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A NEW SPECIES OF *JUNIPEROXYLON* FROM THE EARLY MIOCENE OF NORTHWESTERN TURKEY

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Abstract Many different Cupressaceae species were described from the early Miocene of Turkey. Particularly, *Glyptostroboxylon* Conventz, 1885 and *Taxodioxylon* Hartig, 1848 from Cupressaceae are the most common genera. With the present study, a new fossil *Juniperoxylon* (Houlbert, 1910) Kräusel, 1949 species from early Miocene of northwestern Turkey was described as *Juniperoxylon acarcae* Akkemik sp. nov. The new species has diffuse and zonate axial parenchyma, 2-3 (5) cupressoid pits per cross-field, sometimes presence of crassulae, uniseriate to biseriate, opposite, frequent, contiguous and sometimes spaced radial wall pits, even uniseriate and irregularly or alternately biseriate pits on tangential walls, horizontal walls of rays smooth and/or pitted, ray width uniseriate and rarely partly biseriate, and end walls of axial parenchyma nodular and smooth. The new species is the first *Juniperoxylon* species description from Turkey. According to the vegetation units (VU), this fossil species may indicate the forest was likely well-drained lowland and/or upland conifer forest (VU7).

Keywords: New species, *Juniperoxylon*, *Juniperoxylon acarcae*, Galatian Volcanic Province, Turkey

INTRODUCTION

The Galatian Volcanic Province (GVP) is a rather important area due to having many fossil wood sites from Miocene age, particularly early Miocene and the late Miocene. Akkemik et al. (2009, 2016, 2017), Acarca Bayam et al. (2018), and Akkemik and Acarca Bayam (2019) identified many different fossil genera from this volcanic province. The forest types in the region may be separated as riparian, swamp, and well-drained lowland open mixed forests, and conifer forests (Akkemik et al., 2016; Denk et al., 2017; Güner et al., 2017; Acarca Bayam et al., 2018). Microfossils (Karayiğit et al., 1999; Yavuz-Işık, 2008; Yavuz-Işık and Demirci, 2009) and macrofossils (Kasaplıgil, 1977; Denk et al., 2017) from GVP also showed a rich forest vegetation. Within this woody flora, the genus of *Juniperus* L. was described in two different fossil sites, Hoçaş and Aşağıgüney fossil sites. In both Hoçaş and Aşağıgüney fossil sites, the juniper trees are represented with in-situ and large silicified stems.

Philippe and Bamford (2008) stated that neither real diagnosis nor description was given in the protologue by Houlbert (1910) for *Juniperoxylon*, and they used the Kräusel protologue (1949): "*Conifer wood, cross-field pits in earlywood with oblique more or less narrow pores. Ray cell walls, at least the terminal ones, more or less strongly pitted (juniperoid pitting). Axial resiniferous parenchyma abundant, traumatic wood ever with resin pockets*". Later, Ruiz and Bodnar (2019) made a valuable revision on *Juniperoxylon*. Until now, 11 *Juniperoxylon* species were described from mid-Triassic to Miocene in the world (Ruiz and Bodnar, 2019). In Turkey, *Juniperoxylon* is known from two fossil sites (Akkemik et al., 2016; Acarca Bayam et al., 2018). The purpose of the present study is to describe new fossil species from these materials, which are important elements of GVP and to discuss their potential affinities and growing site conditions.

MATERIAL AND METHODS

Location fossil sites and a brief geology of the area

The fossil areas are Aşağıgüney Fossil Site (Acarca Bayam et al., 2018) near Aşağıgüney Village of the city Beypazarı in the province of Ankara and Hoçaş Fossil Site (Akkemik et al., 2016) near Hoçaş Village of the city of Seben in the province of Bolu (Fig. 1). The autochthonous fossil stems are found in both two sites. The detailed geology of the sites was given in Acarca Bayam et al. (2018, p.2-3, Fig.2). Both fossil sites are of early Miocene aged and belong to Hançili Formation in the Galatian Volcanic Province (Fig. 1). The Galatia Massif is generally Miocene in age and has units formed in a wide range from Early Miocene to Late Miocene. K/Ar aging of the volcanic rocks showed three phases (Keller et al., 1992; Türkecan et al., 1991; Toprak et al., 1996), as early Miocene (Phase 1), early-middle Miocene (Phase 2) and late Miocene (Phase 3). Paleontological findings are also in agreement with these ages (Akyürek, 1981; Yağmurlu et al., 1987; Irkeç and Ünlü, 1993; Keller et al., 1992). The fossil areas in this study fall into the early Miocene. The generalized stratigraphic column (from Akbaş et al., 2002) showed that fossiliferous part is Hançili Formation with early Miocene age. Early-Middle Miocene aged volcanics and intricate Hançili Formation and Late Miocene lacustrine Uruş Formation unconformably overlie the aged units. Pliocene aged Örencik Formation and Quaternary aged sediments constitute the youngest rock units of the region (Fig. 1) (Akbaş et al., 2002).

