Aquatic Botany 90 (2009) 119–123

Contents lists available at ScienceDirect

Aquatic Botany

journal homepage: www.elsevier.com/locate/aquabot

A fossil *Vallisneria* plant (Hydrocharitaceae) from the Early Miocene freshwater deposits of the Most Basin (North Bohemia)

Josef Bogner [a], Zlatko Kvaček [b,*]

[a] Botanical Garden Munich, Menzinger Strasse 63, D-80638, München, Germany
[b] Faculty of Science, Institute of Geology and Palaeontology, Charles University, Albertov 6, CZ-12843 Praha 2, Czech Republic

ARTICLE INFO

Article history:
Received 7 April 2008
Received in revised form 11 July 2008
Accepted 21 July 2008
Available online 26 July 2008

Keywords:
Hydrocharitaceae
Miocene
Vegetative fossil
Central Europe

ABSTRACT

A new fossil species of *Vallisneria* (*V. janecekii* Bogner & Kvaček, sp. n., Hydrocharitaceae) is reported from Early Miocene freshwater lake deposits of the North Bohemian brown coal basin (Czech Republic). It is based on a single fragmentary sterile plant bearing two clusters of ribbon-shaped widely serrulate leaves on a short rhizome. It is a potential producer of seeds described from equivalent and slightly older deposits in Saxony (Germany) as *Vallisneria ovalis* Mai.

1. Introduction

The North-Bohemian brown-coal basin (or the Most Basin) in Central Europe has yielded from its facially diversified Early Miocene deposits of mainly fluvio-lacustrine origin a wealth of plant and animal fossils during the last two centuries (see Kvaček, 1998; Kvaček et al., 2004 for review). These include various aquatic plants, as water ferns *Salvinia*, *Azolla*, extinct dicots *Hemitrapa*, *Schenkiella* and monocots *Stratiotes* and other Hydrocharitaceae, *Limnobiophyllum*, etc. (Bůžek et al., 1971, 1988; Kvaček, 1995a,b, 2003; Wójcicki and Kvaček, 2002a,b). In the present account we report on a monocotyledonous plant superficially recalling grass-like fossils that, from vegetative traits, probably belongs to *Vallisneria*. Monocotyledonous foliage is not always determinable in the fossil state, while fruits and seeds are more reliable for evidence of fossil representatives at the generic level. One of the exceptions is the family Hydrocharitaceae having leaves with characteristic morphology and anatomy (Ancibor, 1979).

During the excursion of the 7th European Palaeobotany and Palynology Conference in 2006, the first author noticed a monocotyledonous carbonised compression in the collections of the headquarters of the Nástup Mines Tušimice in North Bohemia. This fossil plant, which is described below, matches in habit various Hydrocharitaceae with widely serrulate linear leaves, namely *Vallisneria*.

2. Material and methods

The single specimen available is preserved as a carbonised compression. It was recovered 30–40 m above the roof of the main brown coal seam in the western part of the Most Basin, Czech Republic in October 2005. The site belongs to the Libkovice Member, Most Formation of the local lithostratigraphical sequence and was situated within a large opencast mine in a part called the Libouš Quarry at Chomutov (Nástup Mines Tušimice, North Bohemian Mines Company). The approximately 10 m thick fossiliferous layer of grey bedded silty claystone to siltstone has typically variable content of silt, carbonate interbeds (up to 20 cm thick) and bioturbation traces of the Planolites-type (Mikuláš et al., 2006). The layer yielded also carbonized pine cones, needles and leaves of angiosperm woody plants (Teodoridis and Kvaček, 2006). Below it directly in the roof of the seam, there are also masses of Potamogeton fruits (Teodoridis, 2007) and disarticulated fish remains (Obrhelová, 1990). The fossiliferous layer with *Vallisneria* was removed a year ago by mining so that additional collections from the same layer are impossible. The age of the layer is estimated from the mammal fauna at the base of the coal seam in the adjacent Merkur-North Quarry as the Early Miocene, to be Early Burdigalian (~Early Eggenburgian), MN 3 zone (ca. 19 Ma) (Fejfar, 1989).

* Corresponding author. Tel.: +420 221951458; fax: +420 221951452.
E-mail address: kvacek@natur.cuni.cz (Z. Kvaček).

0304-3770/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.aquabot.2008.07.005

The gross morphological comparisons were carried out with living members of the Hydrocharitaceae cultivated in the botanical gardens and additional herbarium material in Munich (M) and Prague (PRC). The photographic documentation was done by the second author by Olympus SZX 12 lens and Olympus E 330 and Coolpix 4500 digital cameras. The fossil material studied is housed in the collections of the palaeontological department, National Museum, Prague.

