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Article *in* Zoology in the Middle East · January 2012

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Saproxylic beetles on old hollow oaks (*Quercus* spp.) in a small isolated area in southern Turkey

(Insecta: Coleoptera)

Erol Atay, Nicklas Jansson, Tolga Gürkan

Abstract. Old oaks (*Quercus* spp.) and their fauna are rare and threatened all over Europe including Turkey. Preliminary results are presented from a study in Turkey using window traps in a cemetery with old hollow oaks. In total, 87 beetle species were identified and the number of beetle species was the highest from the families Elateridae, Anobiidae and Tenebrionidae. Several of the species are considered to be very rare in Europe and one of the species will be described as new to science (*Mycetochara* sp.). Species composition was surprisingly high when compared to similar studies in the region.

Key words. Coleoptera, saproxylic, oak, *Quercus,* biodiversity, window trap, pitfall trap.

Introduction

Saproxylic insects associated with old trees are seriously threatened in Europe, because their habitat has severely decreased (MCLEAN & SPEIGHT 1993). In Sweden, for example, old oaks (*Quercus robur* L.) harbour a very diverse fauna of beetles (PALM 1959), and a large proportion of the species are rare and red-listed saproxylic insect species (JONSELL et al. 1998, RANIUS & JANSSON 2000). These insects live in fungal fruit bodies, dead wood outside the tree (in branches or parts of the trunk) or inside the tree in hollows (SPEIGHT 1989, DAJOZ 2000, GROVE 2002).

Oaks (*Quercus* spp.) can be very large and old. There are examples of oaks nearly 1000 years old and with a breast height circumference of 14 metres. When oaks age, hollows in the trunks fill with wood mould, i.e. the wood becomes softened by decay fungi, often combined with remains from animal nests, insect fragments and droppings from insect larvae. Trunk hollows with wood mould harbour a specialized fauna, mainly consisting of beetles and flies (DAJOZ 1980). The beetle fauna in tree hollows has been of interest to entomologists for a long time, but only recently using quantitative methods (RANIUS & JANSSON 2002, BUSE et al. 2008, SVERDRUP-THYGESON et al. 2010, GOUIX & BRUSTEL 2011). Many insect species dependent on large, old and hollow trees have survived in small remnant woodlands of ancient trees, often in the agricultural landscape. Many of these areas also have a long historical continuity of old trees, which is important for a rich saproxylic fauna (SPEIGHT 1989).

The dead wood substrate found in hollow trunks of old living trees can remain for decades or perhaps even centuries (RANIUS & HEDIN 2001). It has, therefore, been suggested that beetles living in hollow trees have a low dispersal capacity (MCLEAN & SPEIGHT 1993, RANIUS & HEDIN 2001) and are sensitive to reductions in the number of suitable trees in the landscape.

Zoology in the Middle East 57, 2012: 105-114.
ISSN 0939-7140 © Kasparek Verlag, Heidelberg

Oak (*Quercus* spp.) habitats in the Mediterranean region, including Turkey, are today only a fragment of the original extent. Many remnants of forests that survived are now grazed, but differ in size as well as in structure and shape, depending on the current land-use management (GROVE & RACKHAM 2003, WESTPHAL et al. 2009). In Turkey, old oaks are cut not only for firewood but also to make way for the transformation of the oak habitats to plantations of mainly pine (*Pinus brutia* Ten.), but at higher altitudes also cedar (*Cedrus libani* A. Rich.).

Although the Mediterranean region is considered to be a biodiversity hotspot (MEDAIL & QUEZEL 1999, MYERS et al. 2000), only a few systematic studies report on the biodiversity of beetles in Mediterranean tree habitats (e.g. BRIN & BRUSTEL 2006, BUSE et al. 2008, JANSSON & COŞKUN 2008, DA SILVA et al. 2009). Only recently have studies of old oaks (*Quercus* spp.) in Turkey reported a rich fauna, with many new species to science (SCHILLHAMMER et al. 2007, NOVAK et al. 2011, PLATIA et al. 2011, SAMA et al. 2011). Our study aimed to increase the knowledge of the beetle fauna on old oaks in Turkey and to discuss the value of this kind of habitat for the fauna.

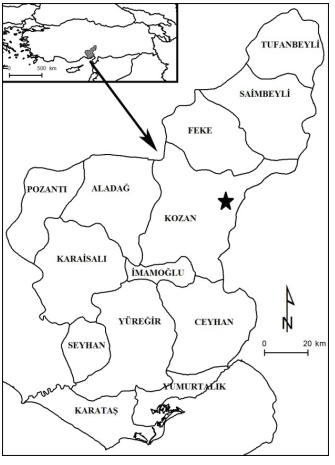

Fig. 1. The position of the studied site in southern Turkey.

