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ON THE OCCURRENCE OF A FOSSIL WOOD IN ASSOCIATION WITH FUNGOUS HYPHAE FROM CHIMO OF EAST SHANTUNG.

(With 1 plate and 4 text figures. All the figures in the plate are untouched photographs*).

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The present paper deals with a petrified wood found in the collections of the former Department of Geology of Peking University. It was collected by a Japanese geologist from Ma-An-Shan of the Chimo district, about 10 km. to the northeast of the Nanchuan Station of the Chingtao-Chinan Railway and 8 km. to the northeast of the City Chimo. The geological formation, from which this wood was derived, is unknown. As the locality Ma-An-Shan of the Chimo district is noted for the occurrence of a Mesozoic fossil forest ("青島之化石林"第一頁,青島山東產業館),the present specimen belongs evidently to the Mesozoic.

The medium of the fossil wood is dark-brown in colour. After examining dozens of sections made from different parts of the specimen, the writer comes to the conclusion that it is a piece of coniferous wood, comparable to *Dadoxylon* (*Araucarioxylon*) *japonicum* described by Shimakura (1936, 1937) from the upper Jurassic and Aptian of Japan. In the ray cells and tracheids of this wood the writer found some well-preserved septate fungous hyphae with clamp connections which are very rarely observed in fossilized state. Evidently the hyphae should belong to the Basidiomycetes.

Dadoxylon (*Araucarioxylon*) cf. *japonicum* Shimakura

(Pl. 1, figs. 1-5; textfigs. 1-4).

The present specimen represents a piece of secondary wood, about 15 cm. long and 6 cm. broad. The external feature indicates that it must have come from a big tree of at least 25 cm. in diameter. No remains of bark, pith and primary xylem are attached to it. Therefore it is impossible to judge whether it was part of a stem or a root.

Transverse section. The transverse section (Pl. 1, fig. 1) shows that it is composed of tracheids and ray parenchyma. Growth rings are almost indistinguishable. Under careful examination, however, one can make out to some extent narrow rings of flattened cells (shown in the middle part of the figure) with smaller caliber, about 45 μ wide and 24 μ thick, intercalated in broad zones of squarish to polygonal cells of about 40 μ to 75 μ across. These rings of small cells are generally of about ten cells in thickness and pass out insensibly in both directions into the broad zones. The two successive rings of smaller cells are about 5 mm. in distance. The secondary wall of tracheids is of considerable thickness, ranging from 3.5 μ to 8 μ. Occasionally middle lamella is preserved. Bordered pits are well developed on the radial walls. No wood parenchyma and resin canals, even traumatic, are found. Sometimes, the lumen of tracheids is filled up with some dark brown substance which is presumably a kind of resin. Xylem rays are distinct and uniseriate. Ray interval ranges from three to nine

*The figured slides are kept in the Institute of Palaeontology, Academia Sinica, Nanking.

cells, being mostly of five on the average.

Radial section. Figures 3-5 of the plate show radial sections of the wood. The radial walls of tracheids generally possess uniseriate round bordered pits which measure about 24 μ in diameter. Both separate and contiguous pits are present, they even occur on the same surface of the tracheids. When contiguous, they are more or less flattened near the contact. Locally biseriate pits are also present, but not common. They are subopposite or arranged densely in alternate series, while in the latter case the borders form hexagonal outlines (Pl.I, fig. 5). Pores of the bordered pits are usually elliptic, arranged obliquely in parallel series (text figs. 1-2), but perpendicular to those located on the other side of the same tracheids. Resinous tracheids are found in these sections, generally adjacent to the ray cells, but not common. Ray cells are elongated and rather thin-walled, and measure about 170 μ long on the average. In the early wood, pits are fairly large, bordered, round in outline, about 11 μ in diameter, bi- or triseriately arranged, ranging from 9-18 in number in a cross field (Pl. I, fig. 3 and textfigs. 3 & 4). These pits are generally separate and subopposite, but tend to be alternate and contiguous, and their pores appear to be round. In these sections the walls of tracheids adjacent to the ray cells exhibit some well-marked spiral patterns (Pl. I, fig. 3), closely simulating the spiral bands of *Taxoxylon*. But the spirals are steeper than those of the latter, and sometimes form networks which are unknown in *Taxoxylon*. In the ray cells, some fungous hyphae are also observed. Therefore it is thought that these spiral patterns are formed by the action of the decay enzyme secreted by the infecting fungus, and therefore are of no diagnostic value.

