

Pollen-dominated “European” palynological assemblages from the Permian of NW Turkey (Asia Minor) – palaeogeographical context and microfloral affinities

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Palynological assemblages from the Çamdağ area of NW Turkey are analysed quantitatively and qualitatively. All preparations logged from different palynomorph sampling sections show high ratios of pollen. Within the pollen fraction percentages of up to 71% for the bisaccate pollen *Lueckisporites* Potonié and Klaus 1954 are remarkable. This pattern is reminiscent of palynofloras described from the Upper Permian of Europe. This enables the study area to be shown in its palaeogeographic context, and constrains interpretation of microfloral affinities, palynostratigraphy, and depositional environment. The palaeoenvironmental model clearly indicates deposition within the hinterland, corroborating previous interpretations.

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INTRODUCTION

In 1995, Alişan and Derman published on the “Permo-Triassic” Çakraz Formation in the Çamdağ area, NW Turkey (Fig. 1A and B). The authors dated part of these deposits palynologically for the first time as “Late Permian”. Furthermore, they noted a similarity to assemblages of similar composition in “Euromeria type basins”. These exotic palynological assemblages from Asia Minor stimulated further investigations. In this study, an origin from the northern hemisphere of the Permian palaeoworld is shown. The assemblages are described in terms of their main constituents, and the relation of the palynological content to the environment of deposition is discussed, as are the climate conditions and depositional age.

GEOLOGICAL BACKGROUND

The Çamdağ area is situated in the western Pontides in the north-west of Turkey. Çamdağ is assigned to the Istanbul–Zonguldak Terrane (also the Istanbul Terrane; e.g., Okay and Göncüoğlu, 2004; Moix *et al.*, 2008; Fig. 1A and C), which represents a part of a terrane complex. This terrane com-

plex included in the Permian the Moesian Terrane (with the Moesian Platform), the Balkan Terrane, the Thracian Terrane (with the Thrace Basin; Yanev and Dimitrova, 1997; Yanev *et al.*, 2006; Fig. 1C), all related to Pangea (Laurussian part; Fig. 1D). In the Çamdağ area, Permian deposits are represented mainly as clastic deposits, including conglomerates, sandstones and claystones; these deposits are succeeded by red colored sandstones of probably mainly Triassic age (e.g., Alişan and Derman, 1995; Gedik and Önalın, 2001). The Permo-Triassic deposits are referred the Çakraz Formation.

MATERIAL AND METHODS

Palynological sampling was carried out at Çamdağ southwards from the town of Karasu. Twenty-four samples were collected from the study area (approx. 4.5 × 4 km). Samples come from two measured sections (from older to younger, one along 1600 m, around 20–60° fall, locally tectonically disturbed), and from one isolated sampling point. Standard preparation methods (e.g., Wood *et al.*, 1996) have been applied to claystones rich in organic matter to separate the palynological material more than 15 µm in size.

