Protopiceoxylon yukonense sp. nov. – A remarkable extinct conifer from the Mackenzie Delta area, northern Yukon

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ABSTRACT

A fossil wood remain of par-autochthonous origin was found in Paleocene sedimentary rocks of the Moose Channel Formation in the Big Fish River area in Yukon, close to the Northwest Territories border, during the CASE 15 expedition. The fossil wood was recovered from overall medium to coarse-grained units of sandstone of an inferred fluvial-deltaic origin. This contribution summarizes the current knowledge primarily on the taxonomy and paleoecology of the protopiceaceous wood specimen. The fossil wood specimen turned out to be without a relationship to extant taxa: *Protopiceoxylon yukonense* sp. nov. as a taxon of the fossil wood genus *Protopiceoxylon* Gothan 1907 belongs to the extinct family of Protopinaceae Kraeusel, 1949. The holo- and paratypes of the generotypus *Protopiceoxylon extinctum* Gothan, 1907 from the King Charles Land (Gothan, 1907) and from Green Harbour/Spitsbergen (Gothan, 1910), were available for this investigation from the Natural History Museum Berlin (NHMB). Although most of samples characteristics are comparable to be extinct genus *Protopiceoxylon*, it is differentiated by some extinct anatomical features that are intermediate between the extinct *Protopiceoxylon* and the extant *Piceoxylon* Gothan, 1905. These features manifest within the radial bordered pits, which are protopinoid in *Protopiceoxylon* and abietoid in *Piceoxylon*. Most other features demonstrate a close relationship between both fossil taxa.

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INTRODUCTION

Pinaceaeous and protopiceaceous fossil woods are well known from Upper Cretaceous and Cenozoic strata in the Northern Hemisphere. However, specimens from the Mackenzie Delta area, northern Yukon, have received only limited investigations and no fossil woods older than Middle Pliocene have been described to date. Hence, this taxonomic investigation is essential for research on the evolution of plants, particularly in the case of extinct woods. In addition, this research has potential for developing a paleo-ecological reconstruction, inter alia, the fossil found in Yukon represents a constituent of vegetation growing under high latitude conditions (*i.e.*, continuous daylight in arctic summer *vs.* darkness for months during arctic winters).

During the CASE 15 geological expedition, a fossil wood remain of parautochthonous origin was found in Paleocene sedimentary rocks of the Moose Channel Formation in the Big Fish River area in Yukon near the Northwest Territories border (Fig. 1).

The wood was anatomically investigated and compared with other fossil woods of the fossil genus *Protopiceoxylon* Gothan, 1907 of the extinct family Protopinaceae. Although most of samples characteristics are comparable to be extinct genus *Protopiceoxylon*, it is differentiated by some extinct anatomical features that are intermediate between the extinct *Protopiceoxylon* and the extant *Piceoxylon* Gothan, 1905. This approach allows the identification of new extinct fossil wood species. By relating the fossil wood specimen to some other *Protopiceoxylon* woods (namely from Ellesmere Island, Spitsbergen and Franz Joseph Land), it is possible to unravel additional details about the species living in the forested areas of the high latitude zone in the Cretaceous-Paleogene.

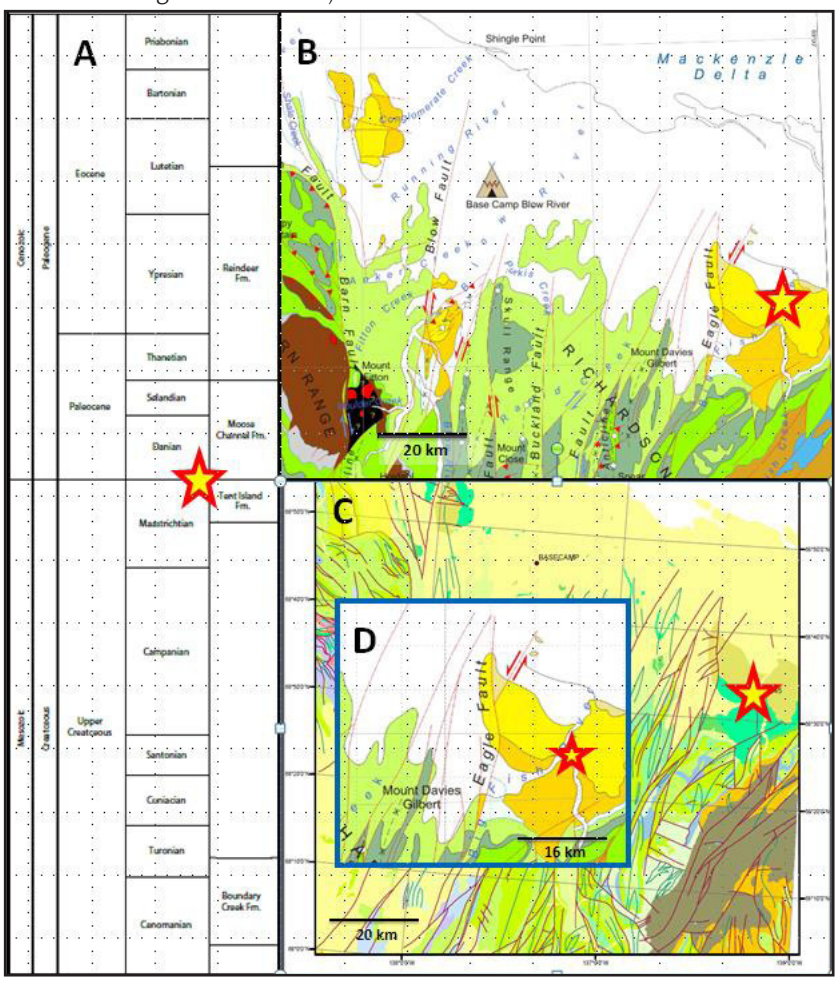

Figure 1. *Geographic and geological overview and stratigraphic reference of the sample locality. (A) Time scale with stratigraphic position of sampled specimen. (B) Geographical and geological map of a part of North Yukon and Mackenzie Delta with sample position indicated by red outlined star (sample number = Yu 045), scale 1:250 000 (Piepjohn, 2013). (C) Geological map with sample position indicated by red outlined star. (D) Detailed map of Big Fish River area (from b), sample position indicated by red outlined star.*

