Role of *Quercus coccifera* (=*Q. calliprinos*) in the light of climate change scenarios in the Mediterranean Basin

Munir Ozturk¹

Centre for Environmental Studies and Botany Department, Ege University, Izmir, Turkey

Volkan Altay

Hatay Mustafa Kemal University, Biology Department, Hatay Turkey

Abstract: The current kermes oak species complex is a descendant of an ancient lineage. It has colonized the Mediterranean area long before the contemporary Mediterranean climates prevailed. Most widespread species of the Group Ilex, *Ouercus coccifera* (=O. calliprinos); occurs across the entire Mediterranean region. The climatic history of this region may be a key to understanding the present situation of O. coccifera. Current climatic adaptations of the western and eastern groups of *Q. coccifera* differ significantly, as in the western Mediterranean the distribution is restricted to the coastal or low altitude humid to subhumid zone with seasonal aridity. All future scenarios for the entire Mediterranean basin indicate a rise in average temperature and significant drops of annual rainfall which may pose problems for this species.

Key Words: adaption, climate change, distribution, biological diversity, kermes oak

INTRODUCTION

The genus *Quercus* L. is an ecologically diverse and economically important plant [Simeone et al., 2016]. It has been valued throughout its historical existence, especially for its hardwood. There are nearly 600 species distributed across the northern hemisphere, but centered in the Americas and East Asia.

The genus is grouped morphologically and anatomically into two subgenera, *Quercus* s.str. and *Cyclobalanopsis*. The former is further divided into 3 to 6 sections [Nixon, 1993]. However, phylogenetic studies on the nucleosome of oaks does not support the two subgenera, but notes some sections as monophyletic groups [Simeone et al., 2016]. These studies consistently present two main lineages within the genus "New World Clade" (sections Protobalanus + *Quercus* (=Lepidobalanus) + Lobatae) and "Old World Clade" consisting of the cycle-cup oaks (Cyclobalanopsis), along with two previously mostly unrecognized lineages, groups Ilex and Cerris, represented in the Euro-Mediterranean area with a relatively lower number of species [Menitsky, 2005; Simeone et al., 2016]. Establishment of the split within the "Old World Clade" between Cyclobalanopsis and Ilex during the Eocene/ Oligocene, must have preceded split of the Cerris from Ilex stock, not before the earliest Miocene [Simeone et al., 2016]. The studies undertaken do show the ancestral character of the group Ilex, previously accepted merely as a subsection. This has putforth the need to transfer numerous taxa from group Cerris to Ilex. Group Ilex now comprises 35 mainly sclerophyllous species from a wide array of habitats covering boreal forests of Japan to subalpine forests of Himalaya and subtropical SE Asian forests, and from arid Central Asian steppe to Mediterranean shrub communities [Menitsky, 2005; Denk, Grimm, 2010].

The genus *Quercus* is characterized by hybridization and introgression among closely related taxa, a feature that may be among the key factors to the success under unfavorable conditions and changing climatic conditions as experienced in the Mediterranean basin.

In a recent study on chloroplast DNA phylogeny of Mediterranean evergreen oaks, group Ilex, the existence of three different chlorotypes has been geographically sorted but shared among the species. The plastid haplotypes forming the phylogenetically isolated "Euro-Med" lineage are encountered in the Q. ilex and Q. coccifera s. l. populations outside Eastern Mediterranean, to which "Cerris-Ilex" and "WAHEA" haplotypes are confined [Simeone et al., 2016]. "Cerris-Ilex" haplotypes found in the Peri-Aegean region plus isolated spot in northern Anatolia (Q. ilex L., O. coccifera L. s. l. and O. aucheri Jaub. & Spach. individuals) are replaced by "WAHEA" haplotypes (Q. coccifera s.l., Q. aucheri, Q. alnifolia) in south-west Turkey [Simeone et al., 2016]. The Italian populations possess the phylogenetically distinct "Euro-Med" haplotype (Fig. 1). This haplotype is less likely to have been isolated from other haplogroups, due to lack

¹E-mail: munirozturk@gmail.com

Received 08.11.2021; Received in revised form 19.11.2021; Accepted 25.11.2021



Figure 1. Map showing the distribution of chlorotypes among Mediterranean evergreen oak species: WAHEA (bold lines), Euro-Med (thin lines), Cerris-Ilex (dashed lines). Question marks indicate unsampled populations (Modified from Simeone et al. [2016]).

of barriers to the east at the time of divergence, and probably has its origins back to a hybridization event with extinct genera of the family Fagaceae in Europe before Miocene [Simeone et al., 2016].

A study on the allozyme variation at seven polymorphic loci in individuals from 24 populations has revealed that populations assigned to *Q. calliprinos* Webb. (including *Q. aucheri* and *Q. coccifera*) from the areal of "Cerris-Ilex" and "WAHEA" are clustered together with a much higher genetic variation as compared to that of "Euro-Med" area [Toumi, Lumaret, 2010]. The phylogenetic network (Neighbor-Net splits graph) based on ITS2 + plastid DNA (trnH-psbA + matK) dataset by M.C. Simeone et al. [2013] further suggests a separation between the east and the west.

Many "WAHEA" species exist along the Himalayas, and it is likely that the species of this haplogroup arrived in the Mediterranean basin through the so-called Himalayan corridor [Güner, Denk, 2012].

The factor which reinforces the hybridization in the oaks is the reduction of mate recognition due to environmental stress [Williams et al., 2001]. Therefore, the Mediterranean climate zone can be addressed for a high potential of hybridization. In *Quercus* Group Ilex, hybrids and different levels of genetic introgression among morphologically pure individuals were molecularly documented in *Q. ilex/Q. coccifera* and, to a lesser rate, in *Q. coccifera/Q. alnifolia* [Neophytou et al., 2007, 2011; Simeone et al., 2016].

It seems that, especially in the east of the range, characterization and identification of Mediterranean evergreen oak species of Group Ilex still remains a phylogenetic puzzle [Michaud et al., 1992]. Keeping in view a low mutation rate in the chloroplast genome [Provan et al., 1999], unlike the genetically more or less homogeneous high latitude lineages [Simeone et al., 2016], the exceptionally high genetic diversity found in this group suggests the ancient and continuous presence of the species in the distribution area [Jimenez et al., 2004].

The modern kermes oak species complex is indeed a descendant of an ancient lineage which colonized the Mediterranean area long before the contemporary Mediterranean climates were formed. The fossil forms of ilex-coccifera type date back to the Oligocene in several localities in southern Europe and Anatolia [Palamarev, 1989; Kvacek, Walther, 1989]. Miocene fossil records imply a preadaptation towards xerophytic morphology [Denk et al., 2014; Velitzelos et al., 2014], although mesic conditions were dominant to some extent at the time, it seems that the species of Group Ilex became adapted in situ to the climatic changes.

The most widespread species of the Group Ilex, Q. *coccifera* occurs across the entire Mediterranean region, distributed from 45°30' N in the Peninsula of Istria to 31°00' N in the Negev (Israel) and from 9°30'

E in Cascais (Portugal) to 37°00' E on the Mountains of Alaouites [Tsiourlis et al., 2009]; dominating the low and high Mediterranean shrub formations across its range, predominantly on limestone substrates [Tsiourlis et al., 2009].

