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# Kräusel's eight genera for fossil softwoods: types, nomenclature, and taxonomy

M. Philippe<sup>1,\*</sup> and V. Wilde<sup>2</sup>

<sup>1</sup>Université Claude Bernard Lyon 1, CNRS, UMR 5023 LEHNA, F-69622, Villeurbanne, France

<sup>2</sup>Senckenberg–Leibniz Institution for Biodiversity and Earth System Research, Sektion Paläobotanik, Senckenberganlage 25, 60325 Frankfurt am Main, Germany

\*Corresponding author; email: philippe@univ-lyon1.fr

## ABSTRACT

Seventy years after its publication Kräusel's review of fossil conifer woods is still among the most quoted references in this field. Several of his earlier contributions are foundational works, but they have largely been overlooked, which has led to some misinterpretations. We reviewed the taxonomy and nomenclature of the eight genera Kräusel described for fossil conifer wood. Two of them should not be used. The genus *Protophyllocladoxylon* is neotypified. Several synonymies are proposed and the way Kräusel used generic names is briefly discussed.

**Keywords:** fossil wood; *Circoporoxylon*; *Paradoxoxylon*; *Protophyllocladoxylon*; *Prototaxoxylon*.

## INTRODUCTION

Richard Kräusel is well known to the fossil wood community, his 1949 review entitled “*Die fossilen Koniferen-Hölzer (Unter Ausschluß von Araucarioxylon Kraus). II: Kritische Untersuchungen zur Diagnostik lebender und fossiler Koniferen-Hölzer*” (The fossil conifer woods (except *Araucarioxylon* Kraus). II. Critical investigations on the diagnosis of living and fossil coniferous woods — all German titles translated by us) is still among the most quoted publications for fossil conifer woods. Largely based on previous, but less well-known papers, the 1949 review is a meta-analysis. It did not describe new material, but up-dated a previous bibliographical survey (Kräusel 1919a) and synthesized contributions where Kräusel had explained his taxonomic positions (Kräusel 1913, 1917, 1918, 1919b, 1920a–c). It is unfortunate that these older papers have largely been overlooked as they are where Kräusel introduced the wood anatomical terminology he used, in particular, his cross-field pit classification.

Despite having been trained as a botanist, Kräusel sometimes did not adhere to the International Code of Nomenclature for algae, fungi, and plants (ICN; Turland *et al.* 2018) (Kräusel 1913, 1949). Kräusel developed generic names for plant fossils based on his hypothesis of the fossil's phylogenetic affinity, combined with a suffix based on the fossil organ (*e.g.*, *Piceoxylon* for fossil wood he thought to be similar to wood of *Picea*). This method of naming fossil woods was then common (Kraus 1870; Tuzson 1911) and is not against the nomenclatural rules. The problem is that he also considered etymology as diagnostic (Philippe & Bamford 2008). In a sense, Kräusel's 1949 contribution reflects the casual relationship to the ICN typical of several earliest-twentieth century palaeobotanists had (*e.g.*, Gothan 1905; Tuzson 1911; Kräusel 1913, 1917). They were little concerned by nomenclatural rules since it was clear for them that “fossil taxa” did not need to be regarded as “real taxa” (Bateman & Hilton 2009).

Eight generic names were published by Kräusel for fossil conifer woods: 1) two were substitute names (*Arctoxylon* and *Prototaxoxylon*); 2) two (*Circoporoxylon* and *Palaeopiceoxylon*) were proposed for species that Kräusel considered to be incorrectly assigned to the genera *Podocarpoxyton* and *Piceoxylon* respectively; 3) one (*Suevioxylon*) was based on material that was determined to differ from the generic diagnosis (Philippe & Gromyko 2007); 4) a sixth genus, *Archaeoxylon*, supposed to be a Precambrian tracheophyte, after its publication was used only by uncritical listings of names like that of Andrews (1955); 5) *Protophyllocladoxylon* is suspected to be a taxonomic synonym of *Metapodocarpoxyton* Dupéron-Laudoueneix & Pons (Kräusel 1939; Philippe *et al.* 2003; Zijlstra & Philippe 2020); and 6) *Paradoxoxylon* has a circumscription that was questioned by Selmeier and Grosser (1980).

