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New species of *Protocedroxylon* from the Upper Jurassic of British Columbia, Canada

David A. Medlyn
Uinta Basin Education Center, Utah State University, Roosevelt, Utah

William D. Tidwell
Brigham Young University

NEW SPECIES OF *PROTOCEDROXYLON* FROM THE UPPER JURASSIC OF BRITISH COLUMBIA, CANADA

David A. Medlyn[1] and William D. Tidwell[2]

ABSTRACT.—*Protocedroxylon macgregorii* sp. nov., from Jurassic strata of British Columbia, Canada, is the first reported occurrence of this genus in North America. *Protocedroxylon macgregorii* combines the tracheal pitting of the araucarians with the crossfield pitting of modern genera of the Abietineae. This species is similar to the type species *Protocedroxylon araucarioides*. They differ in that *P. araucarioides* has tangential pitting, tracheid septations, and entirely uniseriate rays. These features are lacking in *P. macgregorii* with the exception of the rays, which are partially biseriate in the latter species. *Protocedroxylon macgregorii* has traumatic resin canals or cysts that have not been reported in *P. araucarioides*.

Protocedroxylon was proposed by Gothan (1910) for woods combining characters of abietineous and araucarian conifers. The type species *Protocedroxylon araucarioides* Gothan (1910) was described from Upper Jurassic strata near Esmarks Glacier of Spitzbergen. Tracheal pitting of *P. araucarioides* is considered araucarioid, whereas its crossfield pitting is typically abietineous. Hence, the generic epithet of the type species refers to its abietineous characters, and the specific epithet implies araucarian affinities.

Specimens of the petrified wood in this report were collected by D. C. McGregor of the Geological Survey of Canada from the northwest shoulder of an unnamed mountain situated about 2.5 km east of Elbow Mountain (across Graveyard Creek). The locality is at about 51°9′ N Latitude and 123°5′ W Longitude. The age is considered Lower Portlandian (Upper Jurassic) based upon the ammonite *Buchia mosquensis*, which occurs at several levels within the unit (Jeletzky and Tipper 1967). The largest specimen of fossil wood measures approximately 15 cm long and 10 cm in diameter and consists of mature secondary xylem only. This specimen falls within the general parameters of *Protocedroxylon* as defined by Gothan (1910). Since it differs from other species of this genus, it is proposed as a new species.

