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The early angiosperm *Pseudoasterophyllites cretaceus* from Albian–Cenomanian of Czech Republic and France revisited

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The early halophytic angiosperm *Pseudoasterophyllites cretaceus* from the Cenomanian Peruc Korycany Formation of the Bohemian Cretaceous Basin and from the Late Albian of the Northern Aquitanian Basin is redescribed. The plant is characterized by semi-whorled linear, and heavily cutinized leaves with paracytic stomata. Stamens associated with *P. cretaceus* possess an apically emerging connective that possesses the same epidermal cell pattern as the leaves. The stamens are massive, tetrasporangiate, and contain *Tucanopollis* pollen, thus clearly indicating affinities of *P. cretaceus* to the basal angiosperms. The plants that co-occur with *P. cretaceus* in semi-autochtonous taphocoenoses include the conifer *Frenelopsis alata*, which was likely a halophyte or halo-tolerant glycophyte growing in habitats close to the sea.

Key words: Magnoliopsida, *Pseudoasterophyllites*, *Tucanopollis,* Cretaceous, Albian, Cenomanian, Bohemia, France.

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Introduction

The Cenomanian strata of the Czech Republic and France represent some of the classical sites of Cretaceous palaeobotany, and continue to date to provide new insights into the early evolution and diversification of angiosperms. The diversity of mid-Cenomanian angiosperms from the Bohemian Cretaceous Basin in the Czech Republic has been documented in numerous publications based on mega- and mesofossils. First fossil angiosperms were recorded as leaves (Velenovský 1882, 1883, 1884, 1885), but later also impressions and compressions of attached or detached reproductive organs were described (Velenovský 1889; Velenovský and Viniklář 1927, 1929, 1931; Kvaček 1992). During the last decades scientific interest primarily focused on bulk macerated angiosperm mesofossils (Eklund and Kvaček 1998; Kvaček and Eklund 2003; Kvaček and Friis 2010). Angiosperm pollen has been described from dispersed assemblages (e.g., Pacltová 1977, 1978, 1981). Numerous megafossil remains of angiosperms leaves were reported from the late Albian– early Cenomanian of Charente-Maritime, western France (Gomez et al. 2004), but only a probable Lauraceae *Eucalyptolaurus deprei* was described in detail (Coiffard et al. 2009). This paper provides a re-interpretation of the systematic affinity and palaeoecology of *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský, 1887, an enigmatic plant from the Cenomanian of the Czech Republic and Albian of France based on old collections and well-preserved, newly collected specimens.

The affinities of *Pseudoasterophyllites cretaceus* have remained a matter of debate since the plant was first discovered. *Pseudoasterophyllites cretaceus* was first collected by Otokar Feistmantel, and originally published as *Asterophyllites cretaceus* nomen nudum (O. Feistmantel 1874). Based on Feistmantel's experience with Carboniferous plants, this author interpreted the plant as a horsetail. Velenovský (1887), however, who validated the name, interpreted the plant as an aquatic pteridophyte. Later, Zeiller (1907), during his work on Montsec material of *Montsechia vidalii* (Zeiller, 1902) Teixeira, 1954 from the Barremian of Spain, studied and interpreted the original specimens of *P. cretaceus* as conifer remains. Conversely, Velenovský and Viniklář (1926) interpreted the plant as a lycophyte based on reproductive structures believed to belong to *P. cretaceus*. This interpretation was also used by Němejc (1963). Finally, Kvaček and Eklund (1998) suggested that the plant may belong to the gnetophytes because of the phyllotaxis and the presence of paracytic stomata. In this paper we provide evidence that the plant represents an early angiosperm. Stamens associated with the vegetative parts of the plant contain *Tucanopollis*

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pollen, which is an example of the oldest angiosperm pollen types recorded previously from the Barremian of Gabon (Doyle et al. 1977; Doyle 1999), Congo (Doyle and Hotton 1991) and Egypt (Schrank and Mahmoud 2002). As a result, *Pseudoasterophyllites cretaceus* provides yet another insight into the complex evolutionary history of early angiosperms.

Pseudoasterophyllites cretaceus comes from taphocoenoses dominated by the cheirolepidiaceous conifer *Frenelopsis alata* (K. Feistmantel, 1885) Knobloch, 1971. These taphocoenoses are interpreted as sea-influenced deposits, and hence represent environments affected by high salinity (Uličný and Špičáková 1996; Uličný et al. 1997; Néraudeau et al. 2005). The *P. cretaceus*-bearing taphocoenoses from the Czech Republic are characterised by low plant diversity; apart from *F. alata*, the ginkgophyte *Nehvizdyella bipartita* Kvaček Falcon-Lang, and Dašková, 2005 (Kvaček et al. 2005), the enigmatic conifer *Dammarites albens* Presl in Sternberg, 1838 (Hluštík 1976, 1977), and an angiosperm named "*Diospyros*" *cretacea* Velenovský and Viniklář, 1927 have been described from these deposits. Similarly, poorly diversified assemblage co-occurs with *P. cretaceus* from Les Renardières (Néraudeau et al. 2005).