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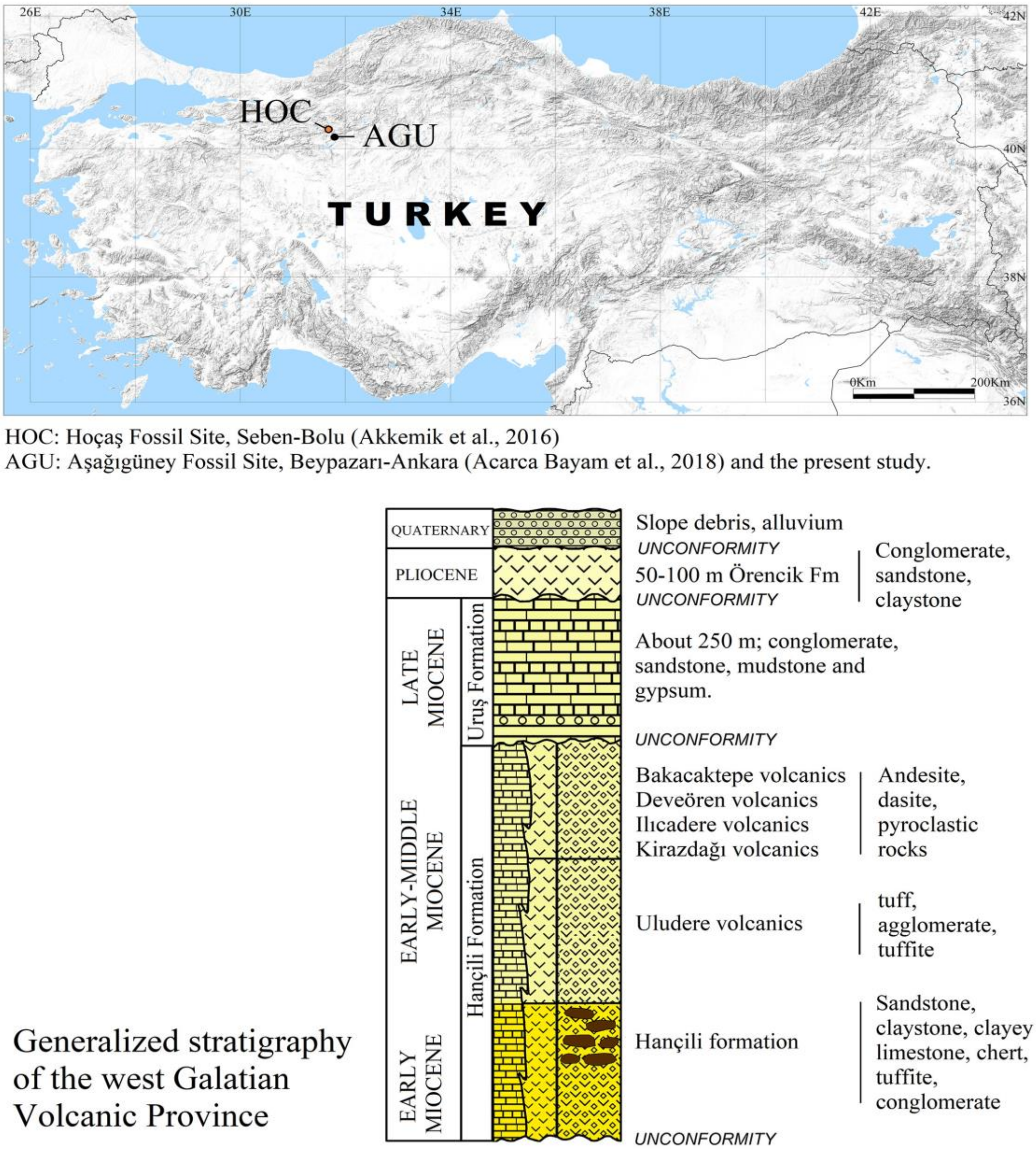

Fig. 1 The location map of the studies samples in Turkey, and the generalized stratigraphic section of the region covering the western parts of the Galatia Massif (Akbaş et al., 2002) and zone of fossils (Hançili Formation). The detailed geological structure of the area was given in Akkemik et al. (2016) and Acarca Bayam et al. (2018).

Materials and wood identification

The materials used in fossil species description were the thin sections housed at the Department of Forest Botany, Faculty of Forestry, Istanbul University-Cerrahpasa.

In the analysis on species-level description, the woods from Hoçaş Fossil Site (HOC86, HOC90, HOC92, HOC93, HOC94, HOC95) (Akkemik et al. (2016) and Aşağıgüney Fossil Site (AGU04, AGU05, AGU09, AGU11, AGUD03, AGUD07, AGUD08, AGUD10) (Acarca Bayam et al. (2018) were used. These fossil woods were identified as *Juniperus* by Akkemik et al. (2016) and Acarca Bayam et al. (2018). Within these wood specimens AGUD08 (Fig. 2) was selected as holotype and identified as a new fossil *Juniperoxylon* species.

In identification on thin sections, reference samples and published papers (e.g. Houlbert, 1910; Stopes, 1915; Eckhold, 1923; Kräusel, 1920, 1949; Stockmans and Wileière, 1934; Grambast, 1954; Bonetti, 1966; Huard, 1966; Van der Burgh, 1973; Watari and Nishida, 1973; Süss and Rathner, 1998; Bodnar and Artabe, 2007; Kłusek, 2014; Akkemik et al., 2016; Dolezych, 2016; Acarca Bayam et al., 2018; Ruiz and Bodnar, 2019) were used, and the criteria of IAWA Committee (IAWA Committee, 2004) for softwood identification were followed.

Fig. 2 The type specimen (AGUD08). These are remaining pieces from AGUD08 after taking three thin sections and storied at the Department of Forest Botany, Faculty of Forestry, Istanbul University-Cerrahpasa.

SYSTEMATIC PALAEBOTANY
Order PINALES Gorozhankin, 1904
Family CUPRESSACEAE Gray, 1822
Genus *JUNIPEROXYLON* (Houlbert) Kräusel, 1949
***Juniperoxylon acarcae* Akkemik sp. nov.**
Figs. 2-5

Holotype. AGUD08.

Repository. The Department of Forest Botany, Faculty of Forestry, Istanbul University-Cerrahpasa, Istanbul, Turkey.

