

## Biostratigraphic data (Mammalia and Palynology) from the Upper Miocene İncesu Formation at Düzyayla (Hafik-Sivas, Central Anatolia)

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**Abstract:** The Upper Miocene İncesu formation, widely exposed in Düzyayla (Hafik-Sivas), consists of mudstones, conglomerates, lacustrine limestones and lignite. The İncesu formation overlies the gypsiferous Hafik formation of controversial Middle Miocene or Oligocene ages.

The mammalian fauna of the lignite horizon includes *Hipparion* sp., *Ceratotherium neumayri* (Osborn), *Deinotherium giganteum* Kaup, *Choerolophodon pentelici* (Gaudry & Lartet), *Adcrocuta* cf. *eximia* (Roth & Wagner), *Oioceros wegneri* Andree, *Helladotherium duvernoyi* Gaudry & Lartet and *Microstonyx erymanthius* (Roth & Wagner), which indicate a Turolian (Late Miocene) age. The palynological assemblage of the lignite is apparently represented by 27 genera and 39 species. Four genera and four species belong to spores, and the others to pollen. The Late Miocene age is supported by the presence of deciduous Angiosperms, such as *Quercus*, *Ulmus*, *Tilia* and *Carya*, and the abundance of Compositae and Chenopodiaceae together with forms of the Gramineae and Umbelliferae.

The mammalian fossils reflect forest and grassland ecosystems. The floral assemblage indicates riparian forest close to a stream and/or lake, mosaic forest, shrubs and grassland areas, and characterizes a warm-temperate climate with temporary dry periods during summer.

**Key Words:** Biostratigraphy, Mammalia, Palynology, Late Miocene, Hafik-Sivas, Paleoecology

### Düzyayla (Hafik-Sivas, Orta Anadolu) Üst Miyosen İncesu Formasyonuna ait Biyostratigrafik (Memeli ve Palinoloji) Bulgular

**Özet:** Düzyayla (Hafik-Sivas) yöresinde yaygın olarak yüzeyleyen Geç Miyosen yaşlı İncesu formasyonu çamurkayaları, çakıltaşları, görsel kireçtaşları ve linyitten yapıldır. Yaşı Oligosen veya Orta Miyosen olarak tartışılan İncesu formasyonu, başlıca jipsten yapılı Hafik formasyonu üzerinde açısız uyumsuz olarak bulunur.

İncesu formasyonu linyit düzeyinin büyük memeli faunası *Hipparion* sp., *Ceratotherium neumayri* (Osborn), *Deinotherium giganteum* Kaup, *Choerolophodon pentelici* (Gaudry & Lartet), *Adcrocuta* cf. *eximia* (Roth & Wagner), *Oioceros wegneri* Andree, *Helladotherium duvernoyi* Gaudry & Lartet ve *Microstonyx erymanthius* (Roth & Wagner) içerir ve Turoliyen (Geç Miyosen) yaşını yansıtır. 7 linyit örneğinin palinolojik topluluğu 27 cins ve 39 türden oluşur. Bunlardan 4 cins ve 4 tür sporlara, diğerleri polenlere aittir. Geç Miyosen yaşlı florada yeralan *Quercus*, *Tilia* ve *Carya* gibi yaprak döken Angiospermilerin, Compositae ve Chenopodiaceae bolluğu yanısıra, Gramineae ve Umbelliferae formlarının varlığı ile desteklenmektedir.

Memeli fosilleri orman ve otsul alanları simgeler. Bitki topluluğu akarsu ve/veya göl kenarı orman topluluklarını, mozayik orman, çalılık ve otsul biyotopları yansıtır ve yaz kuraklığı ile ardalanan mevsimsel olarak nemli ve ılık bir iklimi gösterir.

