A NEW SPECIMEN OF ARAUCARIA FRICII FROM THE EARLY CONIACIAN OF THE BOHEMIAN MASSIF, CENTRAL EUROPE

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Abstract: A specimen of Araucaria fricii is described from the upper part of the Teplice Formation in the Bohemian Cretaceous Basin. It extends the first occurrence of A. fricii from the mid-Coniacian back to the early Coniacian. Found in the Radovesice locality near Kučlín in the northern part of the Czech Republic, it is characterised by a deltoid cone scale complex with a centrally placed seed. It is compared to the type material of A. fricii from the mid-Coniacian Březno Formation and other European Cretaceous species of Araucaria. The taphonomy and palaeoecology of A. fricii is briefly discussed.

Key words: conifers, Araucariaceae, Araucaria, Cretaceous, Coniacian

Introduction

The genus Araucaria Juss. is currently considered a typical representative of the Southern Hemisphere flora (Kunzmann 2007a), but this was not always the case. In the past, Araucariaceae, including the genus Araucaria, were quite common elements of the European Jurassic and Cretaceous floras. Their gradual decline is particularly noticeable in the Late Cretaceous (Stockey 1994, Kunzmann 2007a), but this was not always the case. In the mid-Coniacian of the Bohemian Cretaceous Basin, the locality near Kučlín in the northern part of the Czech Republic, it is characterised by a deltoid cone scale complex with a centrally placed seed. It is compared to the type material of A. fricii from the mid-Coniacian Březno Formation and other European Cretaceous species of Araucaria. The taphonomy and palaeoecology of A. fricii is briefly discussed.

The Early Cretaceous record of the genus is represented by A. carolae L.Kunzmann from the Aptian/Albian of Nehden (Kunzmann 2007b). Other members of the Araucariaceae family from that period are recorded as pollen cone: Araucarites pedreranus Barale and ovuliferous cone Dammarites coriaceae Barale, both described from the Valanginian of Spain (Barale 1989, 1992). Pollen cones Rabagostrobus J.Kvaček, E.Barrón, Hérmánová et M.M.Mendes from the Early Cretaceous Aptian/Albian of Spain (Kvaček et al. 2018) and Callialastrobus J.Kvaček et M.M.Mendes (Kvaček and Mendes 2020) from the Early Cretaceous of Portugal were recently described by the author and his co-workers. Putative representatives of the family are reported from the European Cretaceous as sterile foliage Pagiothyllum brachyphyllum (E.Bayer) L.Kunzmann from the mid-Coniacian of the Bohemian Cretaceous (Kunzmann 2007b), P. pedreranum Barale from the Valanginian of Spain (Barale 1989), Brachyphyllum obesum Heer from the Early Cretaceous of Portugal and Spain (Heer 1881, Saporta 1894, Kvaček et al. 2018), B. squamosum (Velen.) Palib. from the Cenomanian to Santonian of the Czech Republic (Němejc and Kvaček 1975, Kvaček 2007), and B. patens (Mió.) R.W.Ham et van Konijnenb. nom. illeg. (non Brachyphyllum patens (Brongn.) Schenk ex M.Hebert; Hebert 1869) from the Maastrichtian of the Netherlands (van der Ham et al. 2003). Although, the latter was interpreted as of possibly chieirolepidiacean affinity.

European araucariaceous fossil wood from the Cretaceous was described from the Albian of Hungary (Agathoxylon pannonicum (Greguss) Barale, Barbacka...
et Marc Philippe (Barale et al. 2002), and Santonian of Aachen, Belgium (Dammaroxylon aachenense J.J.F. Meijer (Meijer 2000), Dadoxylon cf. subherzynicum J. Schultze-Motel (Gottwald 2000)).

