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CONTRIBUTIONS TO THE STUDY OF THE EARLY JURASSIC PETRIFIED FOREST OF HOLBAV AND CRISTIAN AREAS (BRAȘOV REGION, SOUTH CARPATHIANS, ROMANIA). 1st PART

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Abstract Early Jurassic flora in the Romanian Carpathians is well known by the study of fossil foliages found in the "Liassic" coaly deposits. The identified flora belongs to bryophytes, pteridophytes, pteridosperms, cycads and gymnosperms. With a few exceptions, few data have been published as regards the Early Jurassic lignoflora from the Romanian Carpathians. The present xylotomic study performed on a rich collection of petrified woods found in the Lower Jurassic coaly deposits from the Holbav and Cristian areas in the Brașov region, located in the easternmost part of the South Carpathians, allowed the identification of five newly described Early Jurassic gymnosperm lignotaxa, such as *Agathoxylon holbavicum* sp. nov., *Brachyoxylon holbavicum* sp. nov., *B. cristianicum* sp. nov., *Protophyllocladoxylon holbavicum* sp. nov. and *Palaeoginkgoxylon* sp. This new Early Jurassic gymnosperm lignoflora may shed an outstanding light on the regional paleobiogeographic, paleoecologic and paleoclimatic significance of the Early Jurassic flora in the Romanian Carpathians.

Keywords: Carpathian Early Jurassic Flora, Petrified Forest, Gymnosperms, new taxa.

INTRODUCTION

The Early Jurassic flora in the Romanian Carpathians is well known by the study of vegetal remains, commonly as foliage, found in the "Liassic" Gresten-type deposits with coals. The most important areas are located in the South Carpathians (Anina, Doman and Holbav-Cristian, in the Getic domain; Sirinia, Mehadia, Cernavârf, Baia de Aramă, Obârșia-Cloșani, Crasna-Jiu and north of Vâlcan and Parâng Mts., in the Danubian domain), and also in the Apuseni Mts (Șuncuiuș, in the Bihor domain).

Historical references on the Early Jurassic flora in these areas come mostly from the second half of the 19th century (Foetterle, 1850, Andrae, 1852, 1855; Ettinghausen, 1852a-b, Stur, 1860a-b, 1872; Hauer & Stache, 1863; Herbich, 1878; Römer, 1878; Toula, 1911) and a few from the first half of the 20th century (Podek, 1913; Krasser, 1915, 1922; Manolescu, 1932; Langer, 1947). Modern references come from the second half of the 20th century and the beginning of the 21th century (Semaka, 1955-1972, Semaka & Givulescu, 1965, 1972; Humml, 1957, 1963, 1969; Drăghici & Semaka, 1962; Iliescu & Semaka, 1962; Oarcea & Semaka, 1962; Drăghici *et al*., 1964; Mateescu, 1964; Zberea *et al*., 1966; Givulescu, 1975-2002; Stănoiu, 1982; Preda, 1988; Preda *et al*., 1989a-b, 1994; Bădăluță *et al*., 1988; Givulescu & Czier, 1990; Givulescu & Popa, 1994, 1998; Popa, 1992-2014; Czier, 1995-2016; Barbacka *et al*., 2014, 2015, 2016).

There are several attempts to achieve an Early Jurassic phytostratigraphy (Semaka, 1957, 1961c, 1962d, 1963, 1965b, 1970b; Czier, 1995b, 1999b, 2000, 2016a-b; Dragastan & Popa, 1997; Popa, 1998, 2000b, 2009; Popa & van Konijnenburg-van Cittert, 2006).

As compared with the Early Jurassic leaf flora, the first mentions regarding the presence of the Early Jurassic lignoflora in the Romanian Carpathians have been done for the first time in the second half of the 20th century while the xylotomical study of fossil woods practically started much later. Even if these were presumably known previously, only Vîlceanu, (1960) and Manilici & Vîlceanu (1962, p. 551, pl. 3, fig. 17) have firstly mentioned the presence of silicified wood trunks in the Lower Jurassic deposits with coals from the Holbav area, in the Brașov region, but no xylotomical study was done. Popa (1998, p.181) quotes some preliminary identifications (not published, simply reported to him by Marc Philippe, University of Lyon, France) on a few samples of petrified wood from Holbav and Cristian collected by Grădinaru in the early 1970s, cited as it folows: *Simplicioxylon hungaricum*, *Agathoxylon* sp. (wrong cited as *Agathis* sp.), and *Protocupressinoxylon* sp.

More recently, Philippe *et al*. (2006) based also on the wood material collected by Grădinaru in the early 1970s, reported the occurrence of *Brachyoxylon* sp., *Protelicoxylon* sp., *Protocircoporoxylon* sp. and *Protopodocarpoxylon* sp. in the Hettangian-Sinemurian of Holbav. From the Lower Jurassic deposits at Șuncuiuș, in the Apuseni Mountains, the occurrence of *Simplicioxylon hungaricum* Andreánszky, 1949 is also reported by Philippe *et al*. (2006).

Iamandei *et al*. (2008, 2009, 2011) notified some preliminary identifications in the material collected by Grădinaru from Holbav, as forms of *Agathoxylon*, *Brachyoxylon*, *Circoporoxylon*, and possibly of *Protocupressinoxylon* and *Ginkgoxylon*.

The present study is a further advance in the xylotomical study of the Early Jurassic petrified wood remains from Holbav and Cristian areas, both located in the Brașov region, in the easternmost part of the Getic domain in the South Carpathians. Several Early Jurassic lignotaxa are described, as the following species: *Agathoxylon holbavicum* sp. nov., *Brachyoxylon holbavicum* sp. nov.,

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Brachyoxylon cristianicum sp. nov., *Protophyllocladoxylon holbavicum* sp. nov., and *Palaeoginkgoxylon* sp. The present paper is based exclusively on the study of the silicified woods in the "Grădinaru Collection". As many others silicified woods were collected in the last decades in the Holbav and Cristian areas by the authors of the present paper, their xylotomical study will be done in future papers.

GEOLOGICAL SETTING AND STRATIGRAPHIC DATA

The Lower Jurassic Gresten-type deposits with coals are known for a long time in the Holbav and Cristian areas, both located in the Brașov region. According to Săndulescu (1984), the Holbav area is located in the Holbav Unit while the Cristian area is located in the Brașov Unit, both units belonging to the Getic domain that is prolonged in the easternmost part of the Southern Carpathians (Fig. 1).

Holbav area

In the Holbav area, the industrial mining extraction of coal started early in the second half of the 19th century and continued until the late 1960s when it stopped due to limited coal reserves and difficult geological conditions (Bielz, 1858; Meschendörfer, 1860; Hauer & Stache, 1863; Herbich, 1878; Römer, 1878, 1879, 1885; Wachner, 1914, Jekelius, 1923a-b, 1927, 1938; Vîlceanu, 1960; Semaka, 1962d, 1967a; Mateescu, 1964; Năstăseanu *et al*., 1970; Săndulescu *et al*., 1984).

Obviously, the Lower Jurassic deposits with coals are poorly appearing as natural outcrops in the Holbav area. The description of the stratigraphic successions and of the lithologies of the Lower Jurassic deposits, such as it has been given by the different authors, are based mainly on data obtained from mining works and from boreholes. The tectonic structure of the Holbav Unit (or the so-called "Holbav Synclinal" in the older literature), interpreted as occurring in a tectonic window by Săndulescu (1967; 1984, figures 83, 86), is very complicated due to the

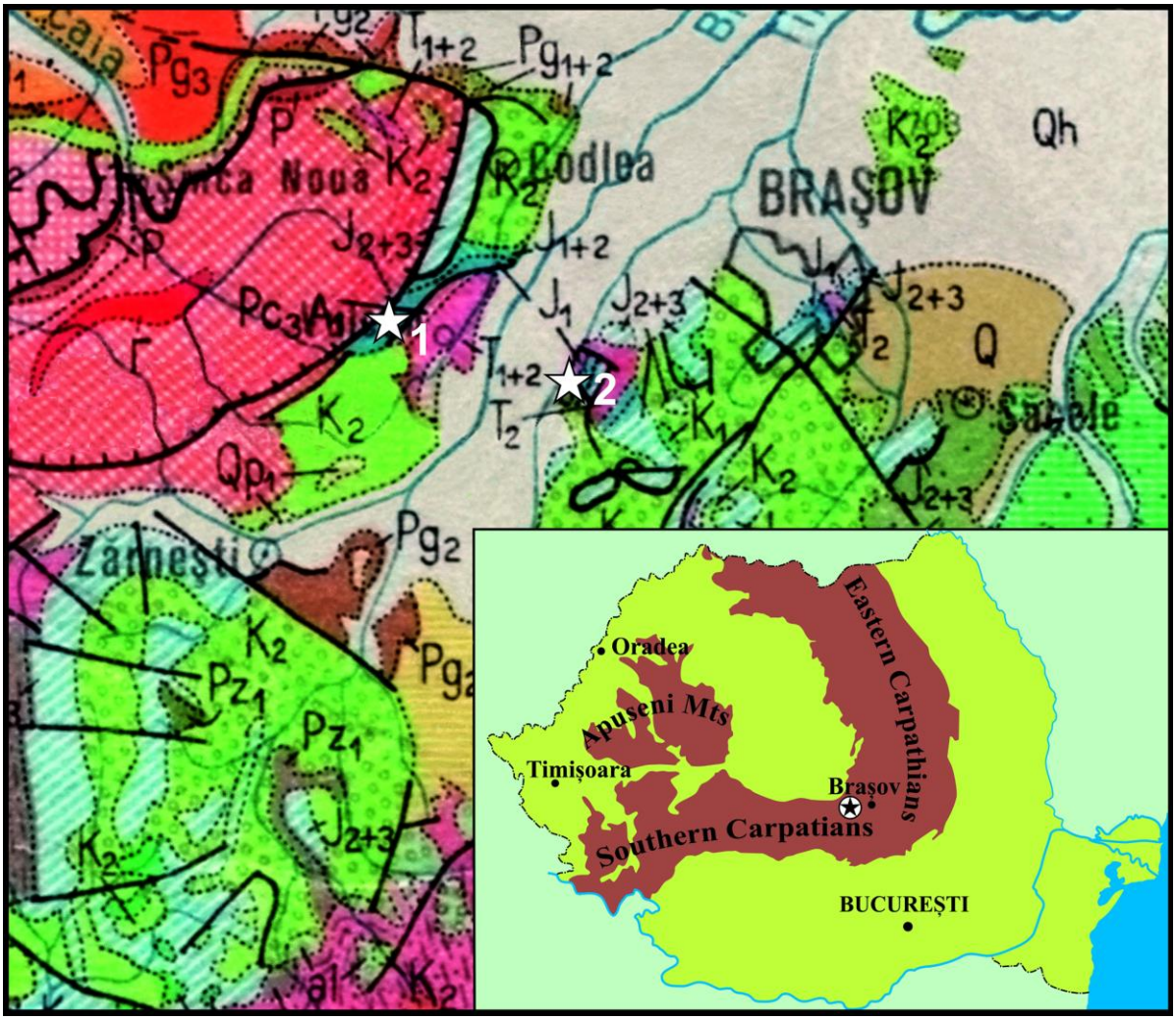

Fig. 1 Location of the Holbav (1) and Cristian (2) areas on the Geological Map of Romania, Scale 1:100000000, ed.1978, Geological Institute of Romania (excerpt). Inset map shows the location of the Brașov region (encircled star), in the easternmost part of the Southern Carpathians.

overthrusting of the Supragetic Unit along the Holbav Fault, and also due to the overthrusting of the Getic Măgura-Codlei Scale and the Brașov Unit.

As a consequence, the stratigraphical and lithological descriptions of the Lower Jurassic deposits in the Holbav Unit given along time by the different authors (Jekelius, 1923a-b, 1927, 1938; Vîlceanu, 1960; Manilici & Vîlceanu, 1962; Semaka, 1962d, 1967a; Mateescu, 1964; Năstăseanu *et al*., 1970; Săndulescu *et al*., 1984; Ștefănuț & Cibotaru, 1986) are, at most, informative (Grădinaru, in Philippe *et al*., 2006, and Grădinaru, in Haas *et al*., 2011).

Vîlceanu (1960), based mainly on data from mining works and boreholes, identified in the Lower Jurassic deposits with coals from the Holbav area (Fig. 2) four lithological complexes, as follows:

- the lower productive complex,
- the effusive-pyroclastic complex (bearing silicified woods),
- the upper productive complex, and
- the sandstone complex.

Patrulius *et al.* (1980) and Săndulescu *et al*. (1984) provided a general lithological description of the Lower Jurassic coaly deposits from the Holbav area, with three sequences:

- the lower sequence, mainly with clays and sandstones bearing coaly clays and coals, occasionally interlayered by reddish-cherry clays;
- the median sequence, volcano-sedimentary, with rhyolitic and trachytic pyroclastites, tuffs, tuffaceous rocks and eruptive rocks such as ignimbrites, trachytes, and basaltic rocks, subordinately having intercalations of clays, bituminous claystones, coaly clays and thin-bedded sandstones.
- the upper sequence, mainly with clays and sandstones, bearing coal intercalations and refractory clays.

All of the above lithostratigraphic schemes are based mainly on data from mining works and boreholes, and not on objective data coming from mapping and definition of stratigraphic relationships in outcrops. The strong tectonic deformation, the poor outcrops and the complex depositional architecture that is characteristic for the alluvial and the coal-bearing lacustrine deposits (Reading, 1996), all of these make difficult to establish the stratigraphic succession of the Lower Jurassic deposits in the Holbav Unit. On the other side, the unevenly distibution of the effusive rocks and pyroclastites in the Lower Jurassic coaly deposits in the Holbav area (Săndulescu *et al*., 1986) makes difficult the distinguishing among the lower and the upper sequences with coals.

Dragastan & Popa (1997) informally grouped the Lower Jurassic deposits with coals from the Holbav area under the name of the "Holbav Formation", with two members, the "Concordia Member" (early Hettangian), and the "Pârâul Crucii Member" (middle Hettangian - Sinemurian - Pliensbachian), respectively.

On his turn, Czier (1999a) introduced the "Codlea-Vulcan Formation" (Hettangian-Pliensbachian), with three members, the "Codlea Conglomerate Member" (Hettangian pro parte), the "Vulcan Sandstone Member" (Hettangian pro parte-Sinemurian), and the "Holbav Clay Member" (Pliensbachian). It should be underlined that the both lithostratigraphic schemes are informal, because none of them is following the principles of stratigraphic classification defined by the International Stratigraphic Guide (Murphy & Salvador, 1999). None of the above-named lithostratigraphic units are defined based on type sections or stratotypes, whereas the indicated ages are not based on reliable biostratigraphic data.

The only firm biostratigraphic data for dating the Lower Jurassic deposits with coals in the Holbav area have been provided by Antonescu (1973) and Antonescu (in Săndulescu *et al*., 1984) based on palynological investigations.

In the upper half of the upper sequence defined by Săndulescu *et al*. (1984), occurring on the Bisericii brook, a Toarcian microflora has been identified, with *Matonisporites crassiangulatus* (Balme) Dettmann, *Calialasporites* spp., *Neoraistrikia samuelssoni* Tralau, *Sestrosporites pseudoalveolatus* Dettman, *Nannoceratopsis gracilis* Alberti, *N. plegas* Drugg, *Leptolepidites major* Couper, and other genera and species of Early Jurassic age. From the base of the upper sequence, just above the volcano-sedimentary sequence, a Pliensbachian microflora has been identified, with *Ischyosporites variegatus* Schultz (extremely frequent), cf. *Manumia irregularis* Pocock and cf. *Cingulatisporites*. A coaly-siltic intercalation, located in the lower part of the volcano-sedimentary sequence, delivered a rich Pliensbachian assemblage with acritarchs of *Micrhystridium* - type, which is correlatable with the acritarch assemblage of the Pliensbachian spathic sandstones from the Cristian area. It is assumed that the lower sequence with coals from the Holbav area may be assigned to the Hettangian(?)-Sinemurian interval.

In the mid 1970s, Grădinaru (unpublished data) collected an early Toarcian dactylioceratid ammonite specimen and also montlivaltid corals in the fine-grained micaceous sandstones of the upper sequence, interlayered by coaly deposits, occurring in the quarry for extraction of refractory clays, which fully confirms the palynological dating by Antonescu (1973) and Antonescu (in Săndulescu *et al*., 1984), and argues also for the marine ingression. On the other side, the finding of the middle Toarcian ammonite *Hildoceras sublevisoni* Fucini, in a dark black mudstone (Grădinaru, unpublished data) documents that the Early Jurassic sedimentation continued in the Holbav area, in fully marine facies in the middle Toarcian.

Plant remains, preserved as foliage in the Lower Jurassic coaly deposits in the Holbav area have been mentioned early by Andrae, 1852; Stur, 1860a-b; 1872; Meschendörfer, 1860; Hauer & Stäche, 1863; Herbich, 1878; Römer, 1878; Toula, 1911; Krasser, 1922. Numerous modern studies on the "Liassic" flora from Holbav area have been published by Semaka (1955, 1956, 1957, 1958, 1962d, 1965b, 1967a, 1971, 1972) and Semaka & Givulescu (1965). Also, Givulescu (1992c, 1997b) and Givulescu & Czier (1990) have contributed to the knowledge on the Early Jurassic flora in the Holbav area.

Data on the plant occurrences and on coal petrography in the Holbav area have been given by Mateescu (1964) and Năstăseanu *et al*. (1970). In the recent decades, contributions to the Early Jurassic flora in the Holbav area have been given by Dragastan & Popa (1997), Popa (1997a, 1998, 2000b-c) and Popa & van Konijnenburg-van Cittert (1999, 2006). Dragastan & Popa (1997) and Czier (2016b) advanced phytostratigraphic schemes for the Early Jurassic foliar material identified in the Holbav

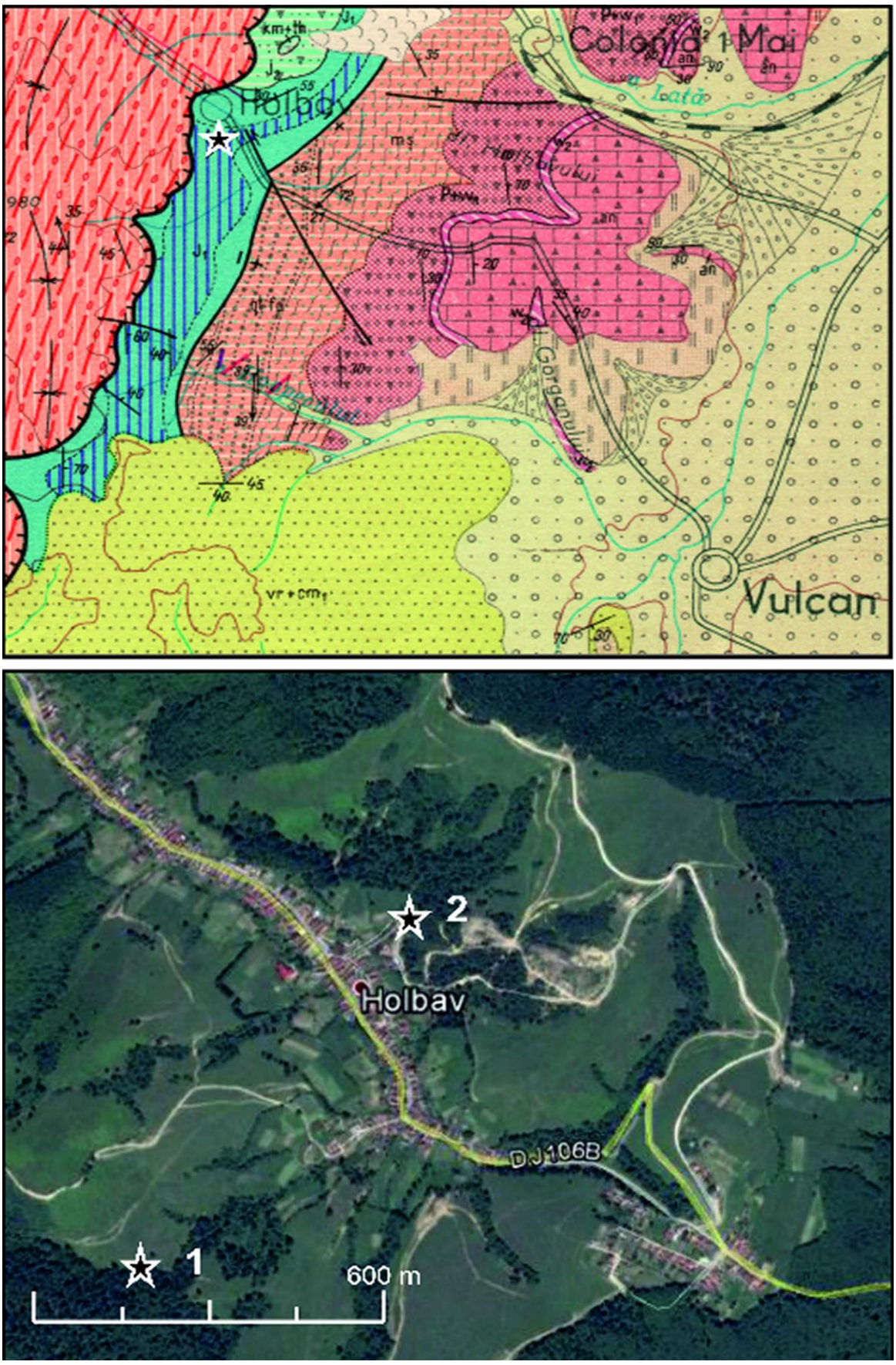

Fig. 2 Location of the Holbav area on the Geological Map of Romania, 1:50000, Sheet 110b Zărnești (excerpt), Geological Institute of Romania (excerpt), and Google Earth image (2018 CNES/Airbus) showing the location on the Maiului brook (star 1) and on the Bisericii brook (star 2) where the Early Jurassic woods were collected. Symbols: P-w1,– Permian-lower Werfenian (Lower Triassic), w2 – upper Werfenian (Lower Triassic); an – Anisian (Middle Triassic).

area. Once more, it should be mentioned that the most part of the Early Jurassic flora described from the Holbav area has been collected from the mining dumps, and thus they do not have a reasonable or reliable stratigraphic control.

With regard to the wood remains in the Lower Jurassic coaly deposits in the Holbav area, it is stressed that Vîlceanu (1960) and Manilici & Vîlceanu (1962) for the first time mentioned the presence of silicified wood trunks, reaching till 0.70 m in thickness, in the effusive-pyroclastic complex.