**Anahtar Sözcükler:** Biyostratigrafi, Memeli, Palinoloji, Geç Miyosen, Hafik-Sivas, Paleokoloji

**Introduction**

In the Düzyayla region (Hafik-Sivas), the Late Miocene İncesu formation, a mainly clastic sequence with a lignite horizon, was established by Yılmaz (1983). Düzyayla is situated 12 km north of Hafik, and 40 km northeast of Sivas (Figure 1). Previous studies on the İncesu formation include Kurtman (1973), Yılmaz (1983), Aktimur *et al.* (1988, 1990), Sümengen *et al.* (1990), Atalay (1993), Bruijn *et al.* (1992) and Poisson *et al.* (1995). The small mammal remains *Apodemus* sp., *Parapodemus* sp., *Schizogalerix* cf. *zapfei*, *Amblycoptus* sp., *Arhaeodesmana* sp., *Petenya hungarica*, *Permenella* sp., *Alilepus turoleensis*, *Keramidomys* sp., *Spermophilinus bredai*, *Pliopetaurista* n. sp., *Hylopetes macedoniensis*, *Glirulus lissiensis*, *Eozapus intermedius*, *Dipoides* sp., "*Blancomys*" sp., *Pliospalax* n. sp.1 & 2, *Pseudomeriones pithagorasi*, *Hansdebruijnina neutrum*, and "*Karnimata*" cf. *provocator* were found in the clay horizon (Bruijn & Mein 1996; Ünay 1996; Fahlbusch & Bolliger 1996; Bruijn *et al.* 1996, 1999). The large mammalian fauna was first described by Kaya & Forsten (1999).

The nomenclature of the *Hipparion* fossils is based on Forsten (1978), and that for *Ceratotherium* on Heissig (1972) and Fortelius (1990). The Düzyayla material is stored in the Ege University, Natural History Museum

(İzmir). The palynological investigation is based on seven samples from the lignite of the İncesu formation. These samples were treated with HCl, HF acid, Schulze solution and NaOH, respectively. The Hafik formation contains a poor palynological assemblage. Nevertheless, four samples from the İncesu formation yielded a dense palynological assemblage appropriate for statistical evaluations.

The objective of this paper is to provide further documentation on the large mammals and sporomorphs of the İncesu formation which is known to be Late Miocene in age, and some remarks on the paleoecology. T. Kaya and A. Forsten studied the *Perissodactyla* fossils, while F. Akgün investigated sporomorphs. The areal study was done by Z. Atalay. Investigation of some other large mammals from the lignite horizon of the İncesu formation is on-going.

**Stratigraphy**

The basement rocks of the Tertiary basin in the Sivas region comprise ophiolitic mélanges, including primarily basic submarine volcanic rocks, serpentinized ultrabasic rocks and blocks of recrystallized limestones (Figure 2). The Middle Eocene Bozbel formation is made up of conglomerates, sandstones and claystones with tuff