Etymology. The epithet "*acarcae*" originates from the surname of Dr. N. Neslihan Acarca Bayam who worked on the petrified woods in the Galatian Volcanic Province for her PhD in Turkey. It was the first PhD on petrified woods in Turkey.

Plant Fossil Names Registry Number: PFN001814

Type locality. Aşağıgüney Village of the city of Beypazarı in the province of Ankara (AGU). This region is called Galatian Volcanic Province (GPV) (Fig. 1).

Age. Early Miocene.

Type horizon. Hançili Formation.

Diagnosis: Growth ring boundaries distinct with 2-3 rows of flattened latewood tracheids. False rings commonly present. Transition from earlywood to latewood indistinct. Tracheids generally circular, and intercellular spaces clearly obvious and occur throughout the wood. Normal axial resin canals absent. Axial parenchyma appears both diffuse (in the transition from earlywood to latewood and within the latewood itself) and tangentially zonate. Rays uniseriate, and sometimes partly biseriate. Ray height is 1-6 (max.16) cells. Tracheidal pits on tangential walls common and 1-2 seriate, irregular or slightly alternate. The rays with one cell height conspicuously longer. Transverse end walls of axial parenchyma cells are nodular and smooth. Ray tracheids absent. End walls of ray parenchyma cells nodular and smooth, horizontal walls of rays sparsely pitted. Tracheid pitting in radial walls of the earlywood is uniseriate and biseriate, opposite, frequent, contiguous, and sometimes spaced. Cross-field pitting is cupressoid with 2–3 (-5) pits per cross-field.

Description: Wood anatomical characteristics of the specimen of *Juniperoxylon* were given as follows:

***Transversal section*:** Growth ring boundaries distinct with 2-3 rows of flattened latewood tracheids. False rings commonly present (Fig. 3: a-c). Transition from earlywood to latewood gradual and indistinct. Tracheids generally circular, and intercellular spaces clearly obvious and occur throughout the wood. Normal axial resin canals absent. Axial parenchyma presents and both diffuse (in the transition from earlywood to latewood and within the latewood itself) and tangentially zonate (Fig. 3: b (arrows)-c).

***Tangential section*:** Rays exclusively uniseriate, and sometimes partly biseriate (Fig. 3: d). Ray height is 2-6 (max.16) cells (Fig. 3: d-e and Fig. 4: a). Tracheidal pits on tangential walls commonly present, and uni- to biseriate, irregularly spaced or slightly alternate (Fig. 3: e-f). The rays with one cell height conspicuously longer (Fig. 3: d-e). Transverse end walls of axial parenchyma cells are nodular and smooth (Fig. 4: b-d).

***Radial section*:** Ray tracheids absent. Tracheid pitting in radial walls of the earlywood is uniseriate and biseriate, opposite, frequent, contiguous (Fig. 4: e-f), and sometimes spaced (Fig. 5: c). Crassulae sometimes presents (Figure 4: f). End walls of ray parenchyma cells nodular and smooth, and horizontal walls of rays sparsely pitted (Figure 5: a-d). Indenture rarely visible (Figure 5d). Cross-field pitting is cupressoid with 2–3 (-5) pits per cross-field (Fig. 5: e-g).

Discussion: According to the discussion by Ruiz and Bodnar (2019), the features of distinct growth ring boundary, narrow latewood band, common spaces among tracheid, presence of pits on tangential walls of tracheids, presence of diffuse and/or zonate axial parenchyma, cupressoid or taxodioid type of cross field pits, low height of rays, generally nodular end walls of axial parenchyma, and homocellular rays are the main characteristics of *Juniperoxylon*. Due to having very close wood anatomical characteristics with Ruiz and Bodnar (2019)'s description, the present fossil specimen was identified as *Juniperoxylon*. Based on the differences in the characteristics of the fossil species (Table 1), the following identification key was prepared to find the exact place of the present *Juniperoxylon* species:

1A. Ray tracheids present
2A. Cross-field pits 4-6 cupressoid; end walls of axial parenchyma cells smooth; radial tracheidal pitting spaced and contiguous > ***Protojuniperoxylon ischigualastense* Bonetti, 1966 emend. Bodnar & Artabe, 2007**
2B. Cross-field pits 1-3 cupressoid and taxodioid; end walls of axial parenchyma nodular; radial tracheidal pits sparse> ***Juniperoxylon rhenanum* van der Burgh 1973**
1B. Ray tracheids absent
3A. Axial parenchyma absent or scarce, if present, diffuse; Ray parenchyma horizontal walls smooth; 4-6 pits per cross-field; radial tracheidal pitting spaced and contiguous > ***Protojuniperoxylon maidstonense* (Stopes, 1915) Eckhold, 1923**