Herein we present a taxonomic and nomenclatural reappraisal of the fossil conifer wood genera Kräusel published. We searched for the original material in his collection at the Senckenberg Museum in Frankfurt am Main as well as elsewhere.

We summarize the current taxonomic and nomenclatural status of these genera and propose solutions, including the choice of a neotype. This is a further step towards our goal to update Kräusel's 1949 key for fossil conifers (Bamford & Philippe 2001; Philippe 2002; Philippe & Cantrill 2007; Philippe & Bamford 2008; Philippe & Hayes 2010).

## MATERIAL AND METHODS

The available literature was reviewed in order to list all of Kräusel's publications dealing with fossil conifer woods some of which were published in obscure journals. At the Senckenberg Museum, Frankfurt am Main, we especially scanned the collection of Kräusel's separates, including a collection of all the reports he published on botanical and palaeobotanical publications as part of a bibliographical survey (*"Referate"* in German).

We previously reviewed the types of two of Kräusel's genera: *Arctoxylon* (Philippe & Cantrill 2007) and *Suevioxylon* (Philippe & Gromyko 2007). In the Tohoku University Museum in Sendai (Japan), we reviewed the type of *Palaeopiceoxylon*. We searched the Senckenberg Museum collections in Frankfurt (Germany) for other holotypes of Kräusel. The repositories for *Paradoxoxylon*, *Prototaxoxylon* and *Suevioxylon* types were clearly identified by Kräusel, and the collections still hold these types (respectively Naturhistorisches Museum, Basel, Switzerland; South African Museum, Iziko, South-Africa; and Staatliches Museum für Naturkunde Stuttgart, Germany). However, the locations of the types of *Archaeoxylon* and *Protophyllocladoxylon* were not specified.

In addition to the eight genera mentioned above, Kräusel (1917) also published a suprageneric taxon for conifer woods, the Protopinaceae. Moreover, he established several genera for woody axes associated with primary tissues, e.g., *Taeniopitys* (Kräusel 1962; Kräusel *et al.* 1962). We will not discuss these genera. At the time of its publication, the Protopinaceae had no nomenclatural status, as this rank was not considered in the ICBN for fossils. It was determined that the Protopinaceae, from both a nomenclatural and taxonomic point of view, should not be used (Bamford *et al.* 2016).

The layout for each genus is copied from the ING, Index Nominum Genericorum (Farr, E. R., and G. Zijlstra, eds. Index Nominum Genericorum (Plantarum). 1996+ (<http://botany.si.edu/ing>, accessed in November 2019), with some minor modifications. All photographs are untouched.

## RESULTS

When checking Kräusel's separate collection we found that the list of his publications compiled by Dilcher and Schaarschmidt (1992) is complete as far as fossil wood is concerned. What is less known is that from 1917 to 1965 Kräusel wrote hundreds of reports on botanical and palaeobotanical publications. These reports were published in *Botanisches Centralblatt*, *Naturwissenschaftliche Wochenschrift*, *Zelle und Gewebe*, *Zentralblatt für Geologie und Paläontologie* and, mostly, in *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie*. Kräusel's first reports were concise and factual. However, later he provided commentary, gave his opinion about the publications, and developed his own ideas therein. The whole collection is an amazing diary of palaeobotany between 1917 and 1964. In our case, these reports are of special interest to follow his thoughts about fossil woods. For example, while reporting on Boureau's 1949 paper, Kräusel (1952) still considered etymology as critical for diagnostic purposes and that a name indicated affinities and implied the taxon had features consistent with that name. As an example of this, he stated that *Cupressinoxylon abrardii* Boureau would have been better assigned to *Taxodioxylon* Hartig because it was more like the wood of *Taxodium* than that of *Cupressus*.

