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The Significance of Striae on Certain Diaspores from the Early Miocene Lignite in the Opencast Mine Oberdorf (N Voitsberg, Styria, Austria)

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Die Bedeutung von Striemen an Diasporen aus dem untermiozänen Braunkohlentagebau Oberdorf (N Voitsberg, Steiermark, Österreich)

Zusammenfassung

Aus dem Braunkohlenrevier Oberdorf wurden einige fossile Samen von *Cephalotaxus miocenica* untersucht, die auffällige "Striemen" zeigen. Diese Verletzungen sind möglicherweise während des Flußtransportes entstanden. Untersuchungen in Trommelmaschinen, welche die Bedingungen an Fließgewässerböden nachvollziehen, sollen die Belastungen, denen Diasporen ausgesetzt sind, aufzeigen. Unterschiedlich körnige Sedimente und verschiedene Umdrehungsgeschwindigkeiten wurden bei diesem Versuch verwendet. Bei diesen Experimenten zeigte sich, daß die verholzten Diasporen abgerundet und ihre Oberfläche angerauht abgeschliffen wurden. Die glatten "Striemen" einiger Samen von *Cephalotaxus miocenica* sind scheinbar im Laufe der Diagenese und nicht während des Transportes entstanden. Deshalb sind Rückschlüsse auf den Transportweg nur schwer möglich.

Abstract

Some of the seeds of *Cephalotaxus miocenica* from the opencast mine Oberdorf display superficial streaks. These could have originated during fluvial transport. In order to simulate conditions in the bedload, experiments with tumbling mills were undertaken. A variety of clastic sediments and speeds of rotation were employed. The experiments demonstrate that lignified diaspores become rounded and the surface abraded. The smooth streaks displayed by the seeds of *Cephalotaxus miocenica* are apparently of diagenetic origin and did not originate during transport. As a result these cannot be used to confirm or negate allochthony.

While *Cephalotaxus* is rare or absent in most Tertiary assemblages, it is quite common in the carpofloras from Oberdorf. Some of the seeds of *Cephalotaxus miocenica* display striae (MELLER, 1995), which could be interpreted as scratches originating from abrasion in the bedload. As such *Cephalotaxus* might represent a "foreign" element, washed into the Styrian Tertiary Basin during flooding.

In order to test their susceptibility to abrasion, recent diaspores (fruits and seeds) of a number of genera were submitted to trials in tumbling mills (HUBER & FERGUSON, 1998a, 1998b). The choice of genera was based on their occurrence in Oberdorf or other Tertiary localities.

The diaspore (D), leaf (L), and pollen (P) assemblages from Oberdorf include the following genera: *Cephalotaxus* = D, L; *Pinus* = P, *Acer* = D, P, L; *Pterocarya/Cyclocarya* D, P; *Carya* = D, P; *Fagus* = D, P; *Magnolia* = D; *Celtis* = D and *Vitis* = D, P; MELLER (this volume), KOVAR-EDER (this volume), KOLCON & SACHSENHOFER (this volume), ZETTER (this volume).

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Those diaspores which initially float in water were first submitted to a partial vacuum in a desiccator in order to make them waterlogged. These were then added along with one of a number of sediment types (including some from Oberdorf) to one of the two tumbling mills (10 cm and 28 cm in diameter) employed in the experiments. Finally, before setting the drums in motion, water was poured into the tumbling mills until these were half full. In order to simulate abrasion under contrasting flow regimes, the tumbling mills were driven at different speeds.

In the recent conifers investigated (*Cryptomeria japonica, Metasequoia glyptostroboides, Picea abies, Pinus strobus*), the distal extremities of the cone-scales became worn or even frayed. In the winged diaspores (*Acer campestre, Liriodendron tulipifera, Pterocarya fraxinifolia*) the wings became badly abraded. The appendices on the cupules of recent *Fagus sylvatica*, which are essential for specific identification, were broken off in the course of the experiments. Likewise hairs are removed by the clastic sediments. Those recent diaspores with a lignified testa (*Cephalotaxus harringtonia, Magnolia* sp.) or endocarp (*Carya illinoensis, Juglans nigra, Celtis australis, Styrax obassia*) were less affected. In this case any sharp faces/ribs became rounded and the smooth surfaces lost their sheen. Investigations under a SEM have shown this to be caused by a roughening of the surface, whereby the outer cell wall was partly or entirely removed.

The pattern of destruction was essentially the same in diaspores which were submitted to abrasion in fine sediments for a long time (up to 50 days) as that caused by coarse clastics in just a couple of days. In some cases, the diaspores were destroyed completely (e.g. *Vitis vinifera*). In those experiments designed to simulate slowly flowing water, the damage was considerably less and sometimes hardly noticeable.

The experiments have shown that abrasion follows certain, well-defined patterns. That the abraded fruits of extant *Acer* and *Pterocarya* look similar to the fossil representatives of these genera as found in Oberdorf (MELLER, 1995), might suggest that the latter have undergone a certain amount of fluvial transport. Because the seeds of *Cephalotaxus* are highly lignified, they would not be expected to show any macroscopic signs of abrasion caused by the bedload. An examination of the striae under a SEM demonstrates that, unlike those resulting from abrasion, these have a smooth appearance. The striae were in all probability generated by pressure from elongate objects (twigs ?) in the early stages of diagenesis, while the testa was still malleable. As a result, it is still a matter of conjecture whether *Cephalotaxus* should be considered an allochthonous or an autochthonous element. The fact that *Cephalotaxus* seeds are more common in coarse-grained sediments might support an allochthonous origin. On the other hand, the presence of *Cephalotaxus* needles (KOVAR-EDER & MELLER in print), which are less robust, would tend to suggest a source not far from the site of deposition. However, like the seeds, these needles are restricted to the sandy/silty facies.

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