GEOLOGICAL SETTING

LOCALITY

Geological fieldwork on the Yukon North Slope and in the northwestern Mackenzie Delta area took place in July 2013. During a reconnaissance examination of a steep cliff outcrop in a secondary valley of the Big Fish River, Tiffani Fraser of the Yukon Geological Survey (YGS) and Lutz Reinhardt of the German Federal Institute of Geosciences and natural resources (BGR) discovered fossil wood remains on a rock pile at the base of the cliff, which had resulted from a recent rock fall. The rocks fell from a position in the steep cliff above that could be clearly identified by its fresh, unweathered colour and some remaining fossil wood (Fig. 2). The outcrop in the river valley, 68° 32′ 51.0″ N/ 136° 14′ 24.6″ W, gives access to parts of the basal sandstone member of the Lower Paleocene Moose Channel Formation.

MOOSE CHANNEL FORMATION

Deltaic sedimentation in the larger Mackenzie Delta area has persisted since the end of the Cretaceous accumulating to a total thickness of more than 10 km of Cenozoic siliciclastic rocks (Young and McNeill, 1984). The thick sedimentary succession is subdivided into nine sequences (*e.g.*, Dietrich *et al.*, 1985; Dixon *et al.*, 1992) beginning with the Fish River sequence above an unconformity with the Turonian black shales of the Boundary Creek Formation. The Fish River sequence includes the latest Cretaceous, shale dominant Tent Island Formation at its base and the overlying sandstone-dominant lower Tertiary Moose Channel Formation.

Mountjoy (1967) initially defined the Moose Channel Formation and Young (1975) subsequently modified this definition and provided a type section (Young, 1975) located near the outcrop where the fossil wood was found. The 1000 m thick Moose Channel Formation comprises a basal sandstone member overlain by the shale Ministicoog member. Originally, the Moose Channel Formation was considered to be Upper Cretaceous (Young, 1975). Subsequent detailed work on palynomorphs (*e.g.*, Sweet, 1978) and on foraminifers (McNeil, 1989) revised the formation to the Early Paleocene.

The basal sandstone member of the Moose Channel Formation is interpreted as to be of deltaic and shallow marine origin (Young, 1975). Plant remains, including woody plant fragments, coalified tree stumps, carbonaceous plant debris-, and leaf impressions, were already described in the formation's type section by Young (1975). The fossil wood examined in more detail here was recovered from a series of overall medium to coarse units of sandstone including some conglomerate layers and minor shale intercalations of inferred fluvial-deltaic origin. The several meters-long trunk or branch of a tree appears to have been transported along a channel of the Early Paleocene delta, where it was later deposited. Thus, the parautochthonous wood either originates in the direct vicinity of the former delta channel or it was transported over a longer lateral distance during a discharge event of the Early Paleocene fluvial system. This situation is assumed to be comparable to the modern depositional system of the Mackenzie River, but during generally warmer climate conditions at the end of the Cretaceous and beginning of the Paleogene.

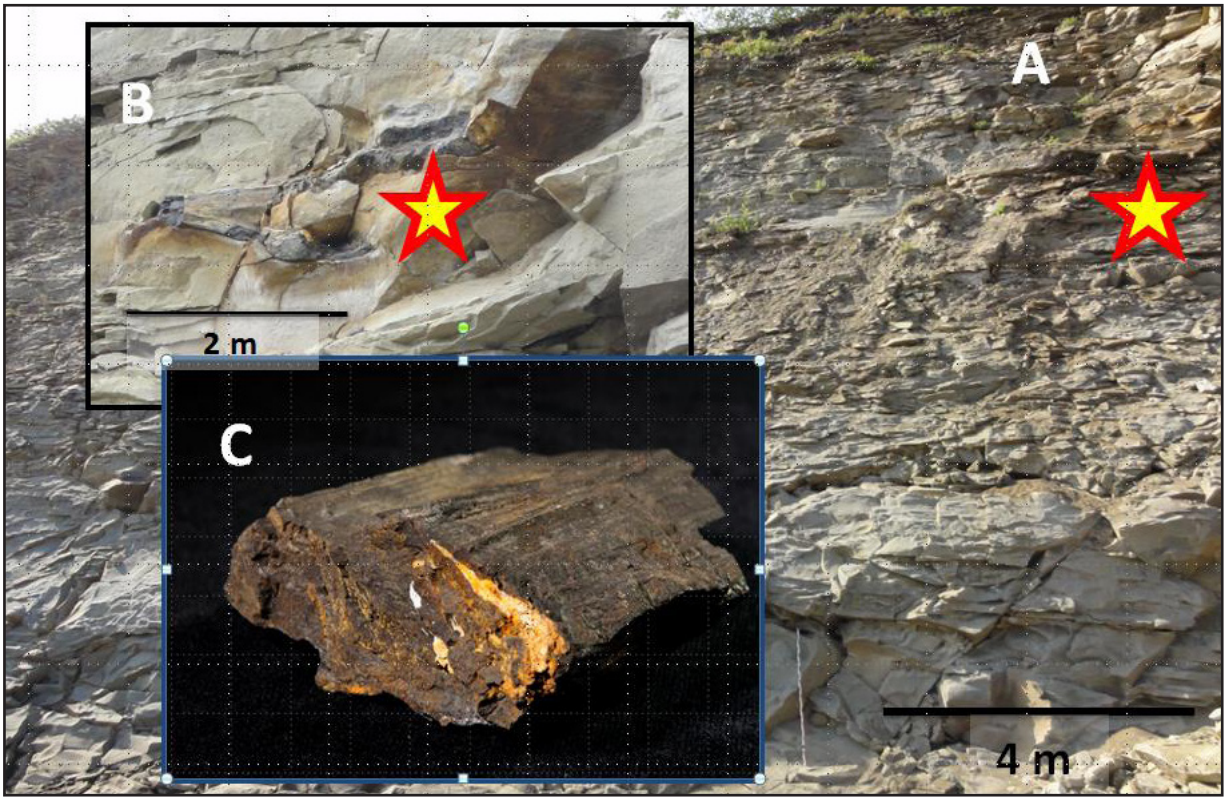

Figure 2. *(A) Outcrop in the Moose Channel Formation sample position indicated by star. (B) Zoomed detail from profil figure a, wood sample position indicated by star. (C) Petrified wood specimen No. 63049 with incrustations of Fe-silicates (in yellow), 7 cm in length.*

MATERIAL AND METHODS

The petrified parts of the wood remains were chosen for analysis. The fossil wood specimen is now housed at the Royal Ontario Museum in Toronto (collection Kevin Seymour, No. 63049; Fig. 2c). It is approximately 7 cm long and has been flattened as a result of compaction pressure, which also folded the approximately 25 growth rings of the wood. The specimen probably is most likely a thin trunk.

