climates, depositional environments, and geography, Greater Green River Basin, Wyoming, Utah, and Colorado. *United States Geological Survey Professional Paper*, *1506*, 74 pp.

Rull, V. (1992). Paleoecología y análisis secuencial de una sección deltaica Terciaria en la Cuenca de Maracaibo. *Boletín Sociedad Venezolana Geólogos*, *46*, 16-26.

Rull, V. (1997a). Sequence analysis of Western Venezuelan Cretaceous to Eocene sediments using palynology. Chrono-paleoenvironmental and paleovegetational approaches. *Palynology*, *21*, 79-90.

Rull, V. (1997b). Oligo-Miocene palynology of the Rio Chama sequence (western Venezuela), with comments on fossil algae as paleoenvironmental indicators. *Palynology*, *21*, 213-229.

Rull, V. (1998a). Middle Eocene mangroves and vegetation changes in the Maracibo Basin. *Palaios*, *13*, 287-296.

Rull, V. (1998b). Biogeographical and evolutionary considerations of *Mauritia* (Arecaceae), based on palynological evidence. *Review of Palaeobotany and Palynology*, *100*, 109-122.

Rull, V. (1999). Paleofloristic and paleovegetational changes across the Paleocene-Eocene boundary in northern South America. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *107*, 83-95.

Ryan, P. D., Harper, D. A. T., & Whalley, J. S. (1995). PALSTAT, Statistics for palaeontologists. Chapman & Hall, London (now Kluwer Academic Publishers).

Salujha, S. K., Kindra, G. S., & Rehman, K. (1974). Palynology of the South Shillong Front Part I: The Paleogene of Khasi and Jaintia Hills. *Palaeobotanist*, *21*, 267-284.

Sancay, R. H., Batı, Z., Işık, U., Kırıcı, S., & Akça N. (2006). Palynomorph, Foraminifera, and Calcareous Nanoplankton Biostratigraphy of Oligo–Miocene Sediments in the Muş basin, Eastern Anatolia, Turkey. *Turkish Journal of Earth Sciences*, *15*, 259-319.

Sarıiz, K. (1985). Keçiborlu kükürt yataklarının oluşumu ve yörenin jeolojisi. *Anadolu Üniversitesi yayınları,* 91pp.

Schalke, H. J. W. (1988). Pollen and Spores (Compilation). In R. Vinken (Ed), The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, *100*, 288-320.

Schalke, H J. W., & Meyer, K. J. (1988). Pollen and Spores (Compilation). In R. Vinken (Ed). The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, *100*, 288-320.

Schimiedl, G., Scherbacher, M., Bruch, A. A., Jelen, B., Nebelsick, J. H., Hemleben, C., Mosbrugger, V., & Rifelj, H. (2002). Palaeoenvironmental evolution of the Paratethys in the Slovenian Basin during the Late Paleogene. *International Journal of Earth Sciences*, *91***,** 123-132.

Schuler, M. C. (1988). Pollen and spores (compilation). In R. Vinken, (Ed.). The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, 100, 288-320.

Serra-Kiel, J., Hottinger, L., Caus, E., Drobne, K., Ferràndez, C., Jauhri, A. K., Less, G., Pavlovec, R., Pignatti, J., Samsó, J. M., Schaub, H., Sirel, E., Strougo, A., Tambareau, Y., Tosquella, J., & Zakrevskaya, E. (1998). Larger foraminiferal biostratigraphy of the Tethyan Paleocene and Eocene. *Bull. Soc. géol. France*, *169* (2), 281-299.

Seward, A. C. (1914). Antarctic fossil plants. *Natur. Hist. Rep. Brit. Antarct. Exped. 1910, Geol., 1* (1), 1-49.

Shpul, V. G. (2002). Changing of flora in the basin of the middle and upper Don in Tertiary time according to Palynological study. *Sixth European Paleobotany Palynology Conference*, 160-161.

Singh, R. S. (1999). Diversity of *Nypa* in the Indian subcontinent: Late Cretaceous to Recent. *Palaeobotanist*, *48*, 147-154.

Sittler, C. (1965). Le paléogenede fossés rhénan et rhodanien. Études sédimantologiques et paléoclimatiques. *Mén. Serv. Carte géol., 24*, 392 pp.

Sivak, J. (1976). Nouvelles espèces du genre *Cathaya* d'apres leurs grains de pollen dans le Tertiaire du sud de la France. *Pollen et Spores*, *18*(2), 243-288.

Snopková, P. (1980). Paleogene Sporomorphs from West Carpathians. *Západ. Karpaty. Ser. Paleont., 5*, 7-74.

Snopková, P. (1983). Indexové fosilie paleogénu Západných Karpát Ćlastk. záver. správa. *Archiv Geol. Úst. D. Śturá*, 1-182.

Sontag, E. (1966). Mikrobotanische (palynologische) Untersuchungen am 2. Niederlausitzer Flözhorizont. *Geologie*, *15*(54), 1-141.

Sözbilir, H., Özer, S., Sarı, B., & Avşar, N. (2001). Supra-allochton sedimentary succession in western Anatolia: new stratigraphic data and tectonic results. *Fourth International Turkish Geology Symposium*, Abstracts, 36.

Sözbilir, H. (2002). Revised stratigraphy and facies analysis of the Palaeocene-Eocene supra-allochthonous sediments and their tectonic significance (Denizli, SW Turkey), *Turkish Journal of Earth Sciences, 11,* 1-27.

Sözbilir, H. (2005). Oligocene-Miocene extension in the Lycian orogen: evidence from the Lycian molasse basin, SW Turkey. *Geodinamica Acta*, *18*, 255-282.

Srivastava, S.K., & Binda, P. L. (1991). Depositional History of the Early Eocene Shumaysi Formation, Saudi Arabia. *Palynology*, *15*, 47-61.

Staplin, F. L. (1976). Tertiary biostratigraphy, Mackenzie Delta region, Canada. *Bulletin of Canadian Petroleum Geology*, *24*, 117-136.

Stuchlik, L., Ziembinska-Tworzydlo, M., Kohlman-Adamska, A., Grabowska, I., Ważyńska, H., Slodkowska, B., & Sadowska, A. (2001). Atlas of pollen and spores of Polish Neogene. *W. Szafer Institute of Botany, Polish Academy Sciences*, *1*, 1-69.

Stuchlik, L., Ziembińska-Tworzydlo, M., Kohlman-Adamska, A., Grabowska, I., Ważyńska, H., & Sadowska, A. (2002). Atlas of pollen and spores of Polish Neogene. *W. Szafer Institute of Botany, Polish Academy Sciences*, *2*, 1-237.

Şahbaz, A., & Görmüş¸ S. (1992). Çardak (Denizli) kuzeyindeki Eosen ve Oligosen yaslı konglomeraların stratigrafik ve sedimantolojik incelenmesi. *Ninth Petroleum Congress of Turkey*, *2*, 62-74.

Şahbaz, A., & Görmüş¸ S. (1993). Çardak (Denizli) Kuzeyindeki Eosen ve Oligosen yaşlı kumtaşlarının kaynak kaya türleri ve provenansı. *Yerbilimleri*, *16*, 43-53.

Şenel, M. (1991). Palaeocene-Eocene sediments interbedded with volcanics within the Lycian Nappes: Faralya formation. *Mineral Research and Exploration Institute of Turkey Bulletin*, *113*, 1-14.

Şenel, M. (1997a). 1/100 000 ölçekli Türkiye Jeoloji Haritaları Denizli- J9 Paftası. *Maden Tetkik Arama Genel Müdürlüğü, 16*, 1-18.

Şenel, M. (1997b). 1/100 000 ölçekli Türkiye Jeoloji Haritaları Denizli- J10 Paftası. *Maden Tetkik Arama Genel Müdürlüğü, 13*, 1-16.

Şengör, A. M. C., & Yılmaz, Y. (1981). Tethyan evolution of of Turkey. A plate tectonic approach. *Tectonophysics*, *75*, 181-241.

Takahashi, K., & Jux, U. (1986). Sporomorphen aus dem paralischen Oberoligozän der südöstlichen Niederrheinischen Bucht (West Deutschland). *Bulletin Faculty Liberal Arts*, *26*, 27-303.

Thanikaimoni, G., Caratini, C., Venkatachala, B. S., Ramanujham, C. G. K., & Kar, R. K. (1984). Selected Tertiary angiosperms pollens from India and their relationship with African Tertiary pollens. Institut français de Pondichéry, *Travaux de la Section Scientifique et Technique*, XIX**,** 1-192.

Thanikaimoni, G. (1987). Mangrove palynology. Institut français de Pondichéry, *Travaux de la Section Scientifique et Technique*, *XXIV*, 1-100.

Tschudy, R. H. (1973). Stratigraphic distribution of significant Eocene palynomorphs of the Mississippi embayment. *Geological Survey Professional Paper, 743*, 400-484.

Tchihatchef, L. (1869). Asie Mineure Description Physique de cette contrée, 8, *Geologie*, Paris.

Thiele–Pfeiffer, H. (1980). Die Miozäne Mikroflora aus dem Braunkohlentagebau Ode bei Wackersdorf / Oberpfalz. *Palaeontographica Abteilung B Ionnides*, *174*, 95-224.

Thiele–Pfeiffer, H. (1988). Die Mikroflora aus dem mittelozänen Ölschiefers von Messel bei Darmstadt. *Palaeontographica Abteilung B Ionnides*, *211*, 1-86.

Thiergart, F. (1937). Die Pollenflora der Niederlausitzer Braunkohle, besonders im Profil der grube Marga bei Senftenberg. *Jahrbuch der Preusissischen Geologischen Landesanstalt*, *58*, 282-351.

Thomson, P. W., & Pflug, H. (1953). Pollen und sporen des mitteleurp.ischen Tertiärs. *Palaeontographica Abteilung B Ioannides*, *94*, 1-138.

Turpin, P. J. F. (1828). Observations sur le nouveau genre Surirella. *Mémoires du Muséum d'Histoire Naturelle de Paris*, *16,* 361-368.

Tüfekçi, M. (1984). Denizli–Çal–Çardak–Çivril–Afyon–Dazkırı kömürlü Neojen jeoloji raporu. *M. T. A. Ege Bölge Müdürlüğü*.

Upchurch, G. R., & Wolfe, J. A. (1987). Mid–Cretaceous to early Tertiary vegetation and climate: evidence from fossil leaves and woods. In E. M., Friis, W. G., Chaloner, & P. H., Crane, (Eds.). *The Origins of Angiosperms and Their Biological Consequences*. Cambridge University Press, 75-105.

Utescher, T., Mosbrugger, V., & Ashraf, A. (2000). Terrestrial Climate Evolution in Northwest Germany Over the Last 25 Million Years. *Palaios*, *15* (5), 430-449.

Ünal, D. (1981). Denizli-Çivril-Tokça kömürlü Neojen havzası jeoloji raporu. *M. T. A. Raporu*, 7016.

Van der Hammen, T. (1954). El desarrollo de la Flora colombiana en los periodos Geologicos 1. Maestrichtiano Hasta Terciaria mas Inferior. *Boletin Geological (Bogotá)*, *11*(1), 49-106.

Van der Hammen, T. (1956). Description of some genera and species of fossil pollen and spores. *Boletin Geological (Bogotá)*, *4*, 103-109.

Van der Hammen, T., & Wymstra, T. A. (1964). Apalynological study on the Tertiary and Upper Cretaceous of British Guayana. *Leidse Geologische Mededelingen*, *30*, 183-241.

Van der Hammen, T., & García de Mutis, C. (1966). The Paleocene flora of Colombia. *Leidse Geologische Mededelingen*, *35*, 105-116.

Van Hoeken-Klinkenberg, P. M. J. (1964). A palynological investigation of some Upper Cretaceous sediments in Nigeria. *Pollen et Spores, 6*, 209-231.

Vinken, R. (1988). The Northwest European Tertiary Basin. (IGCP 124). *Geologisches Jahrbuch*, *100*, 1-508.

Von Der Brelie, G. (1988). Pollen and spores (compilation). In: R. Vinken, (Ed.). The Northwest European Tertiary Basin. *Geologisches Jahrbuch*, *100*, 288-320.

Westgate, J. W., & Gee, C. T. (1990). Palaeoecology of a Middle Eocene mangrove biota (vertebrates, plants and invertebrates) from southwest Texas. *Palaeogeography, Palaeoclimatology, Palaeoecology*, *78*, 163-177.

Westaway, R., Guillou, H., Yurtmen, S., Demir, T., Scaillet, S., & Rowbotham, G. (2005). Constraints on the timing and regional conditions at the start of the presence phase of crustal extension in western Turkey, from observations in and around the Denizli region. *Geodinamica Acta*, *18*, 209-238.

Weyland, H., & Pflug, H. D. (1957). Die Pflanzenreste der Pliozänen Braunkohle von Ptolemais in Nordgriechhenland I. *Palaeontographica Abteilung B Ionnides, 102*, 96-109.

Wilkinson, G. C., & Boulter, M. C. (1980). Oligocene Pollen and Spores from the Western Part of the British Isles. *Palaeontographica Abteilung B Ionnides*, *175*, 27-83.

Wilkonson, G. C., Bazley, R. A. B., & Boulter, M. C. (1980). The geology and palynology of the Oligocene Lough Neagh Clays, Northern Ireland. *Journal of Geological Society*, *137*, 65-75.

Wilson, L. R., & Webster, R. (1946). Plant microfossils from a Forth Union coal of Montana. *American. Journal of Botany*, *33*, 271-278.

Wodehouse, R. P. (1933). Tertiary Pollen II. The Oil Shales of the Eocene Green River Formation. *Bulletin of the Torrey Botanical Club, 60*, 479-524.

Wolfe, J. A. (1978). A paleobotanical interpretation of Tertiary climates in northern hemisphere. *American Scientist*, *66*, 694-703.

Wolfe, J. A. (1992). Climatic, floristic and vegetational changes near the Eocene/Oligocene boundary in North America. In D. R., Prothero, & W. A., Berggren, (Eds.). *Eocene–Oligocene Climatic and Biotic Evolution*. Princeton University Press, 421-436.

Wolfe, J. A., & Hopkins, D. M. (1967). Climatic changes recorded by Tertiary land floras in northwestern North America. In K. Hatai, (Ed.). Tertiary Correlations and Climatic Changes in the Pacific. *11th Pacific Science Congress*, *25*, 67-76.

Wolfe, J. A., & Poore, R. Z. (1982). Tertiary marine and nonmarine climatic trends. In W. Berger, & J. C., Crowell, (Eds.). Climate in Earth history. *National Academy of Science Studies in Geophysics*, Washington, D.C., 154-158.

Wolff, H. (1934). Microfossilien des pliozänen Humodils der Grube Freigericht bei Dettingen a. M. Und Vergleich mit älteren Schichten des Tertiärs sowie posttertiären Ablagerungen. *Arbeiten aus dem Institut für Paläobotanik und Petrographie der Brennsteine*, *5*, 55-88.

Yağmurlu, F. (1994). Isparta Kuzeyinde Yeralan Oligosen Yaşlı Molas Tipi Kırıntılı Tortulların Tektono–Sedimenter Özellikleri. Çukurova Üniversitesi, *15. Yıl sempozyumu*, 241-252.

Yalçınkaya, S., Engin, A., Taner, K., Afşar, P., Dalkılıç., H., & Özgönül, E. (1986). Batı Torosların Jeolojisi (Geology of Western Taurides). *Mineral Research and Exploration Institute of Turkey (MTA) Report, 7898*, 132pp.

Yasamanov, N. A. (1982). The problem of global changes in temperature regime of the earth's surface during Cenozoic time. *Izvestiya AN SSSR, seriya geologicheskaya*, *10*, 106-110.

Yılmaz, Y., Genç, Ş. C., Gürer, F., Bozcu, M., Yılmaz, K., Karacık, Z., Altunkaynak, Ş., & Elmas, A. (2000). When did the western Anatolian Grabens begin to develop? In E. Bozkurt, J. A. Winchester, & J.A.D. Piper, (Eds.) Tectonics and Magmatism in Turkey and the Surrounding Area, vol. 173, *Geological Society, London, Special Publications*, *173*, 131-162.

Zachos, J., Pagani, M., Sloan, L., Thomas, E., & Billups, K. (2001). Trends, rhythms, and aberrations in Global Climate 65 Ma to present. *Science*, *292*, 686-693.

Zaklinskaya, E. D. (1957). Stratigraficheskoye znachenie pyl'tsy golosemiannykh kaynozoyskikh otlozheny Pavlodarskovo Priirtysa i severnovo Priaralya. (Stratigraphic significance of pollen grains of gymnosperms of the Cainozoic deposits of the Irish Basin and of the northern Aral Basin). *Trudy Geologicheskovo Instituta Akademii Nauk SSSR*, *2*(6), 1-220.

Ziembińska–Tworzydlo, M. (1974). Palynological characteristics of the Neogene of Western Poland. *Acta Palaeontologica Polonica*, *19* (3), 309-342.

Ziembińska–Tworzydlo, M., Grabowska, I., Kohlman–Adamska, A., Skawińska, K., Słodkowska, B., Stuchlik, L., Sadowska, A., & Ważyńska, H. (1994). Taxonomical revision of selected pollen and spores taxa from Neogene deposits. In L. Stucklik, (Ed.). Neogene pollen flora of central Europe. *Acta Palaeobotanica*, *1*, 5-30.

APPENDIX 1
Digital images of the palynomorphs

Specimens are denoted by a sample number (e.g. 03/89) with the name of formation. Photomicrograps are the same scale (see 40 micrometer bar in figure 2), except for the figure 1 which have its own 60 micrometer scale because of presence of big spores.

PLATE 1

Figs. 1–5.	(1) *Leiotriletes adriennis* (Potonié & Gelletich, 1933) Krutzsch, 1959, **Fig. 1.** Sample 02B/05 (Başçeşme); **Fig. 2.** Sample 03/129 (İncesu); **Fig. 3.** Sample 03/89 (İncesu); **Figs. 4, 5.** Sample 04/40 (Aksu)
Figs. 6–11.	(2) *Leiotriletes maxoides* Krutzsch 1962a ssp. *maximus* (PFlug *in* Thomson & Pflug 1953) Krutzsch 1962a, **Figs. 6,7,10.** Sample 03/100 (İncesu); **Figs. 8,9,11.** Sample 02i/24 (İncesu).
Figs. 12–14.	(3) *Leiotriletes maxoides* Krutzsch 1962a ssp. *maxoides* Krutzsch 1962a, **Fig. 12.** Sample 03/89 (İncesu); **Fig. 13.** Sample T–8 (Tokça); **Fig. 14.** Sample 02i/09 (İncesu)

PLATE 2

Figs. 1–4.	(4) *Leiotriletes maxoides* Krutzsch 1962a ssp. *minoris* Krutzsch 1962a, **Figs. 1–3** Sample 04/40 (Aksu); **Fig. 4.** Sample 04/44 (Aksu)
Figs. 5–7.	(5) *Leiotriletes triangulus* (Mürriger & Pflug 1952 ex Krutzsch 1959) Krutzsch 1962a, **Fig. 5.** Sample 02i/09 (İncesu); **Fig. 6.** Sample 04/27 (Kavak); **Fig. 7.** Sample 04/40 (Aksu)
Figs. 8–10.	(6) *Leiotriletes microlepioidites* Krutzsch 1962a, **Fig. 8.** Sample 04/40 (Aksu); **Fig. 9.** Sample 04/51 (Aksu); **Fig. 10.** Sample 04/08 (Kavak)
Figs. 11–12.	(7) *Leiotriletes microadriennis* Krutzsch 1959, **Fig. 11.** Sample 04/44 (Aksu); **Fig. 12.** Sample 04/23 (Kavak)
Figs. 13–15.	(8) *Leiotriletes wolffii* Krutzsch 1962a ssp. *wolffii* Krutzsch 1962a, **Fig. 13.** Sample 03/141 (İncesu); **Fig. 14.** Sample 01B/20 (Başçeşme); **Fig. 15.** Sample 02i/09 (İncesu)
Figs. 16–18.	(9) *Leiotriletes neddenioides* Krutzsch 1962a, **Fig. 16.** Sample 04/40 (Aksu); **Fig. 17.** Sample 04/44 (Aksu); **Fig. 11.** Sample 03/143 (İncesu)
Fig. 19.	(10) *Leiotriletes seidewitzensis* Krutzsch 1962a, sample 04/40 (Aksu)
Figs. 20–21.	(11) *Leiotriletes* sp. 1, **Fig. 20.** Sample 02B/31 (Başçeşme); **Fig. 21.** Sample 04/09 (Kavak)
Figs. 22–23.	(12) *Leiotriletes* sp. 2, **Fig. 22.** Sample 03/143 (İncesu); **Fig. 23.** Sample 04/40 (Aksu)
Fig. 24.	(13) *Triplanosporites microsinuosus* Pflanzl 1955, sample 02B/03 (Başçeşme)
Figs. 25–26.	(14) *Triplanosporites sinuosus* Pflug 1952 ex Thomson & Pflug 1953, **Fig. 25.** Sample 02i/09 (İncesu); **Fig. 26.** Sample 04/40 (Aksu)

PLATE 3

Fig. 1.	(14) *Triplanosporites sinuosus* Pflug 1952 ex Thomson & Pflug 1953, sample03i/100 (İncesu)
Fig. 2.	(15) *Triplanosporites sinomaxoides* Krutzsch 1962a, sample 02i/17 (İncesu)
Fig. 3.	(16) *Punctatisporites punctatus* Pflug *in* Thomson & Pflug 1953, sample 02i/24 (İncesu)
Fig. 4.	(17) *Retitriletes lusaticus* Krutzsch 1963a, sample 03/142 (İncesu)
Fig. 5.	(18) *Retitriletes* sp. 1, sample 02B/04 (Başçeşme)
Fig. 6.	(19) *Baculatisporites primarius* (Wolff 1934) Thomson & Pflug 1953 ssp. *oligocaenicus* Krutzsch 1967a, sample 04YC/01 (Varsakyayla)
Figs. 7, 8.	(20) *Baculatisporites ovalis* Kedves 1973, **Fig. 7.** Sample 03/142 (İncesu); **Fig. 8.** Sample 02B/03 (Başçeşme)
Figs. 9–11.	(21) *Baculatisporites nanus* (Wolff 1934) Krutzsch 1959, **Fig. 9**. Sample 02B/03 (Başçeşme); **Fig. 10**. Sample 02i/26 (İncesu); **Fig. 11**. Sample 03/88 (İncesu)
Fig. 12.	(22) *Baculatisporites* sp. 1, sample 02B/03 (Başçeşme)
Fig. 13.	(23) *Cicatricosisporites* sp. 1, sample 01/44 (Başçeşme)
Figs. 14, 15.	(24) *Trilites multivallatus* (Pflug *in* Thomson & Pflug 1953) Krutzsch 1959, **Fig. 14**. Sample 02i/09 (İncesu); **Fig. 15**. Sample 03/85 (İncesu)
Fig. 16.	(25) *Trilites embriyonalis* Krutzsch 1967a, sample 03/85 (İncesu)
Figs. 17, 18.	(26)) *Trilites* sp. 1, Sample 03/129 (İncesu)
Figs. 19, 20.	(27) *Echinatisporis miocenicus* Krutzsch & Sontag *in* Krutzsch 1963b, **Fig. 19**. Sample 03/130 (İncesu); **Fig. 20**. Sample 04/27 (Kavak)
Fig. 21–23.	(28) *Echinatisporis* ? *chattensis* Krutzsch 1963b, sample 03/142 (İncesu)
Fig. 24.	(29) *Echinatisporis* sp. 1, sample 02B/03 (Başçeşme)
Fig. 25.	(30) *Polypodiaceoisporites* cf. *marxheimensis* (Mürriger & Pflug 1952 ex Thomson & Pflug 1953) Krutzsch 1959, sample 03/141 (İncesu)

PLATE 4

Figs. 1.	(31) *Polypodiaceoisporites kedvesii* Stuchlik *in* Stuchlik et al. 2001 sample 02/05 (Başçeşme)
Fig. 2.	(32) *Polypodiaceoisporites gracillimus* Nagy 1963, sample 03/141 (İncesu)
Figs. 3–5.	(33) *Polypodiaceoisporites saxonicus* Krutzsch 1967a, **Fig. 3**. Sample 03/129 (İncesu); **Figs. 4, 5**. Sample 03/141 (İncesu)
Fig. 6.	(34) *Polypodiaceoisporites muricinguliformis* Nagy 1959, sample 01B/20 (Başçeşme)
Fig. 7.	(35) *Polypodiaceoisporites schoenewaldensis* Krutzsch 1967a, sample 03/141 (İncesu)
Figs. 8–10.	(36) *Polypodiaceoisporites corrutoratus* Nagy 1985, sample 03/141 (İncesu)

