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Research papers

Fagaceae from the early Oligocene of Central Europe: Persisting new world and emerging old world biogeographic links

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ABSTRACT

Dispersed pollen from phosphoritic nodules of early Oligocene age from Cospuden (Rupelian, Saxony, Central Europe) comprises six distinct types of Fagaceae belonging to four to five genera, three of which belong to extinct lineages. *Eotrigonobalanus* and *Trigonobalanopsis* have stratigraphic ranges from the Eocene to the Miocene and the Pliocene, respectively, and an unassigned fagaceous pollen type might belong to a lineage related to the middle to late Oligocene *Amentoplexipollenites* from North America. Also pollen of *Eotrigonobalanus* from Cospuden is strikingly similar to pollen attached to staminate catkins in middle to late Oligocene sediments from the North American Gulf Coastal Plain. Both types of pollen co-occur with foliage of the *Eotrigonobalanus* type (*Dryophyllum*, *Berryophyllum*). Furthermore, cupules and fruits from the middle Eocene to lower Miocene in Europe (*Trigonobalanus andreanszkyi* Mai) and the Oligocene of the Gulf Coastal Plain are structurally similar. This suggests an intercontinental distribution of this extinct lineage of Fagaceae with migration across the North Atlantic. *Trigonobalanopsis* is endemic during the Cenozoic in Europe. Although present in late Miocene sediments of Iceland it has not been reported from North America. The extant genera *Fagus* and *Quercus* are not known prior to the Eocene. The unequivocal presence of *Fagus* in Rupelian sediments of Central Europe is the oldest record of the genus in western Eurasia. *Fagus* migrated to Europe from the east (Central and East Asia) after the closure of the Turgai Seaway. Pollen belonging to *Quercus* Group Ilex also marks the oldest record for Europe. Today, this group of oaks is endemic to Eurasia with isolated occurrences in the Mediterranean, the Himalayas, and East Asia. It is unclear, whether the group originated in Europe or East Asia. Pollen belonging to either *Quercus* Group Quercus or Group Lobatae (white and red oaks) dates back at least to the Eocene in Europe (Baltic Amber). Based on systematic affinities of leaves from late Oligocene sediments in Saxony, pollen from Cospuden with the distinctive features of these infrageneric groups may represent Group Lobatae (red oaks). This group is at present confined to North America, but appears to be represented in the fossil record of East Asia and Europe.

1. Introduction

For many families of flowering plants that originated in the Cretaceous the fossil record suggests that these families have undergone major changes in taxon diversity. The Platanaceae, for instance, had a much larger diversity during the course of the middle Cretaceous until the early Cenozoic (Friis et al., 1988; Kvaček and Manchester, 2004; Denk and Tekleva, 2006 Tschan et al., 2008) but consist of a single genus today (Grimm and Denk, 2008, 2009). The Hamamelidaceae comprise more than 25 genera today, but were potentially markedly more diverse in the Cretaceous and the early Cenozoic (e.g., Maslova, 2003). Also the Fagaceae comprised a larger number of genera during the Late Cretaceous and parts of the Cenozoic than today. Several of these genera belong to extinct lineages. Understanding the evolutionary unfolding of plant families relies not only on phylogenetic trees based on data from their modern representatives, but also requires a thorough analysis of their past diversity patterns. For example, unresolved phylogenies including only modern members of a group are often due to the fact that several intermediate forms existed during the geological past and that reticulate evolution among these extinct and the extant groups resulted in complex evolutionary patterns (cf. Denk and Grimm, 2009b). At present, the Fagaceae are a large family of woody angiosperms consisting of ten genera in the Northern Hemisphere (Manos et al., 2008; Denk and Grimm, 2010). The phylogenetic relationships among the members of Fagaceae are not well understood, except for the isolated position of *Fagus* as the sister group to the remaining genera. Based on pollen morphology (Praglowski, 1984; Denk and Grimm, 2009a), the genera circumscribing the traditionally recognized subfamily Castaneoideae Ørsted (*Castanea*, *Castanopsis*, *Chrysolepis*, *Lithocarpus*, *Notholithocarpus*) are more closely related to

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each other than either to *Quercus* or *Trigonobalanus* and its allies. Also, based on pollen morphology, Denk and Grimm (2009a) showed the high diagnostic value of the pollen sculpturing in intrageneric groups of oaks and the Fagaceae (Denk and Grimm, 2010). Apart from this modern diversity, several extinct genera that display a mosaic of characters found in modern genera have been described from the Cenozoic of the Northern Hemisphere (e.g. *Dryophyllum* Debey ex Saporta, *Eotrigonobalanus* Walther & Z.Kvaček, *Trigonobalanopsis* Z.Kvaček & Walther, *Fagopsis* Hollick, *Fagopsiphyllum* Manchester, *Contracuparius* Nixon & Crepet, *Pseudofagus* Smiley & Huggins). Detailed description of these extinct lineages is of paramount importance to better understand phylogenetic relationships among modern members of the Fagaceae.

The present study describes dispersed pollen of Fagaceae from the early Oligocene of Central Europe and compares them to modern and

Fig. 1. Geographical maps indicating the position of the opencast mine at Cospuden near Leipzig, Germany. Panel C modified after Eissmann (2002).