SYSTEMATICS

Coniferales

Protopinaceae

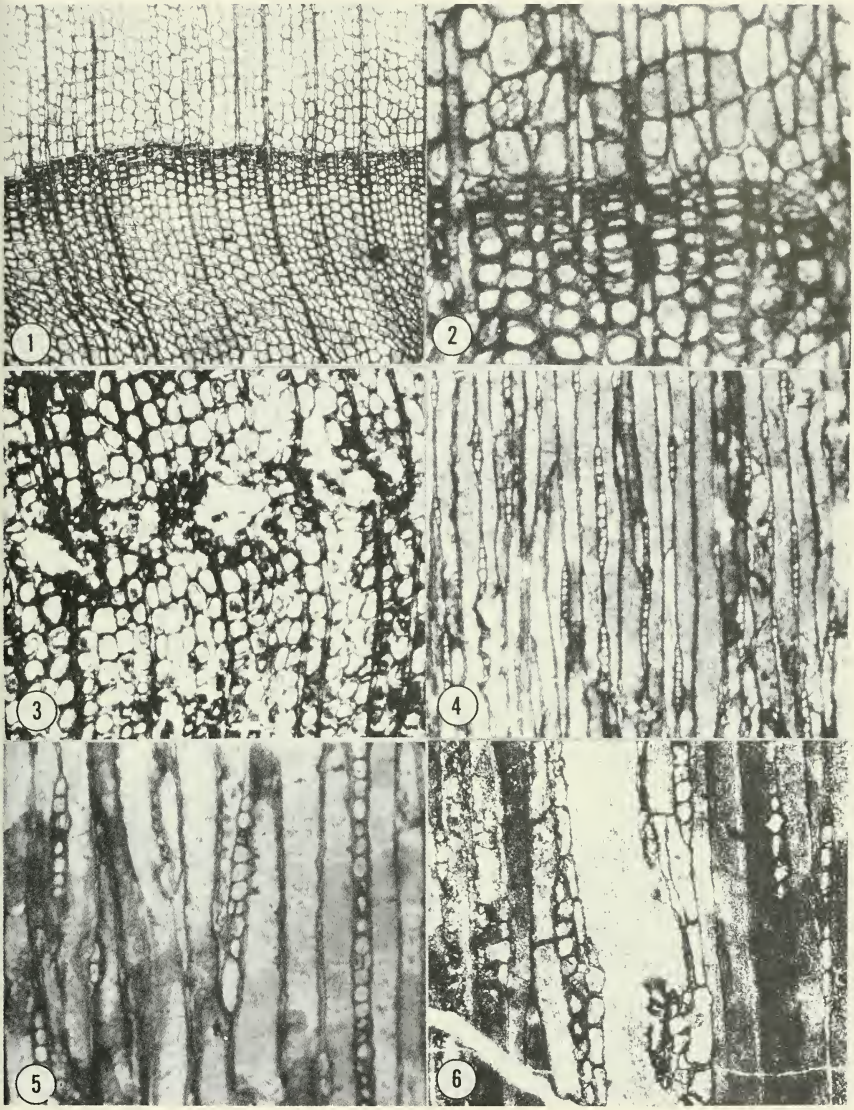
Protocedroxylon Gothan

Protocedroxylon macgregorii sp. nov.