Institutional abbreviations.—NMP, National Museum, Prague, Czech Republic; UL, University Lyon 1 (Claude Bernard), Villeurbanne, France.

Other abbreviations.—LM, light microscope; SEM, scaning electron microscope.

Geographic and geological setting

The plant material described in this paper was collected from localities in the Czech Republic and France. The Czech material comes from the Peruc-Korycany Formation, the basalmost lithostratigraphic unit of the Bohemian Cretaceous Basin (sensu Čech et al. 1980). Palynological data indicate a late middle Cenomanian age for these beds (Pacltová 1977, 1978). The main localities of *Pseudoasterophyllites* include the Pecínov Quarry near Rynholec (50°08'00"N, 13°54' 34"E), the Hloubětín Brickpit (50°06'45"N, 14°32'02"E), an abandoned brick pit in the eastern part of Prague (material collected by Antonín Hluštík, 1973–1974), and the type locality Lipenec.

Geological and sequence stratigraphical analyses indicate that the Peruc-Korycany Formation represents a series of palaeovalley infills (Uličný and Špičáková 1996). These palaeovalley-fill successions (Uličný and Nichols 1997; Uličný et al. 1997) comprise the deposits of a variety of continental (braided rivers, meandering streams and floodplains, and anastomosed fluvial systems) and coastal environments (tidally influenced braided rivers, supratidal marshes, tidal flats, ebb-tidal deltas, estuaries, and lower shoreface). The studied plant fossils come from mudstone units interpreted as supratidal marsh/mangrove facies (Nguyen Tu et al. 2002). The dominant fossils in these deposits are *Frenelopsis alata* (K. Feistmantel, 1885) Knobloch, 1971 and *Eretmophyllum obtusum* (Velenovský, 1885) Kvaček, 1998 (Uličný et al. 1997).

The French material was collected from the subunit A1slA in the former sand quarry Les Renardières, Tonnay-Charente, western France, which unconformably overlaid Kimmeridgian substratum (Néraudeau et al. 2005). The clay beds of the subunit A1 are dated by a palynological study as uppermost Albian (Néraudeau et al. 2002). They are covered by estuarine sands of A1sl-S and A2sm and above change progressively to marine Cenomanian carbonates without the sand/clay alternation typical of margino-littoral series. Thus these Albian–Cenomanian sediments were deposited in coastal environments.

Material and methods

Samples of mudstone containing plant material were treated in a solution of natrium carbonate and samples of clays were bulk macerated in hydrogen peroxide. These extractions were followed by maceration in HF. Some specimens (particularly detached leaves and isolated stamens) were macerated for 1 hour in Schulze's solution and then stored in glycerine. Leaf cuticles were prepared using standard Schulze's techniques (Kvaček 1999, 2000). Pollen grains were obtained from the macerated stamens and separated using a dissecting needle with a human hair glued to its tip (Zetter 1989; Zetter et al. 2002). The material was sorted and examined under an Olympus SZX 12 stereomicroscope, an Olympus BX 50 light microscope, a Phillips 515, and a Jeol JSM-6400 SEM.

Systematic palaeontology

Class Magnoliopsida Brongniart, 1843

Family unknown

Genus *Pseudoasterophyllites* O. Feistmantel ex Velenovský, 1887

Type species: *Pseudoasterophyllites cretaceus*, Lipenec, Cenomanian, Late Cretaceous.

Pseudoasterophyllites cretaceus O. Feistmantel ex Velenovský 1887

Figs. 1–3.

1874 *Asterophyllites cretaceus*; O. Feistmantel 1874: 267 nomen nudum.
1887 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský, 1887; Velenovský 1887: 643, figs. 19–25.
1889 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský, 1887; Velenovský 1889: 44, 48, 52.
1901 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský 1887; Frič and Bayer 1901: 87, fig. 37.
1926 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský 1887; Velenovský and Vinklář 1926: 24, 53, pl. 2: 11, pl. 3: 6, 7, 9, 10.
1902 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský 1887; Zeiller 1902: 11.