Additionally, the holo- and paratypes of the generotypus *Protopiceoxylon extinctum* Gothan, 1907 from King Charles Land (Gothan, 1907; Fig. 3) and from Green Harbour/Spitsbergen (Gothan, 1910; Fig. 4) were available for anatomical comparison and taxonomic classification from the Natural History Museum Berlin.

The wood fossil was extracted mechanically from the surrounding sediment and protected in a plastic bag to preserve its structure.

For xylotomical identification, the fossil wood remains were then cut into thin cross, radial-, and tangential sections, each about 20-30 µm thick. The observations were made with a Leica DM 5500 light microscope, equipped with a digital camera (DFC 480).

The wood remains were identified by comparisons with both living and fossil wood described in the literature, as well as with reference collections of living and fossil wood from the Natural History Museum Berlin, the Senckenberg Naturhistorische Sammlungen in Dresden (SNS), and from the first author's private collection. Descriptive terms correspond to current xylotomical terminology (*e.g.*, Eckhold, 1921, 1923; Kräusel, 1949; Greguss, 1955, 1967; Van der Burgh, 1973; Grosser, 1977; IAWA, 2004; Dolezych, 2005; and Philippe and Bamford, 2008).

XYLOTOMICAL INVESTIGATION

DIAGNOSIS

Protopinaceae Kraeusel, 1949

Protopiceoxylon Gothan, 1907

Protopiceoxylon yukonense sp. nov.

HOLOTYPUS: Plate I (Fig. 5d-f), Plate II (Fig. 6c-f) and Plate IV (8a-f), Royal Ontario Museum Toronto, collection Kevin Seymour, No. 63049, and Senckenberg Naturhistorische Sammlungen Dresden, collection of Martina Dolezych, Hoyerswerda, prep. 190713/4c, t, r.

LOCUS TYPICUS: Big Fish River area, northern Yukon and northwestern Mackenzie Delta area.

FORMATION: Moose Channel Formation, Paleocene.

DERIVATIO NOMINIS: After the region Yukon, Canada, where the fossil was found.

DIAGNOSIS: Coniferous wood with distinct growth rings. The transition from early to late wood is gradual. Early wood tracheids are much wider than the late wood tracheids. Pits in the radial cell walls of the early wood tracheids are protopinoid. Axial parenchyma is seldom present and diffuse. Rays are uniseriate and up to 20 cells high. Vertical resin canals occur. Horizontal resin canals occur only traumatic. Horizontal ray wall cells are about 4 to 5 µm thick and pitted. Tangential ray cell walls are often 3 to 4 µm thick and pitted. Ray tracheids are absent. Cross–field pits are mostly 2–3 (4), predominantly circular and piceoid.

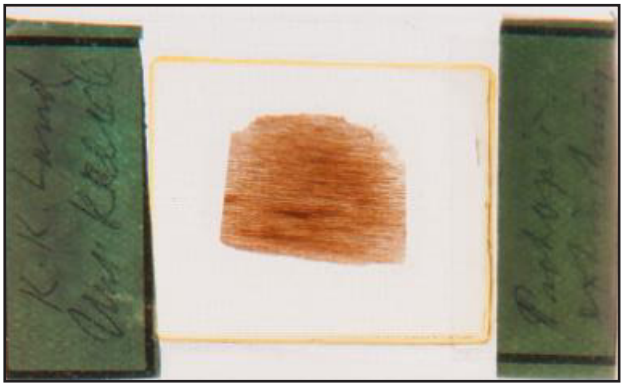

Figure 3. *Slide showing generotypus Protopiceoxylon extinctum Gothan, 1907. Holotype from the King Charles Land (König Karls Land, Unterkreide). Handwriting by Walther Gothan. HNM Berlin 2001/No. 1460.*

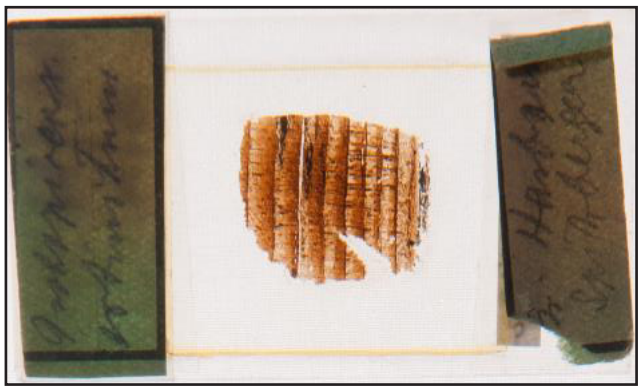

Figure 4. *Slide showing generotypus Protopiceoxylon extinctum Gothan, 1910. Paratype from Green Harbour/ Spitsbergen. Handwriting by Walther Gothan. HNM Berlin 2001/No. 1462.*

WOOD DESCRIPTION

Plate I (Fig. 5d-f); Plate II (Fig. 6c-f); Plate IV (Fig. 8a-f)

Growth rings: The growth rings vary in width. The early and the late wood are differentiated. See Figure 5d-f (Plate I).

Tracheids: The shape of the lumina is polygonal in cross section. Resin particles seldom occur. See Figure 5d-f (Plate I).