The Cenozoic Araucariaceae are reported from the Northern Hemisphere as poorly preserved ovuliferous cones Araucarites pojarkovae Krassilov from the Palaeocene of Siberia (Krassilov 1976), but this fossil was later re-interpreted by Golovneva (2006) and Krassilov and Kodrul (2006) as a fragment of an angiosperm. However, there are more definite fossils of Araucariaceae as fossil woods, Araucarites shandongense U. Prakash et N.Z. Du from the middle Miocene deposits of the Shandong province in China (Prakash et al. 1995), and Agathoxylon sp. from the late Oligocene to early Miocene of the Qiutangling Formation of the Shandong province in Ledong, Hainan Island, China (Feng et al. 2015).

Since the first publication of A. fricii by Bayer (1893) from the mid-Coniacian of Březno (Březno Formation), there has been no other report of the species or the genus within the Bohemian Cretaceous Basin. This situation makes the newly found specimen of great interest, and it also extends the first occurrence of A. fricii from the early/middle Coniacian back to the early Coniacian and adds more diversity to the taxon.

Material and methods

The newly described cone scale complex is impressed in marine sandy marlstone from the Teplice Formation of the Bohemian Cretaceous Basin, as defined by Čech et al. (1980, Čech 2011). The age of the Teplice Formation, late Turonian to early Coniacian, is based on biostratigraphic, sequence stratigraphic and carbon isotope data (Wiese et al. 2004). It is generally quite a complicated formation, however in Radovesice the strata from which the Araucaria cone scale complex comes are assigned to the early Coniacian based on the index fossil belemnite Gonioxamus lundgreni (Košťák et al. 2004). The holotype of Araucaria fricii is partly limonitised and impressed in marine marlstone from Březno locality, the Březno Formation of the Bohemian Cretaceous Basin. The type of sediment in which the fossil is impressed indicates gastropod layers of the Březno Formation that could be assigned to middle/early Coniacian age (Košťák oral communication).

Both specimens were photographed under low angle light with a Canon EOS 6D Camera equipped with a 24 mm Sigma lens. The holotype was collected in 1864 by H. Mayer, a teacher from Březno. The newly described specimen was collected in 1997 by Zdeněk Dvořák from the company Severočeské doly a.s.

Systematic palaeobotany

Family Araucariaceae Henkel et W. Hochst., 1865 nom. cons.

Genus Araucaria Juss., 1789

Type. Araucaria araucana (Molina) K. Koch, 1873.

Remarks. The genus Araucaria has an extended fossil record (e.g., Stockey 1994). Its typical feature is the unique deltoid cone scale complex with a single centrally placed seed complemented by a ligula. All these features are clearly visible in the newly described specimen.

Araucaria fricii Velen. ex E. Bayer, 1893

Text-fig. 1a, b

1893 Araucaria fricii Velen. ex E. Bayer, p. 3, fig. 1.
1893 Araucaria fricii Velen. ex E. Bayer; Bayer in Frič, p. 128, fig. 177.
1894 Araucaria fricii Velen. ex E. Bayer; Bayer in Frič, p. 124, fig. 177.
2007b Araucaria fricii Velen. ex E. Bayer; Kunzmann, p. 109, text-fig. 2a-c, pl. 1, figs 1–4.
2018 Araucaria fricii Velen. ex E. Bayer; Halamski et al., p. 126, pl. 2, figs 1–3.

Holotype. NM-F 1898, coll. National Museum, Prague, leg. H. Mayer in 1864 (Text-fig. 1a).

Type locality. Březno, the Czech Republic.

Type horizon. Březno Formation, middle/early Coniacian, Late Cretaceous.

Emended diagnosis. Ovuliferous cone scale complex cuneate, length greater than width, laterally narrow-winged, having one seed per cone scale complex. Ligula 2/3 to 1/1 of the length of the seed. Seed oval, oblong-oval to oblong-ovate. In cross-section wide oval to rhomboid, considerably narrower and shorter than the cone scale (emended from Kunzmann 2007b).

Other material. NM-F 5010, coll. National Museum, Prague, leg. Z. Dvořák 1997 (Text-fig. 1b); No. 451, coll. Knoll.