In the Levant, traditionally *Q. coccifera* is named *Q*. calliprinos (Palestine oak), based on the morphological characters. Considering the high morphoplasticity within *Q. coccifera* s.l., there is not a consensus among authors whether to classify Eastern Mediterranean taxon as a distinct species [Blondel, Aronson, 1999] or a subspecies [Tutin et al., 1993, 2010] or morphotype [Toumi, Lumaret, 2010) and the plain synonym of the former [Christensen, 1997; Govaerts, Frodin, 1998; Camarda, 2003]. According to M. Zohary [1961]; though not strictly exclusive; the gross morphological differences between the two species are evident. According to S. Pignatti [1982], key characters to identify Q. calliprinos from Q. coccifera are the arborial habit, yellowish young twigs persisting until the second year with stellate-pubescent hairs and tomentose female catkins. Based on these morphological traits, at least 23 varieties of *O. calliprinos* are described mainly from South Anatolia and the Levant.

The geographic distribution of the two entities is not clear [Paffetti et al., 2001]. A. Camus [1936-1938] has indicated that the western Mediterranean basin is the distribution range for *Q. coccifera* and the eastern zone for *Q. calliprinos*. Although there is evidence on the *Q*. coccifera populations in the Central Taurus Mountains, in the proximity of the Levant, are genetically distinct from the rest [Aykut et al., 2013], the presence of Q. calliprinos in Turkey is not accepted. Both species are reported to exist in Albania [Mullaj et al., 2010], in Crete [Barbéro, Quézel, 1980], and in Greece [Knapp, 1965], while in Cyprus it is recorded as a subspecies of the Kermes oak [Hand, 2006]. As distinct species Q. calliprinos is reported from Corsica, Sicily, Sardinia, and Apulia in mainland Italy [Mossa, 1990; Ottonello et al., 1991; Mossa et al., 1998; La Mantia, Gianguzzi, 1999a, b], based on the morphological and anatomicomicrometrical studies of leaf samples, but this view is not accepted by several authors who in general claim that Q. calliprinos and other similar taxa are synonyms of Q. coccifera [Camarda, Valsecchi, 1982; Camarda, 2003].

Q. calliprinos is recognized as a recurrent species in anthropogenically affected areas after abandonment, however, the palynological research in Israel has shown that it has been the dominant forest and maquis tree since Würm and throughout Holocene [Frumkin et al., 1999; Kadosh et al., 2004; Schwab et al., 2004, Quezel, 2005]. There is evidence of a lack of benefit from the disappearance of deciduous oaks [Van Zeist et al., 2009]. This oak species survived the episodes of climatic fluctuations during the early Holocene and afterwards the large-scale land transformation due to agropastoral overexploitation in the Levant [Zohary, 1960, 1961, 1962, 1973; Nave, 1985].

Q. calliprinos is the dominating species among 30 trees of the maquis of Israel, accounting for 80-90 percent of the tree coverage [Zohary, 1973]. Although generally found in a multistemmed shrubby form in this vegetation and attaining 1-2 (up to 4-5) m height, it can grow up to 10-15 m in woodlands unaffected by humans [Nahal, 1962]. Forests of Q. coccifera with a height of about 15 m, in certain locations as in Crete, can also be encountered [Kypriotakis et al., 1996]. Q. calliprinos is found either as pure stand or as a mixed community together with Pistacia palaestina Boiss., especially in upper Galilee, Mt. Carmel and Judean mountains [Liphschitz et al., 1987], on a variety of soil types which are the weathering products of calcareous, dolomitic, basaltic, and sandy bedrock formations, and on alluvial plains [Dan, Raz, 1970]. The companions of *Q. calliprinos* vary on the bais of edaphic and climatic conditions [Danin, 1992]. Q. coccifera is generally accepted as a secondary climax species as a replacement of Pinus brutia Ten. in Turkey and adjacent countries [Barbero et al., 1976]. Whether *Q. calliprinos* is climax Mediterranean tree, instead of P. halepensis Mill. or Q. ithaburensis Decne. is questionable in Israel. However, there are several areas where it was replaced with either of the two during the modern age or prior to it.

Oaks under overgrazing, overexploitation and wildfires. These conditions alter the physiognomy and composition of natural vegetation in the Mediterranean. These come to the forfront as main factors responsible for the regional predominance of this species [Tsiourlis et al., 2009]. The multistemmed look, sclerophyllous and shrubby habit attract less human attention. As such, frugality, resprouting ability enable coppicing and overgrazing. The rapid post-fire regeneration lies behind the recovery success of *Q. calliprinos* and *Q.* coccifera [Barbero et al., 1990; Tsiourlis et al., 2009]. O. coccifera follows a slow-growth strategy in general, which enables replacing the initially dominant fastgrowing species through succession [Paraskevopoulos et al., 1994]. In a study on grazing effects on different maquis trees [Tavşanoğlu, Coşkun, 2009], Q. coccifera

has been found to have the least grazing index values, explained by its vertical growth strategy to avoid grazers [Perevolotsky and Haimov, 1992].

Evergreen and deciduous broad-leaved forests represent the late-successional plant communities in large parts of the Mediterranean however, millennia of traditional land use have shaped the mosaic-like landscapes which are characterized by very high structural and floristic diversity, in particular in the herbaceous and shrubby vegetation [Naveh, 1998]. The natural arboreal vegetation was almost completely destroyed [Zohary, 1960; Liphschitz, Biger, 1990; Westphal et al., 2009]. The so-called natural forests left behind are the changed forests, often corresponding to the different stages of regressive succession of the original forest [Simeone et al., 2016].

In recent decades, dramatic land use changes can be observed in the Mediterranean region with the abandonment of traditional agrosilvopastoral practices in the northern part, and the intensification of land use with modern agriculture and urbanization in the southern part. After cessation of traditional land use, shrub lands can develop in dense sclerophyllous oak forests, as observed in the northwestern Mediterranean region [Etienne et al., 1998; Quézel, Médail, 2003; Westphal et al., 2009].

Mediterranean sclerophyllous oak forests as a part of the mosaic-like landscape are of great significance for nature conservation because they provide wide range of ecosystem functions and services such as; protection of a high overall biological diversity, a low invasibility by exotic species, and the maintenance of soil and water resources [Dufour-Dror, 2005; Buse et al., 2008; Timm et al., 2009]. Natural succession turns this landscape into closed, dense and shady woody vegetation in the absence of human interference. In view of this active management is proposed to prevent tree closure and consequent loss in biodiversity [Perevolotsky, 2005; Agra, Ne'eman, 2011]. With the beginning of agriculture in the Near East about 11.000 years ago, abiotic interferences have been the traditional exploitation techniques of the natural woody vegetation, greatly affecting plants and the landscape [Naveh, 1990; Naveh, Carmel, 2004].