3B. Axial parenchyma common.
4A. Zonate axial parenchyma present
5A. Cross-field pits only taxodioid; 2-6 pits per cross-field; end walls of axial parenchyma smooth or irregularly pitted; ray height 1-14 cells; horizontal end walls of rays smooth or rarely pitted > ***Juniperoxylon breviparenchmatosum*** **Watari & Nishida 1973**
5B. Cross-field pits only cupressoid, and 1-6 per cross-field.
6A. Horizontal walls of rays smooth; ray width uniseriate and rarely partly biseriate; end walls of axial parenchyma smooth or nodular; radial wall pitting uniseriate, rarely bi-to triseriate pits opposite, and spaced > ***Juniperoxylon pachyderma*** **(Göppert, 1850) Kräusel, 1949**
6B. Horizontal walls of rays distinctly pitted.
7A. Radial wall pitting exclusively uniseriate, horizontal walls of rays distinctly pitted; ray width uniseriate; transversal end walls of axial parenchyma smooth > ***Juniperoxylon pottoniense*** **(Stopes, 1915) Kräusel, 1949**
7B. Radial wall pitting uni-to biseriate; transversal end walls of axial parenchyma nodular
8A. Tracheidal pits on radial walls often frequent and contiguous; rays uni- to biseriate; crassulae rarely present, end walls of axial parenchyma nodular and smooth; end walls of rays nodular and smooth; horizontal walls of rays sparsely pitted > ***Juniperoxylon acarcae*** **Akkemik sp.nov.**
8B. Spacing of radial tracheidal pits sparse; rays uniseriate; crassulae present; ray parenchyma horizontal walls distinctly pitted > ***Juniperoxylon juniperoides*** **(Kownas, 1951) Huard, 1966**
4B. Zonate axial parenchyma absent, axial parenchyma only diffuse.
9A. Axial parenchyma scarce; ray heights 2-34 cells; ray parenchyma horizontal walls distinctly pitted; 1-2 (3-4) pits per cross-field; radial tracheidal pitting spaced but not contiguous > ***Juniperoxylon zamunerae*** **(Bodnar et al., 2015) Ruiz & Bodnar 2019**
9B. Axial parenchyma present, abundant, and diffuse; ray height up to 18 cells.
10A. Ray parenchyma horizontal walls smooth; end walls of axial parenchyma cells nodular; ray heights 1-5 cells > ***Juniperoxylon wagneri*** **Süss & Rather 1998**
10B. Ray parenchyma horizontal walls sparsely or distinctly pitted; Ray heights up to 18 cells.
11A. Horizontal walls of ray parenchyma sparsely pitted; rays uniseriate and occasionally biseriate; axial parenchyma abundant; crassulae present > ***Juniperoxylon schneiderianum*** **Dolezych 2016**
11B. Horizontal walls of ray parenchyma distinctly pitted; rays uniseriate; axial parenchyma present; crassulae absent > ***Juniperoxylon turonense*** **Houlbert, 1910**

According to the identification key and the given characteristics in Table 1, the new fossil *Juniperoxylon* species has differences from all former fossil species.

Juniperoxylon zamunerae (Bodnar et al., 2015) Ruiz & Bodnar, 2019 differs from the new species in having scarce and diffuse axial parenchyma, and 2-34 cells height of rays.

Protojuniperoxylon maidstonense (Stopes, 1915) Eckhold, 1923 differ from the present specimen in having scarce axial parenchyma and predominantly uniseriate tracheidal pitting on radial walls, and 4-6 cupressoid pits per cross-field (Bodnar and Artabe, 2007).

Juniperoxylon wagneri Süss & Rather 1998, *Protojuniperoxylon ischigualastense* Bonetti, 1966 emend. Bodnar & Artabe, 2007, and *J. schneiderianum* Dolezych, 2016 differ from the new specimen in having only diffuse axial parenchyma.

Juniperoxylon breviparenchmatosum Watari & Nishida, 1973 differs from the new species in having only taxodioid type cross-field pits.

Juniperoxylon rhenanum van der Burgh, 1973 differs from the new species in having 1-3 cupressoid and taxodioid cross-field pits, space of radial tracheidal pits, much longer rays (1–40 cells), and crassulae formation.

The closest fossil species are *Juniperoxylon pachyderma* (Göppert, 1850) Kräusel, 1949, *J. juniperoides* (Kownas, 1951) Huard, 1966, and *J. pottoniense* (Stopes, 1915) Kräusel, 1949. These three fossil species have only spaced radial tracheidal pits. The new fossil species has both spaced and contiguous radial tracheidal pits. *J. pachyderma* and *J. juniperoides* have also crassulae formation, and *J. pottoniense* has exclusively uniseriate pits on radial walls of tracheids.

Based on these differences, the specimen was described as a new *Juniperoxylon* species and named *Juniperoxylon acarcae* Akkemik sp. nov. The descriptions of *Juniperus* from Hoçaş Fossil site (Akkemik et al., 2016) and from Aşağıgüney Fossil site (Acarca Bayam et al., 2018) were compared with the new species and results showed that they both had very similar features. It can be concluded that the new species, *Juniperoxylon acarcae* Akkemik sp.nov. has an area through the valley between Beypazarı-Aşağıgüney Village and Seben-Kozyaka Village (Fig. 1).

Affinities: The fossil *Juniperoxylon* descriptions (e.g.Vaudois and Privé, 1971; Bodnar and Artabe, 2007; Kłusek, 2014; Akkemik et al., 2016; Dolezych, 2016, Acarca Bayam et al., 2018) revealed that this type of wood is closely related to modern Cupressaceae due to the the presence of "*abietinean tracheid pitting, distinctly pitted ray cell walls, axial parenchyma and cupressoid cross-fields*".