We did not manage to find any of Kräusel's material that we were looking for in the Senckenberg collections at Frankfurt am Main. In 1944 most of Kräusel's collection was moved to a castle in the Wetterau that was shelled intensively in March 1945. According to Dilcher and Schaarschmidt (1992), Kräusel said that he found only debris and melted glass afterward. Therefore, it is highly probable that there is nothing left of the *Archaeoxylon* and *Protophyllocladoxylon* types.

Results are summarized in Tables 1 and 2 at the end of this section.

### *Archaeoxylon* R. Kräusel, Naturwiss. Z. Lotos 72: 36. 1924

#### Type

*Archaeoxylon krasseri* R. Kräusel. Type material is lost. We have not been able to locate any specimens in the palaeobotanical collections of the Senckenberg Museum in Frankfurt, or in Prague from where the studied material came (Jiří Kvacek pers. comm.).

#### Nomenclatural status

The ING considers this genus as validly published. There is, however, no real diagnosis, only a mere *descriptio generica specifica*. The features that distinguish this species and genus from any other fossil wood genus are not listed and the figures do

not show any distinctive features. There is a plate with eight figures but illustrating only tracheids and rounded intertracheary bordered pits. Rays are said not to have been observed.

The original material was recovered during exploratory drilling for coal. A thin schistose and bituminous layer was discovered within a level supposed to be Precambrian in age. This layer included the woody remains that Kräusel described as *Archaeoxylon*, as well as fragments of a ginkgoalean cuticle (Kräusel 1924b). It is probable that the bituminous layer was forced into its present-day position from a younger (Mesozoic?) level by faulting, or more simply, that these plant remains are just contamination from overlying Cenomanian strata.

Apart from some uncritical indices (Andrews 1955), the most recent publication discussing the genus is that of Greguss (1961).

This genus has no diagnosis using distinctive secondary xylem features and no type material. It is not justified to propose a neotype. Thus, it is better that it not be used. Furthermore, *Archaeoxylon krasseri* cannot be used to infer the occurrence of Tracheophytes in the Precambrian due to the probable erroneous age.

### ***Arctoxylon* R. Kräusel, Palaeontographica, Abt. B, Paläophytol. 89: 186. Oct. 1949**

#### *Type*

*Arctoxylon magnoradiatum* (Gothan) R. Kräusel (*Anomaloxylon magnoradiatum* Gothan). Lectotype designated from Nathorst's material in Stockholm at the Swedish Museum of Natural History by Philippe and Cantrill (2007) (SMNH, S1665).

#### *Nomenclatural status*

This is a replacement name for *Anomaloxylon* Gothan, non Felix (ICN, art. 6.11).

#### *Taxonomy*

The study of its lectotype indicated that *Arctoxylon magnoradiatum* is a taxonomic synonym of *Cedroxylon transiens* Gothan and *Protocedroxylon araucarioides* Gothan (Philippe & Cantrill 2007).

The taxonomic relationships between *Protocedroxylon* Gothan and two similar genera, *Araucariopitys* Hollick & Jeffrey and *Planoxylon* Stopes, were later clarified by Philippe and Hayes (2010). As *Protocedroxylon* and *Araucariopitys* are not taxonomic synonyms and *Cedroxylon* Kraus is not a legitimate name, the species that includes *Arctoxylon magnoradiatum*, *C. transiens*, and *P. araucarioides* has to be named by using the first epithet validly published for it: *Protocedroxylon lindleanum* (Witham) Edwards (Philippe & Hayes 2010). Thus, the generic name *Arctoxylon* R. Kräusel is a later heterotypic synonym of *Protocedroxylon* Gothan.