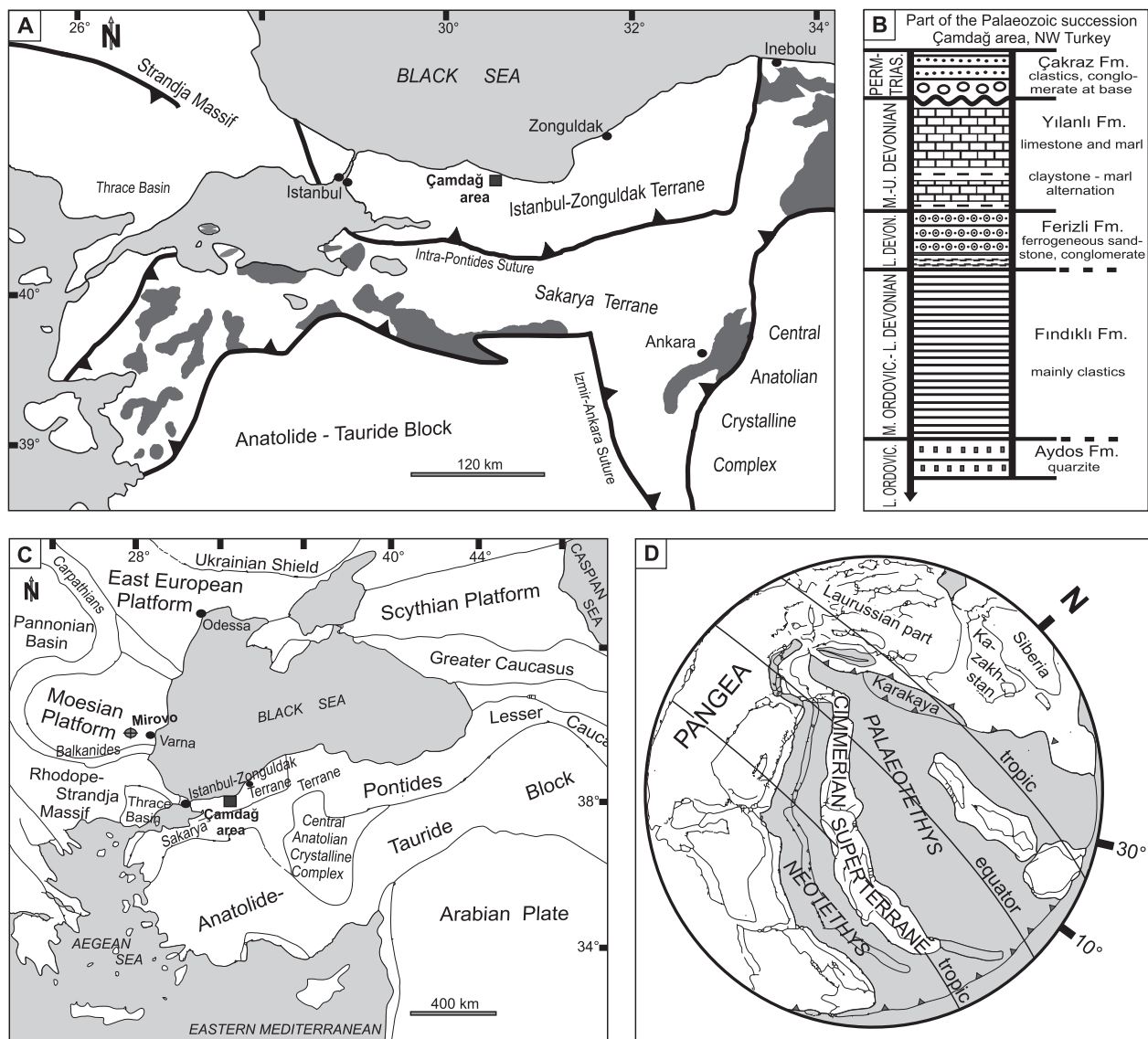


Fig. 1. Geographical (A and C) and palaeogeographical overview (D, land masses and shelf areas in white) of the study area and locations mentioned in the text, with regard to a plate tectonic context

Note for comparison that the dark areas in A belong to deposits of the Karakaya Complex, which are found in D at approx. at 15–20° N palaeolatitudes. Maps (A and C) are redrawn and simplified according to Okay and Tüysüz (1999), Okay and Göncüoğlu (2004) and Okay (2008), the stratigraphic column (B) is redrawn and modified according to Gedik and Önalın (2001), and the global overview (D) is simplified according to Stampfli (2000), Stampfli and Borel (2002)

CHARACTERISTICS OF THE PALYNOLOGICAL ASSEMBLAGES

Preservation. The Paleozoic deposits of the Çamdağ area underwent thermal alteration giving the organic matter in the rock a high degree of maturity. The Permian palynomorphs are blackish-brown (Fig. 2). An identification of pollen to the genus and species level is possible whereas thick-walled spores can often only be identified as “spore”. Pollen were obviously affected by transport, and often occur as fragments.