Fig. 11. (37) *Polypodiaceoisporites microconcavus* Krutzsch 1967a, sample 01B/24 (Başçeşme)

Fig. 12. (38) *Polypodiaceoisporites* sp. 1, sample 03/141 (İncesu)

Fig. 13. (39) *Polypodiaceoisporites* sp. 2, sample 01B/24 (Başçeşme)

Fig. 14. (40) *Laevigatosporites gracilis* Wilson & Webster 1946, sample T–8 (Tokça)

Figs. 15, 16. (41) *Laevigatosporites haardti* (Potonié & Venitz 1934) Thomson & Pflug, **Fig. 15**. Sample 02B/03 (Başçeşme); **Fig. 16**. Sample T–8 (Tokça)

Fig. 17. (43) *Verrucatosporites histiopteroides* Krutzsch 1962b, sample 03/142 (İncesu)

Figs. 18–20. (44) *Verrucatosporites favus* (Potonié 1931c) Thomson & Pflug 1953, **Fig. 18.** Sample 03/72 (İncesu); **Figs. 19, 20.** Sample 03/143 (İncesu)

Figs. 21–23. (45) *Verrucatosporites alienus* (POTONIÉ 1931c) THOMSON & PFLUG 1953(Potonié 1931c) Thomson & Pflug 1953, **Fig. 21.** Sample 02i/09 (İncesu); **Fig. 22.** Sample 03/143 (İncesu); **Fig. 23.** Sample 03/144 (İncesu)

PLATE 5

Fig. 1. (47) *Verrucatosporites balticus* (Krutzsch 1962b) Krutzsch 1967a, sample T–16 (Tokça)

Fig. 2. (49) *Piceapollis* sp. 1, sample 02B/03 (Başçeşme)

Figs. 3–7. (50) *Pityosporites microalatus* (Potonié 1931b) Thomson & Pflug 1953, **Figs. 3–5.** Sample 02B/03 (Başçeşme); **Fig. 6**. Sample 03/88 (İncesu); **Fig. 7.** Sample T–8 (Tokça);

Figs. 8–10. (51) *Pityosporites labdacus* (Potonié 1931c) Thomson & Pflug 1953, **Fig. 8.** Sample 02B/31 (Başçeşme); **Fig. 9.** Sample T–8 (Tokça); **Fig. 10.** Sample T–16 (Tokça)

Figs. 11, 12. (52) *Pityosporites scopulipites* (Wodehouse 1933) Krutzsch 1971, sample 03/88 (İncesu)

Figs. 13, 14. (53) *Pityosporites minitus* (Zaklinskaja 1957) Krutzsch 1971 sample T–6 (Tokça)

PLATE 6

Fig. 1. (53) *Pityosporites minitus* (Zaklinskaja 1957) Krutzsch 1971 sample T–6 (Tokça)

Figs. 2, 3. (54) *Pityosporites* sp. 1, sample 02B/03 (Başçeşme)

Fig. 4. (55) *Cathayapollis krutzschii* (Sivak 1976) Ziembińska–Tworzydlo *in* Stuchlik et al. 2002, sample 03/88 (İncesu)

Fig. 5. (56) *Cathayapollis pulaënsis* (Nagy 1985) Ziembińska–Tworzydlo *in* Stuchlik et al. 2002, sample 02B/03 (Başçeşme)

Fig. 6. (57) *Cathayapollis* sp. 1, sample 02B/03 (Başçeşme)

Fig. 7. (58) *Cedripites* sp. 1, sample T–6 (Tokça)

Fig. 8. (59) *Abiespollenites absolutus* Thiergart ex Potonié 1958, sample 02B/03 (Başçeşme)

Fig. 9. (60) *Abiespollenites* sp. 1, sample 02B/02 (Başçeşme)

Figs. 10, 11. (61) *Inaperturopollenites dubius* (Potonié & Venitz 1934) Thomson

& Pflug 1953, **Fig. 10.** Sample 04/50 (Aksu); **Fig. 11.** Sample 04/65 (Aksu)

PLATE 7

Figs. 1, 2. (61) *Inaperturopollenites dubius* (Potonié & Venitz 1934) Thomson & Pflug 1953, **Fig. 1.** Sample 03/144 (İncesu); **Fig. 2.** Sample 03/94 (İncesu)

Figs. 3–5. (62) *Inaperturopollenites hiatus* (Potonié 1931b) Pflug & Thomson *in* Thomson & Pflug 1953, **Figs. 3, 4.** Sample 04/65 (Aksu); **Fig. 5.** Sample 04/08 (Kavak)

Figs. 6–9. (63) *Inaperturopollenites concedipites* (Wodehouse 1933) Krutzsch 1971, **Fig. 6.** Sample T–4 (Tokça); **Figs. 7, 8.** Sample 04/09 (Kavak); **Fig. 9.** Sample 04/08 (Kavak)

Figs. 10–13 (64) *Inaperturopollenites magnus* (Potonié 1934) Thomson & Pflug 1953, **Figs. 10, 11.** Sample T–8 (Tokça); **Figs. 12,13.** Sample 03/72 (İncesu)

Fig. 14. (65) *Inaperturopollenites* sp. 1, sample 03/94 (İncesu)

Fig. 15. (66) *Sequoiapollenites largus* (Kremp 1949) Manum 1962, sample 03/94 (İncesu)

Figs. 16–19. (67) *Sequoiapollenites polymorfosus* Thiergart 1937, **Figs. 16, 17.** Sample 02B/07 (Başçeşme); **Fig. 18.** Sample 03/94 (İncesu); **Fig. 19.** Sample 04/10 (Kavak)

Figs. 20–24. (68) *Sparganiaceaepollenites polygonalis* Thiergart 1937, **Fig. 20.** Sample 01B/44 (Başçeşme); **Fig. 21.** Sample T–14 (Tokça); **Figs. 22–24.** Sample T–8 (Tokça)

Fig. 25, 26. (69) *Sparganiaceaepollenites neogenicus* Krutzsch 1970a, **Fig. 25.** Sample T–4 (Tokça); **Fig. 26.** Sample T–8 (Tokça)

Figs. 27a, b. (70) *Aglaoreidia cyclops* (Erdtman 1960) Fowler 1971, sample 01B/18 (Başçeşme)

Fig. 28. (71) *Graminidites laevigatus* Krutzsch 1970a, sample 03/94 (İncesu)

PLATE 8

Fig. 1. (72) *Kopekipollenites transdanubicus* Kedves 1974, sample 01B/11 (Başçeşme)

Figs. 2, 3 (73) *Longapertites punctatus* Frederiksen 1994, **Fig. 2.** Sample 03/72 (İncesu)**; Fig. 3.** Sample 03/129 (İncesu)

Fig. 4. (74) *Longapertites* cf. *punctatus* Frederiksen 1994, sample 02i/26 (İncesu)

Figs. 5–7. (75) *Longapertites psilatus* Frederiksen 1994, **Figs. 5, 6.** Sample 03/129 (İncesu); **Fig. 7.** Sample 03/130 (İncesu)

Figs. 8–13. (76) *Longapertites discordis* Frederiksen 1994, **Figs. 8, 9.** Sample 02i/04 (İncesu); **Fig. 10.** Sample 02i/26 (İncesu); **Fig. 11.** Sample 03/141 (İncesu); **Fig. 12.** Sample 02i/17 (İncesu); **Fig. 13.** Sample T–2 (Tokça);

Figs. 14, 15. (77) *Longapertites retipilatus* Kar 1985, **Fig. 14.** Sample 02i/09 (İncesu); **Fig. 15.** Sample 04/09 (Kavak)

Fig. 16. (78) *Longapertites* sp. 1, sample 02B/04 (Başçeşme)

Fig. 17. (79) *Psilamonocolpites* sp., sample 01B/18 (Başçeşme)

Figs. 18a, b. (80) *Mauritiidites franciscoi* (Van Der Hammen 1956) Hoeken–Klinkenberg 1964, sample 02B/03 (Başçeşme)

Figs. 19a, b. (81) *Spinizonocolpites* sp. sample 02B/07 (Başçeşme)

Figs. 20–23. (82) *Cycadopites gracilis* (Wodehouse 1933) Krutzsch 1970a, **Fig. 20.** Sample 01B/11 (Başçeşme); **Fig. 21.** Sample 03/144 (İncesu); **Fig. 22.** Sample 04/09 (Kavak); **Fig. 23.** Sample 01B/33 (Başçeşme)

PLATE 9

Figs. 1, 2. (83) *Cycadopites ?minimus* (Cookson 1947) Krutzsch 1970a, sample 01B/24 (Başçeşme)

Figs. 3, 4. (84) *Cycadopites intrastructus* Krutzsch 1970a, **Fig. 3.** Sample 01B/11 (Başçeşme), **Fig. 4.** Sample 04/40 (Aksu)

Figs. 5, 6 (85) *Cycadopites lusaticus* Krutzsch 1970a, **Fig. 5.** Sample 04/40 (Aksu); **Fig. 6.** Sample 04/09 (Kavak)

Fig. 7. (86) *Cycadopites* sp. 1, sample 03/90 (İncesu)

Figs. 8, 9. (87) *Arecipites brandenburgensis* Krutzsch 1970a, **Fig. 8.** Sample 04/50 (Aksu); **Fig. 9a, b.** Sample 04YC/01(Varsakyayla)

Fig. 10. (88) *Arecipites* sp. 1, sample 01B/11 (Başçeşme)

Figs. 11, 12. (89) *Magnolipollis neogenicus* ssp. *minor* Krutzsch 1970a, sample 03/144 (İncesu)

Figs. 13–15. (90) *Monogemmites pseudosetarius* (Weyland & Pflug 1957) Krutzsch 1970a, sample T–7 (Tokça)

Figs. 16–22. (91) *Dicolpopollis kockelii* Pflanzl 1956, **Figs. 16–18.** Sample 04/40 (Aksu); **Fig. 19**. Sample T–9 (Tokça); **Fig. 20.** Sample 03/90 (İncesu); **Fig. 21.** Sample 04/51 (Aksu); **Fig. 22.** Sample 04/57 (Aksu)

Fig. 23. (92) *Ephedripites* sp. 1, sample 02i/15 (İncesu)

Fig. 24. (93) *Plicapollis pseudoexcelsus* (Krutzsch 1957) Krutzsch 1961 ssp. *turgidus* Pflug *in* Thomson & Pflug 1953, Sample 03/89 (İncesu)

Figs. 25, 26. (94) *Plicapollis pseudoexcelsus* (Krutzsch 1957) Krutzsch 1961 ssp. *semiturgidus* Pflug *in* Thomson & Pflug 1953, **Fig. 25.** Sample 03/100 (İncesu); **Fig. 26.** Sample 02i/08 (İncesu)

Figs. 27, 28. (95) *Plicapollis* sp. 1, **Fig. 27.** Sample 02B/31 (Başçeşme); **Fig. 27.** Sample 01B/31 (Başçeşme)

Figs. 29–35. (96) *Triatriopollenites rurensis* Thomson & Pflug 1953, **Fig. 29.** Sample T–14 (Tokça); **Fig. 30.** Sample T–8 (Tokça); **Fig. 31.** Sample T–4 (Tokça); **Fig. 32.** Sample 04/27 (Kavak); **Fig. 33.** Sample 04YC/02 (Varsakyayla); **Fig. 34.** Sample 04/51 (Aksu); **Fig. 35.** Sample 02i/09 (İncesu)

Fig. 36. (97) *Triatriopollenites pseudorurensis* Pflug & Thomson *in* Thomson & Pflug 1953, sample T–4 (Tokça)

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Fig. 1. (97) *Triatriopollenites pseudorurensis* Pflug & Thomson *in* Thomson & Pflug 1953, sample 02i/09 (İncesu)

Figs. 2–6. (98) *Triatriopollenites bituitus* (Potonié 1931a) Thomson & Pflug 1953, **Fig. 2.** Sample 01B/20 (Başçeşme); **Fig. 3.** Sample 01B/24 (Başçeşme); **Fig. 4.** Sample 03/144 (İncesu); **Fig. 5.** Sample T–4

(Tokça); **Fig. 6.** Sample T–8 (Tokça)

Figs. 7–10. (99) *Triatriopollenites excelsus* (Potonié 1931a) Thomson & Pflug 1953 ssp. *minor* Pflug *in* Thomson & Pflug 1953, **Figs. 7–9.** Sample 01B/20 (Başçeşme); **Fig. 10.** Sample T–6 (Tokça)

Figs. 11–16. (100) *Triatriopollenites excelsus* (Potonié 1931a) Thomson & Pflug 1953 ssp. *typicus* Pflug *in* Thomson & Pflug 1953, **Fig. 11–13.** Sample 01B/44 (Başçeşme); **Figs. 14, 15.** Sample 02i/09 (İncesu); **Fig. 16.** Sample 04YC/02 (Varsakyayla)

Figs. 17–20. (101) *Triatriopollenites myricoides* (Kremp 1949) Thomson & Pflug 1953, sample T–9 (Tokça)

Figs. 21–34. (102) *Plicatopollis plicatus* (Potonié 1934) Krutzsch 1962b, **Fig. 21.** Sample 03/90 (İncesu); **Figs. 22, 23.** Sample 04YC/02 (Varsakyayla); **Figs. 24, 25.** Sample ÜTPL–4 (Tokça); **Fig. 26.** Sample 04/08 (Kavak); **Fig. 27–29.** Sample 01B/44 (Başçeşme); **Fig. 30.** Sample 04YC/01 (Varsakyayla); **Fig. 31.** Sample 04/09 (Kavak); **Figs. 32–34.** Sample 04/27 (Kavak)

Figs. 35, 36. (103) *Plicatopollis hungaricus* Kedves 1974, **Fig. 35.** Sample ÜTPL – 4 (Tokça); **Fig. 36.** Sample 04/27 (Kavak)

Fig. 37. (104) *Plicatopollis lunatus* Kedves 1974, sample 02B/03 (Başçeşme)

PLATE 11

Figs. 1–4. (104) *Plicatopollis lunatus* Kedves 1974, **Figs. 1, 2a, b**. Sample 02B/04 (Başçeşme); **Figs. 3, 4**. sample 01B/20 (Başçeşme)

Figs. 5–9. (105) *Momipites punctatus* (Potonié 1931a) Nagy 1969, **Figs. 5, 6.** Sample 02i/08 (İncesu); **Fig. 7.** Sample 02i/09 (İncesu); **Fig. 8.** Sample 02i/15 (İncesu); **Fig. 9**. Sample 04/27 (Kavak)

Figs. 10–12. (106) *Momipites quietus* (Potonié 1931c) Nichols 1973, **Figs. 10, 11.** Sample T–4 (Tokça); **Fig. 27.** Sample 04/50 (Aksu)

Fig. 13. (107) *Momipites* sp. 1, sample T–8 (Tokça)

Figs. 14, 15. (108) *Triporopollenites megagranifer* (Potonié 1931a) Thomson & Pflug 1953, **Fig. 14.** Sample T–7 (Tokça); **Fig. 15.** Sample T–19 (Tokça)

Figs. 16, 17. (109) *Triporopollenites robustus* (Mürriger & Pflug 1951) Pflug *in* Thomson & Pflug 1953, samples 02B/03(Başçeşme)

Fig. 18. (110) *Triporopollenites* sp. 1, sample 02B/01

Figs. 19, 20. (111) *Labrapollis labraferus* (Potonié 1931b) Krutzsch 1968, **Fig. 19.** Sample T–14 (Tokça); **Fig. 20.** Sample T–8 (Tokça)

Figs. 21, 22. (112) *Olaxipollis matthesi* Krutzsch 1962b, **Fig. 21**. Sample 02i/04 (İncesu); **Fig. 22**. Sample 01B/20 (Başçeşme)

Figs. 23–25. (113) *Trivestibulopollenites betuloides* Pflug *in* Thomson & Pflug 1953, **Figs. 23, 24.** Sample 02B/03 (Başçeşme); **Fig. 25.** Sample 03/141 (İncesu)

Figs. 26–31. (114) *Caryapollenites simplex* (Potonié 1931b) Raatz ex Potonié 1960, **Fig. 26.** Sample 02i/09 (İncesu); **Fig. 27.** Sample T–19 (Tokça); **Figs. 28, 29.** Sample T–8 (Tokça); **Fig. 30.** Sample 03/89 (İncesu) ; **Fig. 31**. Sample 02i/26 (İncesu)

Figs. 32–34. (115) *Subtriporopollenites anulatus* Thomson & Pflug 1953 ssp. *nanus* Thomson & Pflug 1953, **Fig. 32.** Sample 04YC/01

(Varsakyayla); **Fig. 33.** Sample 01B/11 (Başçeşme); **Fig. 34.** Sample T–4 (Tokça)

PLATE 12

Fig. 1. (115) *Subtriporopollenites anulatus* Thomson & Pflug 1953 ssp. *nanus* Thomson & Pflug 1953, sample T–4 (Tokça)

Figs. 2, 3. (116) *Subtriporopollenites constans* pflug *in* Thomson & Pflug 1953, **Fig. 10.** Sample T–14 (Tokça); **Fig. 11.** Sample 01B/20 (Başçeşme)

Fig. 4. (117) *Celtipollenites intrastructurus* (Krutzsch & Vanhoorne 1977) Thiele-Pfeiffer 1980, sample 02/103 (Tokça)

Fig. 5. (118) *Intratriporopollenites instructus* (Potonié 1931c) Thomson & Pflug 1953, sample 04/27 (Kavak)

Fig. 6. (119) *Intratriporopollenites insculptus* Mai 1961, sample 04/40 (Aksu)

Figs. 7, 8. (120) *Intratriporopollenites indubitalibis* (Potonié 1934) Pflug & Thomson *in* Thomson & Pflug 1953 **Fig. 7.** Sample 01B/20 (Başçeşme); **Fig. 8.** Sample 04YC/01 (Varsakyayla)

Figs. 9a, b. (121) *Compositoipollenites rhizophorus* (Potonié 1934) Potonié 1960 ssp. *burghasungensis* (Mürriger & Pflug 1952) Mürriger & Pflug *in* Thomson & Pflug 1953, sample 04YC/01 (Varsakyayla)

Figs. 10–14 (122) *Polyporopollenites undulosus* (Wolff 1934) Thomson & Pflug 1953, **Fig. 10.** Sample 02B/31 (Başçeşme); **Fig. 11.** Sample 03/100 (İncesu); **Figs. 12–14.** sample T–8 (Tokça)

Figs. 15–19. (123) *Carpinuspollenites carpinoides* (Pflug *in* Thomson & Pflug 1953) Nagy 1969, **Fig. 15.** Sample 02B/03 (Başçeşme); **Fig. 16.** Sample 02B/02 (Başçeşme); **Fig. 17**. Sample T–4 (Tokça); **Figs. 18, 19**. Sample T–8 (Tokça); **Fig. 27.** Sample 02i/17 (İncesu);

Figs. 20–22. (124) *Pterocaryapollenites stellatus* (Potonié 1931d) Thiergart 1937, **Fig. 20.** Sample 02i/17 (İncesu); **Fig. 21.** Sample 04/51 (Aksu); Fig. 22. Sample 03/88 (İncesu)

Figs. 23–28. (125) *Polyvestibulopollenites verus* (Potonié 1931a) Thomson & Pflug 1953, **Figs. 23, 24.** Sample 04/65 (Aksu); **Fig. 25.** Sample T–14 (Tokça); **Fig. 26.** Sample 04/10 (Kavak); **Fig. 27.** Sample 02B/03 (Başçeşme); **Fig. 28.** Sample 02i/26 (İncesu)

Fig. 29. (126) *Reevesiapollis triangulus* (Mamczar 1960) Krutzsch 1970c, sample 04/56 (Aksu)

Figs. 30, 31. (127) *Pentapollenites pentangulus* (Pflug *in* Thomson & Pflug 1953) Krutzsch 1957, **Fig. 30.** Sample 01B/11 (Başçeşme); **Fig. 31.** Sample 04/51 (Aksu)

PLATE 13

Figs. 1, 2. (128) *Cupaneïdites eucalyptoides* Krutzsch, 1962b, sample 02i/17 (İncesu)

Figs. 3–7. (129) *Myrtaceidites mesonesus* Cookson & Pike, 1954, **Fig. 3.** Sample 01B/11 (Başçeşme); **Fig. 4.** Sample 04/56 (Aksu); **Fig. 5.** Sample T–19 (Tokça); **Figs. 6, 7.** Sample T–14 (Tokça)

Figs. 8, 9. (130) *Syncolporites* sp. 1, **Fig. 8.** Sample T–21 (Tokça) ; **Fig. 9.** Sample 04/51 (Aksu)

Figs. 10a, b. (131) *Boehlensipollis hohli* Krutzsch, 1962b, sample 03/90 (İncesu)

Figs. 11a, b. (132) *Slowakipollis hippophäeoides* Krutzsch, 1962b, sample 02i/15 (İncesu)

Figs. 12–15. (133) *Tricolpopollenites henrici* (Potonié 1931a) Thomson & Pflug 1953, **Fig. 12.** Sample 04/08 (Kavak); **Fig. 13.** Sample 04YC/02 (Varsakyayla); **Fig. 14.** Sample T–8 (Tokça); **Fig. 15.** Sample 02i/08 (İncesu);

Figs. 16–21. (134) *Tricolpopollenites densus* Pflug *in* Thomson & Pflug 1953, **Fig. 16.** Sample 04/54 (Aksu); **Fig. 17.** Sample 04/50 (Aksu); **Fig. 18.** Sample 04/51 (Aksu); **Fig. 19.** Sample 04/10 (Kavak); **Figs. 20, 21.** Sample T–8 (Tokça)

Figs. 22–27. (135) *Tricolpopollenites liblarensis* (Thomson *in* Potonié, Thomson & Thiergart 1950) Thomson & Pflug 1953 ssp. *fallax* (Potonié 1934) Thomson & Pflug 1953, **Figs. 22, 23.** Sample T–8 (Tokça); **Fig. 24.** Sample 01B/33 (Başçeşme); **Fig. 25.** Sample 04/51 (Aksu); **Fig. 26.** Sample 04/57 (Aksu); Fig. 27. Sample 04/10 (Kavak)

Figs. 28–34. (136) *Tricolpopollenites liblarensis* (Thomson *in* Potonié, Thomson & Thiergart 1950) Thomson & Pflug 1953 ssp. *liblarensis* (Thomson *in* Potonié, Thomson & Thiergart 1950) Thomson & Pflug 1953, **Fig. 28.** T–8 (Tokça); **Fig. 29.** Sample T–19 (Tokça); **Fig. 30.** Sample T–4 (Tokça); **Fig. 31.** Sample 01B/24 (Başçeşme); **Fig. 32.** Sample 04/56 (Aksu); **Fig. 33.** Sample 04/65 (Aksu); **Fig. 34.** Sample 04/10 (Kavak)

Figs. 35–42. (137) *Tricolpopollenites microhenrici* (Potonié 1931d) Thomson & Pflug 1953, **Figs. 35, 36.** Sample 01B/11 (Başçeşme); **Fig. 37.** Sample 02i/15 (İncesu); **Fig. 38.** Sample 03/100 (İncesu); **Fig. 39.** Sample T–8 (Tokça); **Fig.40 6.** Sample 04/57 (Aksu); **Figs. 41, 42.** Sample 04/10 (Kavak)

Fig. 43. (138) *Tricolpopollenites asper* Thomson & Pflug 1953, sample 04YC/01 (Varsakyayla)

Fig. 44. (139) *Tricolpopollenites parmularius* (Potonié 1934) Thomson & Pglug 1953, sample 01B/24 (Başçeşme)

Figs. 45–47. (140) *Tricolpopollenites retiformis* Thomson & Pflug 1953, **Figs. 45, 46.** Sample 02i/15 (İncesu); **Fig. 47.** Sample 02i/08 (İncesu)

PLATE 14

Figs. 1–4. (140) *Tricolpopollenites retiformis* Thomson & Pflug 1953, **Fig. 1.** Sample 01B/33 (Başçeşme); **Fig. 2.** Sample T–7 (Tokça); **Fig. 3.** Sample T–8 (Tokça); **Fig. 4.** Sample 04/50 (Aksu)

Figs. 5–7. (141) *Retitricolpites* sp. 1, sample T–9 (Tokça)

Fig. 8. (142) *Aceripollenites striatus* (Pflug 1959)Thiele–Pfeiffer 1980, sample 04/10 (Kavak)

Fig. 9. (143) *Polycolpites specious* Dutta & Sah, 1970, sample T–8 (Tokça)

Figs. 10–12. (144) *Tricolporopollenites euphorii* (Potonié 1931a) Thomson & Pflug 1953, **Fig. 10**. Sample 04/10 (Kavak); **Fig. 11.** Sample 04/27 (Kavak); **Fig. 12.** Sample T–17 (Tokça)

Figs. 13–21. (145) *Tricolporopollenites cingulum* (Potonié 1931d) Thomson & Pflug 1953 ssp. *fusus* (Potonié 1931a) Thomson & Pflug 1953, **Figs.**

