Mitt. Bayer. Staatsslg. Paläont. hist. Geol.	42	139–153	München, 15. 12. 2002

Silicified Tertiary woods from Iceland (*Larix*) and the northalpine Molasse basin (*Liquidambar*)

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With 13 figures and 1 table

Abstract

This paper deals with a silicified *Larix* wood collected in the Faskruds Fjord on the eastcoast of Iceland. Jagels, LePage & Jiang (2001) have proposed that in future all fossil wood samples resembling *Larix* that cannot be identified using ray-tracheid bordered pit types should be assigend to the artificial genus *Laricioxylon*. A well preserved silicified wood of *Liquidambar* has been found northeast of the village Ambach, Bavaria. It is the first anatomical record of *Liquidambar*, familiy Hamamelidaceae, in the Tertiary northalpine Molasse basin.

Kurzfassung

Dünnschliffe eines verkieselten Holzrestes, gefunden an der Ostküste Islands, zeigen die anatomischen Merkmale der Gattung *Larix*, Familie Pinaceae. Nach Jagels, LePage & Jiang (2001) sind alle fossilen *Larix*-Hölzer ohne Nachweis des Merkmals (ray-tracheid bordered pit type) der Gattung *Laricioxylon* zuzuordnen. Aus Schichten des nordalpinen Molassebeckens, Fundort Ambach, liegt erstmals ein anatomisch gut erhalten gebliebenes Holz des Amberbaums, *Liquidambar*, Familie Hamamelidaceae, vor. Weitere Fundorte aus dem Molassebecken mit Holzresten der Gattung *Liquidambar* sind erwähnt.

1. The *Larix* wood from Faskruds Fjord, Iceland

Tertiary woods from Iceland are mentioned for the first time in works on the Arctic Flora (Heer 1868; "platte Baumstämme"). Wood species were determined by Windisch (1886), Schönfeld (1956) and Blokhina (1991). The 31 petrified woods, collected during a joint USSR-Iceland geologic-geographic expedition were assigned by Blokhina to species (cf.) of *Abies*, *Picea*, *Larix* and *Pinus*. The present silicified wood sample was found on the Faskruds Fjord (Fig. 1, No. 1).

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Fig. 1. Location of fossil woods. 1 - Faskruds Fjord, 2 - Trodlatunga, 3 - Mokodlsdalu, 4 - Tjörne, 5 - Gepir. Localities 2-5 according BLOKHINA (1991).

1.1. Anatomical study

Abbreviations

TS – transversal section, cross section of the wood
LTS – longitudinal tangential section of the wood
LRS – longitudinal radial section of the wood
TK – Topographic map 1 : 25000 and name of the map
IAWA list – a list of microscopic features for wood identification (1989) is a valuable guide and reference for anatomical description. The International Association of Wood Anatomists (IAWA) was founded in 1931 to advance the knowledge of wood anatomy in all its aspects.

Pinaceae

Laricioxylon JAGELS, LEPAGE & JIANG, 2001

Type species: *Larix altoborealis* JAGELS, LEPAGE & JIANG, 2001 from the Arctic, geological age Cenozoic, Eocene.

Laricioxylon faskrudense n. sp.
(Fig. 2–7)

Locality: Faskruds Fjord, formerly whaling station and today a collection place for mineral hunters (Fig. 1, No. 1).