### ***Circoporoxylon* R. Kräusel, Palaeontographica, Abt. B, Paläophytol. 89: 115. Oct. 1949**

#### *Lectotype*

*C. priscum* (W. Prill) R. Kräusel (*Podocarpoxyylon priscum* W. Prill) (*vide* R. Kräusel *et* K. P. Jain, *Palaeobotanist* 12: 62. Mar 1964; note that Andrews' treatment of the genus was erroneous in both 1955 and 1970, *vide etiam* Philippe & Bamford 2008).

*Podocarpoxyylon priscum* Prill *in* R. Kräusel is a legitimate name for “[Cupressinoxyylon ponderosum]” which Göppert effectively published in 1850, but without validation by an accompanying description or diagnosis (ICN, art. 38.1). Göppert (1850) quoted five localities for “[Cupressinoxyylon ponderosum]”, and thus must have examined at least five specimens. Prill (*in* Kräusel 1919b) based the name *Podocarpoxyylon priscum* on a specimen from Patschkau (now Paczków, Poland); thus, this specimen can be considered as the holotype for *Podocarpoxyylon priscum*. Dolezych (*in* Junge *et al.* 2005) identified a specimen from the University of Wrocław Geology Museum as the type for *Circoporoxylon priscum*.

#### *Nomenclature*

*Circoporoxylon* was validly described in 1949 by Kräusel, but lectotypified later (Kräusel & Jain 1964). The *C. priscum* type material was later selected as type for *Doliosstroboxylon priscum* (Prill) M. Dolezych *in* F. W. Junge *et al.* (Junge *et al.* 2005), which makes *Circoporoxylon* Kräusel an earlier homotypic synonym of *Doliosstroboxylon*.

#### *Taxonomy*

Philippe and Bamford (2008) did not publish a comprehensive treatment of the genus *Circoporoxylon*. Their key was intended for Mesozoic woods and consequently did not compare *Circoporoxylon* to the similar *Glyptostroboxylon* Conwentz, which is reported only from the Tertiary. As both have small round cross-field pits in the earlywood cross-field, *Circoporoxylon* and *Glyptostroboxylon* are often confused. Much of the confusion originated from a misunderstanding of the term “glyptostroboid” which Kräusel (1949) did not illustrate nor define, only referring to Bailey and Faull (1934, figs 39, 43). However, Kräusel twice previously illustrated what he considered to be glyptostroboid cross-field pits (1917, fig. 9d; 1920c, pl. 38 fig. 5; here reproduced as Fig 1). We found that, except for Kräusel, and Bailey & Faull, before 1949 only Rudolf (1935) and Witasek (1941) used the term “glyptostroboid”, but with a definition different from that of Kräusel. Kräusel (1949) did not reference

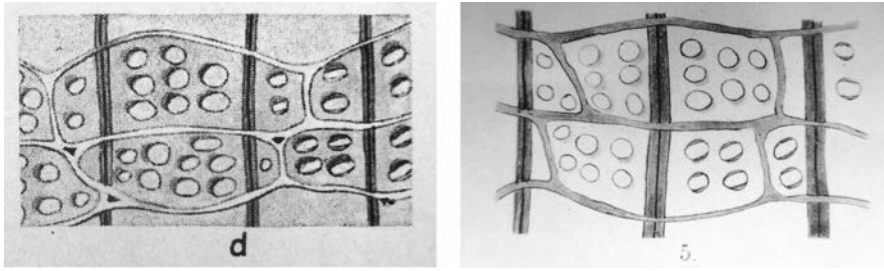


Figure 1. Reproductions of Kräusel's illustrations for the term "glyptostroboid" in 1917 (left) and in 1920 (right) (Kräusel 1917, 1920c). Wood anatomists are warned that alteration, particularly by fire (Gerards *et al.* 2007), generally broadens cross-field pit apertures making araucarioid cross-fields look like glyptostroboid ones (see e.g., Süß & Schultka 2001).

