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BEDRİ SERDAR

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# Comparative wood anatomy of *Rhodothamnus* species

**Bedri SERDAR***
Department of Forest Botany, Faculty of Forestry, Karadeniz Technical University, 61080 Trabzon, Turkey

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**Abstract:** In this study, the comparative wood anatomy of the European [*Rhodothamnus chamaecistus* (L.) Reichb.] and Anatolian (*Rhodothamnus sessilifolius* P.H.Davis) species of *Rhodothamnus* were studied. The wood anatomy of the taxa shows evidence of adaptation to growing in alpine habitats. The woods of the species exhibit primitive wood anatomical characteristics and share similar qualitative anatomical features. However, some of the quantitative anatomical characteristics of the taxa show significant differences, such as the distinctness of the growth ring and the bar number of the scalariform perforation plate. The present study describes and compares the anatomical properties of the wood of the *Rhodothamnus* species.

**Key words:** *Ericaceae, Rhodothamnus*, wood anatomy

## 1. Introduction

The genus *Rhodothamnus* Reichb. has 2 species in the world: *Rhodothamnus chamaecistus* (L.) Reichb. is confined to the eastern Alps of southern Europe (Greguss, 1959), and the other species, *Rhodothamnus sessilifolius*, is endemic to the north-eastern corner of Turkey (Stevens, 1978). *R. chamaecistus* is confined to crevices in calcareous (limestone or dolomite) rocks (Stevens, 1978), whereas on Tiryal Mountain, *R. sessilifolius* grows on igneous dacite rock outcrops that form cliffs or ridges (Terzioğlu & Milne, 2002). An emended description for *R. sessilifolius* was given by Terzioğlu and Milne (2002) based upon specimens collected from north-eastern Turkey in 2000, which was the first gathering of this species since 1960. *R. sessilifolius* was first collected on Tiryal Mountain above Murgul on 23 June 1957 by Davis and Hedge (Davis 29974 & Hedge), and then again from an adjacent mountain range (Şavval Tepe) in July 1960 (Stevens, 1978). The species has since then been known only from these 2 localities in the north-eastern corner of Turkey, in Artvin Province. The type locality is a large rock at 2150 m on Tiryal Mountain.

Comparative wood anatomy consists of 2 main efforts: wood identification and evolutionary studies. Evolutionary studies can be divided into 2 main areas: systematic wood anatomy and ecological wood anatomy (Olson, 2005; Güvenç & Kendir, 2012; Eo & Hyun, 2013; Tiwari et al., 2013).

The 2 species of the genus are closely related to each other by means of morphology (Davis, 1962). The goal of the present study is to define the wood anatomical traits in order to contribute to their identification.

## 2. Materials and methods

The wood samples that were studied were taken from KATO herbarium (*R. sessilifolius*, KATO: 13360 and *R. chamaecistus*, KATO: 10501) materials. Wood samples, from stems about 1.5–3.0 mm diameter in each case, were boiled in water and stored in 50% aqueous ethanol, sectioned using a freezing sliding microtome at a thickness of about 20–25 µm, and then stained with a safranin and alcian blue combination (Ives, 2001). The permanent slides were examined and photographed with an Olympus BX 50 research microscope (Bs200Prop Image Processing and Analysis Systems). Wood portions from each species were macerated using Schultze's method (Normand, 1972) and stained with safranin. All wood terms used conform to the usage of the International Association of Wood Anatomists (IAWA) Committee on Nomenclature (1989).

## 3. Results and discussion

In the present study, the anatomical features of the wood of the *Rhodothamnus* species were studied and are given in detail in the following text.