Bordered pits: The bordered pits in the radial walls of the tracheids occur in single, double and rarely in triple rows. Pits are protopinoid arranged; abietoid and araucaroid pitting occurs (Fig. 8d). Crassulae are present. The diameter of the bordered pits range from 11 to 22 µm.

Axial Parenchyma: Axial parenchyma is seldom present. The pits in the longitudinal walls are similar to those in the cross–fields and have a diameter of *ca.* 3 µm (Fig. 6c).

Rays: Rays are composed solely of parenchyma cells, are uniseriate, and are 4 to 8 cells high, up to 20 cells (Fig. 6c-f). The average height of the middle cells is 20 µm (Fig. 8a-c,e,f). The peripheral cells are somewhat higher. The horizontal cell walls are up to 6 µm thick (Fig. 8a-c,e,f). The tangential walls are up to 5 µm thick and juniperoid pitted (Fig. 8c). The cross–field pits are small and predominantly circular and piceoid (Fig. 8a-c,e). Usually 2 to 3 (4) pits with a diameter of about 6 µm are found in each cross–field (Fig. 8a-c,e). Ray tracheids are absent.

Resin canals: Vertical resin canals are surrounded by thick-walled tissue (Fig. 6f). There are approximately nine epithelium cells, which are pitted (Fig. 6e). The diameter of the vertical canals ranges between 30 and 280 µm (Fig. 6d,f).

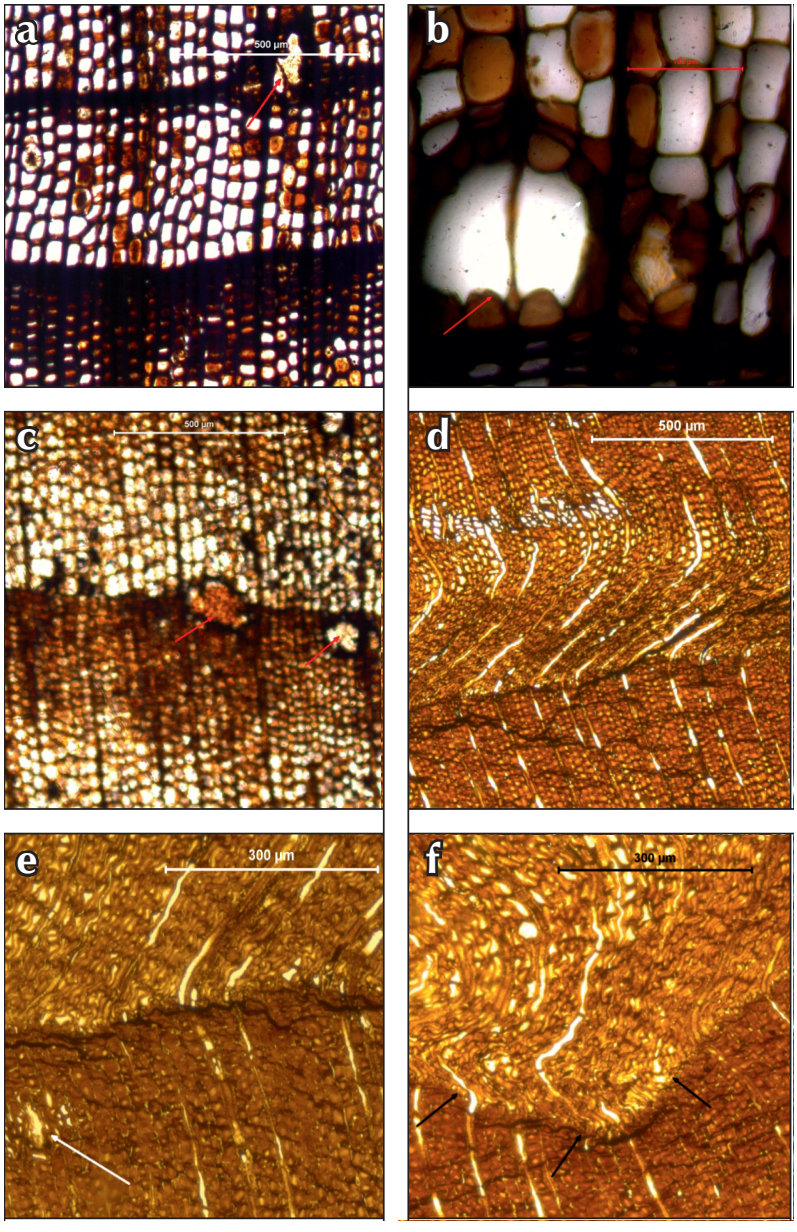

Figure 5. *Plate I: woods of Protopiceoxylon extinctum Gothan, 1907 (Berlin 2001/1460) and 1910 (Berlin 2001/1462), and Protopiceoxylon yukonense sp. nov. (a) Cross section of P. extinctum showing tracheids, distinct growth rings, resin, and a vertical resin canal (red arrow). King Charles Land, holotype by Gothan, 1907, slide no. 1460. Scale bar = 500 µm. (b) Cross section of P. extinctum showing with tracheids, a vertical resin canal, and epithelial cells (red arrow). King Charles Land, holotype by Gothan, 1907, slide no. 1460. Scale bar = 100 µm. (c) Cross section of P. extinctum showing with tracheids, distinct growth rings, resin, a gradual transition from early- to latewood, and vertical resin canals (red arrow). Green Harbour/Spitsbergen, paratype by Gothan, 1910, slide no. 1462. Scale bar = 500 µm. (d) Cross section of P. yukonense showing with tracheids, a gradual transition from the early-to the latewood, and a distinct growth ring. North Slope, prep. 190713/4c. Holotypus. Scale bar = 500 µm. (e) Cross section of P. yukonense showing with tracheids, a distinct growth ring, and a resin canal (white arrow). North Slope, prep. 190713/4c. Holotypus. Scale bar = 300 µm. (f) Cross section of P. yukonense showing with tracheids, a distinct growth ring (black arrows), and resin cannels. North Slope, prep. 190713/4c. Holotypus. Scale bar = 300 µm.*

IDENTIFICATION

A coniferous wood with a particular combination of uniseriate rays, thick and strongly pitted horizontal ray cell walls (Abietineen-pitting *sensu* Gothan, 1905), pitted tangential ray cell walls (*Juniperus*-pitting *sensu* Gothan, 1905), the occurrence of vertical resin- and traumatic horizontal resin canals, and the protopinoid pitted bordered pits corresponds to *Protopiceoxylon* (Gothan, 1907, 1910).