Many investigators hold the opinion that the Mediterranean vegetation has come into being through a process of regeneration and degeneration [Polunin, Huxley, 1967]. Originally, the climax communities in the Mediterranean basin are mainly formed by evergreen *Quercus* and *Pinus* L. species and this is

accepted as a climatic climax. Many extant elements of this vegetation were present by the end of the last glacial age, unaffected by the glacial cycles as the glaciers did not extend down below 2700 m in the region, including even some members like Ceratonia L., Vitis L., Myrtus L., Nerium L., Platanus L., Olea L., Pistacia L. which are known as the actual survivors from the Tertiary Period [Quezel, 1985], together with the boreal newcomers which established themselves in the small enclaves maintaining humid, cool conditions and served as refugia for them. If not subjected to abiotic interference, a climatic climax can remain stable for a long time, which is not the case in the basin being home to great civilizations. Considering the changes seen in the climate and socio-economy through the history of Mediterranean part of Turkey and the Near East in general, it is clear that the original vegetation has been subjected to many interferences which initiated a series of successional stages towards the climax. Phyrgana and maquis, occupy mid-position in this chain [Ozturk et al., 1983]. Thanks to the rapid recovery ability, this vegetation type has persisted in many areas safeguarding what has been left around. Interestingly, this 'mid-position' stage has higher biodiversity than surrounding areas and without any human interference, it transforms into a shady scrub with poor biodiversity value [Perevolotsky, 2005].

An explanation of the distribution of oak species at a regional scale is possible and for this purpose, the most important parameter is the climate. However, the regeneration of *Quercus* species depends on the degree of human impact to a greater extent in addition to the climatic factors [Nakao et al., 2010], as many temperate oak species have acquired their present status due to their post-fire advances. Fire is a reality of the "Mediterranean type Ecosytems". In the Mediterranean Basin, there is evidence of frequent wildfires during later Quaternary [Carrión et al., 2003], different adaptations to wildfires are encountered among Mediterranean plants from various phylogenetic groups indicating deeper roots of fire adaptation [Pausas, Verdú, 2005]. The resprouting ability is the most common adaptation to forest fires among the Mediterranean shrubs and grasses. According to a study in Greece, there is no significant difference between the effect of summer and spring fires on the resprouting ability of *Q. coccifera* [Konstantinidis et al., 2005] however, there is evidence of a decrease in the productivity under higher fire frequencies [Delitti et al., 2005], which provide highest herbaceous plant species richness, and no difference on fertility loss has

been recorded [Ferran et al., 2005].

Role of drought and heat stress. Seasonality of aridity and wet seasons influence the water availability of plants [Ozturk et al., 2010a]. Combination of abiotic and anthropogenic stress factors multiply the influence of water scarcity. The major environmental factor limiting photosynthesis and plant growth is water scarcity, which induces morphological and ecophysiological changes affecting plant growth, survival, distribution and abundance [Sakcalı, Ozturk, 2004; Sakcalı et al., 2008; Ozturk et al., 2010a]. Various morphological and physiological adaptations are observed in the Mediterranean sclerophyllous plants with a high water use efficiency under frequent drought stress to cope with.

As regards to the Mediterranean climate seasonality conditions, plant life is strongly influenced by drought [Pereira, Chaves, 1995]. The physiological and phenological responses in plant taxa are probably associated with predicted water stress in the basin, but different plant taxa can develop different responses towards the changes in the climate [Penuelas et al., 2001; Houghton et al., 2001; Ozturk et al., 2010a]. In a study by Ozturk et al. [2010a], net photosynthesis and transpiration in Q. coccifera communities from two sites, one burnt and healthy, were studied. In the degraded site a higher net daily photosynthesis has been recorded as compared to the healthy site. This can be attributed to the lack of competition as similar findings were obtained from *Q. ilex* by Fleck et al. [1998]. To a lesser extent, the same difference can be seen in transpiration rates. With regard to the seasonality, water availability takes over, as observed by higher rates in rainy September. It can be said that human interference and precipitation regime are equally effective on this arid-adapted plant. An opposite trend can be seen in Q. calliprinos [Karam et al., 2011], regarding net daily photosynthesis and transpiration rates, which possibly means that at least the studied population is more susceptible to human interference.

There will be changes in plant growth following the consistent global climate change. The alterations in the annual temperature and rainfall patterns is important in determining if local species will benefit from the increased photosynthesis and water use efficiency [Ozturk et al., 2010a]. The higher temperature together with reduced availability of water combined together will enhance several stressing factors very difficult to overcome. Any variability in the climate at the local level can cause dramatic differences in photosynthesis among populations within short distances. In view of this, sustainable use and conservation of water resources need to be planned from now in the Mediterranean. The competitive relationship among the Mediterranean scrubland species may change with dry and warm conditions [Ozturk et al., 2010a]. Annual productivity of shrubs in the Mediterranean may decrease under future drier conditions. However, the magnitude of such decreases will be species-specific. We come across exploration of larger soil volumes by the evergreen oaks. They use the competition free water stored in the soil. The plantations with closed canopy are less sensitive to moderate droughts, more vulnerable to severe droughts and *Q. coccifera* is a drought-resistant species [Ozturk et al., 2010a].

The future warming effects will significantly increase leaf heat stress, limit the growth and survival of plants. The reason being severe restrictions on photosynthesis which will affect the physiological activity of the plant life in the Mediterranean [Ozturk et al., 2010a]. In many plant taxa in this region U. Vardar and A.M. Ozturk [1972], K.H. Sheikh [1976] and J.D. Tenhunen et al. [1985] have reported midday stomatal closure as a feature of these species, allowing them to limit water loss particularly at the time of high atmospheric demands when these are maximum during the course of the day. Another effect is expected from the global change which will vary with the regions. It will depend on the pre-existing climatic conditions and the species adaptation potential [Niinemets et al., 2009]. For the characterization of water stress intensity duration in different species seasonal gradients interfer. The recently highlighted importance of decrease in photosynthesis regulation during water stress, this work will attract more attention under natural conditions. A correlation between photosynthesis and transpiration variation, called also water use efficiency, WUE, gives us an indication of the degree of adaptation of each species to the environmental condition [Ozturk et al., 2010a].

In addition to these information, a number of physiological adaptations enabling to thrive in dry environment and cope with unfavorable soil conditions have been described. Investigation into the annual rhythm of cambial activity of *Q. calliprinos* showed that it may be active throughout the entire year, thus indicating a better adaptation to the Mediterranean climate [Ephrat, 1971]. The stored energy reserves in the roots supports the regenerative capacity [Tsiourlis et al., 2009] supplies of water and the extensive and deeply

penetrating roots provide nutrients and water theriby allowing during the summer drought these plants to extract water from the sources inaccessible to other species. We find a high transpiration level for this period necessary to develop its young leaves, giving another competitive advantage [Konstantinidis et al., 2005; Tsiourlis et al., 2009]. In response to a lesser amount of precipitation, the direct response in Quercus coccifera is the reduction of water transport capacity. This takes place via reduction of vessel diameter without changing the amount of xylem tissue or foliage [Villar-Salvador et al., 1997]. Changes regarding photosynthetic electron transport rates were found to be lower than O. suber in O. coccifera under severe drought stress conditions, as an adaptation to xeric conditions, decreasing ETR photo-inactivating PSII centers (evidenced by their low predawn Fv/Fm ratios at high water stress, largely due to Fm quenching) [Peguero-Pina et al., 2009]. The species shows extremely high resistance to droughtinduced xylem cavitation [Vilagrosa, 2002].