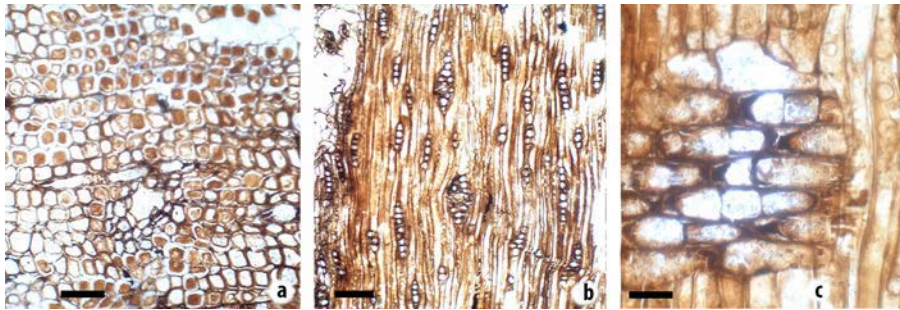


Figure 2. Type of *Palaeopiceoxylon transiens* (Shimakura) R. Kräusel, sample 5840 in Tohoku University Museum, Sendai, Japan: (a) transverse section with an axial resin canal, scale bar 150 µm; (b) tangential section with radial resin canals in fusiform rays, scale bar 150 µm; (c) radial section, ray with marginal tracheids, scale bar 75 µm.

Witasek. Our search across Kräusel's bibliographical survey ("Referate", see above) also failed to find any mention of Witasek, which may possibly be explained by WW II. Kräusel (1949) knew Rudolf's paper from 1935 and quoted it, but Kräusel does not refer to his definition and illustration of glyptostroboid. It is clear that when using Kräusel's key (1949: 151, couplet 10) for distinguishing *Glyptostroboxylon* one should refer to Kräusel's figures as reproduced here (Fig. 1). This term is not in the IAWA list of microscopic features for softwood identification (IAWA Committee 2004), although it is used by some wood anatomists (Dolezych & van der Burgh 2004, Teodoridis & Sakala 2008). The genus *Circoporoxylon* was reappraised by Tian *et al.* (2020).

This genus appeared during the Early Jurassic in southern Gondwana and spread to the northern hemisphere during the Middle Jurassic, possibly through a Gondwanan terrane that accreted to Asia (Tian *et al.* 2020).

***Palaeopiceoxylon* R. Kräusel, Palaeontographica, Abt. B, Paläophytol. 89: 127. Oct 1949**

*Type*

*P. transiens* (M. Shimakura) R. Kräusel (basonym *Piceoxylon transiens* M. Shimakura).

The type of this species is in the Tohoku University Museum, Sendai, Japan, under accession number 58450. It was recently illustrated by Kim *et al.* (2005). Three additional views are given here (Fig. 2). Figure 2c shows marginal ray tracheids, which were previously shown in a sketch by Shimakura (1937). Nishida & Nishida (1995) described additional material of this species.

*Nomenclature*

No nomenclatural problems have been recognized for this genus, although it belongs to a taxonomically complex group.

*Taxonomy*

This genus belongs to a group of woods with "Abietineentüpfelung" (*sensu* Gothan, *i.e.* with pits in the ray cell cross walls, see Mantzouka *et al.* 2017) and an araucarian to mixed type of radial intertracheary pitting (*Pinuxylon* Knowlton, *Protocedroxylon* Gothan, *Pseudotsugoxylon* N.I. Blokhina & O.V. Bondarenko). Most of these genera have some species with features intermediate between the genera. This group urgently needs a taxonomic revision, but this is beyond the scope of the present paper. Among these genera, the *Palaeopiceoxylon* type material is similar to that of *Protocedroxylon*.



## Nomenclature

This is a replacement name for *Spiroxylon* J. Walton, *non* T. Hartig. Walton's type was restudied by Kräusel and Dolianiti (1958) and Bamford (1999), the latter providing more detailed and clearer illustrations.