The generotypus of *Protopiceoxylon, P. extinctum*, was established from the Jurassic of the King Charles land (Gothan, 1907; Holotype, NHMB; Figs. 3, 5a,b, 6a,b, and 7a-c) and from the Upper Jurassic and Lower Cretaceous of Green Harbour/Spitsbergen (Gothan, 1910; Paratype, NHMB; Figs. 4, 5c, and 7c-f). *Pinites cavernosus* Cramer, 1868 *ex parte* were assigned to *P. extinctum* (Gothan, 1910). Supplementary slides, labeled as *P. extinctum*, which were used for illustration by Gothan (1907), were found by Philippe and Cantrill (2007), in the Swedish Museum of National History in Stockholm. In the holotype, Gothan (1907) did not describe the protopinoid pitting of the bordered pits, first, Gothan (1910) featured this attribute in the paratype by an extinct major anatomical feature. The protopinoid pitting is characterized by abietoid pitting with predominantly rounded pits in opposite arrangement (Fig. 7e) as well as by araucaroid pitting with predominantly angular-hexagonal pits in alternating arrangement (Fig. 7f). The term "protopinoid" goes back to Bailey (1933), who translated the "Übergangstyp" *sensu* Eckhold (1921, 1923) as "protopinaceous" type. Eckhold used this term to describe this type of bordered pitting in the tracheids walls. Furthermore, this character is also named as mixed- or transitional type (Philippe and Bamford, 2008). Vogellehner (1968) proposed a conservation of the name *Protopiceoxylon* and placed the fossil wood genus *Pinoxylon* Knowlton, 1900 and the generotypus *Pinoxylon dacotense* Knowlton, 1900 emendavit Read, 1932, from the Mesozoic of the Black Hills, into this fossil wood genus.

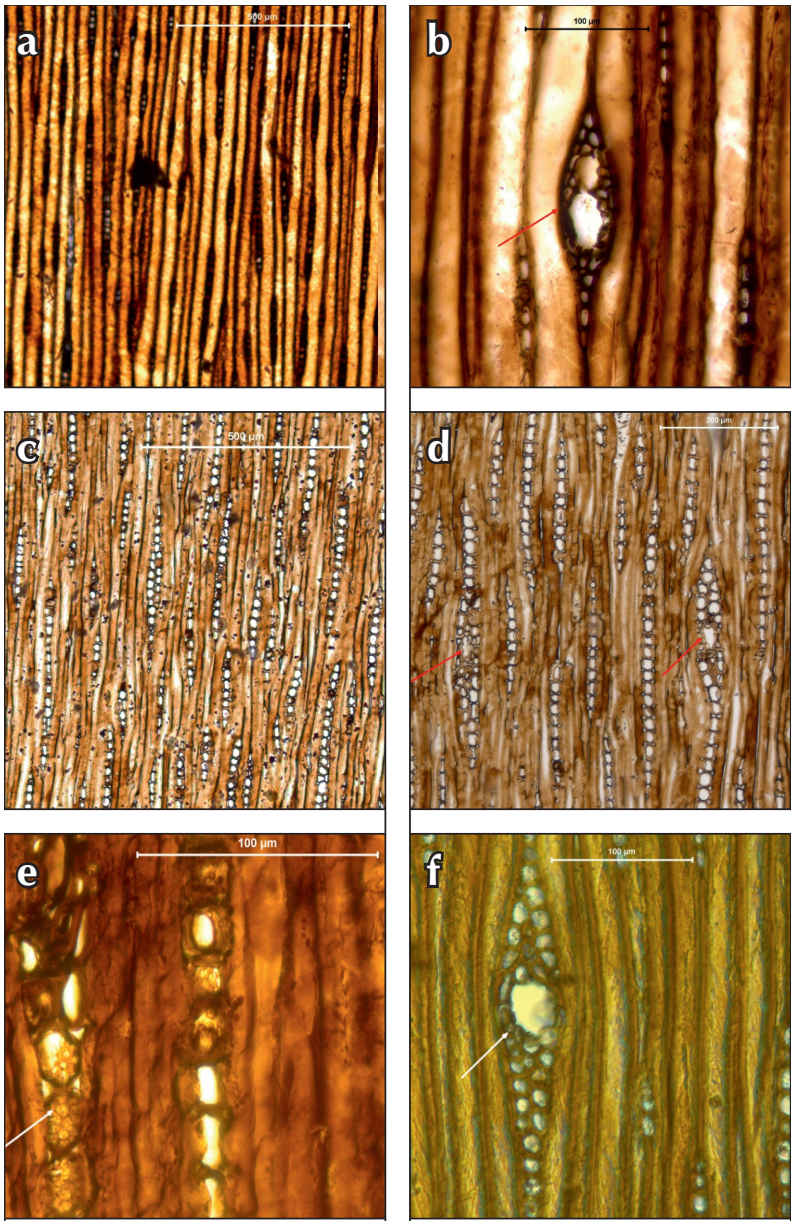

Figure 6. *Plate II: woods of Protopiceoxylon extinctum Gothan, 1907 (Berlin 2001/1460) and Protopiceoxylon yukonense sp. nov. (a) Tangential section of P. extinctum showing tracheids and rays. King Charles Land, holotype by Gothan, 1907, slide no. 1460. Scale bar = 500 µm. (b) Tangential section of P. extinctum showing tracheids, rays, and a vertical resin canal (red arrow). King Charles Land, holotype by Gothan, 1907, slide no. 1460. Scale bar = 100 µm. (c) Tangential section of P. yukonense showing tracheids, rays, and tangential pits. North Slope, prep. 190713/4t. Holotypus. Scale bar = 500 µm. (d) Tangential section of P. yukonense showing tracheids, rays, and vertical resin canals (red arrows). North Slope, prep. 190713/4t. Holotypus. Scale bar = 200 µm. (e) Tangential section of P. yukonense showing tracheids, rays, and pitted epithelial cells (white arrow). North Slope, prep. 190713/4t. Holotypus. Scale bar = 100 µm. (f) Tangential section of P. yukonense showing tracheids, rays, and a vertical resin canal (white arrow). North Slope, prep. 190713/4t. Holotypus. Scale bar = 100 µm.*