13, 14. Sample 01B/44 (Başçeşme); **Fig. 15.** Sample 04YC/01 (Varsakyayla); **Fig. 16.** Sample 04/10 (Kavak); **Fig. 17.** Sample 04/27 (Kavak); **Fig. 18**. Sample 04/51 (Aksu); **Fig. 19**. Sample 04/57 (Aksu); **Fig. 20.** Sample 04/56 (Aksu); **Fig. 21.** Sample T–8 (Tokça)

Figs. 22–29. (146) *Tricolporopollenites cingulum* (Potonié 1931d) Thomson & Pflug 1953 ssp. *pusillus* (Potonié 1934) Thomson & Pflug 1953, **Figs. 22, 23.** Sample 04/56 (Aksu); **Fig. 24.** Sample 02i/15 (İncesu); **Fig. 25.** Sample 04/10 (Kavak); **Fig. 26.** Sample 04/08 (Kavak); **Fig. 27**. Sample 04/65 (Aksu); **Fig. 28.** Sample 04/51 (Aksu); **Fig. 29.** Sample T–4 (Tokça)

Figs. 30–37. (147) *Tricolporopollenites cingulum* (Potonié 1931d) Thomson & Pflug 1953 ssp. *oviformis* (Potonié 1931a) Thomson & Pflug 1953, **Fig. 30.** Sample 04/09 (Kavak); **Fig. 31.** Sample 04/27 (Kavak); **Fig. 32.** Sample 04/10 (Kavak); **Fig. 33.** Sample 02i/15 (İncesu); **Fig. 34.** Sample 04/56 (Aksu); **Fig. 35.** Sample 04/65 (Aksu); **Fig. 36.** Sample 04/50 (Aksu); **Fig. 37.** Sample T–14 (Tokça)

Figs. 38–46. (148) *Tricolporopollenites megaexactus* (Potonié 1931d) Thomson & Pflug 1953 ssp. *brühlensis* (Thomson *in* Potonié, Thomson & Thiergart 1950) Thomson & Pflug 1953, **Fig. 38.** Sample T–4 (Tokça); **Fig. 39.** Sample T–8 (Tokça); **Figs. 40, 41.** Sample 01B/44 (Başçeşme); **Figs. 42, 43.** Sample 04/56 (Aksu); **Figs. 44, 45.** Sample 04/50 (Aksu); **Fig. 46.** Sample 04/57 (Aksu)

Figs. 47–53. (149) *Tricolporopollenites megaexactus* (Potonié 1931d) Thomson & Pflug 1953 ssp. *exactus* (Potonié 1931d) Thomson & Pflug 1953, **Figs. 47, 48.** Sample T–4 (Tokça); **Fig. 49.** Sample T–8 (Tokça); **Fig. 50.** Sample 04/09 (Kavak); **Fig. 51.** Sample 04/10 (Kavak); **Fig. 52.** Sample 04/56 (Aksu); **Fig. 53.** Sample 04/50 (Aksu)

PLATE 15

Figs. 1–4. (150) *Tricolporopollenites pseudocingulum* (Potonié 1931a) Thomson & Pflug 1953, **Fig. 1.** Sample 03/88 (İncesu); **Fig. 2.** Sample 04YC/02 (Varsakyayla); **Fig. 3.** Sample T–4 (Tokça); **Fig. 4.** Sample 04/56 (Aksu)

Figs. 5, 6. (151) *Tricolporopollenites marcodurensis* Pflug & Thomson *in* Thomson & Pflug 1953, **Fig. 5.** Sample 03/88 (İncesu); **Fig. 6.** Sample 02/105 (Tokça)

Figs. 7, 8. (152) *Tricolporopollenites genuinus* (Potonié 1934) Thomson & Pflug 1953, sample T–9 (Tokça)

Figs. 9–13. (153) *Tricolporopollenites microreticulatus* Pflug & Thomson *in* Thomson & Pflug 1953 **Figs. 9, 10.** Sample T–8 (Tokça); **Fig. 11.** Sample 04YC/01 (Varsakyayla); **Fig. 12.** Sample 02i/15 (İncesu); **Fig. 13.** Sample 04/09 (Kavak)

Fig. 14. (154) *Tricolporopollenites oleoides* Krutzsch & Vanhoorne 1977, sample 04YC/01 (Varsakyayla)

Figs. 15, 16. (155) *Tricolporopollenites edmundii* (Potonié 1931d) Thomson & Pflug, 1953, **Fig. 15.** Sample 03/90 (İncesu); **Fig. 16.** Sample 04/65 (Aksu)

Figs. 17–19. (156) *Tricolporopollenites pacatus* Pflug *in* Thomson & Pflug 1953,

	Fig. 17. Sample 04/27 (Kavak); **Fig. 18.** Sample 04/56 (Aksu); **Fig. 19.** Sample T–8 (Tokça)
Figs. 20–24.	(157) *Tricolporopollenites villensis* (Thomson *in* Potonié, Thomson & Thiergart 1950) Thomson & Pflug 1953, **Fig. 20.** Sample 04YC/02 (Varsakyayla); **Fig. 21.** Sample 04/08 (Kavak); **Fig. 22**. Sample 04/56 (Aksu); **Figs. 23, 24.** Sample 04/51 (Aksu)
Fig. 25.	(158) *Tricolporopollenites solé de portai* Kedves 1965, sample 04YC/02 (Varsakyayla)
Fig. 26.	(159) *Tricolporopollenites baculoferus* Pflug *in* Thomson & Pflug 1953, sample 04/56 (Aksu)
Fig. 27.	(160) *Tricolporopollenites satzveyensis* Pflug *in* Thomson & Pflug 1953, sample 04/56 (Aksu)
Figs. 28–30.	(161) *Tricolporopollenites kruschi* (Potonié 1931b) Thomson & Pflug 1953 ssp. *pseudolaesus* (Potonié 1931b) Thomson & Pflug 1953, **Fig. 28.** Sample 04YC/02 (Varsakyayla); **Fig. 29.** Sample T–6 (Tokça); **Fig. 30.** Sample 04/65 (Aksu)

PLATE 16

Figs. 1, 2	(162) *Retitricolporites* sp. 1, **Fig. 1.** Sample T–8 (Tokça)**; Fig. 2.** Sample 04/65 (Aksu)
Figs. 3–8.	(163) *Psilatricolporites crassus* Van Der Hammen & Wymstra 1964, **Figs. 3, 4**. Sample 04YC/01 (Varsakyayla); **Figs. 5–8.** Sample 01B/24 (Başçeşme)
Fig. 9.	(164) *Psilatricolporites* cf. *costatus* Dueñas 1980, sample 01B/24 (Başçeşme)
Fig. 10, 11.	(165) *Ilexpollenites margaritatus* (Potonié 1931a) Thiergart 1937 ex Potonié 1960, **Fig. 10**. Sample T–14 (Tokça); **Fig. 11.** Sample 02i/15 (İncesu)
Fig. 12.	(166) *Ilexpollenites iliacus* (Potonié 1931a) Thiergart 1937 ex Potonié 1960, sample T–14 (Tokça)
Fig. 13.	(167) *Umbelliferaepollenites peissenbergensis* Kirchner 1984, sample 04/50 (Aksu)
Fig. 14.	(168) *Tetracolporopollenites sapotoides* Pflug & Thomson *in* Thomson & Pflug 1953, sample 04/57 (Aksu)
Fig. 15–18.	(169) *Tetracolporopollenites obscurus* Pflug & Thomson *in* Thomson & Pflug 1953, **Fig. 15.** Sample 04/01 (Aksu); **Fig. 16**. Sample 04/51 (Aksu); **Fig. 17.** Sample 04YC/01 (Varsakyayla); **Fig. 18.** Sample 04/10 (Kavak)
Fig. 19.	(170) *Tetracolporopollenites biconus* Pflug *in* Thomson & Pflug, 1953, sample 04/65 (Aksu)
Figs. 20–22.	(171) *Tetracolporopollenites microrhombus* Pflug *in* Thomson & Pflug, 1953, **Figs. 20, 21.** Sample 04/57 (Aksu); **Fig. 22.** Sample 04/65 (Aksu)
Figs. 23, 24.	(172) *Chenopodipollis multiplex* (Weyland & Pflug 1957) Krutzsch 1966, sample 01B/20 (Başçeşme)
Fig. 25.	(173) *Periporopollenites multiporatus* Pflug & Thomson *in* Thomson & Pflug 1953, sample 04/65 (Aksu)
Figs. 26, 27.	(174) *Periporopollenites* sp. 1 thallictrum type, sample T–19 (Tokça)

Figs. 28, 29. (175) *Novemprojectus tumanganicus* (Bolotnikova 1973) Frederiksen et al. 2002, **Figs. 28a, b.** Sample 02/03 (Başçeşme); **Fig. 29.** Sample 02/04 (Başçeşme)

PLATE 17

Figs. 1–4. 175) *Novemprojectus tumanganicus* (Bolotnikova 1973) Frederiksen et al. 2002, **Figs. 1–3.** Sample 02/03 (Başçeşme); **Fig. 4 a, b.** Sample 02/04 (Başçeşme)

Figs. 5–7. *Botryococcus braunii* Kützing 1849, **Fig. 5**. Sample 03/88 (İncesu); **Fig. 6.** Sample 03/89 (İncesu); **Fig. 7.** Sample T–7 (Tokça)

Figs. 8–11. *Pediastrum boryanum* (Turpin 1828) Meneghini 1840, **Figs. 8, 9.** Sample 02B/03 (Başçeşme); **Fig. 10.** Sample 02i/26 (İncesu); **Fig. 11.** Sample 03/142 (İncesu)

Fig. 12. *Pediastrum duplex* Meyen 1829, sample 02B/03 (Başçeşme)

Fig. 13. *Cleistopheridium* sp., sample 04YC/01 (Varsakyayla)

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Figs. 1–5. *Cleistopheridium* sp., **Fig. 1.** Sample 02B/04 (Başçeşme); **Fig. 2.** Sample 04/57 (Aksu); **Fig. 3.** Sample 04/50 (Aksu); **Fig. 4.** Sample 04/08 (Kavak); **Fig. 5.** Sample 02i/26 (İncesu)

Fig. 6. *Apectodinium* sp., sample 03/88 (İncesu)

Fig. 7. *Homotrybilium* sp., sample 02B/08 (Başçeşme)

Fig. 8. *Cordosphaeridium* sp., sample 04YC/01 (Varsakyayla)

Figs. 9–12. Dinoflagellate spp. **Fig. 9.** Sample 02B/05 (Başçeşme); **Fig. 10.** Sample 04YC/02 (Varsakyayla); **Fig. 11**. Sample 03/129 (İncesu); Fig. 10. Sample 03/85 (İncesu); **Fig. 12.** Sample 04/51 (Aksu)

PLATE 1

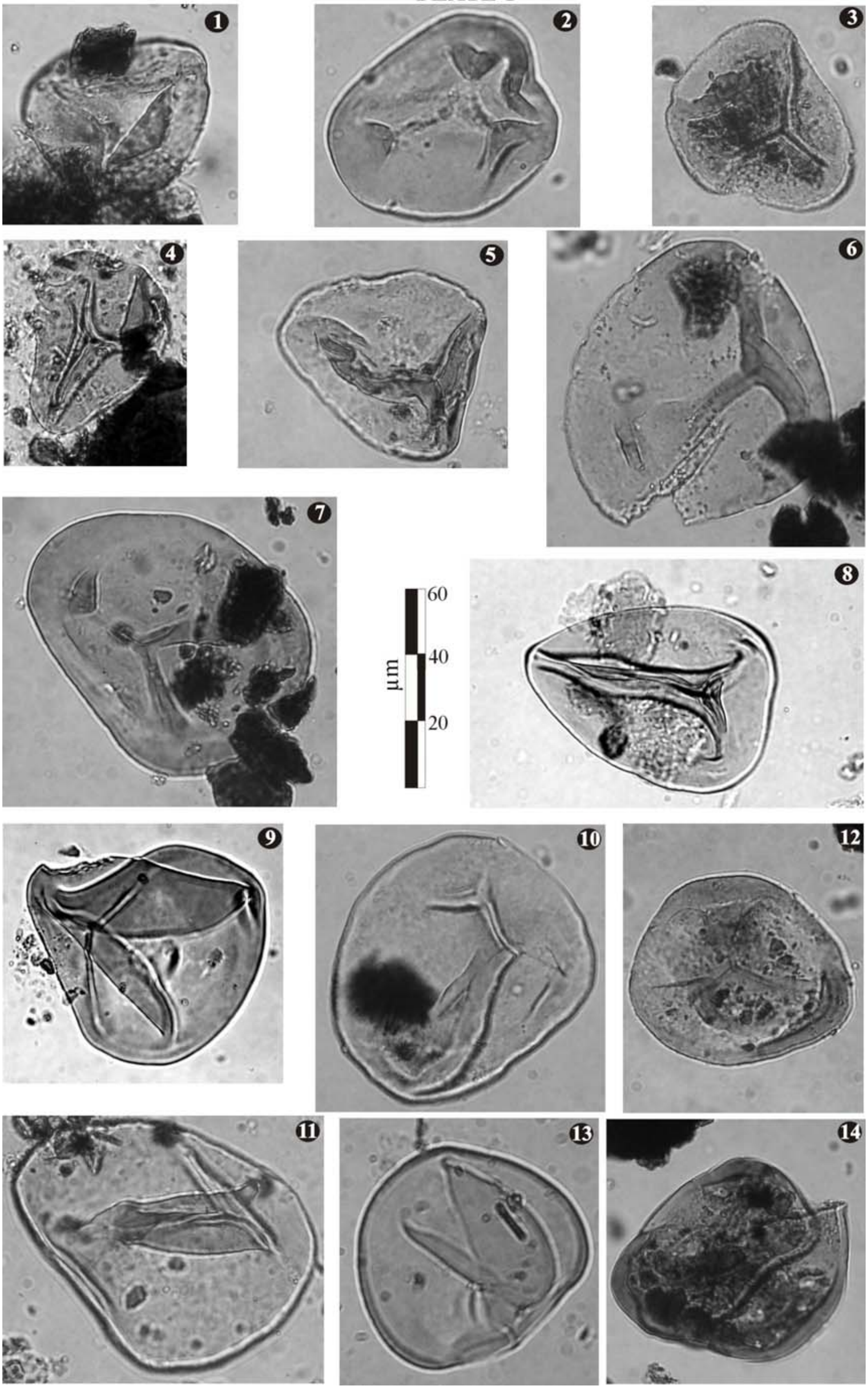

PLATE 2

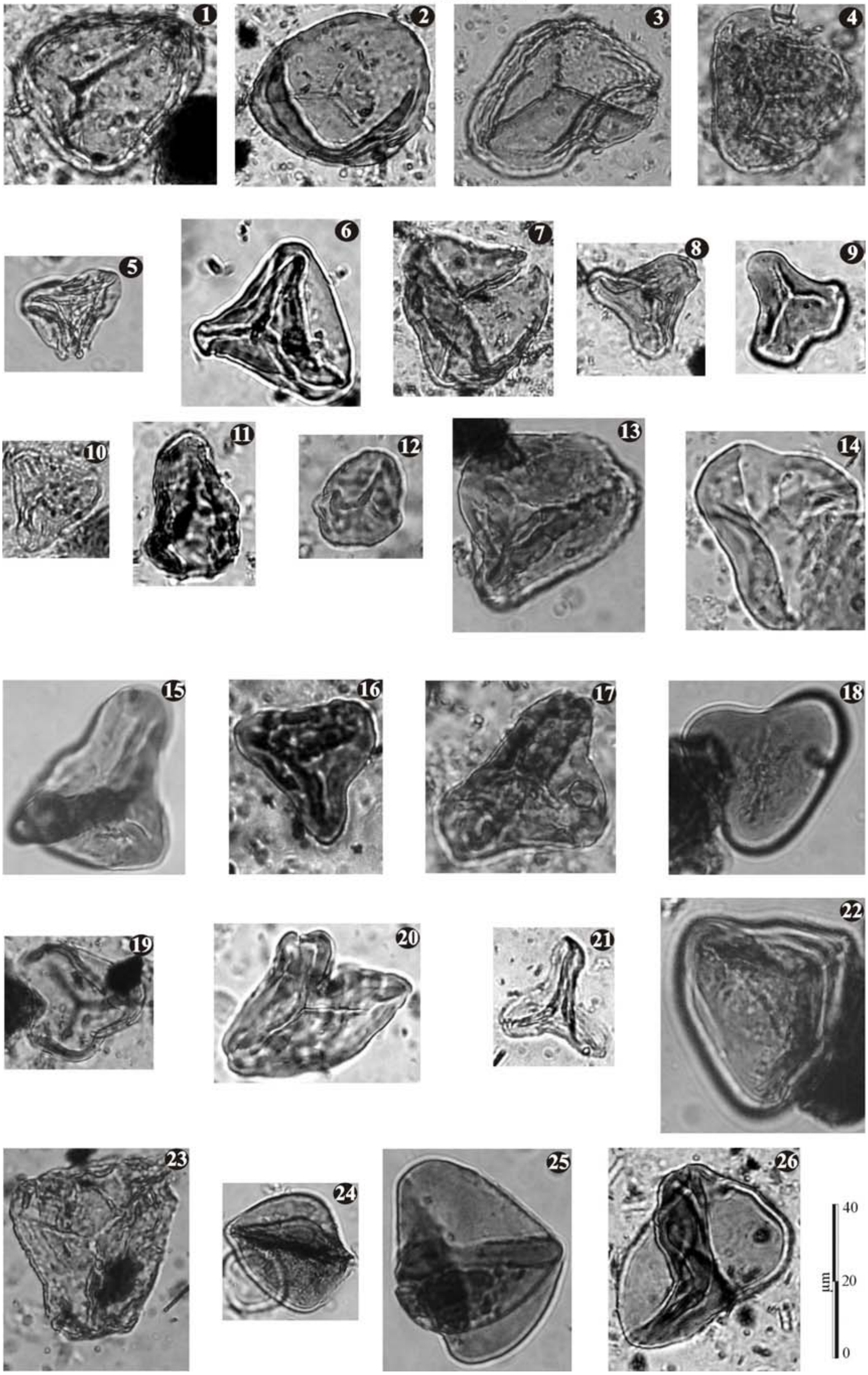

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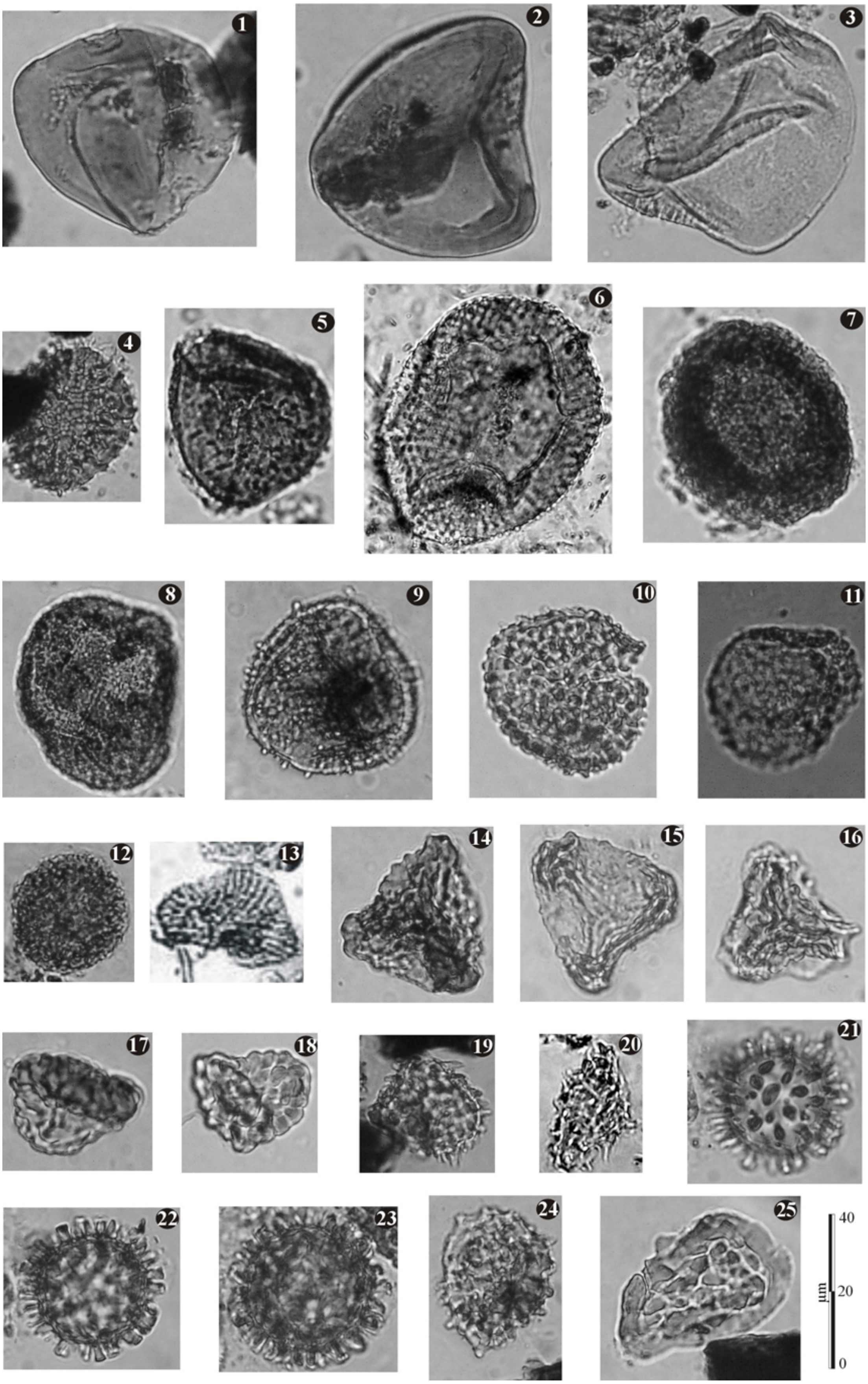
PLATE 3



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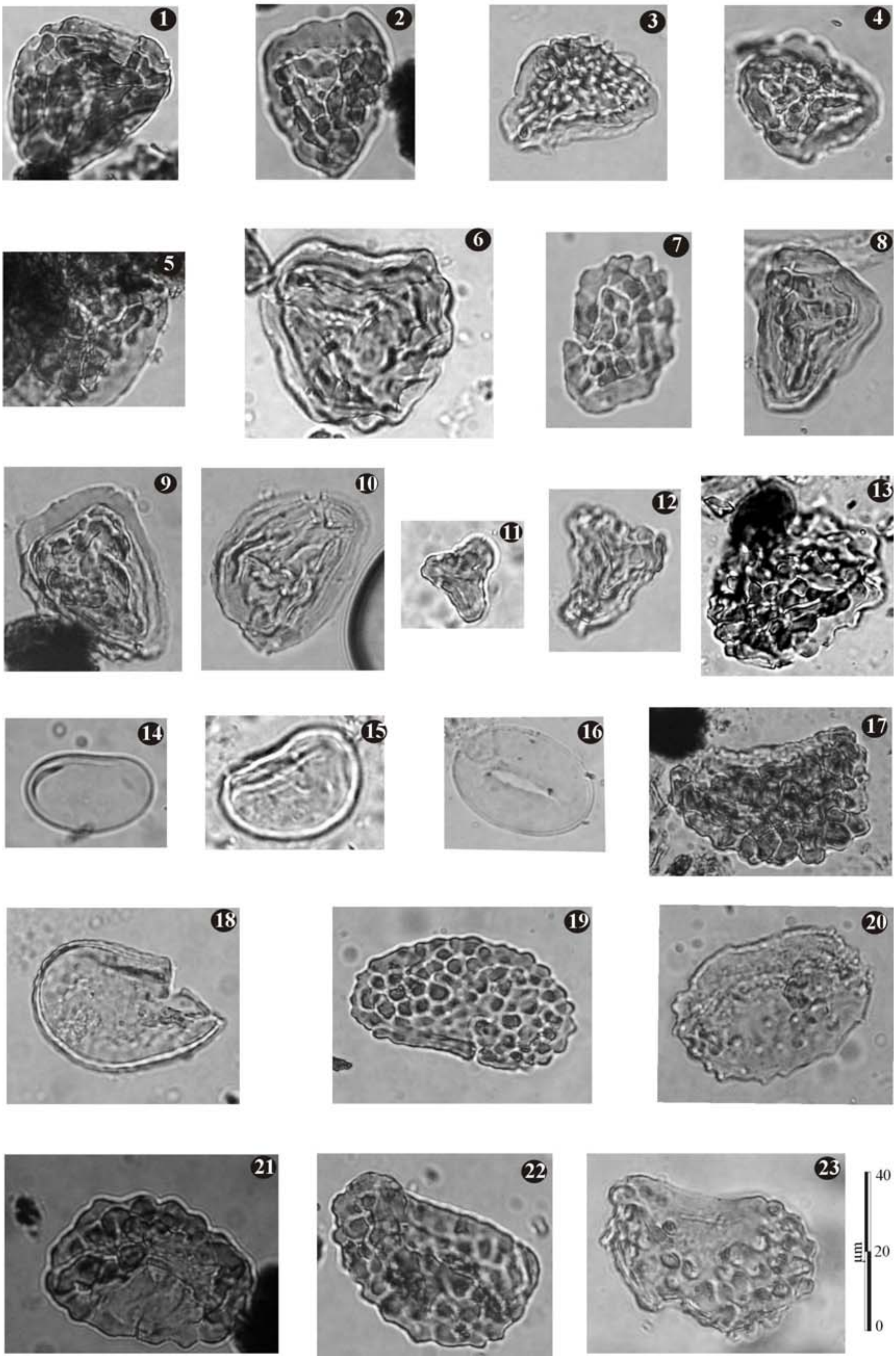

