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SILICIFIED STEM FROM THE LATE EOCENE FOSSIL LOCALITY OF KUČLÍN (CZECH REPUBLIC): OVERVIEW AND NEW REMARKS

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Abstract. The silicified stem from Kučlín was first attributed to *Podocarpoxylon helmstedtianum* and linked with the co-occurring remains of *Doliostrobus*. Later it was re-interpreted as *Tetraclinoxylon vulcanense* and associated with twigs and seeds of *Tetraclinis*. The new anatomical comparison reveals that exact botanical affinities of the silicified stem cannot be unequivocally established, mainly with respect to poorly preserved cross-field pitting.

■ fossil conifer wood; *Podocarpoxylon*; *Tetraclinoxylon*; *Doliostrobus*; *Tetraclinis*; Late Eocene; Kučlín; Czech Republic

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Introduction

In 1976, a large silicified tree attaining 7.5 m in length was found in the locality of Kučlín by F. Holý (Text-fig. 1). In 1994, the stem was systematically attributed to *Podocarpoxylon helmstedtianum* GOTTWALD and tentatively linked with the co-occurring twigs and cone scales of *Doliostrobus* MARION (Březinová et al. 1994). In 2003, the wood was re-interpreted as *Tetraclinoxylon vulcanense* PRIVÉ and associated with twigs and seeds of *Tetraclinis* MASTERS (Sakala 2003). In fact, *Doliostrobus* and *Tetraclinis* are the only two conifers described in Kučlín (Kvaček 2002, Kvaček and Teodoridis 2011 in this volume), well characterized and unequivocally separated

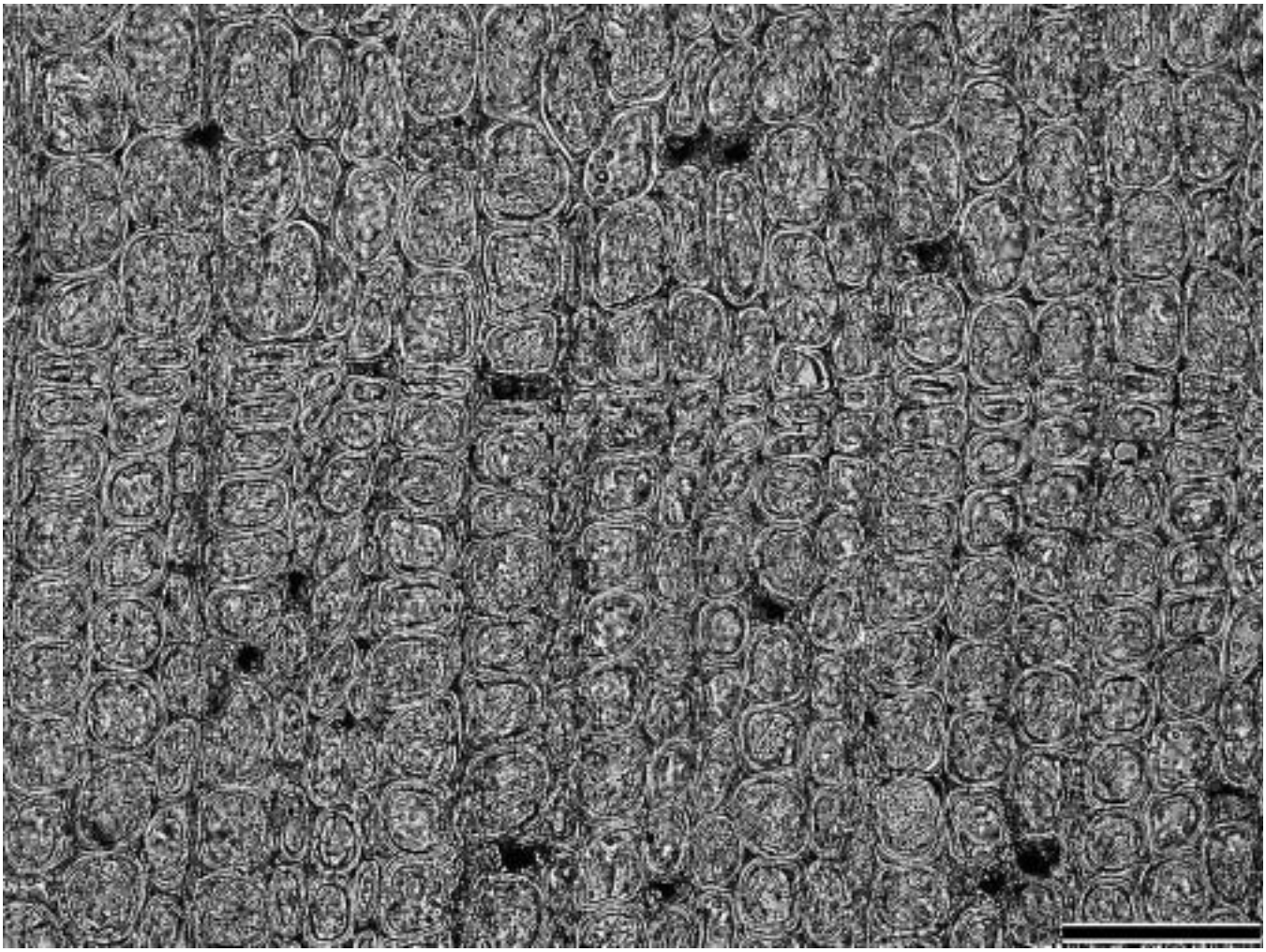
Text-fig. 1. Historical photo by M. Mag of the discovery of the silicified stem in the locality of Kučlín in 1976 (courtesy Regional Museum Teplice).