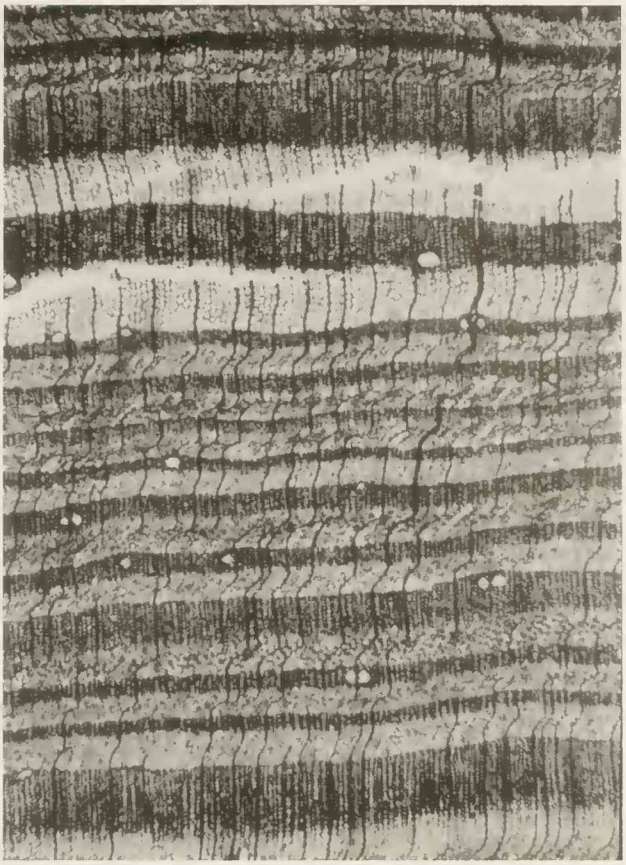

Fig. 2. TS. Twelve growth rings with longitudinal resin canals in the late wood. x 10.

Age and horizon: Tertiary, Miocene-Pliocene. The stratigraphic position of the fossil from Faskruds Fjord is unknown. The Neogene volcanic deposits with the tuffaceous sediments contain plant imprints, pollen and petrified wood remains.

Derivation of name: The specific name points to the locality of the wood sample, the Faskruds Fjord.

Material: The original size of the black silicified fossil was about 9 cm long with a perimeter of 14 cm. It was collected by V. GISLASON, Iceland, and received in 2001 from ROBERT HOCHLEITNER, Munich; 5 thin slides, TS – (2,5 x 3, 2,5 x 2,8) cm, LTS – (2,4 x 2,5) cm, LRS – (2,5 x 2, 2,5 x 2) cm. The material is deposited in the Bavarian State Collection of Palaeontology and Geology, Munich.

Diagnosis:

Growth rings distinct, transition from early to late wood abrupt. Early wood tracheids with bordered pits in 1-2 rows on the radial walls. Number of cross field pits 2-4-(5). Axial parenchyma sparse or wanting. Rays of two types, uniseriate, 3-20 cells in height, rarely in some portions biseriate, and rays with transverse resin canals, rays 2-3-seriate through the central thickeness portion, diameter of transverse resin canals 20-45 µm, epithelium thick-

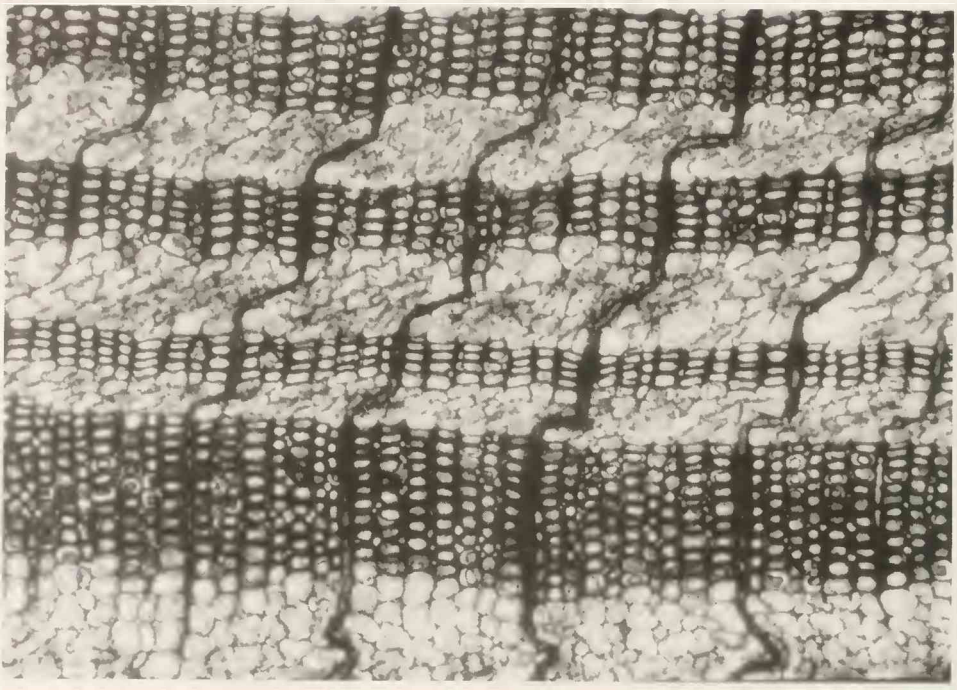

Fig. 3. TS. Late wood portions small or broad, transition from early to late wood abrupt; dark uniseriate rays deformed by radial pressure. x 30.