Protopiceoxylon belongs to the Mesozoic family Protopinaceae (Kräusel, 1949; Müller-Stoll and Schultze-Motel, 1990) and is known from Jurassic to Cretaceous. In addition, Grambast (1952) as well as Süss and Velitzelos (1993) classified woods of Protopinaceae into the Cenozoic. Because of the parautochthonous and allochthonous character of the Cenozoic findings of Protopinaceae, the noted origin is debatable. This family is considered extinct because there is no basis for comparisons with today's relatives. It is a transitional family between Araucariaceae and Pinaceae because it characterized by a combination of araucarian and abietineous features (Grambast, 1961; Vogellehner, 1967).

Until now the only known fossil woods from the Yukon near the Northwest Territories border are no older than Late Pliocene. Late Pliocene woods of *Picea* L. and *Larix* Mill., as well as Middle Pliocene woods of *Abies* Mill. and *Pinus* L., from the Porcupine River (Ch'ijee's Bluff) are described by Wheeler and Arnette (1994).

Protopiceoxylon spp. was found in other Arctic regions by different authors. Selmeier & Grosser (2011) identified drift wood, recovered from Early Cretaceous sediments along Reptile Creek on Ellesmere Island (Canada), as *Protopiceoxylon* sp.

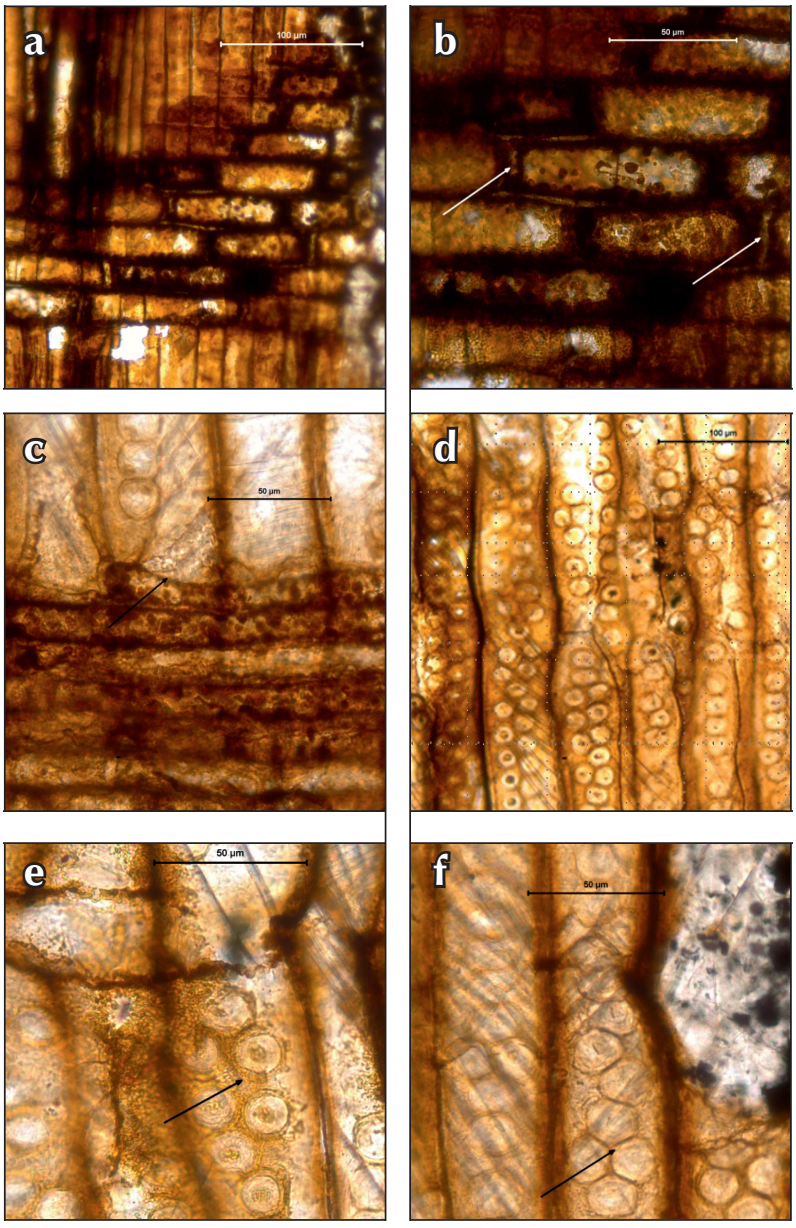

Figure 7. *Plate III: woods of Protopiceoxylon extinctum Gothan, 1907 (Berlin 2001/1460) and 1910 (Berlin 2001/1462). (a) Radial section of P. extinctum showing radial tracheids and a ray. King Charles Land, holotype by Gothan, 1907, slide no. 1460. Scale bar = 100 µm. (b) Radial section of P. extinctum showing a ray, horizontal ray cell walls, and pitted tangential ray cell walls (white arrows). King Charles Land, holotype by Gothan, 1907, slide no. 1460. Scale bar = 50 µm. (c) Radial section of P. extinctum showing radial tracheids, a ray, and a ray tracheid (black arrow). King Charles Land, holotype by Gothan, 1907, slide no. 1460. Scale bar = 50 µm. (d) Radial section of P. extinctum showing radial tracheids with protopinoid pitted bordered pits. Green Harbour/Spitsbergen, paratype by Gothan, 1910, slide no. 1462. Scale bar = 100 µm. (e) Radial section of P. extinctum showing radial tracheids with protopinoid pitted bordered pits (here a part with abietoid character, black arrow). Green Harbour/Spitsbergen, paratype by Gothan, 1910, slide no. 1462. Scale bar = 50 µm. (f) Radial section of P. extinctum showing radial tracheids with protopinoid pitted bordered pits (here a part with araucaroid character, black arrow). Green Harbour/Spitsbergen, paratype by Gothan, 1910, slide no. 1462. Scale bar = 50 µm.*