In the early 1970s, Grădinaru collected numerous wood trunks, of various sizes, in the middle section of the Maiului brook, and also a few specimens in the middle section of the Bisericii brook (Fig. 2). As concerns the stratigraphic position of the wood trunks, at least in the Maiului brook, there are evidences for their occurrence in the lahar deposits of the uppermost part of the effusive-pyroclastic complex.

Cristian area

In the Cristian area, the mining extraction of coal started in the late 1870s and stopped in the early 1920s (Herbich, 1878; Wachner, 1914; Jekelius, 1923a-b), while the mining extraction of refractory clays continued until the early 1980s. Data on the occurrence and stratigraphy of the Lower Jurassic coaly deposits in the Cristian area have been published by Herbich (1878), Jekelius (1914, 1915a, 1923a-b, 1938), Wachner (1914), Patrulius (1961), Săndulescu (1964), Kusko *et al.* (1979), Patrulius *et al.* (1980), Săndulescu *et al*. (1984). The stratigraphic succession of the Lower Jurassic deposits in the Cristian area is substantially different than that in the Holbav area (Jekelius, 1923a-b, 1938; Patrulius *et al*., 1980; Săndulescu *et al*., 1984).

It starts with a coaly sequence with refractory clays, the Hettangian-Sinemurian age of which is fairly demonstrated by the invertebrate fauna (bivalves and ammonites) identified by Jekelius (1914, 1915b) and Popa (in Patrulius *et al*., 1980). Antonescu (1973), and Antonescu in Patrulius *et al*. (1980) and in Săndulescu *et al*. (1984), identified palynological assemblages that demonstrated the Hettangian-Sinemurian age of the coaly sequence in the Cristian area. The Hettangian age is demonstrated by the occurrence of *Rogalskaisporites cicatricosus* (Rogalska) Schulz, *Convolutispora microrugulata* Schulz, *C. microfoveolata* Schulz, *Tigrisporites rhaeticus* (Schulz) Schuurman, *T. rudis* (Leschik) Klaus, *Triancoraesporites ancorae* (Rheinhardt) Schulz, *Auritulinasporites triclavus* Nilsson and *Kyrtomisporites* sp. The Sinemurian age is demonstrated by a very rich assemblage of spores and pollens, including *Dictyophyllidites harrisi* Couper, *Cyathidites australis* Couper, *C. minor* Couper, *Concavisporites juriensis* Balme, *Deltoidospora* sp., *Osmundacidites wellmanii* Couper, *Lycopodiacidites cerebriformis* (Naumova ex Bolchovitina) Semenova, *Punctatosporites scabratus* (Couper), *Cerebropollenits macroverrucosus* (Thiergart) Schulz, *Chasmatosporites apertus* (Rogalska) Nilsson, *Monosulcites minimus* Cookson, *Corollina meyeriana* (Klaus) Venkatachala & Góczán, *Classopollis torosus* (Reissinger) Balme, emend. Morbey, *Bennettitinaepollenites bitorosus* Bóna, *Vitreisporites pallidus* (Reissinger) Nilsson, *Obtusisporites junctus* (Kara-Murza) Pocock, *Lycopodium* spp.

On this basis it is demonstrated that the coaly sequence from Cristian is correlable with the lower coaly sequence from the Holbav area. The coaly sequence from Cristian has the most extended distribution on the left side of the Căldării valley and in the regions of the Fabricii and Joaderului valleys. Czier (1999a) introduced the "Cristian Formation" for the coaly sequence from the Cristian area, but it is an informal lithostratigraphic unit because no type section or stratotype is indicated. On the other hand, it is not possible owing to the poor outcropping conditions of the coaly sequence. The coals were extracted only in the Căldării valley, while the refractory clays were extracted in the regions of the Fabricii and Joaderului valleys. Upwards, the succession of the Lower Jurassic deposits from the Cristian area (Fig. 3) is developed in fully marine facies, with Pliensbachian spathic sandstones and Toarcian fine-grained micaceous sandstones (Jekelius, 1914, 1915a, 1938; Săndulescu, 1964; Patrulius *et al*., 1980).

Thus, when the Lower Jurassic sedimentary successions in the Holbav and Cristian areas are compared, it is to underlie that the coaly deposition in the Holbav area lasted until the lower Toarcian, while in the Cristian area the coaly deposition is limited only to the Hettangian-Sinemurian time interval. It means that while the marine invasion in the Holbav area happened later, in the early Toarcian, in the Cristian area the marine influence happened much earlier and it is demonstrable by the presence of intercalations of siltstones with Sinemurian marine fauna in the coaly sequence (Jekelius, 1915b; Patrulius *et al*., 1980).

Another marked difference among the Holbav and Cristian areas is represented by the missing or a more reduced and only the local occurrence of the effusive-pyroclastic rocks in the Cristian area. Only greenish ignimbritic rocks were found in the upstream section of the Căldării valley, and in the excavation works for building the PECO oil repository from Cristian (Grădinaru, unpublished data).

Data on the Early Jurassic flora from the Cristian area have been published early by Meschendörfer (1960), Hauer & Stache (1863), Stur (1960a-b, 1872), Herbich (1878), Toula (1911) and Krasser (1922) and these are based on plant remains coming from the mining works in the Căldării valley. Semaka (1965b) and Popa (1998, 2000a-c) discussed on the Early Jurassic flora from the Cristian area based on historical materials, and identified them as being of Sinemurian age.

Based on plant remains collected by Grădinaru in the early 1970s from the dump rocks coming from mines extracting refractory clays in the upstream of the Fabricii valley, Popa (1998) described a new species of *Pachypteris*: *P. grădinarui* Popa.

Czier (2016b) also agrees the Sinemurian age, and assigned the foliage material described from Cristian to his "*Anomozamites marginatus* Biozone".

Also, in the early 1970s Grădinaru collected some fragments of petrified wood from the right tributary of the Fabricii valley, just upstream of the former charging station of refractory clays, and originating probably from the dumps of the old mine galleries (Fig. 3).

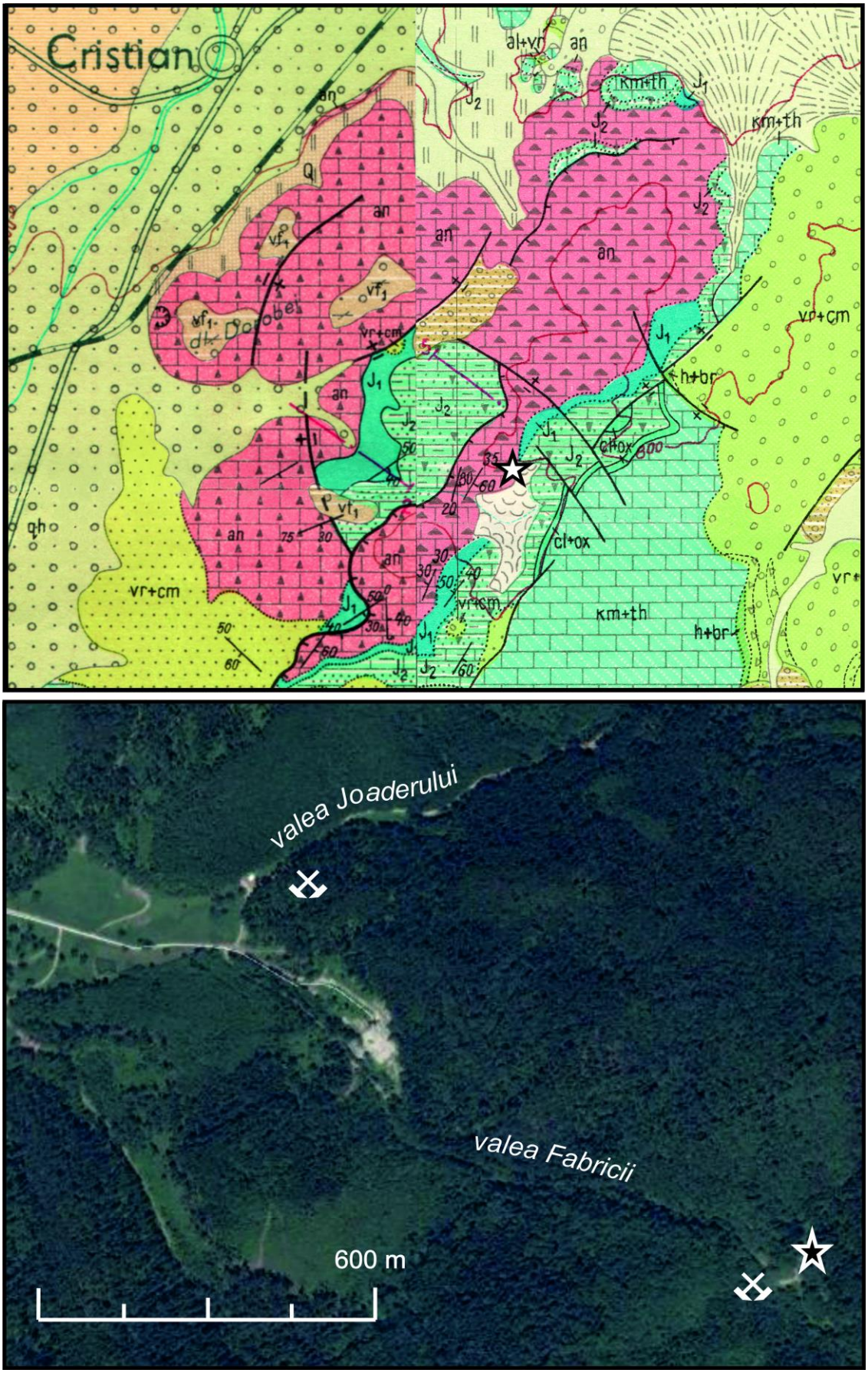

Fig. 3 Location of the Cristian area on the Geological Map of Romania, 1:50000, Sheet 110b Zărnești (excerpt) combined with Sheet 111a Brașov (excerpt), Geological Institute of Romania, and Google Earth image (2018 CNES/Airbus) showing the location on the Valea Fabricii brook (star) where the Early Jurassic woods were collected. Symbols: an – Anisian, Middle Triassic; J1 – Lower Jurassic; J2 – Middle Jurassic; x - abandoned mines.

MATERIAL AND METHODS

A rich fossil wood material was collected in the early 1970s by Grădinaru from the Lower Jurassic coaly deposits in the Holbav and Cristian areas. The most part of the wood material was collected in the mid section of the Maiului brook (Google Earth coordinates: 45º39'12.74" N; 25º22'51.02" E, elev. 776 m), which is a left tributary of the Holbav valley, reaching it in the center of the Holbav village.

Apparently, the material is stratigraphically located in the uppermost part of the effusive-pyroclastic sequence of the Lower Jurassic deposits of the Holbav area, which on palynological data is dated as Pliensbachian in age. A small number of specimens were collected in the Cristian area, on a left tributary reaching the Fabricii valley in its upper section (Google Earth coordinates: 45º36'09.95" N; 25º30'13.23" E, elev. 735 m), all coming from the Hettangian-Sinemurian coaly sequence.

This collection of petrified woods, from which 33 samples were included in the present palaeoxylotomical study, is hosted now by the National Geological Museum, in Bucharest, under the name of "Grădinaru Collection".

The most part of the wood material is represented by trunk fragments, sometimes partially charcoalified and included in the lahar deposits where, subsequently, have been silicified. An additional rich material was collected by the authors of this study in the last decades, from the Holbav and Cristian areas, and this will be studied in the future.

The samples of petrified wood were firstly macroscopically studied and the directions of standard oriented sections (transversal, tangential and radial) were carefully marked. In the next stage, following the petrologic method, thin sections were cut and realized (excluding the mounting of lamella, replaced with transparent laquer, even nail polish), in the specialized laboratory of the Geological Institute of Romania, in Bucharest.

The sections have been studied under a microscope with transmitted light (NIKON - Eclipse E400). The microphotos were realized with a video-camera "EverFocus". The plates with microphotos were realized with the help of "PaintShopPro" program combined with "StarOffice5.2"-Presentation.

During the microscopic study a description of the xylotomical details with possible taxonomical value was done for every specimen in all the three standard oriented sections. After all these, in a chapter of "affinities and discussions" we cited other studies and we tried to compare our studied structures with other xylotomically described fossil forms already published, in order to identify the studied fossil wood as a known or new taxon.

The xylotomic description generally followed the nomenclatural code for gymnosperm woods of IAWA Committee (2004) and Ruffinatto *et al*. (2015) and the genera delimitation by Philippe & Bamford (2008) and also, the suprageneric taxonomy of Christenhusz *et al*. (2011) and Chase & Reveal (2009).

PALAEOXYLOTOMICAL STUDY

Gymnospermae

Division **Pinophyta** Cronquist, Takht. & Zimm. ex Reveal, 1996
Order **Pinales** Gorozhankin, 1904

Genus ***Agathoxylon*** (Hartig) Philippe, 1995
Agathoxylon holbavicum sp. nov.
Fig. 4 a-i.

The studied material

The studied material is represented by a decimetric-sized piece of silicified wood collected from Holbav locality area (Brașov County), on Maiului brook, in Lower Jurassic continental pyroclastic deposits considered of Pliensbachian age. The studied sample is a trunk or thick-branch fragment with decimetric size, dark to black color and by magnifying glass, or even by naked eye, a regular fibrous structure, suggesting a conifer wood. The studied specimen with the field-number 1041 belong to "Grădinaru Collection", and is deposited in the collections of the Geological Institute of Romania (G.I.R. Collections), hosted by the National Geological Museum, Bucharest, under the inventory number 27611.

Microscopic description

The studied specimen presents s e c o n d a r y w o o d with tracheidoxylic structure, with relatively distinct growth-rings boundaries and devoid of any normal or traumatic resin canals.

T r a c h e i d s - with polygonal cross-section with slightly rounded corners, often determining small intercellular spaces. With polygonal rounded lumina unequally sized with radial/tangential diameters of 20-30/20-38 μm and thick walls, of 8-13 μm (double wall), thinner in early-wood: 5-8 μm the double-wall. There are 1-9 radial regular rows of tracheids between two successive rays and the density is (675)1155-1650 tracheids per mm2. Tangentially seen, the tracheids are unpitted. The radial pitting is typical araucarian, as uniseriate vertical rows of contiguous hexagonal pits and as biseriate rows with alternate contiguous also hexagonal bordered pits with a diameter of 17-20 μm, and oblique elliptic to vertical apertures of 7.5/2.3 μm in diameters. There are no crassulae or helical thickenings.

A x i a l p a r e n c h y m a - is absent.

M e d u l l a r y r a y s - are thin, rectilinear and are constituted of quadrangular cells with smooth horizontal walls. Tangentially the rays have 1-19 cells in height, i.e. 20-380 μm high. Sometimes the taller rays are locally biseriate, so often they appear as biseriate rays with long endings. The ray cells are polygonal slightly rounded and flattened, unequal in size and relatively thick walled: of 2.5-3.1 μm the simple wall. The ray density is 8-14 rays per horizontal tangential millimeter. Radially the rays are homocellular, cells all procumbent of 20-30 μm high, moderately thick-walled: 5-6.2 μm the double wall. Indentures were not observed. Within the marginal rows the ray-cells are higher, of 30-40(-45) μm, with their outer wall slightly wavy. The typical araucarioid cross-fields have 1-6(-9) oculipores, cupressoid (tending to araucarioid) pits, slightly rounded or hexagonal, of 9-13 μm in diameter, with round or short elliptic tilted apertures to vertical, of 3.5-5.5 μm. In the cross-fields with body ray-cells the pits are 1-3 arranged in one horizontal row, or 2-

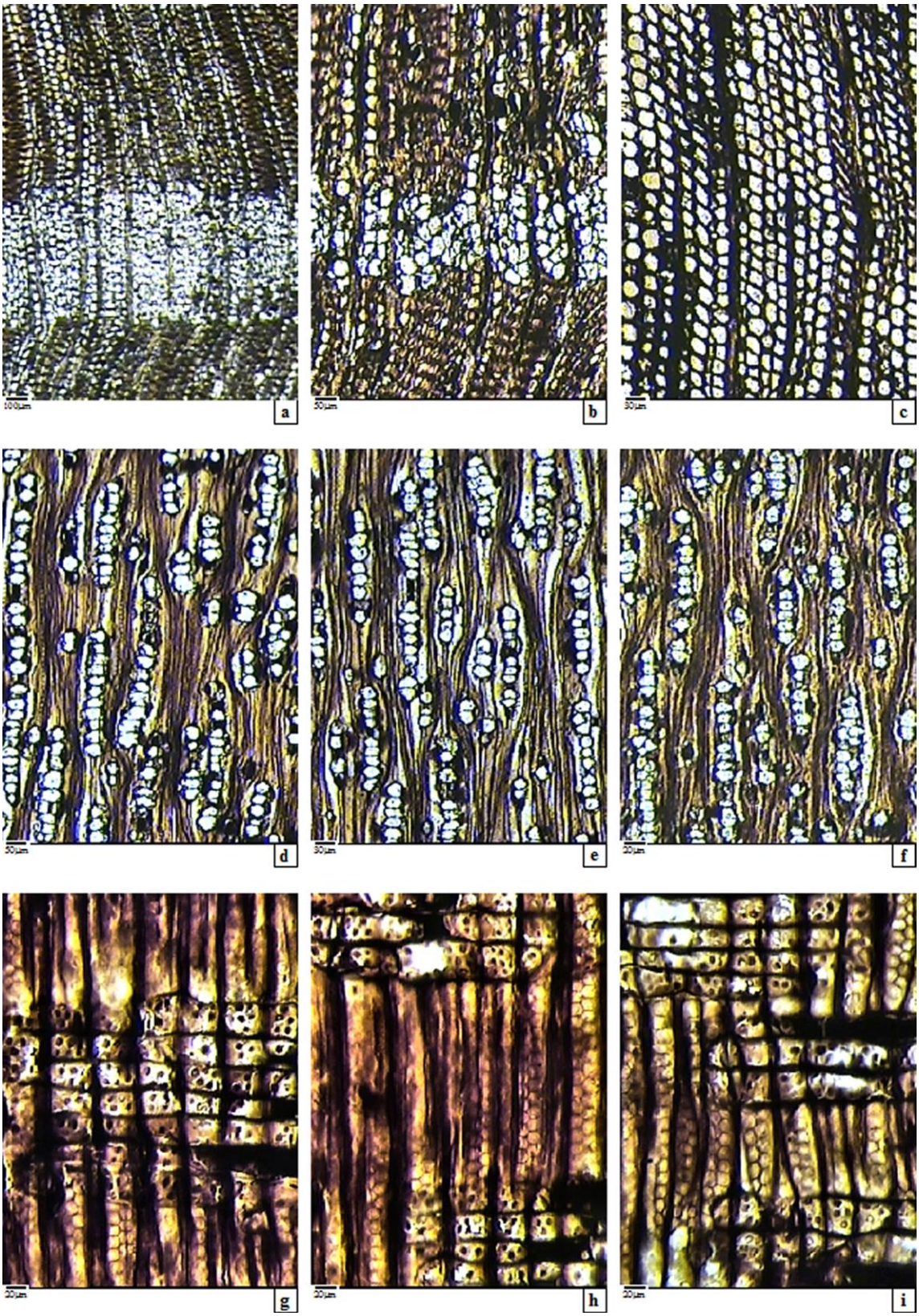

Fig. 4 *Agathoxylon holbavicum* sp. nov. - holotype - inventory no. 27611 (field no. 1041). **a-c** Cross section - tracheids polygonal with rounded corners, and linear rays. **d-f** Tangential section - uniseriate rays with biseriate storeys with polygonal ray-cells, with lateral empty spaces; unpitted tracheids. **g-i** Radial section - araucarian radial piting on tracheids, alternate hexagonal pits, araucarioid cross-fields with 2-3 superposed rows of hexagonal pits.

6 pits on 2 rows, alternately arranged, or slightly irregular. In the marginal fields they are more numerous, alternately arranged, or slightly irregular, in 2-3 horizontal superposed rows. Often, isolated ray-cells or rows of ray-cells in the body or even marginal cells are full of resin content, visible also in tangential view.

Affinities and discussions

The studied specimen presents a combination of xylotomic characters similar to the extant araucariaceous conifers, consequently a comparison with this type of wood structure was performed and we observed similitude with *Araucaria* and *Agathis* (see Greguss, 1955).

Many fossil woods with tracheidoxylic structure collected from the Palaeozoic and Mesozoic formations have been recorded as species of *Araucarioxylon* and *Dadoxylon*, genera whose status is not legitimate in all cases and thus they have been invalidated (see Philippe, 1993, 1995; Philippe & Barbacka, 1997; Rößler *et al*., 2014). Thus, for this type of wood was kept the genus *Agathoxylon* Hartig, validly described and published and not yet typified, even if the type material is probably lost (Philippe, 1993).

Other genera as *Dammaroxylon* Schultze-Motel and *Pseudagathoxylon* Greguss are considered as taxonomic synonym of *Agathoxylon*, respectively of *Simplicioxylon* Andreanszky which is a valid genus (see Philippe & Bamford, 2008).

Using the identification key proposed by Philippe (1993) and Philippe & Bamford (2008) for tracheidoxyls with araucarioid cross-fields, we found that the here studied specimen fits to *Agathoxylon* Hartig. The generotype, *A. cordaianum* Hartig, presents similar features having araucarian radial pitting, araucarioid cross-fields and sometimes axial parenchyma. Although the original diagnosis of the genus *Agathoxylon* Hartig (Hartig, 1848; Philippe & Bamford, 2008) includes the presence of axial parenchyma as a diagnostic character (a feature absent in several specimens referred to *Agathoxylon*), Philippe (1995) reformulated the original diagnosis proposed by Hartig (1848), allowing the inclusion of woods with and without axial parenchyma.

This taxonomic decision is adequate since a high number of genera have already been proposed, and erecting another one for including *Agathoxylon*-like woods without axial parenchyma would lead to a more confuse taxonomy.

- We take into account that many European Cretaceous species of *Araucarioxylon*, *Dadoxylon* (*Araucarioxylon*), or *Dadoxylon* (see Schultze-Motel, 1962, 1966), only some of them equivalent to Agathoxylon, it is difficult to compare our material with them, but since a serious revision of them is missing. Also, in some recent partial revisions of the Cretaceous woods from Hungary, Italy, France and Austria, it is shown that many of them come from the Lower Cretaceous, or are not tracheidoxyls (Philippe, 1995; Philippe & Barbacka, 1997).