PLATE 5

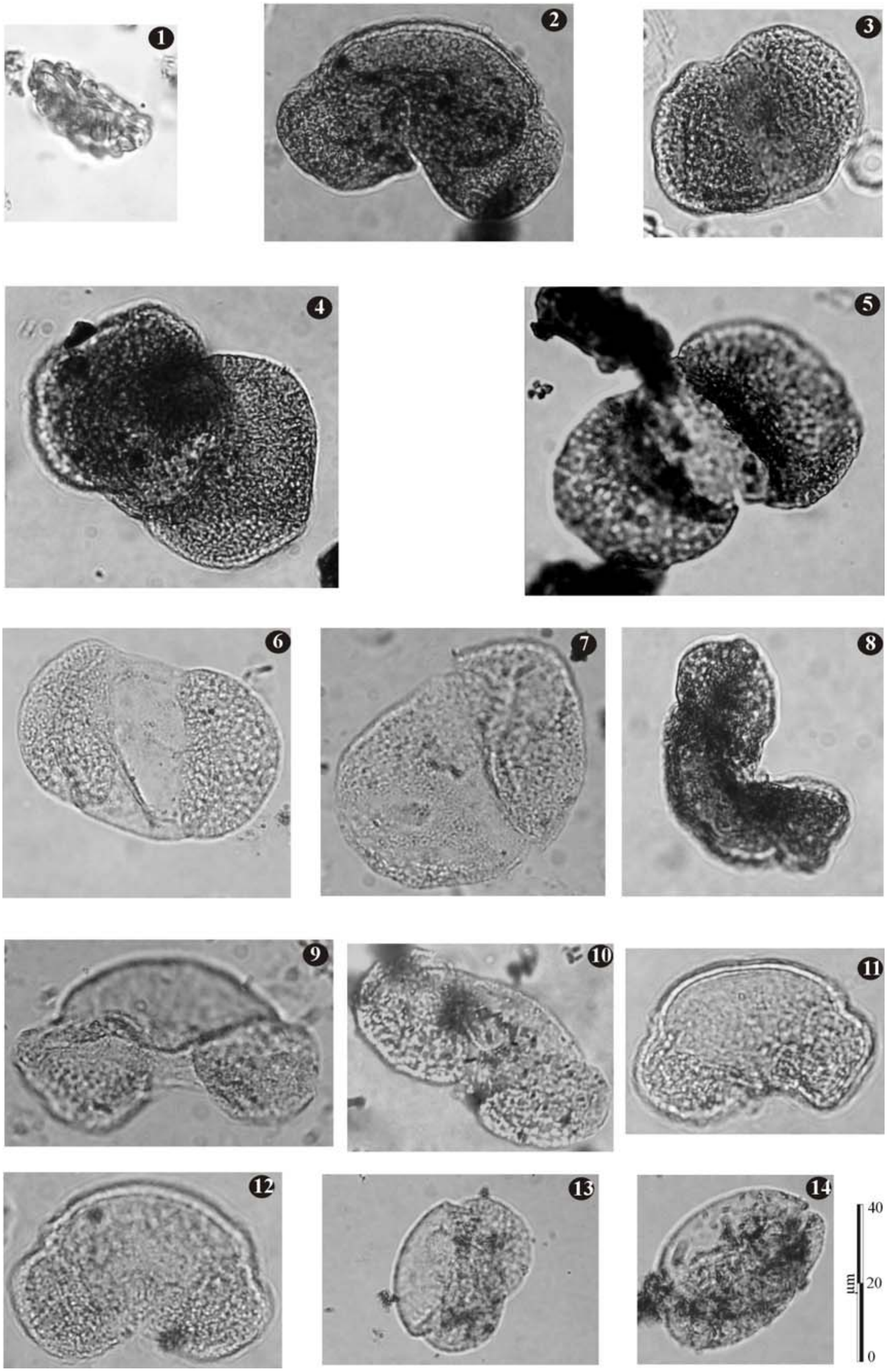

PLATE 6

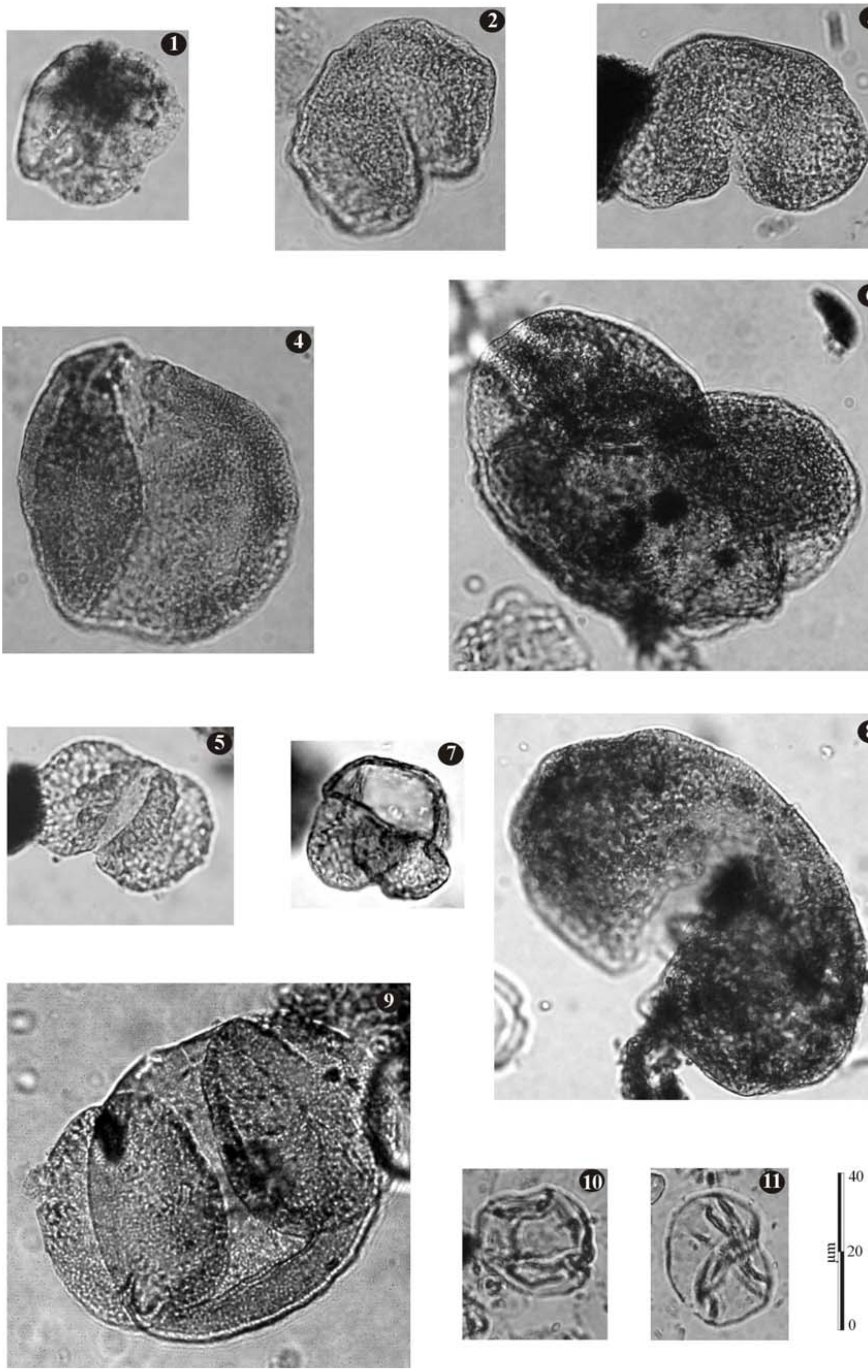

PLATE 7

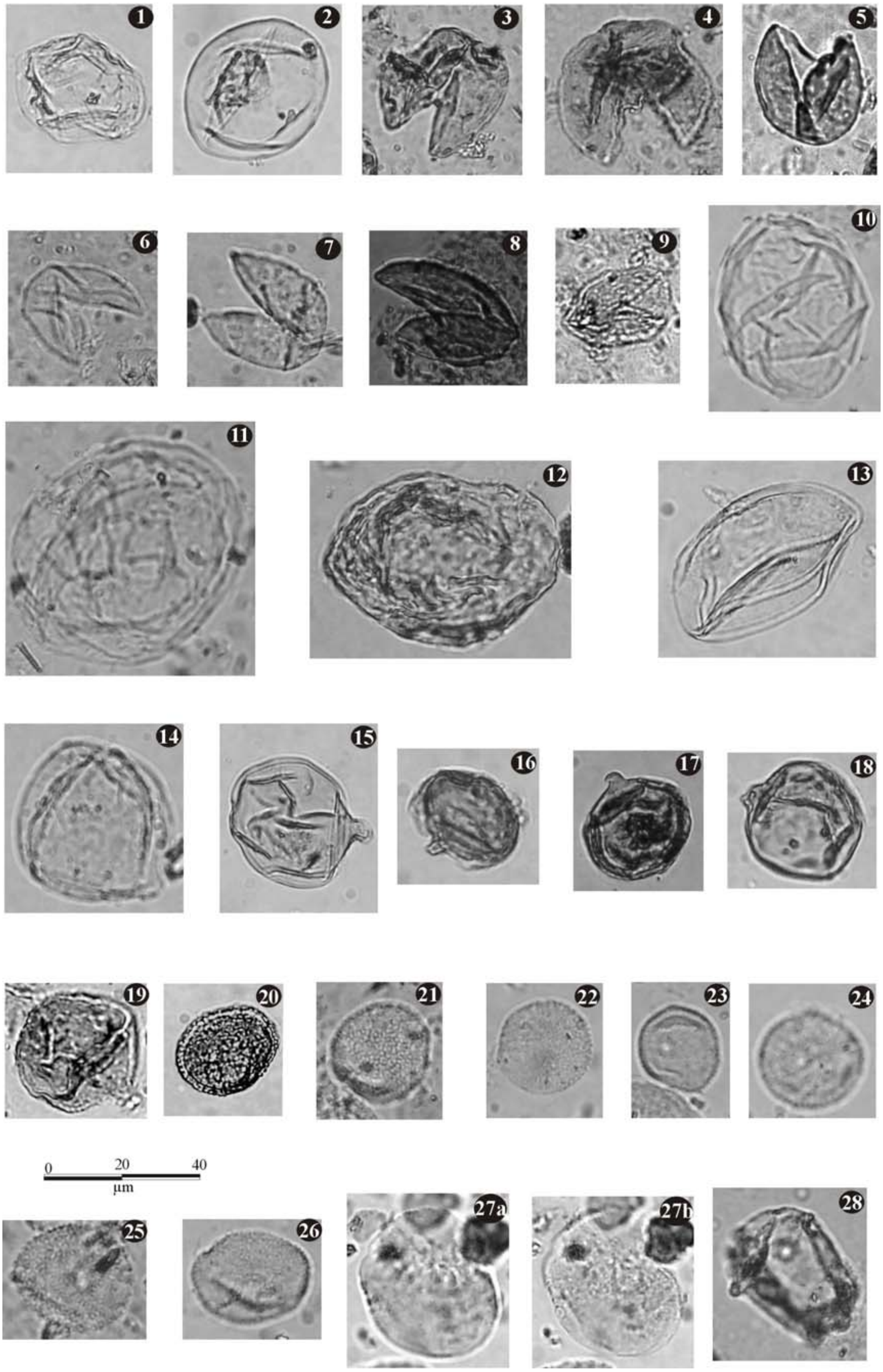
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PLATE 8

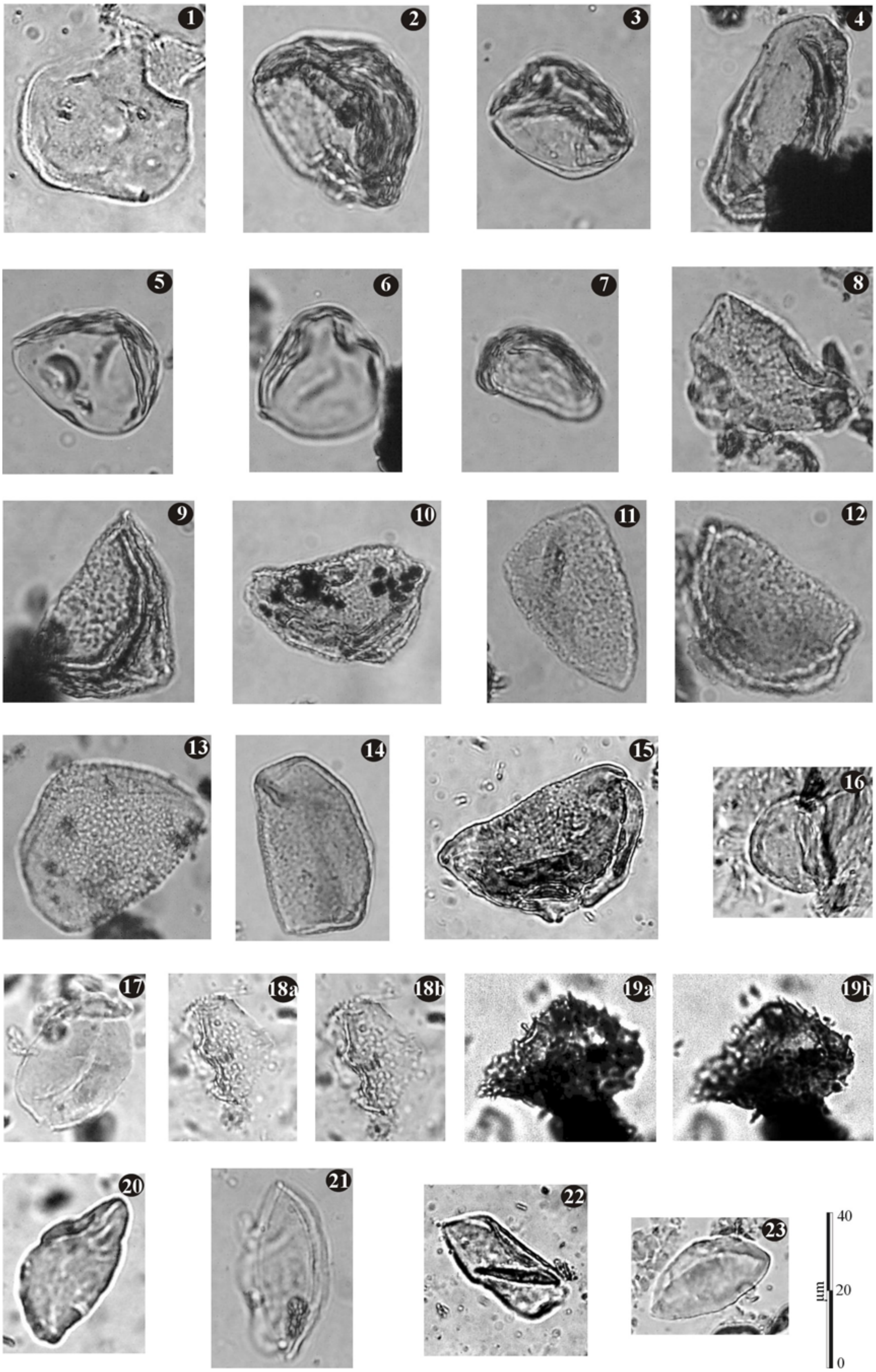

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PLATE 9

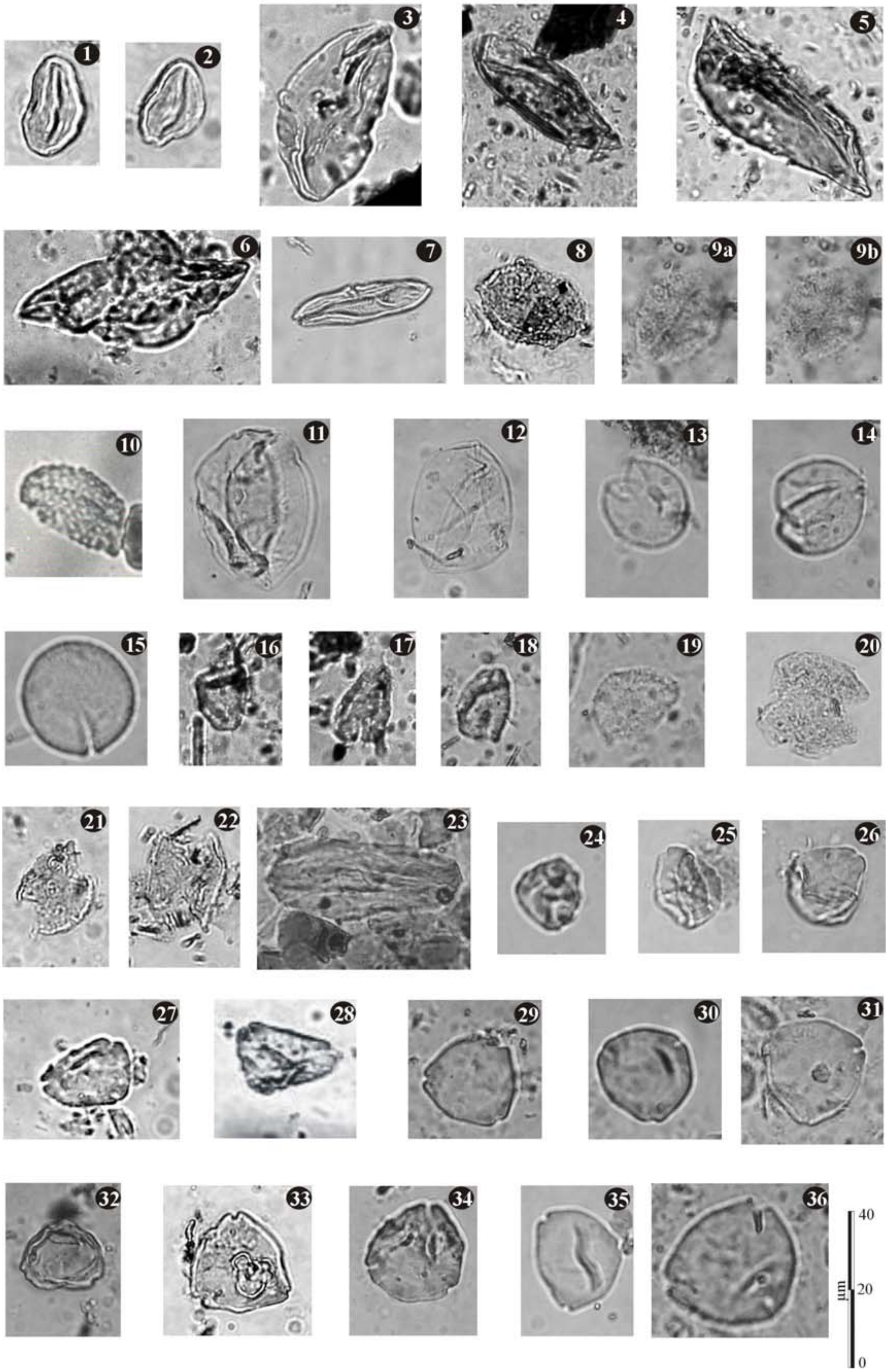
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PLATE 10

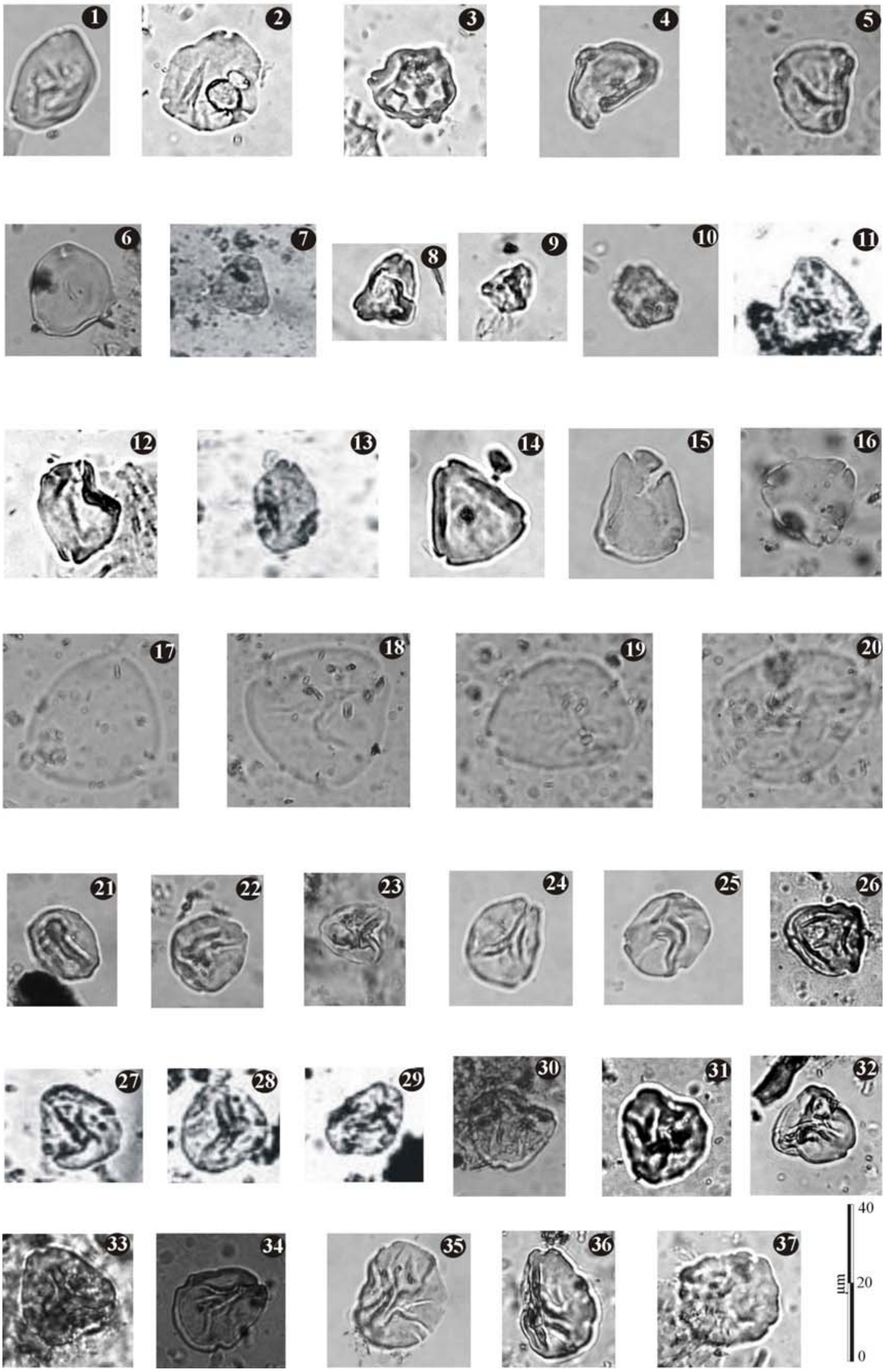

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PLATE 11

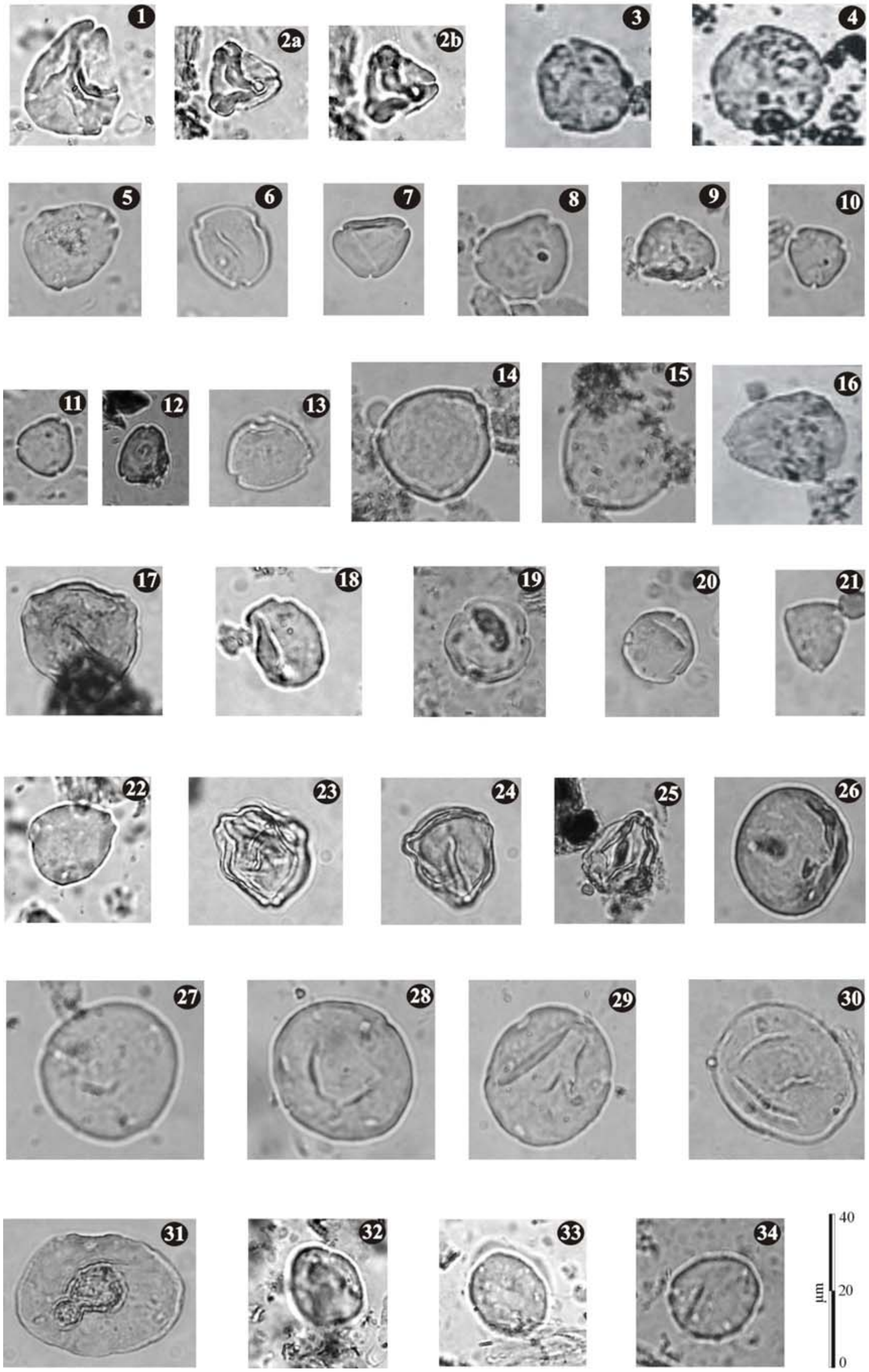
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PLATE 12