Evaluation in terms of Climate Models. The climate of the Mediterranean rim, determined by mainly macroand meso- climatic factors, is characterized by dry-hot summers and rainy mild winters [Ozturk et al., 2008, 2010a]. Summer is always the driest season, rainy days extend from November to April in general. The mean annual rainfall is the crucial difference between the Mediterranean and adjacent arid climate zones. It is rather difficult to put forth precipitation extremes of this region, however, these could be accepted as those with mean annual precipitation ranging from 275-350 mm for day and 900 mm for the rainy period. The frost is not rare being met with all over this region, but is not strong enough. The mean annual temperature for the winters lies between 3-10°C and for the summers between 21-30°C [Ozturk et al., 1983].

The climatic history of the region may be a key to understanding the present situation of *Q. coccifera* s.l., and the different bioclimatic responses to be expected under climatic changes. There have been substantial drops in temperatures in the West Mediterranean during the last ice age. The exceptions to this are the coastal areas of southern Spain and North Africa [Elenga et al., 2000], where *Q. coccifera* persisted locally. The lack of geographical genetic structure and relatively low genetic diversity in the area implies the presence of recent range expansions from refugial pockets [Lopez de Heredia et al., 2007a, b; Toumi, Lumaret, 2010]. On the contrary, Eastern Mediterranean oaks appear to have survived the Ice Age continuously at least in the Levant [Schiebel, 2013].

Also the present day climatic adaptations of the western and eastern groups of Q. coccifera s.l. differ greatly [Quezel, Me'dail, 2003], as in the western Mediterranean the distribution is restricted to the coastal or low attitude humid to subhumid zone with seasonal aridity, while the area of occurrence extends more interior and higher parts in Anatolia and the Levant [Zohary, 1962]. As far altitudinal variation in Israel; between 0-200 m; Q. calliprinos can be found in drier parts up to about 1650-1700 m altitude [Zohary, Feinbrun-Dothan, 1966], climbing up to 1600 m in Lebanon [Abi-Saleh, 1978], being dominant tree at mid-elevations but in Cyprus up to 1400 m [Hand, 2006]. Q. coccifera can grow in central Greece at about 1000 m [Greig, 1973], in Epirus 900 m [Higgs et al., 1967], whereas in Turkey it reaches up to an altitude of 1500 m [Ozel et al., 2012]. The study on the oaks from Lebanon dealing with the abiotic factors affecting their distribution shows; where *Q. calliprinos* type locality is situated; it can be found in the meso-and supra-mediterranean steppe, among the thermo-, meso- and supra-Mediterranean belts according to Emberger classification [Stephan et al., 2016]. Along with Q. ithaburensis, the species is positively affected by maximal temperature averages of the hottest month, differing from it by its wider range towards interior and more elevated areas, and the two species are not significantly affected by rainfall, while it is the only oak to thrive in mid-elevations due to its morphoplasticity. Q. calliprinos exist in all bioclimatic zones except the ones with very cold and cold winters. The absolute winter temperature limit for Q. coccifera is -27°C [McMillan, 2012]. A study carried out in Turkey on species response curves of oak species along climatic gradients by Ughurlu and Oldeland [2012] has revealed the precipitation seasonality as the most important climatic gradient for *Q. coccifera*. In Portugal, Q. coccifera cannot withstand wet summers of the coastal strip and cold winters of the interior of the northern half of the country [Varela, 2001]. In Italy, according to climate maps [Constantini et al., 2013], it can be seen that the current distribution of Q. coccifera/Q. calliprinos in mainland Italy, Sardinia and Sicily can be defined by annual rainfall, aridity index, but not precipitation seasonality. On the other hand, the distribution agrees with other western Mediterranean coastal distribution patterns.

A study on some Mexican oaks regarding their

potential distributional changes under severe and conservative climate-change scenarios for 2050 has been published which regionalizes the HadCM2 model of climate change [Gomez-Mendoza, Arriaga, 2007], shows how drastic the effects could be. According to the study, the current ranges of individual oak species in Mexico will be decreased by 7-48 %, to the level that necessitates seeking ways of *ex-situ* conservation.

Unfortunately, all future scenarios for the entire Mediterranean Basin, indicate a rise in average temperature and significant drops of annual rainfall. Some scenarios announce more extreme precipitation events [Lenderink, Van Meijgaard, 2008]. As a consequence of a moribund combination of lesser amounts of precipitation except for winters and substantial summer temperature rise estimates, one of the expected immediate results of climate change is an increase in the wildfires across the Mediterranean rim. A projection made for Sardinia, Apulia, Croatia and Spain [Dubrovsky et al., 2012], based on 17 GCMbased climate change scenarios, presents (Fire Weather Index) simulations for 2050. They have used M&Rfi weather generator which indicates increased wildfire risk. In most of the stations studied the expectations are 20-50 % increase in the frequency of occurrence of FWI>FWI* days. An average annual number of forest fires all through the Mediterranean basin currently is close to 50000, 2 times the 1970s [Ozturk et al., 2010b].

CONCLUSIONS

Currently, one of the greatest challenges to humanity is climate change. It is among the great international concerns. Among a large percentage of humans it is a major emerging problem but according to them global climate change is simply global warming, but this change is an integrated system of several atmospheric phenomena and their products [Ozturk et al., 2010c].

Our earth is becoming hotter and major source is greenhouse gas emissions, a highly important problem ever known to Earth's biodiversity and ecosystems [Ozturk et al., 2010c]. Any change in the environmental niche of a species is expected to affect whole ecosystems, habitats and this change will alter their compositions. Keeping this in view, one of important current topics is to predict temperature rise effects on individual plant taxa. Another factor adding to the current global climate change is agriculture which through greenhouse gas emissions is proving harmful. Its contribution is said to lie around 10 and 12 % of the global average. The high deforestation rate also adds to this [Ozturk et al., 2010c]. How exactly the physical processes mediating between greenhouse gases emissions and changes in earths climate is still not clear. The question is these processes are not easy to reverse and may even be irreversible. In the long run and longer we wait the risks will increase and catastrophic effects are possible. Therefore, we have to increase the efforts to mitigate climate change. These will be an insurance against these growing risks. Moreover, larger and more immediate negative impacts should be expected following the climate change. It should be organized within the context of sustainable development, which will be the key to achieving a global agreement representing the interests of humanity on mother Earth [Ahmad, 2008; Ozturk et al., 2010c].

In general 2.7 global ha (gha) has been estimated as the average ecological footprint of one human which stresses that we as humans will need two planets to maintain its level of consumption. Latest investigations have revealed during the coming few decades a devastating impact on the wild relatives of important crops can be expected following climate change. A major percentage of our plant taxa are under threat and 60 % of high altitude species may vanish during the next 100 years [Ozturk et al., 2010c].

We as humans are on the sharp edge of an environmental crisis, not experienced earlier. We believe in that all around us is for us, simply a crisis of mind and spirit. The habitat destruction will increase with increase in our population and loss of species in following years is expected to be around 20 to 50 thousand species each year [Zedan, 2002; IUCN, 2006]. This problem is gradually attracting public awareness. We see that education and conservation related to the biodiversity are gaining much attention and importance. We must start environmental education at home stressing the fact that an answer to all these questions lies in sustainable development. The humans have to meet their needs of the present without compromising the ability of future generations to meet their own needs [Ozturk, 1985; Ozturk et al., 2010c].