- Some Cretaceous similar tracheidoxyls come also from the Carpathian area (Apuseni mts.): *Agathoxylon* sp. (described initially as *Araucarioxylon* sp.) of Petrescu & Nuţu (1971), *Agathoxylon ultimum* and *A. formosum*, the last described as species of *Dammaroxylon* (by Iamandei & Iamandei, 2004), all of them presenting the typical araucarian combination of xylotomic characters.

Numerous other Jurassic–Early Cretaceous fossil-woods from Mid-Eastern Europe described as *Agathoxylon* (or equivalents that were reattributed to *Agathoxylon*) are cited by Philippe *et al*. (2006) as folows:

- *Agathoxylon agathiforme* (Kedves) Philippe et Barbacka, (in Philippe & Barbacka, 1997) and *A. parenchymatosum* (Greguss) Philippe, Zijlstra et Barbacka (in Philippe *et al*., 1999), both of them from the upper Liassic of Hungary.

- *Agathoxylon desnoyersii* (Lemoigne) Philippe, 1995 from the middle Callovian of Poland, initially described as *Araucarioxylon* sp. by Reymanówna (1956), redescribed by Lemoigne as a species of *Brachyphyllum* and now considered only as a junior taxonomical syonym (Philippe *et al*., 2018).

- *Agathoxylon pannonicum* (Greguss) Barale, Barbacka et Philippe, from the Aptian or Albian of Hungary (see Greguss, 1952; Barale *et al*., 2002).

Numerous specimens having the typical xylotomical characters: araucarian radial pitting on biseriate rows, contiguous pits, rarely spaced, and only occasionally as uniseriate rows. The cross-field pits are araucarioid, usually as 1-2 cupressoid oculipores arranged in araucarioid manner in the cross-fields were described as *Agathoxylon* sp. either as new data or reattributed to *Agathoxylon*, come from a large area:

- From the Bajocian and Barremian of Bulgaria (Philippe *et al*., 2006);
- From the Liassic of Hungary (Philippe & Barbacka, 1997; Philippe *et al*., 1999);
- From the Rhaeto–Liassic and from the Bathonian of Poland (in Philippe *et al*., 2006);
- From the Bathonian of Romania (Philippe *et al*., 1999),
- From the late Cretaceous of Spain (García Esteban *et al*., 2006);
- From Upper Cretaceous (upper Maastrichtian), Dutlu Formation of Turkey (Kutluk *et al*., 2012);
- Mencl *et al*. (2013) discuss in their paper the occurrence, the anatomical features and the taxonomy of numerous silicified woods from the Late Paleozoic Basins of the Czech Republic attributed to *Agathoxylon*.
- Philippe *et al*. (2015) reattributed an old taxon of Unger described as *Pinites* from the Keuper sandstones in Attelsdorf, Germany as *Agathoxylon keuperianum* nov. comb.
- Also Philippe *et al*. (2018) studying an old collection of Cretaceus fossil woods from France ("Lignier collection"), reattributed some badly identified woods also to *Agathoxylon* as new species or new combinations (*A. crasseradiatum*, *A. tranchantii*, or simply to *Agathoxylon* sp.).

It is obvious that this type of coniferous genus was widespread on the Earth since it was described from already all the continents. Thus, many species were described from the Middle to Upper Cretaceous of Far-East Asia and we quote: *A. tankoense* Stopes & Fujii (initially described as *Dadoxylon tankoense* (Stopes et Fujii) Shimakura (in Philippe, 1993), then an *Agathoxylon kiiense* (Ogura) Oh *et al*., *A. togeumense* Oh *et al*., *A. byeongpungense* (Kim *et al*.) Oh *et al*., (in Schultze-Motel, 1966 and in Oh *et al*., 2011).

- From Africa, we cite a species (*Agathoxylon lifiyii*) described from the Upper Cretaceous of Egypt (Karga Oasis) by Youssef *et al.* (2000) having typical generic features, and also two Permo-Triassic species (*A. africanum, A. karooensis*) described by Bamford (2016), in which the araucarian radial pitting is preserved as "Steinkerne" that mimic the mixed type of pitting (see Bamford, 2016), details not observed in our specimen.
- From South America, from the Middle Jurassic of Argentina an *Agathoxylon matildense* with distinct growth-rings, uniseriate pitting on the radial tracheidal walls with contiguous round pits and cross-fields with 4-5 cupressoid pits irregularly arranged and very low rays was described by Zamuner & Falaschi (2005) and other quasi-similar four species by Kloster & Gnaedinger (2017), all of them different of our specimen.
- Also from the Aptian of Patagonia, Vera & Césari (2012) described an *Agathoxylon*, a wood characterized by araucarian tracheid pitting, predominantly uniseriate, rarely biseriate arranged, alternate to opposite and by araucarioid cross-field pits, typical for Araucariaceae. It is true that this type of wood appears also to the Pteridospermales and Cheirolepidiaceae, and the older Agathoxylon could represent stems of various cordaitalean - conifer origin (Philippe *et al*., 2004a). In this respect must be remind that in our specimen description was observed that the taller rays are locally biseriate, often with aspect of biseriate rays with long endings, and also that often ray cells are full of resin content.
- From the Paleocene and Eocene of Western Antarctica some *Agathoxylon* species were described suggesting even possible austral Araucariaceae-dominated forests (Pujana *et al*., 2014; 2015; Mirabelli *et al*. 2018).

After this discussion of the widespread spread of this Mesozoic genus and taking into account the opinion of García Esteban *et al*. (2006) on the difficulty of distinguishing species of this genus which is species plethoric and the distinction of species is very difficult, so they preferred to describe their material only at generic level, we still believe that we are faced with a new species of *Agathoxylon* that lived within Carpathian area at least during Early Jurassic.

Thus, the studied specimen is characterized by typical araucarian pitting in uniseriate and biseriate-alternate arrangement of contiguous hexagonal pits with oblique-elliptic apertures and typical araucarioid cross-fields with numerous polygonal pits alternately arranged on 1-3 superposed horizontal rows. We named this new species *Agathoxylon holbavicum* sp. nov., remembering the name of the original area (Holbav) from where the studied material was collected. The specimen with inventory no. 27611 (field number 1041) was designated as holotype hosted now in G.I.R. Collections, in the National Geological Museum, Bucharest.

Diagnosis of the new species *Agathoxylon holbavicum* sp. nov.:

Tracheidoxyl with typical araucarian cross-section, with distinct growth rings, without resin canals or axial parenchyma. Tangential tracheidal walls unpitted, radial pitting typical araucarian, uniseriate and biseriate alternate, with contiguous, hexagonal pits with oblique elliptic to vertical apertures. Rays - uniseriate, locally biseriate, homocellular, marginals higher, with outer wall slightly waved, often with resin content. Cross-fields typical araucarioid with 1-9 oculipores as araucarioid pits alternately arranged on 1-3 horizontal rows, hexagonal or slightly rounded, with short elliptic tilted apertures to vertical.

Genus ***Brachyoxylon*** Hollick & Jeffrey, 1909
Brachyoxylon holbavicum sp. nov.
Fig. 5 a-i; Fig. 6 a-i.

The studied material

The studied material is represented by 24 decimetric-sized samples of silicified wood found around Holbav locality area (South Braşov County), on Maiului brook, in the Early Jurassic continental pyroclastic deposits considered of Pliensbachian age. All the studied samples are trunk or thick-branch fragments, with decimetric size, dark to black color and by magnifying glass or even by naked eye, regular fibrous structure without vessels suggesting a conifer wood. The specimens with field numbers: 1006, 1007, 1008, 1009, 1010, 1012, 1013, 1014, 1021, 1022, 1024, 1025, 1026, 1028, 1030, 1031, 1033, 1034, 1035, 1039, 1044, 1045, 1046, 1047 - belong to "Grădinaru Collection", are deposited now in the collections of the Geological Institute of Romania (G.I.R. Collections), under the inventory numbers 27612 - 27635 respectively, at the National Geological Museum, in Bucharest.

Microscopic description

In a synthetic description, all the studied specimens present s e c o n d a r y w o o d with tracheidoxylic structure devoid of normal resin canals, with a slight gradual diminishing of tracheids' size from the early to the late wood (very obvious in the specimens 1012, 1033), with relatively less distinct up to clearly distinct growth rings boundaries, marked by few rows of smaller flattened tracheids of the late wood. However in a specimen (i.e. 1010), an isolated canal rounded by a parenchyma cells was observed in cross section, most probably of traumatic origin and keeping inside some granular dark content. In some other specimens the thinner walled early and transitional wood is slightly compressed, or crushed or even collapsed, like in the charcoal (in the specimens: 1012, 1013, 1014, 1026, 1028). Sometimes, few details can be seen due to bad preservation during fossilization processes leading to vitrinite (as in the specimen 1029 which was excluded from study since it has no any structure kept, or only partially in the specimen 1031). Only in the sample 1044 appear the axial zone with primary wood that in cross section shows also arthropods galleries with coprolites, visible especially in the longitudinal sections.

T r a c h e i d s with polygonal, mainly quadrangular cross section with rounded corners are displaying quadrangular slightly rounded lumina, or with curled walls often giving a "star-like" aspect of the lumina, often with discontinued walls due to the fossilization processes that often lead to deformed lumina or all of them are crushed by lateral compression (like in the specimen 1047). In a normal structure the tracheids, unequal in size, i.e. gradually diminishing from the early to the late wood, with radial/tangential diameters of 25-50 (60)/20-

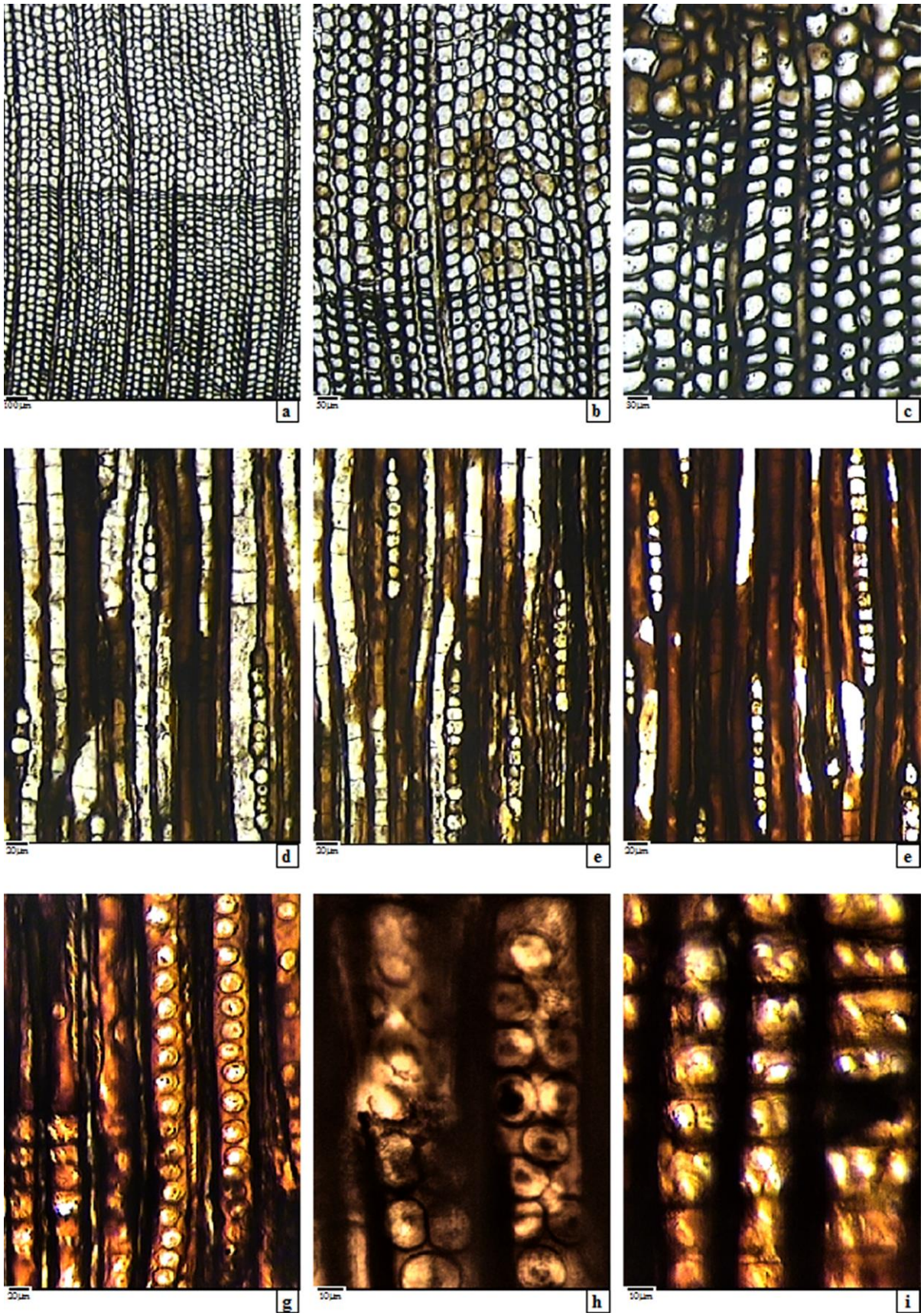

Fig. 5 *Brachyoxylon holbavicum* sp. nov. - holotype - inventory no. 27614 (field no. 1008). **a-c** Cross-section: distinct growth-ring boundary, thick-walled tracheids polygonal with rounded corners; linear rays. **d-f** Tangential section: unpitted tracheids, parenchyma, uniseriate rays. **g-i** Radial section: radial piting of mixed type on tracheids, araucarioid cross fields with 2-3 superposed rows of cupressoid pits.

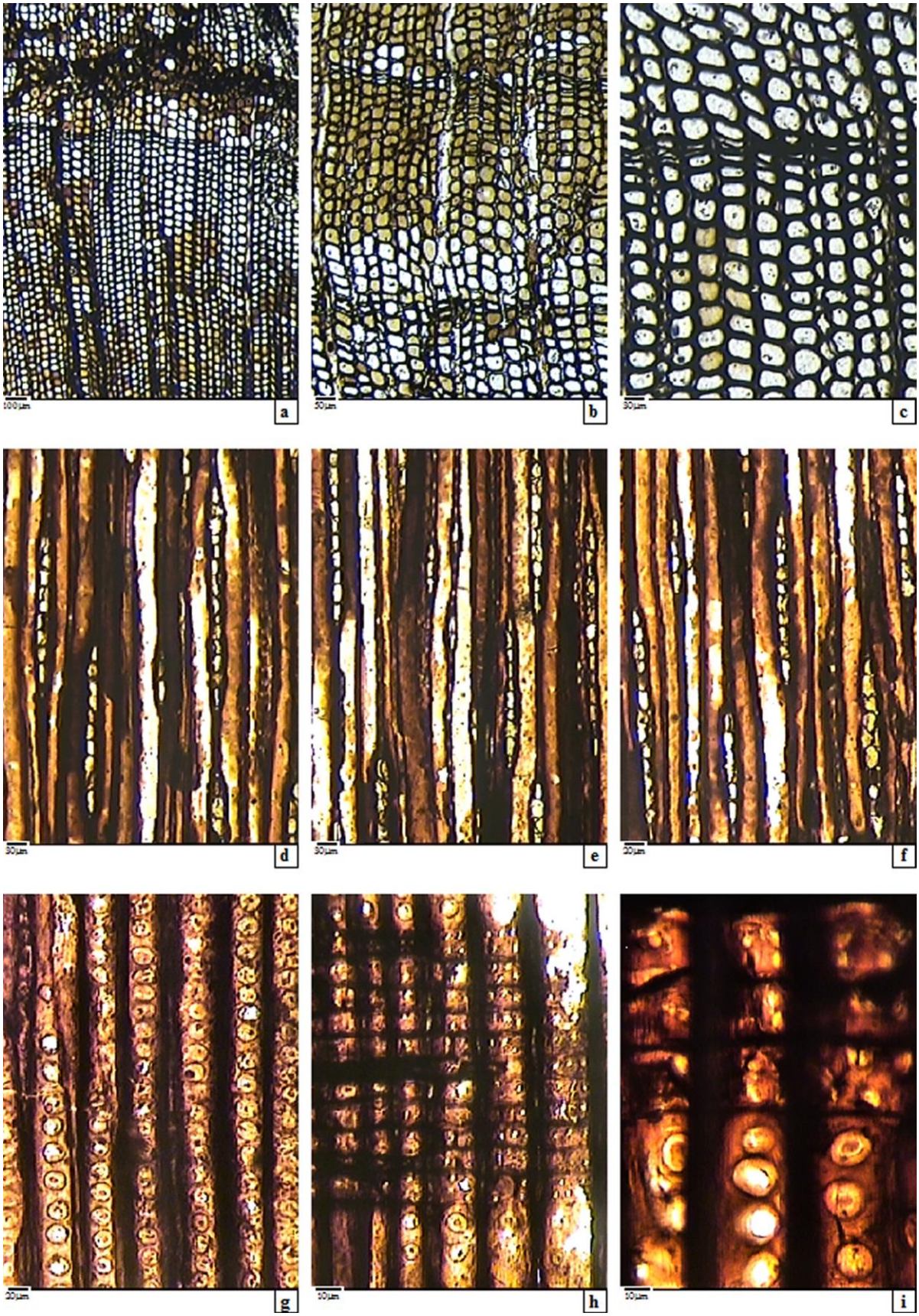

Fig. 6 *Brachyoxylon holbavicum* sp. nov. - paratype - inventory no. 27635 (field no. 1039). **a-c** Cross-section: quite distinct growth-ring boundary, thick-walled tracheids polygonal with rounded corners, and linear rays. **d-f** Tangential section: unpitted tracheids, uniseriate rays with biseriate storeys. **g-i** Radial section: radial piting on tracheids of mixed type, araucarioid cross fields with 2-3 superposed rows of cupressoid pits.

40(60) μm and with thinner walls (3.5)5-7 μm (double wall) in the early wood and thicker in transitional wood, of 7-9 μm, to very thick in the late wood, of 10-13 μm the double wall. Between two successive rays there are bundles usually of 1-12 radial regular rows of normal tracheids, sometimes with obvious inter-cellular spaces (in the specimen 1008, 1034), and the density is of (550)836-1520 tracheids per square millimeter, even if sometimes is difficult to appreciate their number or to count them. Tangentially the tracheidal walls are usually unpitted, only sometimes seem to be uniseriately pitted with round or slightly flattened pits (smaller than on the radial walls), of 14-17 μm in diameters, contiguous or slightly spaced (in the specimens: 1026, 1030, 1047). The radial pitting is of mixed type, both uniseriate, with round pits, spaced or contiguous in a single vertical row and variably flattened (flattening index: d/D=0.56-0.79-0.88), or, (less) biseriate, round to oval, opposite to/or alternate, sometimes contiguous, combined with short uniseriate portions (in 1012). Generally, the pitted areas don't cover integrally the tracheidal wall. Also, when biseriate, round to oval pits appear, opposite or alternate, sometimes contiguous, combined with short uniseriate portions (in the specimens 1008, 1010). The pits have round to slightly oval borders of 19-24 μm in diameter to horizontal elliptic shape (when flattened), of 15.5-22 μm in diameters, and with round to oblique-elliptic apertures of 7-10/(2)3-5 μm. There are no crassulae or helical thickenings. In the specimen 1034 the tracheids seems to show striations on the walls. Rarely (in specimen 1010), a solitary isolated canal was seen, rounded by epithelial parenchyma cells, probably of unknown traumatic origin, situation observed only in cross section. Inside the canal, some granular dark content appear.

A x i a l p a r e n c h y m a - is absent.

M e d u l l a r y r a y s - in cross section seen are thin, have a linear trajectory and are constituted from rectangular cells radially elongated, with smooth unpitted horizontal walls. Tangentially the rays are exclusively uniseriate, having 1-25 cells in height, or more, i.e. 25-600(650) μm. Sometimes the taller rays have 1-2 short biseriate storeys of the same thickness that one cell, more numerous in specimen 1046. The ray-cells are polygonal-rounded to oval (in height), usually having relatively not too thick walls and, sometimes, obvious lateral empty spaces (in specimens 1007, 1013, 1014, 1024, 1026, 1031, 1034). The ray-density is of 7-12 rays per tangential horizontal millimeter. In radial section the rays are homocellular, constituted by cells all procumbent of 20-24 μm in height. In the marginal rows, the cells are taller, of 28-35(-50) μm. The ray cells have moderately thick horizontal walls, of 4-6.2 μm the double wall, sometimes more, and the outer wall of the marginals is slightly curled. The tangential wall is thick and there are no visible indentures. The typical araucarioid cross-fields have 1-6 oculipores of cupressoid, tending to podocarpoid, usually hexagonal-rounded to oval, with diameters of of 9-15(18) / 6-8(10) μm, with tilted elliptic apertures of 5-8 / 3-5 μm. The pits arrangement is usually alternate as 1-6(9) pits on 1-2(3) horizontal rows in the body ray cells and 2-9 pits on 2-3 horizontal rows, alternate or slightly irregular, in the marginal fields

Affinities and discussions

All the here studied 24 samples of fossil wood present tracheidoxylic structure and mostly uniseriate rays, pitting of mixed type on the radial tracheidal walls and araucarioid cross-fields, xylotomical details that send to *Brachyoxylon* Hollick et Jeffrey, a type of Mesozoic tracheidoxyl.

The type species for this genus, *Brachyoxylon notabile* Hollick et Jeffrey, 1909 has also radial tracheidal pitting of mixed type and araucarioid cross-fields. The presence of traumatic resin canals is considered as a result of injury (see table 1). Otherwise, in a synthesis of Taylor & Taylor (1993, p. 689) is noted that no "cheirolepidiaceous" wood has normal resin canals but traumatic canals can be present sometimes in this genus, as a result of injury or freezing (see also Phillipe, 1995).

So, the description of our studied structures agrees with the diagnosis of the genus *Brachyoxylon* Hollick et Jeffrey, even if the original diagnosis, after the designated generotype (*B. notabile* Hollick et Jeffrey, 1909) is very elliptic, defining "a tracheidoxyl devoid of normal secretory ducts, with mixed radial pitting, araucarioid cross-fields and other ray walls integer" (see Philippe, 1993; Philipe & Bamford, 2008).