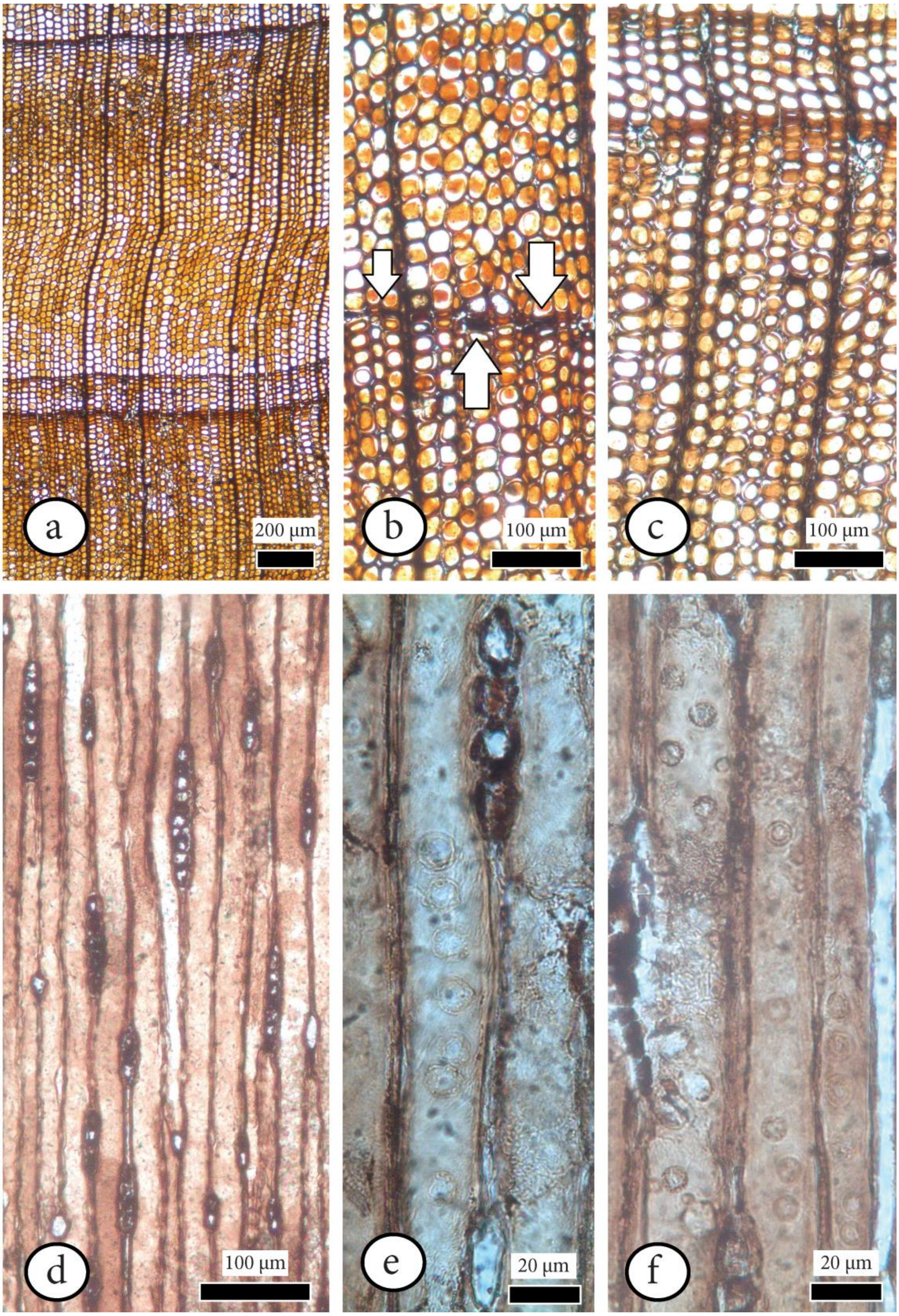

Fig. 3 The thin sections of *Juniperoxylon acarcae* Akkemik sp. nov. a) Transversal section with false rings and without resin canals, b) Marginal (zonate) axial parenchyma (arrows) and spaces between tracheids, c) Spaces between tracheids, and diffuse axial parenchyma cells, d) Tangential section with uni-to partly biseriate rays, e) Uniseriate pits on tangential walls of tracheids, f) Biseriate and alternate pits on tangential walls of tracheids.