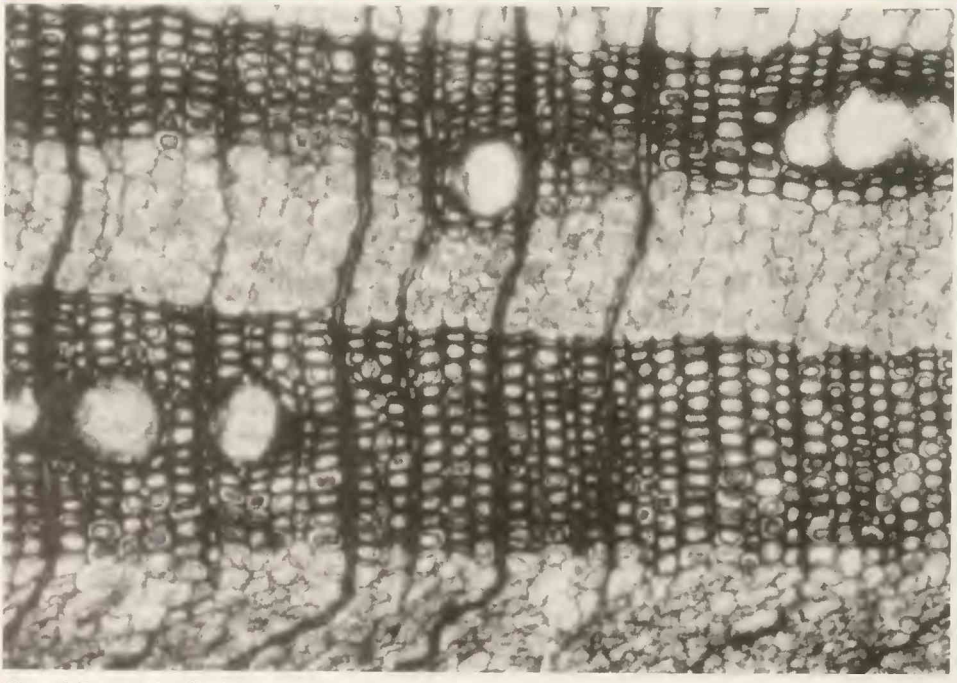

Fig. 4. TS. Longitudinal resin canals in the late wood; transition from early to late wood abrupt. x 35.

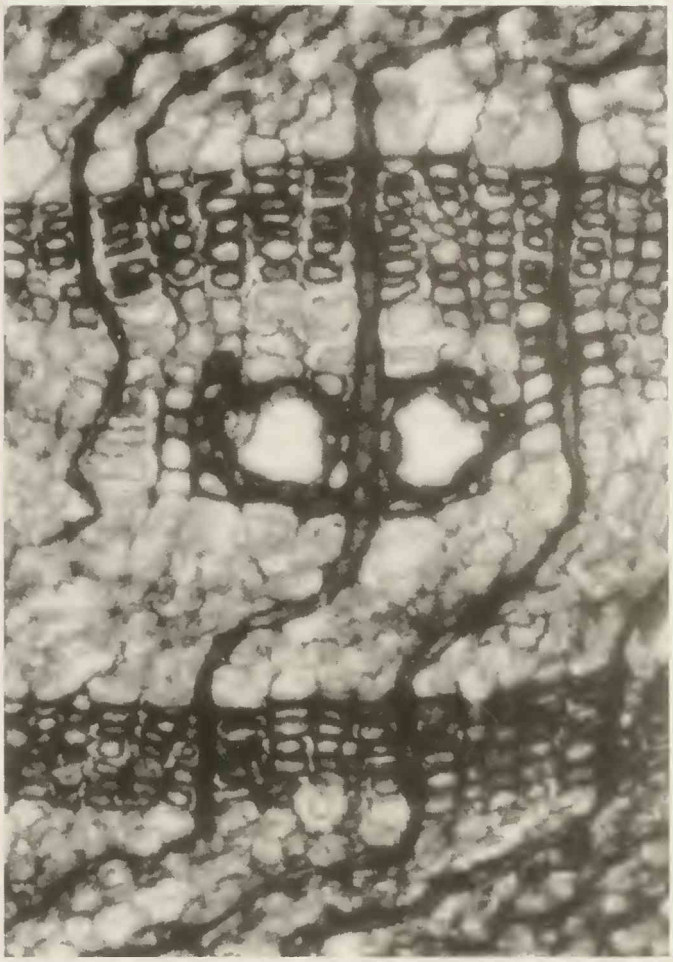

Fig. 5. TS. Two longitudinal canals in contact with an uniseriate ray; epithelial cells thick-walled. x 100.

walled; 7-8 rays per mm tangential. Axial resin canals present, confined largely to the central or outer portions of the growth rings, epithelium thick-walled.