3. Systematic description

3.1. Hydrocharitaceae Juss

3.1.1. Genus Vallisneria L.

Vallisneria is a genus of monocots popular as aquarium ornamental plants. The living members distributed worldwide are dioecious submersed annual or perennial herbs rooted by short rhizomes bearing clusters of ribbon-shaped leaves or stems with cauline leaves. Molecular studies (Les et al., 2006) indicate a close relationship to two other genera, *Maidenia* Rendle and *Nechamandra* Planch. This plant group is well known by a peculiar pollination behavior, where the male flowers disarticulate from the submersed inflorescence and reach flowers of the female plants by floating on the water surface (Cook, 1982). The taxonomy of the genus is based on the properties of the stamens in male flowers and carpels and staminodes in the female flowers, and hence not applicable for identifying sterile plants (Lowden, 1982; Jacobs and Frank, 1997). *Vallisneria* plants grow in freshwater lakes or slow streams in warm temperate to tropical zones. Within the almost cosmopolitan area of the genus the number of species was variously estimated (two to several). New cladistic studies based on a combination of morphological and molecular data have shown that the genus *Vallisneria* consists of 14 species with two varieties and an aberrant form of *V. neotropicalis* Marie-Victorin with an umbellulate inflorescence (Les et al., 2008). Our new fossil species is from Europe and overlaps the distribution of *V. spiralis* L., which is distributed in Eurasia and Africa. The vegetative traits reflected in the foliage are unreliable diagnostic criteria and vary due to environment (Cook, 1990). For the present study the following characters differentiate the foliage of *Vallisneria* from similar monocots: plants with clusters of ribbon-shaped leaves in a rosette (in rosulate species) on short rhizomatous stems or on an elongate shoot (caulescent species), leaves sessile, with 3–9 parallel primary veins and thinner veins of several lower orders, cross veins perpendicular to oblique, in two orders, wide apart, margin in most cases more or less finely serrulate. Similar leaves of some species of *Ottelia Pers.* differ in widened bases (cf. Ancibor, 1979: Fig. 4). Les et al. (2008) have included *Maidenia rubra* Rendle in the genus *Vallisneria* as *V. rubra* (Rendle) D. Les & S.W.L. Jacobs and thus with *V. triptera* S.W.L. Jacobs & K.A. Frank and V. caulescens F.M. Bailey & F. Mueller this genus now contains three caulescent species, all known only from Australia.

Fig. 1. *Vallisneria janecekii* Bogner & Kvaček, sp. n, holotype (no. NM G 8554), Early Miocene, North Bohemia (scale bar 20 mm).

Fig. 2. *Vallisneria janecekii* Bogner & Kvaček, sp. n, detail of the rhizome and attachment of leaf clusters, the same specimen (scale bar 10 mm).

Fig. 3. *Vallisneria janecekii* Bogner & Kvaček, sp. n, detail of venation, the same specimen (scale bar 3 mm).

From field observation and experience from cultivation, *Vallisneria* species grow best in alkaline and hard waters, and thrive optimally in shallow standing lakes but withstand more high-energy environment in streams and rivers (Kasselmann, 1999).

Vallisneria janecekii Bogner & Kvaček, sp. n. (Figs. 1–4): A sterile plant fragment (Fig. 1) consisting of two clusters of ribbon-shaped leaves arising at nodes of a 30 mm long rhizome with short remnants of broken rootlets and a few teeth on the surface (Fig. 2); leaves sessile, ribbon-shaped, ca. 3–5 mm wide, incompletely preserved in length (up to 120 mm long), narrowed at base, widely

Fig. 4. *Vallisneria janecekii* Bogner & Kvaček, sp. n, detail of marginal teeth, the same specimen (scale bar 1 mm).

and irregularly bluntly serrulate on margin, more densely in the lower part of the lamina; texture massive as seen in thick carbonized matter, venation expressed as up to 7 low ribs of parallel primary veins, about 1 mm apart; in some places remains of finer veins of the second order between veins visible as much denser longitudinal strands (ca. 12 per 1 mm), cross veins not observed (Fig. 3); teeth blunt, tiny, max. 0.5–1 mm high, straight or hooked (Fig. 4).

Holotype designated here: The specimen no. G 8554 (leg. O. Janeček, Oct. 2005, coll. National Museum Prague,) illustrated in Fig. 1.

Fig. 5. *Vallisneria spiralis* L., plants in an aquarium. Photograph by B. Wallach.

Fig. 6. *Vallisneria caulescens* F.M. Bailey & F. Mueller, a caulescent species growing in an aquarium. Photograph by B. Wallach.

Locus typicus: Quarry Libouš at Chomutov, Nástup Mines Tušimice, Most Basin, North Bohemia, Czech Republic (50°24′N, 13°19′E).

Stratum typicum: Basal part of the Libkovice Member (Most Formation); Lower Miocene, Burdigalian, ca. 19 Ma.

