Acta Palaeobot. 37(1): 13–16, 1997

OTOZAMITES GRAPHICUS (LECKENBY) SCHIMPER FROM THE SHALES OF THE SUPRA-POSIDONIA BEDS (PIENINY KLIPPEN BELT OF THE WESTERN CARPATHIANS, SLOVAKIA)

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ABSTRACT. The second discovery of the genus *Otozamites* in the Klippen Belt demonstrates the important role of Cycadopsida in the plant cover of islands surrounded by the Middle Jurassic sea at the northern margin of the Western Tethys.

KEY WORDS: Middle Jurassic, Pieniny Klippen Belt, Pieniny succession, Cycadopsida

In the abandoned Halečková quarry near Trstená (Orava region) we found in the debris under the rock wall a well preserved specimen of *Otozamites graphicus* (Leckenby) Schimper. It is the first well preserved terrestial plant of the Middle Jurassic age to be discovered in the Slovak Republic. The remains of higher plants of the Jurassic age are very rare in the Western Carpathians. From the Klippen Belt, Andrusov (1945, 1959) reported the presence of some carbonized plant detritus, and also a thin allochthonous coal seam, found in the flysch-like beds (Aalenian-Bajocian) of the Kysuca (Branisko) "Series" near Streženice.

The quarry is situated in the vicinity of Trstená on the side of Halečková hill, near the road to Tvrdošín (Fig. 1). The fragment (size $7 \times 5 \times 2$ cm) of rock containing the aforementioned plant print was found at first floor level, approximately 30 m from the eastern edge of the quarry (Fig. 2). An disturbed sequence of Posidonia Beds (Harcygrund Shale Formation according to Birkenmajer, 1977), Supra-Posidonia Beds (Podzamcze Limestone Formation l.c.) and radiolarites (Czajakowa Formation l.c.) of the Pieniny Succession outcrops in the extraction wall. The plant specimen came from the older part of the Supra-Posidonia Beds, represented by hard, dark grey limy shales and clayey limestones with abundant carbonized plant detritus. They outcrop about 7 m below the quarry surface. The abundant plant detritus was mentioned also by Mišík (in Ožvoldov, 1992) in a petrographic description of the quarry.

From the younger part of the Supra-Posidonia Beds (samples T-10, T-11) situated in a horizon about 30 m below the quarry surface, Ožvoldová (1992) reported a radiolarian association representing the Lower to Middle Callovian. It can be considered as the youngest possible age for our plant specimen.

The plant print was preserved on an uneven bed surface of a tick, laminated limy claystone with a high content of calcite grains. It passes into a lighter clayey limestone with voids created by dissolved radiolarians and spicules, mainly rhaxa of silicisponges filled by calcite (radiolarian-spongy microfacies). The latter are arranged parallel to the bedding planes. Pyrite pigment, carbonized plant debris, muscovite flakes, clastic quartz of sand and silt fractions, chalcedony and phosphatized fish scales are rare or very rare in thin sections.

The described plant print (Figs 3, 4) consists of the upper part of a leaf with 12 pairs of pinnae. The width of the leaf is about 5 cm and it narrows toward the tip. The length of the pinnules varies from 1 cm to 2.5 cm. They possess cordate incisions at their base, with auricles about 3–4 mm wide and are slightly falcate. The veining is radial and all veins are

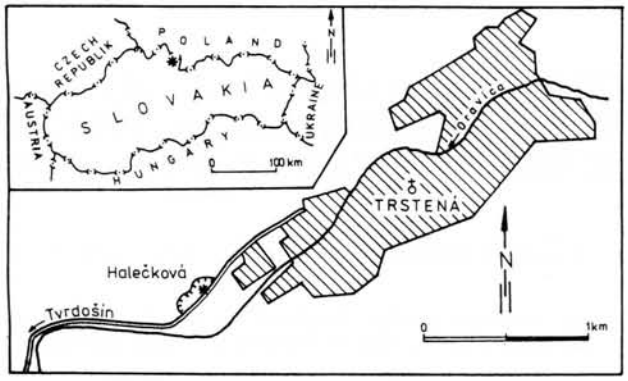

Fig. 1. Location map of the Halečková quarry (*) near Trstená

Fig. 2. View of the quarry. * – place where the sample was found, === – most likely place of primary occurrence

of the same thickness. Pinnae arise at an angle of 50° with the axis in the apical part and 70° at the pinnule base.

A similar print was reported by Lilpop (1937) from the Posidonia Beds of the Pieniny Mts. under the name of *Otozamites bechei* Brongn. It differs from our specimen in the form of the pinnae – they are broader near the base, narrower apically and the angle made by the pinnules with the axis is more acute.