Minute anatomy:

Growth rings distinct, visible already with the naked eye, delineated by a pronounced band of darker late wood, 44 growth rings variable in width, 0,1-1,9 mm. Early-wood zone usually occupying generally one-third or more of the rings; transition from early to late wood in 42 rings distinctly abrupt (Fig. 2-4). Late-wood portion e.g. radial 157-705 µm (7-15 tracheids). The early wood tracheids (TS) are polygonal or quadratic, radial 40-68 µm, the utmost late wood tracheids (TS) are rectangular-flattened, radial 8-34 µm, thickness of the walls 5 µm. Tracheids with bordered pits in 1-2 rows on the radial walls. Diameter of bordered pits maximal 22-25 µm, apertures 8 µm; number of the decayed cross-field pits 2-4-(5). Axial parenchyma very sparse or wanting. Rays of two types, a) uniseriate or rarely in part biseriate, numerous, 3-19 cells in height, e.g. 3 cells (68 µm), 10-14 cells (193-276 µm), 19 cells (389 µm),

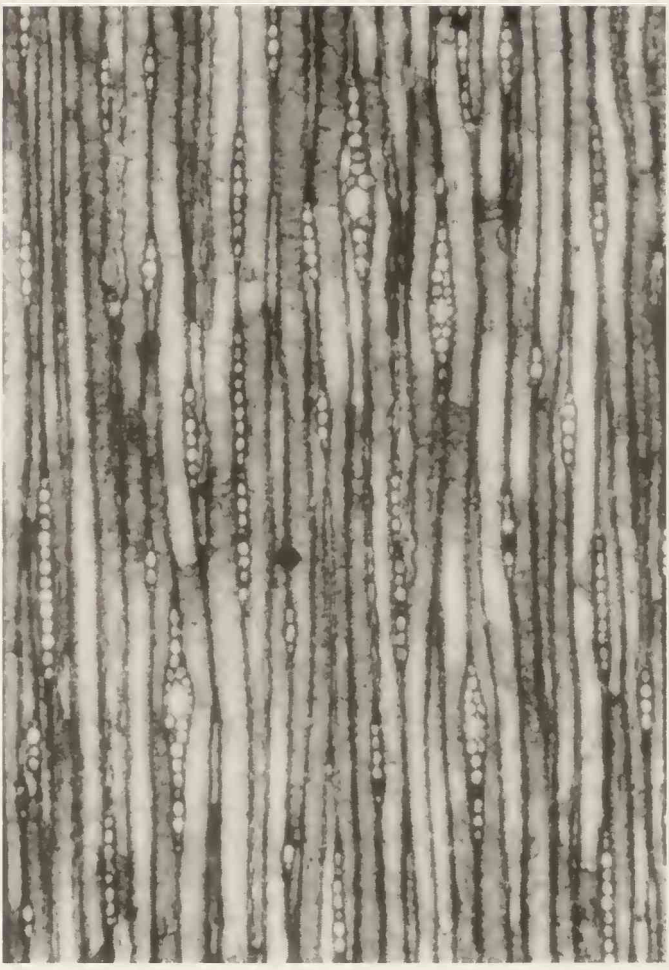

Fig. 6. LTS. Uniseriate rays and four rays with transverse resin canals. x 30.

ray cells tangential 18-21 µm, b) rays with transverse resin canals scattered, 2-3-(4)-seriate through the central thickened portion, resin canals partly near the end of a ray (16 %), round or oval diameter of the transverse canals 20-45 µm, epithelium thick-walled; 7-8 rays per mm tangential. Axial resin canals present, solitary or 2-several contiguous in tangential direction, confined largely to the central or outer portions of the growth rings, epithelium thick-walled, diameter of the longitudinal canals 48-116 µm.

1.2. Affinity

The fossil wood agrees with all the general and minute characteristics of the genus *Larix* (Pinaceae). The wood anatomy of *Larix* has often been studied in detail, e.g. Greguss (1955, 1959), Grosser (1977), Panshin & de Zeeuw (1980), Grosser & Vogel (1996).