Material and methods

Study area and tree characteristics. During the season 2009 we collected saproxylic beetles near Kozan village (37°31'N, 35°54'E) in the province of Adana in southern Turkey (Fig.1). The area studied is a 3 ha large cemetery at 400 m alt. with approximately 50 old oaks. All trees studied were old, hollow oaks mainly of *Quercus cerris* (L.) and *Quercus infectoria* (Olivier), but also with some *Quercus coccifera* (L.) (Fig. 2). The two last mentioned species are evergreen. In total, 13 oaks were studied. The ages of the examined trees are not known, but, in a study of hollow oaks (*Quercus robur*, N=73) of similar size and hollow stage in Sweden, ages varied from 214 to 499 years, when calculated from the most probable growth rate from dendrochronology analysis (BERG 2006). Even if the growth rate differs among different species of oaks (*Quercus* spp.) and in different climatic zones, it shows that hollow oaks often are very old.

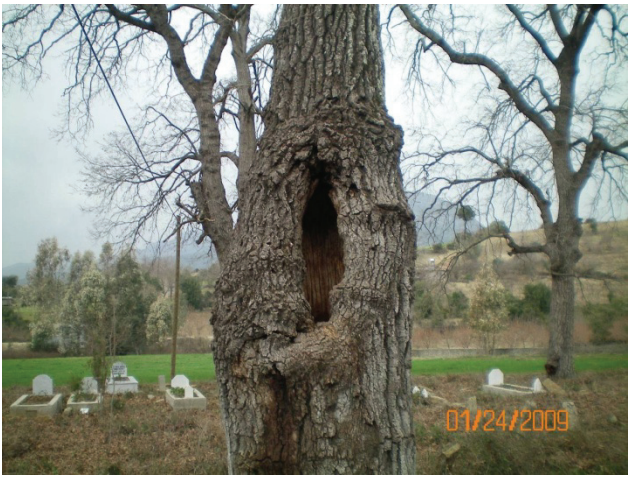

Fig. 2. One of the old oaks studied near Kozan in southern Turkey.

Sampling methods. The beetles were collected with window traps. The window traps used consisted of a 30x60 cm wide transparent plastic plate with a tray underneath (JANSSON & LUNDBERG 2000). They were placed near the trunk (<1 m), beside or in front of a cavity entrance. Their positions were 2.0-3.0 m from the ground, depending on where the cavity entrance was situated on the studied tree. The traps were partially (about ½ of the volume) filled with ethylene glycol and water (50:50 v/v), with some detergent added to reduce surface tension. The traps were placed in the trees at the end of April, were emptied every third week, and were eventually removed in the middle of August. As the sampling did not cover the entire flight periods for all species, some early and late species may not be represented in the material. The material is deposited in the Biology Department of Mustafa Kemal Üniversity.

Analyses. Most of the beetles were identified by experts for individual groups (see acknowledgements). Due to the limited time available and difficulties in identification, we concentrated on the identification of beetles in 18 families known to consist of many saproxylic species. These represent 60% of the collected material. Estimation of the species richness was computed using EstimateS (COLWELL 2009).

Results

In total, 87 species of beetle from 18 families were identified. Most of the species live on old oaks and are saproxylic. The number of beetle species found at each tree varied from 7 to 28 (Table 1).

The number of beetle species was the highest from the families Elateridae, Anobiidae and Tenebrionidae. One of the species found is new to science (*Mycetochara* sp.). The dominating species were *Cryptarcha bifasciata* (Baudi, 1870) (Nitidulidae), *Mycetochara* sp. and *Hymenalia morio* (Redtenbacher, 1849) (Tenebrionidae).

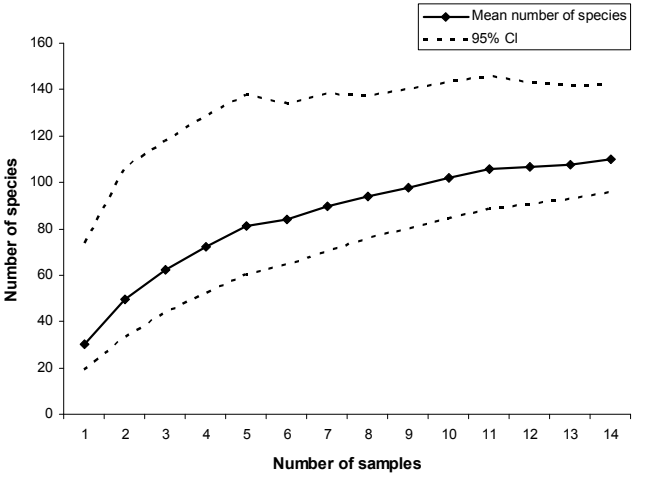

Fig. 3. A rarefaction curve showing the estimated species richness (Chao 1) for the 18 studied beetle families on old oak in a cemetery in southern Turkey.