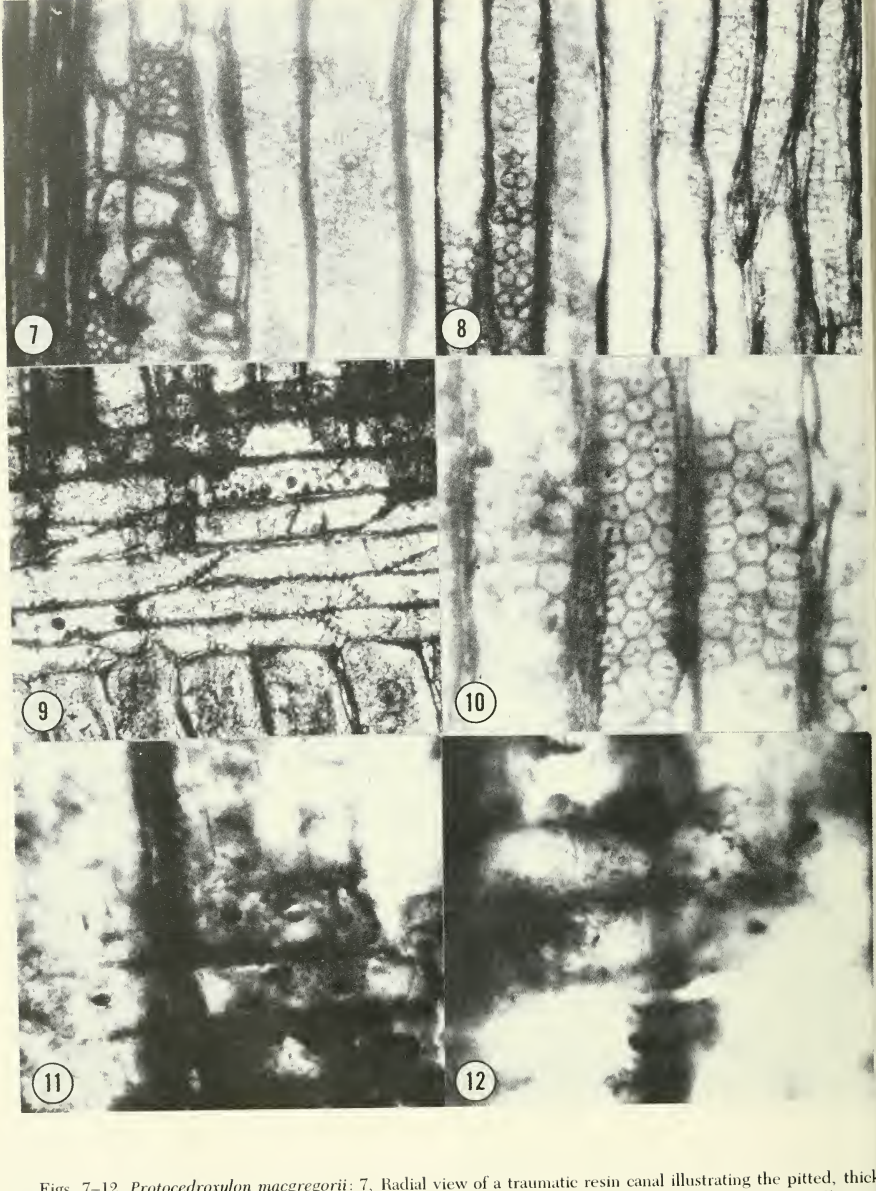
Figs. 1–12

DIAGNOSIS.—Growth rings distinct, 19–70 tracheids wide, transition from early to late wood gradual, occasionally abrupt; late wood tracheids radially flattened with narrow elliptic lumens and walls 5–7 μm thick, early wood tracheids large, angular, with walls 4–7 μm thick, lumens large, 50–85 μm in radial diameter; traumatic resin canals occasionally present having 6–12 thick walled and pitted epithelial cells, horizontal resin canals absent; rays uniseriate, frequently partially biseriate, occasionally entirely biseriate, never multiseriate, 1–40 cells high (commonly 12–25); individual ray cells round to elliptical, largest cells 17–25 μm wide, 25–30 μm high; tracheal pitting variable, 1–4 seriate; early wood tracheal pitting typically multiseriate, alternate and tightly appressed (araucarioid), rarely opposite or in stellate pit clusters; late wood pitting mostly uniseriate, separate or contiguous; pit borders 17–25 μm in diameter with rounded apertures; tangential pits and wood parenchyma absent; rays homogenous, ray parenchyma highly resinous, horizontal and tangential walls pitted, end walls slightly to

[1]Uinta Basin Education Center, Utah State University, Roosevelt, Utah 84066.
[2]Department of Botany and Range Science, Brigham Young University, Provo, Utah 84602.



Figs. 1–6. *Protocedroxylon macgregorii*: 1, Transverse section—note the relatively narrow band of late wood (33X). 2, Transverse section showing large, angular tracheids in the early wood (110X). 3, Tangential row of traumatic resin canals in a transverse section (66X). 4, Tangential section showing the uniseriate nature of the vascular rays (66X). 5, Tangential section showing the uniseriate rays containing occasional paired cells (110X). 6, Tangential section showing epithelial cells of a traumatic resin canal (110X).



Figs. 7–12. *Protocedroxylon macgregorii*: 7, Radial view of a traumatic resin canal illustrating the pitted, thick walled epithelial cells (245X). 8, Radial section showing variation in tracheary pitting, note particularly the stellate pit clusters at the left (160X). 9, Radial section showing the pitted nature of the horizontal and vertical walls of the vascular rays (300X). 10, Radial section showing araucarioid tracheal pitting that typifies this genus (300X). 11, Radial section showing crossfield pitting, note the bordered pit (arrow) (750X). 12, Closeup of radial view of vascular ray (150X).

acutely oblique, crossfields with 1–3 circular, thinly bordered pits (7–10 μm), pit borders 2 μm wide, with rounded to elliptic lumens, the cross-field pits tend to be horizontally aligned.

HOLOTYPE: Geological Survey Canada Collection No. 6776.

PARATYPE: Brigham Young University 5027.

ETYMOLOGY: This species is named for its collector D. C. McGregor.

DISCUSSION

Since Gothan (1910) described the genus *Protocedroxylon*, the history of this taxon has become rather complex. *Metacedroxylon* was proposed by Holden (1913) to replace *Protocedroxylon* Gothan on the basis that the latter name implies an abietineous affinity. She further concluded that because *Metacedroxlyon* lacked "bars of Sanio" and possessed araucarioid pitting, it could be none other than an araucarian conifer. In the early 1900s many workers, including Gerry (1910), Holden (1913), and Stopes (1916), debated the diagnostic value of bars or rims of Sanio (crassulae). The presence of crassulae was said to indicate possible abietineous relationships, and the absence of crassulae suggested araucarian affinities. Holden (1913) maintained that presence or absence of crassulae was the only sure criterion for diagnosing fossil conifers. This theory was later investigated by Bailey (1933), who concluded that, although crassulae do not occur in the wood of extant Araucariaceae, it is fallacious to assume that these structures would be preserved under all conditions of fossilization.