To do a comparison with fossil forms already described and published, it is important to remind that some species are no more considered as *Brachyoxylon* species, so must be excluded from a discussion, as for example:

- *Brachyoxylon nipponicum* Nishida, that according Vozenin-Serra & Pons (1990) is synonymous with *Protopodocarpoxylon orientale* Serra, 1969 (see also Machhour & Pons, 1992);
- *Brachyoxylon brachyphylloides* (Torrey) Kräusel, according Philippe (1993) is in fact a species of *Telephragmoxylon*: *T. brachyphylloides* (Torrey) Philippe;
- *Brachyoxylon notabile* Hollick et Jeffrey, 1909, *B. woodworthianum* Torrey, 1923, B. libermanii Philippe, 1995 preserve also primary structure and pith and such structures were described as *Telephragmoxylon* (by Torrey, 1921) or as *Brachyoxylon* sp. (by Holden, 1913a; Shimakura, 1937), having mostly uniseriate radial pitting and low rays (according to Machhour & Pons, 1992);
- *Brachyphyllum desnoyerisii* as initially was described by Lemoigne (1968) was renamed as *Agathoxylon desnoyersii* (Lemoigne) Philippe, 1995, and now considered as a junior taxonomical syonym (Philippe *et al*., 2018).
- Also, *Brachyoxylon urkutense* Greguss according Philippe & Barbacka (1997) it is synonymous with *Simplicioxylon hungaricum* Andreánszky, 1949.

Two older described taxa from North America as Paracedroxylon scituatense Sinnot and *Voltzioxylon dokumense* Torrey were sent into synonymy with *Brachyoxylon*, as *B. scituatense* (Sinnot) Philippe, 1993 and *B. dokumense* (Torrey) Philippe, 1993 - respectively, having typical characters of this genus.

Anyway, we tried to describe more accurately the very specific features of this big group of specimens (24) which could define a new species. All these characters were introduced into a comparative table of other described species of *Brachyoxylon* (Table 1), taken from Bodnar *et al*. (2013), and we observed that our described material is slightly different, by the rare apparition of trau-

Table 1 Comparative table of species of the genus *Brachyoxylon* (after Bodnar *et al.*, 2013).

Species of *Brachyoxylon*	Age	Distri-bution	False growth rings	Resin canals	Tangential tracheid pitting	Radial tracheid pitting	Axial paren-chyma	Cras-sulae	Rays (height)	Cross-field pits
B. notabile Hollick et Jeffrey, 1909	Upper Cretaceous	USA	absent	traumatic	present	mixed 1–2 seriate	absent	present	uniseriate (1–8 cells)	5–11 cupressoid
B. woodworthianum Torrey, 1923	Lower Cretaceous	USA	absent	absent	absent	mixed	absent	absent	uniseriate (high) bi-pluri-seriate(low)	cupressoid
B. brachyphylloides (Torrey, 1923) Kräusel, 1949	Middle Jurassic-Cretaceous	Tunisia, Nigeria, Chad,USA	absent	traumatic	present	mixed 1–2 seriate	absent	absent	uniseriate, partially biseriate (1–20 cells)	1–10 cu-pressoid
B. japonicum (Shimaku-ra, 1937) Kräusel, 1949	Lower Cretaceous	Japan	absent	absent	present	mixed 2–3 seriate	absent	absent	uniseriate (50–60 cells)	cupressoid
B. saurinii Boureau et Serra, 1961	Jurassic (?)	Cambodia	absent	traumatic	absent	mixed 1–2 seriate	absent	absent	uniseriate (1–31 cells)	2–12 cupressoid
B. boureaui Serra, 1966	Jurassic (?)	Cambodia	absent	absent	absent	mixed 1–2seriate	absent	absent	uniseriate (low)	4–36 cupressoid
B. nonakai Yamazaki et Tsunada, 1981	Upper Jurassic	Japan	absent	absent	absent	opposite 2–4 seriate	absent	absent	uniseriate (unknown)	cupressoid
B. lagonense (Lau-douén.) Dupéron-Laudouéneix 1991	Cretaceous	Chad	absent	traumatic	absent	mixed 2–3 seriate	absent	absent	uniseriate (low)	cupressoid
B. trautii (Barale, 1981) Philippe, 1995	Middle Jurassic	France	present	absent	present	mixed 1–2 seriate	absent	absent	uniseriate (low)	4–9 cu-pressoid
B. liebermanii Philippe, 1995	Jurassic	France	present	absent	present	mixed 1 seriate	absent	absent	uniseriate (low)	5-12 cu-pressoid to podocarpoid
B. eboracense (Holden, 1913a) Phillippe, 2002	Jurassic	England	absent	absent	absent	mixed 1–2 seriate	absent	absent	uniseriate (low)	numerous cupressoid
B. orientale (Serra,1969) Philippe *et al*., 2004	Lower Cretaceous	Tibet	present	absent	absent	mixed 1–2 seriate	absent	absent	uniseriate (low)	3–10 podo-carpoid
Brachyoxylon sp. *A* Philippe *et al*., 2004	Late Jurassic	Thailand	present	absent	present	mixed 1–2 seriate	absent	absent	uniseriate (low)	up to 12 cupressoid
B. semibiseriatum (Pant et Singh, 1987) Kurzawe et Merlotti, 2010	Permian	Brazil	absent	present	present	mixed 1–5 seriate	absent	absent	uniseriate (1–38 cells)	4–16 cu-pressoid
B. serrae Phillipe *et al*., 2011	Lower Cretaceous	Thailand	absent	traumatic	present	mixed 1–2 seriate	absent	absent	uniseriate (1–15 cells)	5–16 cu-pressoid
B. avramii Iamandei et Iamandei, 2005	Early Cretaceous	Romania	absent	traumatic	rare	mixed, 1–2 seriate	absent	absent	uniseriate (1–21 cells)	1–8 cu-pressoid to podocarpoid
B. dobrogiacum Iaman-dei et Iamandei, 2005	Early Cretaceous	Romania	absent	absent	present	mixed 1–3 seriate	present	present	uniseriate (1–10 cells)	1–6 cu-pressoid to podocarpoid
B. holbavicum sp. nov 24 specimens	Lower Jurassic	Romania	absent	absent (+ rarely traumatic)	absent, or rarely present	mixed type (1-seriate + partially 2-seriate)	absent	absent	uniseriate + biseriate storeys [1-25 cells tall]	1-9 pits cupressoid to podocarpoid + alternate arrangement
B. cristianicum sp. nov. 8 specimens	Lower Jurassic	Romania	absent	absent	absent	mixed 1–2 seriate	present (+crystals)	absent	uniseriate + partially biseriate [1–20 cells tall]	1-6 pits cupressoid to podocarpoid +alternately arranged

matic canals, the absence of the axial parenchyma, and the presence of the exclusively uniseriate rays, relatively tall, of up to 25 cells.

There are numerous already described forms of *Brachyoxylon*, from different regions of the Earth, with various very specific details. However, we observed that *B. saurinii* of Boureau & Serra (1961), *B. avramii* and *B. dobrogiacum* of Iamandei & Iamandei (2005) and *B. serrae* of Phillipe *et al*. (2011) have high rays of more than 20 cels and uniseriate radial pitting, quite similar to our studied material. The both species described by Iamandei & Iamandei (2005) from Romania are branch fragments preserving also primary wood, like the specimen 1044 studied here which also shows arthropods galleries with coprolites, but the characters of the secondary wood are not similar.

Many other forms of *Brachyoxylon* were described in the world, showing a large spread of this Mesozoic genus on the planet, and we only quote some of them:

- Iijima *et al*. (1989) described a species of *Brachyoxylon*, from Far East, from the uppermost Triassic - Lower Jurassic, in the Adoyama Chert from Kuzuh, Japan, by the study of a drifted piece of wood with this type of structure.
- Cevallos-Ferriz (1992) described some other species of *Brachyoxylon* from the Upper Cretaceous from north of Mexic.
- Philippe *et al*. (2004a) cited above, made a complex biogeographic analysis of Jurassic–early Cretaceous wood assemblages, *Brachyoxylon* included, from Gondwana.
- Hickey *et al.* (2011) described a typical *Brachyoxylon* from the Upper Triasssic from Connecticut, USA.
- Also, Vera & Césari (2012) have described five specimens of Aptian fossil woods from Argentina, identified as *Brachyoxylon* sp. cf. *Brachyoxylon boureaui* Serra, 1966 characterized by radial mixed pitting as predominantly uniseriate rows of circular to polygonal bordered pits. The biseriate and triseriate pitting pattern is also

present, but is less common. The cross-field regions show 8-26 small circular pits arranged in 2-4 rows, with slit-like pit apertures, obliquely oriented, in rays exclusively uniseriate, and relatively low.

- Bodnar *et al*. (2013) described a *Brachyoxylon currumilii* from the lower-middle Jurassic of Argentina and made a comparative table of already published species of *Brachyoxylon* (Table 1), in which we added the xylotomical characters of our here studied material, for the comparison of the essential xylotomical features.
- Garcia *et al.* (1998) made a debate on the Jurassic palaeoenvironment of large European forests of *Agathoxylon* and *Brachyoxylon* described on the France territory.
- More recently, Philippe *et al*. (2018) reidentified from "Lignier collection" a sample initially identified by Lignier as *Cedroxylon blevilense*, as new combination: *Brachyoxylon blevillense* (Lignier) Philippe *et al*., 2018 - based on the mixed type of radial pitting and the araucarioid cross-fields. Also they identified the "Échantillon n°150" as having typical araucarioid cross-fields, with up to six crowded oculipores and resiniferous axial parenchyma (traumatic?), similar to *Brachyoxylon liebermannii* Philippe, a species previously described by Philippe (1995), from the Liassic of northeastern France.

So, considering the xylotomic matches of our studied material and the already published species from the comparative table (see Table 1) and the comparison with the original description of other species, we concluded that our material (which presents a secondary wood structure usually devoid of resin canals, even if rarely of traumatic type can appear, with mixed radial pitting, with axial parenchyma usually, with uniseriate rays or partially biseriate, relatively high, up to 25 cells and and cross-fields with oculipores of cupressoid type, tending to podocarpoid, in an araucarioid arrangement) has a structure of *Brachyoxylon* of a special type.

Here, in our paper, other very similar form of *Brachyoxylon* was described (i.e. *B. cristianicum*), slightly similar and coming almost from the same areal (see Table 1). So, taking into account these observations and discussions, we consider we have described here a new species of *Brachyoxylon*, that we named *Brachyoxylon holbavicum* sp. nov., after the name of the locality area (Holbav) from where it was found.

From the studied material it was designated as holotype the specimen with inventory number: 27614 (field no. 1008) and a paratype with inventory number: 27635 (field no. 1039) from a population of 24 specimens of fossil wood from "Grădinaru Collection"with similar xylotomic characters to almost identical. The mentioned types and all the studied material are now deposited in G.I.R. Collection, in the National Geological Museum in Bucharest,

Diagnosis of the new species *Brachyoxylon holbavicum* sp. nov.:

The secondary wood of tracheidoxylic type has distinct growth rings, sometimes with rare, isolated, traumatic canals, thick-walled tracheids, polygonal in cross-section gradually diminishing in size to the late-wood. Tangentially the tracheids are usually unpitted, rarely with smaller pits contiguous or slightly spaced. The radial pitting is of mixed type, usually uniseriate with round pits, spaced or contiguous and variably flattened and, less, biseriate, with round to oval, opposite to alternate, sometimes contiguous pits, combined with short uniseriate portions. Pits with round to oblique-elliptic apertures. Axial parenchyma is absent. Rays exclusively are uniseriate, tall, with biseriate storeys. Rays exclusively uniseriate, tall, with biseriate storeys, with lateral empty spaces and relatively thick walls. Homocellular, with curled outer wall, and without indentures. Cross-fields typical araucarioid, 1-6(9) oculipores hexagonal-rounded to oval of cupressoid type tending to podocarpoid in 1-3 horizontal rows arranged, alternate to slightly irregular, in the marginal fields on 2-3 horizontal rows.

Brachyoxylon cristianicum sp. nov.
Fig. 7 a-i; Fig. 8 a-i.

The studied material

The studied material is represented by 8 pieces of silicified wood, four of them found in the Cristian area, on the Fabricii valley, and four in the Holbav area, on the Maiului brook, in the Lower Jurassic continental deposits with pyroclastic character considered of Sinemurian-Pliensbachian age, most probably Pliensbachian. All the studied samples are trunk or thick-branch fragments, having decimetric size, dark to black color and, by magnifying glass or even by naked eye, regular fibrous structure without vessels can be seen, clearly suggesting a conifer wood. The specimens having field-numbers: 1015, 1016Cr, 1018Cr, 1019Cr, 1020Cr, 1027, 1042, 1043 belong to "Grădinaru Collection", and are deposited now in the collections of the Geological Institute of Romania (G.I.R. Collections), under the inventory numbers: 27636 –27643 respectively, at the National Geological Museum, in Bucharest.

Microscopic description

All the eight studied specimens present s e c o n d a r y w o o d with tracheidoxylic structure with quite distinct growth-rings boundary marked by the late wood which has smaller tracheids than the early wood. The structure is devoid of any normal or traumatic resin canals.

T r a c h e i d s - in cross section viewed are polygonal with slightly rounded corners, sometimes determining intercellular spaces (specimens 1020, 1027), unequal in size, with quadrangular to rounded large lumina with radial/tangential diameters of 20-42(50-60)/20-35-(45-65) μm (smaller in the late wood), and with relatively not too thick walls: (4)6-9 μm the double wall in the early and in the transitional wood, up to 9-13 μm the double wall in the late wood. The interradial bundles have 1-10(12) radial regular rows of tracheids and density is 992-1444(1518) tracheids per mm2. Tangentially seen the tracheids are usually unpitted, or rarely pitted (in specimen 1019) with small round pits (d=8-12 μm) with small apertures (d=4-5 μm), in a single row arranged, slightly irregular, locally as two opposite pits. The radial pitting is of mixed type, with almost abietinean pits, arranged either in a single vertical row as round pits, spaced, or contiguous separated by a horizontal line, with round or slightly elliptic apertures, or biseriate, round, alternate or opposite, contiguous on short rows often continued by uniseriate portions, not occupying all the length of the wall. In fact, generally, the pitted areas don't cover integrally the tracheidal wall.

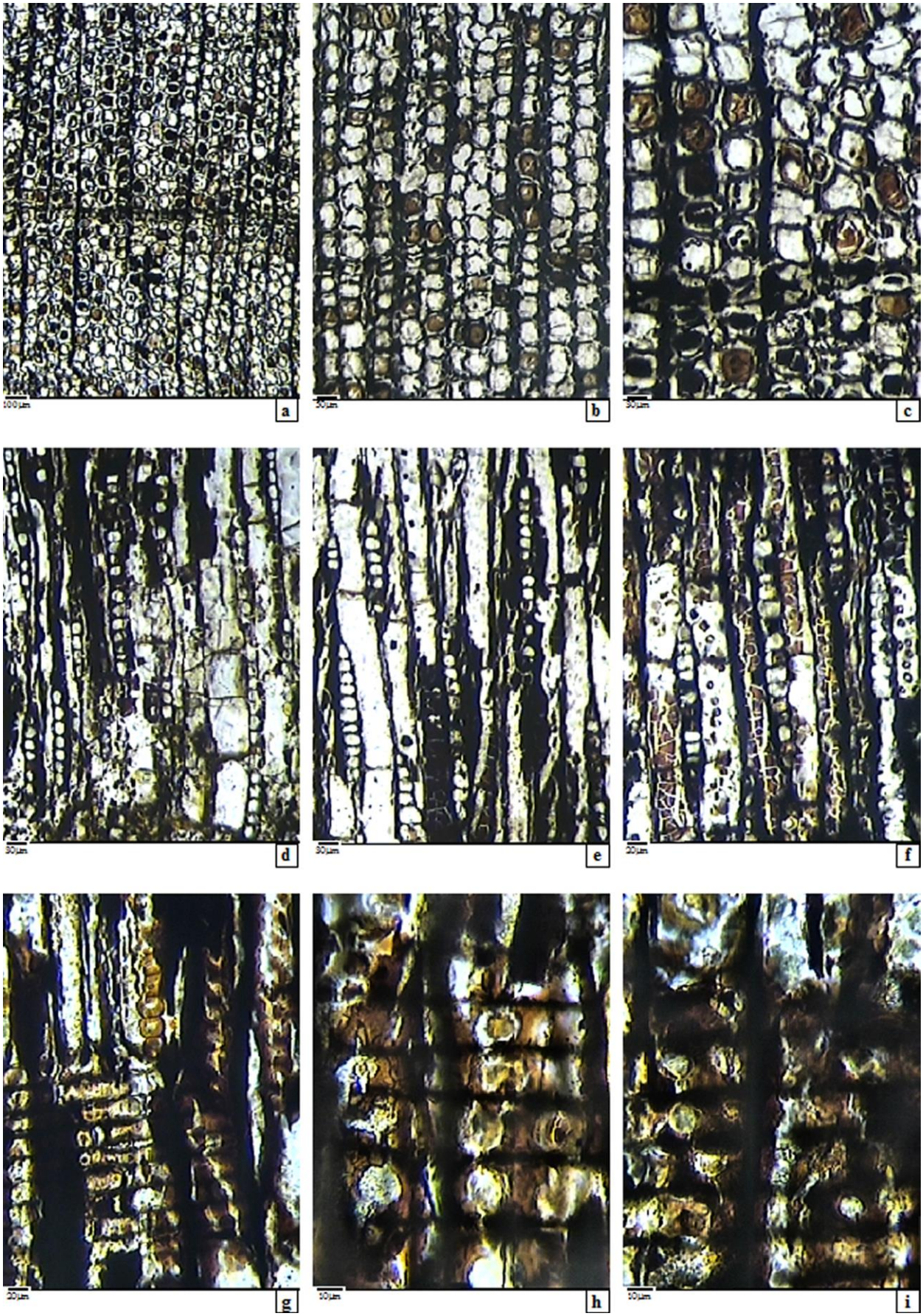

Fig. 7 *Brachyoxylon cristianicum* sp. nov. - holotype - inventory no. 27639 (field no. 1019cr). **a-c** Cross-section: distinct growth-ring boundary, thick-walled tracheids, polygonal with rounded corners, and linear rays. **d-f** Tangential section: unpitted tracheids, parenchyma with pits and crystals; uniseriate rays. **g-i** Radial section: uniseriate radial piting on tracheids of mixed type, cross fields with 1-2 rows of oculipores.

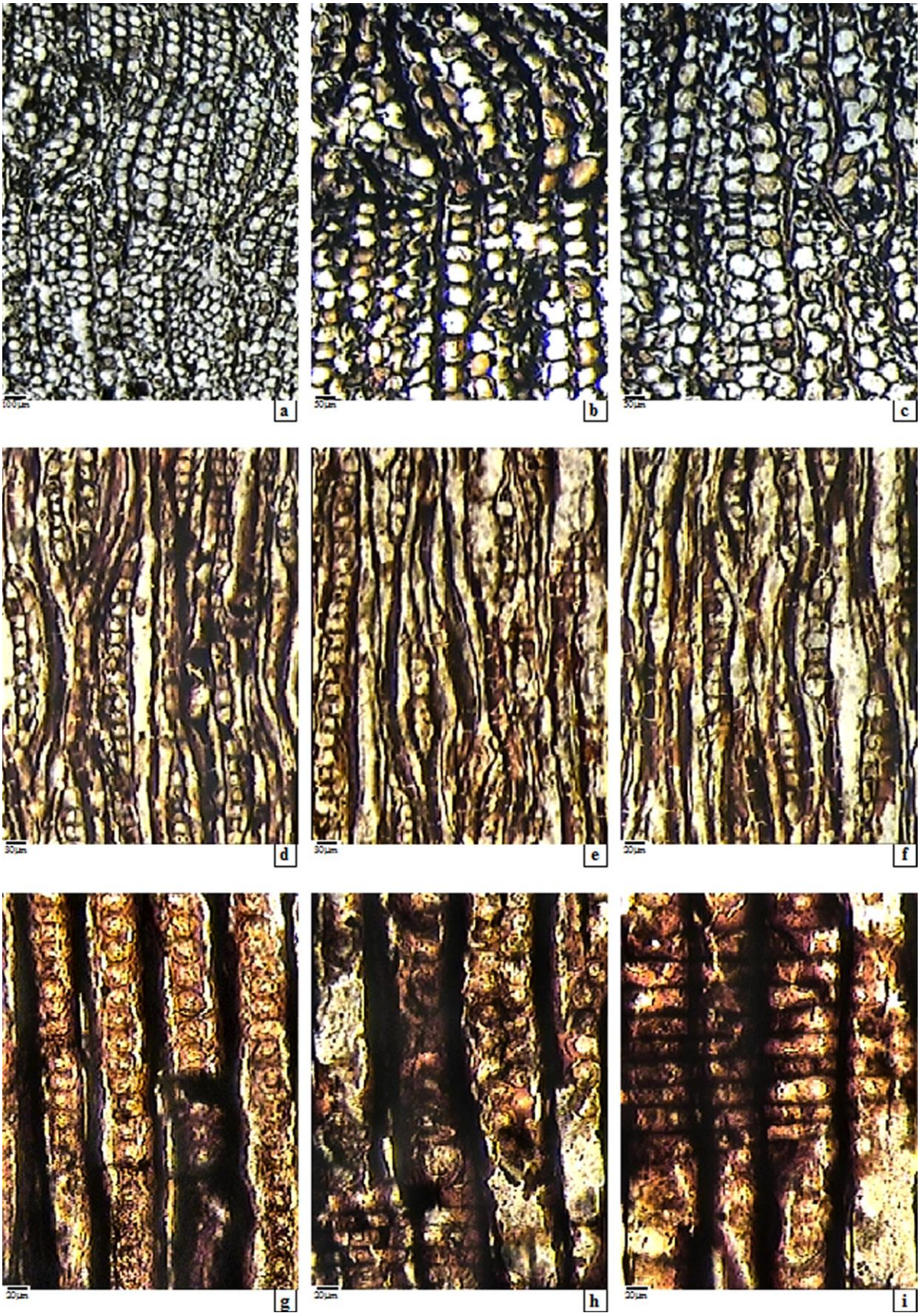

Fig. 8 *Brachyoxylon cristianicum* sp. nov . - paratype - inventory no. 27640 (field no. 1020cr). **a-c** Cross-section: distinct growth-ring boundary, polygonal tracheids with rounded corners and thick walls; linear rays. **d-f** Tangential section: unpitted tracheids, parenchyma with pits and uniseriate rays. **g-i** Radial section: radial piting on tracheids of mixed type, uniseriate and biseriate, cross fields with 1-2 rows of oculipores.