P. extinctum is known from the King Charles Land and from Spitsbergen (Gothan 1907, 1910, respectively). This fossil wood species is further characterized from the fossil wood genus *Protopiceoxylon* by the occurrence of 2 to 4 small circular cross-field pits, the lack of axial parenchyma, the lack of ray tracheids, the occurrence of tangential pits and the up to 30 cells high rays (Gothan, 1907, 1910). However, our observations of Gothan´s slides (Fig. 7c) indicate that *P. extinctum* is more characterized by the occurrence of ray tracheids than the lack of them, as previously noted. *Protopiceoxylon arcticum* Seward, 1919, a Cretaceous (Albian-Aptian) wood from the Franz Joseph Land was assigned to *P. extinctum* by Vogellehner (1968). Furthermore, Harland *et al.* (2007) identified three woods from Spitsbergen and the Canadian Arctic as *P. extinctum*. The Yukon wood differs from that fossil by the absence of ray tracheids, the fewer ray cells and the occurrence of axial parenchyma.

Protopiceoxylon johnseni Schroeter, 1880 emendavit Edwards, 1925 known from the Upper Jurassic of the King Charles Land is characterized by a small difference to *P. extinctum*. It varied only by the absence of traumatic horizontal resin canals and has somewhat fewer rays.

Another fossil wood species is known as *Protopiceoxylon wordii* Walton, 1927, from Middle Jurassic of Storfield/ Spitsbergen. On the basis of the occurrence of the traumatic origin of the vertical resin canals, this assignment is questionable.

Protopiceoxylon woods have not only been defined in from Arctic areas. Stopes (1915) described *Protopiceoxylon edwardsi* from the Early Cretaceous of England. However, this wood is not characterized by the mixed type of bordered pitting, so it probably does not belong to the *Protopiceoxylon* genus.

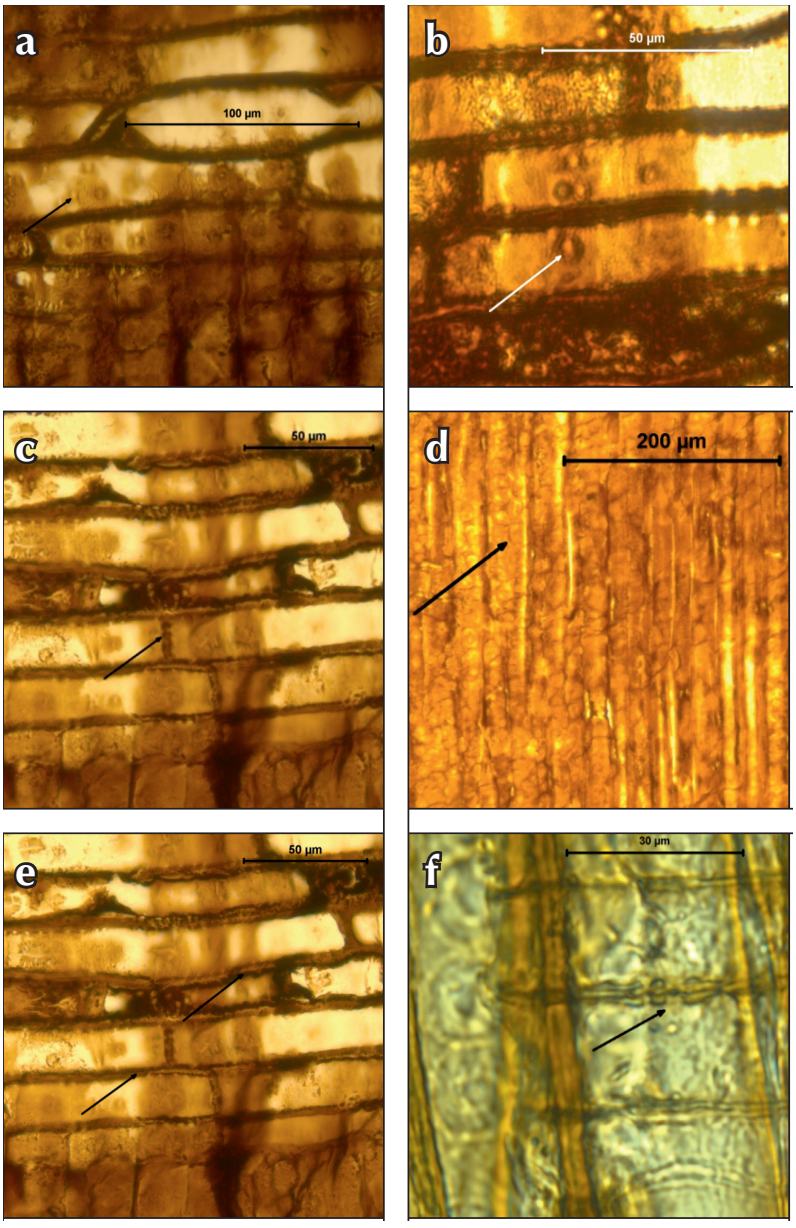

Figure 8. *Plate IV: woods of Protopiceoxylon yukonense sp. nov. (a) Radial section of P. yukonense showing a ray, pitted horizontal and tangential ray cell walls, and cross-field pits (black arrow). North Slope, prep. 190713/4r. Holotypus. Scale bar = 100 µm. (b) Radial section of P. yukonense showing a ray, pitted horizontal and tangential ray cell walls, and cross-field pits (white arrow). North Slope, prep. 190713/4r. Holotypus. Scale bar = 50 µm. (c) Radial section of P. yukonense showing a ray, pitted horizontal ray cell walls, and tangential ray cell walls (black arrow). North Slope, prep. 190713/4r. Holotypus. Scale bar = 50 µm. (d) Radial section of P. yukonense showing radial tracheids and protopinoid pitted bordered pits (black arrow). North Slope, prep. 190713/4r. Holotypus. Scale bar = 200 µm. (e) Radial section of P. yukonense showing a ray, pitted tangential ray cell walls and tangential ray cell walls (black arrow). North Slope, prep. 190713/4c. Holotypus. Scale bar = 50 µm. (f) Radial section of P. yukonense showing a ray with and pitted horizontal ray cell walls (black arrow). North Slope, prep. 190713/4r. Holotypus. Scale bar = 30 µm.*

Protopiceoxylon canadense and *Protopiceoxylon resiniferous,* established by Medlyn and Tidwell (1979), are described from the Upper Jurassic of British Columbia and Utah, respectively. However, *P. resiniferous* is not marked by the mixed type of the tracheid walls and so it is concluded that this taxon does not belong to *Protopiceoxylon*. *P. canadense* is a fossil wood species which is very similar to the Yukon fossil. It is distinguished by the higher rays and the pinoid cross-field pitting versus the circular/piceoid cross-field pitting in the Arctic wood.