A problem for the fossil record of *Larix* is the great similarity of anatomical features between *Larix* and *Picea* (Huber 1970). These two genera of the Pinaceae have axial and transverse resin

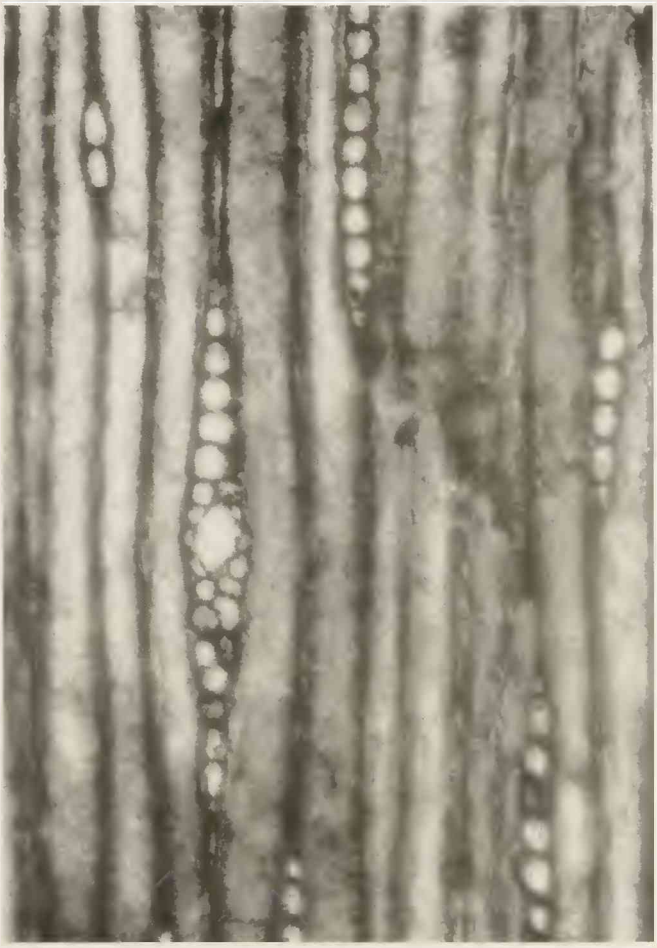

Fig. 7. LTS. Transverse resin canal, epithelial cells thick-walled. x 60.

canals, thick-walled epithelial cells, similar cross-field pits and ray tracheids. The woods of *Larix* and *Picea*, until 1979 thought to be indistinguishable can be separated by the structure of the bordered pits in their ray tracheids (BARTHOLIN 1979; drawing Fig. 8). In a detailed study (58 samples representing 30 species of *Picea* and 29 samples representing 9 *Larix* species) the results of BARTHOLIN (1979) have been confirmed by ANAGNOST, MEYER & DE ZEEUW (1994). The ray tracheid pit border types (Fig. 8) constitute the most reliable anatomical characteristic for separating the recent and fossil wood of *Larix* and *Picea*. Last year, JAGELS, LEPAGE & JIANG (2001) provided the first definitive identification of *Larix* wood from the fossil record. This study (2001) extends the putative record of *Larix* wood to the middle Eocene (Axel Heiberg Island, Canadian High Arctic).

Note (absence of ray-tracheid pitting analysis): The proportion and type of ray tracheid bordered pits (BARTHOLIN 1979) could not be seen in the available thin sections from the present silicified wood (Faskruds Fjord).

To minimize the nomenclatural and taxonomic clutter caused by mis-identifications, JAGELS et al. (2001, p. 81) propose, that fossil wood sampels resembling *Larix* that have not been

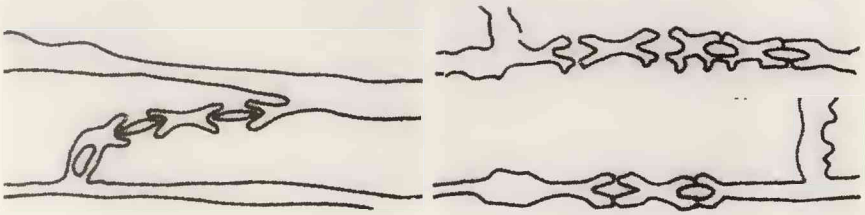

Fig. 8. LRS. Bordered pits in the ray tracheid cells. *Larix* type (left) - pits with big apertures. Two *Picea* types (right) - pits and apertures are relatively small, *Picea* type 2 has dentate borders. Drawing BARTHOLIN (1979).