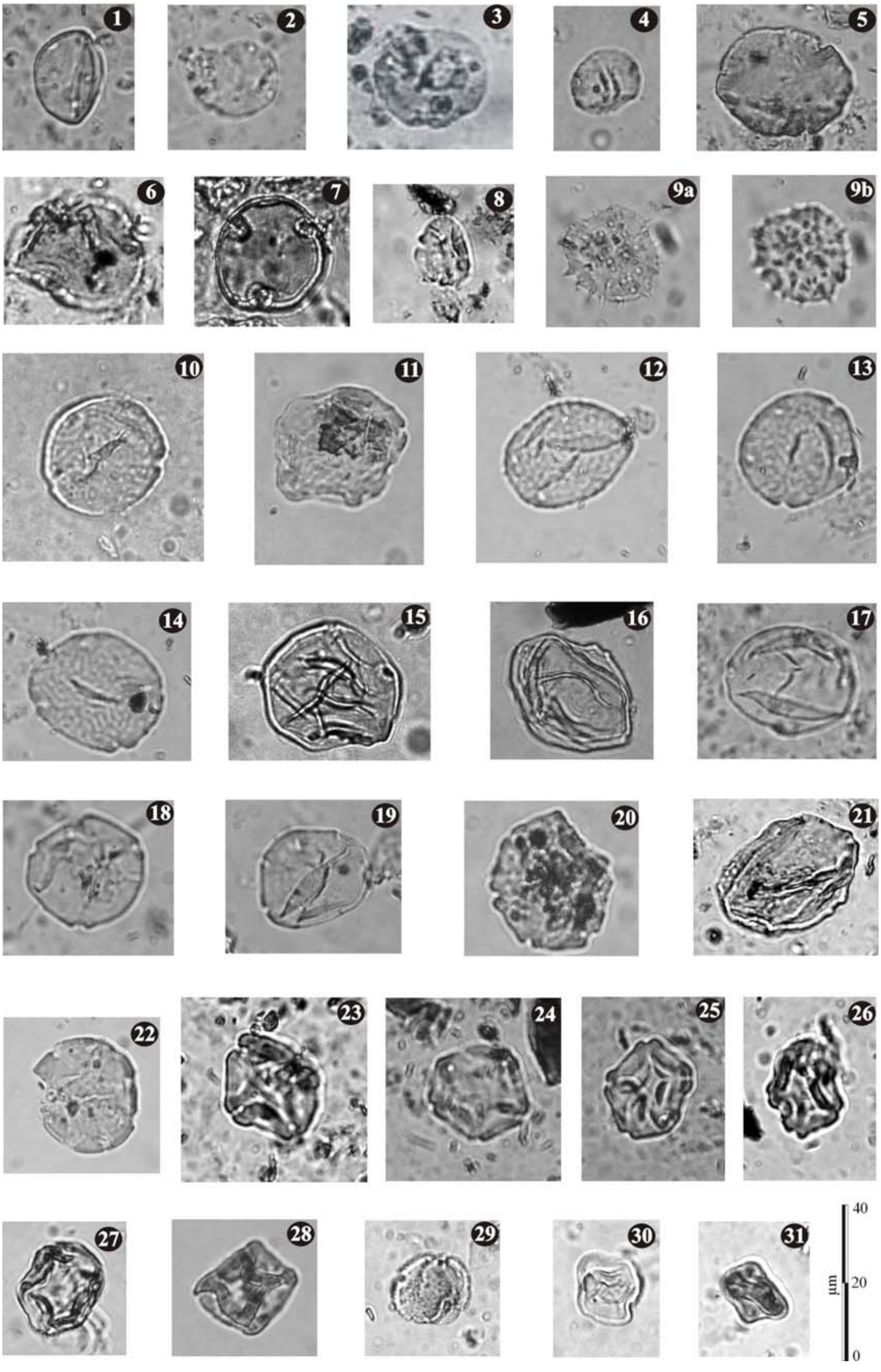

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PLATE 13

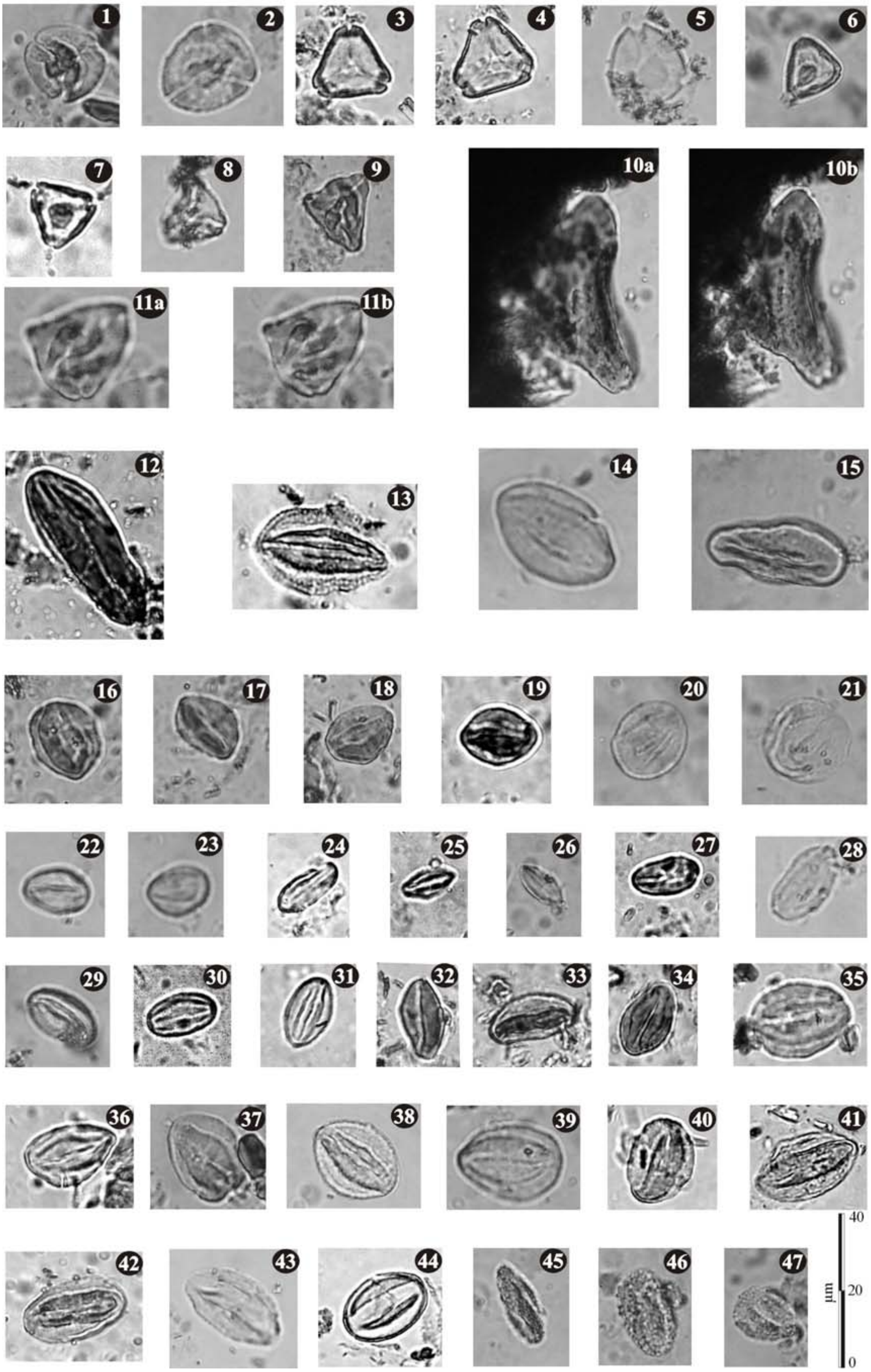
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PLATE 14

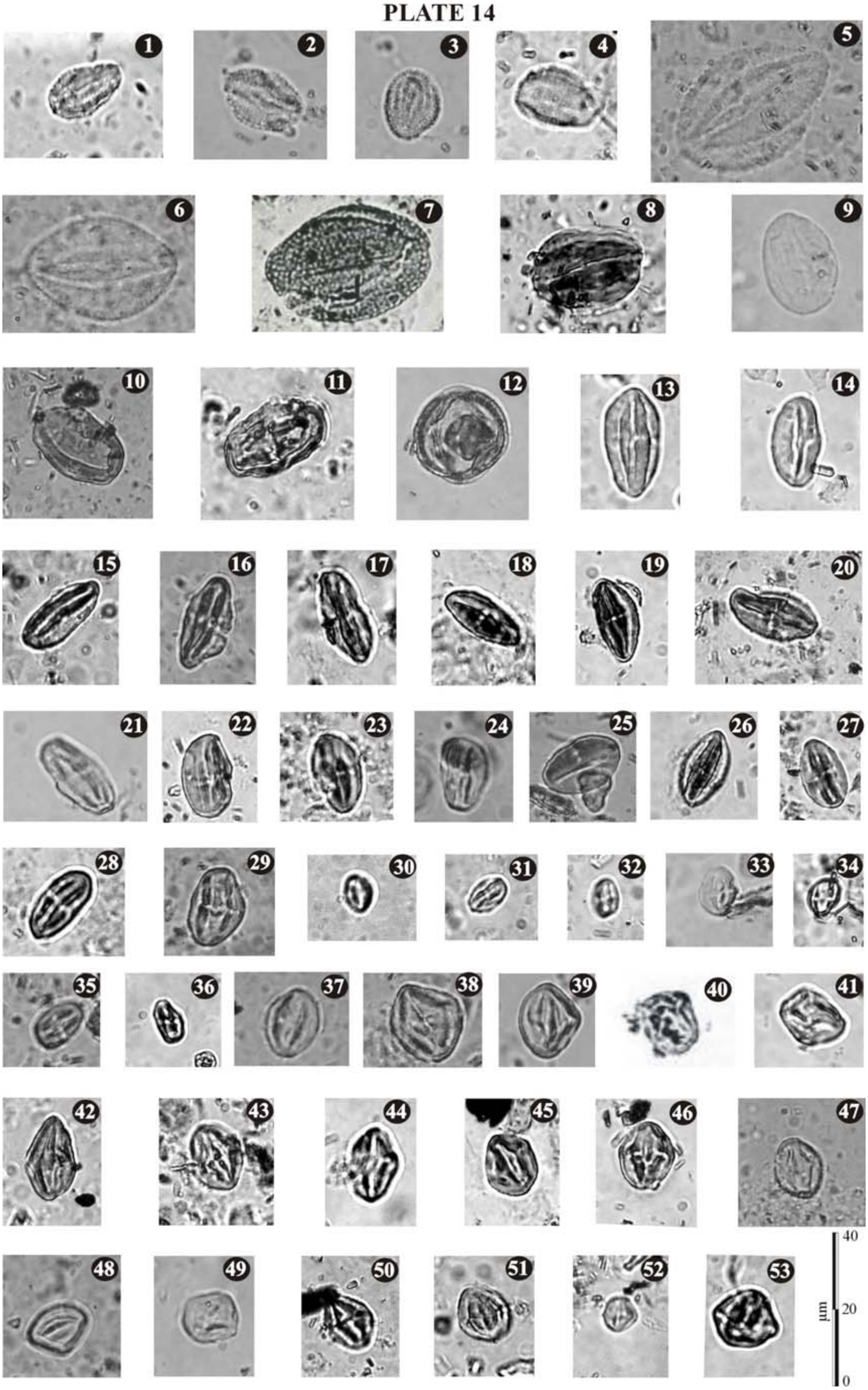
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PLATE 15

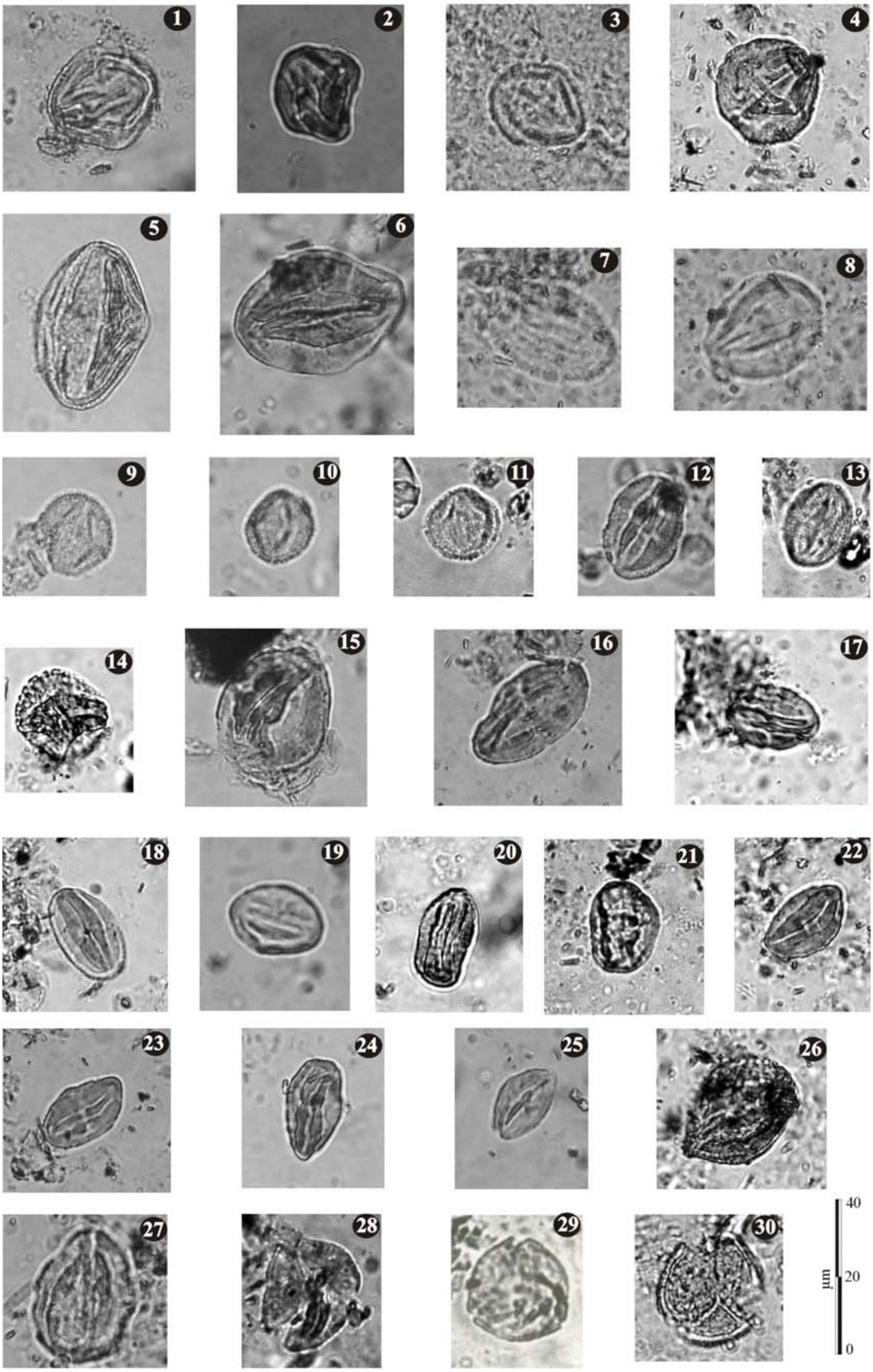
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PLATE 16