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Fig. 1. Early angiosperm *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský, 1887 from the Late Cretaceous (Cenomanian) of Czech Republic. **A**. Lectotype, branched leafy axis, Lipenec, NMP F 654. **B**. Detail of lectotype, showing semi-whorled arrangement of leaves, Lipenec, NMP F 654. **C**. Leaf cuticle with stomata arranged perpendicularly, longitudinally, and obliquely to the leaf axis, Pecínov (unit 3), NMP F 2880a. **D**. External surface of paracytic stoma, Pecínov (unit 3), NMP F 2880a. **E**. Papillae in marginal part of the leaf, Pecínov (unit 3), NMP F 2880b. **F**. Axilary branches on a leafy twig, Pecínov (unit 3), NMP F 2880. Scale bars A, B 5 mm; C 100 μm; D, E 50 μm; F 10 mm.

1954 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský 1887; Teixeira 1954: 144, figs. 1, 2.

1963 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský 1887; Němejc 1963: 318, text-fig. 167.

1997 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský 1887; Uličný et al. 1997: 193.

2003 *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský 1887; Kvaček and Eklund 2003: 1033, fig. 12.

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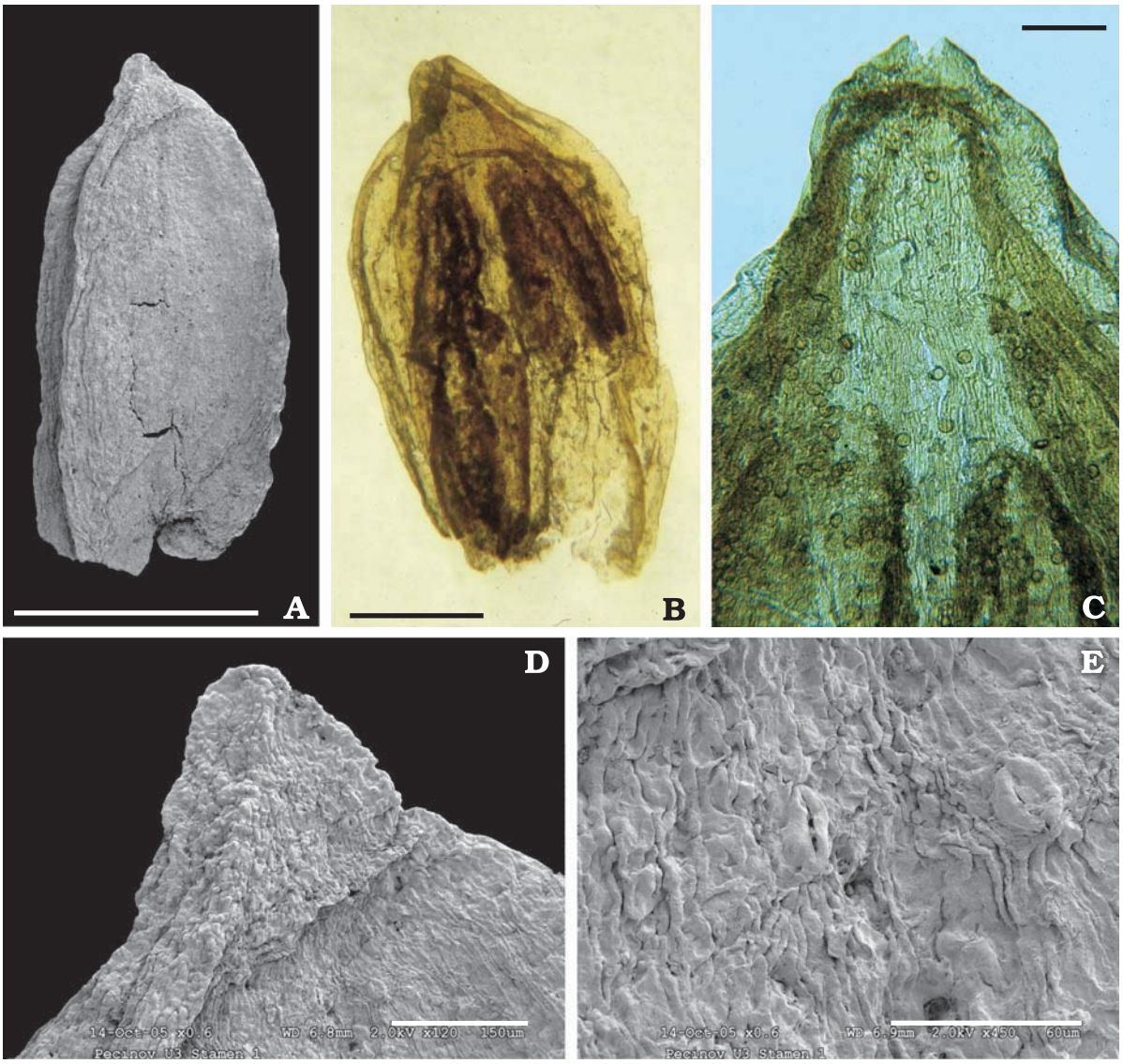