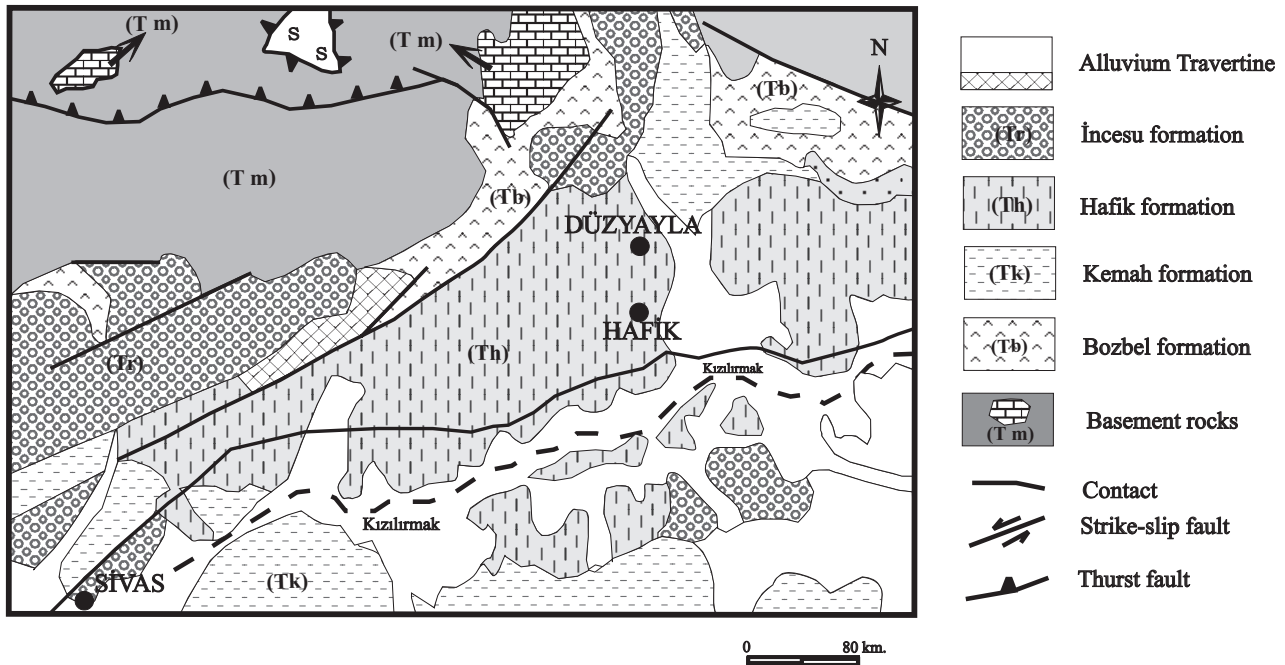


Figure 1. Geological map of the study area (simplified from Aktimur *et al.* 1988).



**Table 1.** Relative percentages of sporomorphs encountered in the samples from the Düzyayla lignite

SAMPLE NUMBERS		1	2	3	4
SPORES					
<i>Laevigatsporites haardti</i>	(Polypodiaceae)	34	62	35	75
<i>Stereisporites</i> sp.	(Sphagnaceae)	1			
<i>Leiotriletes microadriennis</i>	(Schizaceae)			1	
<i>Cycadopites cycadoides</i>	(Cycadaceae)			2	
<i>Cycadopites minor</i>		1			
GYMNOSPERM SACCAT POLLEN					
<i>Pityosporites microalatus</i> (haploxyton-type)	( <i>Pinus</i> )			2	1
<i>P. labdacus</i> (silvestris-type)					*
GYMNOSPERM NON-SACCAT POLLEN					
<i>Inaperturopollenites dubius</i>	(Cupressaceae)	1	3	1	
<i>Inaperturopollenites hiatus</i>	( <i>Taxodium</i> )	1		1	
<i>Inaperturopollenites</i> sp.		1			
<i>Ephedripites</i> sp.	( <i>Ephedra</i> )			1	
ANGIOSPERM POLLEN					
MONOCOTYLEDONEAE					
<i>Sparganiaceapollenites neogenicus</i>	( <i>Sparganium/Typha</i> )	1			
<i>Sparganiaceapollenites polygonalis</i>		*		2	1
<i>Monoporopollenites gramineus</i>	(Gramineae)	*			
<i>Monoporopollenites gramineoides</i>			2	2	
<i>Graminidites laevigatus</i>		*			
<i>Graminidites</i> sp.				*	
cf. <i>Achantotricolpites intermedius</i>					*
<i>Monocolpopollenites tranquillus</i>	( <i>Palmae</i> )	1			
<i>Monogemmites pseudosetarius</i>	(*Nymphaeaceae)	4	2		
<i>Monocolpopollenites</i> sp.			2		
DICOTYLEDONEAE					
<i>Triatriopollenites bituitus</i>	(Myricaceae)			1	
<i>Triatriopollenites</i> sp.				1	
<i>Intratropopollenites insturctus</i>	(Tiliaceae)			*	
<i>Intratropopollenites</i> spp.		2			
<i>Subtriporopollenites simplex</i>	( <i>Carya</i> )				1
<i>Polyvestibulopollenites verus</i>	( <i>Alnus</i> )	1	1		
<i>Polyporopollenites undulosus</i>	( <i>Ulmus</i> )	2		1	
<i>Polyporopollenites</i> cf. <i>stellatus</i>	( <i>Pterocarya</i> )	*			
<i>Tricolpopollenites densus</i>	( <i>Quercus</i> )	4	1	2	
<i>Tricolpopollenites microhenrici</i>	(? <i>Quercus</i> )			3	1
<i>Tricolpopollenites retiformis</i>	( <i>Platanus/Salix</i> )	1	1	3	1
<i>Tricolpopollenites liblarensis</i>	(Fagaceae)			2	
<i>Tricolpopollenites</i> spp.		1	2		
<i>Tricolporopollenites cingulum</i>	( <i>Castanea</i> )	4	1	3	
<i>Tricolporopollenites megaexactus</i>	(Cyrillaceae)	7	*	1	
<i>Tricolporopollenites pseudocingulum</i>	(Anarcardiaceae)	3			
<i>Tricolporopollenites donatus</i>			1	1	
<i>Tricolporopollenites microreticulatus</i>	( <i>Sambucus</i> )	1		1	
<i>Tricolporopollenites</i> sp.	(Umbelliferae)	1	1	2	
<i>Tricolporopollenites</i> sp. (Tubiliflorae-type)	(Compositae)	8	7	9	9
<i>Tricolporopollenites</i> sp. (Liguliflorae-type)		4		1	1
<i>Tricolporopollenites</i> sp.		*			
<i>Tetracolporopollenites microellipsus</i>	(Sapotaceae)	1		1	
<i>Periporopollenites multiporatus</i>	(Chenopodiaceae)	6	5	4	8
<i>Periporopollenites perplexus</i>		4			1
<i>Periporopollenites granulatus</i>					*
<i>Periporopollenites halifani</i>		5	8	15	1
<i>Periporopollenites</i> sp.				*	
<i>Periporopollenites stigmatosus</i>	( <i>Liquidambar</i> )			1	