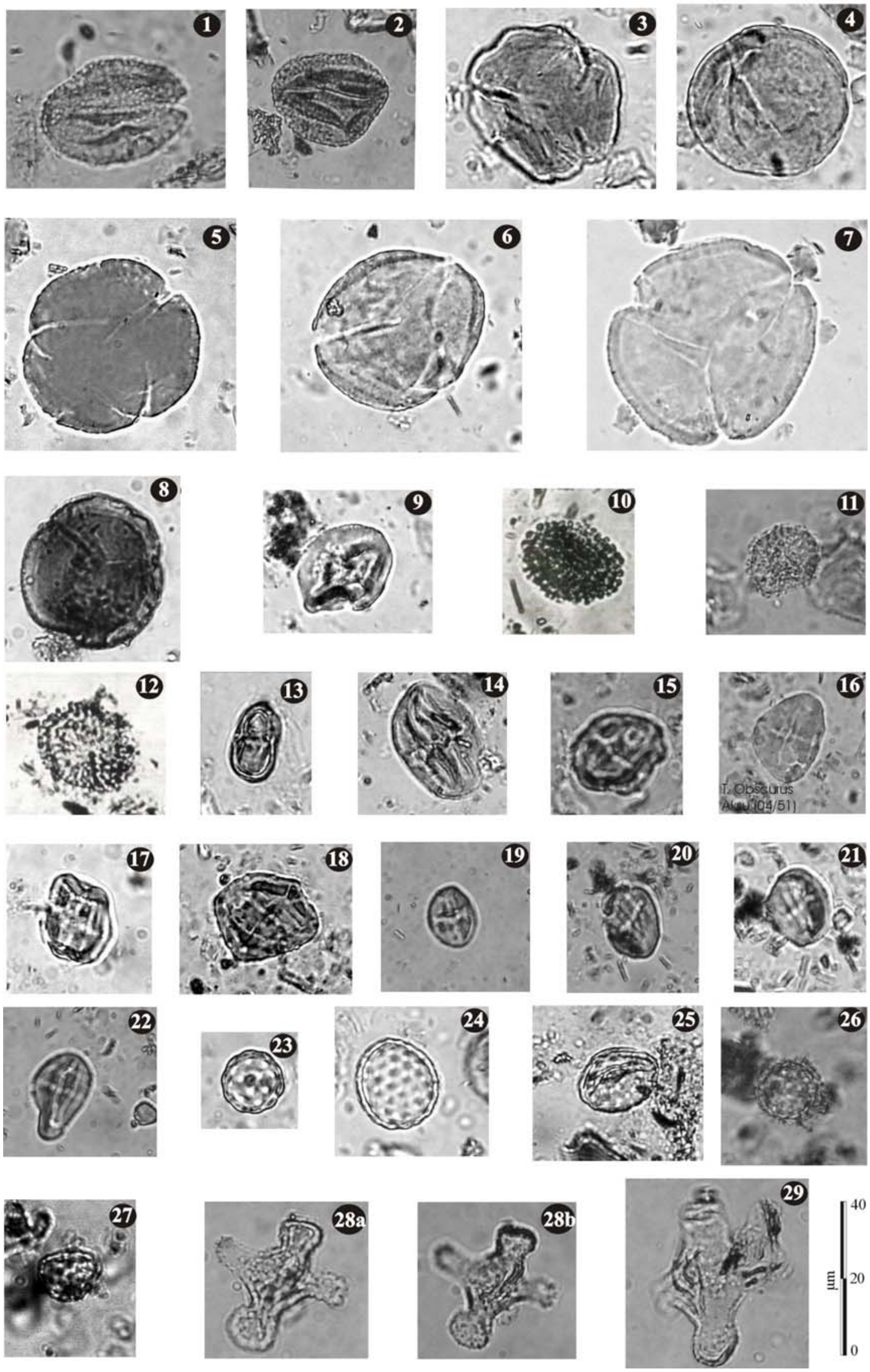

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PLATE 17

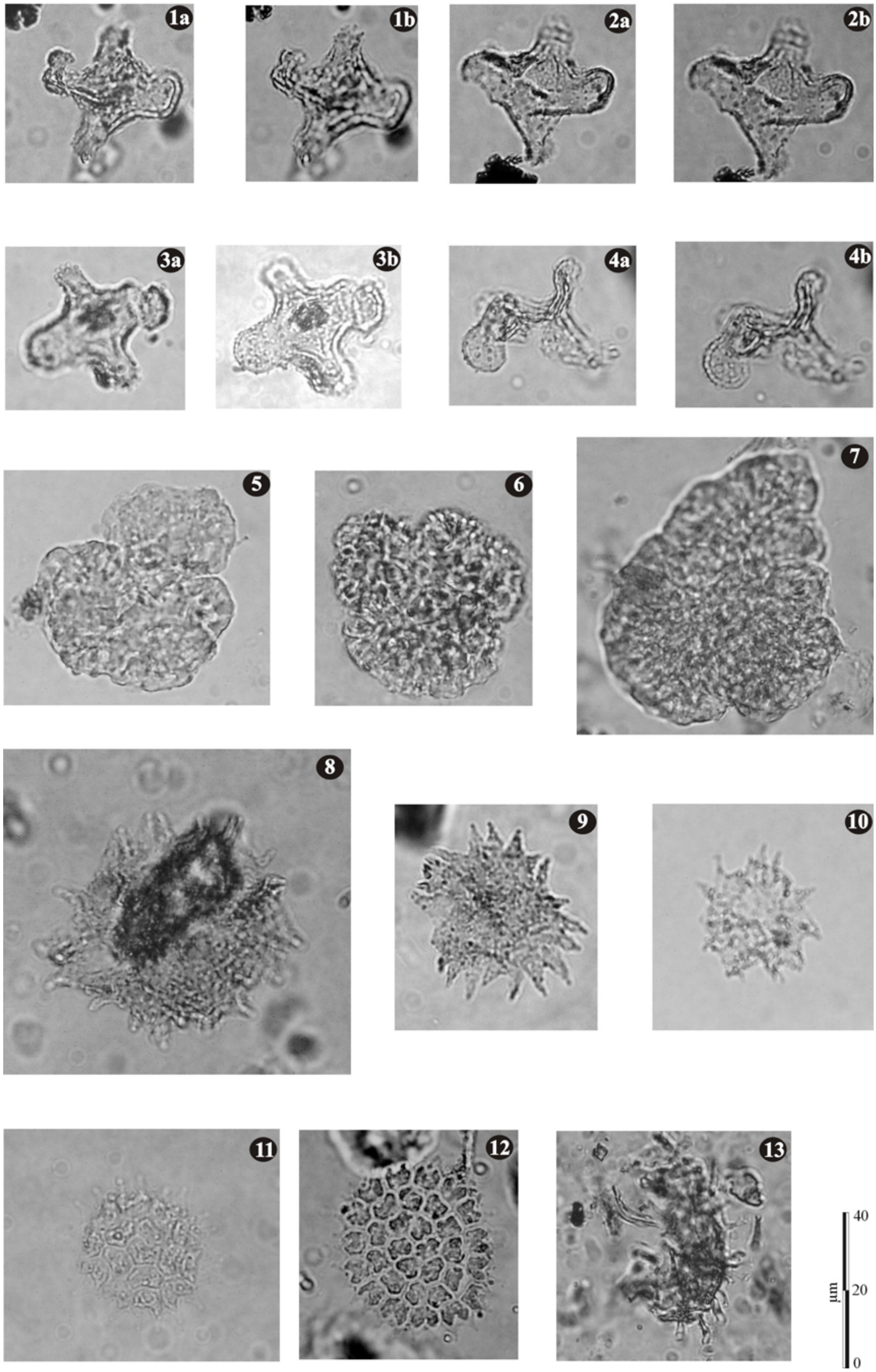
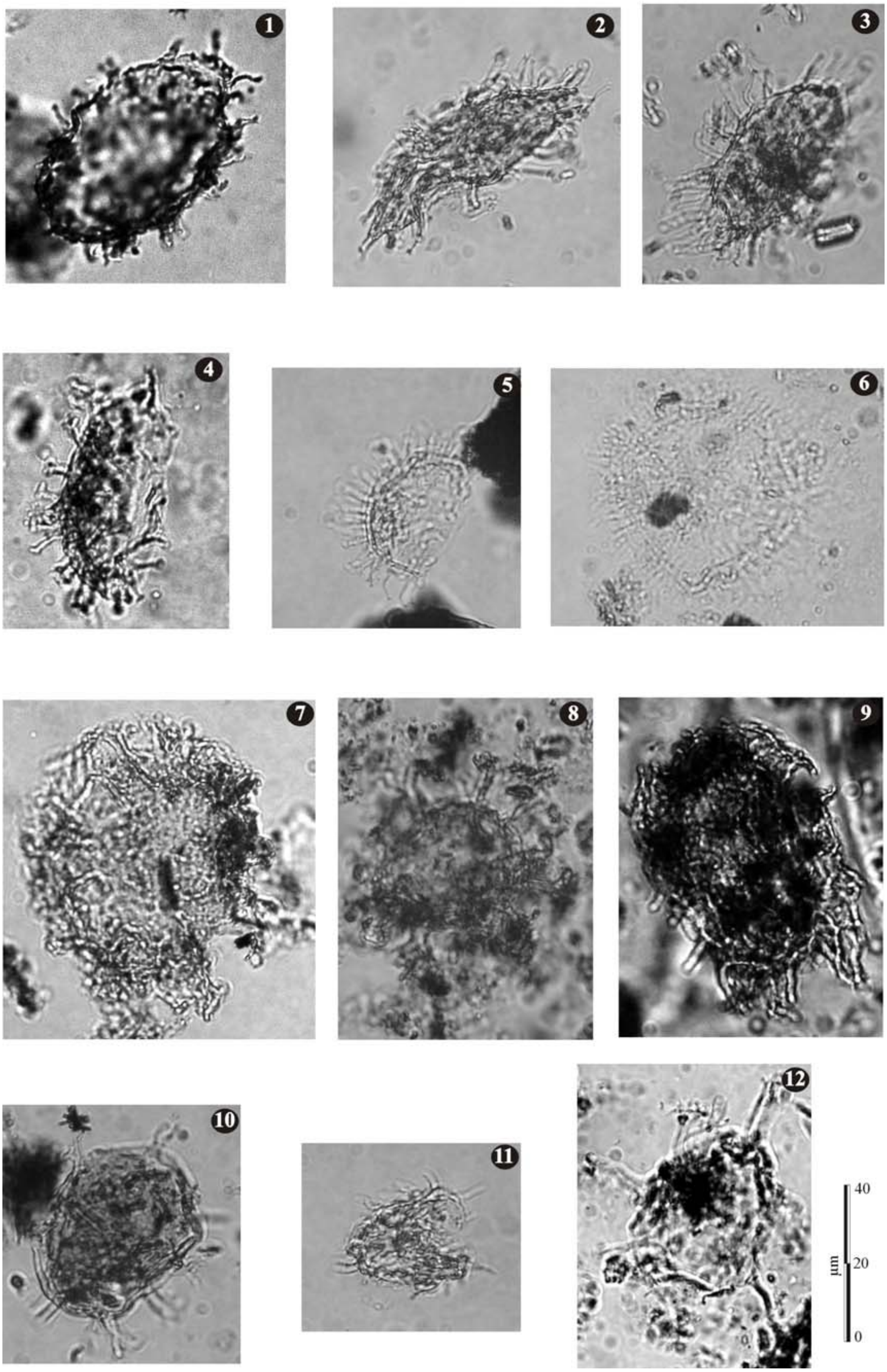


PLATE 18



APPENDIX 2
Digital images of the foraminifers

Specimens are denoted by a sample number (e.g. D1–5) with the name of formation. All photomicrograps have thier own scales.

PLATE 1

Fig. 1. *Globotruncana aegyptiaca* Nakkady, sample D1–5, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Figs. 2, 3. *Globotruncana arca* Cushman, sample D1–5, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Fig. 4. *Globotruncana arca–oriantalis* sample D1–8, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Figs. 5, 6. *Globotruncana bulloides* Vogler, sample D1–8, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Figs. 7, 8. *Globotruncanita* cf. *calcarata* Cushman, sample D1–8, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Fig. 9. *Globotruncana linneiana* D'Orbigny, sample D1–5, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Figs. 10–13. *Globotruncana rosetta* Carsey, **Fig. 10.** Sample D1–5, **Figs. 11, 12.** Sample D1–8, **Fig. 13.** D1–6, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Figs. 14, 15. *Globotruncanita stuartiformis* Dalbiez, **Fig. 14.** Sample D1–5; **Fig. 15.** Sample D1–6, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Figs. 16, 17. *Globotruncana ventricosa* White, sample D1–6, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

Fig. 18. *Contusotruncana walfischensis* Todd, samle D1–7, Pelagic limestones of Bey Dağları Autochthonous (Delikarkası section)

PLATE 2

Fig. 1. Nodosariidae, sample 03/27G

Figs. 2, 3. Lagenidae, **Fig. 2**. Sample 03/27G; **Fig. 3.** Sample 03/28G

Figs. 4, 5. *Acarinina* cf. *bulbrooki* Bolli, **Fig. 4.** Sample 03/29G; **Fig. 5.** Sample 03/30G

Figs. 6–8. *Acarinina* sp., **Figs. 6, 7.** Sample 03/27G; **Fig. 8.** Sample 03/30G

Figs. 9–11. *Morozovella* sp., sample 03/27G

Figs. 12–14. *Globigerina* sp., sample 03/28G

Fig. 15. *Globigerapsis* sp., sample 03/27G

Figs. 16, 17. *Globigerapsis* ? sp., **Fig. 16.** Sample 03/30G; **Fig. 17.** Sample 03/31G

Figs. 18-20. Globigeriniidae, **Figs. 18, 19**. Sample 03/27G; **Fig. 20.** Sample 03/28G

PLATE 3

Fig. 1. *Nummulites* sp., sample 03/10G (Kayıköy Formation)

Fig. 2. *Assilina* sp., sample 03/13G (Kayıköy Formation)

Fig. 3. *Discocyclina* sp., sample 03/14G (Kayıköy Formation)

Figs. 4–6. Rotaliidae, **Fig. 4.** Sample 03/13G; **Fig. 5.** Sample 03/11G; **Fig. 6.** Sample 03/06G (Kayıköy Formation)

Fig. 7. Nodosariidae, sample 03/11G (Kayıköy Formation)

PLATE 4

Figs. 1–4. *Nummulites striatus* Bruguiere, **Fig. 1.** Sample A2; **Fig. 2.** Sample A3; **Fig. 3.** Sample A3; **Fig. 4.** Sample A7 (Başçeşme Formation)

Figs. 5, 6. *Nummulites fabianii* Prever, **Fig. 5.** Sample A2; **Fig. 6.** Sample A4 (Başçeşme Formation)

PLATE 5

Fig. 1. *Nummulites fabianii* Prever, sample A4 (Başçeşme Formation)

Fig 2. *Assilina* sp., sample A3 (Başçeşme Formation)

Figs. 3, 4. *Discocyclina* sp., sample A14 (Başçeşme Formation)

Figs. 5, 6. *Praebullalveolina* sp., **Fig. 5.** Sample A6; **Fig. 6.** Sample A15 (Başçeşme Formation)

Figs. 7–9. *Cibicides* sp., **Fig. 7.** Sample A1; **Fig. 8.** Sample A18; **Fig. 9.** Sample A15 (Başçeşme Formation)

PLATE 6

Figs. 1-3. *Fabiania cassis* Oppenheim, **Fig. 1.** Sample A47; **Fig. 2.** Sample A2; **Fig. 3.** Sample A34 (Başçeşme Formation)

Fig. 4. *Baculogypsinoides tetraedra* Gumbel, sample A25 (Başçeşme Formation)

Fig. 5. *Alveolina* sp., sample A12 (Başçeşme Formation)

Fig. 6. *Heterostegina* sp., sample A26 (Başçeşme Formation)

Fig. 7. *Orbitolites* sp., sample A21 (Başçeşme Formation)

Fig. 8. *Distichoplax* sp., sample A11 (Başçeşme Formation)

PLATE 7

Figs. 1–3. *Nummulites fabianii* Prever, **Fig. 1.** Sample 04YC/01; **Figs. 2, 3.** Sample 04YC/14 (Varsakyayla Formation)

Fig. 4. *Eorupertia magna* Le Calvez, sample 04YC/01 (Varsakyayla Formation)

Figs. 5-7. *Peneroplis* sp., sample 04YC/16 (Varsakyayla Formation)

Figs. 8,9. Peneropliidae, sample 04YC/11 (Varsakyayla Formation)

PLATE 8

Figs. 1,2. *Halkyardia minima* Liebus, **Fig. 1.** Sample 04YC/13; **Fig. 2**. Sample 04YC/20 (Varsakyayla Formation)

Fig. 3. *Eorupertia magna* Le Calvez, sample 04YC/02 (Varsakyayla Formation)

Fig. 4. *Mississippina* sp., sample 04YC/23 (Varsakyayla Formation)

Fig. 5. *Textularia* sp., sample 04YC/22 (Varsakyayla Formation)
Fig. 6. *Planorbulina* sp., sample 04YC/23 (Varsakyayla Formation)
Fig. 7. *Linderina*? sp., sample 04YC/32 (Varsakyayla Formation).
Figs. 8,9. Discorbiidae, sample 04YC/08 (Varsakyayla Formation)
Figs. 10. *Ditrupa* sp., sample 04YC/37 (Varsakyayla Formation)

PLATE 9

Figs. 1–3. *Lepidocyclina (Nephrolepidina)* sp., **Figs. 1, 3**. Sample Ü–14; **Fig. 2.** Sample Ü–13 (Üçtepeler reef member)
Fig. 4. *Lepidocyclina (Eulepidina)* sp., sample Ü–1(Üçtepeler reef member)

PLATE 10

Fig. 1. *Spiroclypeus* sp., sample Ü–19 (Üçtepeler reef member)
Figs. 2, 3. *Amphistegina* sp., sample Ü–17 (Üçtepeler reef member)
Figs. 4, 5. *Discorbis* sp., sample Ü–16(Üçtepeler reef member)
Fig. 6. *Miogypsinoides*? sp., sample Ü–13 (Üçtepeler reef member)
Fig. 7. *Mississippina* sp., sample Ü–6 (Üçtepeler reef member)
Fig. 8. *Planorbulina* sp., sample Ü–4 (Üçtepeler reef member)
Figs.9,10. *Archaias* sp., sample Ü–18 (Üçtepeler reef member)
Fig. 11. *Anomalina* sp., sample Ü–3 (Üçtepeler reef member)
Fig. 12. Nodosarinidae, sample Ü–16 (Üçtepeler reef member)

PLATE 11

Figs. 1,2. *Austrotrillina* sp., sample Ü–17 (Üçtepeler reef member)
Fig. 3. Lagenidae, sample Ü–17 (Üçtepeler reef member)
Fig. 4. Valvulinidae, sample Ü–5 (Üçtepeler reef member)
Fig. 5. Hauerinidae, sample Ü–18 (Üçtepeler reef member)
Fig. 6. Peneropliidae, sample Ü–8 (Üçtepeler reef member)
Fig. 7. Dasycladacea, sample Ü–15 (Üçtepeler reef member)

PLATE 12

Figs. 1-4. *Nummulites intermedius* D'Archiac, sample D2–02 (Delikarkası Formation)
Figs. 5, 6 *Pyrgo* sp., sample D2–01 (Delikarkası Formation)
Fig. 7. *Anomalina* sp., sample D1–20 (Delikarkası Formation)
Fig. 8. *Quinqueloculina* sp., sample D2–01 (Delikarkası Formation)
Fig. 9. Haueriniidae, sample D2–01 (Delikarkası Formation)
Figs. 10,11. Valvuliniidae?, sample D1–17 (Delikarkası Formation)

PLATE 13

Figs. 1, 3,4 *Nummulites intermedius* D'Archiac, sample D2–02 (Delikarkası Formation)
Fig. 2. *Nummulites* cf. *vascus* Joly & Leymerie, sample D2–02 (Delikarkası Formation)
Fig. 5. *Lepidocyclina* cf. *dilatata* D'Archiac, sample D2–02 (Delikarkası Formation)
Figs. 6, 7. *Lepidocyclina* sp., **Fig. 6.** Sample D2–03; **Fig. 7.** Sample D2–02

(Delikarkası Formation)

Fig. 8. *Operculina* sp., sample D2–02 (Delikarkası Formation)

PLATE 14

Figs. 1-3. *Amphistegina* sp., **Fig. 1.** Sample D1–09; **Fig. 2.** Sample D1–14; **Fig. 3**. Sample D1–10 (Delikarkası Formation)

Fig. 4. *Asterigerina* sp., sample D1–18 (Delikarkası Formation)

Figs. 5,6. *Austrotrillina* sp., sample D1 – 26 (Delikarkası Formation)

Figs. 7,8. *Borelis* sp., **Fig. 7.** Sample D1–14; **Fig. 8.** Sample D1–20 (Delikarkası Formation)

Fig. 9. *Discorbis* sp., sample D1–26 (Delikarkası Formation)

Fig. 10. *Gypsina* sp., sample D2–01(Delikarkası Formation)

PLATE 15

Fig. 1, 2. *Halkyardia maxima* Cimerman, sample D1–17 (Delikarkası Formation)

Fig. 3. *Sphaerogypsina globulus* Reuss, sample D1–21 (Delikarkası Formation)

Fig. 4. *Sphaerogypsina* sp., sample D1–20 (Delikarkası Formation)

Fig. 5. *Halkyardia* sp., sample D1–15 (Delikarkası Formation)

Fig. 6. *Pararotalia* sp., sample D1–12 (Delikarkası Formation)

Fig. 7. *Heterostegina* sp., sample D1–22 (Delikarkası Formation)

Fig. 8. *Victoriella* sp., sample D1–29 (Delikarkası Formation)

Fig. 9. Rotaliidae, sample D2–03 (Delikarkası Formation)

Figs. 10,11. *Microcodium* sp., sample D1–25 (Delikarkası Formation)

PLATE 16

Figs. 1, 2. *Lepidocyclina* sp., **Fig. 1.** Sample 04/22K; **Fig. 2.** Sample 04/21K (Kavak Formation)

Fig. 3. *Sphaerogypsina globulus* Reuss, sample 04/24K (Kavak Formation)

Figs. 4,5. *Archaias* sp., **Fig. 4**. Sample 04/06K; **Fig. 5**. Sample 04/03K

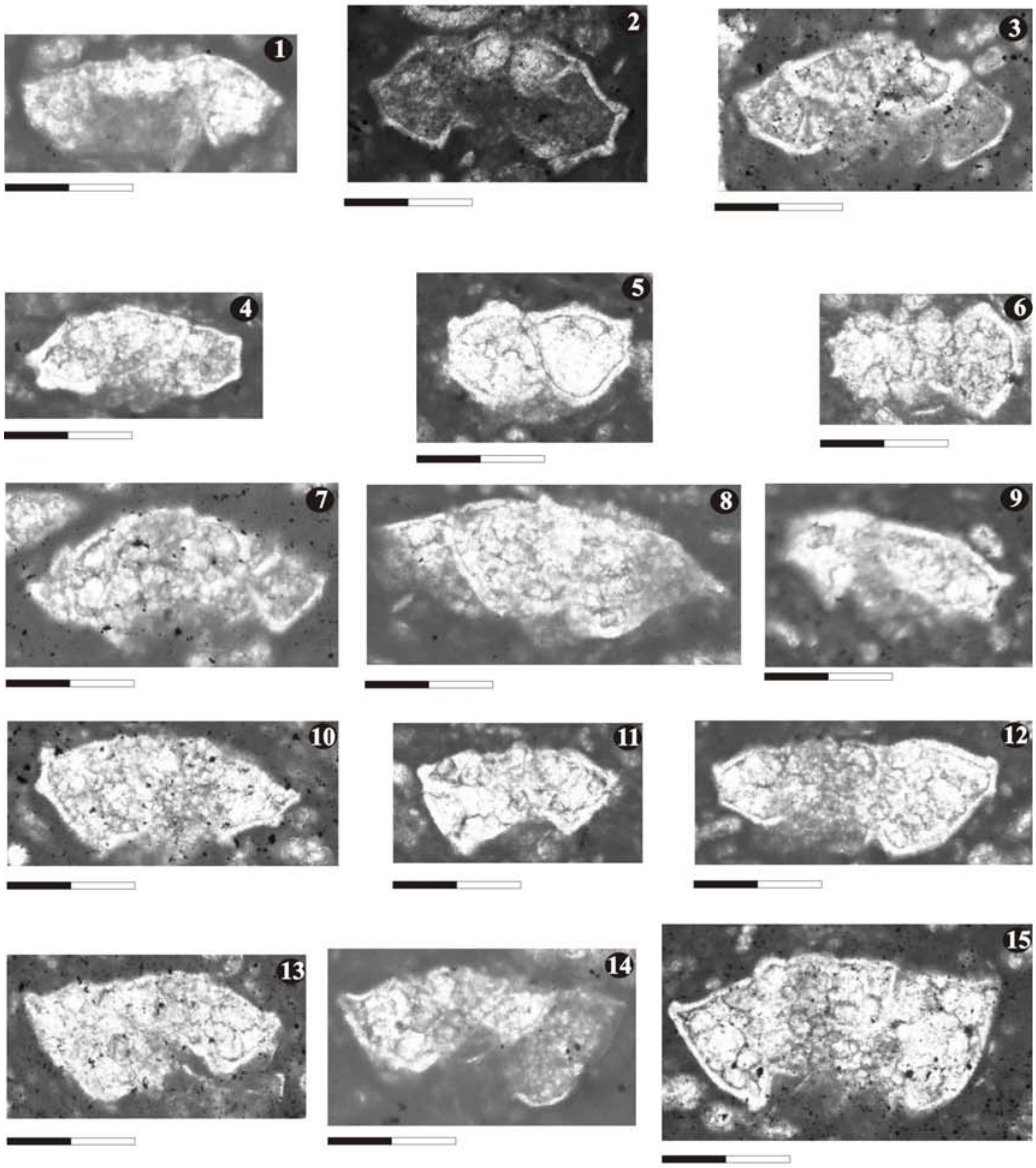
Figs. 6,7. *Pararotalia* sp., **Fig. 3.** Sample 04/18K; **Fig. 4.** Simple 04/23K(Kavak Formation)

Fig. 8. *Borelis* sp., sample 04/03K (Kavak Formation)

Fig. 9. *Eofabiania* ? sp., sample 04/25K (Kavak Formation)

Fig. 10. Textulariidae, sample 04/14K (Kavak Formation)

PLATE 1



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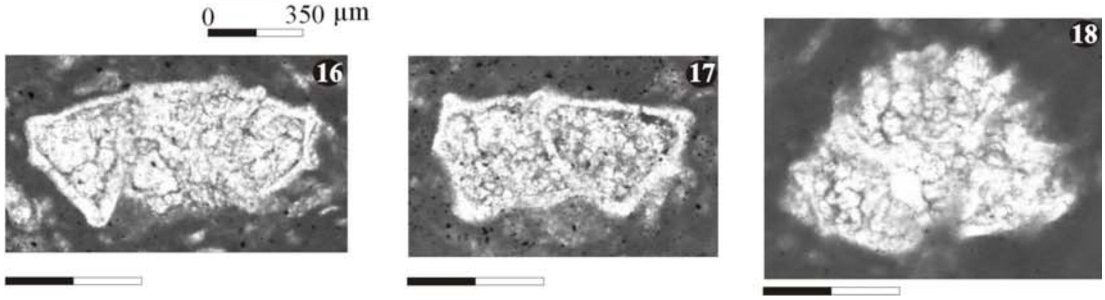

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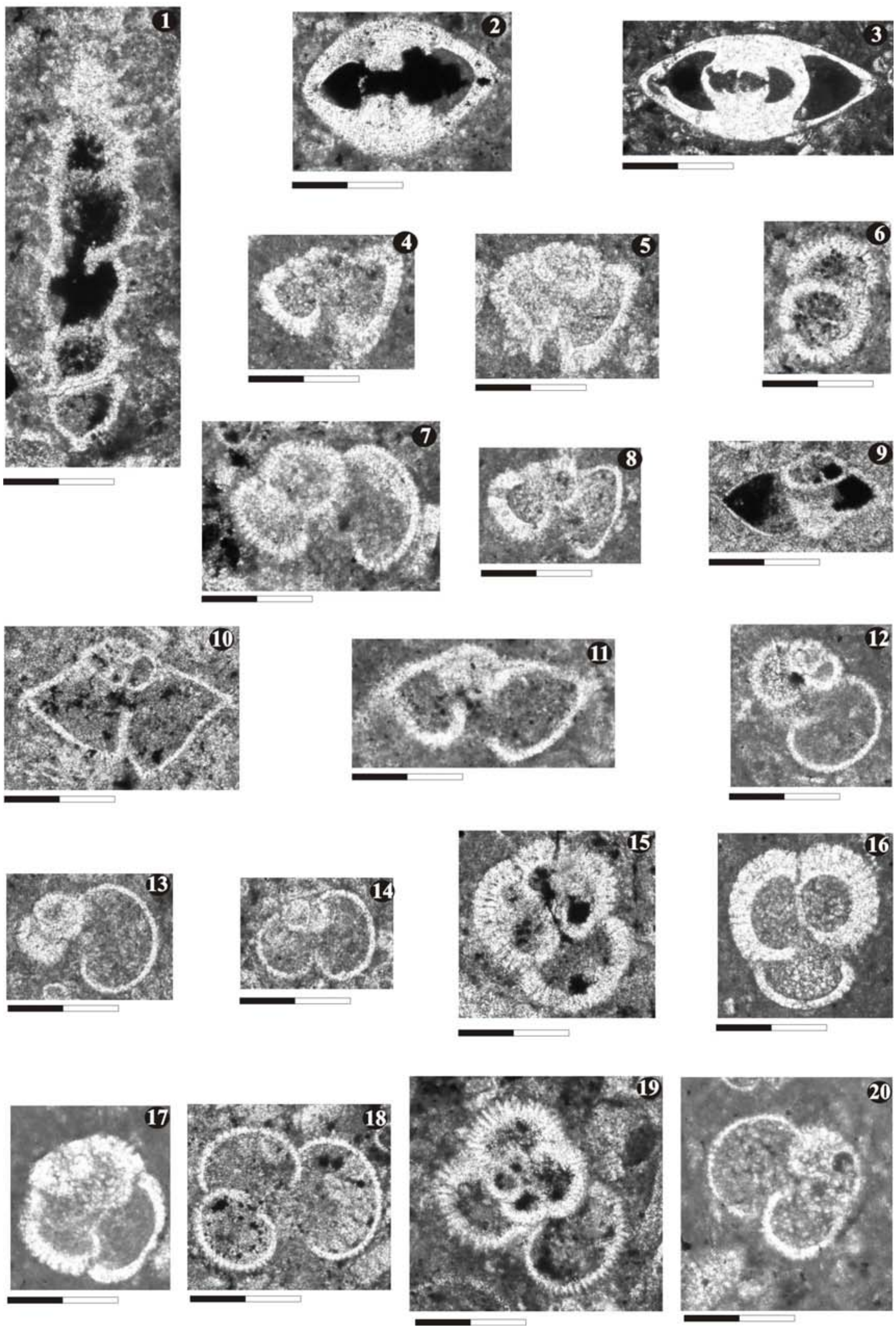