The rarefaction analysis (Chao 1) indicates that we have found between 60 and 89% of the species of the families studied in the area. The shape of the curve also indicates that our study has identified a large proportion of the species from the beetle families studied which are likely to exist in the study area (Fig. 3). The overlap of the found species with another study (JANSSON & COŞKUN 2008), in the same habitat in the region, was only 29% (35/121). The smallest overlap was found in the families Tenebrionidae, Cleridae and Histeridae.

Discussion

Even if only a proportion of the beetle material has been identified, the results point to Turkey as being important also for the beetle fauna on oaks. Many species rare in Europe were found, and three of the beetle species can be found on the European Red List (NIETO & ALEXANDER 2010). These species are the Longhorn Beetle *Cerambyx dux* (Faldermann), the Click Beetle *Ectamenogonus montandoni* (Buysson) and the Violet Rose Chafer *Protaetia mirifica* (Mulsant) (see also Table 1), which is a very rare species and only known from a few sites in the whole Mediteranean region. These results make the oak habitat in Turkey of high value for future scientific research.

The landcape surrounding the studied area consists of other habitat types like pine plantations, so old hollow trees are rare. The small size of the area studied and its isolation from other areas with a similar habitat may be a problem for some of the species found. BERGMAN et al. (2012) showed that some species living in hollow oaks in Sweden needed a high density of hollow oaks on both a fine and a broad scale (100 and 859 metres radii).

Some other smaller studies on saproxylic beetles on old hollow oaks have recently been conducted in southern Turkey (e.g. 300-900 km west of our study site). But they each only cover one beetle family (e.g. Leiodidae, Staphyllinidae (*Hesperus*), Tenebrionidae

Table 1. The identified beetle species from old oaks in southern Turkey. Data from Kızılen and Derbent from JANSSON & COŞKUN (2008).

Species	Kozan	Kızılen	Derbent
Anobiidae			
Caenocara affine (Sturm)	2	x	
Dignomus irroratus (Kiesenwetter)			x
Dorcatoma ambjoerni (Baranowski)	22		
Dorcatoma cf. agenjoi (Espanol)	2		
Dorcatoma chrysomelina (Sturm)	2	x	x
Dorcatoma setosella (Mulsant & Rey)		x	
Dorcatoma spp.	13	x	x
Falsogastrallus unistriatus (Zoufal)	2	x	x
Hedobia pubescens (Olivier)			x
Lasioderma serricorne (Fabricius)		x	
Mesothes cylindricus (Germar)	1		
Mesothes granulatus (Pic)	3	x	x
Oligomerus ptilinoides (Wollaston)		x	x
Ptinus basilanus (Pic)		x	x
Ptinus bicinctus (Sturm)			x
Ptinus bidens (Olivier)		x	x
Ptinus bruchi (Pic)			x
Ptinus calcarifer (Reitter)			x
Ptinus diversipennis (Pic)	1		
Ptinus frivaldszkyi (Reitter)	2	x	x
Ptinus spitzyi (Villa)		x	
Ptinus variegatus (Rossi)	2	x	x
Stagetus byrrhoides (Mulsant & Rey)		x	
Stagetus dorcatomides (Brenske & Reitter)	2		x
Stagetus elongatus (Mulsant & Rey)	14	x	x
Stagetus franzi (Espanol)	16	x	x
Stagetus sp	2		
Stegobium paniceum (Linnaeus)	1		
Xyletinus laticollis (Duftschmid)		x	x
Buprestidae			
Achmaeodera sexicola (Spinola)	1		
Agrilus graminis (Kiesenwetter)	4		
Agrilus laticornis (Illiger)	1		
Agrilus relegatus alexeevi (Bellamy)	8		
Anthaxia millefolii (Fabricius)	2		
Nalanda fulgidicollis (Lucas)	2		
Cerambycidae			
Cerambyx dux (Faldermann)	2		
Chlorphorus nivipictus (Kraatz)	1		
Ergates gaillardoti (Chevrolat)	1		
Exocentrus adspersus (Mulsant)	2		
Vadonia soror (Holzschuh)	2		
Cerylonidae			
Philothermus semistriatus (Perris)	1		
Cleridae			
Korynetes caeruleus (De Geer)	4	x	x
Opilo taeniatus (Klug)			x
Tilloidea unifasciata (Fabricius)			x
Trichodes holtzi (Hintz)		x	x
Trichodes suspectus (Escherich)			x