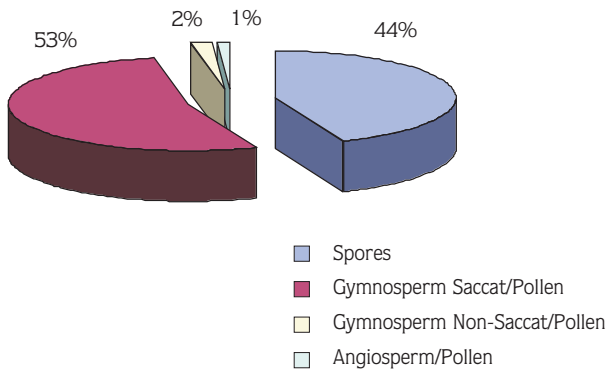


Figure 3. Relative percentages of sporomorphs of the plant associations.

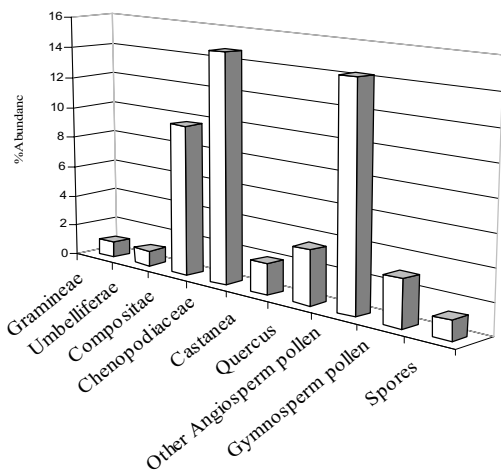


Figure 4. Relative percentage values for the genera and groups of herbaceous and arboreal plants.

Garkın (Staesche & Sondaar 1979), Gülpınar (Forsten & Kaya 1995), and Kemiklitepe (Koufos & Kostopoulos 1994).

### *Ceratotherium neumayri* (Osborn 1900)

The *Ceratotherium* teeth from Düzyayla resemble those from the Turolian of Kinik, Kemiklitepe, Mahmutgazi (Heissig 1975) and Pıkermi (Geraads 1988) with respect to size, crown height, in the weak inclination of the paracone and metacone ribs, the flat buccal surface of the upper teeth, the presence of the crochet, and the strongly developed mesial cingulum. The teeth of Düzyayla are larger than those of the Vallesian of Eşme-Akçaköy (Heissig 1975) and Sinap Tepe (Kaya & Forsten 1999).

### Age and Discussion

The sporomorph association obtained from the lignite samples of the İncesu formation can be correlated with the “Kızılhisar sporomorph association” (Becker-Platen 1970; Benda 1971). The spores, such as Polypodiaceae and Osmundaceae, which are represented in high percentages in the Kızılhisar association, *magnus-dubius* group, *Taxodiaceapollenites hiatus*, *Ulmipollenites undulosus*, *Alnipollenites verus*, non-saccat Gymnosperm and Angiosperm pollen are not of stratigraphic importance (Benda *et al.* 1974a; Benda & Meulenkamp 1979, 1990). The stratigraphic distribution of these taxa spans the whole Tertiary period. The stratigraphic importance of herbaceous Angiosperm taxa such as Gramineae, Chenopodiaceae and Cyperaceae as in the Kızılhisar association, is dealt with in detail. There are two *Pinus* morphotypes used for the Neogene biostratigraphic subdivision in the eastern Mediterranean area. *Pinus haploxylon* is an old type. The relative frequency of this type in Turkish, Italian, Spanish and Greek associations decreases from Early Miocene to Late Miocene (e.g., Baltuille *et al.* 1992; Benda *et al.* 1974a; Benda & Meulenkamp 1979, 1990). This *Pinus* type is represented by a high percentage in Benda’s (1971) Kızılhisar association. The second *Pinus* type is *Pinus silvestris*. This type occurs in ample frequency at the boundary of the Miocene and Pliocene periods, but in lower percentages than *Pinus haploxylon* in the Kızılhisar association. In studies conducted in the coal horizons around Soma and Bigadiç, two types of *Pinus* were used as criteria (Akgün 1993; Akyol & Akgün 1987, 1990; Akgün & Akyol 1999). However, in this study, infrequent and poorly preserved *Pinus* forms do not allow the distinction of sub-types during counting.