Tangential section. The tangential sections (Pl. I, fig. 2) show that the xylem rays are usually uniseriate, ranging from 1 to 17 or more cells in height, and being about 10 cells on the average. Occasionally there are locally biseriate rays. These cells appear laterally compressed and elliptic in section with smooth walls. Tangential pits are very rarely found on walls of trachids of the late wood. They are circular in outline and bordered, but smaller than those seen on their radial surface. Occasionally large dises of resinous substance, or resin-spools, are seen in the lumen of some tracheids (Pl. I, fig. 2, *rt*.).

Judging from the characters just described it is obvious that this wood is of conifer in affinity. In structure it appears quite simple, consisting of only tracheids and ray cells, and is free from resin canal and wood parenchyma. Bordered pits, when biseriate, are alternately arranged on the radial walls of the tracheids. Ray cells are generally uniseriate, with smooth horizontal and tangential walls. These indicate that the present fossil should belong to the genus *Dadoxylon* (*Araucarioxylon*)*, and may be taken as a coniferous wood of araucarian type.

Compared with known species of *Dadoxylon* this wood in many respects resembles *D*. (*Araucarioxylon*) *japonicum* described by Shimakura (1936) pp. 268-293, pl. XII, figs. 1-6, textfig. 1; 1937, pp. 5-6, Pl. 1, figs. 7-10) from the Upper Jurassic and Aptian of Japan. However, the present wood differs from it in having mostly uniseriate bordered

*Occurrence of the wood was already reported by the writer (1950). In that note the wood was wrongly named under a non-committal generic term *Brachyoxylon*, as *B. Sahnii sp. nov.*

pits on the radial walls of the tracheids. In the present fossil biseriate bordered pits, though present, are poorly developed; while in the case of the Japanese specimens, biseriate pits are quite common and even the triseriate ones are recorded. The included aperture of the bordered pits on the radial walls of the ray cells of the present fossil is round in outline, but those of the Japanese specimens are elongated, lenticular and obliquely placed. Moreover, in the present wood the number of pits in a cross field on the walls of the ray cells of the early wood is more than that of the Japanese ones, being 9-18 instead of 5-14.

Fungous Hyphae (mostprobably of Basidiomycetes)

(Pl. I, figs. 6-7; textfigs. 1, 3-4)

In the radial sections of the wood, it is very interesting to note that there occur some beautifully preserved fungous hyphae in the ray cells and the tracheids adjacent to them. These hyphae generally measure about 3 μ across, branching and septate (Pl. I, figs. 6-7 *h*; textfigs. 3-4 *h*). They are uniseriate with cross walls perpendicular to the surface of the elongated cells. These cells range from 30 μ to 60 μ (or even more) in length. The lateral branches or outgrowths mostly arise alternately from the main body at right angles; usually they are as thick as the main one, but slender ones are also observed.

Some lateral connecting tubes of two neighbouring cells, known as clamp connections, are frequently found, (Pl. I, fig. 6, *c*; textfig. 3 *c*), and look quite similar to those of the recent Basidiomycetes.

These hyphae pass into and out of the ray cells along the direction of the ray, and occasionally intrude into the lumen of the adjoining tracheids and then run along the tracheid wall (text fig. 1, *h*).

All these features agree closely with those of the recent Basidiomycetes, especially the wood rotting Polyporaceae. Clamp connections of fungal mycelium are generally to be confined to the hyphae of Basidiomycetes and usually serve as a useful aid for identification. So there leaves not much doubt that the present hyphae are the remains of Basidiomycetes, if not Polyporaceae.

A good example of a clamp connection in a fossil mycelium is given by Conwentz in his monograph on the Baltic amber-trees of Oligocene age (Seward 1898, p. 211). Undoubtedly, Basidiomycetes existed in Tertiary. It has been claimed that a number of leaf spots resembling the aerial, uredinial, and telial sori of the Pucciniaceae have been observed on the foliage of the Upper Cretaceous plants (Arnold 1947, p. 44). The present discovery confirms that Basidiomycetes occurred at least in the Cretaceous. Some fungous hyphae have been figured by Arnold (1931, Pl. v, fig. 4) from the Upper Devonian of N. America. His figure, however, does not show the clamp connection.

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