Etymology: Named for the founder Ing. Oldřich Janeček, geologist of the Nástup Mines at Tušimice.

Occurrence: Known from the type locality only.

Remarks: *Vallisneria janecekii* is so far the only vegetative fossil record of this genus known. It may represent the same species as the mother plant that produced seeds of *Vallisneria ovalis* Mai in (Mai and Walther, 1978), another morphotaxon known from equivalent and older deposits in Saxony (Mai and Walther, 1985, 1991; Mai, 1995, 1997). Foliage previously assigned to *Vallisneria* from the Upper Oligocene of SE France (*Vallisneria bromeliaeformis* Saporta, 1873) was recognized as belonging to an extinct species of *Stratiotes* aberrant in its leaf shape (Kvaček, 2003).

V. janecekii is a better match for *V. spiralis* L. (Fig. 5), in particular some populations from Eurasia, than other species, e.g. the caulescent *V. caulescence* F.M. Bailey & F. Mueller (Fig. 6), or *V. americana* Michx (Fig. 7) despite its densely serrulate leaves. A similar elongate rhizome is known, e.g. in *V. denseserrulata* Makino from E China and Japan. The thickly carbonized lamina suggests that the leaves were relatively stiff like in an ecotype of *V. spiralis* living in high-energy waters of Lake Tanganjika (Kasselmann, 1999), or the recently described *V. erecta* S.W.L. Jacobs from tropical Australia (Les et al., 2008)

Seeds of *V. ovalis* are larger than in any living species (Mai and Walther, 1978). The fossil populations of *Vallisneria* from Central Europe may thus represent an extinct lineage quite far from any living relative.

Climatic conditions derived from forest vegetation co-occurring with *V. janecekii* were estimated as optimally humid (mean annual precipitations ca. 1800 mm), warm-temperate, with the mean annual temperature 10–15 °C and the mean of the coldest month well above zero (Teodoridis and Kvaček, 2006).

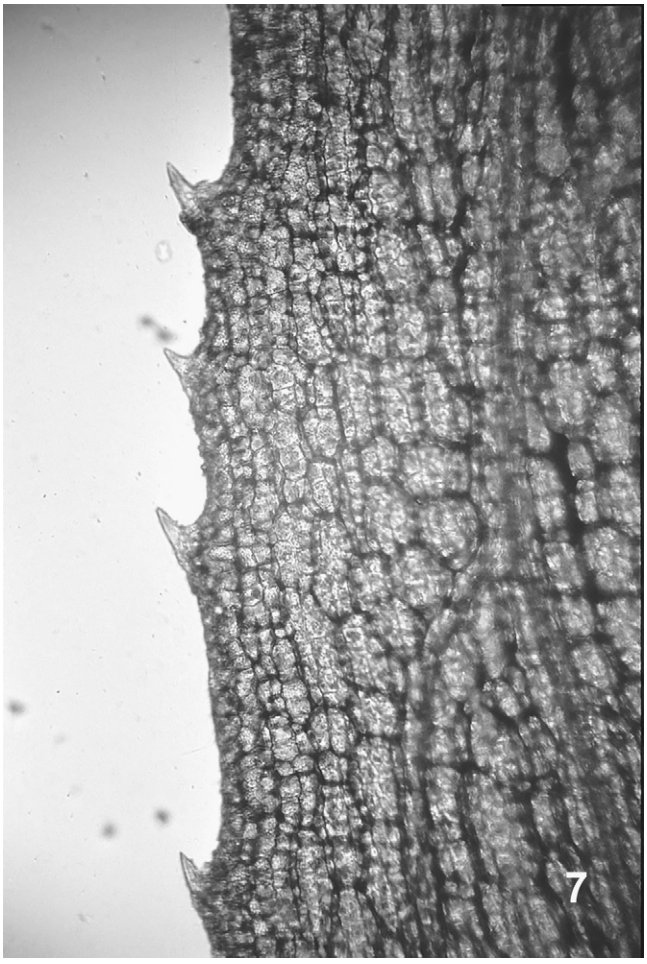

Fig. 7. *Vallisneria americana* Michx., leaf margin with teeth. Photograph by Ch. Kasselmann.

Acknowledgments

The authors are thankful to the founder, Ing. Oldřich Janeček who donated the holotype specimen to the collections of the National Museum, Prague. Facilities offered by the staff of the botanical gardens and herbaria in Munich and Prague are also much appreciated. B. Wallach and Ch. Kasselmann have kindly supplied the photographs of living plants for comparison. Two anonymous reviewers suggested useful improvements of the first version of the manuscript.

The research has been financially supported by the grant project of the Czech Republic (GAČR) no. 205/01/0639 and the research scheme MSM 002162085.

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