TERTIARY CONIFEROUS WOODS OF WESTERN NORTH AMERICA

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INTRODUCTION AND REVIEW OF LITERATURE

Almost four decades have elapsed since Platen (1908), the German paleobotanist, published his report upon the fossil woods of the western United States. Since then no over-all treatment of these materials has been attempted. although Platen overlooked the Pacific Northwest with its abundance of Tertiary petrified woods. The purpose of this paper is to bring knowledge of the western coniferous woods of the Tertiary up to date. In this effort the writer recognizes that much of this information has been accumulated incidentally in the study of the Russell Petrified Forest series of central Washington, and that it is not as complete as he might wish.

Platen's paper is written in German and this has limited its use among Americans. Furthermore, as is to be expected, its usefulness has diminished with time as more and more has been learned about modern woods and the critical anatomical details upon which they may be separated. Platen made no serious effort to reduce his types to modern genera and his descriptions are hardly adequate for that purpose today; nor are his type specimens available to us for review.

It is to be regretted that Platen failed to use the then new ray-cell pitting method of Gothan (1905) for establishing the main divisions of the Coniferae. Eleven years after the appearance of Platen's paper, Krausel (1919), a convert to Gothan's system, reviewed Platen's work and possibly his type specimens. Krausel is not always definite in his commitments, but he seems to have accepted several of Platen's types as counterparts of modern genera. He also accepted one of Gothan's California woods as the fore-runner of the modern Douglas fir *(Pseudotsuga taxifolia)*.

In the introduction to this key to the known coniferous woods of the western Tertiary, sometihng needs to be said in defense of the elaborate techniques and complicated system of nomenclature which are employed by the wood-paleobotanist. Since Witham (1833) first adapted petrographic thin-sections to the study of petrified woods, students have sought in vain for some short-cut and less tedious means to achieve the same result. Research upon fossil woods has also been handicapped by the lack of modern comparative materials in even the larger colleges and universities.

Finally there is the system of nomenclature. Much as one may object to the somewhat confusing and apparently artificial system of classification evolved by the wood-paleobotanist, one must admit in the end that the advantages of the system outweigh the obvious disadvantages. Probably no other branch of paleontology employs as cumbersome an array of multisyllabic and apparently contradictory terms, largely due to the extreme handicap imposed by high magnifications upon material typically poorly preserved. Furthermore, the wood-paleobotanist is dependent upon thin-sections not only difficult to produce, but which by their very nature can hardly be compared directly or studied in transitional series. Had the early workers failed to develop a generalized system of classification they would have been under compulsion to label most of their specimens as wood only.

The result has been an admixture of the artificial form-genus and the relatively real modern species concept. Progress is always being made towards the latter but too many woods of uncertain relationship appear to dispense with the form-genus entirely. The form-genus is of particular value as a label (1) for field specimens, (2) for imperfectly preserved specimens, (3) for single, isolated specimens, and (4), for anomalous or abnormal specimens.

Each student in turn has been required to review the evolution of this technical vocabulary not only for the evaluation of previously established generalized types, but also to understand the system of classification and mold it closer to any system in current use among wood technologists.

Not until the twentieth century did the modern genus find acceptance in the naming of a Tertiary American coniferous wood. Penhallow (1907 and somewhat earlier) applied the name *Sequoia langsdorfii* (Brngn) Heer—as previously applied to foliar remains—to woods he took to be obvious ancestral redwoods. Present practice would reject some if not most of these references (for want of traumatic canal rows), but some of them still stand and entitle Penhallow to credit for the innovation.

The evolution of the largely artificial system of classification employed in the study of fossil woods has its remote beginnings with Luidius to whom Ward (1885) gives credit for the coinage of the word "Lithoxylon"—literally rock-wood—in 1699. Since the time of Luidius the suffix *-oxylon* (frequently for hardwoods reduced to *-inium*) has been employed quite universally in the creation of form-generic names for woods bearing a real or apparent resemblance to a given modern genus, or group of genera.

Witham, the accepted father of wood-paleobotany, created no categories for Tertiary woods that have continued in use to the present. Even Goeppert (1850), master paleobotanist of all time, has left but one term in current use—Cupressinoxylon—an unwieldy but very useful reference for woods of generalized cedar (cypress) structure. Goeppert, himself, according to Krausel (1919) despaired of ever being able to recognize the precise modern generic counterpart of a fossil conifer.

In the 1860's Kraus (Gothan, 1905) added the form-genus Pityoxylon for woods resembling the pitchy or pine-like conifers, and Cedroxylon for woods suggesting members of the fir group. Unfortunately the latter name suggests the cedar (cypress) of popular concept as well as *Cedrus* (cedar of Lebanon) of the fir alliance, from which Cedroxylon apparently takes its root. Kraus also revived Unger's Taxoxylon as a category for yew-like coniferous woods.

In 1905 Gothan gave science the term Piceoxylon for spruce-like woods formerly included with the pines under Pityoxylon. He also adopted Felix's Taxodioxylon for the woods of apparent *Taxodium* or *Sequoia* affinity which had previously been submerged in the more general Cupressinoxylon. Probably the greatest single contribution to wood-paleobotany has been Gothan's segregation of the so-called "abietineous pitting" whereby the members of the fir alliance can be distinguished from other generalized woods.