Percentage ratios. Every palynological assemblage from each sample within the study area is dominated by bisaccate pollen. Counts of different morphological groups show relatively similar ratios for the samples (the average ratios in Fig. 3). The palynological taxa so far identified are shown in Table 1. Species of *Lueckisporites* (Infraturma Murornati-Costati, having a corpus with numerous sub-parallel ridges = taeniae), are the main elements within the morphogroup of the “taeniate/striate bisaccate pollen”. *Lueckisporites* may comprise up to 71% of the palynological assemblages (of all counted palynomorphs).

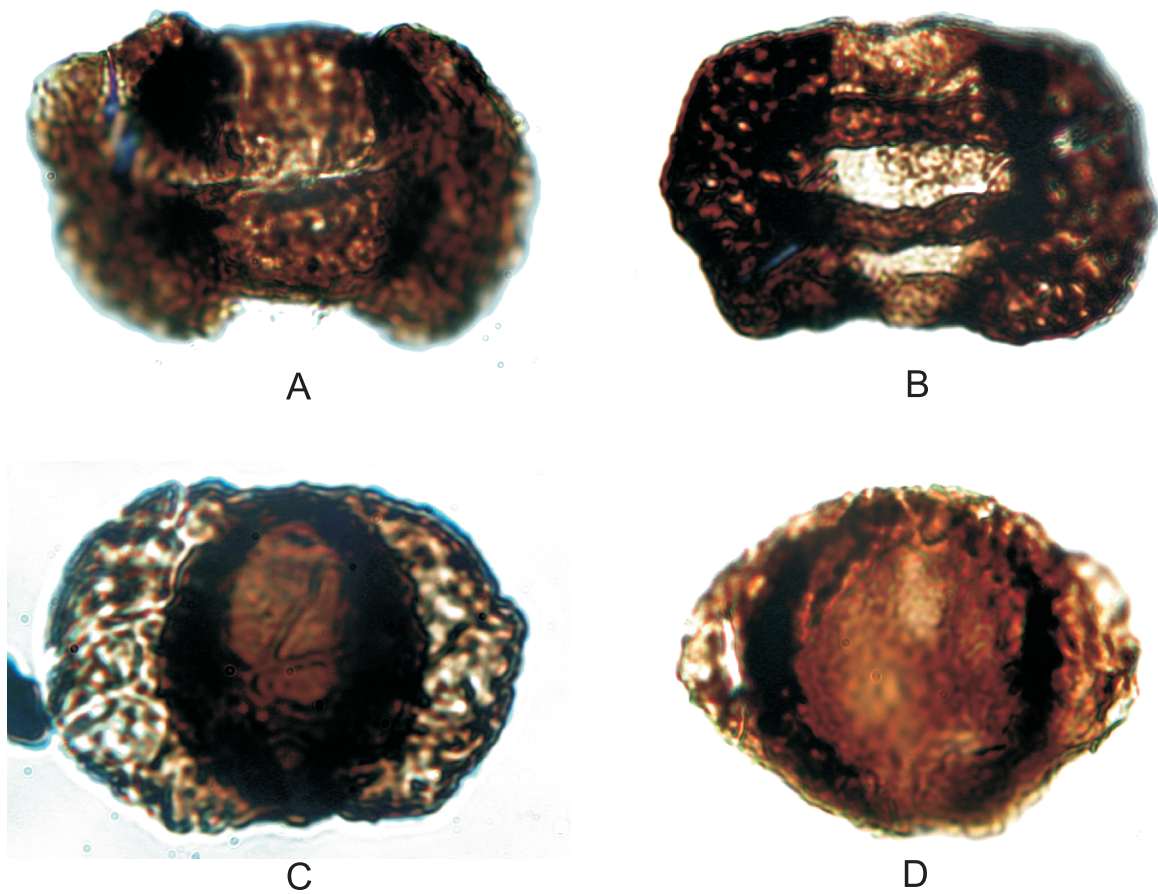


Fig. 2. Common palynological taxa from the Çakraz Formation (Permian part) in the Çamdağ area, NW Turkey

A – *Lueckisporites virkkiae*, 56 µm, CDK1/2, O29.4; **B** – *Taeniaesporites noviaulensis*, 85 µm, CDK1/4, Y49.4; **C** – *Alisporites* sp., 51 µm, CDK1/3, X31.4; **D** – *Alisporites tenuicarpus* (a specimen with small sacci), 42 µm, CDK1/3, V32 (this form appears under different names in the literature); each bisaccate pollen with dimensions in micrometer, slide number and England Finder coordinates