Fig. 2. Early angiosperm *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský, 1887 from the Late Cretaceous of Pecinov (unit 3), Czech Republic (A, D, E; SEM photographs) and Les Renardières, France (B, C). **A**. Isolated stamen showing apical extension of connective, NMP F 2880c. **B**. Macerated stamen showing two pairs of pollen sacs, UL REN 001. **C**. Detail of macerated stamen showing pollen in situ, UL REN 002. **D**. Detail of the apical extension of connective, NMP F 2880c. **E**. Epidermis surface of the apical extension of connective showing paracytic stomata and papillae, NMP F 2880c. Scale bars: A 1 mm, B 0.5 mm, C 100 μm, D 150 μm, E 60 μm.

Lectotype: designated here, NMP F 654, Velenovský 1887: fig. 22 (refigured in Fig. 1A of this paper).

Type locality: Lipenec, Czech Republic.

Type horizon: Peruc Korycany Formation, Cenomaninan, Late Cretaceous.

Other material.—NMP F 654, NMP F 655, NMP F 656, NMP F 657, NMP F 1423, NMP F 2280, NMP F 2285, NMP F 2899, UL REN002.

Emended diagnosis.—Twigs branch 3–4 times. Axes consisting of nodes and internodes. Nodes consisting of two pairs of decussately arranged leaves very closely spaced forming semi-whorls. Lateral branches borne in leaf axils; branches either well developed or represented only by axilar bud. Leaves coriaceous, linear to cylindrical with rounded tip and broad, shortly decussate base. Leaves amphistomatic, bearing stomata in two distinct bands on adaxial and abaxial sides of leaf. Ordinary epidermal cells rectangular to isodiametric, with thick anticlinal walls, stomata paracytic with two narrow subsidiary cells and two exposed guard cells.

Dimensions.—Length of the axis: more than 110 mm; width of the axis: 0.5–3 mm; length of the leaves: 1–10 mm; width of leaves: 0.6–1 mm; length of guard cells: 20–24 μm; width of guard cells: 5–8 μm; length of epidermal cells: 20–35 μm; width of epidermal cells: 15–20 μm.

Description.—The lectotype specimen consists of 3 axes, each constructed of 4–6 nodes and internodes. Each axis is 10–15 mm long, and gives off leaves that are 7–9 mm long

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(Fig. 1A, B). Another specimen is 32 mm long (Fig. 1F). It shows axilary branching. Each branch possesses at least 5 nodes and internodes. The axis is longitudinally striate and 0.5–3 mm in diameter. The nodes consist of whorls of simple coriaceous linear leaves, which are wrinkled, suggesting that they were 3D cylindrical in vivo. Leaves are heavily cutinized and variable in size, i.e., 1-10 × 0.3-1 mm; they extend from the nodes in semi-whorls each consisting of two pairs very closely spaced of decussately arranged leaves. Lateral branches are given off in axilary position of each leaf. Branches may be well developed (i.e., real branches), or present only as axilar buds. The buds, together with the leaves, form rich semi-whorls. Due to their shape, the leaves do not possess clearly defined abaxial and adaxial sides. Stomata are arranged in two bands, probably one on the adaxial and one on the abaxial side. The stomata are oriented perpendicularly, longitudinally or obliquely to the leaf margin. The stomatal apparatus consists of two partly exposed guard cells (8–10 × 22–27.5 μm) and two narrow subsidiary cells (2–3 × 25–32.5 μm). Ordinary epidermal cells are isodiametric quadrangular or polygonal; their size is (8)–15–(20) × (8)–20–(25) μm (Fig. 1C, D). Anticlinal cell walls are straight (up to 3 μm in thickness). The periclinal walls are covered by small wrinkles and papillae, especially in parts close to the leaf margin (Fig. 1E).

Associated with the vegetative remains are stamens that are very similar in appearance to sterile leaves. Moreover, they possess the same epidermal cell pattern and idiocuticular features as the sterile leaves (compare Fig. 1D, E with Fig. 2E). Stamens are ovoid-elongate, 3–3.5 mm long and 1–1.5 mm wide, massive, and not divided into an anther and filament showing a considerable amount of sterile tissues (Fig. 2A). They possess an apically expanded connective forming acute apical extensions (Fig. 2D), with a blunt apex bearing paracytic stomata. The stamens are tetrasporangiate and consist of two indistinct lobes. If macerated, each lobe shows two narrow pollen sacs (Fig. 2B) embedded in the tissue of the abaxial side of the stamen. Dehiscence is by longitudinal slits.

