

A NEW HOMOXYLOUS TRÉE IN THE MIOCENE FLORA OF HUNGARY*, *TETRACENTRONITES HUNGARICUM* NOV. SP.

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IN the preparation of the monograph on fossil trees in Hungary several remarkable relict tree fossils were examined. From more than 150 different relicts the most interesting was perhaps a homoxylous tree that came to light from Sarmatian layers of Tokaj, Northern Hungary (see Map, T). The piece of stem or branch might have had a diameter of about 5-6 cm. as may be concluded from the curve of the annual ring limits hardly perceptible in the tree (PL. 1, FIG. 1). From the piece of stem that became completely silicified, were made cross, tangential and radial sections to carry out more exact investigations. Relying on the evidence of these investigations we are now in a position to report on the one time existence of a new homoxylous species *Tetracentronites hungaricum*.

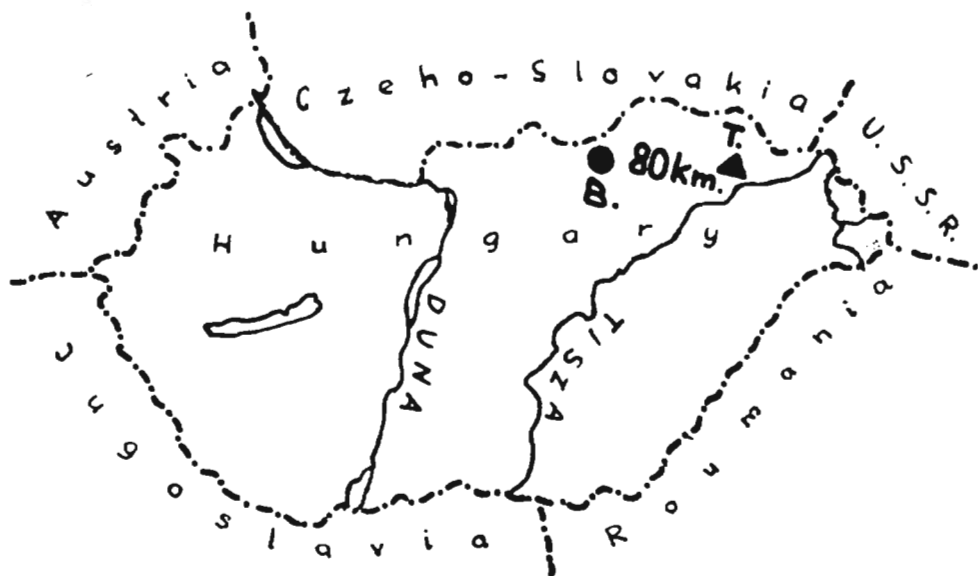
The structure in the cross section undoubtedly reveals that the interior consists of elements of completely identical size. There are no tracheids, vessels or elements of different size and the structure is absolutely homogeneous (PL. 1, FIGS. 1, 2 & 3). At the spots corresponding to the annual ring limits at distances of 2, to 3 or 5 millimetres curved parallel lines proceed, but even at these spots there is almost no difference between the elements. In the annual rings here and there smaller or larger vertical ducts and cavities are present, some of these containing a brim-stone coloured resiniferous substance (PL. 1, FIG. 6). The reality of the canals is verified by the form of the marginal cells (PL. 1, FIG. 6). The resiniferous canals are generally 510 μ in radial and 250 μ in tangential diameter. The dimensions of a smaller resin-canal are: 250 μ in radial and 50 μ in tang. diameter (PL. 1, FIG. 6). Amidst the elements 1 to 2 (3) cells wide rays proceed radially, following each other at a distance of 2 to 6 elements. In cross section the elements are regularly quadrate

or oblong (PL. 1, FIG. 3). Their radial dimension is 30 to 40 or 50 μ , whereas their tangential diameter is almost the same, 36 to 37 μ ; they might be, however, bigger or smaller than that. In some places the elements are somewhat radially elongated rectangles or hexagons, very much suggestive of the radial layout of the tracheids as in Coniferae (PL. 1, FIGS. 3-7). Since there is hardly any difference between the elements of the early and late wood near the apparent annual ring limits, we may definitely conclude from this structure on the origin of a plant that lived once in a region of uniform climate or in the tropics (PL. 1, FIGS. 1, 2, 3).