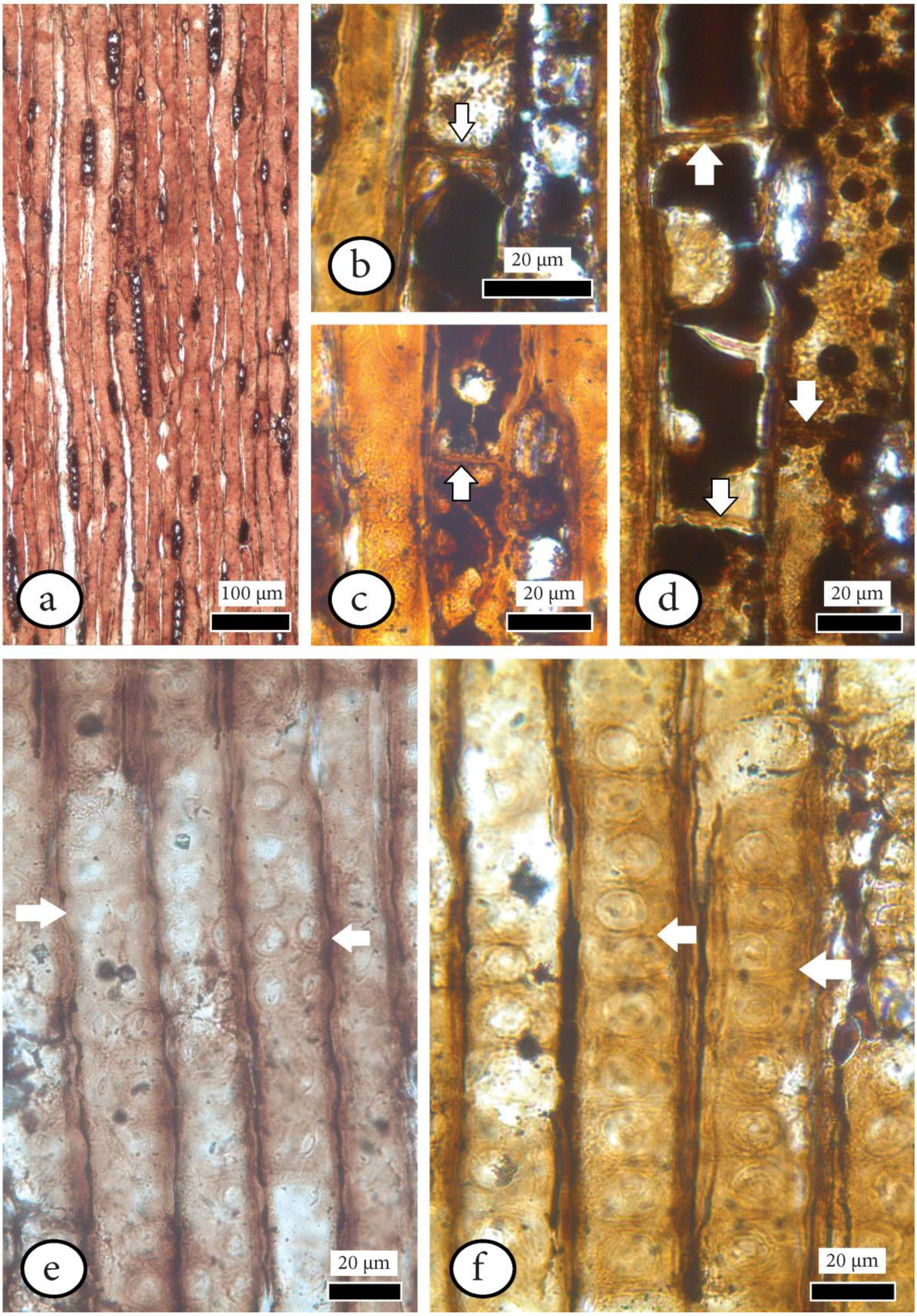

Fig. 4 The thin sections of *Juniperoxylon acarcae* Akkemik sp. nov. a) Tangential section with short rays, b-d) Nodular and smooth end walls of axial parenchyma, e) Mostly uniseriate and sometimes biseriate pits on radial walls of tracheids (arrows), f) Frequent uniseriate pits and crassulae formation (arrows).