A *Protopiceoxylon* wood with the combination of very high rays, up to 70 cells, the occurrence of axial parenchyma, the occurrence of tangential pits and the more abietoid- as araucaroid pitting of the radial tracheid walls is indicative of *Protopiceoxylon yabei* Shimakura,1936 emendavit Vogellehner, 1968 (Shimakura,1936; Vogellehner, 1968). This fossil is described from the Middle Jurassic of the Manschukuo/China. This taxon is distinguished from the Yukon fossil by the higher rays, the occurrence of ray tracheids, the more common occurrence of axial parenchyma and abietoid pitting of the radial tracheid walls within the protopinoid character.

Some *Protopiceoxylon* woods are also known from the Heilongjiang area in Northeast China and Russia: *P. mohense* Ding, 2000 from Lower Cretaceous sedimentary rocks and *P. amurense* Du, 1982 from Jurassic to Lower Cretaceous rocks also reported from the Late Cretaceous by Wang *et al.* (1997) and from Paleocene sedimentary rocks by Terada *et al.* (2011). Because of their lack of the protopinoid pitting of the radial tracheid walls, these woods are not considered to belong to the fossil wood genus *Protopiceoxylon*. In addition, Terada *et al.* (2011) found for *P. amurense* an affinity to the extant conifer genera *Keteleeria* Carrière, 1866 or *Nothotsuga* Hu exparte C.N. Page, 1989. Also arguable is the assignment of *Protopiceoxylon chaoyangense* Duan, 2000 and of *Protopiceoxylon yizhouense* Duan and Cui, 1995 (Duan *et al.*, 1995) to *Protopiceoxylon* based on the absence of transitional type pitting of radial tracheid walls. *P. chaoyangense* and *P. yizhouense* remains originate from Mesozoic sedimentary rocks of the Liaoning Province in Northeast China.

The Yukon fossil is characterized by a coniferous wood with distinct growth rings, the gradual transition from early to late wood, having 4 to 5 µm thick and pitted horizontal ray cell walls (Abietineen-pitting), up 3 to 4 µm thick and pitted tangential ray cell walls (*Juniperus*-pitting), the protopinoid pitting of the radial tracheid walls, the seldom occurrence of axial parenchyma, the uniseriate rays with a high of up to 20 cells, the occurrence of vertical and traumatic horizontal resin canals, the lack of ray tracheids and the mostly 2-3 (4) small and predominantly circular and piceoid cross-field pits. Because there is no identical fossil wood species known, it is required that a new fossil species of *Protopiceoxylon* be established. It is proposed that the epitheton of this new fossil wood species be named after the Yukon region where the fossil is found: ***Protopiceoxylon yukonense* sp. nov.**

This new fossil wood genus, which shares xylotomical features with both Pinaceae and Araucariaceae, is characterized by extinct anatomical features that are intermediate between *Protopiceoxylon* and *Piceoxylon*, which manifest within the radial bordered pits. These are protopinoid in the first mentioned taxon and abietoid in the other discussed taxon. Most other features, such as the general coniferous structure, the occurrence of vertical resin ducts, the thick and pitted horizontal and tangential ray cell walls and the partially piceoid cross-field pits, demonstrate a close relationship between both fossil taxa. Vogellehner (1968) considered *Protopiceoxylon*, a plant with heterobathmic character *sensu* Takhtajan, 1959, was convergent in its evolutionary line with *Piceoxylon*. In contrast, Müller-Stoll (1986) did not recognize the extinct family Protopinaceae as a necessary link in the evolutionary line, because protopinaceous and abietoid (modern) woods have their genesis in the same time period.

CONCLUSIONS

For the first time a new taxon of *Protopiceoxylon, Protopiceoxylon yukonense* sp. nov. from the Paleocene of the Moose Channel Formation in Yukon near the Northwest Territories boundary, is successfully established.

This taxon belongs to the gymnospermous family Protopinaceae. Because this family is extinct and characterized by a transitional type, the taxonomic investigation is essential for research on evolution of plants. The major anatomical feature of *Protopiceoxylon yukonense* is the protopinoid pitting which is characterized by abietoid as well as araucaroid pitted radial tracheid walls. This fossil wood species is distinct from other *Protopiceoxylon* woods by the seldom occurrence of axial parenchyma, the uniseriate rays, up to 20 cells high, the occurrence of vertical and traumatic horizontal resin canals, the lack of ray tracheids, and the mostly 2-3 (4) small and predominantly circular and piceoid cross-field pits.

Protopiceoxylon woods are distributed throughout primarily Mesozoic and Paleogene in Arctic zones of North America and Europe as well as in other regions of North America, Europe and East Asia. Relating the fossil wood specimen to some other woods of this fossil species (namely from Ellesmere Island, Spitsbergen and Franz Joseph Land), which also had been growing in high latitude zones, it is possible to provide the evidence of forested areas and to unravel additional details about the species living in the forested areas in Cretaceous and Paleogene times.

The fossil wood was recovered as a parautochthonous, petrified wood remain from the Moose Channel Formation, a formation of deltaic and shallow marine origin in the Big Fish River area. The origin of the fossil wood is either in the direct vicinity of the former delta or was transported over a longer distance during a discharge event of the Paleocene fluvial system.

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