In situ pollen grains of the *Tucanopollis* type are sulcate, oblate to spheroidal, in polar view elliptic to circular, 18–24 μm in diameter (Fig. 3A, C, D). The aperture is broad and short, the membrane thin and often covered by echinate Ubisch bodies (Fig. 3D). The sculpture is psilate in LM, microechinate, perforate in SEM (Fig. 2B); exine thick (1.5–2 μm), nexine 0.8–1 μm, short columellae, tectum 1–1.2 μm.

Stratigraphic and geographic range.—Early to Late Cretaceous, Albian to Cenomanian. Czech Republic (Cenomanian): Pecínov, Praha-Hloubětín, Lipenec, Touchovice; France (Albian): Les Renardières, Tonnay-Charente, Charente-Maritime.

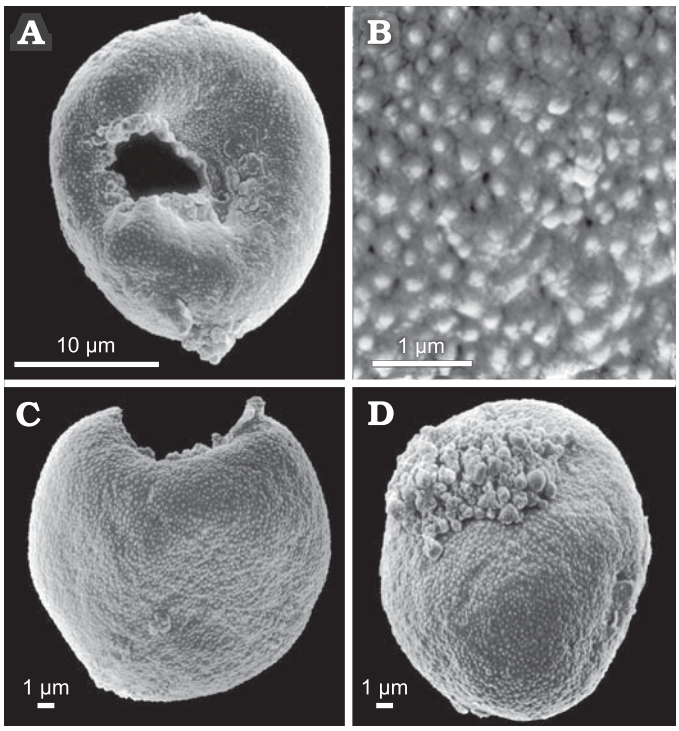


Fig. 3. Pollen *Tucanopollis* sp. from the stamen on Fig. 2C, which is associated with the vegetative parts of angiosperm *Pseudoasterophyllites cretaceus* O. Feistmantel ex Velenovský, 1887 from the Late Cretaceous of Les Renardières, France, specimens UL REN 002. **A**. Monosulcate pollen grain in situ showing irregular sulcus area. **B**. Microechinate, perforate exine sculpturing, detail of pollen exina. **C**. Monosulcate pollen grain in situ showing sulcus area. **D**. Pollen grain in situ showing Ubish bodies. Scale bars: A 10 μm, B–D 1 μm.

Discussion

We were unsuccessful to trace the suite of original specimens of *Pseudoasterophyllites cretaceus* collected by Feistmantel (1874) from the locality Touchovice in the old museum collection. However, one important specimen, which was used by Velenovský (1887) in his validation of the genus and species, could be located. It comes from the locality of Lipenec. Consequently, this specimen is here designated as the lectotype.

The only other fossil plant similar in overall morphology to *Pseudoasterophyllites cretaceus* is *Montsechia vidalii* (Zeiller, 1902) Teixeira, 1954 from the Barremian limestone of Las Hoyas (La Huérguina Formation, South-western Iberian Ranges) and of El Montsec (Plant and Vertebrate limestone Formation, Western Pyrenees, Spain) (Zeiller 1902; Teixeira 1954; Blanc-Louvel and Barale 1983; Gomez et al. 2006). *Montsechia,* which was originally included in *Pseudoasterophyllites* by Zeiller (1902), shows a branching pattern very similar to that seen in *P. cretaceus*. Moreover, *M. vidalii* displays paracytic stomata that are similar to *P. cretaceous*. *Pseudoasterophyllites* differs from *Montsechia* in having leaves arranged in semi-whorls and narrow subsidiary cells in the paracytic stomata. Both plants probably represent members of an extinct lineage of basal angiosperms. The presence of *Tucanopollis*-type pollen grains suggests a relationship of *Pseudoasterophyllites* with the Piperales; it is possible, however, that this correspondence in pollen morphology is only