Although there is almost no difference in shape and size of the elements, the thickness of the walls sometimes reveals certain differences. The walls of some elements are quite thick, their cavities narrow, sometimes almost slit-like, while in others the walls are thin and the cavity is quite big. This may lead perhaps to the conclusion that thin-walled parenchyma cells occur amidst the elements, more precisely among the tracheids (PL. 1, FIGS. 4, 5). This homogeneity in the cross sections of the elements is strongly suggestive of Conifers but similarly or perhaps even completely coincides with the so-called homoxylous trees: *Sahnioxylon*, *Bucklandia* (BOSE, 1953), *Cycadeoidea* (WIELAND, 1906-1916) and the homoxylous angiosperms. On the evidence of the cross section structure it may be stated definitely that our fossil originates from some Gymnosperm or a homoxylous angiosperm. But, which does it originate from?

Tangential Section — The structure of the tangential section allows a narrower approach. Although as a consequence of marked disorganization not all details of the tree could be exactly established, the identified details explicitly indicate for the homoxylous origin of the tree.

*Detail from the author's work "A monograph of fossil trees in Hungary", in preparation now.



TEXT-FIG. 1 — B, Provenance of *Tetracentron*-leaf. (Balaton). T, Provenance of *Tetracentronites hungaricum* trunk. (Tokaj).

The rays are generally uniseriate and 1 to 20 cells high, but they may be shorter or somewhat higher as well. The higher rays at some places broaden into two cells layers and very exceptionally even rays of 3 cell layers occur (PL. 1, FIGS. 8, 9; PL. 2, FIGS. 10, 11, 13). The marginal cells of the rays are higher here and there than the central cells, and in these cases the rays are of heterogeneous nature. In Fig. 8 the wider ray on the right side appear to be an accumulated ray, because several uniseriate rays are meandering in it.

The shape of the ray cells differs from the form of the ray cells in Conifers as the cross sections are in most cases regular rectangles (PL. 1, Fig. 9; PL. 2, FIGS. 10, 11) with a height of 65 to 70 μ . They may be somewhat larger or smaller too. The walls are thin as a rule, sometimes considerably thickened; in this case the cavity becomes almost slit-shaped (PL. 2, FIG. 11). The end cells are conical.

No axial parenchyma cells could be established with certainty, because in cross sections, shape and size of the cells involved coincides with shape and size of the ray cells, while the cell content in the interior is completely disorganized. It may be

concluded on their presence only from the thickness of the walls (PL. 1, FIGS. 4, 5).

In the tracheid cavities the cell content is dark yellow (FIG. 12) and cross designs can be distinguished in them.

Radial Section — Still more precise details could be observed from the radial section. The rays are of heterogeneous nature (PL. 2, FIGS. 14, 15, 16). Radially the ray cells are quadrate or of a standing oblong shape, most of them 65 to 70 μ high and about of the same width and thin-walled. In the cross-fields there are generally several, simple, circular pits (10 to 12), with 5 to 6 μ diameter (PL. 2, FIG. 16). Here it is sometimes seen that the tracheids behind are pitted.

The most characteristic features are displayed, however, by the radial walls of the tracheids. Though the walls are largely disorganized, at some places the pitting and the cell wall thickening partly remained, constituting a very important factor in the later determination of the tree. The radial walls of the tracheids are densely covered with tiny bordered pits closely adhering to each other; their openings being oblique slits. In the width of one tracheid even 6 to 8 pits rows are arranged (PL. 2, FIGS. 17,

18, 19). The dimensions of the pits are 7 to 9 μ , the apertures are somewhat oblique ellipses.

Similarity or almost identity with the homoxyulous trees is proved also by the Photos No. 20 and 21. This is further strengthened by the scalariform thickening of the spring tracheids (PL. 2, FIG. 21). resemblance between the two is startling and corroborates more and more our view according to which our fossil is really a homoxyulous tree.

Relationship with homoxyulous trees is further enhanced by the fact that a latex or milk tube is seen in our fossil. The structure of the contents of the canal indicates that not a resin canal of some conifer but a latex or milk canal of a deciduous tree is involved.

The morphological characteristics observed on the radial section definitely corroborate our assumption that the fossil under discussion is really a homoxyulous tree.

DISCUSSION

Metcalfe & Chalk (1950) in their work on Anatomy of the Dicotyledons, separate those trees that have no vessels. These trees belong to *Trochodendraceae*, *Tetracentraceae* and *Winteraceae*. Recently *Amborella trichopoda* Baill. (BAILEY & SWAMY, 1948) of the family Monimiaceae and *Sarcandra* (SWAMY & BAILEY, 1950) of Chloranthaceae have been added to this list of vesselless angiosperms. The first two families are represented by one recent species each, namely *Trochodendron aralioides* Sieb et Zucc. occurring in Japan and Taiwan, *Tetracentron sinensis* Oliv. in Southern China and Burma, while *Winteraceae* living in S. E. Asia and South America include several genera. In the tracheids of *Trochodendron*, the bordered pits are circular or scalariform, thus in this respect similar to our fossil. As a strong contrast the rays of *Trochodendron* are upto 12 cells wide, while in our fossil the rays have a width of only 1 to 2 (3) cells. Therefore, it can in no way be considered as a fossil wood of *Trochodendron*. In *Tetracentron*, on the other hand, the pits in the tracheid walls are circular and scalariform, the same as in our fossil, and the heterogeneous rays are not wider than 4 cells either. A further important characteristic of *Tetracentron* is that it has canals containing a latex type substance exactly as

in our fossil. Consequently the latter is more suggestive of *Tetracentron* than of *Trochodendron* without being completely identical.