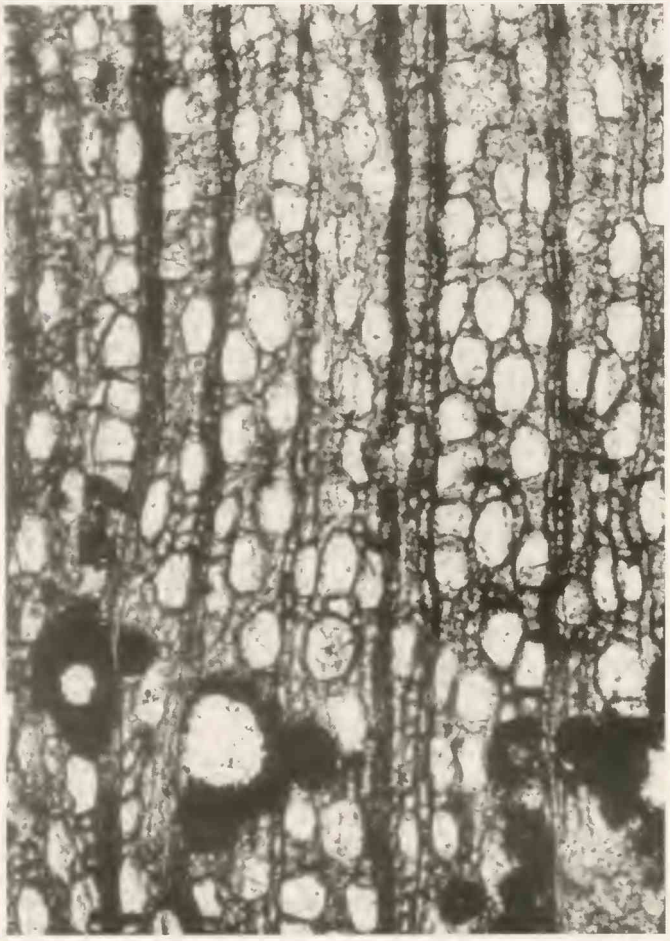

Fig. 9. TS. Evenly distributed vessels and an indistinct growth ring boundary at bottom, vessels in cross section polygonal and occurence of a traumatic gum canal (?). x 30.

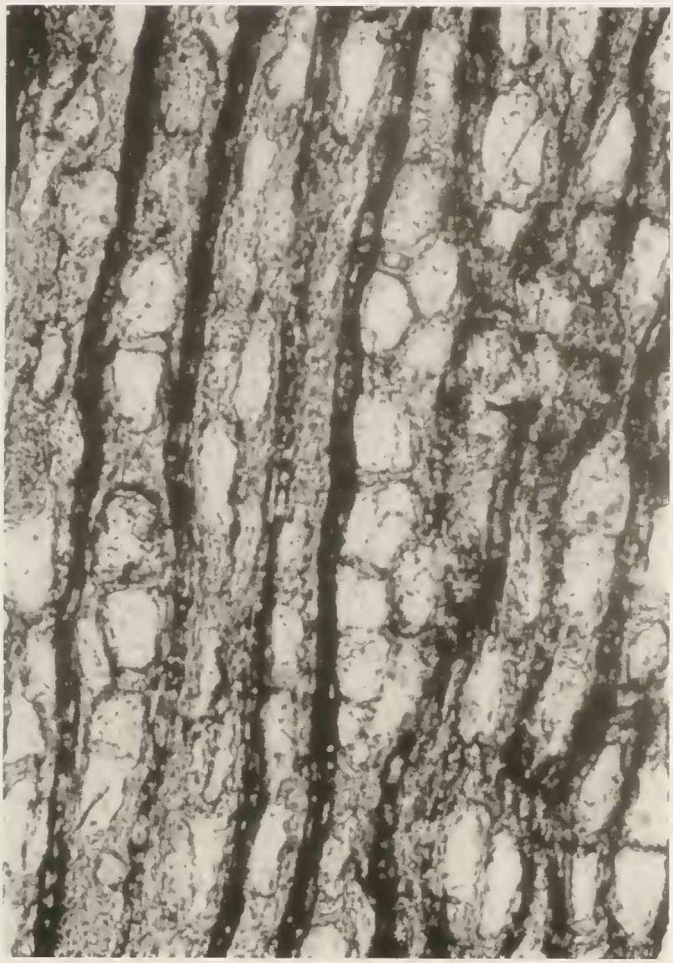

Fig. 10. Ground tissue decayed, evenly distributed pores between the dark rays. x 50.

identified or cannot be identified using ray-tracheid bordered-pit types should be assigned to *Laricioxylon*. The name of the silicified wood from Faskruds Fjord is therefore *Laricioxylon faskrudense* n. sp.