The pits have round borders of 18-22 often flattened when contiguous (d/D=0.65-0.88), and round or tilted to lying elliptic apertures of 7.5-10/2-3 μm (in specimen 1019). None crassulae or helical thickenings have been seen, but sometimes a brown content is present.

A x i a l p a r e n c h y m a - in cross-section view is present, few, dispersed, often difficult to identify amongst the tracheids. It has relatively thin vertical walls relatively similar to those of the tracheids and sometimes with simple pits, irregularly arranged on 1-2 rows. The horizontal (terminal) walls are thin and smooth or slightly nodular and, inside the cells, resin content or plugs or granules, and sometimes small polygonal crystals are present (specimens 1015, 1019).

M e d u l l a r y r a y s - in cross section appear usually uniseriate, rectilinear, and with smooth horizontal cellular walls. In tangential view the rays have 1-20 (sometimes up to 25) cells in height, i.e. 30-570(650) μm high. The taller uniseriate rays have biseriations, sometimes giving aspect of fusiform rays (specimens 1015, 1016). The ray cells are polygonal rounded to oval sometimes having dark content and relatively thin walls. Ray density is 5-11 rays per horizontal tangential millimeter. Radially the rays are homocellular, cells all procumbent of 20-30 μm tall, moderately thin walled, of 4-5(7) μm the double wall. Within the marginal rows the cells are taller, of 25-35(40) μm, and have corrugated outer wall. The cross-fields of araucarioid type have 1-6 oculipores, hexagonal or slightly rounded to oval, of cupressoid type, tending to podocarpoid, with 15-19/8-12 μm in diameters, having circular or short elliptic tilted apertures of 10-14/5-7 μm. The pits arrangement is in 1-2 rows in the ray body fields, in the marginal fields on two horizontal rows, always alternate to slightly irregular when on two rows.

Affinities and discussions

After the microscopic study of each sample and the synthetic evaluation of their generic characters, a number of 8 samples of fossil wood were grouped all of them having tracheidoxylic structure, uniseriate rays, radial pitting of mixed type on the tracheids and araucarioid cross-fields, suggesting a *Brachyoxylon* type of wood slightly differebt of the above described form (see Table 1).

The discussion on the status of the genus *Brachyoxylon* Hollick et Jeffrey, and of the species described under it along the time is presented in detail above. Even if the type species (*Brachyoxylon notabile* Hollick et Jeffrey, 1909) has a very elliptic diagnosis, referring only to "a tracheidoxyl devoid of normal secretory ducts, with mixed radial pitting, araucarioid cross-fields and other ray walls integer" (see Philippe, 1993), it is interesting that traumatic canals were described, considered as a result of injury or freezing (Taylor & Taylor, 1993, p. 689; Philippe, 1995). Anyway, the specimens described here are devoid of any kind of canal.

In our studied specimens, apart from the known characters of the genus, there are some specific xylotomic details regarding the size of tracheids or their behavior inside the growth ring, their pitting type, aspect and size of the pits on the tracheids and in the cross fields. The accurate description of these very specific features of the studied material can be useful for the comparison with the already published and valid species (see Table 1).

Anyway, it seems that the presence or the absence of the axial parenchyma and of the crassulae, and also the ray heights and the pits' number in the cross-fields, are important to separate the species of *Brachyoxylon* (Philippe, 1993, 1995).

- Two forms of *Brachyoxylon* preserving primary structure and pith were described from the Lower Cretaceous in southeastern of Romania as *B.avramii* and *B. dobrogiacum* (Iamandei & Iamandei, 2005) as having a tracheidoxylic structure with few parenchyma and uniseriate low rays, with mixed radial pitting and araucarioid cross-fields (sensu Philippe, 1993), bearing cupressoid to podocarpoid pits in an araucarioid arrangement, but are slightly different of the here studied material which has high rays with biseriate stories, even with aspect of biseriate fusiform rays.

- Also, Vera & Césari (2012) have described an interesting material represented by five specimens of Aptian fossil woods from Argentina and identified as *Brachyoxylon* sp. cf. *Brachyoxylon boureaui* Serra, 1966 having radial pitting of a mixed type, predominantly uniseriate, with circular to polygonal bordered pits, sometimes biseriate and triseriate, even if less common, and numerous pits in the cross-fields (8 up to 26 small circular pits arranged in 2-4 rows, with slit-like pit apertures, obliquely oriented), details which are very different of our specimens.

- The Jurassic new species of *Brachyoxylon currumilii* described by Bodnar *et al*. (2013) from Argentina, has also some details which differ of our material. But in that paper there is a very well documented discussion on the status of *Brachyoxylon* genus and its already described species, and a comparative table of the valid species of *Brachyoxylon* in which we added, for comparison, the essential xylotomical characters of our studied material (Table 1).

- Interesting for comparison seems to us the more recently reidentification of Philippe *et al.* (2018) from "Lignier collection" of a sample initially identified as Cedroxylon blevilense by Lignier, as *Brachyoxylon blevillense* (Lignier) Philippe *et al*., 2018 based on the mixed type of radial pitting and the araucarioid cross-fields. Also the identification of the "Échantillon n°150" from the same collection, which showed typical araucarioid cross-fields with up to six crowded oculipores and traumatic(?) resiniferous axial parenchyma is similar to *Brachyoxylon liebermannii* Philippe, 1995, a species previously described from the Liassic of northeastern France.

But, considering the xylotomic similarities and dissimilarities of our studied material with the already published species from this comparative table (Table 1) and the comparison with the original description of the species, and also, the discussions from above, it can be observed that our material is special.

Thus, it presents a secondary wood structure without resin canals, with mixed radial pitting, uniseriate spaced or contiguous, or biseriate, alternate or opposite, contiguous, with round to elliptic apertures, with axial parenchyma, with uniseriate rays or even biseriate, relatively high, and

cross fields with cupressoid oculipores in an araucarioid arrangement.
These xylotomical details are slightly different of the other species of *Brachyoxylon* described in this paper and, based on this diference well exprimed in the Table 1 from above, we considered we have described here a new species that we named *Brachyoxylon cristianicum* sp. nov., after the name of the region from where it was found (Romanian spelling for Christian is Cristian). From the studied material a holotype was designated the specimen with field number 1019 in "Grădinaru Collection", (inventory number 27639), and a paratype the specimen with field number 1020 in "Grădinaru Collection (inventory number 27640), from a population of 8 specimens of fossil wood with similar to almost identical xylotomic, all material now deposited in GIR Collection, in the National Geological Museum, Bucharest, as we specified above.

Diagnosis of the new species *Brachyoxylon cristianicum* sp. nov.:
Tracheidoxyl with distinct growth rings, devoid of any canal. Tangentially the tracheids are usually unpitted, rarely with small pits, uniseriate. Radial pitting of mixed type, of pits abietinean but with araucarian arrangement, uniseriate, spaced or contiguous, with round or slightly elliptic apertures, or biseriate, alternate or opposite, contiguous and flattened, in short rows often continued by uniseriate portions, not occupying all the length of the wall. Axial parenchyma present, dispersed, in longitudinal view presenting thin and smooth or slightly nodular horizontal walls and resin content or even crystals. Rays uniseriate, relatively tall, with biseriations, sometimes with fusiform aspect, homocellular, having typical araucarioid cross-fields with 1-6 oculipores alternate to slightly irregular on 1-2 rows, hexagonal ronded to oval, of cupressoid type tending to podocarpoid, with round or short elliptic tilted apertures.

Genus ***Protophyllocladoxylon*** (Kräusel, 1939) Vogellehner, 1968
Protophyllocladoxylon holbavicum sp. nov.
Fig. 9 a-i.

The studied material
The studied material is represented by a sigle decimetric sized sample of silicified wood found in Holbav area, on the Maiului brook, in Lower Jurassic continental pyroclastic deposits considered of Pliensbachian age. The studied sample represents a trunk fragment, having dark to black color and by magnifying glass or even by naked eye, regular fibrous structure without vessels is visible, suggesting a coniferous wood. The specimen with the field number 1040 belong to "Grădinaru Collection" and is deposited now under the inventory number 27644 in the collections of the Geological Institute of Romania (G.I.R. Collections), hosted by the National Geological Museum, Bucharest.

Microscopic description
The studied specimen has s e c o n d a r y w o o d with tracheidoxylic structure devoid of any normal or traumatic resin canals, with diminishing tracheid size only in the last part of the transitional wood close to the late wood, which is represented by few rows of smaller tracheids, marking distinctly the growth ring boundary.
T r a c h e i d s - with polygonal in cross-section and polygonal lumina, slightly rounded at corners, have radial/tangential diameters of 20-40/20-45 μm and relatively thick walls, of 4-10 μm double wall. The interradial bundles have 1-9 radial regular rows of tracheids and the density is 784-899 tracheids per mm2. Tangentially seen the tracheids are usually unpitted, but sometimes small circular pits of 8-12 μm in diameter, in a single vertical row appear. Radial pitting is of mixed type, almost exclusively uniseriate, with pits circular, spaced or contiguous, with round or oblique elliptic apertures. When contiguous they are slightly flattened. The pits have round borders of 17-21 μm and rounded to tilted elliptical apertures of 5-7/3-4 μm. There are no crassulae or helical thickenings.
A x i a l p a r e n c h y m a - appears in cross-section as few, disperse cells relatively thick-walled, difficult to distinguish of tracheids, but visible in tangential view, having thick terminal (horizontal) walls.
M e d u l l a r y r a y s - are fine, rectilinear in cross-section, with smooth horizontal cellular walls. Tangentially the rays have 1-21 cells in height, or more, i.e. 30-550 μm high. The taller rays have high biseriations (up to ten storeys) giving to the rays a biseriate aspect with long uniseriate endings. The ray cells are polygonal rounded to oval and have relatively thick walls. Ray density is 8-12 rays on horizontal tangential millimeter. Radially the rays are homocellular, cells all procumbent of 20-30 μm high, moderately thick-walled: 5-6.2 μm the double wall. The tangential walls are thick-walled or slightly nodular. Indentures indistinct or absent. The typical cross-fields have 1-2 oopores of phyllocladoid type, more or less bordered, and inclined, of 13-17 μm in diameters, with large lens-like apertures of 6.5-8.5/3-5 μm.

Affinities and discussions
The here studied sample of fossil wood presents tracheidoxylic structure with uniseriate rays, pitting of mixed type on the radial tracheidal walls and phyllocladoid cross-fields, aspects which suggest similitude with members of the Family Podocarpaceae Endlicher, 1847, especially with the extant *Phyllocladus* Rich. ex Mirb., and send to the fossil correspondent *Protophyllocladoxylon* (Kräusel) Vogellehner, 1968, a type of tracheidoxylic Mesozoic fossil wood having such characters. In fact the species described from the Cretaceous of Syria (*P. leuchsii*) and designated as type-species by Kräusel (1939), has some problems of origin, age and anatomy (Philippe *et al*., 2003; Pujana, 2005), so a reappraisal of this genus is necessary.
The correct diagnosis of the genus *Protophyllocladoxylon* (Kräusel, 1939) as is emended by Vogellehner (1968), is presented by Philippe (1995) like this: "Tracheidoxyl without secretory canals, with radial pitting of mixed type and cross-fields with 1-2 elliptic oopores to large oval, more or less oblique, horizontal ray-cells walls integer". Or, as it's specified by Philippe & Bamford (2008), "oopore more phyllocladoid (i.e. pointed and oblique), usually somewhat bordered in the latewood". In fact, large, oval, more or less oblique oopores are present in the cross-fields only to *Protophyllocladoxylon*, but not to

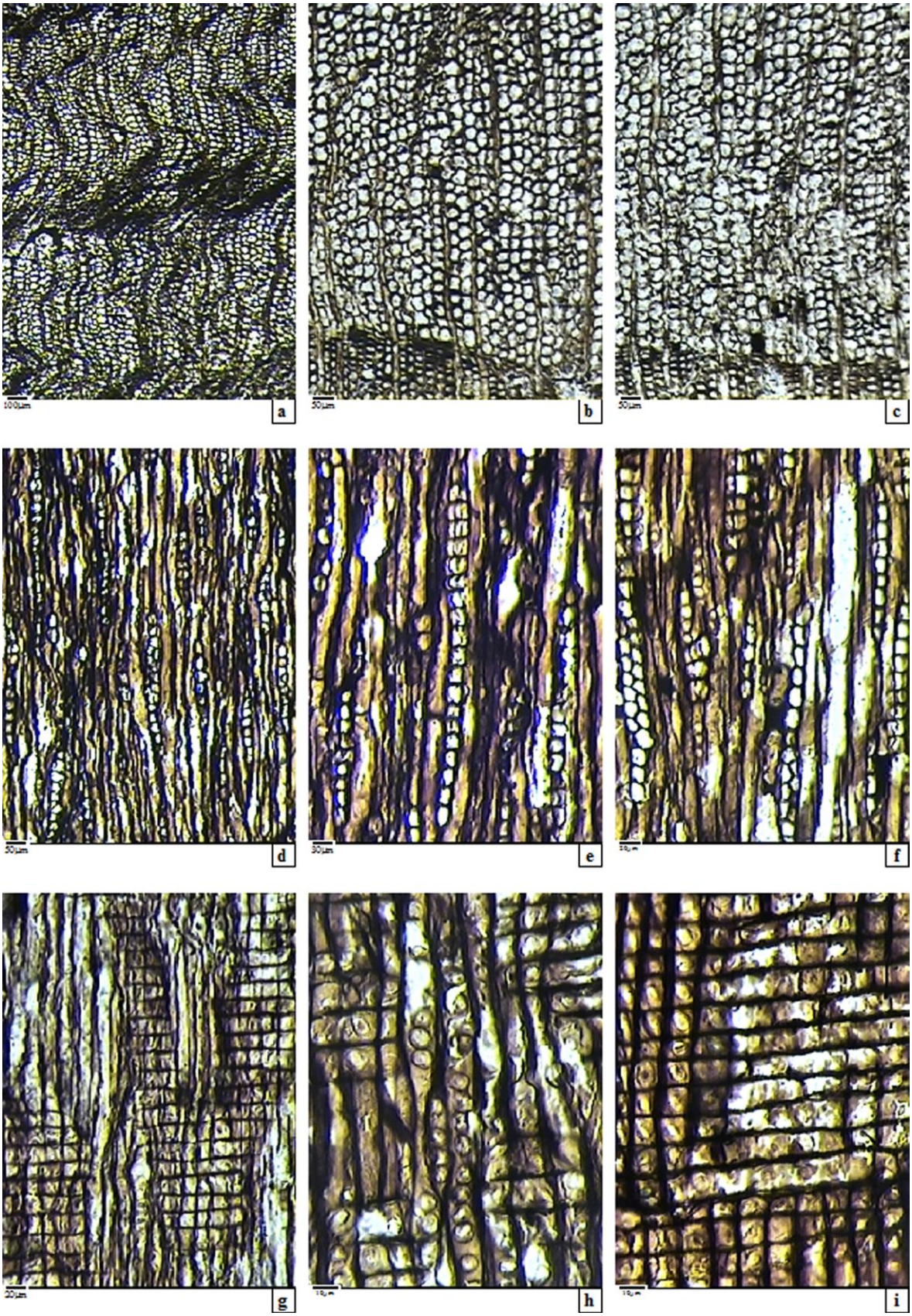

Fig. 9 *Protophyllocladoxylon holbavicum* sp. nov . - holotype - inventory no. 27644 (field no. 1040). **a-c** Cross-section: distinct growth-ring boundary, polygonal tracheids with rounded corners, and linear rays. **d-f** Tangential section: unpitted tracheids, uniseriate rays, and biseriate with long endings. **g-i** Radial section: uniseriate radial piting on tracheids of mixed type, phyllocladoid cross-fields with 1-2 phyllocladoid large inclined oculipores.

Xenoxylon, *Protocircoporoxylon* or *Prototaxodioxylon*, where other types of oopores appear.
We tried a comparative analyse of our studied specimen with some already described forms from worldwide because during Paleozoic and Mesozoic times it seems that this genus had a widespreading, and we cite:
- *Paraphyllocladoxylon araucarioides* Holden, 1913b, was relatively badly described and, having araucarian characters, is possibly to be reconsidered as *Protophyllocladoxylon* (Philippe & Bamford, 2008). In fact, these authors specified that the groups of Paleozoic and Mesozoic described species of *Protophyllocladoxylon* have araucarian characters and must be recognized and a reappraisal of this genus is necessary.
- Also, numerous species of *Protophyllocladoxylon* described before 2003 felt in synonymy with *Metapodocarpoxylon libanoticum* (Edwards) Dupéron-Laudoueneix et Pons, aspect discussed in detail by Philippe *et al*. (2003) and Philippe & Bamford (2008).
- *Protophyllocladoxylon quedlinburgense* Schultze-Motel, 1961 has flattened radial uniseriate pitting and also biseriate opposite, so it's slightly different of our material.
- *Protophyllocladoxylon franconicum* was described from Germany by Vogellehner (1966) is a Mesozoic form with phyllocladoid type of oopores and with radial uniseriate pitting, rather similar to our specimen.
- More recently, Zhang Yi *et al.* (2010) have described a Paleozoic species: *Protophyllocladoxylon jingyuanense*, from Carboniferous (Late Mississipian) deposits from NW China, with similar features in radial pitting and in cross-fields.
- Boura *et al*. (2013) described some Early Cretaceous woods from Vietnam beside some species of other gymnosperms, a *Protophyllocladoxylon xalucense*, a new species bearing all the typical features of the genus and more than that, an abundance of axial parenchyma. Also, a documented comparison with numerous species of *Protophyllocladoxylon* described in far-eastern Asia was done, all of them different of our specimen.
- Also, Fletcher *et al*. 2014 have described a *Protophyllocladoxylon owensii* as a new species from the Upper Cretaceous of Queensland (Australia), having radial pitting on the tracheid predominantly alternate and contiguous (of araucarian type), uniseriate in latewood, biseriate and rarely triseriate, in earlywood, but the cross-field pits are typically phyllocladoid and have oopores or more rarely circopores, two per cross-field in earlywood, one in latewood.
- Pujana *et al*. (2014, 2015) described a Palaeocene and Eocene species of *Protophyllocladoxylon* from Antarctica, with tracheid radial pitting uniseriate to biseriate, rarely triseriate, sometimes scattered and mostly contiguous, opposite to alternate, so, of mixed type with pits circular to hexagonal, usually flattened. The axial parenchyma is absent. Cross-field pitting is fenestriform, with 1-2 large oopores (simple pits) per cross-field, so it's very different of our material.
- Vajda *et al*. (2016) described a permineralized conifer wood attributed to *Protophyllocladoxylon* sp., from Korsaröd, southern Sweden, from some volcaniclastic deposits associated to a Jurassic volcanism, and tried palaeoclimatically the presence of such an exotic taxon in the Sweden Jurassic.
Our specimen has a tracheidoxylic structure, radial pitting of mixed type, usually uniseriate, with round pits, spaced or contiguous (when flattened), parenchyma with thick terminal (horizontal) walls, and uniseriate rays with high biseriations and phyllocladoid cross-fields, with 1, sometimes 2 oopores of phyllocladoid type, inclined, and with large lens-like apertures.
All these details define a special form of *Protophyllocladoxylon*, and analysing them in comparison with other valid species presented above we think we are faced with a new species that we named *Protophyllocladoxylon holbavicum* sp. nov., after the name of the locality area from where it was found. The studied specimen designated holotype has the inventory number 27644 (field number 1040) and is now deposited in G.I.R. Collections, in the National Geological Museum in Bucharest.

Diagnosis of the new species *Protophyllocladoxylon holbavicum* sp. nov.
Secondary wood with tracheidoxylic structure without any canal, with distinct growth-ring boundary, marked by few rows of smaller tracheids. Tangentially seen the tracheids usually unpitted, but sometimes small circular pits in a single vertical row appear. Radial pitting is of mixed type, usually uniseriate with pits circular, spaced or contiguous, with round or oblique elliptic apertures. When contiguous they are slightly flattened. Axial parenchyma few, disperse, with thick terminal (horizontal) walls. Medullary rays uniseriate, the taller ones with high biseriations giving aspect of biseriate rays with long uniseriate endings, radially homocellular, tangential walls are thick-walled or slightly nodular, no indentures and cross-fields with 1-2 phyllocladoid oopores, bordered, inclined, with large lens-like apertures.

Order **Ginkgoales** Gorozhankin, 1904
Family **Ginkgoaceae** Engl. in Engler et Prantl 1897
Genus ***Palaeoginkgoxylon*** Feng, Wang et Rößler, 2010
Palaeoginkgoxylon sp.
Fig. 10 a-i; Fig. 11 a-i.

The studied material
The studied material is represented by three decimetric-sized samples of silicified wood, two found in the Holbav locality area (South Brașov County), on the Maiului brook and one around Cristian locality, on the Fabricii valley, in the Early Jurassic continental deposits maybe with pyroclastic character considered of Sinemurian-Pliensbachian age, most probably Pliensbachian. The studied sample represent trunk or thick-branch fragments, having dark to black color and by magnifying glass or even by naked eye, regular fibrous structure without vessels suggesting a conifer wood. The specimens with field-numbers 1011, 1023, 1017Cr - in "Grădinaru Collection", are deposited now under the inventory numbers 27645 - 27747 in the collections of the Geological Institute of Romania (G.I.R. Collections), hosted by the National Geological Museum in Bucharest.

