

## Dendroclimatic Investigation of the Chestnut-Leaved Oak (*Quercus castaneifolia* C.A.Mey.) Distributed in Lerik Region of Azerbaijan

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Climate change and extreme natural events have a negative impact on the growth of most plants. The purpose of this study is to investigate the effects of the environmental factors on the radial growth of the chestnut leaved oak spread out in the territory of Lerik region. It was revealed that the *Quercus castaneifolia* C.A.Mey., which are spread in this area, are very sensitive to changing of environmental conditions. The plant negatively reacted to the short-term temperature drop and in the result formed frost rings.

**Keywords:** Climate change, radial growth, Lerik, *Quercus castaneifolia*, dendroclimatic investigation, anatomical methods.

### INTRODUCTION

In the nature, most of the trees are very sensitive to the changes of hydrological regime, temperature and light conditions. Often these changes are being instantly, short term or long term. In these times in trees occurring catastrophic or small damages in the structure of the trees. Plants growing in different environments, altitudes and conditions are reacting to this kind of changes by following way: tree migration, leave fall or damages in alive cells (Schweingruber, 2007; Stockli and Schweingruber, 1996). Trees reaction to the changing conditions allow us to determine distribution limits of the adapted trees.

Dendrochronology is one of the most important environmental techniques for a variety of natural environmental processes and a monitor for human caused changes to the environment such as pollution and contamination. Dendrochronology examines events through time that are recorded in the tree-ring structure or can be dated by tree-rings. Because tree becomes the instrument for environmental monitoring, it serves as a long-term bioindicator that extends for the lifetime of the tree. Trees record any environmental factor that directly or indirectly limits a process that affects the growth of ring structures from one season to the next, making them usefully monitor for a variety of events.

Extremal climate conditions like long-term droughts and short-term frosts negatively affecting radial growth of the trees. With application of the dendroclimatic methods and analyzing of scars and damages in the stem of tree it is possible to determine the past climatic conditions. Generally for studying past climate are using tree-ring width. Only in few cases analyzing anatomical structure of the stem. During extreme events, in the tree rings occurring traumatic resin ducts, compression and tension tree

rings, callus rings, frost rings. During all these events there observing abnormal cells like collapsed cells, callus cells and bent rays (Glock and et al., 1963; Studhalter, 1955). Drought rings anatomically belonging to the same category (Larson, 1995). We can observe these in the investigations of the some researchers (Stockli and Schweingruber, 1996).

Oak species is one of the most distributed and used for dendrochronological and for anatomical investigation in the world. There were distributed 450 species in the world, 19 species in the Caucasus and 9 species in Azerbaijan. *Quercus castaneifolia* is of the oak species, which mainly distributed in Hirkan forests (Caфapов, 1962).