2. *Liquidambaroxylon* sp. from Ambach, Germany

In Tertiary sediments from the northalpine Molasse Basin (Switzerland, southern Germany predominantly between the river Danube and the Alps, Austria) thousands of silicified wood pieces have been collected in the last decades (SELMEIER 1998). A sucessful "wood hunter" in farming fields and gravel pits is LUDWIG LANG, Ehekirchen. The present *Liquidambar* wood, number L15/150, is a small piece from his collection (LANG 2001).

Fig. 11. LTS. Rays predominantly 1-2 seriate. x 55.

2.1. Anatomical study

Hamamelidaceae

Liquidambaroxylon FELIX 1884

Type species: *Liquidambaroxylon speciosum* 1884

Liquidambaroxylon sp.
(Fig. 9–12)

Locality: Ambach, Germany, TK 7332 Burgheim-Süd, farming fields 1,5 km northeast of the village.

Age and horizon: Upper Miocene, Upper Freshwater Molasse; Mammal Neogene unit MN 5, 16-16,5 Ma.

Fig. 12. LRS. Scalariform perforation plates with fine bars (left), oval and opposite intervessel pits (arrow). x 180.

Material: A silicified specimen, 14 cm long, brown-yellow, collected by LUDWIG LANG, Ehekirchen; 3 thin sections, maximal (4,2 x 3) cm, collection No.15/150. The material is deposited in the Bavarian State collection of Palaeontology and Geology (BSP), Munich.

Minute anatomy:

Growth rings indistinct, not very conspicuous, delimited by some thick-walled flattened fibres, presumable nine growth rings, width 3,7-1,9-3,1-2,4-4,2-3,5-5,7-5,9-4,1 mm, ring borders locally very vague. Vessels diffuse porous, evenly distributed, oval to sligthly angular in cross section, solitary, in multiples of 2-(3), quite uniform in size and crowded; density more than 100 pores per mm^2; vessels small, 48-72 µm in tangential diameter, up to 82 µm in radial diameter. Perforation plates scalariform with more than 20 fine bars, distance between two bars about 4 µm; intervessel pits in transverse rows, sometimes opposite, horizontally elongated, orbicular to oval or linear through fusion. Axial parenchyma scarce, paratracheal and diffuse