based on foliage and reproductive structures. Therefore, the uncertainty, which persists about exact botanical affinities of the silicified stem, is rather problematic.

Historical overview

Březinová in Březinová et al. (1994) described the wood from Kučlín as *Podocarpoxylon helmstedtianum*. The cross-fields, which are of crucial interest for attribution to the morphogenus *Podocarpoxylon* GOTHAN, were characterized as cupressoid and taxodioid. The author, however, noticed they were "usually poorly preserved" (Březinová in Březinová et al. 1994: p. 224). When I re-analyzed the fossil wood (Sakala 2003), I did not observe any "taxodioid" cross-field pit, i.e., with "large, oval to circular, included apertures; the aperture exceeds the width of the border at its widest point" (IAWA Committee 2004: feature 94, p. 53). In fact, all the observed cross-field pits were "cupressoid", i.e., with "elliptical apertures included within the limits of the pit border (contrary to the often extended piceoid pits); apertures are definitely narrower than the border" (IAWA Committee 2004: feature 93, p. 53). However, similarly to Březinová, I could note that the cross-field pits were "poorly preserved" (Sakala 2003: p. 26), in other words, the fact that I did not observe any taxodioid cross-field pit might be also related to the bad preservation or high recrystallisation of the Kučlín wood. I consequently concentrated on features other than cross-field pitting and I realized that, contrary to the previous description (Březinová in Březinová et al. 1994), the tracheids were markedly roundish in cross-section (Text-fig. 2) with characteristic intercellular spaces (Sakala 2003). This feature in combination with other ones (see in Sakala 2003) allowed me to re-attribute the sample to *Tetraclinoxylon vulcanense*, which had originally been described from the Pliocene of Rochefort-Montagne, France by Privé (1973). This fossil morphospecies is considered to describe the wood of *Tetraclinis*, even it differs from the only living representative of *Tetraclinis – T. articulata* (VAHL) MASTERS by having both strongly developed crassulae (= Sanio bars) and numerous biseriate parts of pitting in radial tracheid walls (see in Privé 1973: p. 173). Therefore, I associated the fossil wood with twigs and seeds of *Tetraclinis salicornioides* (UNGER) Z. KVAČEK described from the same locality by Kvaček (2002).