Metacedroxylon araucarioides (Gothan) Holden and *M. latiporosum* Holden were described by Holden (1913) from the Upper Jurassic of the Yorkshire Coast of England. Holden (1915) later reported *M. scoticum* from the Jurassic Corallian beds of the Sutherland Coast of Scotland. Seward (1919) subsequently pointed out the invalidity of Holden's name and combined *Metacedroxylon* with *Protocedroxylon*.

Stopes (1916) not only questioned the use of *Metacedroxylon* but also *Protocedroxylon* and *Cedroxylon* Kraus (1872), believing them to be "taxonomic misfits." She further added that it is not justifiable to assume an affinity of fossil genera, whose fructifications are unknown, to living genera. Therefore, to her, Gothan's use of the names *Protocedroxylon* and *Cedroxylon* and Holden's use of *Metacedroxylon* all seemed inappropriate. Stopes (1916) then proposed a new genus, *Planoxylon*, in which the principal characters are similar to Gothan's genus *Protocedroxylon*. She assigned two species to her new genus: *Planoxylon hectori* Stopes from the Cretaceous of New Zealand and *Planoxylon lindleii* (Whitham) Stopes. The latter species was first described by Whitham (1833) as *Peuce lindleii* and, since that time, has been shuffled from genus to genus. Stopes (1916) removed *P. lindleii* from *Araucarioxylon* Kraus, where it was previously classified by Seward (1904). This species has since been placed in *Protopiceoxylon* Gothan by Eckhold (1922), *Protocedroxylon* Gothan by Edwards (1925), *Pinoxylon* Knowlton by Read (1932), *Dadoxylon* Endl. by Shimakura (1936), and *Yorkoxylon* Vogellehner by Vogellehner (1968).

Krausel (1949) placed *Protocedroxylon*, as well as various species of *Metacedroxylon*, *Paracedroxylon* Sinnott, *Paracupressinoxylon* Holden, and *Thylloxylon* Gothan into synonymy with *Araucariopitys* Jeffrey. Vogellehner (1968) subsequently included *Araucariopitys*, *Metacedroxylon*, and *Planoxylon* in *Protocedroxylon*. Lemoigne (1970) included *Protocedroxylon araucarioides* Gothan, *Metacedroxylon scoticum* Holden, and *Mesembrioxylon libanoticum* Edwards (1929) in the new genus *Embergerixylon* Lemoigne (1968). However, based upon priority, *Protocedroxylon* should have precedent over *Embergerixylon*.

Shilkina and Khudayberdyyev (1971) followed Krausel (1949) and concluded that *Planoxylon* should be separated from *Protocedroxylon* based upon a difference in their tracheal pitting. Nishida and Nishida (1984) retained *Planoxylon* for fossil conifer woods having typical araucarian pitting and vertical pairs of pits in the crossfield.

COMPARISONS

Protocedroxylon has been reported from strata of Middle Jurassic to upper Lower Cretaceous age (Gothan 1910, Seward 1919, Negri 1914, Vogellehner 1968). *Protocedroxylon araucarioides* has been reported from Meso-

zoic strata of Svalbard, West Spitzbergen, and Manchuria (Gothan 1910, Walton 1927, Shimakura 1940). Among the characteristics of *Protocedroxylon araucarioides*, Gothan made a special point of noting the absence of normally formed resin canals in this species. Axillary or wood parenchyma is sparse to absent in *P. araucarioides*, and its vascular rays are always uniseriate. The horizontal and tangential walls of the ray parenchyma of *P. araucarioides* are heavily pitted and in each crossfield are 1–3 circular pits. The tracheal pitting in *P. araucarioides* is araucarian. It is characterized by uniseriate to triseriate, large, bordered pits (20–24 μm in diameter) with flattened and contiguous borders. Gothan (1910) did not mention the occurrence of crassulae between the bordered pits in this species, and their presence could not be observed in any of his figures. Numerous tangential pits are present in the late wood tracheids.