It has been suggested that about 10 million years ago, in a large part of the northern hemisphere, widespread Early-Middle Miocene forests of tropical and sub-tropical character were replaced by widespread vegetation of savannah character. In the Late Miocene, this type of vegetation was dominated mainly by arboreal and herbaceous plants such as *Quercus*, *Carya*, Tiliaceae, *Alnus* and *Ulmus*, and bushes including Compositae and Chenopodiaceae, which reflect a warm climate (e.g., Hsü *et al.* 1977; Kovar-Eder 1987; Traverse 1988; Benda & Meulenkamp 1990; Nagy 1990; Rivas-Carballo 1991). The Gramineae, Compositae, Chenopodiaceae and Cyperaceae are among the herbaceous Angiosperms that

covered widespread seasonal dry areas. The frequency of these plants was low during the Early and Middle Miocene (but Compositae and Chenopodiaceae are not included in this frequency; moreover, the size of members of these families in the Early and Middle Miocene was bigger than the those in the Late Miocene, but the variety of species was rather low). From the Late Miocene onward, they show a great improvement. The Umbelliferae appear scarcely before the Late Miocene is abundant enough to be included in the percentages (1-5 %). In the latest Miocene, on the other hand, members of this family are found together with modern taxa (i.e., *Zonalapollenites-Tsuga*) as a harbinger of the Pliocene.

Gillet *et al.* (1978) reported that the sporomorph associations from the Çanakkale and İstanbul provinces are characterized by the predominance of Angiosperm and saccat Gymnosperm pollen. Akyol & Akgün (1990), examining samples from the Bigadiç area, and Ediger *et al.* (1996) studying samples from the İskenderun region, reported that the percentages of saccat Gymnosperm and Angiosperm pollen were highest in samples which they cited as having good correlation with the Kızılhisar association. In samples collected from the coal horizon of Sivas-Hafik-Düzyayla, the percentages of Angiosperm pollen were also high but the percentages of saccat Gymnosperm pollen were low (Table 1). In the sporomorph association from Kastellios Hill in Crete, Benda *et al.* (1974a) observed the characteristic features of the Kızılhisar association. When these studies were compared with regard to the relative frequency of herbaceous Angiosperm pollen - important for an association of the Late Miocene (Table 2).

The Kızılhisar association was subdivided into two subassociations in Crete: a Middle Miocene-Late Tortonian one (lower association) and a Late Tortonian-Messinian one (upper association) (Benda *et al.* 1974a). However, this was not done in Turkey. The main

differences between the two subassociations are decreases in the relative frequencies of the Gymnosperm pollen and spores in the Messinian association, but an increase in the relative frequencies of the Angiosperm pollen, and especially in the percentages of the Compositae and Chenopodiaceae.

Ediger *et al.* (1996) applied the Crete subdivision to their samples and reported that the Hacıahmetli and Kızılargözü samples are similar to the lower association (the Middle Miocene-Late Tortonian) and the upper association (the Late Tortonian-Messinian), respectively. However, Ediger *et al.* (1996) claimed that the use of such a subdivision in Turkey would be problematic, that it is a feature peculiar to Crete. In particular, the distribution in relative frequency of Gramineae and Compositae from the Kastellios Hill association does not resemble the samples of Hacıahmetli and Kızılargözü (Ediger *et al.* 1996). A similar case has been observed in the samples from Düzyayla. The sporomorph association obtained from this study can be correlated with the Late Tortonian - Messinian association of Benda *et al.* (1974b) and Ediger *et al.* (1996). Since Umbelliferae forms, which are the harbingers of the Pliocene, occur in low percentages compared to the other herbaceous Angiosperm in our samples, they cannot be dated as late Late Miocene. For similar reasons, the ages of sporomorph associations that Benda *et al.* (1974a) and Ediger *et al.* (1996) studied should not reach up to the Messinian. The Düzyayla samples are of Late Miocene (Middle-Late Tortonian) age.