In 2005, the trunk wood of *Doliostrobus* was described from the Late Eocene locality of Groitzsch, Germany and a new morphogenus *Doliostroboxylon* was proposed by Dolezych in Junge et al. (2005) to accommodate a unique combination of wood anatomical features. The wood has an overall cupressaceous character (similar to Cupressaceae s.l.) except for the peculiar cross-field pitting; Dolezych in Junge et al. (2005) described cross-field pits as cupressoid,



Text-fig. 2: Microscopic photo of the wood from Kučlín (specimen No. G 4723, NM, transverse section) shoving growth ring boundary with markedly rounded tracheids and abundant axial parenchyma (dark cells) present both in late- and earlywood (scale bar = 100 µm).

Table 1. Comparative anatomical table, for more information, see explanation in the text, part called New remarks, note: "height of ray cells" means ratio between the height of ray cells in 1-cell high rays and the height of the middle ray cells in 3- or more-cell high rays; this ratio cannot be determined from the publications about *Doliostroboxylon* and the holotype of *Tetraclinoxylon vulcanense* so there are only total ranges of ray cell height in these two cases.

	Doliostrobus (twig wood)	***Doliostroboxylon*** (trunk wood)	***Podocarpoxylon helmstedtianum***	**Kučlín wood**	***Tetraclinoxylon vulcanense***	***Tetraclinis articulata***
	Geiseltal, Germany Middle Eocene	Groitzsch, Germany Late Eocene	Helmstedt, Germany Middle Eocene	Kučlín, Czech Republic Late Eocene	Rochefort-Montagne, France Pliocene	Recent
	thin slides	Dolezych in Junge et al. 2005	Gottwald 1966 and thin slides	thin slides	Privé 1973	thin slides
tracheid shape in transverse section	angular to polygonal	angular to polygonal	angular to polygonal	rounded	rounded to polygonal	polygonal to rounded
radial diameter of widest tracheid	25 µm	50 µm	35(40) µm	60(70) µm	55 µm	30(40) µm
radial pitting	1-seriate, no crassulae	1(-2)-seriate, crassulae	1-seriate, without crassulae	1-2-seriate, strong crassulae	1-2-seriate, strong crassulae	1-seriate
axial parenchyma	very abundant	abundant	very abundant	abundant	rare	extremely rare
height of ray cells	20-27 µm /15-17 µm	12-40 µm	23-40 µm / 20-30 µm	40-45 µm / 25-30 µm	15-30(-39) µm	25 µm /15-20 µm
cross-field pits	doliostroboid	1-2(-3-4) cupressoid, podocarpoid, pinoid	1-2 ?cupressoid and ?glyptostroboid	1-2(-4) cupressoid, ?podocarpoid	1-2(-4) cupressoid	1-4 cupressoid

podocarpoid and pinoid. This was complementary to a unique cross-field pitting seen in a small leafy branch of *Doliostrobus* from the Middle Eocene locality of Geiseltal, Germany, which was first illustrated by Bůžek et al. (1968), and later formalized by Rüffle and Süss (2001) by defining "doliostroboid" cross-field pits as large, mostly simple pits, 1-5 in number, irregularly disposed in a cross-field and variable in shape. The uniqueness of the cross-field pitting in *Doliostrobus* is still matter of controversy, partly related to its aspect (podocarpoid vs. araucarioid), partly to terminological problems with consensual definition of "podocarpoid" cross-field pit (see in Dolezych and Sakala 2007). However, this debate is beyond the scope of the present overview, especially as the cross-field pits are poorly preserved in the Kučlín wood. Finally, it must be noticed that Rüffle (1976) had already suggested that *Podocarpoxylon helmstedtianum*, described originally from the Middle Eocene locality of Helmstedt, Germany by Gottwald (1966), might in fact be also related to *Doliostrobus*. However, strictly speaking, the only unequivocal and incontestable record of *Doliostrobus* wood is represented today by the small branch from Geiseltal with *Doliostrobus* leaves in direct organic connection; the others are 'only' more (or less) plausible hypotheses.