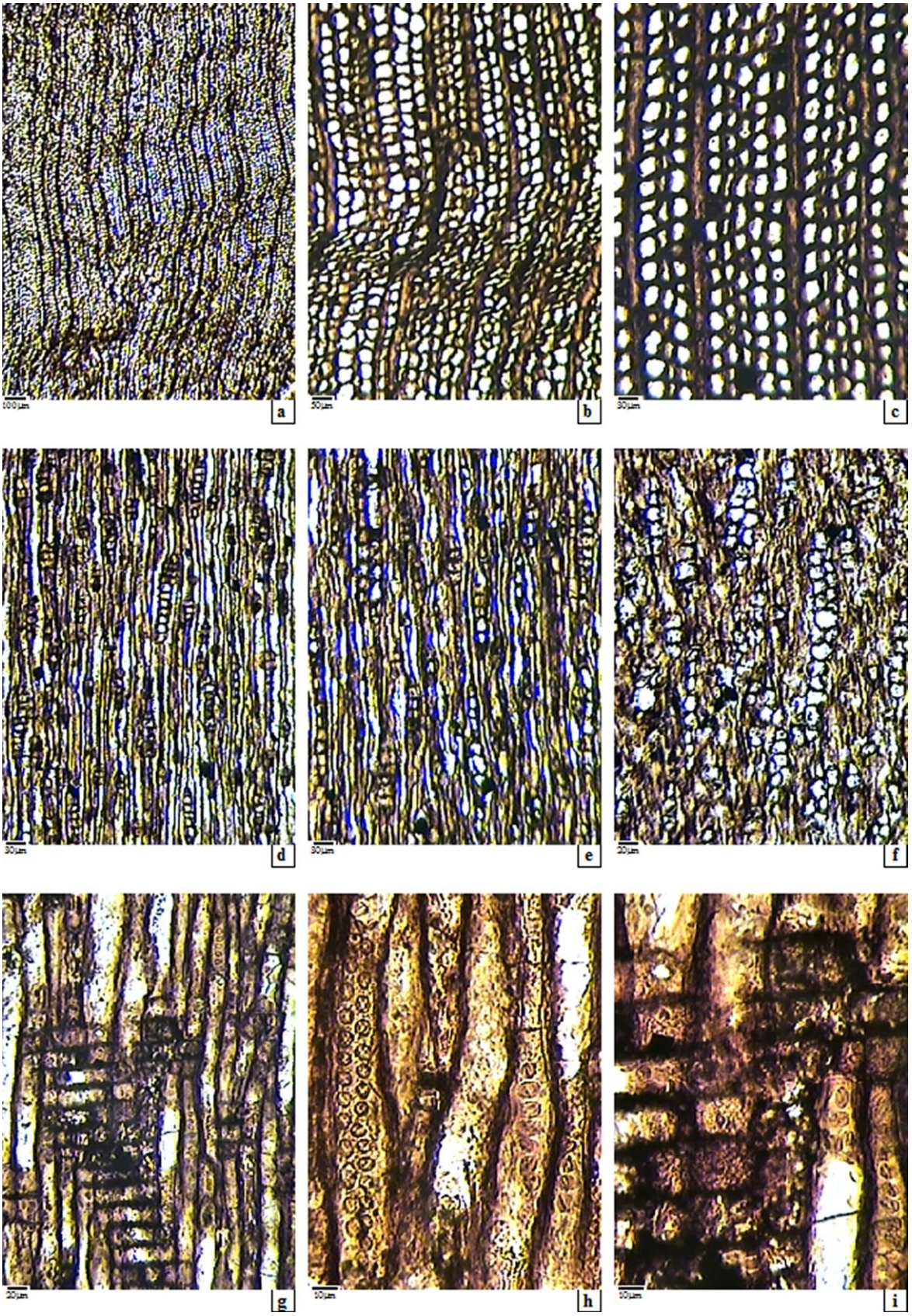

Fig. 10 *Palaeoginkgoxylon* sp. - material - inventory no. 27746 (field no. 1023). **a-c** Cross section: indistinct growth-ring boundary, thick-walled polygonal tracheids with rounded corners, and linear rays. **d-f** Tangential section: unpitted tracheids, uniseriate rays, and biseriate with long endings; polygonal-rounded ray-cells. **g-i** Radial section: radial piting on tracheids of mixed type, cross-fields with 1-2 rows of oculipores.

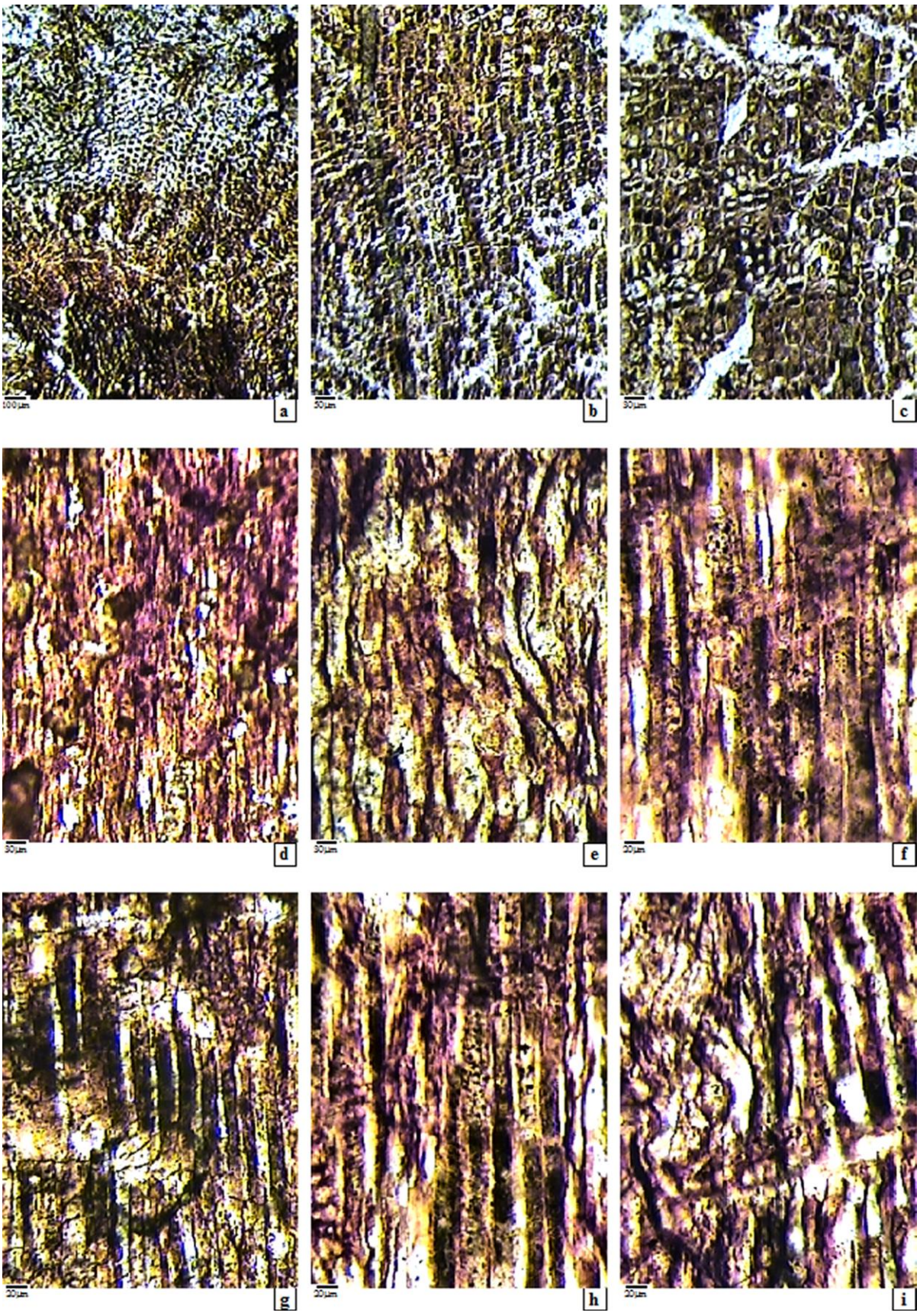

Fig. 11 *Palaeoginkgoxylon* sp. - material - inventory no. 27747 (field no. 1017cr). **a-c** Cross section: less distinct growth-ring boundary, thick-walled polygonal tracheids with rounded corners, and linear rays. **d-e** Tangential section: tracheids with bent ends, uniseriate rays. **f-i** Radial section: tracheids have bent ends which overlap each other, radial piting on tracheids of mixed type, bad preserved cross-fields.

Microscopic description

Both the studied specimens present s e c o n d a r y w o o d with tracheidoxylic structure, with relatively thick-walled tracheids and few parenchyma, devoid of any resin canals, and with quite indistinct growth-rings boundaries, relatively badly preserved (1017).

T r a c h e i d s - with polygonal cross-section with slightly rounded corners, unequal in size, with polygonal or quadrangular rounded lumina gradually diminishing in size from early to late wood, having radial/tangential diameters of 25-35)/25(35-40) µm, smaller in the late wood, and not too thin-walled, of 4-7 µm double wall thicker in the late-wood. The interradial bundles have 2-12 radial regular rows of tracheids and the density is 1360-1728 tracheids per mm2. Tangentially seen the tracheids are usually unpitted, rarely uniseriate pitted and with the terminal parts slightly leaned over the neighbor cells. Radial pitting is of mixed type, with pits either polygonal to slightly rounded, spaced or contiguous, in one vertical row, or less, biseriate, alternate or slightly irregular to opposite. The bordered pits are polygonal to rounded, slightly flattened, relatively small, of 8-10 µm in diameter when biseriate, and round of 10-16 µm in diameter, also slightly flattened when uniseriate. Often only the pit chamber is visible, the aperture difficult to observe is small round to short elliptic, of 1.5-2(3.5) µm. Crassulae or helical thickenings were not observed. Sometimes the tracheids have bent ends which overlap each other (specimen 1017Cr) and bear some dark content inside lumina.

A x i a l p a r e n c h y m a - appears sometimes like few dispersed cells in transversal view and isolated or in short vertical rows usually, difficult to observe due to bad preservation.

M e d u l l a r y r a y s - are fine, rectilinear in tranversal view. Simple pits irregularly arranged could appear on the horizontal walls. Tangentially the usually uniseriate rays have 1-7(-16) cells in height, i.e. 20-180(-350) µm high. Sometimes the taller rays have 1-5 biseriate storeys, giving an almost biseriate aspect (specimen 1023). The ray cells are round to oval and have moderately thin walls, of 2.5-3 µm double walls. Simple pits irregularly present on the tangential walls. Ray density is 7-12 rays on horizontal tangential millimeter. Radially the rays are homocellular, cells all procumbent of 19-20(-28) µm high, moderately thick-walled: 5-6.2 µm the double wall. Within the marginal rows the cells are slightly higher, of 28-30(-40) µm. The cross fields of cupressoid type have 1-4(6-9?) oculipores, rounded or oval of 4-8(13) µm in diameter, with circular or short elliptic tilted apertures of 1-2(3.5) µm. Their arrangement is alternate or slightly irregular on 1-3 rows. Sometimes the walls of ray cells seem to be slightly wrinkled, but few details can be observed, due to the bad preservation.

Affinities and discussions

The presence of some xylotomical details of the secondary wood in our specimens like the presence of bent tracheids' ends overlapping each other and the presence of parenchyma suggested us a possible affinity with some fossil ginkgophyte trunks described from different Mesozoic sites in the world also mainly in the Asian space, in Mesozoic deposits, but in other. As is well known, only a species of ginkgophyte (*Ginkgo biloba* L.) survived, living now, naturally, in China.

Some fossil taxa show xylotomical details similar to extant *Ginkgo* wood anatomical structure, as *Ginkgoxylon* (Saporta, 1884) Philippe et Bamford, 2008), *Proginkgoxylon* (Khudajberdyev, 1971) Zheng et Zhang 2008 (in Zheng *et al*., 2008), *Szeioxylon* Wang, Jiang et Qin, 1994, *Sinopalaeospiroxylon* Zhang et Zheng, 2006 (in Zhang *et al.*, 2006), *Primoginkgoxylon* Süss, Rößler, Boppré et Fischer, 2009; *Palaeoginkgoxylon* Feng, Wang et Rößler, 2010.

Taking into account the diagnosis of the genus *Palaeoginkgoxylon* Feng, Wang et Rößler, 2010 which specify that, beside the primary structure with pith, there is an well developped secondary xylem - which is pycnoxylic (i.e. tracheidoxylic) with size and slightly irregular arrangement of the tracheid, which, vertically have bent ends overlapping each other, have mixed radial pitting 1-2 seriate, cross-field pits cupressoid, ray cells irregularly pitted on the horizontal and the radial walls and also, and have axial parenchyma - we observed that our studied specimens, even if badly preserved, exhibit more similar features (regarding the tracheidal pitting usually 1-2 seriate, the cupressoid cross fields, the parenchyma), with the secondary wood of the species *Palaeoginkgoxylon zhoui* Feng, Wang et Rößler, 2010, than with other above cited fossil genera.

Thus, based on these similitudes with the type species of a new genus described by Feng *et al.* (2010), we have attribute the studied material (3 specimens) to *Palaeoginkgoxylon* sp., hoping to find a better preserved material and to document, at specific level, the presence of a ginkgophyte wood in the Jurassic flora of the Romanian Carpathians. In this context it's good to remark that Czier (1998a) described *Ginkgo* foliage from the Jurassic of the Carpathian Basin and such identification could support as acceptable Czier's proposal regarding the transfer of *Ginkgoites* and *Baiera* to the genus *Ginkgo*, because in addition to the similar foliage structure of these genera, our Jurassic material xylotomically is very similar the extant *Ginkgo* wood.

CONCLUSIONS

The finding of petrified woods in the Holbav and Cristian areas represents the first and the most significant collection of Early Jurassic lignoflora in the Romanian Carpathians.

The present study is an important contribution to the knowledge on the Mesozoic flora, respectively of the Early Jurassic flora from the Romanian Carpathians. Five Early Jurassic gymnosperm lignotaxa are newly described in the present paper, as follows:

•Order **Pinales**

- *Agathoxylon holbavicum* sp. nov.
- *Brachyoxylon holbavicum* sp. nov.
- *Brachyoxylon cristianicum* sp. nov.
- *Protophyllocladoxylon holbavicum* sp. nov.

•Order **Ginkgoales**

- *Palaeoginkgoxylon* sp.

All of the newly described lignotaxa come mainly from Holbav, and these were collected from the lahar deposits in the upper part of the Pliensbachian volcano-

sedimentary sequence cropping out on the Maiului brook. *Brachyoxylon cristianicum* sp. nov. and *Palaeoginkgoxylon* sp. come from the Hettangian-Sinemurian coaly sequence of Cristian, but they also appear in Holbav area.

The studied petrified wood material from the Lower Jurassic coally deposits in the Holbav and Cristian areas may contribute significantly to improve the paleobiogeographic, palaeoenvironmental, paleoecologic and palaeoclimatic reconstructions, already advanced in previous studies of other plant parts (pollen, spores, leaves and fruits imprints).

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E.G. remembers with nostalgia the many years, from 1968 to 1975, when he as a young field-geologist was hosted during summers in the family of Peter and Ida Hull alongside Brigitte, Renate and Peter, in the Vulcan village (Brașov County). E.G. reminds also Stefan Hermanstädter from Vulcan village having a good knowledge on basic mineralogy gained in the Horticulture School before the WWII, who despite his advanced age accompanied him on field and helped to carry by foot several kilometers the fossil woods collected at Holbav on the Maiului brook.

REFERENCES

Andrae, K.I., 1852. Briefliche Mittheilung über die geologischen Verhältnisse bei Holbak und Zaison. Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt, 3: p.12

Andrae, K.I., 1855. Beiträge zur Kenntniss der fossilen Flora Siebenbürgens und des Banates. Abhandlungen der kaiserlich-königlichen geologischen Reichsanstalt, 2: 1-48.

Andreánszky, G., 1949: Baumstämme aus der unteren Kreidezeit. Földtani Közlöny, Budapest, 79: 244–252.

Antonescu, E., 1973. Quelques données sur la palynologie du Lias sous faciès de Gresten de Roumanie. Palynology of Mesophyte. Proceedings of the 3rd International Palynological Conference, Nauka, Moscow: 13-17.

Bădăluță, A., Preda, I. & Culda V., 1988. Sur le Liasique du sommet Culmea Obîrșia (zone Obîrșia Cloșani – Monts Mehedinți). Analele Universității București, Geologie, 37: 23-30.

Bamford, M.K., 2016. Fossil Woods from the Upper Carboniferous to Lower Jurassic Karoo Basin and their environmental interpretation. In: Linol, B., de Wit, M.J. (eds) Origin and Evolution of the Cape Mountains and Karoo Basin. Springer International Publishing AG, in Cham (Switzerland): 159–167.

Bamford, M.K. & Philippe, M. 2001. Jurassic–Early Cretaceous Gondwanan homoxylous wood: a nomenclatural revision of the genera with taxonomic notes. Review of Palaeobotany and Palynology, 113: 287–297.

Barale, G., 1981. La paléoflore jurassique du Jura français: étude systématique, aspects stratigraphiques et paléoecologiques. Documents Laboratoire Géologie de Lyon, 81: 1-467.

Barale, G., Barbacka, M. & Philippe, M., 2002. Early Cretaceous flora of Hungary and its palaeoecological significance. Acta Palaeobotanica, 42: 13–27.

Barbacka, M., Bodor, E., Jarzynka, A., Kustatscher, E., Pacyna, G., Popa, M.E, Scanu, G. G., Thevenard, F. & Ziaja, J., 2014. European Jurassic floras: statistics and palaeoenvironmental proxies. Acta Palaeobotanica, 54: 173-195.

Barbacka M., Popa M.E., Mitka J., Bodor E. & Pacyna, G., 2015. Relationships between ecosystems and plant assemblages as responses to environmental conditions in the Lower Jurassic of Hungary and Romania. Acta Palaeobotanica, 55(1): 3-17.

Barbacka, M., Popa, M.E., Mitka, J., Bodor, E., Puspoki, Z. & Mcintosh, R. W., 2016. A quantitative approach for identifying plant ecogroups in the Romanian Early Jurassic terrestrial vegetation. Palaeogeography, Palaeoclimatology, Palaeoecology, 446: 44-54.

Bielz, E.A., 1858. Üeber das Vorkommen und die Verbreitung der Mineralkohlen in Siebenbürgen. Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt, 9: 53-56

Bodnar, J., Escapa, I., Cúneo, N.R. & Gnaedinger, S., 2013. First record of conifer wood from the Cañadón Asfalto Formation (Early–Middle Jurassic), Chubut province, Argentina. Ameghiniana, 50 (2): 227-239.

Boura, A., Pons, D., Vozenin-Serra, C. & Phú My, B., 2013. Mesozoic fossil wood of Kiên Giang Province, southwestern Vietnam. Palaeontographica Abt. B, 290(1-3): 11-40.

Boureau, E. & Serra, C., 1961. Sur les structures normales et traumatiques d'un bois mésozoïque du Cambodge, le *Brachyoxylon saurinii*, n.sp. Revue générale de botanique, 68: 373-393.

Bădăluță, A., Preda, I. & Culda, V., 1988. Sur le Liassique du sommet Culmea Obârșia (Zone Obârșia Cloșani - Monts Mehedinți). Analele Universității București, 37: 8.

Cevallos-Ferriz, S.R.S., 1992. Tres Maderas de Gimnospermas Cretacicas del Norte de Mexico. Anales del Instituto de Biologia Universidad Nacional Autonoma de Mexico, Serie Botanica, 63(2): 111-137.

Chase, M.W. & Reveal, J.L., 2009. A phylogenetic classification of the land plants to accompany APG III. Botanical Journal of the Linnean Society, 161: 122-127.

Christenhusz, M.J.M., Reveal, J.L., Farjon, A., Gardner, M.F., Mill, R.R. & Chase, M.W., 2011. A new classification and linear sequence of extant gymnosperms. Phytotaxa, 19: 55–70.

Czier, Z., l995a. Two new fossil plant species from the Lower Liassic of Anina, Romania: *Ptilophyllum ani-*

naensis n. sp. and *Williamsonia aninaensis* n. sp. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 12: 747-755.

Czier, Z., 1995b. Paleobotanical Biostratigraphy of the Terrestrial Liassic of Western Romania. Studia Universitatis Babeş-Bolyai, Geologia, 40(2): 95-104.

Czier, Z., 1995c. The bibliography of the Liassic flora from Romania. Studia Universitatis Babeş-Bolyai, Geologia, 40(2): 105-111.

Czier, Z., 1996a. *Banatozamites* Czier, gen. nov. (Cycadeoidales) from the lower Liassic of Romania. Review of Palaeobotany and Palynology, 94(3-4): 345-356.

Czier, Z., 1996b. Repertoriul punctelor fosilifere cu flora liasică din România. Nymphaea, Folia naturae Bihariae, 22: 67-70. [In Romanian].

Czier, Z., 1998a. *Ginkgo* foliage from the Jurassic of the Carpathian Basin. Palaeontology, 41(2): 349-381.

Czier, Z., 1998b. A concordance and bibliography of Carpathian-Pannonian Liassic macroflora localities. Nymphaea, Folia naturae Bihariae, 26: 125-146.

Czier, Z., l999a. Lithostratigraphic units yielding the lower Jurassic macroflora from Romania. Nymphaea, Folia naturae Bihariae. 27: 5-42.

Czier, Z., 1999b. Biostratigraphy of the lower Jurassic from Romania, based on the macroflora fossil record. Nymphaea, Folia naturae Bihariae, 27: 43-58.

Czier, Z., l999c. Originea macroflorei Jurasicului inferior din Romania. O nouă interpretare paleofitogeografică. Nymphaea, Folia naturae Bihariae, 27: 59-72. [In Romanian].

Czier, Z., 2000. Rezumatul tezei de doctorat „Flora liasică din Crişana şi Banat" (Universitatea Eötvös Loránd - Budapesta, 1994).- Nymphaea, Folia naturae Bihariae, 28: 27-46, 1 Fig., 1 Tab., Oradea.) [In Romanian].

Czier, Z., 200l. Încadrarea paleoclimatică şi paleofitogeografică a macroflorei Jurasicului inferior din România. Locul florei în context european. Acta Musei Porolissensis, 23(2): 823-834. [In Romanian].

Czier, Z., 2003. Jurasicul inferior continental din România - aspecte prezentate în expoziţie temporară la Muzeul Ţării Crişurilor. Nymphaea, Folia naturae Bihariae, 30: 199-237. [In Romanian].

Czier, Z., 2008. *Banatozamites remotus* Czier sp. nov. (Cycadeoidales) from the Lower Jurassic of Anina, Romania. Nymphaea, Folia naturae Bihariae, 35: 5-26.

Czier, Z., 2009. *Banatozamites calvus* Czier sp. nov. and *Bucklandia aninaensis* Czier sp. nov. from the Lower Jurassic of Anina, Romania. Nymphaea, Folia naturae Bihariae, 36: 5-26.

Czier, Z., 2010. The presence of the genus *Ptilophyllum* in the Lower Jurassic flora of Romania. Nymphaea, Folia naturae Bihariae, 37: 5-38.

Czier, Z., 2011. Revision of *Ptilophyllum*-like leaves from the Lower Jurassic of Romania. Nymphaea, Folia naturae Bihariae, 38: 5-16.

Czier, Z., 2014. Taxonomic attribution of the species *Pterophyllum pectinatum* (Jaeger) Csaki and Ulrichs, em. Czier (Bennettitales) based on cuticular analysis, and its presence in the Euro-Sinian palaeofloristic region. Brukenthal Acta Musei. 9(3): 567-586.