Concerning the mammals from Düzyayla, the *Hipparion* species in faunas from Eurasia range in age from Late Miocene to Pliocene. Hypsodonty index, protoconal index and sagittal keel index (Şen *et al.* 1978; Staeshe & Sondaar 1979; Koufos & Kostopoulos 1994) indicate a Vallesian to Pliocene age for the Düzyayla material (Kaya & Forsten 1999).

Kızılhisar	Benda <i>et al.</i> (1974a)		Gillet <i>et al.</i> (1978)	Akyol & Akgün (1990)	Ediger <i>et al.</i> (1996) Hacıah. Kızlar.	This study
	Lower Association	Upper				
Association						
Gramineae	15	19	17	12	0.3	1.5
Compositae	0.6	4.7	0.4	0.3	5.5	15
Chenopodiaceae	2.9	7	4	3	1	11
Umbelliferae	0	1	1	0	0.7	2.4

**Table 2.** Relative percentage correlation of the herbaceous Angiosperm pollen

*C. neumayri* is a widespread species, known from the Vallesian of Eşme-Akçaköy, Sinap Tepe (Heissig 1975; Ozansoy 1965) and the Turolian of Kınık, Mahmutgazi, Kemiklitepe, Kayadibi, Gülpınar (Heissig 1975, 1996; Geraads 1994; Kaya 1994), Pikermi, Samos, Pentalophos-I and Maragheh (Geraads 1988; Geraads & Koufos 1990). The stratigraphic range of the species is between the MN 9 - MN 13 zones (Heissig 1975, 1996). The Anatolian *Ceratotherium* material shows a single lineage that increased in size from MN 9 to MN 13 (Heissig 1975, 1996; Kaya 1994). The sizes of the samples from Düzyayla are similar to those of the Turolian forms known from other Turkish localities (Kaya & Forsten 1999).

The Düzyayla fauna is known to be Turolian (MN 11-MN 12) in age, on the basis of small mammals (Ünay 1996; Bruijn *et al.* 1996). The presence of *Helladotherium duvernoyi* supports the Turolian age. The age data presented by floral and faunal elements suggests that the lignite horizon is of Turolian (Late Miocene) age.

### Paleoecology

The teeth of *Hipparion* from Düzyayla are low-crowned and with a low to high plication number. The lower teeth have a variable protostylid and occasional ectostylid (Kaya & Forsten 1999). The low-crowned teeth indicate adaptation to a forest environment (Forsten 1968). The presence of the ectostylid indicates a humid biotope. High-crowned teeth and the flat buccal surfaces of *C. neumayri* suggest that this form was a grazer living in open areas (Heissig 1975). The habitat of *Deinotherium giganteum* was forest. *Helladotherium* was a grazing form.

The fact that *Pinus* is infrequent in the Düzyayla lignite leads to the conclusion that highlands were situated same distance from the area of coal formation. During the period of coal formation, widespread steppes

may have existed, in which individuals of Compositae, Chenopodiaceae and Umbelliferae constituted a rich cover, and open areas of herbaceous plants with Ephedraceae and Gramineae, rich in *Quercus* were accompanied sparsely by *Ulmus*, *Carya*, *Castanea*, Fagaceae, Cyrillaceae and Sapotaceae, forming a mosaic of forests and dense bushes. Areas covered by herbaceous plants must have been cut away by rivers in the shade of *Alnus*, *Platanus* / *Salix* and by marshlands formed by aquatic Angiosperms like Nymphaeaceae, Cupressaceae, *Taxodium*, and *Sparganium/Typha*. In Europe, the Late Miocene vegetation shows a progression, ranging from arid steppe areas under the influence of a warm climate, to open forests and pastures under the influence of a seasonal Mediterranean climate (one season cool, the other season warm and dry but with no extreme temperatures) (Kovar-Eder 1987; Nagy 1990; Rivas-Carballo 1991). The İncesu formation at Düzyayla, with its features of a Late Miocene microflora, shows similarity to those of the European Late Miocene in terms of both vegetation and climatic features.

As a result, the Late Miocene flora reflects wide steppes, on which Compositae and Chenopodiaceae were dominant, and tree associations composed of deciduous Angiosperms and herbaceous ground cover. This flora also reflects a warm and humid climate with temporary dry periods during summer.