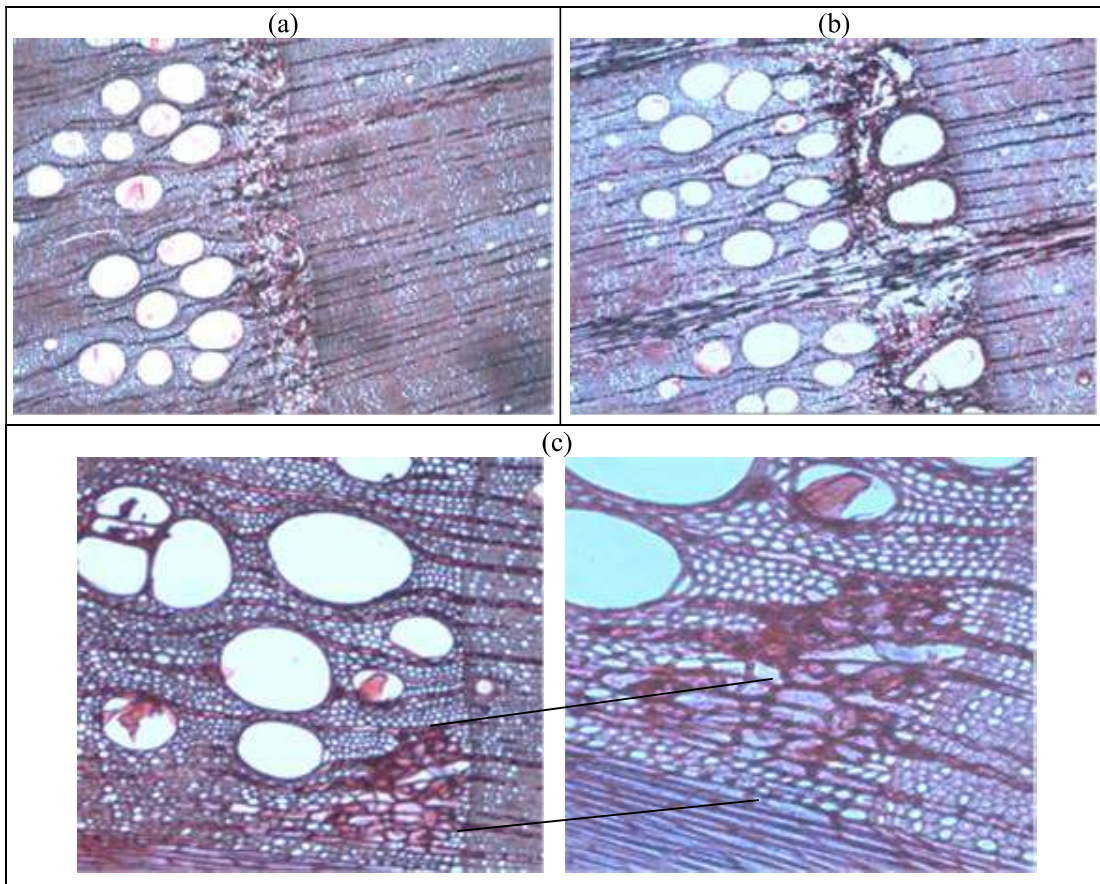
In this study we used dendroclimatic and anatomical methods for analyzing impact of climate on the radial growth of the chestnut-leaved oak.

### MATERIALS AND METHODS

The chestnut-leaved oak (*Quercus castaneifolia*) is native to the Azerbaijan and Alborz mountains of Iran. It is a deciduous tree growing up to 35 m tall, with a trunk up to 2.5 m diameter (exceptionally up to 50 m tall with a trunk up to 3.5 m diameter) (Prilipko, 1961). The leaves are 10–20 cm long and 3–5 cm wide, with 10–15 small, regular triangular lobes on each side (Fig. 1.). The flowers are wind-pollinated catkins; the fruit is an acorn, maturing about 18 months after pollination, 2–3 cm long and 1.5–2.0 cm broad, bicoloured with an orange basal half grading to a green-brown tip; the acorn cup is 2 cm deep, densely covered in soft 4–8 mm long 'mossy' bristles. The acorns are very bitter, but are eaten by jays and pigeons; squirrels usually only eat them when other food sources have run out (Prilipko, 1961; Tutayug, 1965).



**Figure 1.** View chestnut-leaved oak in study site.



**Figure 2.** Early frost ring (a), late frost ring (b) and tongue like damages (c), which was observed in our samples.

We carried out investigations in Lerik region 1500 m a.s.l., which was located in 38°45'04'' N and 48° 22'36'' E geographical coordinates. This site is high limit of the distribution of *Quercus castaneaefolia*. Samples was taken with increment and trephor borers. We took tree-ring core samples from 15 trees. Samples was prepared in the laboratory. For studying climate-growth relations was used dendroclimatic methods and anatomical structure was analyzed under microscope.