Hartig (1848) was the first to institute the term *Homoxylon* for the fossil "homoxyulous" tree and Sahni in 1932 made use of this term when describing a homoxyulous tree under the name *Homoxylon rajmahalense*. This discovery at that time produced considerable sensation. Hšu and Bose in 1952 published a more detailed description of this fossil bringing it in close comparison with *Tetracentron*, *Trichodendron* and *Drymis* and showed it to be a Bennettitalean wood. Bose & Sah in 1954 gave to the original *Homoxylon rajmahalense* the new name *Sahnioxylon rajmahalense* (SAHNI) comb. nov.

Bose (1953) in another paper reports on a stem of *Bucklandia sahnii* comparing it with *Sahnioxylon rajmahalense* and also with *Cycadaceae* and *Williamsonia*. Our fossil, however, cannot be brought in closer relation either with *Bucklandia* or with *Cycadaceae* except for the bordered pits in the tracheid walls being arranged in 1 to 10 rows in our fossil while in recent *Cycas* 4 to 5 row araucaroid arrangement is already considered as a rarity. In our opinion, the fossil tissue which in several characteristics coincides with *Sahnioxylon*, positively differs from *Sahnioxylon*, *Bucklandia*, *Cycadaceae* and *Cycadeoidea*. Therefore, our homoxyulous tree must be referred to the most primitive dicotyledonous plants and can be brought in close association with *Winteraceae*, *Trochodendraceae* and *Tetracentraceae*, but more so with the genus *Tetracentron*.

Apart from the Indian finds few other homoxyulous fossil trees are known up to the present. Boureau (1957) reports on two homoxyulous trees from the Mesozoic, *Homoxylon awiasii* from the Lias and *Homoxylon australe* from the Trias. The rays of these are 1 to 2 cells wide.

Boureau (1957) also described *Homoxylon neocaledonicum* from the Trias; the rays of this tree are only one cell wide and its pitting is similar to that of *Sahnioxylon rajmahalense*.

The Soviet scientist Yarmolenko (1939) also reports on two homoxyulous trees; one of these, *Homoxylon ugamicum*, came to light from the Lias layers of Tiensan, the other from the Apt-albien of the Ural mountains.

Fossil forms of *Trochodendromagnolia* (ZANDER, 1923) and *Trochodendroxylon beckii* (Hergert and Phinney, 1954) known from Germany and the Tertiary of Oregon respectively, also differ quite markedly from the present fossil wood. In 1932 Mathiesen described a vesselless fossil wood, *Tetracentronites hartzii*, from the Eocene of Greenland, showing its nearest affinity with the wood of the modern genus *Tetracentron*. The present fossil wood although resembling *T. hartzii* in several features also differs from it.

It is significant that the occurrence of the present fossil is supported by Andreánszky (1959) who described a leaf impression, from Balaton near Tokaj, Northern Hungary, as *Tetracentron hungaricum* nov. sp. (see Map B). Since he is convinced of the correctness of his determination the question arises whether there is some genetical link between the undoubtedly homoxyloous tree found in Tokaj and the *Tetracentron* leaf remains that came to light in Balaton. This assumption seems to be supported by the fact that both the Tokaj and the Balaton finds originate from the Sarmatian layers of the Miocene and therefore the fossil piece of a stem and the leaf impression might have existed at a time near each other.

In this connection, however, it is important to note that the homoxyloous trees that came to light up to the present predominantly originate from the earlier epochs, from the Liassic and Jurassic, whereas the present fossil just as the *Tetracentronites hartzii* Mathiesen from the younger layers, and accompanied mainly by plants that lived in subtropical environments. *Tetracentron* is a tree living in the subtropical regions of South East Asia and reaching a

considerable height; it thrives in our days at a general temperature of at least 15°C. i.e. in the same sort of environment as might have existed in the area of Hungary in the Sarmatian.

As a summary, it can be said that our fossil is some kind of homoxyloous tree with a structure showing near relationship with the genus *Tetracentron*, and for this reason it is referred to the organ genus *Tetracentronites* Mathiesen (1932). The species name *Tetracentronites hungaricum* is after the place of occurrence.