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**PLATE I**

(All illustrations X 500)

- Figure 1 *Laevigatosporites haardti* (R. POTONIE VENITZ) THOMSON & PFLUG  
 2 *Stereisporites* sp.  
 3 *Leiotriletes microadriennis* KRUTZSCH  
 4 *Cycadopites cycadoides* (ZAKLEAN) KEDVES  
 5 *Cycadopites minor* (KEDVES) KEDVES  
 6 *Ephedripites* sp.  
 7 *Pityosporites microalatus* (R. POTONIE) THOMSON & PFLUG  
 8 *Pityosporites labdacus* (R. POTONIE) THOMSON & PFLUG  
 9 *Inaperturopollenites dubius* (R. POTONIE & VENITZ. ) THOMSON & PFLUG  
 10 *Inaperturopollenites hiatus* (R. POTONIE) THOMSON & PFLUG  
 11 *Inaperturopollenites* sp.  
 12 *Sparganiaceapollenites neogenicus* KRUTZSCH  
 13, 14 *Sparganiaceapollenites polygonalis* (THIERGART) KRUTZSCH  
 15, 16 *Monoporopollenites gramineus* WEYLAD, PFLUG & MUELLER  
 17 *Monoporopollenites gramineoides* MEYER  
 18 *Graminidites pseudogramineus* KRUTZSCH  
 19 *Graminidites soellichauensis* KRUTZSCH  
 20 cf. *Achantotricolpites intermedius* SINGH & MISRA  
 21 *Monocolpopollenites tranquillus* (R.POTONIE) THOMSON & PFLUG  
 22-24 *Monogemmites pseudosetarius* (WEYLAND & PFLUG) KRUTZCH  
 25 *Monocolpopollenites* sp.  
 26 *Triatriopollenites bituitus* (R.POTONIE) THOMSON & PFLUG  
 27 *Intratropollenites instructus* (R.POTONIE & VENITZ) THOMSON & PFLUG  
 28,29 *Intratropollenites* sp.  
 30 *Polyvestibulopollenites verus* (R.POTONIE) THOMSON & PFLUG  
 31 *Polyporopollenites undulosus* (WOLFF) THOMSON & PFLUG  
 32 *Polyporopollenites* cf. *stellatus* (R.POTONIE & VENITZ) THOMSON & PFLUG  
 33 *Tricolpopollenites densus* PFLUG in THOMSON & PFLUG  
 34,35 *Tricolpopollenites microhenrici* (R.POTONIE) THOMSON & PFLUG  
 36,38 *Tricolpopollenites retiformis* PFLUG & THOMSON in THOMSON & PFLUG  
 39,40 *Tricolporopollenites cingulum* (R.POTONIE) THOMSON & PFLUG  
 41,42 *Tricolporopollenites megaexactus* (R.POTONIE) THOMSON & PFLUG  
 43 *Tricolporopollenites pseudocingulum* (R.POTONIE) THOMSON & PFLUG  
 44,45 *Tricolporopollenites donatus* PFLUG in THOMSON & PFLUG  
 46 *Tricolporopollenites microreticulatus* PFLUG & THOMSON in THOMSON & PFLUG  
 47-49 *Umbelliferaepollenites peissenbergensis* KIRCHNER  
 50 *Umbelliferaepollenites nogradensis* NAGY  
 51,52 *Tubulifloridites* cf. *granulosus* NAGY  
 53 *Tubulifloridites* cf. *antipodica* COOKSON  
 54-59 *Tricolporopollenites* sp. (Compositae-Tubuliflorae)  
 60-62 *Cichoriaeanumpollenites gracilis* NAGY  
 63-66 *Tricolporopollenites* sp. (Compositae-Liguliflorae)  
 67 *Tricolporopollenites* sp.  
 68 *Tetracolporopollenites microellipsus* PFLUG in THOMSON & PFLUG  
 69-71 *Periporopollenites multiporatus* PFLUG & THOMSON in THOMSON & PFLUG  
 72,73 *Periporopollenites periporatus* NAKOMAN  
 74 *Periporopollenites perplexus* NAKOMAN  
 75 *Periporopollenites* cf. *halifani* NAKOMAN  
 76-80 *Periporopollenites halifani* NAKOMAN  
 81 *Periporopollenites stigmosus* (R. POTONIE) THOMSON & PFLUG  
 82 *Periporopollenites* sp.

PLATE I