The precise determination of leaf prints of the genus *Otozamites* based only on morphology is problematic. Alas, it was not possible to extract the cuticle, so anatomical features could not be used. According to Harris (1969) this name is not valid, but he continued to use it, because he could not be certain which of the possible older names really referred to the present species. Similar plant prints have been noted by different authors under such na-

Fig. 3. *Otozamites graphicus* (Leckenby) Schimper. Magn. × 1. Halečková Quarry near Trstená Magn. × 1

mes as *Otozamites bechei* Brongn. (Lilpop 1937), *O. pterophylloides* Brongn. (Lemoigne & Thierry 1968), *O. graphicus* (Leckenby) Schimper (Saporta 1875, Harris 1969), *O. ptilophylloides* Barnard & Miller (Barnard & Miller 1976) and so on; all came from Middle Jurassic sediment. All forms similar to the above from Europe were found in Middle Jurassic sediments (Aalenian to Oxfordian). According to Harris (1969), *Otozamites graphicus* occurred in the Bathonian, which corresponds well with the age of strata bearing our plant print.

The genus *Otozamites* belongs to the class Cycadopsida and to the artificial group Cycadophylla. Cycadopsida represents an ancient group developed from an early evolutionary stage in the development of the Pteridophyta. Development of the Cycadopsida probably took place in moist plains during the Late Carboniferous, and only later did they gradually adapt themselves to the dry climate in the Triassic and more humid climate of the Jurassic periods. Cycadopsida were widespread during the earlier part of the Mesozoic. They declined in the Cretaceous and only nine genera have survived until the present time. Representatives of the genus *Otozamites* resembled small trees. They dominated the Western European flora especially during the Middle Jurassic.

The state of preservation proves that the studied leaf was not transported from dry land over a great distance in spite of the hemi-pelagic nature of the surrounding sediment. The proximity of dry land is indicated only by an accumulation of terrigenous clay minerals and a considerable quantity of the carbonized detritus of higher plants transported by currents into the depositional environment situated within the reach of waves (deeper neritic ?). Single grains of clastic quartz are probably of aeolian origin.

During the Middle Jurassic epoch there were two emerged areas in the sedimentation zones of units which are now adjacent to the Pieniny Unit s.s. The first was an island in the Tatric depositional area (Andrusov 1959, p. 210) which is, however, the less probable as a source of plant remains transported into the deep water sedimentation zone of the Pieniny Unit, because it was not in direct contact with the Pieninic sedimentation zone at that time (Aubrecht 1993). The second and a more probable source could be the External Czorsztyn Terrestrial Ridge (Mišík & Aubrecht 1994) which supplied the terrigenous admixture in the Middle Jurassic crinoidal limestones of the Czorsztyn Unit.

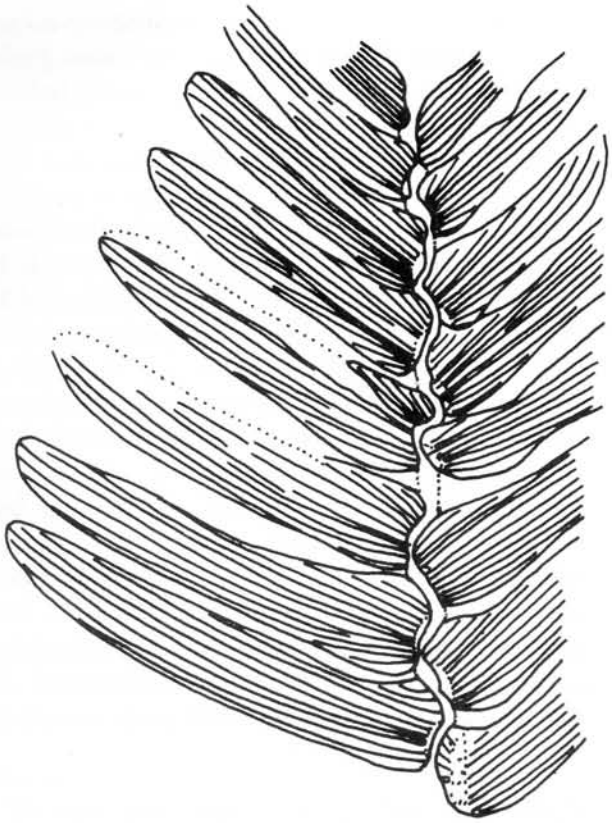

Fig. 4. Arrangements of the pinnae and veins. Magn. × 3

ACKNOWLEDGEMENT

The authors would like to thank Prof. M. Mišík and Dr. L. Ožvoldová for their valuable advice and help in completing this study.

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