Diagnosis — *Tetracentronites hungaricum* Greg. n. sp. In sectione transversali xylem-elementa perfecte aequaliter magna, in texto fundamentali trachea omnes magnitudine aequales. In sectione transversali tracheidae in genere quadrangulares isodiametricae, limites stratorum concentricorum perfecte conspicui. Radii medullares latitudine ex 1-2 cellulis formati, structura heterogenei, raro coacervati. In ligno nonnumquam utriculi, vel meatus materiam flavam gummi similem continentes. Cellulae radiorum medullarium in latere radiali plus-minus isodiametricae, vel non, 65-70 μ altae, in pariete radiali earum in zonis ex radiis medullaribus tracheidisque formati 8-12 pori simplices. Paries tracheidarum longitudinalium crassus in lumine angusto earum saepe materia obscura gummi similis. In pariete radiali tracheidarum pori foveolati parvi, 7-8 μ diam., in seriebus 4-6 ordinati, dense, vel laxe dispositi. In tracheidis zonae prioris nonnumquam incrasatio scalaris. In meatibus longitudinalibus gummiferis resina vel materia gummi similis.

Holotypus — The preparations are at the department of Botany, University of Szeged, Hungary.

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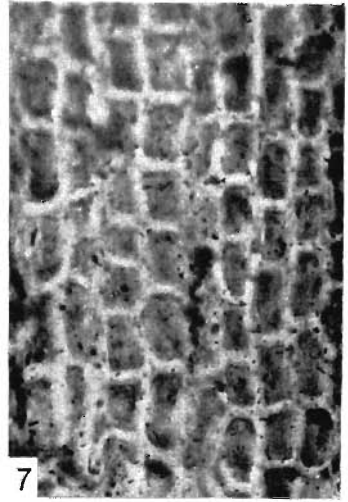
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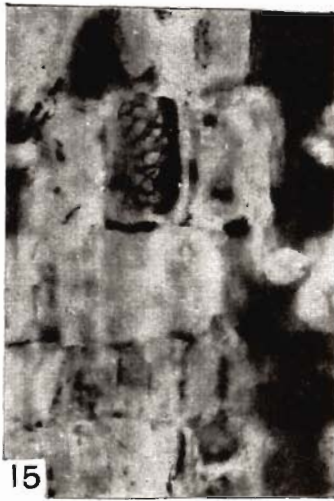
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EXPLANATION OF PLATES

Tetracentronites hungaricum n. sp.

PLATE 1

1. Cross section showing indistinct annual ring limits, xylem almost completely homogeneous, without vessels. Larger or smaller cavities in the xylem are probably latex canals. $\times 2\frac{1}{2}$.
2. The same slightly magnified. $\times 4$.
3. Cross section magnified to show details from the xylem. Tracheids are of the same size, joining each other in longitudinal and horizontal rows; some are thick-walled, while others thin-walled, the latter are probably parenchyma cells. $\times 100$.
4. Cross section to show tracheids (generally square), and uniseriate and biseriate rays between them. $\times 100$.
5. Cross section to show occasionally thin-walled parenchyma cells, among the thick-walled tracheids. $\times 200$.
6. Transverse section to show resin or latex tube in the xylem. In the canal a golden yellow coloured content is present. Probably it is a schizogenous canal. $\times 100$.
7. Cross section magnified to show the disposition of the tracheids suggestive of Conifers. $\times 200$.
8. Tangential section showing 1- and 3-seriate rays. Those on the right side are probably accumulated rays. $\times 100$.
9. Tangential section to show 1-2 seriate rays. $\times 100$.

PLATE 2

10. Tangential section showing uniseriate rays. $\times 75$.
11. Tangential section showing uniseriate rays with thick walls and their cavities almost like slits. $\times 300$.
12. Tangential section showing thick-walled tracheids with their cavities filled with a latex type content. Primary lamellae marked with vertical black lines. $\times 300$.
13. Tangential section showing biseriate rays. $\times 100$.
14. Radial longitudinal section showing ray structure. The ray cells are squares or standing oblongs; somewhat heterogeneous structure. $\times 100$.
15. R.L.S. showing details from Fig. 14. $\times 200$.
16. R.L.S. showing 8 to 10 tiny pits in the cross-field. $\times 200$.
17. Radial walls of the tracheids densely covered with tiny bordered pits. $\times 300$.
18. R.L.S. showing pitting of the radial walls of the fossil. Figs. 18 & 19 are very similar. $\times 300$.
19. R.L.S.—In the tracheid walls the bordered pits are rather compressed. $\times 300$.
20. R.L.S.—In the tracheid walls the bordered pits are sometimes loosely arranged next to each other. $\times 300$.
21. Scalariform thickenings from the fossil wood. $\times 300$.