REFERENCES

- Abi-Saleh B. (1978) Etude phytosociologique, phytodynamique et e'cologique des peuplements sylvatiques du Liban. Thesis, Faculte' des Sciences et Techniques St. Jérome.
- Agra H., Ne'eman G. (2011) Quercus calliprinos regrowth advantage under grazing in Mediterranean

maquis and its management implications. *For. Ecol. Manag.*, 261: 143-147.

- Ahmad I. (2008) Climate change and its implications for the muslim world. P. 25-28 In: 16th Science Conference IWAS, Science, Technology and Innovation for Sustainable Development of Islamic World: The policies and politics rapproachement, Kazan, Tatarstan.
- Aykut Y., Uslu E., Babac M. (2013) Molecular diversity among Turkish oaks (Quercus) using random amplified polymorphic DNA (RAPD) analysis. *Afr. j. biotechnol.*, 12(45): 6358-6365.
- Barbéro M., Bonin G., Loisel R., Quezel P. (1990) Changes and disturbances of forest ecosystems caused by human activities in the western part of the Mediterranean Basin. *Vegetatio*, 87: 151-173.
- Barbéro M., Chalabi N., Nahal I., Quezel P. (1976) Les formations a coniferes Mediterraneens en Syrie littorale. *Ecol. Mediterr*, 2: 87-99.
- Barbéro M., Quézel P. (1980). La végétation forestière de Crète. *Ecol. Mediterr.*, 5: 175-210.
- Blondel J., Aronson J. (1999) Biology and wildlife of the Mediterranean region. Oxford University Press, Oxford.
- Buse J., Levanony T., Timm A., Dayan T., Assmann T. (2008) Saproxylic beetle assemblages in three managed oak woodlands in the Eastern Mediterranean. *Zool. Middle East*, 45: 55-66.
- Camarda L. (2003). Some considerations about diversity, distribution and problems of *Quercus* L. in Sardinia. *Bocconea*, 16(1): 65-72.
- Camarda I., Valsecchi F. (1982) Alberi e arbusti spontanei della Sardegna. Galizzi, Sassari.
- Camus A. (1936-1938) Les Chenes. Monographie du genre *Quercus*. I.P. Lechevalier, Ed., Paris.
- Carrión J.S., Sanchez-Gomez P., Mota J.F., Yil. R., Chain C. (2003) Holocene vegetation dynamics, fire and grazing in the Sierra de Gador, southern Spain. *Holocene*, 13: 839-849.
- Christensen K.I. (1997) Quercus L. pp. 42-50 In Strid. Flora hellenica 1. Königstein.
- Costantini E.A.C., Fantappiè M., L'abate G. (2013) The Soils of Italy. Springer, 19-38.
- Dan Y., Raz Z. (1970) The soil association map of Israel (Scale 1: 250.000). Ministry of Agriculture, Department of Scientific publications, Bet Dagan, Israel.
- Danin A. (1992) Flora and vegetation of Israel and adjacent areas. *Bocconea*, 3: 18-42.
- Delitti W.B.C., Ferran A., Vallejo R., Trabaud L. (2005)

effects of fire recurrence in *Quercus coccifera* L. shrublands of the valencia region (spain): 1. plant composition and productivity. *Plant Ecol.*, 177: 57-70.

- Denk T., Grimm G.W. (2010) The oaks of western Eurasia: traditional classifications and evidence from two nuclear markers. *Taxon*, 59: 351-366.
- Denk T., Guner T., Grimm G.W. (2014) From mesic to arid: Leaf epidermal features suggest preadaptation in Miocene dragon trees (Dracaena). *Review of Palaeobotany and Palynology*, 200: 211-228.
- Dubrovsky M., Duce P., Arca B., Pellizzaro G., Vucetic V., Vucetic M. (2012) Wildfire risk in the Mediterranean under future climate. *MEDCLIVAR conference*. Madrid 26-28.9.2012.
- Dufour-Dror J. (2005) The significance of dense sclerophyllous oak forests in the landscapes of northern Israel and their ecological values: an unconventional viewpoint. *Isr. J. Plant Sci.*, 53: 215-224.
- Elenga H., Peyron O., Bonnefille R., Jolly D., Cheddadi R., Guiot J., Andrieu, V. et al. (2000) Pollen-based biome reconstruction for southern Europe and Africa 18.000 year BP. J. Biogeogr., 27: 621-634.
- Ephrat Y. (1971) Periderm Development and the Annual rhythm of phellogen and cambial Activity in *Quercus suber* and *Quercus calliprinos*. M.Sc. thesis, Tel Aviv University, Israil.
- Etienne M., Aronson J., Le Floc H.E. (1998) Abandoned lands and land use conflicts in Southern France.In: Rundel P.W., Montenegro G., Jakstic F.M., Eds. Landscape disturbance and biodiversity in Mediterranean-type ecosystems. Ecological Studies, 136, Springer Verlag, Berlin.
- Ferran A., Delitti W., Vallejo V.R. (2005) Effects of fire recurrence in *Quercus coccifera* L. shrublands of the Valencia Region (Spain): II. plant and soil nutrients. *Plant Ecol.*, 177: 71-83.
- Fleck I., Hogan K.P., Lorens L., Abadaia A., Aranda X. (1998). Photosynthesis and photoprotection in *Quercus ilex* resprouts after fire. *Tree Physiol.*, 18: 607-614.
- Frumkin A., Carmi I., Gopher A., Ford D.C., Schwarcz H.P., Tsuk T. (1999) A Holocene millennial-scale climatic cycle from a speleothem in Nahal Qanah cave, Israel. *The Holocene*, 9: 677-682.
- Gomez-Mendoza L., Arriaga L. (2007) Modeling the effect of climate change on the distribution of oak and pine species of Mexico. *Conserv. Biol.*, 21(6): 1545-1555.