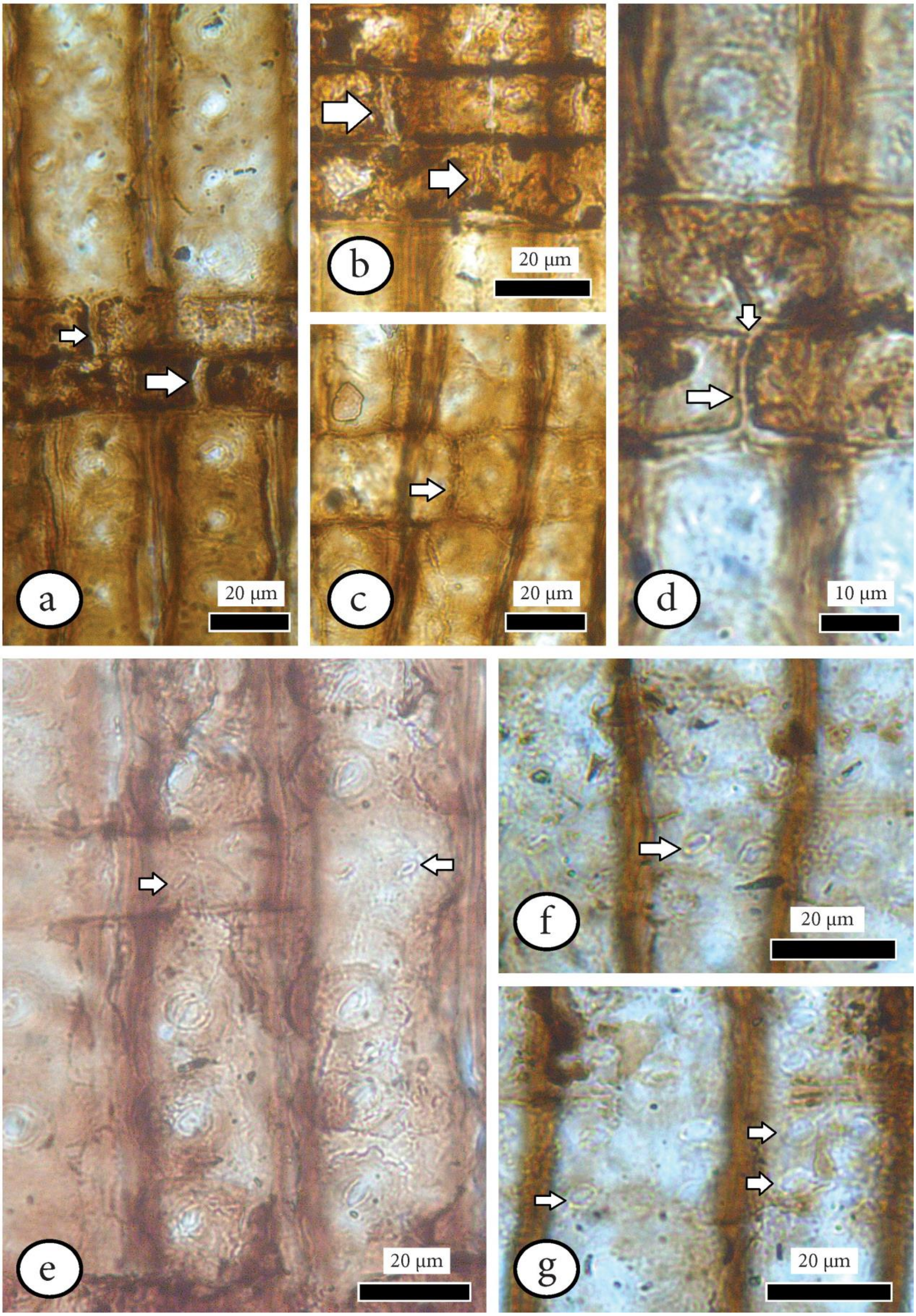

Fig. 5 The thin sections of *Juniperoxylon acarcae* Akkemik sp. nov. a) Smooth end walls of rays (arrow), b-c) Slightly dentate end walls of ray, and sparsely pitted horizontal walls of rays, d) Indenture (vertical arrow) and sparsely nodular horizontal walls of rays (horizontal arrow), e-g) Cupressoid type cross-field pits, 2-5 pits per cross-field.

Table 1 Comparison of the new species with the former fossil species (Ruiz and Bodnar, 2019)

Fossil species	Age; Country	Pits on radial tracheidal walls		Arrangement of multiseriate pits	Axial parenchyma		Ray height	Ray width	Ray tracheids	Horizontal walls of rays	Number and type of cross-field pits	Crassulae
					Type	End walls						
Juniperoxylon acarcae Akkemik sp. nov.	Early Miocene; Turkey	Uniseriate, sometimes biseriate	Frequent, contiguous	Opposite	Diffuse, and zonate	Smooth and nodular	1-16	Uniseriate, rarely partly biseriate	-	Smooth or pitted	2-3 (5), cupressoid	±
Juniperoxylon breviparenchymatosum Watari & Nishida, 1973	Eocene; Japan	Uniseriate, biseriate	Spaced	Opposite	Abundant, diffuse, and zonate	Smooth or irregularly thickened	1-14	Uniseriate, rarely partly biseriate	-	Smooth or rarely pitted	2-6, taxodioid	-
Juniperoxylon juniperoides (Kownas, 1951) Huard, 1966	Miocene; Germany	Uniseriate, biseriate	Spaced, contiguous	Opposite	Abundant, diffuse, and zonate	Nodular	1-12	Uniseriate	-	Distinctly pitted	1-4 (6), cupressoid	+
Juniperoxylon pachyderma (Göppert, 1850) Krausel, 1949	Miocene; Germany, Belgium, Netherlands, Poland, Siberia	Uniseriate, rarely biseriate, triseriate	Spaced	Opposite	Abundant, diffuse, and zonate	Smooth or nodular	1-15	Uniseriate, rarely partly biseriate	-	Smooth	1-6, cupressoid	+
Juniperoxylon pottoniense (Stopes, 1915) Krausel, 1949	Cretaceous-Eocene; England, Denmark	Uniseriate	Spaced	-	Abundant, zonate	Smooth?	1-12	Uniseriate	-	Distinctly pitted	Cupressoid	-
Juniperoxylon rhenanurn van der Burgh, 1973	Miocene; Germany	Uniseriate, biseriate	Spaced	Opposite	Present, diffuse, and zonate	Nodular	1-40	Uniseriate, occasionally biseriate	±	Distinctly pitted	1-3, cupressoid, taxodioid	+
Juniperoxylon schneiderianum Dolezych, 2016	Miocene; Germany	Uniseriate, biseriate	Spaced	Opposite	Abundant, diffuse	Nodular	2-18	Uniseriate, occasionally biseriate	-	Sparsely pitted	2-4, cupressoid, taxodioid	+
Juniperoxylon wagneri Süss & Rather, 1998	Miocene; Germany	Uniseriate, rarely biseriate	Spaced	Opposite	Abundant, diffuse	Nodular	1-5	Uniseriate	-	Smooth	2-8, cupressoid	-
Juniperoxylon zamunerae (Bodnar, Ruiz, Artabe, Morel,& Ganuza, 2015) Ruiz & Bodnar, 2019	Middle Triassic; Argentina	Uniseriate, rarely biseriate	Spaced	Opposite	Scarce, diffuse	Smooth or irregularly thickened	2-34	Uniseriate, rarely partly biseriate	-	Distinctly pitted	1-2(3-4), cupressoid	-
Protojuniperoxylon ischigualastense Bonetti, 1966 emend.Bodnar & Artabe, 2007	Late Triassic; Argentina	Uniseriate, biseriate	Spaced, contiguous	Alternate, opposite	Present, diffuse	Smooth	1-45	Uniseriate, less frequent partly bi- or triseriate	+	Distinctly pitted	2-4, cupressoid	-
Protojuniperoxylon maidstonense (Stopes, 1915) Eckhold, 1923	Lower Cretaceous; England	Uniseriate	Spaced, contiguous	?	?	?	1-20	Uniseriate, rarely partly biseriate	-	Smooth?	4-6, cupressoid	+

Table 2. Comparison of modern *Juniperus* species (Esteban et al., 2004; Akkemik and Yaman, 2012) and *Juniperoxylon acarcae* sp. nov.