## Taxonomy

Although some woods with a mixed type of radial intertracheary pitting have been assigned to *Prototaxoxylon* (Fakhr & Marguerier 1977), it seems wiser to limit the genus to the woods with only araucarian radial intertracheary pitting, as in the type *P. africanum* and in accordance with the original diagnosis, which states “radial pits never perfectly round or opposite” (Philippe 1995; Philippe et al. 2019). Consequently, this genus should not be used for woods with a mixed type of intertracheary pitting. The genus is characterized by longitudinal tracheids with thick helical thickenings at a 30°–40° angle with the axis. Several Mesozoic woods belong to *Prototaxoxylon*. They are limited to Gondwana, where they mostly occur at high palaeolatitudes (Table 3 and Appendix in Philippe et al. 2019).

## *Suevioxylon* R. Kräusel, *Senckenbergiana* 10: 253. 15 Dec 1928

### Type

*Suevioxylon zonatum* R. Kräusel. The type material is in the Staatliches Museum für Naturkunde Stuttgart (Germany), with accession number P1035. Philippe and Gromyko (2007) found that its features do not match Kräusel's diagnosis.

### Taxonomy

This wood was once thought to be a dicotyledon of Jurassic age and was listed as such in Andrews (1970) and it is still so listed in the Index Nominum Genericorum (ING, <https://naturalhistory2.si.edu/botany/ing/>, accessed 15 December 2019). However, it is a poorly preserved conifer. Kräusel (1956) admitted that *Suevioxylon*'s relationship with dicotyledons was “not safely proven”, and later realized that he should not have published on this poorly preserved material (Kräusel, cited by Andrews 1980).

This monospecific genus should be forgotten, and the name should not be used.

## DISCUSSION

The main contribution of Kräusel on fossil conifer wood is the synthesis he published in 1949. In many respects, it is a synthesis and update on a set of his papers published from 1913 to 1920. Kräusel's thesis (1913), entitled “*Beiträge zur Kenntnis der Hölzer aus der schlesischen Braunkohle*” (Contributions to the knowledge of woods from Silesian lignite), was much influenced by Gothan. In 1917 Kräusel published his own wood anatomical Credo “*Die Bedeutung der Anatomie lebender und fossiler Hölzer für die Phylogenie der Koniferen*” (The significance of the anatomy of extant and fossil wood for the phylogeny of conifers). The similarity of the title to Jeffrey's 1905 paper (*The comparative anatomy and phylogeny of the conifers*) to Kräusel's 1917 paper might indicate that Kräusel was influenced by the American school of wood anatomists led by Jeffrey. However, similar wording has been used over the years (Jarmolenko 1933; Boureau & Marguerier 1987).

In 1918 Kräusel gave his first system of fossil conifer wood classification in “*Einige Bemerkungen zur Bestimmung fossiler Koniferen-Hölzer*” (Some remarks on the identification of fossil conifer woods) where he explicitly related each fossil wood genus to either a single or a group of living conifer genera. The 1919 review does not add much about fossil conifer taxonomy in general but is an impressive bibliographical review of the published species. Kräusel (1920a and b) published a set of two “*Paläobotanische Notizen*” (Palaeobotanical notes), the first “*Nachträge zu Zusammenstellung fossilen Koniferen Hölzer*” (Supplements to the compilation of fossil conifer woods) completed the 1919 review, while the second “*Zur Bestimmung fossiler Koniferenhölzer*” (On the determination of fossil conifer wood) outlined a more sophisticated classification system of fossil softwood. It included a key, with a first dichotomy stating: (i) wood without relationships to living forms *vs.* (ii) wood related to living forms. This is typical for the way palaeobotanists approached fossil wood nomenclature and taxonomy at that time. After 1920 Kräusel more sporadically worked on fossil conifer woods (Dilcher & Schaarschmidt 1992), although he still published important contributions on fossil angiosperms and was incredibly productive in other fields of paleobotany.