Czier, Z., 2016a. The Bennettitalen genus *Pterophyllum* in the fossil flora of Romania, and the global phytostratigraphic context. Vestnik TvGU, Seriya Biologiya i Ekologiya, 3: 133-184.

Czier, Z., 2016b. Probleme de stratigrafie cu privire la depozitele continentale ale Jurasicului inferior din România. In: Moisa, G., Goman, I., Şipoş, S. (coord.), Omagiu Chiriac Aurel. Fragmentarium, studii interdisciplinare în onoarea lui Aurel Chiriac. 538-573. Ed. Muzeului Ţării Crişurilor, Oradea. [In Romanian].

Czier, Z., 2016c. European Paleofloristic Affinities of the Romanian Jurassic Macroflora. Nymphaea, Folia naturae Bihariae, 43: 13-66.

Dragastan, O.N. & Popa, M.E., 1997. Early Jurassic Phytostratigraphy of the Holbav Formation, Getic Nappe, Braşov County. Revue Roumaine de Géologie, 41: 51-60.

Drăghici, C. & Semaka, A., 1962. Observaţii asupra Liasicului de la Baia-de-Aramă. Studii şi cercetări de geologie, 7(1): 33-44. [In Romanian].

Drăghici, C., Mercus, D. & Semaka, A., 1964. Zur Kenntnis der Lias-Ablagerungen von Cernavârf-Mehedinţi-Hochebene/Rumänien. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 8: 447-514.

Dupéron–Laudouéneix, M., 1991. Importance of fossil woods (conifers and angiosperms) discovered in continental Mesozoic sediments of North-ern Equatorial Africa. Journal of African Earth Sciences 12: 391–396.

Engler, H.G.A. & Prantl, K.A.E., 1897. Die Natürlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten. Nachträge I-IV: p.19.

Ettingshausen, C., 1852a. Fossilen Pflanzen von Steierdorf im Banat.

Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt, 3: p. 194.

Ettingshausen, C., 1852b. Begründung einiger neuen oder nicht genau bekannten Arten der Lias- und Oolithflora. Abhandlungen der kaiserlich-königlichen geologischen Reichsanstalt, 1(3): 1-10.

Fletcher, T.L., Cantrill, D.J., Moss, P.T. & Salisbury, S.W., 2014. A new species of *Protophyllocladoxylon* from the Upper Cretaceous (Cenomanian–Turonian) portion of the Winton Formation, central-western Queensland, Australia. Review of Palaeobotany and Palynology, 208: 43-49.

Feng, Z., Wang, J. & Rößler, R., 2010. *Palaeoginkgoxylon zhoui*, a new ginkgophyte wood from the Guadalupian (Permian) of China and its evolutionary implications. Review of Palaeobotany and Palynology, 162: 146–158

Foetterle, F., 1850. Verzeichniss der an die k. k. geologische Reichsanstalt gelangten Einsendungen von Mineralien, Petrefacten, Gebirgsarten u.s.w. Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt, 1(2): 350-364.

García Esteban, L., Palacios, P.de, Philippe, M., Guindeo, A. & García Fernández, F., 2006: New xylological data and the biogeography of the Iberian Peninsula during the Early Cretaceous. Geobios, 39: 805–816;

Garcia, J.-P., Philippe, M. & Gaumet, F., 1998. Fossil wood in Middle-Upper Jurassic marine sedimentary cycles of France: relations with climate, sea-level

dynamics, and carbonate-platform environments. Palaeogeography, Palaeoclimatology, Palaeoecology, 141(3-4): 199-214.

Givulescu, R., 1975. Monografia holotipurilor de flora fosilă descrise din România. Memorii, Institutul Geologic, Bucureşti, 22: 1-72. [In Romanian].

Givulescu, R., 1989a. La flore fossile du Liasique inferiéur d'Anina (une mise au point nomenclatorique). Contribuţii Botanice: 135-138, Cluj-Napoca.

Givulescu, R., 1989b. Recherches nouvelles sur les plantes fossiles du Liassique inférieur d'Anina (Roumanie). Studia Universitatis Babeş-Bolyai, Geologie-Geografie, 34(2), Cluj-Napoca.

Givulescu, R., 1990a. Le genre *Arctopteris* Samylina 1964 dans la flore du Lias inférieur d'Anina, Roumanie. Documenta Naturae, 59(1): 58-62.

Givulescu, R., 1990b. Über die Wahre Angeshorigkeit von Stachyotaxus lipoldi (Stur) Kräusel aus dem Unteren Lias von Anina, Rumänien. Contribuţii Botanice, Grădina Botanică "Al. Borza", Cluj-Napoca.

Givulescu, R., 1990c. Zwei neue Bennettitenblüten aus dem Unteren Lias von Anina (Banat, Rumänien). Documenta Naturae, 59(2): 1-7.

Givulescu, R., 1991a. *Zamites vachrameevii* Doludenko 1969 in dem Unteren Lias, Rumänien. Acta Palaeobotanica, 31(1-2): 17-21.

Givulescu, R., 1991b. Zwei neue Pflanzen aus dem Unteren Lias von Anina, Rumänien: *Baiera polymorpha* Samylina und *Pseudotorella nordenskjoeldii* (Nathorst) floren. Documenta Naturae, 65(2): 12-17.

Givulescu, R., 1992a. A new contribution to the knowledge of the fossil flora at Anina, Romania. Studia Botanica Hungarica (Antea: Fragmenta Botanica), 23: 9-15.

Givulescu, R., 1992b. *Ptilophyllum maculatum* n. sp., a new *Ptilophyllum* from the Early Lias of Anina/Romania. Courier Forschungsinstitut Senckenberg, 147: 241-245.

Givulescu, R., 1992c. Une révision nomenclatorique et taxonomique de la flore du Lias de Vulcan-Codlea, Roumanie. Contribuţii Botanice, Grădina Botanică "Al. Borza", Cluj-Napoca.

Givulescu, R., 1993. *Taxodiophyllum* cf. *scoticum* van der Burgh et van Konijnenburg-van Cittert, 1984 in Unteren Lias von Anina, Rumanien. Acta Palaeobotanica, 1(33): 47-51.

Givulescu, R., 1997a. *Aninopteris*, a new genus of the Matoniaceae. Romanian Journal of Palaeontology, 77: 1-4.

Givulescu, R., 1997b. La flore du Lias inférieur d'Anina (Roumanie). (Note preliminaire). Natura Silvaniae, 1: 67-81.

Givulescu, R., 1998a. Flora fosilă a Jurasicului inferior de la Anina. Ed. Acad. Rom., Bucureşti, 90 pp. [In Romanian].

Givulescu, R., 1998b. *Ptilophyllum maculatum* Givulescu, 1992 or *Ptilophyllum aninaensis* Czier, 1995 - a problem of priority. Documenta naturae, 117: 81-87.

Givulescu, R., 2002. Considérations sur la flore du Liasique inférieur de Şuncuiuş, Departement de Bihor, Roumanie: Departement de Bihor. Studia Universitatis Babeş-Bolyai, Geologia, Special volume, 1: 207-211, Cluj Napoca.

Givulescu, R. & Czier, Z., 1990. Neue Untersuchungen über die Floren des Unteren Lias (Rumänien). Documenta Naturae, 59(3): 8-19.

Givulescu, R. & Popa, M.E., 1994. Eine neue *Dictyophyllum* - Art aus dem unteren Lias von Anina (Rumänien). Documenta Naturae, 84: 42-46.

Givulescu R. & Popa M.E., 1998. *Aninopteris formosa* Givulescu et Popa, gen. et sp. nov., a new Liassic matoniaceous genus and species from Anina, Banat, Romania. Review of Palaeobotany and Palynology, 104: 51-66.

Gorozhankin, I.N., 1904. Gingkoales. (Published in: Lektsii po Morfologii i Sistematike Archegonialnykh Rastenij. II. Pteridophyta I. Archispermae. Moscow: A.I. Mamontov) (Russian scientific publication usually cited as: Lekts. Morf. Sist. Archegon.), 73: p.93. [in Russian].

Greguss, P., 1952. Magyarországi mezozói famaradványok. Földtani Közlöny, 82: 157-180.

Greguss, P., 1955. Xylotomische Bestimmung der heute lebenden Gymnospermen. Akadémiai Kiadó, Budapest.

Haas, J., Kovács, S., Gawlick, H-J., Grădinaru, E., Karamata, S., Sudar, M., Péró, C., Mell, J., Polák, M., Ogorelec, B. & Buser, S., 2011. Jurassic Evolution of the Tectonostratigraphic Units of the Circum-Pannonian Region. Jahrbuch der Geologischen Bundesanstalt, 151(3-4): 281–354.

Hartig, T., 1848. Beiträge zur Geschichte der Pflanzen und zur Kenntnis der norddeutschen Braunkohlen-Flora. Botanische Zeitung, 6: 122–128.

Hauer, F.R. von & Stache, G., 1863. Geologie Siebenbürgens. Wilhelm Braumüller K.K. Hofbuchhändler, Wien, 1-636.

Herbich, F., 1878. Das Széklerland mit Berücksichtigung der angrenzenden Landestheile, geologisch und paläontologisch beschrieben. Jahrbuch der Königlichen Ungarischen Geologischen Anstalt, 5(2): 19-363.

Hickey, L.J., Hu, S. & Skinner, B.J., 2011. A New genus of silicified conifer wood from the Late Triassic of Connecticut. American Journal of Science, 311(7): 608-631.

Hollick, A. & Jeffrey, E.C. 1909. Studies of coniferous cretaceous remains from Kreischerville (New-York). Memoirs of the New York Botanical Garden, 3: 1-137.

Holden, R., 1913a. Some fossil plants from Eastern Canada. Annals of Botany, 27(2): 243–255.

Holden, R., 1913b. Contributions to the Anatomy of Mesozoic Conifers. 1. Jurassic coniferous woods from Yorkshire. Annals of Botany, 27:533-549.

Humml, H., 1957. Contributions à l'étude de la flore du Lias inférieur de Steierdorf-Anina. Studii şi cercetări ştiinţifice, 3-4: 65-74.

Humml, H., 1963. Catalogul florei fosile păstrate in Muzeul regional al Banatului. Studii şi Cercetări. Biologie şi Ştiinţe Agricole, Timişoara, 10: 185–201. [In Romanian].

Humml, H., 1969. Contribuţii la flora fosilă a Liasicului inferior de la Steierdorf-Anina. Studii şi cercetări de geologie, geofizică, geografie, Seria Geologie, 14(2): 385-404. [In Romanian].

Iamandei, E. & Iamandei, S., 2004. New Conifers in Late Cretaceous lignoflora from the South Apuseni. Acta Palaeontologica Romaniae, 4: 137-150.

Iamandei, E. & Iamandei, S., 2005. Early Cretaceous protopinaceous fossil wood from South Dobrogea, Romania. Acta Palaeontologica Romaniae, 5: 231–247.

Iamandei E., Iamandei S. & Grădinaru E., 2008. Jurassic petrified forests in Carpathians. Terra Nostra-Schriften der GeoUnion Alfred-Wegener-Stiftung, 2: p.123.

Iamandei, E., Iamandei, S. & Grădinaru, E., 2009. Liassic Petrified Wood in the Carpathian Mountains. 7th Romanian Symposium on Paleontology, 22-24 Oct.2009, Cluj-Napoca, Romania. Abstract Book, p.52.

Iamandei, S., Iamandei, E. & Grădinaru, E., 2011. New Liassic woods from Holbav, Romania. Eighth Romanian Symposium on Paleontology, 29-30 September 2011, Bucharest, Romania. Abstract Book: 66-67.

IAWA Committee, 2004. IAWA list of microscopic features for softwood identification. International Association of Wood Anatomists, Baas, P. *et al*. in: IAWA Journal , 25: 1–70.

Iijima, A., Kakuwa, Y. & Matsuda, H., 1989. Silicified Wood from the Adoyama Chert, Kuzuh, Central Honshu, and Its Bearing on Compaction and Depositional Environment of Radiolarian Bedded Chert. In: Hein J.R., Obradović J. (eds), Siliceous Deposits of the Tethys and Pacific Regions. Springer, New York.

Iliescu, O. & Semaka, A., 1962. Contribuții la cunoașterea Rheto-Liasicului din împrejurimile Mehadiei. Dări de Seamă ale şedinţelor Comitetului Geologic, 48: 113-119. [In Romanian].

Jekelius, E., 1914. Die mesozoischen Bildungen des Keresztényhavas. Jahresbericht der Königlichen Ungarischen Geologischen Anstalt für 1913, 1: 155-181.

Jekelius, E., 1915a. Die geologische Bau des Nagyköhavas und Keresztényhavas. Jahresbericht der Königlichen Ungarischen Geologischen Reichsanstalt für 1914, 1st Teil: 310-325.

Jekelius, E., 1915b. Die mesozoische Faunen der Berge von Brassó: I. Liasfauna von Keresztényfalva. Jahrbuch der Königlichen Ungarischen Geologischen Anstalt, 23/2: 25-113

Jekelius, E., 1923a. Zăcămintele de cărbune din România, I. Cărbunii liasici din împrejurimile Braşovului. Studii tehnice şi economice, Institutul Geologic al României, 3(1): 30 p., 3fig., 8 h., 7 pl., 1 tab. [In Romanian].

Jekelius, E., 1923b. Cărbunii liasici din împrejurimile Braşovului. Dări de seamă ale şedinţelor, Institutul Geologic al României, 11: 119-120. [In Romanian].

Jekelius, E., 1927. Structura geologică a regiunei liasice cu cărbuni dela Vulcan-Codlea (Jud. Braşov). Dări de seamă ale şedinţelor. Institutul Geologic al României, 10: 55-59. [In Romanian].

Jekelius, E., 1938. Das Gebirge von Braşov. Anuarul Institutului Geologic al României, 19: 379-408.

Khudajberdyev, R., 1971. The woody fossil Ginkgoales. In: Sixtel, T.A., Kuzichkina, Y.M., Savitskaya, L.I., Khudajberdyev, R. & Shetsova, E.M., (Eds.), History of Development of Ginkgoales in Middle Asia. Paleobotany of Uzbekistan, 2: 98–104. [In Russian].

Kloster, A.C. & Gnaedinger S.C., 2017. Coniferous wood of *Agathoxylon* from the La Matilde Formation, (Middle Jurassic), Santa Cruz, Argentina. Journal of Paleontology, 2017: 1 - 22 Copyright © 2018, The Paleontological Society 0022-3360/15/0088-0906 doi: 10.1017/jpa.2017.145

Krasser, F., 1915. Männliche Williamsonien aus dem Sandsteinschiefer des unteren Lias von Steierdorf im Banat. Denkschriften der Kaiserlichen Akademie der Wissenschaften mathematisch-naturwissenschaftliche Klasse, 93(107): 1–18, Wien.

Krasser, F., 1922. Zur Kenntnis einiger fossiler Floren des unteren Lias den Sukzessionsstaaten von Österreich-Ungarn. Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften - mathematisch-naturwissenschaftliche Klasse (1921), 130: 345-373, Wien.

Kräusel, R., 1939. Ergebnisse der Forschungsreisen Prof. E. Stromers in den Wüsten Ägyptens. IV. Die fossilen Floren Ägyptens. 3. Die fossilen Pflanzen

Ägyptens, E.L. Abhandlungen Bayerische Akademie der Wissenschaften.

Mathematisch-Naturwissenschaftliche Klasse, N.F. 47: 1-140.

Kräusel, R., 1949. Die fossilen Koniferen-Hölzer (Unter Ausschluß von *Araucarioxylon* Kraus) II. Teil. Kritische Untersuchungen zur Diagnostik lebender und fossiler Koniferen-Hölzer. Palaeontographica Abt.B, 89: 83–203.

Kurzawe, F. & Merlotti, S., 2010. O complexo *Dadoxylon-Araucarioxylon*, Carbonífero e Permiano do Gondwana: estudo taxonômico do gênero *Araucarioxylon*. Pesquisas em Geociências 37: 41–50.

Kusko, M., Cibotaru, T. & Damian, R., 1979. Proiect geologic de cercetare cu foraje pentru cărbuni superiori (huilă) şi argile refractare în depozitele mezozoice din perimetrul Poiana Braşov-V. Rîşnoavei, jud. Braşov. Raport, Arhiva IGPSM, MMPG, Bucureşti. [In Romanian].

Kutluk, H., Kır, O. & Akkemik, Ü., 2012. First Report of Araucariaceae wood (*Agathoxylon* sp.) from the Late Cretaceous of Turkey. IAWA Journal, 33(3): 319-326.

Langer, J., 1947. Über einige Stucke der Liassflora von Steierdorf und der Keuperflora von Lunz. Jahrbuch der kaiserlich-koniglichen geologische Reichsanstalt, 90 (1945): 21-33.

Lemoigne, Y., 1968. Caractères histologiques du bois secondaire du *Brachyphyllum desnoyerisii* (Brongn.) de Saporta. Annuaire du Société Géologique Nord, 88: 159-161.

Machhour, L. & Pons, D., 1992. Bois de Coniférales dans l'Albien du synclinal du Beausset (Var, SE France). Signification paléogeogaphique et paléoclimatique. Géobios, Paris, 25(2): 181-193.

Manolescu, G., 1932. Das Alter der Schela-Fromation. Buletinul Societății Române de Geologie, 1; 169-175.

Manilici, V. & Vîlceanu, P., 1962. Contribuții la studiul rocilor efusive din Bazinul Codlea. Studii şi cercetări de geologie, 7(3-4): 549-568. [In Romanian].

Mateescu, I., 1964. Studiul petrografic al cărbunilor din Bazinul Codlea-Vulcan. Studii tehnice şi economice, A/6: 69-100. [In Romanian].

Mencl, V., Bureš, J. & Sakala, J., 2013. Summary of occurrence and taxonomy of silicified *Agathoxylon* - type of wood in Late Paleozoic basins of the Czech Republic. Folia, 47(1-2): 14-26.

Meschendörfer, J., 1860. Die Gebirgsarten im Burzenlande, ein Beitrag zur Geognosie von Siebenbürgen. Verhandlungen und mitteilungen des Siebenbürgischen vereins für naturwissen schaften zu Hermannstadt, 11:236-249; 255-287.

Mirabelli, S. L., Pujana, R. R., Marenssi, S. A. & Santillana, S. N. 2018. Conifer fossil woods from the Sobral Formation (Paleocene, Western Antarctica). Ameghiniana, 55: 91-108.

Murphy, M.A. & Salvador, A., 1999. International Stratigraphic Guide - An abridged version. Episodes, 22(4): 255-271.

Năstăseanu, S., Bițoianu, C. & Răzeșu, S., 1970. Considerații geologice și petrografice privind zăcămintele de cărbuni de la Codlea-Vulcan și Schela. Studii tehnice și economice, A/8: 87-104. [In Romanian].

Oarcea, C. & Semaka, A., 1962. Flora Liasică din colecția de la Anina. Dări de Seamă, Comitetul Geologic, 46: 239-244. [In Romanian].

Oh, C., Kim, K., Paik, I.-S. & Lim, J.-D., 2011. Cretaceous conifer woods of Korea: Occurrences and palaeobiological implications. Review of Palaeobotany and Palynology, 164(1-2): 67–83

Pacyna, Gr., 2013. Critical review of research on the Lower Jurassic flora of Poland. Acta Palaeobotanica, 53(2):141-163; DOI: 10.2478/acpa-2013-0015

Pant, D. & Singh,V., 1987. Xylotomy of some woods from Raniganj Formation (Permian), Raniganj Coalfield, India. Palaeontographica B, 203: 1–82.

Patrulius, D., 1961. La couverture mésozoïque des massifs cristallins des Carpates orientales. Annales Instituti Geologici Publici Hungarici, 49(1): 75-102.

Patrulius, D., Antonescu, Em., Avram, E., Baltreș, A., Dumitrică, P., Iordan, M., Iva, M., Morariu, Al., Pop, Gr., Popa El. & Popescu, Il. 1980. Studiul petrologic și biostratigrafic complex al formațiunilor jurasice și neocomiene, din Carpații Românești și Dobrogea, în vederea evaluării potențialului de resurse minerale. Sectorul Leaota-Brașov-Munții Perșani. Tema 47/1979. Raport, Arhiva Institutului de Geologie și Geofizică, București. [In Romanian].

Petrescu, I. & Nuțu, A., 1971. Asupra unor noi aflorimente de lemne fosile din Miocenul superior al munților Metaliferi. Sargetia, Acta Musei Devensis, Series Scientia Naturae, 8: 9-14. [In Romanian].

Philippe, M., 1993. Nomenclature générique des trachéidoxyles fossiles mésozoïques à champs araucarioïdes. Taxon, 42: 74-80.

Philippe, M., 1995. Bois fossils du Jurassique de Franche-Comté (NE-France). Palaeontographica Abt. B, 236: 45-103.

Philippe, M., 2002. Reappraisal of five genera designed for fossil coniferous woods by early American wood anatomists. IAWA Journal, 23: 319–326.

Philippe, M. & Bamford, M.K., 2008. A key to morphogenera used for Mesozoic conifer-like woods. Review of Palaeobotany and Palynology, 148: 184-207.
naturales Musei nationalis hungarici, 89: 11-22.

Philippe, M., Bamford, M., McLoughlin, S., Alves, L.S.R., Falcon Lang, H.J., Gnaedinger, S., Ottone, E.G., Pole, M., Rajanikanthi, A., Shoemaker, R.E., Torres, T. & Zamuner, A., 2004. Biogeographic analysis of Jurassic–Early Cretaceous wood assemblages from Gondwana. Review of Palaeobotany and Palynology, 129: 141-173.

Philippe, M., Barbacka, M., Grădinaru, E., Iamandei, E., Iamandei, S., Kázmér, M., Popa, M.E., Szakmány, G., Tchoumatchenco, P. & Zatoń, M., 2006. Fossil wood and Mid-Eastern Europe terrestrial palaeobiogeography during the Jurassic–Early Cretaceous interval. Review of Palaeobotany and Palynology, 142: 15–32.

Philippe, M., Cuny, G., Bamford, M., Jaillard, E., Barale, G., Gomez, B., Ouaja, M., Thevenard, F., Thiebaut, M. & Sengbusch, P. von, 2003. The palaeoxylological record of *Metapodocarpoxylon libanoticum* (Edwards) Duperon-Laudoueneix et Pons and the Gondwana Late Jurassic–Early Cretaceous continental biogeography. Journal of Biogeography, 30: 389–400.