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superficial. Whorled leaves are typical for certain species of the genus *Peperomia*, a member of the Piperaceae. James Doyle (personal communication 2006) regards certain features of *Tucanopollis* similar to pollen of the family Austrobaileyaceae. *Pseudoasterophyllites cretaceus* is also remotely similar to the gnetophyte *Drewria potomacensis* from the Aptian of the Potomac Formation (Crane and Upchurch 1987). However, *P. cretaceus* differs from *D. potomacensis* in having single-veined leaves (instead of two- to three-veined leaves in *Drewria*) that are arranged in whorls.

Isolated stamens were found in the same layer as leafy axes of *P. cretaceus* at the localities Pecínov and Les Renardières. Because of their close co-occurrence with the sterile remains of *P. cretaceus* and because the stamens display the same epidermal cell pattern and idiocuticular features as the foliage, we believe that both structures were produced by the same plant. The pollen grains contained in the stamens are monosulcate, which adds support to the hypothesis that *P. cretaceus* was an angiosperm.

Superficially similar to *Pseudoasterophyllites cretaceus* in overall morphology are several species in the extant genera *Myriophyllum* Linnaeus, 1753 and especially *Hippuris* Linnaeus, 1753. These taxa remind *Pseudoasterophyllites* in the general appearance of the axes, in which simple linear leaves are arranged in whorls. Moreover, certain species in *Hippuris* (e.g., *H. tetraphylla* Linnaeus, 1782 and *H. lanceolata* Retzius, 1783) are halophytes. However, both families, the Hippuridaceae and Haloragaceae (Orchard 1979; Couch and Nelson 1988; Husák 1997), belong to the eudicots and produce triaperturate pollen grains, which argues against a closer biological relationship with *P. cretaceus*.

Further studies on additional specimens from historical collections and newly collected material are needed to fully decipher the affinities and palaeoecology of this interesting early angiosperm.

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References

Blanc-Louvel, C. and Barale, G. 1983. *Montsechia vidali* (Zeiller) Teixeira 1954. Nouvelles observations et réflexions sur son attribution systématique. *Annales de Paléontologie* 69: 151–174.

Couch, R. and Nelson, E. 1988. *Myriophyllum quitense* (Haloragaceae) in the United States. *Brittonia* 40: 85–88.

Crane, P.R. and Upchurch, G.R., Jr. 1987. *Drewria potomacensis* gen. et sp. nov., an Early Cretaceous member of Gnetales from the Potomac Group of Virginia. *American Journal of Botany* 74: 1723–1738.

Čech, S., Klein, V., Kříž, J., and Valečka, J. 1980. Revision of the Upper Cretaceous stratigraphy of the Bohemian Cretaceous Basin. *Věstník Ústředního Ústavu geologického* 55: 277–296.

Coiffard, C., Gomez, B., Thiébaut, M., Kvaček, J., Thévenard, F., and Néraudeau, D. 2009. *Eucalyptolaurus depreii*, gen. et sp. nov., intramarginal veined Lauraceae leaves from the Albian–Cenomanian of Charente-Maritime (Western France). *Palaeontology* 52: 323–336.

Doyle, J. 1999. The rise of angiosperms as seen in the African Cretaceous pollen record. *In*: K. Heine (ed.), *Proceedings of the Third Conference on African Palynology, Johannesburg 14–19 September 1997, Palaeoecology of Africa and the Surrounding Islands*, 3–29. Balkema, Rotterdam.

Doyle, J. and Hotton, C.L. 1991. Diversification of early angiosperm pollen in a classic context. *In*: S. Blackmore and S.H. Barnes (eds.), Pollen and Spores, Patterns of Diversification. *Systemaics Association, Special Volume* 44: 169–195.

Doyle, J., Biens, P., Doerenkamp, A., and Jardiné, S. 1977. Angiosperm pollen from the pre-Albian Cretaceous of Equatorial Africa. *Bulletin des Centres de Recherches Exploration-Production Elf-Aquitaine* 1: 451–473.

Eklund, H. and Kvaček, J. 1998. Lauraceous inflorescences and flowers from the Cenomanian of Bohemia (Czech Republic, Central Europe). *International Journal of Plant Sciences* 159: 668–686.

Frič, A. and Bayer, E. 1901. Studien im Gebiete der Böhmischen Kreideformation. *Perucer Schichten. – Archiv der naturwisschenschaftlichen Landesdurchforschung von Böhmen* 11: 1–180.