***Rhodothamnus chamaecistus:*** Wood diffuse porous with distinct growth rings in contrast to *R. sessilifolius*. Vessels evenly distributed without any tendency to a specific pattern, many to numerous (370–1010 vessel/mm$^2$), very small (9.33–16.79 µm, 9.33–22.39 µm in tangential and

* Correspondence: bserdar@ktu.edu.tr

radial diameters, respectively), angular in cross-section, exclusively solitary, and mean number of vessels per group 2.32, with thin walls (1.75 µm) (Figure). Vessel elements short (288–720 µm), perforation plates scalariform with many to numerous bars (13–53 per perforation plate), intervessel pits mostly scalariform, sometimes tending to opposite. Helical thickening not observed in vessel lateral walls and ligulate ends. Fibre tracheids 254–628 µm long, 9.33–14.93 µm wide with rather thin walls (1.86–4.67 µm), with bordered pits on radial and tangential walls. Axial parenchyma is not abundant, apotracheal diffuse, and scanty paratracheal. Rays homogeneous and uniseriate, composed of only upright cells, ray 86–202 µm high (Figure).

***Rhodothamnus sessilifolius:*** Wood diffuse porous with indistinct growth rings. Vessels evenly distributed without any tendency to a specific pattern, many to numerous (720–1150 vessel/mm$^2$), very small (9.33–20.52 µm, 11.19–20.52 µm in tangential and radial diameters, respectively), angular in cross-section,

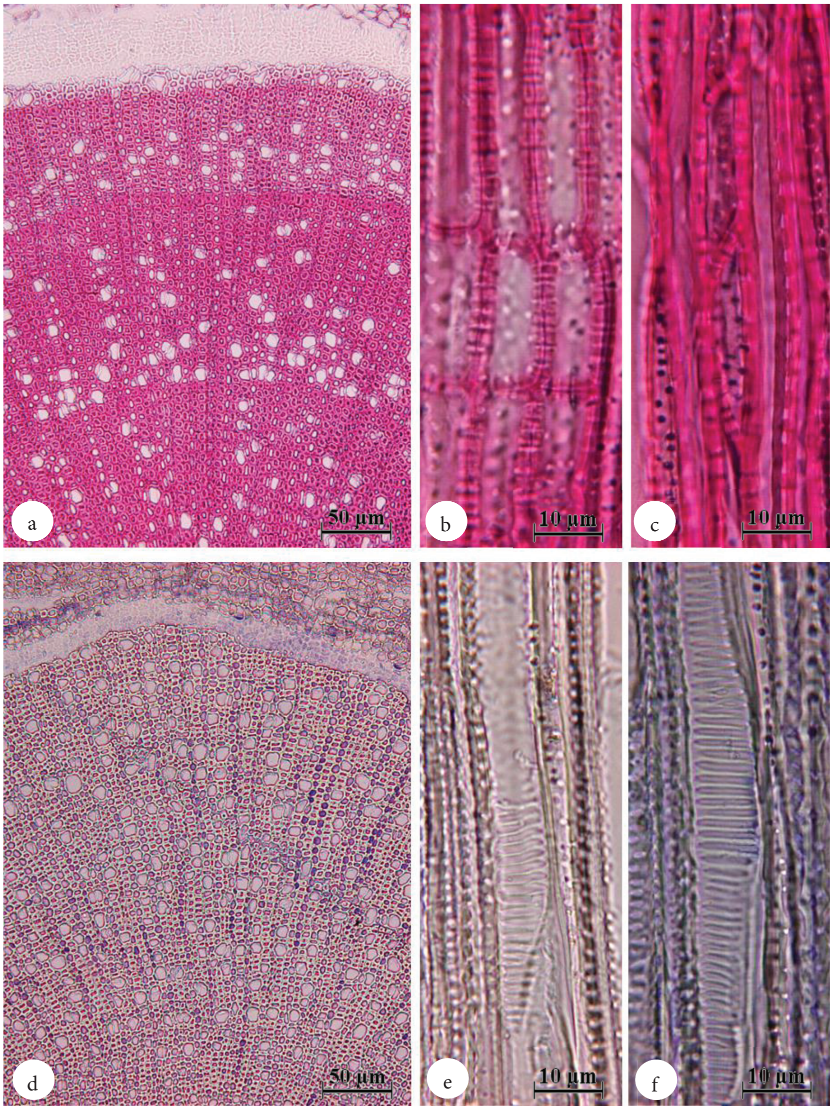


**Figure.** a, b, and c- *Rhodothamnus chamaecistus*; d, e, and f- *R. sessilifolius.* a- TS, wood diffuse porous, growth ring boundaries distinct with thick-walled and radially flattened latewood fibres. b- RLS, rays homogeneous, composed of only upright cells. c- TLS, uniseriate rays. d- TS, wood diffuse porous, growth ring boundaries indistinct. e- RLS, scalariform perforation plate. f- TLS, scalariform intervessel pits. Scale bars: a, d = 50 µm; b, c, e, f = 10 µm. Abbreviations: TS: transverse section, RLS: radial longitudinal section, TLS: tangential longitudinal section.