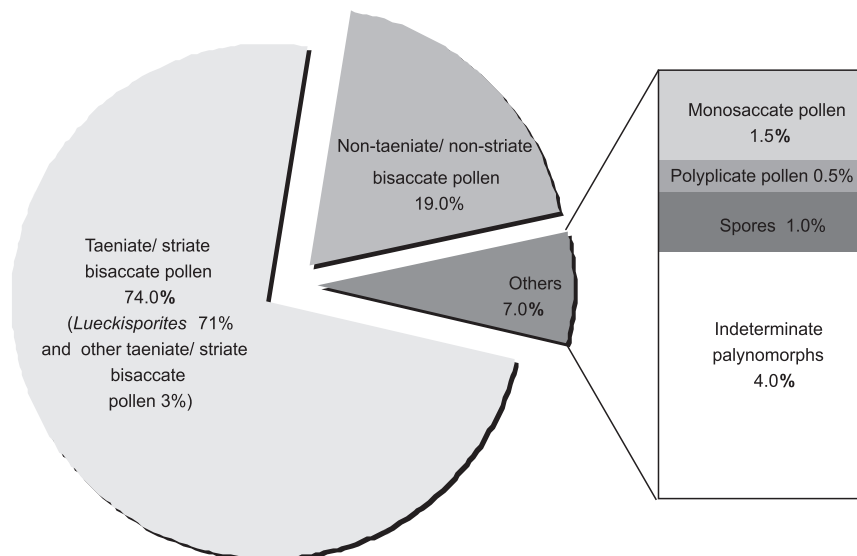


Fig. 3. The average ratios in per cent of different morphological groups from pollen-dominated palynological assemblages (Çamdağ, NW Turkey)

Data derived from twenty-four samples within the study area; all samples show relatively similar ratios of the main constituents

Table 1

Morphological groups and their main constituents (genera, species) of the palynological assemblages from the Çamdağ area, NW Turkey

Main palynological morphogroups used in this study	The constituents (species and genera) of assemblages from Çamdağ area, NW Turkey
Taeniate/striate bisaccate pollen	<i>Lueckisporites</i>
	<i>Lueckisporites virkkiae</i> Potonié and Klaus, 1954
	<i>Lunatisporites</i>
	<i>Protohaploxypinus</i>
	<i>Striatopodocarpites</i>
	<i>Striatopodocarpites cancellatus</i> (Balme and Hennelly) Hart, 1964
	<i>Taeniaesporites</i>
	<i>Taeniaesporites noviaulensis</i> Leschik, 1956
Non-taeniate/non-striate bisaccate pollen	<i>Alisporites</i>
	<i>Alisporites tenuicarpus</i> Balme, 1970
	<i>Alisporites nuthallensis</i> Clarke, 1965
	<i>Falcisporites zapfei</i> (Potonié and Klaus) Leschik, 1956
	<i>Klausipollenites</i>
	<i>Platysaccus</i>
	<i>Platysaccus papilionis</i> Potonié and Klaus, 1954
	<i>Striatoabieites</i>
	<i>Striatoabieites multistriatus</i> (Balme & Hennelly) Hart 1964
	<i>Vesicaspora</i>
Monosaccate pollen	<i>Vitreisporites</i>
	<i>Plicatipollenites</i>
Polyplicate pollen	<i>Potonieisporites</i>
	<i>Vittatina</i>
Spores	<i>Punctatisporites</i>
	<i>Punctatosporites</i>
	<i>Calamospora</i> ?

