Supplementary Materials:

Schuster, J. Über ein pliocänes Eichenholz aus Idaho. Neue Jahrb. Mineral. Geol. Pal. 1908, 2, 49–54.

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Schuster, J. About a Pliocence Oak Wood from Idaho.

Fossil oak is known from Tertiary formations all around the world: from leaf remains, around 200 different types are thought to be distinguishable. Examples of wood anatomy, on the other hand, are comparatively scarce, most of them originating from Hungary as so-called wood opal. Apart from that, only occasional finds of Neogene age are known. It therefore appears prudent to report on a fossil oak wood of rare, beautiful preservation which I received from Professor Dr. STERZEL.

The wood originated from Idaho, in particular from Clover Creek in Lincoln County. According to the director of the U.S. Geological Survey in Washington, fossil wood from Clover Creek should be assigned to the Pliocene. Professor STERZEL had received the wood from Dr. KRANZ who had initially classified it as *Araucarites* sp. The sample consists of two stem specimens, one a little thinner, 14.5 cm long, and 9 cm in diameter, the other somewhat thicker, 23 cm long, 15 cm in diameter, and 1.7 cm thick. From these two stem specimens; VOIGT & HOCHGESANG prepared 9 thin sections, which proved congruency of the wood type between the two specimens. They also showed that the wood was not *Araucaites*, but was non-coniferous instead. This assessment agrees with Professor STERZEL who had compared the samples to UNGER, *Chloris protogae*, Table XXIX, Figure 4–6, and had assumed they were *Quercinium*.

The anatomy of *Quercus* is commonly known, as it has become the prime example for dicotyledonous deciduous trees, diffuse porous wood. I therefore do not need to further justify classifying the wood from Idaho as a kind of *Quercus*; instead I can simply refer the reader to the microscopy results and photomicrographs presented below.

The tree rings are clear in their presentation: they are consistently close, only 0.5 mm wide. The large vessels always seem to be isolated and appear in two rows. In general, they have oval shape, and only rarely are they round; the radial diameter measures between 0.180 mm and 0.400 mm, the tangential width ranges from 0.108 mm to 0.342 mm, and the wall thickness from 0.0075 mm to 0.0105 mm. Beyond the second row, the large vessels suddenly and considerably decrease in size, rendering them barely visible macroscopically, and they remain at these smaller dimensions, even at the late wood. The rows of large vessels often are arranged in the radial direction while the small vessels align diagonally. Filling the space adjacent to the vessels and between them is parenchyma, which also creates tangential, non- bifurcated, single-row connections inside the wood fibers. Other than that, parenchyma and prosenchyma alternate in a very characteristic fashion in the radially stretched portions of the cross-section: inside the small vessel zone, adjacent to the large medullary rays we observe parenchyma which also extends to include two to three rows of the secondary medullary rays; the following four rows of secondary medullary rays are from parenchyma, followed by prosenchyma and again parenchyma, eventually lined by wood fibers just before the next primary medullary ray. The wood parenchyma contains a large number of small vessels, while there are almost no vessels inside the libriforms. The tangential connective parenchyma can be found both in the parenchyma as well as in the prosenchyma. The latter is arranged in rather regular radial rows. The large primary medullary rays are separated by varying distances; in general, spacing of 3 to 4 mm between rays alternates with spacing of only 1 mm. Their lateral width ranges from 0.180 mm to 0.540 mm.

The vessels along the longitudinal cross sections are all filled by tyloses, the vessel and the wood fiber walls display small elliptical ringed protrusions. For the vessels, these protrusions are on average 17.5 microns high, their gap is 10.5 microns. The vessel perforations are circular, as is expected in secondary wood. The wood fibers appear flared through 6 to 8 lateral walls and have a wall thickness of 7–10.5 microns. On the tangential cross sections, the primary medullary rays are 3–25 mm high, 0.378-0.786 mm wide, and 19-42 cell rows high, while the secondary medullary rays are 4-14 cell rows high and almost exclusively arranged in single rows, with only a few double-row exceptions. Also on the tangential cross sections, the cells of the large medullary rays often contain crystals whose circumferences indicate they might be monocline calcium oxalate crystals.

The large number of primary medullary rays, 7 on a cross sectional cut of 18 mm, is a clear indicator that the sample described here consists of wood originating from stems rather than roots.