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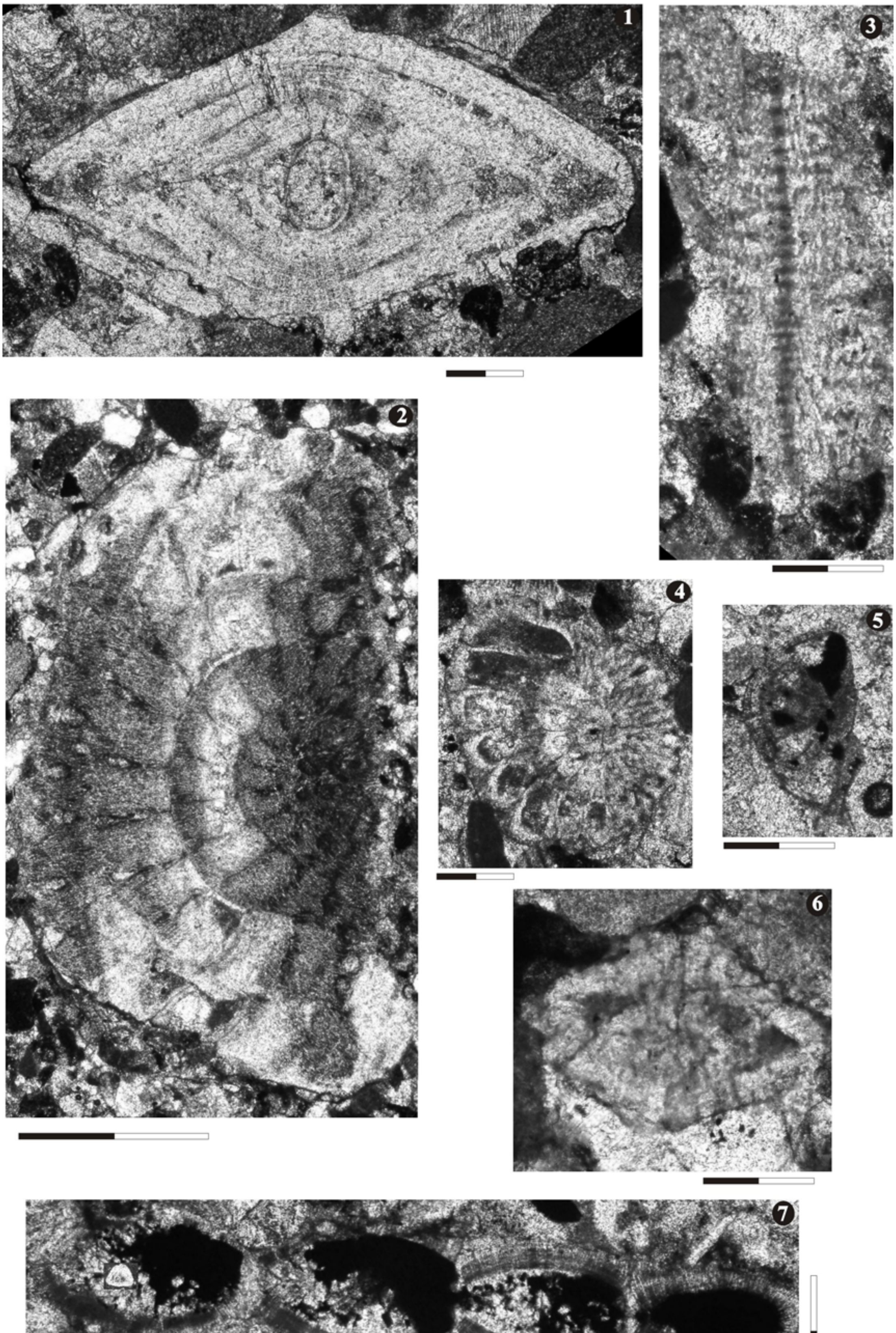

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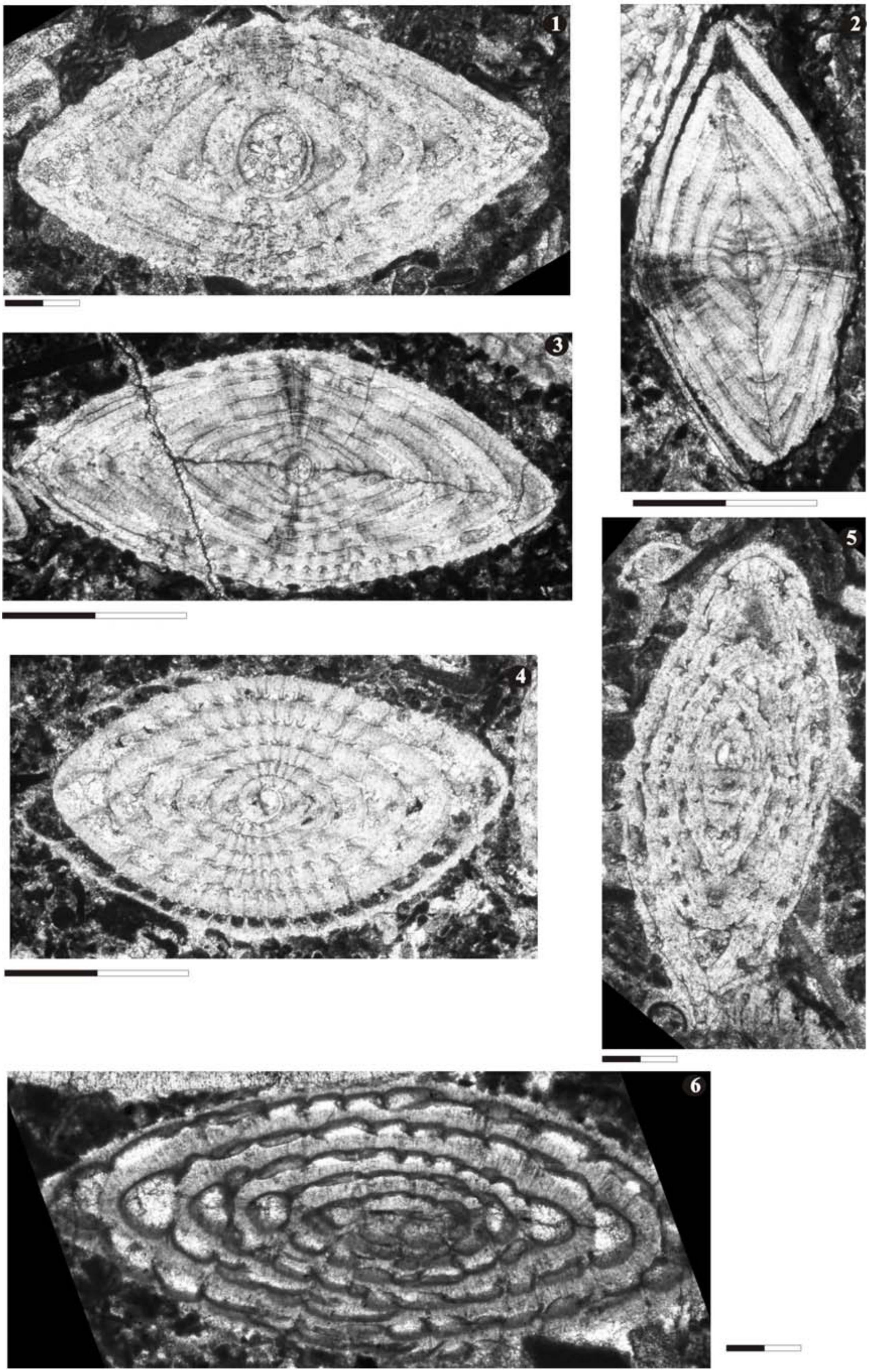

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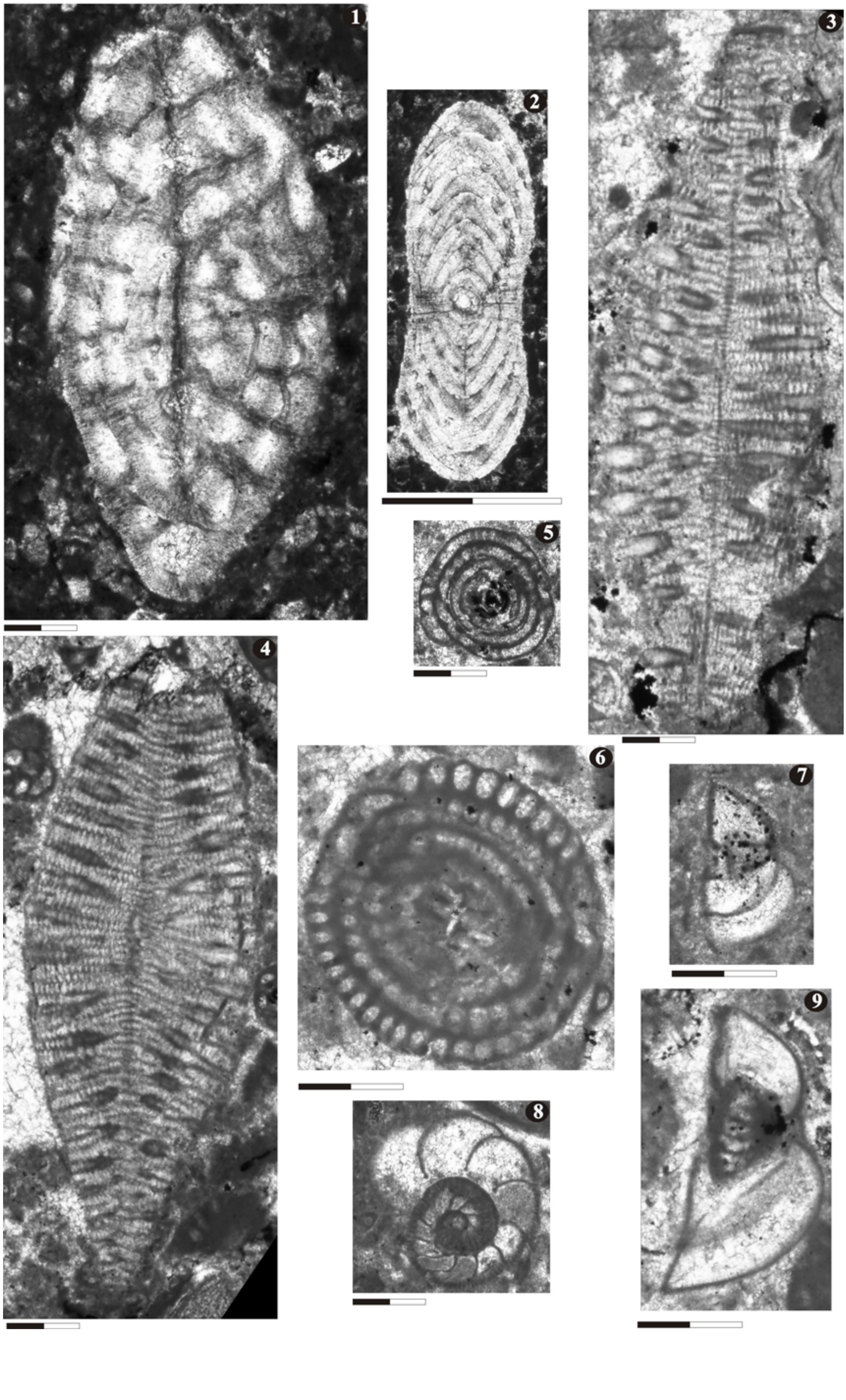

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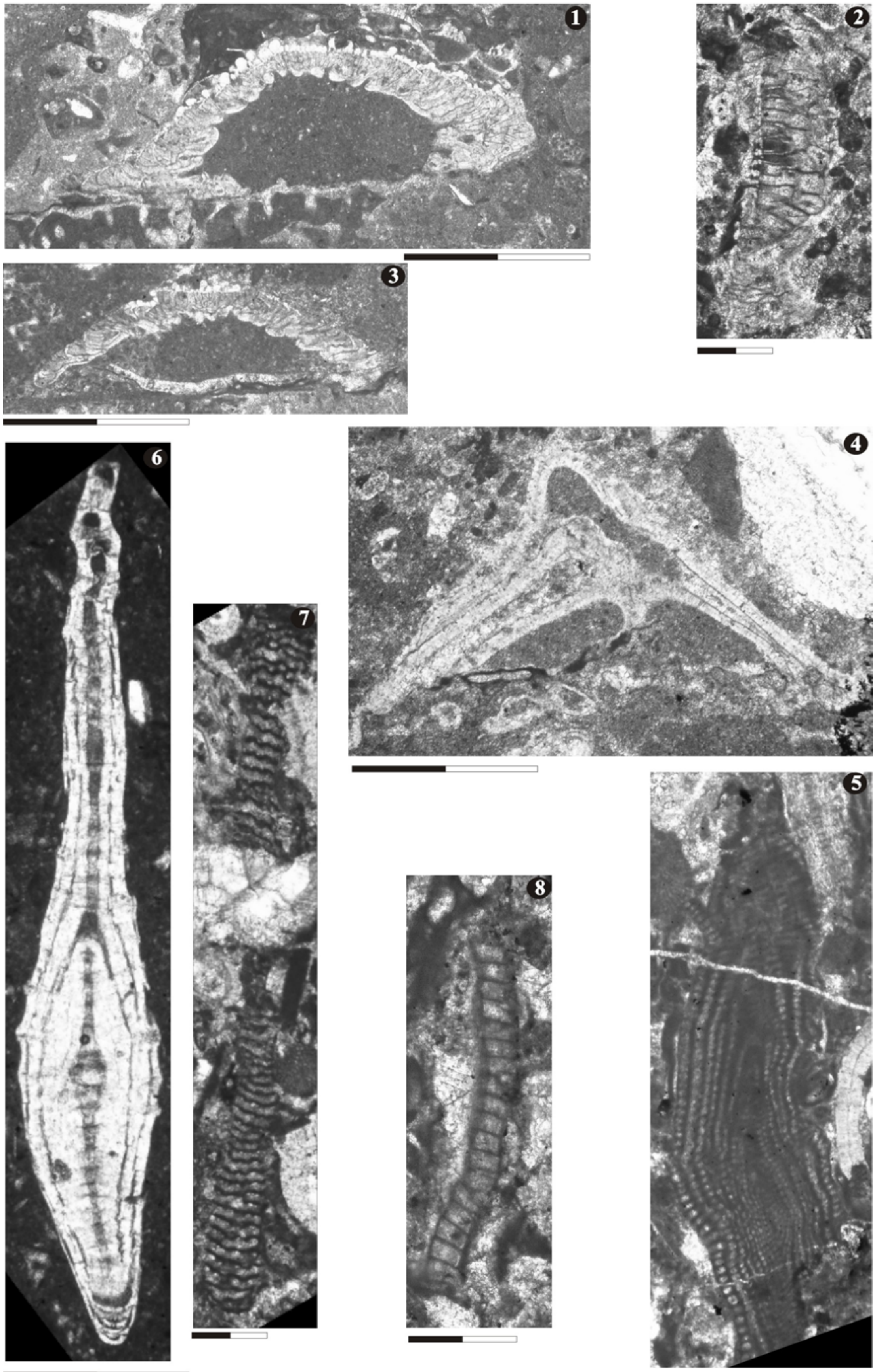

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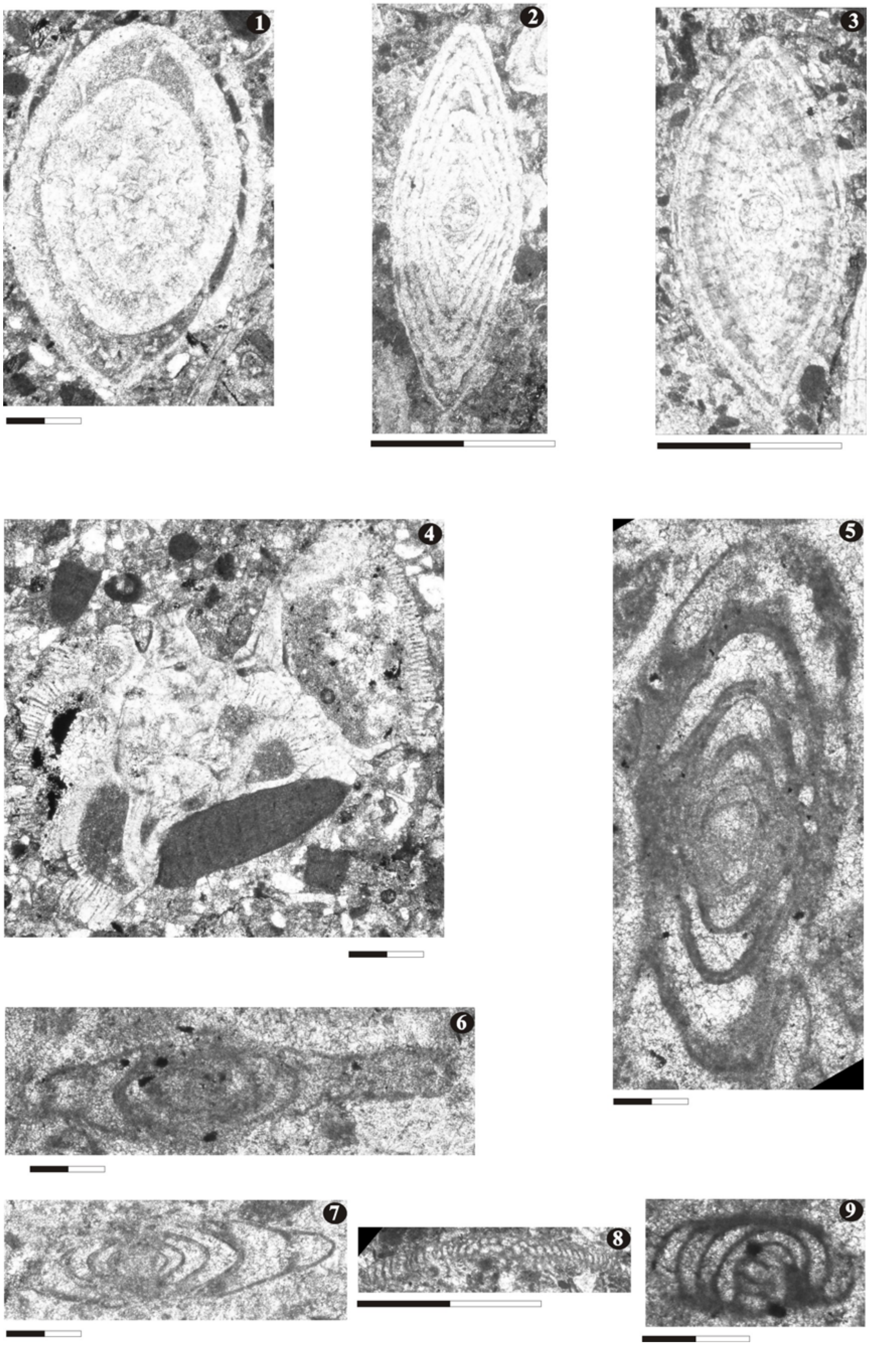


PLATE 8

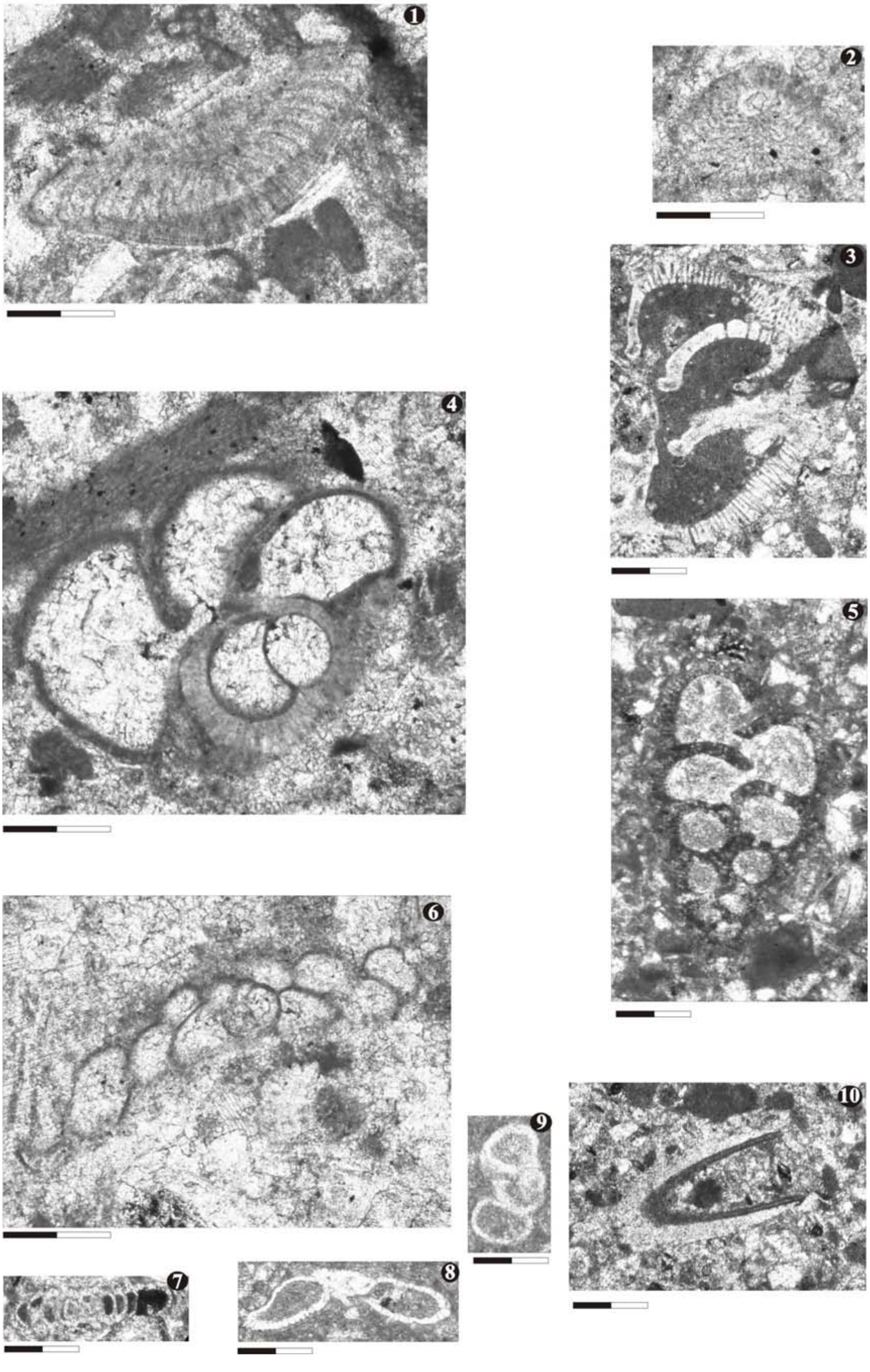
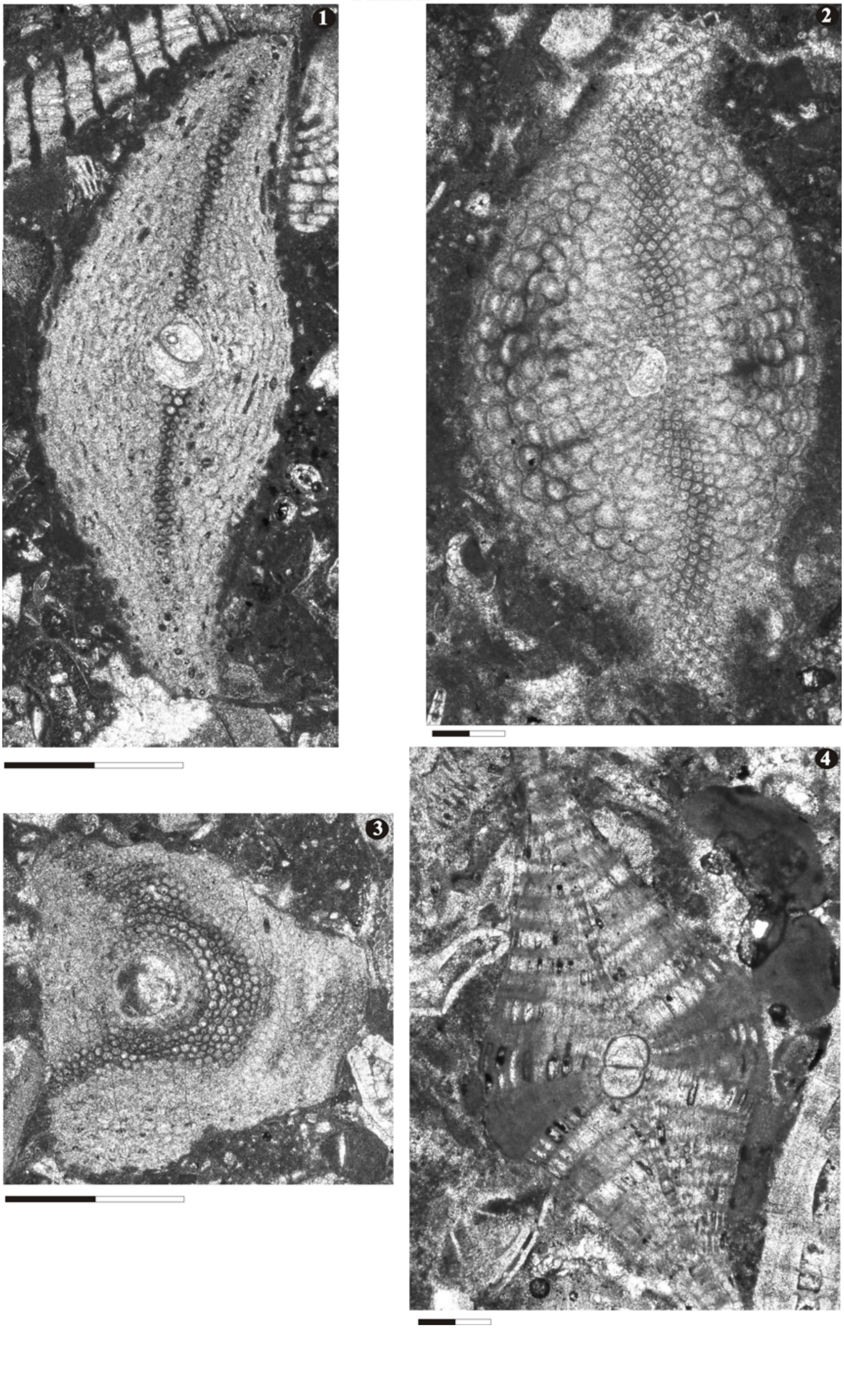