Kräusel several times complained about the misuse of fossil wood genera, in particular of *Mesembrioxylon* Seward (Kräusel 1949). He regarded the creation of new fossil conifer wood genera as useless (Kräusel 1951, about *Simplicioxylon* Andreanzenky) or stated the lack of knowledge of the literature (*e.g.*, Kräusel 1952, about several of Boureau's papers). This might have stimulated him to update his 1917–1920 papers and to merge them in a synthesis (Kräusel 1949), which was a milestone in the history of fossil conifer wood research.

Kräusel's wood anatomical manuscripts typically suggest that he tried to fit his observations into the intellectual schemes he had developed from the study of the literature about both extant and fossil conifer wood, of which he had an outstanding knowledge. From his very first work on fossil conifer wood for his thesis, Kräusel had a “bibliographical first” approach.

Table 1.  
Mesozoic species once assigned to *Protophyllocladaxylon* Kräusel, their basionym (if different), and their proposed designation.

Name when assigned to <i>Protophyllocladaxylon</i>	Basionym (if different)	Proposed designation
<i>Protophyllocladaxylon araucariooides</i> (Holden) Kräusel ex Serra, 1966	<i>Paraphyllocladaxylon araucariooides</i> Holden	<i>Protophyllocladaxylon araucariooides</i> (see Philippe 2002).
<i>Protophyllocladaxylon capense</i> (Walton) Kräusel, 1949	<i>Phyllocladaxylon capense</i> Walton, 1925	<i>Protocircoropoxylon capense</i> (Walton) Vogellehner, 1967
<i>Protophyllocladaxylon chaoyangense</i> Zhang, Zheng & Ding, 2000	–	<i>Xenoxylon</i> sp.
<i>Protophyllocladaxylon chudeaui</i> Batton, 1965	–	<i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>Protophyllocladaxylon cortaderitaense</i> Menendez, 1956	' <i>cortaderitaensis</i> ' in Menendez, 1956	<i>Protocircoropoxylon cortaderitaense</i> (Menendez) Vogellehner, 1967
<i>Protophyllocladaxylon curitiense</i> Pons, 1978	–	<i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>Protophyllocladaxylon diphtericum</i> Batton & Bourreau, 1965	–	<i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>Protophyllocladaxylon franconicum</i> Vogellehner, 1966	–	<i>Protophyllocladaxylon franconicum</i>
<i>Protophyllocladaxylon haizhouense</i> Ding <i>et al.</i> , 2000	–	<i>Xenoxylon</i> sp.
<i>Protophyllocladaxylon holbavicum</i> lamandei, lamandei & Gradinaru, 2018	–	<i>Protophyllocladaxylon holbavicum</i>
<i>Protophyllocladaxylon korubaense</i> Serra, 1967	–	<i>Protophyllocladaxylon xenoxyloloides</i> (see Boura <i>et al.</i> , 2013)
<i>Protophyllocladaxylon huzinamiense</i> Ogura, 1960	<i>Araucarioxylon huzinamiense</i> Ogura, 1960	<i>Protoceadroxylon huzinamiense</i> (Ogura) <i>nov. comb.</i> (type material seen)
<i>Protophyllocladaxylon leuchsii</i> Kräusel, 1939	–	? <i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>Protophyllocladaxylon libanoticum</i> (Edwards) Kräusel, 1949	<i>Mesembrioxylon libanoticum</i> Edwards, 1929	<i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>Protophyllocladaxylon mauritanum</i> Gazeau, 1967	–	<i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>Protophyllocladaxylon oolithicum</i> Vogellehner, 1966	–	<i>Protophyllocladaxylon oolithicum</i>
<i>Protophyllocladaxylon owensii</i> Fletcher <i>et al.</i> , 2014	–	<i>Protophyllocladaxylon owensii</i>
<i>otophyllocladaxylon quedlinburgense</i> Schultze-Motel, 1961	–	<i>Protophyllocladaxylon quedlinburgense</i>
<i>otophyllocladaxylon rosaeblancaense</i> Pons, 1971	–	<i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>otophyllocladaxylon subdiphthericum</i> Dupéron-Laudoueneix, 1976	–	<i>Metapodocarpoxylon libanoticum</i> Dupéron-Laudoueneix & Pons, 1985
<i>otophyllocladaxylon thylloides</i> Serra, 1966	–	<i>Protophyllocladaxylon xenoxyloloides</i> (see Boura <i>et al.</i> 2013)
<i>otophyllocladaxylon uzbekistanicum</i> Junusov, 1977	–	? poor protologue, type to be revised
<i>otophyllocladaxylon xalucense</i> Boura et Pons 2013	–	<i>Protophyllocladaxylon xalucense</i>
<i>otophyllocladaxylon xenoxyloloides</i> Serra, 1966	–	<i>Protophyllocladaxylon xenoxyloloides</i>