The relative distributions of parenchyma and prosenchyma are the major characteristics for a comparison of the oak wood from Idaho with other previously described fossil *Quercinium*. Unfortunately, previous studies did not consider these characteristics which are the essential feature for distinguishing individual species. It is therefore impossible to relate the current sample to the three species described by UNGER (Gen. et. Spec. pl. foss. 1850, p. 405.). UNGER's samples, the ones providing the basis for the classification of his three distinct species, would have to be re-analyzed also to include these current characteristics. Other fossil oak woods have previously been studied in more detail by Felix, earlier even by MERCKLIN, and later by CASPARY and CONWENTZ. According to those studies, fossil oak woods easily can be categorized into two groups. In the first group, the space between the smaller vessels is filled by prosenchyma which is transected by tangential connective parenchyma. This, for example, is the case for *Quercinium knowltoni* Felix (Zeitschr. Deutsch. Geol. Ges. 1896. p. 250) from Yellowstone National Park. In the second group, prosenchyma and parenchyma alternate as described above for the current sample. Therefore comparison of the fossil oak wood from Idaho only needs to consider fossil oak woods with two distinct tissues in the small vessel zone. *Quercinium Böckhianum* Felix (Mitt. Jahrb. K. Ung. Geol. Anst. 7, 1884, p. 15) is distinctly different from the current sample since it is missing the tangential connective parenchyma in the prosenchyma. *Quercinium compactum* (SCHLEIDEN, Über die organische Struktur der Kieselhölzer. p. 42; Felix, Zeitschr. Deutsch. Geol. Ges. 1883. p. 75) differs from this sample by missing the connective parenchyma in the prosenchyma, by the crystals in the parenchyma cells, and by narrower primary medullary rays. The closest similarity to the current sample definitely is displayed by *Quercinium montanum* (MERCKLIN, Palaeodendrologicum rossicum. p. 27–33. Table VII Figure 3 pro var.; Felix Zeitschr. Deutsch. Geol. Ges. 1883. p. 72). It contains two kinds of tissue, parenchyma and prosenchyma, and both are transected by tangential connective parenchyma (see FELIX lc. Tab. III Figures 2 and 7), similarly to the characteristics observed on the wood from Idaho. Distinguishing features between *Quercinium montanum* and the wood from Idaho are the calcium oxalate crystals in the wood parenchyma and the medullary rays: the primary medullary rays in the American wood are higher and wider, and the secondary medullary rays are lower and restricted to one row of cells. This difference in the primary medullary rays could be explained by its origin; the *Quercinium montanum* samples might have been obtained closer to the center of the tree where the medullary rays could be narrower, while the Idaho wood might have been obtained closer to the periphery. If that was the case, the vessels in the American wood would also be expected to be larger than in *Quercinium montanum*. The vessel diameter has been observed to increase from 0.1 mm in the inner tree rings to 0.23 mm in stems of 40-50 year old trees, remaining approximately constant after that. At least, this is the case for domestic oak according to HARTIG (Holzuntersuchungen, Altes and Neues. 1901. p. 34). However, the Idaho wood displays even smaller vessels than *Quercinium montanum*. I therefore propose that the Idaho wood represents a new species which I will term *Quercinium pliocaenicum*.

In relating the Pliocene oak from Idaho to current oak, we certainly need to consider the very thorough work by ABROMEIT in his Über die Anatomie des Eichenholzes (Jahrb. f. wissensch. Botanik. 15. 1884). There, ABROMEIT also describes numerous American oak woods and provides a classification table. According to this table, *Quercinium pliocaenicum* would be assigned to ABROMEIT's Main Section A, oak with large and wide medullary rays, Subdivision II, oak with thick-walled vessels, Group γ, oak with clearly displayed radial groups in the rings of the larger vessels in spring wood. Among the species described by ABROMEIT, this group includes the Southern European *Quercus corris* L., the Japanese *Quercus serrate* Thunb., and *Quercus Phellos* L and *coccinea* Wangnh. from North America. Even though they do not exactly coincide, *Quercinium pliocaenicum* appears to most closely resemble *Quercus coccinea* Wangenh. which grows on sandy soils close to the coast in eastern Massachusetts and in Minnesota. However, *Quercus coccinea* differs from the current Pliocene oak wood, in particular through the laterally attached vessels, the significantly lower primary medullary rays, and the wider tree rings. As observed from the three consistent horizontal cross section cuts, the Idaho wood appears to have consistently narrow tree rings. The low wood production in the Idaho wood seems to indicate rather poor growing conditions, possibly due to a location on rocky ground or on similarly disadvantageous ground conditions. Oak, of course, is not always confined to wooded areas, but will also sprout on rock or cliffs along the coast (compare MICHAUX, Geschichte der amerikanischen Eichen. 1802. p. 5). The pronounced annual ring structure proves that the oak periodically changed its foliage, since the growth zones for evergreen oak are generally much less pronounced. This had been observed first by SIMON (Bau des Holzkörpers sommer—und wintergüner Gewächse, Ber. Deutsch. Bot. Ges. 20. 1902. p. 243) and was later confirmed by HOLTERMANN (Der Einfluss des Klimas auf den Bau der pflanzlichen Gewebe. 1907). In his studies in tropical regions, he found that the rapidly growing deciduous trees exhibit the most distinctive growth zones.

The Pliocene oak from Idaho can therefore be classified as a deciduous kind, which in ENGELMANN's classification seems to correspond to Division 2 *Melanobalanus*, Sub Genus III *Erythrobalanus* Engelmann. The group *Erythrobalanus*, which is exclusive to North American species of oak, therefore was already present in North America in the Pliocene.

With regard to the state of conservation of the sample, it should be noted that the wood has turned to opal, given that the majority of the petrifying material is opal. On the polished cross sections, the petrified wood displays a light yellow color while the circumferences of the specimen exhibit some discoloration. The opal in the vessels shows signs of change: while some of the vessel fill is still isotropic, most of the vessels are devitrified, displaying more or less spherulitic chalcedony. The devitrification in the vessels did not originate in the tyloses. The radial cuts under incident light reveal a beautiful blue color for the opal. Discolored sections of the specimen have collected a dirty brown substance, probably hydrated ferric oxide.

Explanation of the Tables

Table III. *Quercinium pliocaenicum* Schuster n. sp., Pliocene from Clover Creek, Lincoln County, Idaho.

Figure 1. Horizontal section. Magnification 25.

Figure 2. As above. To the right, a primary medullary ray; adjacent on both sides prosenchyma, which alternates with wood parenchyma. Connective parenchyma in the parenchyma and prosenchyma. Magnification 130.

Table IV. Quercinium pliocaenicum Schuster n. sp., Pliocene of Clover Creek, Lincoln County, Idaho

Figure 1. Tangential section with primary and secondary medullary rays, and vessels filled with tyloses. Magnification 25

Figure 2. As above. On the left side, part of a primary medullary ray with calcium oxalate crystals in the cells; adjacent secondary medullary rays, towards the right ringed prosenchyma protrusions. Magnification 290.