Protocedroxylon transiens (Gothan) Shilkina and Khudayberdyyev (= *Cedroxylon transiens* Gothan) is similar to *P. araucarioides*. Terminal parenchyma and stellate pit clusters are the only specific differences between *P. transiens* and *P. araucarioides*. Gothan (1907, 1910) cited two occurrences of the former species, one from the Lower Cretaceous of King Charles Land and the other from the Upper Jurassic or Lower Cretaceous of Spitzbergen.

Protocedroxylon macgregorii sp. nov. from the Upper Jurassic of British Columbia is the first report of this genus from North America. *Protocedroxylon macgregorii* is placed in *Protocedroxylon* Gothan on the basis of a predominance of araucarioid tracheal pitting coupled with pitted horizontal and tangential walls of the rays. A combination of the foregoing characters is unique to this genus and the araucarioid type tracheal pitting excludes *P. macgregorii* from either *Araucariopitys* Jeffrey (1907) or *Cedroxylon* Kraus (1872). The absence of normally formed resin canals precludes the possibility of close affinities to *Protopiceoxylon* Gothan.

Protocedroxylon macgregorii is remarkably similar to *P. araucarioides* but differs from it primarily in the absence of tangential pitting, the presence of traumatic resin canals or cysts, the marked absence of tracheid septations (a feature notably present in Gothan's figured specimen, P1.5, Fig. 4 [1910]), and occurrence of partially biseriate vascular rays in *P. macgregorii*. The rays of *P. araucarioides* are always uniseriate. The tracheal pitting of both *P. transiens* and *P. araucarioides* is similar to that of *P. macgregorii*. However, the presence of stellate pit clusters in *P. macgregorii* makes it more closely allied with *P. transiens*, although differing from the latter by not having terminal parenchyma. *Protocedroxylon macgregorii* differs additionally from both *P. transiens* and *P. araucarioides* in having occasional quadraseriate rows of appressed pits. *Yorkoxylon lindleianum* (Whitham) Volgellehner is very similar to *P. macgregorii*, but the height of the vascular rays (1–12 cells), the presence of wood parenchyma (Holden 1914), and the absence of stellate pit clusters in the former are notable differences. *Protocedroxylon hectori* (Stopes) is similar to our species; however, the presence of terminal parenchyma in *P. hectori* and the height of the vascular rays separate them. *Protocedroxylon scoticum* (Holden) Seward (1919), with its predominance of uniseriate pitting, is distinct from *P. macgregorii*. *Protocedroxylon paronai* Negri, from the Cretaceous of North Africa, is not well preserved and therefore not adequately described. A comparison of *P. macgregorii* with *P. paronai* would be inconclusive.

Protocedroxylon macgregorii is similar to several *Protocedroxylon* species from Japan. This species differs from *P. japonicum* Nishida (1967) from the Cretaceous of Choshi by the latter species having septate tracheids and lower rays (1–4, rarely 6 cells high). *Protocedroxylon okafujii* Nishida and Oishi (1982) from the Triassic of Yamaguchi perfecture can be distinguished from *P. macgregorii* by having abundant wood parenchyma in increments and septate tracheids. Also from the same strata as *P. okafujii* are specimens of *P. mincense* (Ogura) Nishida and Oishi. Originally reported as *Araucarioxylon mincense* Ogura (1960), this species was subsequently placed in *Protocedroxylon* by Nishida and Oishi (1982). They further included *P. triassicum* Yamazaki and Tsunada (1981, Yamazaki et al. 1980) in this species. *Protocedroxylon macgregorii* is separated from *P. mincense* by the tangential pitting and septate tracheids in the latter and the presence of triseriate pitting

and stellate pit clusters in the former. *Protocedroxylon yezoense* Nishida and Nishida from the Cretaceous Upper Yezo Group, Hokkaido differs from *P. macgregorii* in that *P. yezoense* has septate tracheids, typically uniseriate pitting, the presence of wood parenchyma, and lower rays (1–28 cells high) that do not occur in *P. macgregorii*.

Protocedroxylon macgregorii and *Protopiceoxylon canadense* Medlyn and Tidwell (1979), are presently the only species of petrified conifer wood of Jurassic age reported from British Columbia. Additional studies of fossil woods, as well as compression materials from this area, will be necessary before the nature and composition of the Jurassic forest of this region can be fully understood.

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