**THE “ÇAMDAĞ ASSEMBLAGES”
IN RELATION TO PALAEOGEOGRAPHY,
ENVIRONMENT AND AGE**

The pollen-dominated palynological assemblages from Çamdağ (Asia Minor) resemble similar assemblages described in the classic publications on the Upper Permian of Western Europe (e.g., Leschik, 1956; Grebe and Schweitzer, 1964; Clarke, 1965; Visscher, 1967; Clement-Westerhof, 1974). These assemblages contain species such as *Lueckisporites virkkiae*, *Falcisporites zapfei* and *Klausipollenites schaubegeri*, and were dated as Late Permian, often in the sense of latest Permian. The uppermost Permian strata of Western Europe were deposited in the northern hemisphere, and deposition took place under arid climate conditions (e.g., Grebe, 1957; Hochuli *et al.*, 2010). Palaeogeographically, the Permian deposits from the Çamdağ area in Turkey have a similar setting. The Istanbul–Zonguldak Terrane was situated in the northern hemisphere at approx. 10–30°N (e.g., Stampfli, 2000; Stampfli and Borel, 2002), and thus probably in the tropical or subtropical region. Palynologically, the assemblages from

Çamdağ show similarities to microfloras from the palaeogeographically adjacent northeastern Bulgaria area (Mirovo, Moesian Terrane; Dimitrova *et al.*, 2006). In their OR-1 Mirovo section, pollen is the dominant constituent in the assemblages with ratios of 92–96%. Taxa such as *Lueckisporites virkkiae*, *Vittatina* and *Alisporites* species are common. *L. virkkiae* is abundant comprising approx. 3–12% in assemblages from the upper sections (palynozones M2, M3). These sections (depths of 1243–3325 m) have been considered as late Guadalupian to Lopingian on palynological grounds, mainly on the basis on taxa such as *L. virkkiae* (for the early Guadalupian to Lopingian) and *Klausipollenites* (Lopingian). In northwestern Turkey, Alişan and Derman (1995), “...noticed that *Lueckisporites virkkiae* (striate-bisaccate pollen) which is commonly found in “Euromeria type” basins is abundant in this area too”. Consequently, part of the Çakraz Formation has been dated by the authors as Late Permian. But the term “Late Permian” was formerly used with different meanings, such as an equivalent to the Lopingian (or otherwise having a range from Guadalupian to Lopingian). However, the marker *L. virkkiae* has in the Permian of the northern hemisphere a range from Roadian/Wordian to Changhsingian (e.g., Burov and Esaulova,

1995). An abundance of *L. virkkiae* in bisaccate pollen-dominated assemblages can therefore also indicate Roadian/Wordian ages. On this basis, the age determination for the assemblages from Çamdağ span from mid to latest Permian. Although the associations show strong “European” affinities, suitable corresponding palynozonations from Europe are missing for a more precise age assignment.

Given the lack of a narrowly defined age range for the assemblages from Çamdağ wider conclusions are hard to draw, for instance regarding palaeoclimatic interpretation (correlation to a specific phase). The depositional conditions at Çamdağ have been described by Alişan and Derman (1995) as “continental”, deposited in river channel and flood plain environments, possibly on an alluvial fan and in related small lakes. In relation to the recent palaeoenvironmental models of Demschuk *et al.* (2008) and Michoux (2002), the relative abundance of bisaccate pollen from hinterland conifers and of terrestrial organic matter in the assemblages as well as the virtually absence of pteridophyte spores and freshwater algae support the suggestion of deposition just within in the hinterland area.

CONCLUDING REMARKS

According to recent literature, the Permian part of the Çakraz Formation in the study area (Çamdağ, NW Turkey) was deposited in a northern hemisphere setting at latitudes of approx. 10–30°N. Preliminary analyses on material of

twenty-four samples from the formation show without exception a dominance of bisaccate pollen in the palynological assemblages (average 93%). All assemblages are characterized by high percentages of *Lueckisporites* (average 71%). The assemblages from Çamdağ (Asia Minor) show similarities to those from the palaeogeographically adjacent situated Upper Permian of northeastern Bulgaria, and are reminiscent of “Late Permian” pollen-dominated assemblages described from Western Europe. However, corresponding palynozonations from Europe are still missing for a precise age assignment. More detailed statements can be given on the palaeoenvironment. The composition of the microfloras (mainly bisaccate pollen from hinterland conifers) clearly indicates that the depositional environment was within the hinterland.

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