The pioneering American, Penhallow (1907), like Platen failed to appreciate the discovery of Gothan, and therefore, today, we find Penhallow's descriptions incomplete. Only one American, Bailey, has made as notable a contribution to the science under consideration as the Germans previously cited. This author and his associates (1933, 1934, 1938) have made a number of studies upon the diagnostic features of living conifers. An attempt has been made to follow Bailey and his school especially as regards (1) their interpretation of abietineous pitting, (2) their concept of variability in tracheid pitting, and (3), their acceptance of wide variation in the cross-field pitting of the Cupressinoxyla. In respect to the third of these items I have felt constrained to drop all of Gothan's sub-divisions of the form-genus Cupressinoxylon save Taxodioxylon; but reviving Unger's Thujoxylon for cedar-like woods exhibiting a low maximum height of ray, and restricted (1, rarely 2) seriation of the tracheid pits.

Very welcome contributions to this study have been made recently by S. J. Record and his school concerning the variable thickness in transverse and end walls of the ray cells in living Cupressinoxylon types (Pierce, 1936,

1937). Usefulness of this feature is often minimized by loss of the secondary ray-cell wall, in whole or in part.

The present report is based upon an evolving fund of information coming in its main lines through the sequence Witham — Goeppert — Kraus — Gothan —Krausel—Bailey. I am particularly indepted to I. W. Bailey for his many kindnesses, and to S. J. Record for the generous loan of the Yale thin-sections of modern woods. Also this work would have been seriously handicapped but for the use of the Hough collection of modern wood slides made available through Ralph W. Chaney of the University of California.

In the key, the writer, like previous workers, has found it necessary to redefine the form-genera according to the extended or limited use to which each has been put. Five of these (not to include Ginkgo) are divisions of the first order: Cupressinoxylon, Pityoxylon, Cedroxylon, and Coniferoxylon. Coniferoxylon is a version of the form "Coniferites" used by Cramer (1868) for an indeterminate Greenland wood. In this treatment the term has been expanded to include anomalous woods —especially the Ft. Union specimens from Beach, North Dakota (Felix, 1886). In the second order stand Taxodioxylon, Piceoxylon, Thujoxylon and Spiropitys —the last named being a revival of one of Goeppert's form-genera.

(To be continued in next issue)

LITERATURE CITED

Andrews, Henry N. 1936. A new Sequoioxylon from Florissant, Colorado. Annals Missouri Botanical Garden 23: 439-446.

Bailey, I. W. 1933. The cambium and its derivative tissues, VII. Problems in identifying the Mesozoic coniferae. Annals Botany 47: 145-157.

....., and Anna F. Faull, 1934. The cambium and its derivative tissues, IX. Structural variability in the redwood, *Sequoia sempervirens,* and its significance in the identification of fossil woods. Jour. Arnold Arboretum 15: 233-254.

....., and E. S. Barghoorn, 1938. The occurrence of *Cedrus* in the auriferous gravels of California. American Jour. Bot. 25: 641-647.

Cramer, Carl, in Oswald Heer, 1868. Flora fossilis Artica. I. Holzer der artischen Zone, 167-180, Zurich.

Felix, Johannes, 1886. Untersuchungen uber fossile holzer. Deutsche Geol. Gesell. Zeitschr. 38: 483-492.

....., 1896. Untersuchungen uber fossile holzer. Deutsche Geol. Gesell. Zeitschr. 48: 249-255.

Goeppert, H. R. 1850. Monographie der fossilen coniferen. Naturkundige Verhand. Leiden.

Gothan, W. G. 1905. Zur anatomie lebender und fossiler gymnospermum-Holzer. Abh. Prussiche Geol. Landes. n.f. Heft 44: 1-108, Berlin.

Krausel, Richard 1919. Die fossilen coniferenholzer . Paleontographica 62: 187-284.

Penhallow, D. P. 1907. A manual of North American gymnosperms. Boston.

Penhallow, D. P. in R. A. Daly, 1912. Geology of the North American cordillera. Canada Geol. Sur. Dept. of Mines, Memoir 38: 800-829.

Pierce, Alan J. 1936. Anatomical relationships of the taxodiaceae. Tropical Woods 46: 1-14.

....., 1937. Systematic anatomy of the woods of the Cupressaceae. Tropical Woods 49: 5-21.

Read, Charles B. 1930. Fossil floras of the Yellowstone National Park. I. Coniferous woods of the Lamar River flora. Carnegie Inst. Washington Pub. 416: 1-19.

Seward, A. C. 1919. Fossil Plants. IV. Cambridge, England.

Ward, Lester F. 1885. Sketch of paleobotany. U. S. Geol. Survey Fifth Annual Report, 359-453.

Webber, Irma E. 1933. Woods from the Ricardo Pliocene of Last Chance Gulch, California. Carnegie Inst. Washington 412: 113-134.

Witham, Henry T. M. 1833. The internal structure of fossil vegetables. Edinburgh and London.