- Govaerts R., Frodin D.G. (1998) World checklist and bibliography of Fagales (Betulaceae, Corylaceae, Fagaceae and Ticodendraceae). Kew: Royal Botanic Gardens.
- Greig J.R.A. (1973) Studies in the vegetational history of Greece. Durham theses, Durham University.
- Güner T., Denk T. (2012) The genus Mahonia in the Miocene of Turkey: taxonomy and biogeographic implications. *Rev. Palaeobot. Palynol.*, 175: 32-46.
- Hand R. (2006) Supplementary notes to the flora of Cyprus V. *Willdenowia*, 36: 761-809.
- Higgs E.S., Vita-Finzi C., Harris D.R., Fagg A.E. (1967) The climate, environment and industries of Stone Age Greece. Proc.Prehist. SoC., XXXIII: 1-29.
- Houghton J.T., Ding Y., Griggs D.J., Noguer M., Van Der Linden P.J., Dai X., Maskell K., Johnson C.A. (2001) The scientific basis, contribution of working group I. In: IPCC, Climate change. Third Assessment Report of Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.
- IUCN (2006) www.iucn.org/places/medoffice/ documentos/press-release-red-list.pdf.
- Jimenez P., Lopez De Heredia U., Collada C., Lorenzo Z., Gil L. (2004) High variability of chloroplast DNA in three Mediterranean evergreen oaks indicates complex evolutionary history. *Heredity*, 93: 510-515
- Kadosh D., Sivan D., Kutiel H., Weinstein-Evron M. (2004) A late quaternary paleoenvironmental sequence from Dor, Carmel coastal plain, Israel. *Palynology*, 28: 143-157.
- Karam F., Doulis A., Ozturk M., Dogan Y., Sakcalı S. (2011) Eco-physiological behaviour of two woody oak species to combat desertification in the east Mediterranean-a case study from Lebanon. *Procedia Soc.*, 19: 787-796.
- Knapp R. (1965) Die Vegetation von Kephallinia, Griechenland. Verlag Otto Koeltz, Loenigstein, 206 p.
- Konstantinidis P., Tsiourlis G., Galatsidas S. (2005) Effects of wildfire season on the resprouting of kermes oak (*Quercus coccifera* L.). For Ecol. Manag., 208: 15-27.
- Kvacek Z., Walther H. (1989) Palaeobotanical studies in Fagaceae of the European Tertiary. *Plant Syst. Evol.*, 162: 213-229.
- Kypriotakis Z., Tzanoudakis D., Tsiourlis G. (1996) Vegetation map of Crete. Proceedings of the 6th Botanical Scientific Conference, Hellenic Botanical Society and Biological Society of Cyprus Society, Paralimni, Cyprus: 301-306.

- La Mantia A., Gianguzzi L. (1999a) Nuove stazioni di *Quercia spinosa (Quercus calliprinos* Webb) presso Capo Rama (Sicilia Nord-occidentale). *Naturalista Sicil.*, 23: 113-129.
- La Mantia A., Gianguzzi L. (1999b) La *Quercia spinosa* in Sicilia. *Sicilia Foreste*, 21/22: 2-10.
- Lenderink G., Van Meijgaard E. (2008) Increase in hourly precipitation extremes beyond expectations from temperature changes. *Nat. Geosci.*, 1(8): 511-514.
- Liphschitz N., Biger G. (1990) Ancient dominance of the *Quercus calliprinos-Pistacia palaestina* association in Mediterranean Israel. J. Veg. Sci., 1: 67-70.
- Liphschitz N., Lev-Yadun S., Gophna R. (1987) The dominance of *Quercus calliprinos* Webb. (kermes oak) in the Central Coastal Plain of Israel in antiquity. *Isr. Explor. J.*, 37: 43-50.
- Lopez De Heredia U., Carrioon J.S., Jiménez P., Collada C., Gil L. (2007a) Molecular and palaeobotanical evidence for multiple glacial refugia for evergreen oaks on the Iberian Peninsula. *J. Biogeogr.*, 34: 1505-1517.
- Lopez De Heredia U., Jiménez P., Collada C. et al. (2007b) Multi-marker phylogeny of three evergreen oaks reveal vicariant patterns in the Western Mediterranean. *Taxon*, 56: 1209-1220.
- McMillan A. (2012) A GIS approach to palaeovegetation modelling in the Mediterranean: the case study of southwest Turkey. School of Geographical, Earth and Environmental Sciences, University of Birmingham. PhD Thesis.
- Menitsky Y.L. (2005) Oaks of Asia. Enflied, New Hampshire: Science Publishers.
- Michaud H., Lumaret R., Romane F. (1992) Variation in the genetic structure and reproductive biology of holm oak populations. *Vegetatio*, 99/100: 107-113.
- Mossa L. (1990) La vegetazione forestale del campo dunale di Buggerru-Portixeddu (*Sardegna occidentale*). Ann. Bot., 48(7): 291-306.
- Mossa L., Bacchetta G., Brullo S. (1998) Considerazioni tassonomiche sulle querce caducifoglie della Sardegna. *Monti e Boschi*, 2: 41-46.
- Mullaj A., Shehu J., Tan K., Imeraj A. (2010) New records for the Albanian flora. *Botanica Serbica*, 34(2): 163-167.
- Nahal I. (1962) La vegetation du Baer-Bassit et du DJ. Alaouite de Syrie. Webbia, 16(2): 477-641.
- Nakao K., Matsui T., Horikawa M., Tsuyama I., Tanaka N. (2010) Assessing the impact of land use and climate change on the evergreen broad-leaved

species of *Quercus acuta* in Japan. *Plant Ecol.*, 212(2), 229-243.

- Nave Z. (1985) The climax of the Mediterranean maquis-Imagination or reality The Mediterranean maquis and forests in Israel. *ROTEM-Bulletin of the Israel Plant Information Centre*, 18: 14-33.
- Naveh Z. (1990) Ancient man's impact on the Mediterranean landscape in Israel: ecological and evolutionary perspectives. In: Bottema S., Entijes-Neiborg G., Zeist W., Eds., Man's Role in Shaping East Mediterranean Landscape. Balkema, Rotterdam, p. 43-52.
- Naveh Z. (1998) From biodiversity to ecodiversityholistic conservation of the biological and cultural diversity of Mediterranean landscapes. In: Rundel P.W., Montenegro G., Jakstic F.M., Eds. Landscape disturbance and biodiversity in Mediterraneantype ecosystems. Ecological Studies, 136, Springer Verlag, Berlin, p. 127-140.
- Naveh Z., Carmel Y. (2004) The evolution of the cultural Mediterranean landscape in Israel as affected by fire, grazing, and human activities. In: Evolutionary Theory and Processes. Modern Horizons Papers in Honour of Eviatar Nevo. Kluwer Academic Publishers, Dordrecht, p. 337-409.
- Neophytou C., Palli G., Dounavi A., Aravanopoulos F. (2007) Morphological differentiation and hybridization between *Quercus alnifolia* Poech and *Quercus coccifera* L. (Fagaceae) in Cyprus. *Silvae Genet.*, 56: 271-277.
- Neophytou C., Aravanopoulos F.A., Fink S., Dounavi A. (2011). Interfertile oaks in an island environment: II. Limited hybridization *Quercus alnifolia* Poech and *Q. coccifera* L. in a mixed stand. *Eur. J. For. Res.*, 130: 623-635.
- Niinemets U., Diaz-Espejo A., Flexas J., Galmes J., Warren C.R. (2009) Role of mesophyll diffusion conductance in constraining potential photosynthetic productivity in the field. *J. Exp. Bot.*, 60: 2249-2270.
- Nixon K.C. (1993) Infrageneric classification of *Quercus* (Fagaceae) and typification of sectional names. *Ann. sci. for.*, 50: 25-34.
- Ottonello D., Aleo M., Romano S. (1991) La macchia mediterranea a *Quercus calliprinos* Webb di Marausa (TP): un'area da conservare. *Giorn. Bot. HaI.*, 125: 435.
- Ozel N., Kavgaci A., Oner H.H., Akbin G., Altun N. (2012) İzmir ve Manisa çevresindeki kermes meşesi (*Quercus coccifera* L.) çalılıklarının sınıflandırılması ve ekolojik gösterge niteliklerinin belirlenmesi. *Batı*

Akdeniz Ormancılık Araştırma Enstitüsü Dergisi, 13(I): 37-61.