Other occurrences. Radovesice near Kučín, the Czech Republic (Teplice Formation, early Coniacian, Late Cretaceous); Hauset near Aachen, Belgium (late Santonian, Late Cretaceous; Kunzmann 2007b).

Description. The holotype (Text-fig. 1a) is a laterally narrow cuneate ovuliferous cone scale complex 15 mm wide × 29 mm long. It shows a centrally placed oval oblong seed 16 mm × 6 mm. A fragment of ligula is 8 mm wide. The apical part of the cone scale complex exhibits a terminal projection 6 mm wide × 7.5 mm long. The cone scale complex is partly limonitised, showing resin fragments imitating resin canals in the apical and central parts, some of irregular shape, always less the 0.2 mm in diameter.

The newly found specimen, No. NM-F 5010, (Text-fig. 1b) is an impression in sandy marlstone from the Teplice Formation. It shows a deltoid cone scale complex, 20 mm wide × 27 mm long. The terminal projection is 7 mm wide × 5 mm long. The centrally placed seed impression is an elongate ovoid 15 mm × 5 mm. The ligula impression is 9 mm wide.

Discussion

The present emendation of the species diagnosis follows a more conservative approach than Kunzmann (2007b). He used a complete ovuliferous cone for his emendation, from the Santonian locality in Belgium. Although the Santonian material is more complete, it is from a different stratigraphic
horizon, a different locality, and is in a different state of preservation. To avoid confusion, the author prefers having the emendation based only on the type material from the type horizon.

The studied cone scale complex *A. fricii* from the early Coniacian is broader than the holotype and does not show the long apical projection. However, as is known from recent ovuliferous cone scale complexes of various modern species of *Araucaria*, shapes and sizes of cone scale complex can vary remarkably, even within a single cone. This is why the shape and size of the newly described specimen are judged to fall within the accepted variability of *A. fricii*.

*A. fricii* was compared to other similar species by Kunzmann (2007b), in particular to *Araucaria carolae* L. Kunzmann, from which it differs in having larger cone scale complexes and smaller seeds. *A. fricii* is similar to *Aachenia debeyi* Erw. Knobloch (1972) in having a terminal projection and deltoid shape, but this similarity is only superficial; it differs from *A. debeyi* in having a single centrally placed seed. The type material of *A. debeyi* does not exhibit any seeds, therefore it cannot even be definitively assigned to the Araucariaceae (Kunzmann 2007a). *A. fricii* is similar to *Araucaria* sp. from the Maastrichtian of the Netherlands (van der Ham et al. 2010) in size and shape but differs from it in having a well-pronounced terminal projection.

Considering extant species of *Araucaria*, *A. fricii* is similar to species belonging to the section *Eutacta*. It shares a similar conspicuous apical projection with *A. biramulata* J. Buchholz, *A. muelleri* (Carrière) Brongn. et Gris, *A. luxurians* (Brongn. et Gris) De Laub., *A. rulei* F. Muell. ex Lindl. and *A. subulata* Vieill. (Kunzmann 2007b).

**Remarks**

Both specimens of the *A. fricii* cone scale complex known from the Bohemian Cretaceous Basin, also the discussed material from Belgium, and *Araucaria* sp. from the Maastrichtian of the Netherlands come from marine sediments.

The strictly marine taphonomy of the specimens might be due to the fact that *Araucaria fricii* and possibly other European Cretaceous araucarias grew in environments far from terrestrial sedimentary basins. This hypothesis is supported by the predominantly mesophytic character of extant *Araucaria*. It could therefore not have been preserved in the fresh-water sediments of the Klikov Formation from the South Bohemian Cretaceous Basins, although that formation is of Late Turonian to Santonian age (Knobloch 1985).

The species might have been relatively scarce because *Araucaria* was already a rare taxon in the Late Cretaceous, facing strong competition from angiosperms (Kunzmann 2007a, b).

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