PLATE 9



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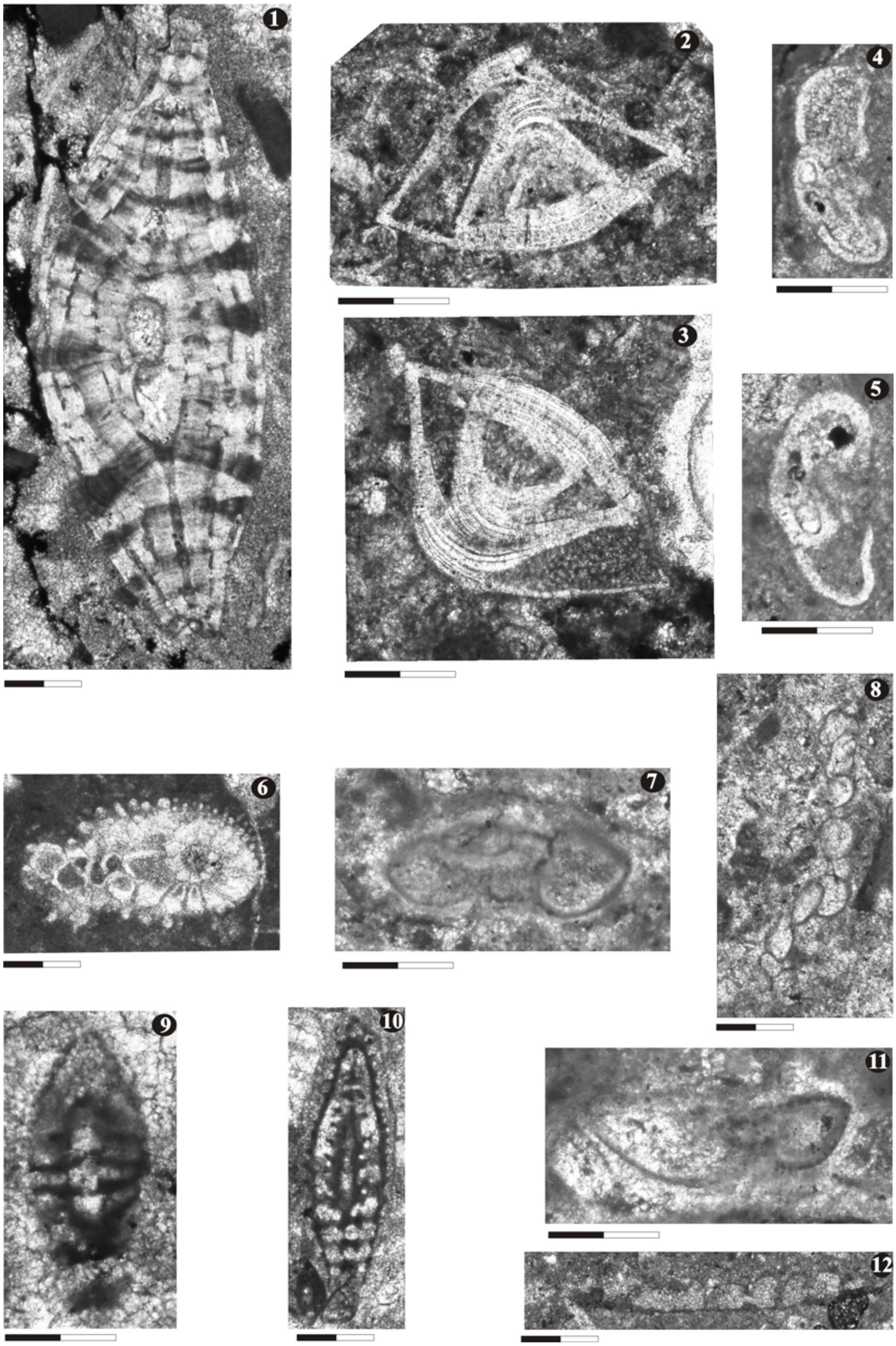
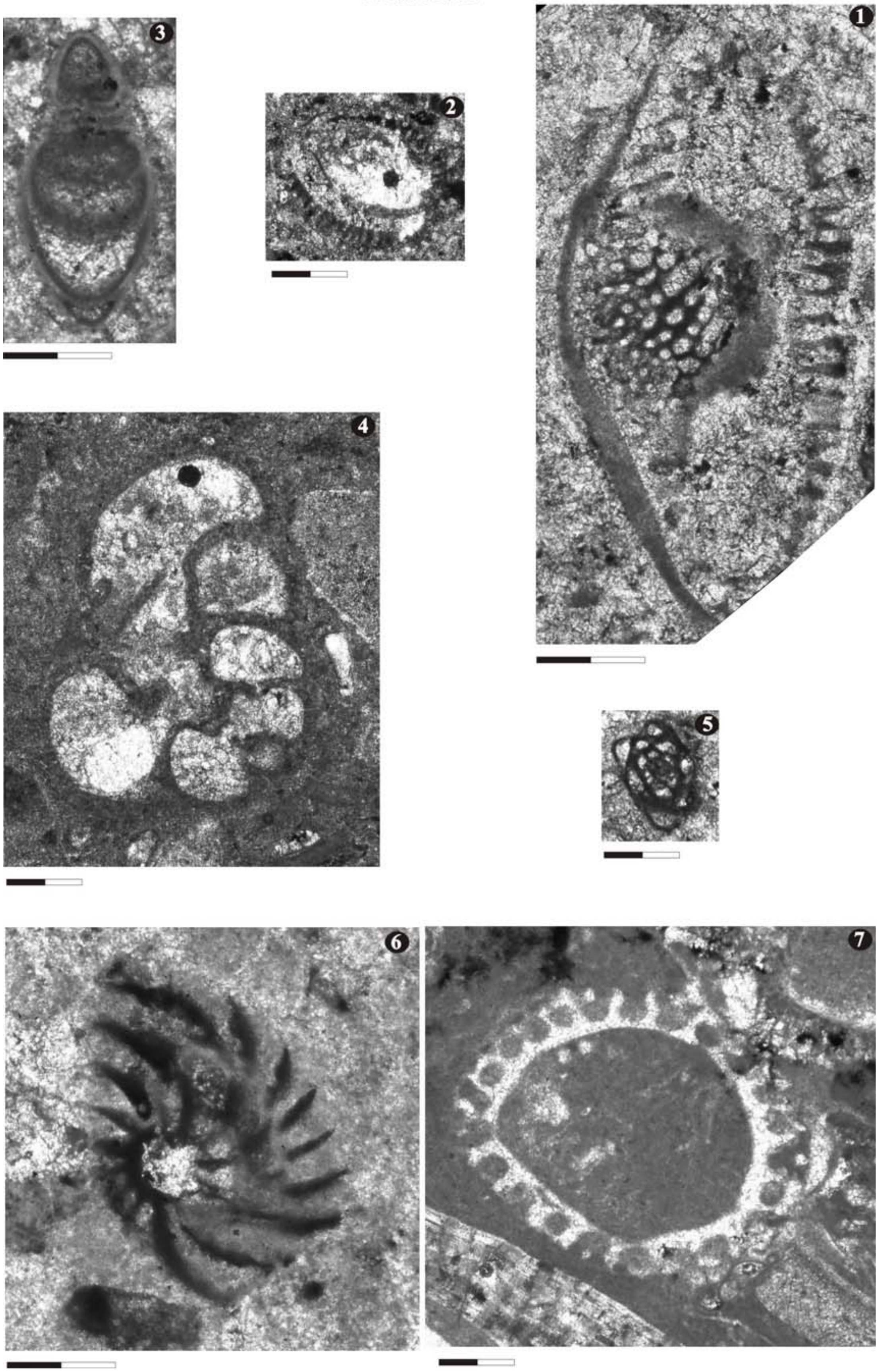


PLATE 11



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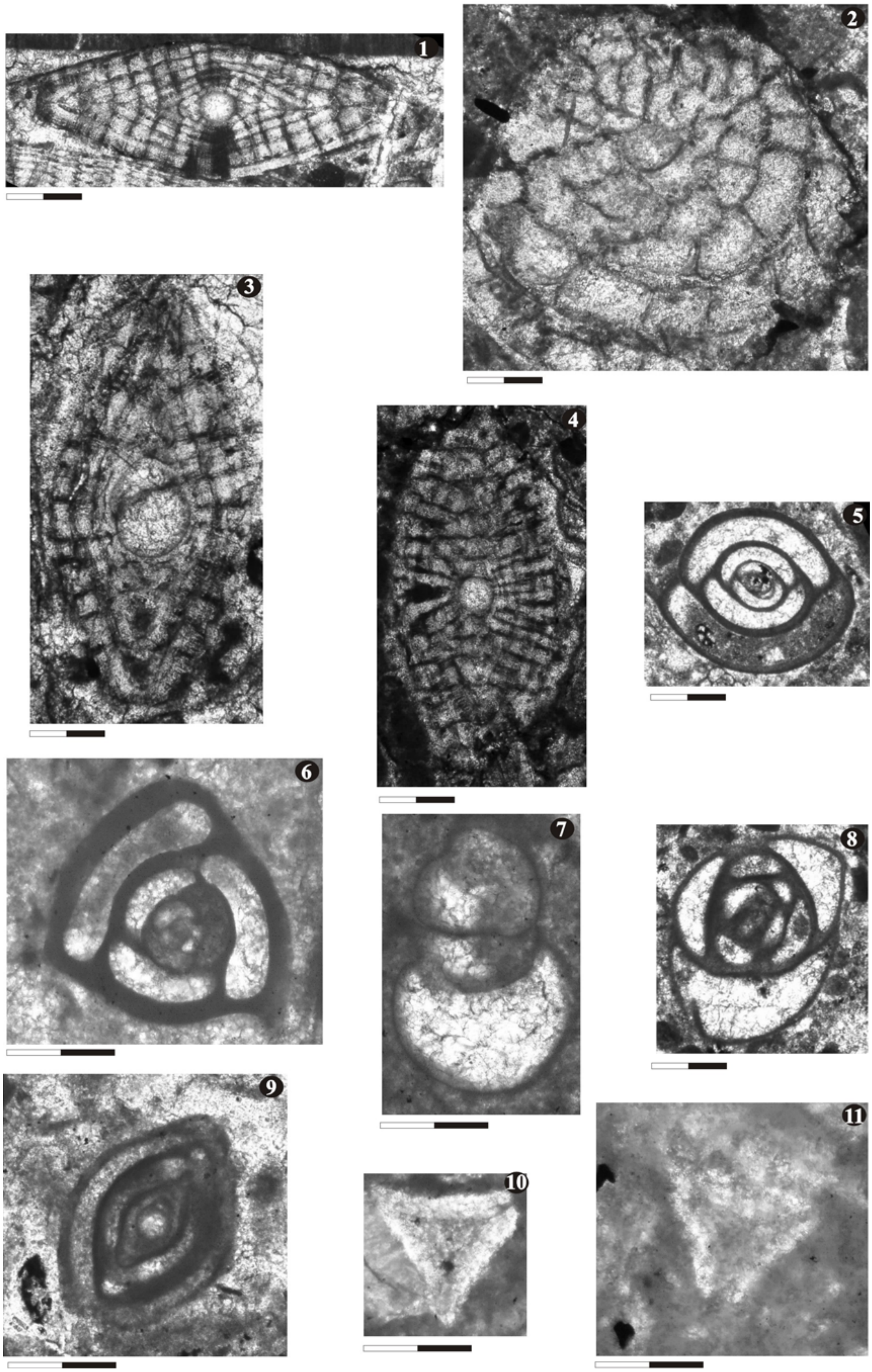

PLATE 13

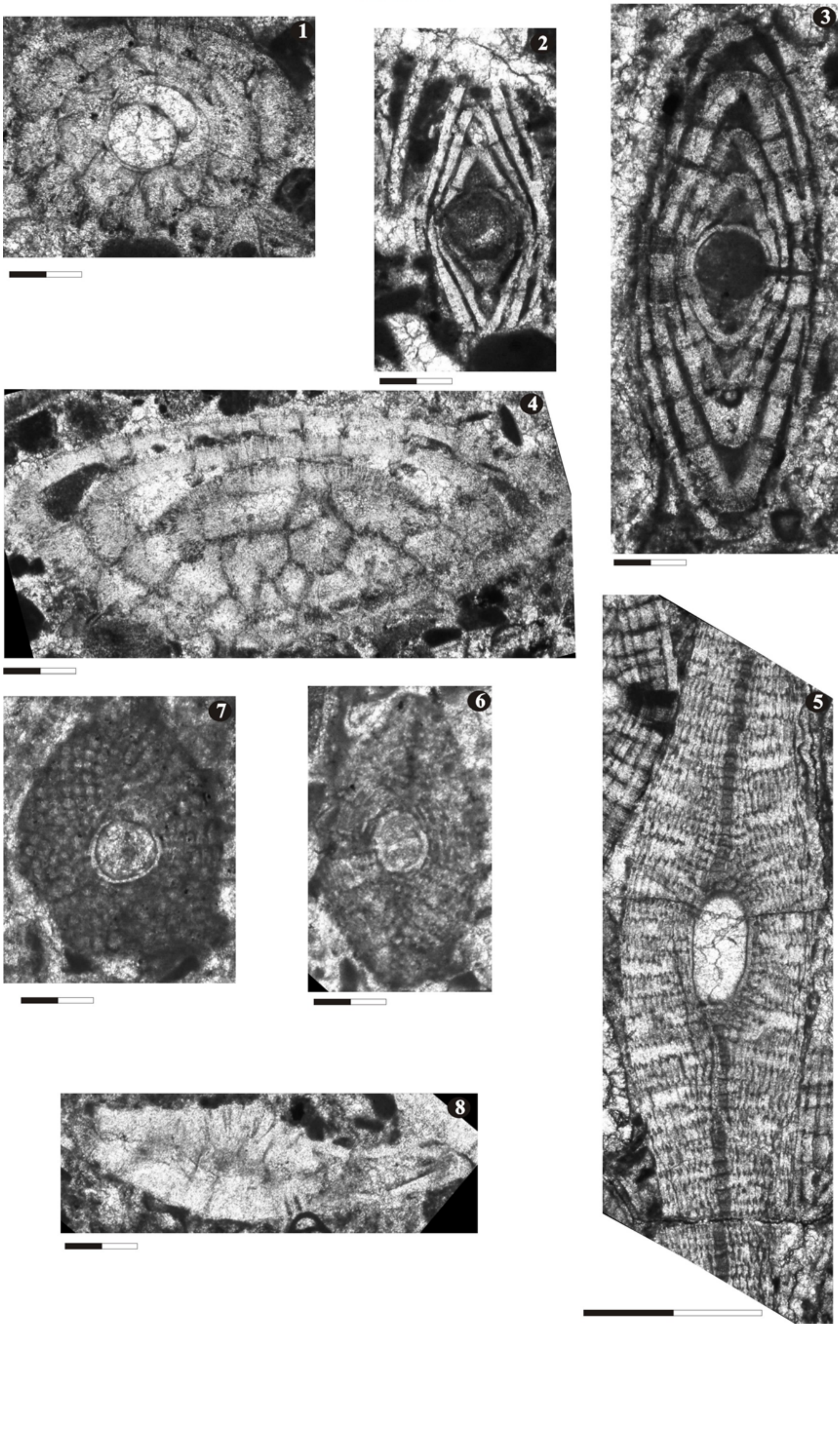

PLATE 14

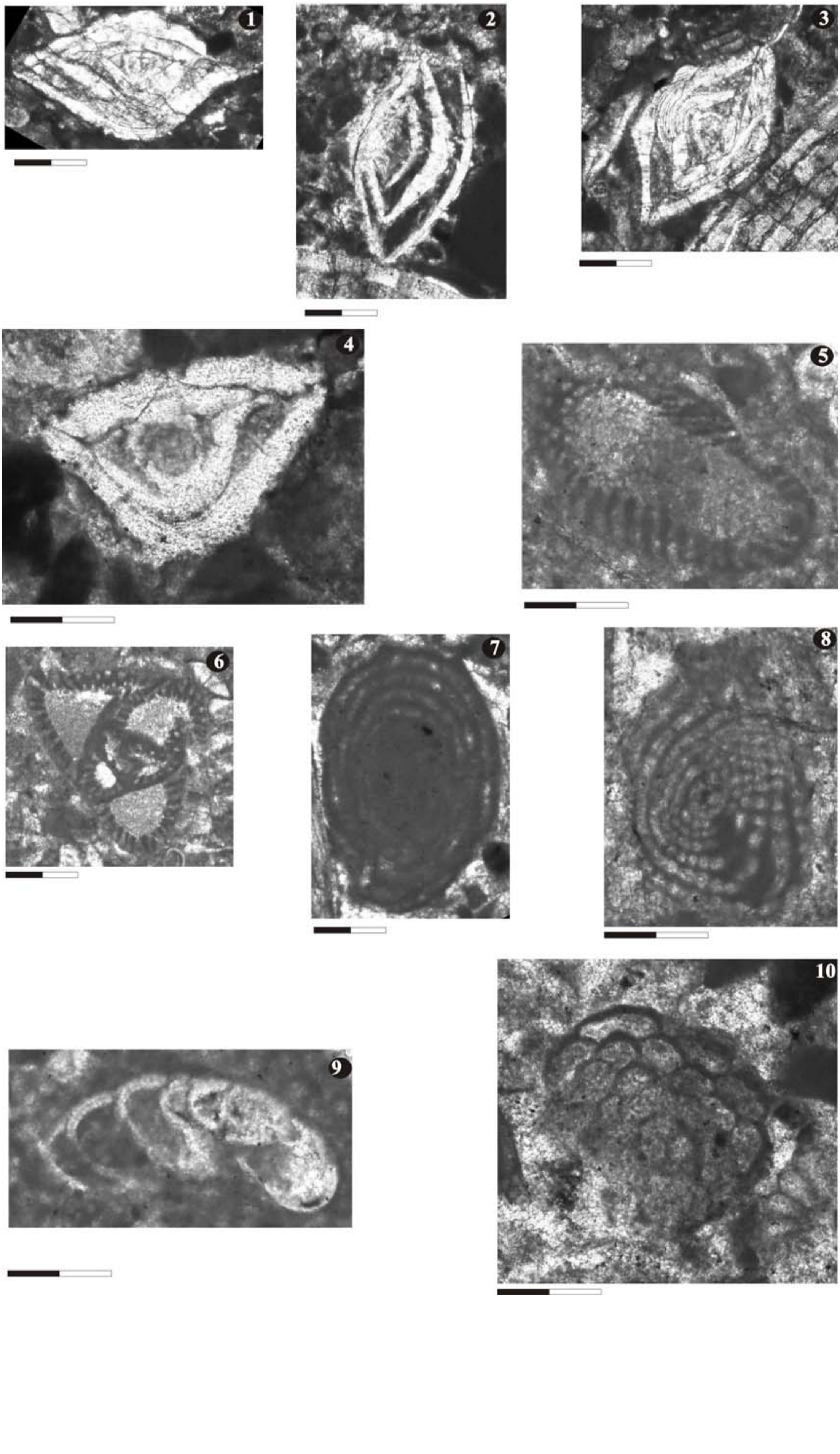

PLATE 15

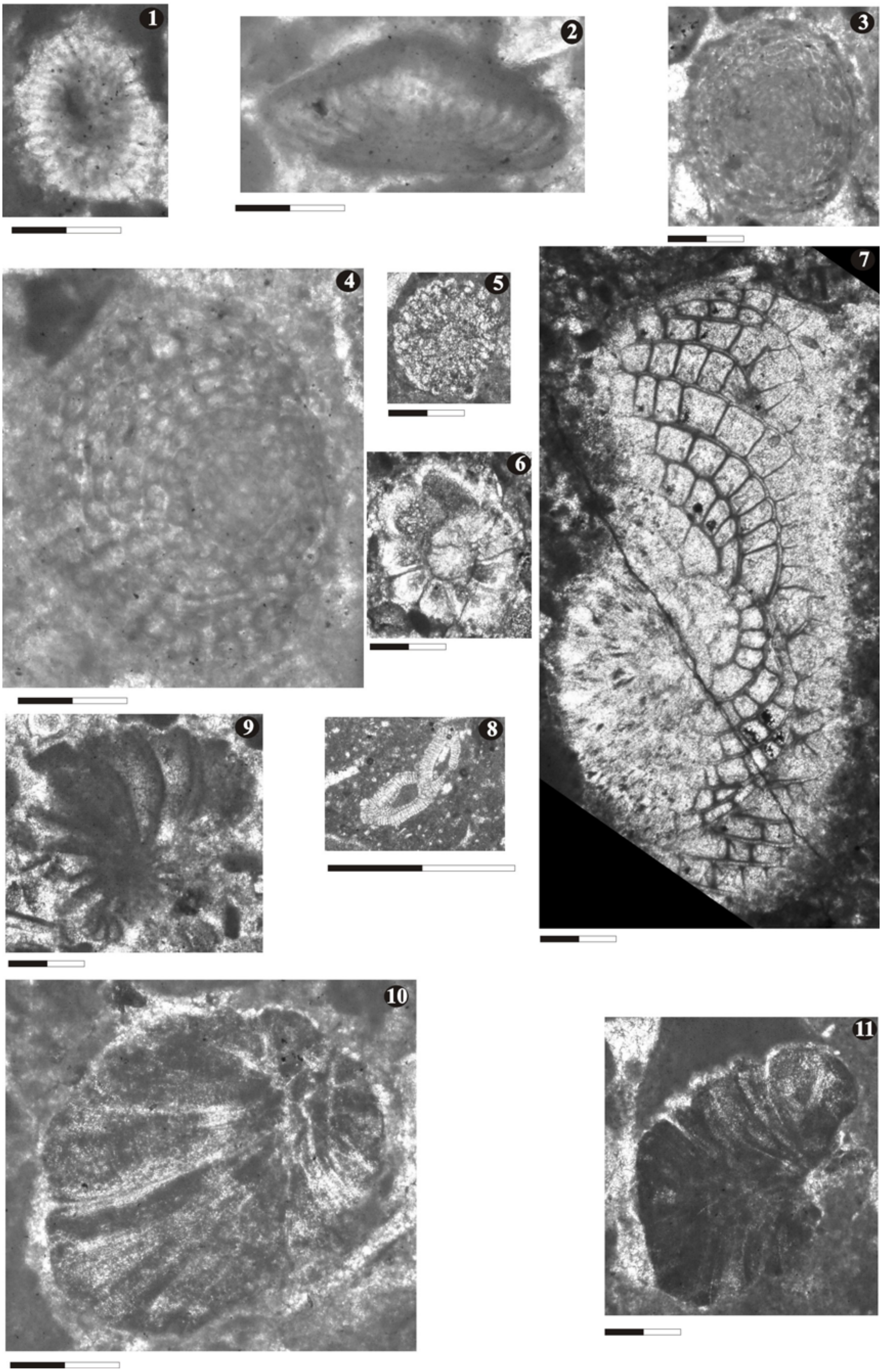

PLATE 16