Feistmantel, O. 1874. Vorbericht über die Perucer Kreideschichten in Böhmen und ihre fossilen Reste. *Sitzungsberichte der königlichen böhmischen Gesellschaft der Wissenschaften in Prag, Jahrgang* 1874: 253–276.

Gomez, B., Daviero-Gomez, V., Perrichot, V., Thévenard, F., Coiffard, C., Philippe, M., and Néraudeau, D. 2004. Floristic assemblages from the Albian–Cenomanian of Charente-Maritime (SW France). *Annales de Paléontologie* 90:147–159.

Gomez, B., Daviero-Gomez, V., Martín-Closas, C., and de la Fuente, M. 2006. *Montsechia vidalii*, an early aquatic angiosperm from the Barremian of Spain. *7th European Palaeobotany and Palynology Conference, Prague 6–11 September 2006. Abstract volume* , 49. National Museum, Prague

Hluštík, A. 1976. Contribution to the systematic and leaf anatomy of the genus *Dammarites* Presl. *Acta Musei Nationalis Pragae, Series B, Historia Naturalis [Sborník Národního muzea v Praze, Řada B, přírodní vědy]* 30: 49–70.

Hluštík, A. 1977. Remarks on *Dammarites albens* Presl. *Věstník Ústředního ústavu geologického* 52: 359–366.

Husák, Š. 1997. Hippuridaceae Link-prustkovité. *In*: B. Slavík (ed.), *Květena České republiky*, 139–140. Academia, Praha.

Kvaček, J. 1999. New data and revision of three gymnosperms from the Cenomanian of Bohemia—*Sagenopteris variabilis* (Velenovský) Velenovský, *Mesenea bohemica* (Corda) comb. n. and *Eretmophyllum obtusum* (Velenovský) comb. n. *Acta Musei Nationalis Pragae, Series B, Historia Naturalis [Sborník Národního muzea v Praze, Řada B, přírodní vědy]* 55: 15–24.

Kvaček, J. 2000. *Frenelopsis alata* and its microsporangiate and ovuliferous reproductive structures from the Cenomanian of Bohemia (Czech Republic, Central Europe). *Review of Palaeobotany and Palynology* 112: 51–78.

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Eklund, H. and Kvaček, J. 1998. Lauraceous inflorescences and flowers from the Cenomanian of Bohemia (Czech Republic, Central Europe). *International Journal of Plant Sciences* 159: 668–686.

Kvaček, J. and Eklund, H. 2003. A report on newly recovered reproductive structures from the Cenomanian of Bohemia (Central Europe). *International Journal of Plant Sciences* 164: 1021–1039.

Kvaček, J. and Friis, E.M. 2010. *Zlatkocarpus* gen. nov., a new angiosperm reproductive structure with monocolpate-reticulate pollen from the Late Cretaceous (Cenomanian) of the Czech Republic. *Grana* 49: 115–127.

Kvaček, J., Falcon-Lang, H., and Dašková, J. 2005. A new Upper Cretaceous ginkgoalean reproductive structure *Nehvizdyella* from the Czech Republic and its whole-plant reconstruction. *American Journal of Botany* 92: 1958–1969.

Kvaček, Z. 1992. Lauralean angiosperms in the Cretaceous. *Courier Forschungsinstitut Senckenberg* 147: 345–367.

Němejc, F. 1963. *Paleobotanika II, systematická část, rostliny mechovité, psilofytové a kapraďorosty*. 529 pp. Nakladatelství Československé akademie věd, Praha.

Néraudeau, D., Perrichot, V., Dejax J., Masure, E., Nel, A., Philippe, M., Moreau, P., Guillocheau, F., and Guyot, T. 2002. Un nouveau gisement à ambre insectifère et à végétaux (Albien terminal probable): Archingeay (Charente-Maritime, France). *Geobios* 35: 233–240.

Néraudeau, D., Vullo, R., Gomez, B., Perrichot, V., and Videt, B. 2005. Stratigraphie et Paléontologie (plantes, vertébrés) de la série paralique Albien terminal – Cénomanien basal de Tonnay-Charente (Charente-Maritime, France). *CR Palevol* 4: 79–93.

Nguyen Tu, T.T., Kvaček, J., Bocherens, H., Mariotti, A., Broutin, J., and Uličný, D. 2002. Isotopic reconstruction of plant palaeoecology, case study of Cenomanian floras from Bohemia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 183: 43–70.

Orchard, A.E. 1979. *Myriophyllum* (Haloragaceae) in Australasia. 1. New Zealand: A revision of the genus and a synopsis of the family. *Brunonia* 2 (2): 247–87.

Pacltová, B. 1977. Cretaceous angiosperm of Bohemia-Central Europe. *The Botanical Review* 43: 128–142.