An invalidly published species "*Protophyllocladaxylon madamuense*" Bourau (1948) is not taken into account. The indication "cf." is proposed here for taxonomic reassignment proposals based on original description and illustrations only. *Araucarioxylon huzinamiense* Ogura, once transferred to *Protophyllocladaxylon* (Serra 1966), after having reviewed the type material in the University of Tokyo Museum is here recombined as *Protoceadroxylon huzinamiense* (Ogura) Philippe & Wilde comb. nov. ≡ *Araucarioxylon huzinamiense* Ogura, J. Fac. Sci. Univ. Tokyo, sect. III, 7 (10): 507. Fig. 6-12. 1960.



Table 2.

Summary of the results about the genera for fossil conifer woods described by Kräusel.

Genus name	Nomenclatural status	Type	Taxonomy
<i>Archaeoxylon</i>	Validly published	Lost	Minimal protologue, incomplete description and lost type prevent to use this genus
<i>Arctoxylon</i>	Substitute name for <i>Anomaloxylon</i> Gothan, <i>non</i> Felix	Reviewed	Taxonomical synonym of <i>Protocedroxylon</i> Gothan
<i>Circoporoxylon</i>	Validly published and legitimate	<i>Non vidi</i> ; in the Geology Museum of Wrocław University according to Junge <i>et al.</i> , 2005	Not to be confused with <i>Glyptostroboxylon</i> Conwentz
<i>Palaeopiceoxylon</i>	Validly published and legitimate	Reviewed; 5840 in the Tohoku University Museum collection.	Close to <i>Protocedroxylon</i> Gothan, belongs to a group that needs a taxonomical revision
<i>Paradoxoxylon</i>	Validly published and legitimate	<i>Non vidi</i> ; B208 in the Naturhistorisches Museum, Basel; reviewed by Süß (1992)	Diagnosis emended by Selmeier and GROSSER (1980)
<i>Protophyllocladoxylon</i>	Validly published and legitimate	Lost; conservation with a conserved type is proposed	According to Kräusel's diagnosis to be used for woods with exclusively or almost exclusively araucarian type of radial pitting of the tracheids
<i>Prototaxoxylon</i>	Validly published substitute name	<i>Non vidi</i> ; SAM2945 in South African Museum, Iziko, RSA; reviewed by Bamford (1999)	<i>Vide</i> Philippe <i>et al.</i> , 2019
<i>Suevioxylon</i>	Validly published and legitimate	P1305 in Staatliches Museum für Naturkunde Stuttgart (DE); reviewed by Philippe and Gromiko (2007)	Minimal protologue and unpreserved type prevent to use this genus

good taxonomist, he synthesized the existing literature in a first step and then studied new material in a second step. Kräusel usually published the results of his literature review of fossil conifers first, with fewer publications treating new material. In this respect, Kräusel while seeking to increase the quality of palaeoxylogy, sometimes had a better knowledge of literature than of the fossils.

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