New remarks

In order to see what the differences are between the above-mentioned woods, I prepared a kind of synoptic table (see Tab. 1). The published descriptions as well as some original thin slides were used to complete the table; more concretely, the thin slides alone were used in the case of *Doliostrobus* twig, Kučlín wood and extant *Tetraclinis*, combination of both published descriptions and thin slides in *Podocarpoxylon* from Helmstedt, and finally the published description alone in the case of *Doliostroboxylon* from Groitzsch and the holotype of *Tetraclinoxylon vulcanense*. I could observe under microscope the following thin slides: 1) original slides of *Doliostrobus* twig from Geiseltal described in Bůžek et al. (1968) Nos Ge 2/1, 2/2, 2/3, all three sections (courtesy Z. Kvaček), 2) part of Gottwald's type material of *Podocarpoxylon helmstedtianum* from Helmstedt Nos BFA Nr. 12 252 f (holotype), 12 262 f – 12 276 f, 12 278 f – 12 287 f, all three sections (courtesy Z. Kvaček), 3) original slides of *Podocarpoxylon helmstedtianum* from Kučlín described by Březinová in Březinová et al. (1994) Nos G 4700-4710 and G 4715-4726 from the collections of the National Museum in Prague (NM), all three sections (courtesy J. Kvaček) and 4) wood of extant *Tetraclinis articulata* No. 2280 from the collections of Laboratoire de paléobotanique et paléoécologie, UPMC, Paris, all three sections (courtesy C. Privé-Gill).

The results are presented in Tab. 1. I did not see any significant difference between the height of ray cells in 1-cell high rays and that of the middle ray cells of 3- or more-cell high rays, as underlined like typical feature of *Doliostrobus*

wood by Rüffle and Süss (2001: p. 416). Generally, the results clearly show that two woods can be distinguished quite easily by distinct combination of features: *Doliostrobus* twig and extant *Tetraclinis*. The resting four types are rather similar to each other, except for *Podocarpoxylon helmstedtianum* from Helmstedt, which presents narrow tracheids with only uniseriate radial pitting; its cross-field pitting, described by Gottwald (1966), was not confirmed by inspection of the type thin slides. Contrary to *Doliostroboxylon* from Groitzsch, I observed only the cross-field pits with narrow 'slit-like' apertures in the wood from Kučlín; our wood seems to have also more numerous biseriate parts of pitting in radial tracheid walls with more distinct crassulae and more abundant axial parenchyma than the wood from Groitzsch. Moreover, it seems that the Kučlín stem itself is smooth (Text-fig. 1) and does not present typical "burls" on the trunk surface, recorded by Dolezych in Junge et al. (2005: pictures 19-22) in *Doliostroboxylon* from Groitzsch. Finally, the holotype of *Tetraclinoxylon vulcanense* and our wood are very similar, only the former seems have less abundant axial parenchyma. In fact, a reappraisal of the original thin slides of the holotype from France would be the only possibility to quantify this feature.

Conclusions

The fossil wood from Kučlín, originally described as *Podocarpoxylon helmstedtianum* and later re-interpreted as *Tetraclinoxylon vulcanense*, is newly compared to five wood types: *Doliostrobus* from Geiseltal, *Doliostroboxylon* from Groitzsch, *Podocarpoxylon helmstedtianum* from Helmstedt, *Tetraclinoxylon vulcanense* from France and extant *Tetraclinis articulata*. Our wood is the most similar to *Tetraclinoxylon vulcanense*, which is not surprising, but the anatomical feature, indispensable in this context, i.e., cross-field pitting, is poorly preserved. Therefore, the question about its unequivocal systematical attribution or exact botanical affinities is still open.

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