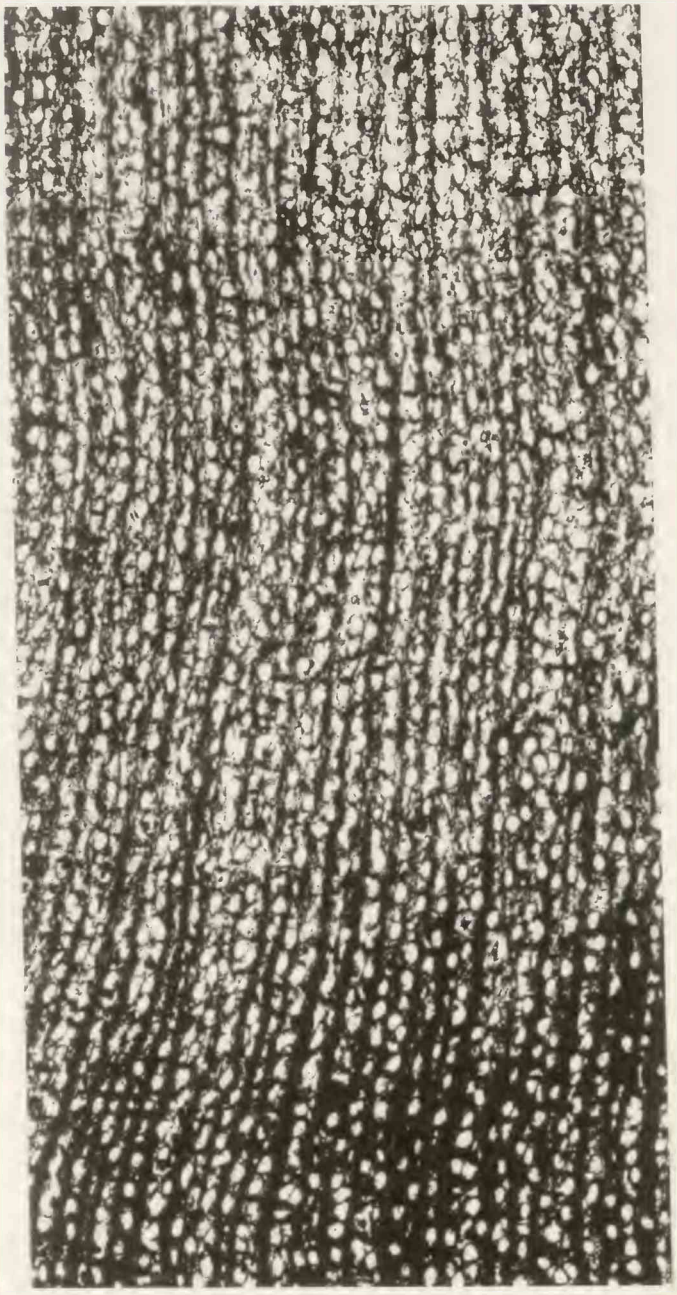

Fig. 13. TS. Silicified wood badly preserved with evenly distributed pores, dark rays with an indistinct growth ring boundary; wood sample collected on a farming field near Möckenlohe (TK 7133 Eichstätt). x 10.

Table 1. Silicified wood remains of *Liquidambaroxylon* sp. from different localities in the northalpine Molasse Basin (Bavaria). Fossil woods collected by P. HOLLEIS, L. LANG and A. SELMEIER. Topographic map 1 : 25000 (TK-No.).

Locality	TK-No.	Samples	Deposited
Ambach	7332	L 15/50	Coll. L. LANG
Attenfeld	7233	12	Coll. P. HOLLEIS
Bergheim	7133	1	BSP
Eitensheim	7133	1	BSP
Goldbach	7628	1	BSP
Hainberg	7445	1	BSP
Hollenbach	7332	1	Coll. L. LANG
Landshut	7438/39	1	BSP
Möckenlohe	7133	4	BSP
Neuburg a. d. Donau	7233	1	BSP
Prielhof	7133	17	BSP
Sandizell	7433	1	BSP
Sinning	7332	1	Coll. L. LANG
Weissenkirchen	7133	1	BSP
Zahling	7532	1	BSP
Ziegelau	7232	1	Coll. P. HOLLEIS

or found as solitary cells among the fibres, lumen of fibres, e.g. 7-10 µm, thick-walled 6-8 µm. Rays 1-2-(3)-seriate, heterocellular, 5-87 cells (103-603 µm) high, composed of both procumbent and upright cells (KRIBS type II), multiseriate rays are composed of procumbent and quadratic cells, upright and quadratic cells form long uniseriate extensions; 13-18 rays per mm tangential.

2.2. Affinity

Species of the extant genus *Liquidambar* show a broad similarity in their qualitative features to the present fossil. Fossil wood species of *Liquidambar* are known from the Tertiary in Hungary (FELIX 1884, GREGUSS 1969), in the Netherlands (VAN DER BURGH 1973), in USA (PRAKASH & BARGHORN 1961), in Canada (ROY & STEWART 1971), in Japan (SUZUKI & WATARI 1994) and France (SAKALA, PRIVÉ-GILL & KŒNIGUER 1999). It is difficult and nearly impossible to compare and to distinguish each of the about 12 species based on their descriptions and microphotographs, especially the anatomical features of the longitudinal sections. To minimize the nomenclatural and taxonomic clutter caused by miss-identifications of fossil species and the unnecessary creation of new names, the present silicified wood is assigned only to the genus. Therefore, it seems best to identify the wood sample from Ambach, presumable stemwood, as *Liquidambaroxylon* sp.

The silicified wood remains (Table 1) represent presumable also mature secondary xylem (trunk, branch). The samples and the thin sections are deposited a) in the Bavarian State Collection of Palaeontology and Geology (BSP), b) in the collections of PETER HOLLEIS or

Ludwig Lang. A microphotograph (Fig. 13) shows the anatomical structure of a silicified specimen from the locality Möckenlohe (TK 7133, Eichstätt).

Acknowledgements

The author is greatly indebted to Dr. Robert Hochleitner and Dr. Helmut Mayr for providing fossil material from Faskruds Fjord, Iceland. Thanks are due to Academic Director Dr. Dietger Grosser, Institute of Wood Research, Technical University, Munich, for discussion about the *Larix-Picea* problem, and also for other facilities. Technical assistance: C. Helbig, H. Mertel, U. Projahn. (thin sections) and R. Rosin (film processing, prints).

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