exclusively solitary, and mean number of vessels per group 1.12, with thin walls (0.90 µm) (Figure). Vessel elements short (163–432 µm), perforation plates scalariform with many to numerous bars (11–60 per perforation plate), intervessel pits mostly scalariform, sometimes tending to opposite, vessel-ray pits similar to intervessel pits (Figure). Helical thickening not observed in vessel lateral walls and ligulate ends. Fibre tracheids 163–542 µm long, 7.46–13.06 µm wide with rather thin walls (1.86–4.66 µm), with bordered pits on radial and tangential walls. Axial parenchyma is not abundant and scanty paratracheal. Rays homogeneous and uniseriate, composed of only upright cells, ray 103–448 µm high.

The growth rings are very narrow to uncountable in the *Rhodothamnus* species. The width of the growth rings is variable according to the growth rate in many dicotyledonous woods. In members of Ericaceae, the growth rings are narrower in dwarf shrubs and shrubs, while wider in small trees and trees. Many authors regard this as a reflection of the slow growth associated with the shrublet/shrub habit (Suzuki & Ohba, 1988; Noshiro et al., 1995a, 1995b).

These 2 dwarf shrub species of *Rhodothamnus* differ in features of growth rings, the number of vessels/mm$^2$, and the dimensions of the vessels, fibres, and rays (Table). Variation in vessel diameter with relation to seasonality was evident in these species, which had very narrow and short vessels. This characteristic might reflect the habit and/or result from growing in dry sites at high altitudes. Narrowness of vessels is inversely correlated with the number of vessels/mm$^2$. Furthermore, vessel number was found to increase with altitude in *Rhododendron* (Merev & Yavuz, 2000). According to Carlquist (1977), short and narrow vessel elements are theorised to resist high tension in the water column. The safety and efficiency of water transport are strongly related to vessel diameter and vessel density, and decreasing vessel diameter increases the safety of water conduction (Zimmermann, 1983; Baas & Wheeler, 1996).

Forsaith (1920) considered that narrower vessels and uniseriate or narrower rays were all reduced in size by the influence of alpine conditions. This implies that wood structure can vary according to ecological factors, and is therefore not solely determined by the plant's genetically determined habit.

In the present study, the 2 dwarf shrubs had fibre with distinctly bordered pits. The taxa examined here both had uniseriate ray tissues that comprised upright cells only (Figure). The longest dimensions of the ray parenchyma cells are oriented in the axial direction of the plant; these were observed both in the radial and tangential sections.

The following wood anatomical characters are considered primitive in the Baileyan sense (Baas et al., 2000): scalariform perforation plates, fibre with distinctly bordered pits, apotracheal parenchyma, and heterocellular rays. In *Rhodothamnus*, lateral wall pitting is scalariform to opposite, which might account for the presence of scalariform perforation plates. Perforation plates comprising numerous bars per perforation plate and scalariform lateral wall pitting are primitive characteristics. Furthermore, according to classical evolutionary theory (Baileyan sense), a higher number of bars indicates a more primitive species, whereas fewer bars tend to indicate one that is more evolved.

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**Table.** Selected qualitative and quantitative data (min–max) showing differences between *Rhodothamnus sessilifolius* and *Rhodothamnus chamaecistus*.

| **Feature** | ***R. sessilifolius*** | ***R. chamaecistus*** |
|---|---|---|
| Growth ring | indistinct | distinct |
| Vessel elements' length (µm) | 163–432 | 288–720 |
| Number of vessels/mm$^2$ | 720–1100 | 370–1010 |
| Bar number per perforation plate | 11–60 | 13–53 |
| Fibre length (µm) | 163–542 | 254–628 |
| Ray height (µm) | 103–448 | 86–202 |

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