Frosts rings are anatomically abnormal, eco-physiologically pathological structures. Frost rings consisting of from thin wall-damaged tracheids, bent rays, callus cells, and morphologically reversed tracheids. The frost rings formed during the vegetation period have different anatomical structures. They can consist of phenol-prone single-cell sequences, gradually scattered, and then gradually expanding tracheids, from complete "frost rings" and small resin ducts.

## RESULTS AND DISCUSSION

As mentioned before generally, the main cause of forming frost rings is the short-term drop of temperature. At the beginning of the vegetation period, the plant begins to operate actively. In broadleaf trees, vessels and fibers are responsible for water transportation. During temperature drop water are freezing in the vessels and fibers. Water freezing are destroying cell walls and disturbing the form of the cells completely or partially. In the result, forming frost rings or wounds.

We observed frost rings in our tree-ring samples (Fig. 2). Tree-ring core samples covered 1967-2012 years interval. For analyzing frost ring, we divided these years into two period: 1967-1989 and 1990-2012 years intervals. During our investigations, in the first period we observed 2 (1981, 1987), but in the second period 5 (1990, 1993, 2004, 2009, 2010) frost rings. Our analysis showed that latest years frequency of the frost rings are increased. This is sign of the new local growing conditions, which related with climate change. In our samples, we observed early, late frost rings and tongue like damages.

Bend cells are observing in all disturbances. The severe frost occurring during the beginning of the vegetation period and damaging first cell are called early frost ring, but frosts occurring later forming late frost rings. In spite of that, different tree species have different anatomy and frequency of frost rings, generally they have common features,

In Europe, frost rings forming rarely, even one time in 100 year or more late. It shows that trees adapted to extremal environmental conditions and can easily react them. However, due to the climate change, there forming new environmental conditions, which trees cannot react to the new extreme conditions by proper way and forming frost rings.

In our samples mean sensitivity coefficient was 0.305 and max value 0.384. Observed high confidents of sensitivity indicating that trees growing in this area is very sensitive to the changing of the local climate and they reacting to year-to year

climate variation. That is why during early spring when temperature is dropping more than usual, there forming frost rings in the steam of the tree.

The investigation of such damages has great importance. By studying these, it is possible to learn the effects of extreme climatic conditions on plants and to evaluate climate changes.

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**Azərbaycanın Lerik Rayonunda Yayılmış Şabalıdyarpaq Palıdın (*Quercus castaneifolia* C.A.Mey.) Dendroiqlim Tədqiqi**

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İqlim dəyişkənliyi və ekstremal təbii hadisələr əksər bitkilərin artımına mənfi təsir göstərir. Bu tədqiqatda məqsəd mühit amillərinin Lerik rayonunun ərazisində yayılan şabalıdyarpaq palıdın radial artımına təsirini öyrənməkdən ibarətdir. Məlum olmuşdur ki, bu ərazidə yayılan şabalıdyarpaq palıdlar mühit amillərinin dəyişilməsinə çox həssasdırlar. Temperaturun qısamüddətli normadan aşağı düşməsi bitkinin artımına mənfi təsir göstərmiş və nəticədə oduncaqda don yaraları yaranmışdır.

**Açar sözlər:** *İqlim dəyişkənliyi, radial artım, Lerik, Quercus castaneifolia, dendroiqlim tədqiqat, anatomik metodlar.*

**Дендроклиматическое Исследование Каштанолистного Дуба (*Quercus castaneifolia* C.A.Mey.) в Лерикском Районе Азербайджана**

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Изменение климата и экстремальные природные явления негативно влияют на прирост большинства растений. Целью этого исследования является изучение влияния окружающих факторов на радиальный прирост *Quercus castaneifolia*. Было выявлено, что каштанолистные дубы, которые распространены в этой области, очень чувствительны к изменяющимся условиям окружающей среды. Кратковременное падение температуры ниже нормы отрицательно сказывается на росте растения и способствует образованию на древесине морозобойных колец.

**Ключевые слова:** *Климатические изменения, радиальный прирост, Лерик, Quercus castaneifolia, дендроклиматическое исследование, анатомические методы*