Pacltová, B. 1978. Evolutionary trends of platanaceoid pollen in Europe during the Cenophytic. *In*: Z. Kvaček and F. Schaarschmidt (eds.), International symposium advances in angiosperm palaeobotany Liblice (ČSSR), June 13–17, 1977. *Courier Forschungsinstitut Senckenberg* 30: 70–76.

Pacltová, B. 1981. The evolution and distribution of Normapolles pollen during the Cenophytic. *Review of Palaeobotany and Palynology* 35: 175–208.

Schrank, E. and Mahmoud, M.S. 2002. Barremian angiosperm pollen and associated palynomorphs from the Dakhla Oasis area, Egypt. *Palaeontology* 45: 33–56.

Teixeira, C. 1954. La flore fossile des calcaires lithographiques de Santa Maria de Meyá (Lérida, Espagne). *Boletim da Sociedade Geológica de Portugal* 12: 139–152.

Uličný, D. and Špičáková, L. 1996. Response to high-frequency sea-level change in fluvial estuarine succession: Cenomanian palaeovalley fill, Bohemian Cretaceous Basin. *In*: J. A. Howell and J.F. Aitken (eds.), High-resolution Sequence Stratigraphy Innovations and Applications. *London Geological Society Special Publication* 104: 247–268.

Uličný, D. and Nichols, G.J. 1997. Shallow marine and coastal sandstone bodies: Processes, facies and sequence stratigraphy; Examples from the Bohemian Cretaceous Basin, Czech Republic, September 6–9, 1997. *In*: D.Uličný (ed.), *AMOCO Field Course Guide Book*. 156 pp. Charles University, Praha.

Uličný, D., Kvaček, J., Svobodová, M., and Špičáková, L. 1997. High-frequence sea-level fluctuations and plant habitats in Cenomanian fluvial to estuarine successions: Pecínov quarry, Bohemia. *Palaeogeography, Palaeoclimatology, Palaeoecology* 136: 165–197.

Velenovský J. 1882. Die Flora der Böhmischen Kreideformation. *Beiträge zur Paläontologie Österreich-Ungarns und des Orientes* 2: 8–32.

Velenovský, J. 1883. Die Flora der Böhmischen Kreideformation. *Beiträge zur Paläontologie Österreich-Ungarns und des Orientes* 3: 1–22.

Velenovský, J. 1884. Die Flora der Böhmischen Kreideformation. *Beiträge zur Paläontologie Österreich-Ungarns und des Orientes* 4: 1–14.

Velenovský, J. 1885. Die Flora der Böhmischen Kreideformation. *Beiträge zur Paläontologie Österreich-Ungarns und des Orientes* 5: 1–14.

Velenovský J. 1887. Neue Beiträge zur Kenntnis der Pflanzen des böhmischen Cenomans. *Sitzungsberichte der Königlichen Gesellschaft der Wissenschaften, Mathematisch-naturwissenschaftliche Classe* 1886: 633–645.

Velenovský, J. 1889. Květena Českého cenomanu. *Rozpravy Královské České Společnosti Nauk* 7: 1–75.

Velenovský, J. and Viniklář, L. 1926. *Flora Cretacea Bohemiae I*. 57pp. Státní Geologický ústav Československé republiky, Praha.

Velenovský, J. and Viniklář, L. 1927. *Flora Cretacea Bohemiae II*. 54pp. Státní Geologický ústav Československé republiky, Praha.

Velenovský, J. and Viniklář, L. 1929. *Flora Cretacea Bohemiae III*. 33pp. Státní Geologický ústav Československé republiky, Praha.

Velenovský, J. and Viniklář, L. 1931. *Flora Cretacea Bohemiae IV*. 112pp. Státní Geologický ústav Československé republiky, Praha.

Zeiller, R. 1902. Sobre las impressiones vegetales del Kimeridgense de Santa Maria de Meyá. *Memorias Real Academia de Ciencias y Artes de Barcelona* 4 (26): 1–27.

Zeiller, R. 1907. Les progrès de la Paléobotanique de l'ère des Gymnospermes. *Progressus rei botanicae* 2: 171–226.

Zetter, R. 1989. Methodik und Bedeutung einer routinemäßig kombinierten lichtmikroskopischen und rasterelektronmikroskopischen Untersuchung fossiler Mikrofloren. *Courier Forschung Institut Senckenberg* 109: 41–50.

Zetter, R., Hesse, M., and Huber, K.H. 2002. Combined LM, SEM and TEM studies of Late Cretaceous pollen and spores from Gmünd, Lower Austria. *Stapfia* 80: 201–230.

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