Philippe, M., Suteethorn,V. & Buffetaut, E., 2011, Révision de *Brachyoxylon rotnaense* Mathiesen, description de *B. serrae* n. sp. et conséquences pour la stratigraphie du Crétacé inférieur d'Asie du Sud-Est. Geodiversitas, 33: 25–32.

Philippe, M., Pacyna, G., Wawrzyniak, Z., Barbacka, M., Boka, K., Filipiak, P., Marynowski, L., Thévenard, F. & Dieter Uhl, D., 2015. News from an old wood - *Agathoxylon keuperianum* (Unger) nov. comb. in the Keuper of Poland and France. Review of Palaeobotany and Palynology, 221: 83–91.

Philippe, M., Rioult, J.-Ph. & Thévenard, F., 2018. Reappraisal of Lignier's Mesozoic fossil wood collection: ages, nomenclature and taxonomy. Review of Palaeobotany and Palynology, 252: 10-19.

Philippe, M., Suteethorn, V., Lutat, P., Buffetaut, E., Cavin, L., Cuny, G. & Barale, G., 2004. Stratigraphical and palaeobiogeographical significance of fossil wood from the Mesozoic Khorat Group of Thailand. Geological Magazine, 141: 319–328.

Philippe, M., Zijlstra, G. & Bamford, M., 2002. Proposal to conserve the name *Protopodocarpoxylon* Eckhold (Fossil, Gymnospermae, Coniferales) with a conserved type. Taxon, 51: 207–208.

Philippe, M., Zijlstra, G. & Barbacka, M., 1999. Greguss's morphogenera of homoxylous fossil woods: a taxonomic and nomenclatural review. Taxon, 48: 667-676.

Podek, Fr., 1913. Über ein neues Vorkommen von Liasgestein im Burzenlande. Földtani Közlöny, 43: 130-132.

Popa, M.E., 1992. The Early Liassic of Anina: New Paleobotanical Aspects. Documenta Naturae, 74: 1-9.

Popa, M.E., 1994. Studiul geoecologic al Liasicului inferior cu plante de la Anina, Banat. Graduation Thesis, University of Bucharest, 1-104 pp. [In Romanian].

Popa, M.E., 1997a. Corystospermal pteridosperms in the Liassic continental deposits of Romania. Acta Palaeontologica Romaniae, 1: 81-87.

Popa, M.E., 1997b. Liassic ferns from the Steierdorf Formation, Anina, Romania. 4th European Palaeobotanical and Palynological Conference. Mededelingen

Nederlands Instituut voor Toegepaste Geowetenschappen TNO, Heerlen: 139-148.

Popa, M.E., 1998. The Liassic continental flora of Romania: Systematics, Stratigraphy and Paleoecology. Acta Botanica Horti Bucurestensis 1998: 177-184.

Popa, M.E., 2000a: Aspects of Romanian Early Jurassic palaeobotany and palynology. Part II. A new species of *Pachypteris* from Cristian. Review of Palaeobotany and Palynology, 111: 31-47.

Popa, M.E., 2000b. Aspects of Romanian Early Jurassic palaeobotany and palynology. Part III. Phytostratigraphy of the Getic Nappe. Acta Palaeontologica Romaniae, 2: 377-386.

Popa, M.E., 2000c. Early Jurassic land flora of the Getic Nappe. PhD thesis, University of Bucharest, 258 p, Bucharest. [In Romanian].

Popa, M.E., 2001. Aspects of Romanian Early Jurassic palaeobotany and palynology. Part IV. A new species of *Weltrichia* from Anina. Studia Universitatis Babeş-Bolyai, Geologie, 46(2): 69-76.

Popa, M.E., 2009. Late Palaeozoic and Early Mesozoic continental formations of the Reşiţa Basin. Editura Universităţii din Bucureşti, 1-197 p, Bucureşti.

Popa, M.E., 2005. Aspects of Early Jurassic Romanian palaeobotany and palynology. Part VI. Anina – an exceptional locality. Acta Palaeontologica Romaniae, 5: 375-378.

Popa, M.E., 2009. Late Palaeozoic and Early Mesozoic continental formations of the Reşiţa Basin. Editura Universităţii din Bucureşti, 1-197 p., Bucureşti.

Popa, M.E., 2014. Early Jurassic bennettitalean reproductive structures of Romania. Palaeobiodiversity and Palaeoenvironments, 94(2): 327-362.

Popa, M.E. & van Konijnenburg-van Cittert, J.H.A., 1999. Aspects of Romanian Early Jurassic palaeobotany and palynology. Part I. In situ spores from the Getic Nappe, Banat, Romania. 5th EPPC. Acta Palaeobotanica, W.Szafer Institute of Botany, Krakow, 1999: 181-195.

Popa, M.E. & van Konijnenburg-van Cittert, J.H.A., 2006. Aspects of Romanian Early - Middle Jurassic palaeobotany and palynology. Part VII. Successions and floras. Progress in Natural Sciences, 16(Special Issue): 203-212.

Popa, M.E., Barbu, O. & Codrea, V. 2004. Aspects of Romanian Early Jurassic palaeobotany and palynology. Part V. *Thaumatopteris brauniana* from Suncuiuş. Acta Palaeontologica Romaniae, 4: 361-367.

Popa, M.E. & Meller, B., 2009. Review of Jurassic Plants from the Anina (Steierdorf) Coal Mining Area, South Carpathians, in the Collections of the Geological Survey of Austria. Jahrbuch der Geologischen Bundesanstalt, 149 (4): 487–498.

Preda, I., 1988. Les variations de faciès du Lias et du Dogger de Plateau du Mehedinți. Analele Universității București, Geologie, 37; 17-21.

Preda, I., Bădăluță, A., Culda, V. & Grădinaru, E., 1989a. Contributions à la connaissance de la flore liasique de Roumanie. Carpatho-Balkan Geological Association Congress, Sofia, 1989, Abstracts Volume, 2: 768-770.

Preda, I., Bădăluță, A. & Culda, V., 1989b. Sur le Liasique du sommet Culmea Obîrşia (zone Obîrşia-Cloşani), Monts Mehedinți. Analele Universității București, Geologie, 38: 18-28

Preda, I., Culda, V., Bădăluță, A. & Androhovici, A., 1994. La flore liasique de valea Porcului. Analele Universității București, Geologie, 43: 49-57.

Pujana, R.R., Santillana, S.N. & Marenssi, S.A., 2014. Conifer fossil woods from the La Meseta Formation (Eocene of Western Antarctica): Evidence of Podocarpaceae-dominated forests. Review of Palaeobotany and Palynology, 200: 122-137.

Pujana, R.R., Marenssi, S.A. & Santillana, S.N., 2015. Fossil woods from the Cross Valley Formation (Paleocene of Western Antarctica): Araucariaceae-dominated forests. Review of Palaeobotany and Palynology, 222: 56-66.

Reading, H.G. (Ed.), 1996. Sedimentary Environments: Processes, Facies and Stratigraphy, xiv, 688 pp., Blackwell Science, Oxford.

Reveal , J.L., 1996. Newly required suprageneric names in Magnoliophyta. Phytologia, 79: 68–76.

Reymanówna, M., 1956. O drevnach kopalnich typu *Araucarioxylon* w Polsce. Acta Societatis Botanicorum Poloniae, 25: 529-535.

Römer, J., 1878. Die Steinkohlengrube „Concordia" bei Wolkendorf. Geologische Skizze. Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissen-schaften zu Hermannstadt, 28: 47-56.

Römer, J., 1879. Ist die Wolkendorfer "Concordiakohle" Braunkohle oder Steinkohle? Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt, 29: 104-106.

Römer, J., 1885. Der Durchschlag in der Steinkohlengrube "Concordia" bei Wolkendorf. Verhandlungen und Mitteilungen des Siebenbürgischen Vereins für Naturwissenschaften zu Hermannstadt, 35: 32-37.

Rößler, R., Philippe, M., van Konijnenburg-van Cittert, J.H.A., McLoughlin, S., Sakala, J. & Zijlstra, G., [coordinating authors] & al., 2014. Which name(s) should be used for Araucaria-like fossil wood?—Results of a poll. Taxon, 63(1): 177–184.

Ruffinatto, F., Crivellaro, A., & Wiedenhoeft, A.C., 2015. Review of macroscopic features for hardwood and softwood identification and a proposal for a new character list. IAWA Journal, 36(2): 208–241.

Saporta, G. de, 1884. Paléontologie française, plantes jurassique, vol. 2. Masson, , Paris.

Săndulescu, M., 1964. Structura geologică a Masivului Postăvarul-Runcu (Munții Brașovului). Anuarul Comitetului Geologic, 34(2): 381-432. [In Romanian].

Săndulescu, M., 1967. Structura geologică a terenurilor mezozoice de la exteriorul masivului cristalin al Făgărașului. Dări de Seamă ale Ședințelor, Comitetul Geologic, 50(2): 177-208. [In Romanian].

Săndulescu, M., 1984. Geotectonica României. Editura Tehnica, București, 336p. [In Romanian].

Săndulescu, M., Antonescu Em., Popa El., Tomescu, C., 1984. Cercetări pentru reevaluarea perspectivelor de cărbuni liasici din Țara Bîrsei. Tema 1.1.b. Raport Arhiva Institutului de Geologie și Geofizică. [In Romanian].

Săndulescu, M., Russo-Săndulescu, D., Udrescu, C. & Medeşan, A., 1986. Position structurale, pétrologie et ambiance géotectonique des magmatites mésozoïque

de Țara Bîrsei. Dări de Seamă ale Şedinţelor, Institutul de Geologie şi Geofizică, 70-71(5): 197-221.

Schultze-Motel, J., 1961. Gymnospermenhölzer aus dem Jura des nördlichen Harzvorlandes: *Protophyllocladoxylon quedlinburgense* n. sp. Monatsberichte der Deutschen Akademie der Wissenschaften zu Berlin, 3: 418–426.

Schultze-Motel, J., 1962. Gymnospermen Hölzer aus den Oberen Kreide von Quedlinburg: *Dadoxylon subhercinicum* n.sp. Geologie (Berlin), 11(4): 461-477, 5 taf.

Schultze-Motel, J., 1966. Gymnospermen Hölzer aus den Oberkretazischen Uzamba-Schichten von Pondoland (S-Afrika). Senckenbergiana lethaea (Frankfurt am Main), 47(3): 279-337.

Semaka, A., 1955. Contribuţii la flora liasică de la Vulcan-Codlea. Nota I. Buletin Ştiinţific, Secţiunea de Ştiinţe Biologice, Agronomice, Geologice şi Geografice, Academia R.P.R., 6(3); 835-856. [In Romanian].

Semaka, A., 1956. Contribuţii la flora liasică de la Vulcan-Codlea. Nota II. Buletin ştiinţific, Secţia de geologie şi geografie, Academia R.P.R, 1(1-2): 107-121. [In Romanian].

Semaka, A., 1957. Contribuţii la flora liasică de la Vulcan-Codlea. Nota III. Buletin ştiinţific, Secţia de geologie şi geografie, Academia R.P.R, 2(2): 329-342. [In Romanian].

Semaka, A., 1958. Uber die pflanzenführenden Lias-Schichten Rumäniens (I. Getische Decke). Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 8-9: 407-414.

Semaka, A., 1961a. Über die pflanzen führenden Lias-Schichten Rumäniens (II. Danubikum). Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 8: 389-394.

Semaka, A., 1961b. Über einen Würzelboden aus dem Unterlias von Cozla in Banat (Rumänien). Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 1: 20-21.

Semaka, A., 1961c. Palaeobotanische Untersuchungen in Rumänien. Eine Übersicht über die Zeitspanne 1945-1959. Palaeontographica, Abt. B, 109(5-6): 147-161.

Semaka, A., 1962a. Asupra Rheticului de la Bigăr. Dări de Seamă ale Şedinţelor Comitetului Geologic, 45: 173-176. [In Romanian].

Semaka, A., 1962b. Flora liasică de la Anina (Banat). Anuarul Comitetului Geologic, 32: 527-569. [In Romanian].

Semaka, A., 1962c. Flora liasică de la Doman (Banat). Dări de Seamă ale Şedinţelor Comitetului Geologic, 43: 125-242. [In Romanian].

Semaka, A., 1962d. Contribuţii la stratigrafia Liasicului de la Vulcan-Codlea (sinclinalul principal). Dări de Seamă ale Şedinţelor Comitetului Geologic, 43: 131-154. [In Romanian].

Semaka, A., 1962e. Reconsiderarea grupului *Zamites schmiedelii* Sternberg. Dări de Seamă ale Şedinţelor Comitetului Geologic, 46: 93-99. [In Romanian].

Semaka, A., 1962f. Observaţii asupra florei Toarcian-Aalenianului din Banat. Dări de Seamă ale Şedinţelor Comitetului Geologic, 46: 225-237. [In Romanian].

Semaka, A., 1963. Observaţii asupra florelor paleo-mesozoice din Danubianul Banatului. Dări de Seamă ale Şedinţelor Comitetului Geologic, 47: 309-321. [In Romanian].

Semaka, A., 1965a. Studiul paleobotanic al depozitelor jurasice de pe rama sudică a Carpaţilor Meridionali. Dări de Seamă ale Şedinţelor Comitetului Geologic, Bucureşti, 49(3). [In Romanian].

Semaka, A., 1965b. Zur Kenntnis der *Nilssonia orientalis* - Flora in den Südkarpaten. Acta Palaeobotanica Polonica, 6(2): 27-39.

Semaka, A., 1966. Der Lias von Crasna-Jiu (Rumänien). Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 1: 44-51.

Semaka, A., 1967a. Geologia regiunii Vulcan - Codlea, cu privire specială asupra cărbunilor şi argilelor refractare. Studii tehnice şi economice, A/7: 109-163. [In Romanian].

Semaka, A., 1967b. Bemerkungen zur Altersstellung der Lias-Flora von Vrska-Cuka. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 2: 114-117.

Semaka, A., 1968a: Einige Bemerkungen uber altere Angaben zur Lias-Flora des Danubikums, Rumänien. Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 4: 241-243.

Semaka, A., 1968b. Flora liasică din Infrageticul din Zona Baia de Aramă-Cernavîrf. Rap.T. 13/40-1968, Arhiva Institutului Geologic, Bucureşti. [In Romanian].

Semaka, A., 1968c: *Williamsonia latecostata* n. sp. aus dem rumänischen Lias. Argumenta Palaeobotanica, 2: 15-17.

Semaka, A., 1969a. Die *Selenocarpus* - Flora aus dem Apuseni-Gebirge (Rumänien). Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 5: 609-617.

Semaka, A., 1969b. Studiul florei mezozoice din zona Mehadia. Rap.T. 59/1968, Arhiva Institutului Geologic, Bucureşti. [In Romanian].

Semaka, A., 1970a. Flora Rhaeto-Liasică de la Mehadia. Dări de Seamă ale Sedinţelor Comitetului Geologic, 56(3): 61-75. [In Romanian].

Semaka, A., 1970b. Geologisch-Paläobotanische Untersuchungen in S.O. Banaten Danubikum. Memorii. Institutul Geolologic, Bucureşti, 11:5-79 pp.

Semaka, A., 1971. Matoniaceele fosile din România. Dări de Seamă ale Şedinţelor Comitetului Geologic, 57: 125-146. [In Romanian].

Semaka, A., 1972. Einige Bemerkungen zu *Sphenopteris obtusifolia* Andrae. Paläontologische Abhandlungen B, 3: 861-866.

Semaka, A. & Givulescu, R., 1965. Flora Fossilis Rumana. Catalogus genera et species plantarum. Palaeontographica Abt. B, 116 (1-4): 55-122.

Semaka, A., Huică, I. & Georgescu, L., 1972. Noi puncte cu plante liasice in Formaţiunea de Schela (Carpaţii Meridionali). Studii şi cercetări de geologie, geofizică, geografie, Secţia Geologie, 17(2): 435-440. [In Romanian].

Serra, C., 1966. Étude anatomique et paléogéographique de quelques espèces homoxylées du Sud-Vietnam et du Cambodge. Archives geologiques du Vietnam, 8: 59-131.

Serra, C., 1969. Sur les bois fossiles de l'archipel de Th o-Chau (Golfe de Thailande). Archives geologiques du Vietnam, 12: 1-15.

Shimakura, M., 1937. Studies of fossil woods from Japan and adjacent Lands. II. The Cretaceous Woods from Japan Saghalin and Manchoukuo. Science Reports of the Tōhoku University, Series 2 (Geology), 8: 267-298; 19: 1-73.

Stănoiu, I., 1982. Prezența unor fosile mezozoice și a unor cărbuni (meta-antracit) în șisturile cristaline ale "Grupului Tulișa" pe versantul nordic al Munților Vîlcan și Parîng. Dări de Seamă ale Ședințelor, Institutul de Geologie și Gerofizică, 62(3); 141-165. [In Romanian].

Ștefănuț, V. & Cibotaru, T., 1986. Proiect geologic de cercetare cu foraje pentru cărbuni superiori și argile refractare în depozitele mezozoice din perimetrul Holbav-Codlea, jud. Brașov. Raport, Arhiva IPGG, MMPG, București. [In Romanian].

Stur, D., 1860a. Über das Alter der Steinkohlen von Holbak und Neustadt, nach den darin vorkommenden Pflanzen. Verhandlungen und mitteilungen des Siebenbürgischen vereins für naturwissen schaften zu Hermannstadt, 11: 58-59.

Stur, D., 1860b. Fossile Liaspflanzen aus Siebenbürgen. Verhandlungen der kaiserlich-königlichen Geologischen Reichsanstalt, 11: 57-60.

Stur, D., 1872. Beiträge zur Kenntnis der Liasablagerungen von Holbach und Neustadt in der Umgegend von Kronstadt in Siebenbürgen. Verhandlungen der kaiserlich-königlichen Geologischen Reichsanstalt, 17: 341-347.

Süss, H., Rößler, R., Boppré, M. & Fischer, O.W., 2009. Drei neue fossile Hölzer der Morphogattung *Primoginkgoxylon* gen. nov. aus der Trias von Kenia. Fedes Repertorium, 120 (5–6): 273–292; https://doi.org/10.1002/fedr.200911108

Taylor, T.N. & Taylor, E.L., 1993. The Biology and Evolution of Fossil Plants. Publisher: Pearson College Englewood Cliffs, Prentice Hall, 1-982 pp.

Toula, Fr., 1911. Paläontologische Mitteilungen aus den Sammlungen von Kronstadt in Siebenbürgen. II. Pflanzenreste aus dem Horizonte der Grestener Fazies von Neustadt (Schneebrich) bei Kronstadt. Abhandlungen der kaiserlich-königlichen Geologischen Reichsanstalt, 20(5): p.17.

Torrey, R.E., 1923. The comparative anatomy and phylogeny of the Coniferales, Part. 3: Mesozoic and Tertiary coniferous woods. Memoirs of the Boston Society of Natural History, 6: 39–106.

Vajda, V., Linderson, H. & McLoughlin, S., 2016. Disrupted vegetation as a response to Jurassic volcanism in southern Sweden. In: Kear, B. P., Lindgren, J., Hurum, J. H., Milan, J. & Vajda, V. (eds). Mesozoic Biotas of Scandinavia and its Arctic Territories. Geological Society, London, Special Publications, 434: 127–147

Vîlceanu, P., 1960. Contribuții la cunoașterea geologică a regiunii Codlea. Studii și Cercetări de Geologie, 5(1): 119–134. [In Romanian].

Vera, E.I. & Césari, S.N., 2012. Fossil woods (Coniferales) from the Baqueró Group (Aptian), Santa Cruz Province, Argentina. Anais da Academia Brasileira de Ciências (Annals of the Brazilian Academy of Sciences), 84(3): 617-625.

Vozenin-Serra, C. & Pons, D., 1990. Intérêts phylogénétique et paléoécologique des structures ligneuses homoxylées découvertes dans le Crétacé inférieur du Tibet méridional. Palaeontographica Abt. B, 126: 107–127.

Vogellehner, D., 1966. Zwei neue Vertreter der fossilen Sekundärholzgattung *Protophyllocladoxylon* Kräusel aus dem deutschen Mesozoikum. Geologisches Jahrbuch, 84: 307–326.

Vogellehner, D., 1968. Zur Anatomie und Phylogenie de Mesozoischer Gymnospermenholzer, 7: Prodromus zu einer Monographie de Protopinaceae. II. Die Protopinoiden Holzer des Jura. Palaeontographica Abt. B, Stuttgart, 124(4-6): 125-162.

Wachner, H., 1914. Die geologischen Verhältnisse der Umgebung von Volkány und Kererstenyfalva im Komitat Brassó. Jahresberichte der Königlich Ungarischen Geologischen Anstalt für 191), 1: 126-154.

Wang, S.J., Jiang, Y.F. & Qin, Y., 1994. A new petrified wood from Taiyuan Formation, Xuzhou coalfield, Jiangsu province. Acta Botanica Sinica, 36, 194–198.

Yamazaki, S. & Tsunada, K., 1981. A new species of *Brachyoxylon* Hollick & Jeffrey, from the Upper Jurassic Torinosu Group, Southweest Japan. Bulletin of the Science and Engineering Research Laboratory, Waseda University, 95: 1-14.

Youssef, G.M., El Saadawi, W.E., Kedves, M. & Mostafa, R.M., 2000. Wood anatomy of a silicified trunk from the Kharga Oasis, Egypt. Journal Plant Cell Biology and Development, 12: 30-39.

Zamuner, A.B. & Falaschi, P., 2005. *Agathoxylon matildense* n. sp., leño araucariaceo del Bosque Petrificado del cerro Madre e Hija, Formación La Matilde (Jurásico medio), provincia de Santa Cruz, Argentina. Ameghiniana, 42: 339-346.

Zberea, A., Semaka, A. & Cioată, R., 1966. Der Lias von Crasna-Jiu (Rumänien). Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 1: 44-51.

Zhang, W., Li Y., Zheng, S.L., Li, N., Wang, Y.D., Yang, X.J., Yi, T.M., Yang, J.J. & Fu, X.P., 2006. Fossil woods of China (Chinese ed.). China Forestry Publishing House, Beijing., 1-356 p.

Zhang, Y., Wang, J., Liu, L. & Li, N., 2010. *Protophyllocladoxylon jingyuanense* sp. nov., a gymnospermous wood of the Serpukhovian (Late Mississippian) from Gansu, Northwest China. Acta Geologica Sinica, 84: 257-268.

Zheng, S.L., Li, Y., Zhang, W., Li, N., Wang, Y.D., Yang, X.J., Yi, T.M., Yang, J.J. & Fu, X.P., 2008. Fossil woods of China (English edition). China Forestry, Beijing: 1-356 p.