- Ozturk M.A. (1985) Recovery and rehabilitation of Mediterranean type ecosystem. A case study from Turkish maquis. In.: Rapport D., Gudet C.L., Calow P., Eds., Evaluating and NATO-ARW, Springer-Verlag, Berlin, p. 319-332.
- Ozturk M., Seçmen O., Gork G., Kondo K., Segawa M. (1983) Ecological studies of macchia elements in Aegean region of Turkey. Mem. Fac. Integrated Arts and Sci., Hiroshima Univ., Ser. IV. 8: 51-86.
- Ozturk M., Yucel E., Gucel S., Sakcali S., Aksoy A. (2008) Plants as Biomonitors of Trace Elements Pollution in Soil. In: Prasad, M.N.V., Eds., Trace Elements as Contaminants and Nutrients: Consequences in Ecosystems and Human Health. John Wiley and Sons, Inc., Hoboken, N.J., p. 721-742.
- Ozturk M., Dogan Y., Sakcali M.S., Doulis A., Karam F. (2010a) Ecophysiological responses of some maquis (*Ceratonia siliqua* L., *Olea oleaster* Hoffm. & Link, *Pistacia lentiscus* and *Quercus coccifera* L.) plant species to drought in the east Mediterranean ecosystem. J. Environ. Biol., 31: 233-245.
- Ozturk M., Gucel, S., Ozkan, K., Kucuk, M., Saxena, A.K. (2010b) Forests-Forestry-Environment in Turkey. J. Environ. Biol., 31(01/02): 245.
- Ozturk M., Gucel S., Kucuk, M., Sakcali S. (2010c) Forest diversity, climate change and forest fires in the Mediterranean region of Turkey. *J. Environ. Biol.*, 31: 1-9.
- Paffetti D., Vettori C., Giannini R. (2001) Relict populations of *Quercus calliprinos* Webb on Sardinia Island identified by chloroplast DNA sequences. *Forest Genetics*, 8(1): 1-11.
- Palamarev E. (1989) Paleobotanical evidences for the tertiary history and origin of the Mediterranean sclerophyll dendroflora. *Plant Syst. Evol.*, 162: 93-107.
- Paraskevopoulos S.P., Iatrou G.D., Pantis J.D. (1994) Plant growth strategies in evergreen-sclerophyllous shrublands (Maquis) in Central Greece. *Vegetatio*, 115(2): 109-114.
- Pausas J.G., Verdú M. (2005) Plant persistence traits in fire-prone ecosystems of the Mediterranean Basin: A phylogenetic approach. *Oikos*, 109: 196-202.
- Peguero-Pina J.J., Sancho-Knapik D., Morales F., Flexas J., Gil-Pelegrin E. (2009) Differential photosynthetic performance and photoprotection mechanisms of three Mediterranean evergreen oaks under severe

drought stress. Funct. Plant Biol., 36: 453-462.

- Penuelas J., Lloret F., Montoya R. (2001) Severe drought effects on Mediterranean woody flora in Spain. *For. Sci.*, 47: 214-218.
- Pereira J.S., Chaves M.M. (1995) Plant responses to drought under climate change in Mediterranean-type ecosystems. In: Moreno J.M., Oechel, W.C, Eds., Global change and Mediterranean-type ecosystems. *Ecological Study*, Springer, New York, 117: 140-160.
- Perevolotsky A. (2005) Integrating landscape ecology in the conservation of Mediterranean ecosystems: The Israeli experience. *Israel J. Plant Sci.*, 53: 203-213.
- Perevolotsky A., Haimov Y. (1992) The effect of thinning and goat browsing on the structure and development of Mediterranean woodland in Israel. *For. Ecol. Manag.*, 49: 61-74.
- Pignatti S. (1982) Flora d'Italia. Vol. I, Edagricole Bologna.
- Polunin O., Huxley A. (1967) Flowers of the Mediterranean. Chattu and Windus, London, p. 145.
- Provan J., Soranzo N., Wilson N.J., Goldstein D.B., Powell W. (1999) A low mutation rate for chloroplast microsatellites. *Genetics*, 153: 943-947.
- Quezel P. (1985) Definition of The Mediterranean Region and the origin of its flora. In. Campo, C., Ed., Plant conservation in the Mediterranean Area, 9-24, W. Junk, Doderecht.
- Quézel P. (2005) Large-scale Post-glacial Distribution of Vegetation Structures in the Mediterranean Region. In: Mazzoneli S., Di Pasquale G., Mulligan M., Di Martino P., Rego F., Eds., Recent Dynamics of the Mediterranean Vegetation and Landscape. p. 3-13. Chichester: John Wiley & Sons.
- Quézel P., Médail F. (2003) Ecologie et Biogéographie des forêts du bassin méditerranéen. Elsevier, Paris.
- Sakcalı M.S., Ozturk M. (2004) Eco-physiological behaviour of some mediterranean plants as suitable candidates for reclamation of degraded areas. *J. Arid Environ.*, 57: 141-153.
- Sakcalı M.S., Bahadir H., Ozturk M. (2008) Ecophysiology of *Capparis spinosa* L.: A plant suitable for combating desertification. *Pak. J. Bot.*, 40: 1481-1486.
- Schiebel V. (2013) Environmental response on climate impact in the levant during the last glacial and holocene and their role in the origin of agriculture. Ph.D. dissertation, University of Bonn, Bonn.
- Schwab M.J., Neumann F., Litt T., Negendank

J.F.W., Stein M. (2004) Holocene palaeoecology of the Golan Heights (Near East: investigation of lacustrine sediments from Birkat Ram Crater Lake). *Quaternary Sci. Rev.*, 23: 1723-1731.

- Sheikh K.H. (1976) Variations in leaf hydration and stomatal openings of some maquis in response to changes in some environmental factors. In: Vardar Y., Sheikh K.H., Ozturk M., Eds., Proceedings of the third mediterranean plant physiology meeting. Izmir, Ege University Press, p. 24-36.
- Simeone M.C., Grimm G.W., Papini A., Vessella F., Cardoni S., Tordoni E., Piredda R., Franc A., Denk T. (2016) Plastome data reveal multiple geographic origins of *Quercus* Group Ilex. *Peer J*, 4, e1897: 1-31.
- Simeone M.C., Piredda R., Papini A., Vessella F., Schirone B. (2013) Application of plastid and nuclear markers to DNA barcoding of Euro-Mediterranean oaks (*Quercus*, Fagaceae): problems, prospects and phylogenetic implications. *Bot. J. Linn. Soc.*, 172(4): 478-499.
- Stephan J., Chayban L., Vessella F. (2016) Abiotic factors affecting the distribution of oaks in Lebanon. *Turk J. Bot.*, 40(6): 595-609.
- Tavşanoğlu Ç., Coşkun U. (2009) Köprülü Kanyon Milli Parkı'nda (Antalya) bulunan bazı maki türlerinin gelişme formu üzerinde keçi otlamasının etkisi. *Ekoloji*, 18 (72): 74-80.
- Tenhunen J.D., Lange O.L., Harley P.C., Beyschlag W., Meyer A. (1985) Limitations due to water stress on leaf net photosynthesis of *Quercus coccifera* in the Portuguese evergreen scrub. *Oecologia*, 67: 23-30.
- Timm A., Buse J., Dayan T., Härdtle W., Levanony T., Assmann T. (2009). At the interface of historical and present day ecology: ground beetles in woodlands and open habitats in Upper Galilee (Israel) (Coleoptera: Carabidae). *Zool. Middle East*, 47: 93-104.
- Toumi L., Lumaret R. (2010) Genetic variation and evolutionary history of holly oak: a circum-Mediterranean species-complex [*Quercus coccifera L./Q. calliprinos* (Webb) Holmboe, Fagaceae]. *Plant Systematics and Evolution*, 290(1-4): 159-171.
- Tsiourlis G., Konstantinidis P., Xofis P. (2009) Syntaxonomy and Synecology of *Quercus coccifera* Mediterranean Shrublands in Greece. *J. Plant Biol.*, 52: 433-447.
- Tutin T.G., Burges N.A., Chater A.O., Edmonson J.R., Heywood V.H., Moore D.M. et al. (1993) Flora Europaea. Cambridge University Press, London.
- Tutin T.G., Heywood V.H., Burges N.A., Valentine D.H.,