Fossil species / Features	***Juniperus drupacea*** **Labill.**	***Juniperus excelsa*** **M.Bieb.**	***Juniperus foetidissima*** **Willd.**	***Juniperus oxycedrus*** **L.**	***Juniperus phoenicea*** **L.**	***Juniperus saltuaria*** **Rehder & E.H.Wilson**	***Juniperus thurifera*** **L.**	***Juniperoxylon acarcae*** **Akkemik sp. nov.**
Growth ring	Distinct	Distinct	Distinct	Distinct	Distinct	Distinct	Distinct	Distinct
Partial and false ring	Present	Present	Present	Present	Present	Present	Present	Present
Transition from earlywood to latewood	Gradual	Gradual	Gradual	Gradual; 2-3 seriate of flattened latewood tracheids	Gradual	Gradual	Gradual	Gradual; 1-2 seriate of flattened latewood tracheids
Radial pitting	Predominantly uniseriate	Predominantly uniseriate	Predominantly uniseriate	Predominantly uniseriate	Predominantly uniseriate	Predominantly uniseriate	Predominantly uniseriate	Uniseriate, Sometimes biseriate, opposite, spaced and contiguous
Intercellular space	Commonly present	Commonly present	Commonly present	Commonly present	Commonly present	Present	Present	Commonly present
Helical thickening	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent
Latewood tracheids	Thick walled	Thick walled	Thick walled	Thick walled	Thick walled	Thick walled	Thick walled	Thick walled
Axial parenchyma	Common	Common	Common	Common	Common	Common	Common	Common
Marginal axial parenchyma	Absent	Present	Absent	Present	Absent	Absent	Present and 1-3 seriate	Present, uniseriate
End walls	Distinctly pitted	Distinctly pitted	Distinctly pitted	Distinctly pitted	Distinctly pitted	Smooth Pitted	Smooth Pitted	Distinctly pitted
Rays	Exclusively uniseriate, rarely partly biseriate	Exclusively uniseriate, rarely partly biseriate	Exclusively uniseriate, rarely partly biseriate	Exclusively uniseriate, rarely partly biseriate	Exclusively uniseriate, rarely partly biseriate	Exclusively uniseriate, partly biseriate	Uniseriate	Rays exclusively uniseriate, rarely partly biseriate.
End walls of rays	Nodded	Nodded	Nodded	Nodded	Nodded	Nodded	Nodded	Nodded
Cross-field pitting	Cupressoid	Cupressoid	Cupressoid and taxodioid	Cupressoid	Cupressoid	Cupressoid	Cupressoid	Cupressoid
Pit number per cross-field	1-2 (1-4)	2 (2-4)	2 (1-4)	1-2 (1-5)	1-2 (1-5)	1-4	1-4	2-3 (-5)
Ray heights	3 (1-6)	1-4 (-13)	1-11 (-19)	1-8 (-19)	1-7 (-14)	1-15	1-15	2-6 (-16)
Indenture	Present	Present	Present	Present	Present	Present	Absent	Present

In Cupressaceae, normal resin canals and helical thickenings are also absent. When some fossil species such as *J. zamurense* are related to different modern genera, *Chamaecyparis* Kurz., *Cupressus* L., *Fitzroya* Lindl. and *Juniperus* (Ruiz and Bodnar, 2019), the new species, *Juniperoxylon acarcae*, is closely related to the modern *Juniperus*. A comparison of the features of the new fossil species with the five modern *Juniperus* species in Turkey, which are native, and two similar species given in Esteban et al. (2004), which are *Juniperus saltuaria* Rehder et E.H. Wilson from south of China and Tibet and *Juniperus thurifera* L. from the western Mediterranean Basin, showed the highest similarities. However, *Juniperus foetidissima* Willd. has both cupressoid and taxodioid cross-field pits, and *Juniperus saltuaria* has not marginal and metatraheal axial parenchyma, therefore, these two species slightly differ from the fossil species and the other five modern Mediterranean species (Table 2). Wood features demonstrated that both fossil and modern species are rather close to each other, and therefore, the fossil species may be evaluated as a possible ancestor of the modern species in the Mediterranean basin.

Possible growing site conditions: The described *Juniperoxylon acarcae* Akkemik sp. nov. is a forest tree of the Galatian Volcanic Province (GVP). The new species was one of the elements within a rich woody flora of GVP (Akkemik et al., 2016; Acarca Bayam et al., 2018). The early Miocene trees of *Pinus* L., *Juniperus, Cedrus* Trew., *Ulmus* L., *Zelkova* Spach., *Liquidambar* L., and *Acer* L., grow under the conditions of VU0, and VU5 to VU7 in GVP. These vegetation units (VU) classify that VU0 is subtropical, moist or dry light forests, VU5 is well-drained lowland forests, VU6 is well-drained upland forests, and VU7 is well-drained (lowland and) upland conifer forest.

The *Juniperoxylon acarcae* stems are autochthonous in the field. The other autochthonous early Miocene trees are *Quercus* Sect. *Ilex,* palms (later they were identified as *Palmoxylon* sp. cf. *Trachycarpus* by Iamandei et al., 2018), *Liquidambar* and *Salix/Populus* in Hoçaş Fossil Site (Akkemik et al., 2016). Because these fossil woods are found in their original positions in the field, to interpret their life conditions is more satisfactory. The presence of these riparian and lowland trees may suggest that the growing area of *Juniperoxylon acarcae* trees was a forest having an open, well-drained lowland growing conditions.

CONCLUSION

The present study focusing on a new species description from the Galatian Volcanic Province suggested a new species, *Juniperoxylon acarcae*. This is the first fossil species of the genus of *Juniperoxylon* from the early Miocene of Turkey. The wood anatomical characteristics reflected very close features to the modern five Mediterranean juniper species and more stable wood characteristics from the early Miocene to the present. This new species likely grows\grew under the growing site conditions of VU0 and VU7, which means that the region was an open and lowland coniferous forest. Today, the similar modern species such as *Juniperus oxycedrus* L., *J. excelsa* M. Bieb., *J. foetidissima* Willd., *J. drupacea* Labill., *J. phoenicea* L., and *J. thurifera* L. grow in open, lowland and upland conifer forests in the Mediterranean basin.

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