Walters S.M., Webb D.A. (2010) Flora Europaea. Vol. 1, second edition. Cambridge University Press, London.

- Uğurlu E., Oldeland J. (2012) Species response curves of oak species along climatic gradients in Turkey. *Int. J. Biometeorol*, 56: 85-93.
- Van Zeist W, Baruch U., Bottema S. (2009) Holocene Palaeoecology of the Hula Area, Northeastern Israel.In: Kaptijn K., Petit L.P., Eds., A Timeless Vale, Archaeological and related essays on the Jordan Valley. Leiden: Leiden University Press, p. 29-64.
- Vardar Y., Ozturk A.M. (1972) Relative transpiration of the old and young leaves of some macchia elements. *Phyton*, 14: 251-262.
- Varela M.C. (2001) Country report: Portugal. P. 52-56 In: Compil. Borelli S., Varela M.C., Eds., Mediterranean Oaks Network. Report of the first meeting. 12-14 October 2000, Antalya, Turkey. International Plant Genetic Resources Institute, Rome, Italy, p. 6-14.
- Velitzelos D., Bouchal J.M., Denk T. (2014) Review of the Cenozoic floras and vegetation of Greece. *Rev. Palaeobot. Palynol.*, 204: 56-117.
- Vilagrosa A. (2002) Estrategias de resistencia al déficit hídrico en Pistacia lentiscus L. y *Quercus coccifera* L. PhD Thesis; Departamento de Ecología, Universidad de Alicante; Alicante; Spain
- Villar-Salvador P., Castro-Diez P., Pérez-Rontomé C., Montserrat-Marti G. (1997). Stem xylem features in three *Quercus* (Fagaceae) species along a climatic gradient in NE Spain. Trees, 12: 90-96.
- Westphal C., Von Oheimb G., Meyer-Grünefeld M., Tremer N., Härdtle W., Levanony T., Dayan T., Assmanna T. (2009). Ya'ar Bar'am-An old *Quercus calliprinos* forest of high nature conservation value in the Mediterranean region of Israel. *Isr. J. Plant Sci.*, 57: 13-23.
- Williams J.H., Boecklen W.J., Howard D.J. (2001) Reproductive processes in two oak (*Quercus*) contact zones with different levels of hybridization. *Heredity*, 87: 680-690.
- Zedan H. (2002) Foreword: The Global Strategy for Plant Conservation. The Secretariat of the Convention on Biological Diversity, Quebec, Canada.
- Zohary M. (1960) The maquis of Quercus calliprinos in Israel and Jordan. Bull. Res. Counc. Isr., 9D: 51-72.
- Zohary M. (1961) On the oak species of the Middle East. Bull. Res. Counc. Isr., 9(4): 161-186.
- Zohary M. (1962) Plant life of Palestine, Israel and Jordan. Ronald Press, New York, 262 p.
- Zohary M. (1973) Geobotanical foundation of the

Middle East. Gustav Fischer Verlag, Stuttgart, 738 p.

Zohary M., Feinbrun-Dothan N. (1966) Flora Palestina (Volume 1). Jerusalem: The Israel Academy of Sciences and Humanities, Jerusalem.

Aralıq dənizi hövzəsində iqlim dəyişikliyi ssenariləri kontekstində *Quercus coccifera* (= Q. *Calliprinos*) rolu

Munir Öztürk

Ətraf Mühitin Tədqiqatları və Botanika Mərkəzi, Ege Universiteti, İzmir, Türkiyə

Volkan Altay

Hatay Mustafa Kamal Universiteti, Biologiya Fakültəsi, Hatay, Türkiyə

Hazırkı kermes palıd cinsi kompleksi gədim nəslin nümayəndəsidir. O, Aralıq dənizi ərazisində müasir Aralıq dənizi iqlimi formalaşmazdan çox öncə məskunlaşmışdır. İlex qrupunun ən çox yayılmış növü olan Quercus coccifera (= Q. calliprinos) bütün Aralıq dənizi bölgəsində rast gəlinir. Bu bölgənin iqlimi Q. coccifera növünün indiki vəziyyətini başa düşmək üçün əsas ola bilər. Qərbi və şərqi Q. coccifera qruplarının müasir iqlim şəraitinə uyğunlaşmaları çox fərqlidir, belə ki, Aralıq dənizinin qərbində yayılma sahil zonası, aşağı rütubət və yaxud mövsümü quraqlıq və subrütubət zonası ilə məhdudlaşır. Bütün Aralıq dənizi hövzəsi üçün gələcək mümkün ssenarilər orta temperaturun artmasına və illik yağıntıların əhəmiyyətli dərəcədə azalmasına işarə edir ki, bu da bu növ üçün problemlər yarada bilər.

Açar sözlər: adaptasiya, iqlim dəyişikliyi, yayılma, bioloji müxtəliflik, kermes palıdı

Роль *Quercus coccifera* (= *Q. calliprinos*) в свете сценариев изменения климата в Средиземноморс-ком бассейне

Мунир Озтюрк

Центр экологических исследований и ботаники, Эгейский университет, Измир, Турция

Волкан Алтай

Университет Хатай Мустафа Кемаль, Биологический факультет, Хатай, Турки

Вид дуб кермесовый является потомком древней линии. Он колонизировал Средиземноморье задолго до того, как стал преобладал современный средиземноморский климат. Самый распространенный вид группы Ilex - *Quercus coccifera* (= *Q. calliprinos*), встречается во всем Средиземноморском регионе. Климатическая история этого региона может стать ключом к пониманию нынешнего положения Q. coccifera. Современные климатические адаптации западной и восточной групп Q. coccifera сильно различаются, так как в западном Средиземноморье их распространение ограничено прибрежной зоной или низко-влажной или субгумидной зоной с сезонной засушливостью. Все будущие сценарии для

всего Средиземноморского бассейна указывают на повышение средней температуры и значительное уменьшение годового количества осадков, что может создать проблемой для этого вида.

Ключевые слова: адаптация, изменение климата, распространения, биологическое разнообраие, дуб кермесовый