Species	Kozan	Kızılen	Derbent
Colydidae			
Colobicus hirtus (Rossi)	1		
Dermestidae			
Anthrenus delicatus (Kiesenwetter)	4	x	x
Anthrenus flavidus (Solskij)			x
Anthrenus scrophulariae (Linnaeus)	4	x	x
Anthrenus sp	1		
Anthrenus verbasci (Linnaeus)	1	x	
Attagenus brunneus (Faldermann)		x	
Attagenus quadrimaculatus (Kraatz)		x	x
Attagenus unicolor (Brahm)		x	
Ctesias maculifasciata (Reitter)	1	x	
Ctesias syriaca (Ganglbauer)	1	x	x
Dermestes erichsoni (Ganglbauer)		x	
Dermestes undulatus (Brahm)	1		
Globicornis picta (Küster)		x	x
Megatoma ruficornis (Aubé)			x
Orphilus niger (Rossi)	1		
Trogoderma glabrum (Herbst)	1	x	x
Elateridae			
Adelocera pygmaea (Baudi)		x	x
Cardiophorus kindermanni (Candèze)	12	x	x
Drapetes mordelloides (Host)	2		
Ectamenogonus montandoni (Buysson)	1	x	
Elathous rufobasalis (Wurst)	2		
Haterumelater fulvago (Marseul)	4	x	
Ischnodes sanguinicollis (Panzer)		x	x
Lacon ladae (Mertlik & Dusanek)	1		x
Limoniscus violaceus (Ph.W.Müller)		x	x
Melanotus crassicollis (Erichson)	2		
Melanotus dichrous (Erichson)	1		
Melanotus fraseri (Platia & Schimmel)			x
Melanotus fuscipes (Gyllenhal)	2	x	x
Mulsantheus manuelae (Platia & Gudenzi)		x	x
Nothodes parvalus (Panzer)	4	x	x
Peripontius terminatus (Erichson)			x
Pittonotus theseus (Germar)	27	x	x
Reitterelater dubius (Platia & Cate)	2	x	x
Histeridae			
Carcinops pumilio (Erichson)		x	
Dendrophilus punctatus championi (Lewis)		x	x
Epierus comptus (Erichson)	1		
Gnathoncus nannitensis (Marseul)	1		
Merohister ariasi (Marseul)	9	x	x
Paromalus simplicistrius (Schmidt)		x	x
Platylomalus gardineri (Scott)	1		
Platysoma compressum (Herbst)	1		
Platysoma inexpectatum (Lackner)	1		
Lucanidae			
Dorcus peyroni (Reiche & Saulcy)	1	x	
Dorcus parallelopipedus (Linnaeus)	3	x	x
Malachidae			
Troglops semiinermis (Wittmer)	1		

Species	Kozan	Kızılen	Derbent
Melandryidae			
Orchesia micans (Panzer)	2	x	x
Mycetophagidae			
Mycetophagus quadriguttatus (Müller)	1	x	x
Nitidulidae			
Carpophilus mutilatus (Erichson)	7		
Cryptarcha bifasciata (Baudi)	131		
Soronia oblonga (Brisout)	12		
Oedemeridae			
Ischnomera fuscipennis (Svihla)	1		
Scarabaeidae			
Oryctes nasicornis (Linnaeus)	1		
Propomacrus bimucronatus (Pallas)		x	
Protaetia angustata (Germar)	1		
Protaetia cuprea (Fabricius)	2		
Protaetia mirifica (Mulsant)	6		x
Protaetia speciosa (Adams)	2	x	x
*Trox perrisi (*Fairmaire)			x
Scolytidae			
Xyleborus monographus (Fabricius)	2		
Tenebrionidae			
Allecula oronthea (Baudi di Selve)	32		
Allecula striata (Thomson)		x	x
Alphitophagus bifasciatus (Say)		x	
Blaps tibialis (Reiche)		x	
Cylindronotus incultus (Allard)		x	
Diaperis boleti (Linnaeus)	2		x
Entomogonus peyroni (Reiche)	1		
Helops cyanipes (Allard)			x
Hymenalia atronitens (Fairmaire)	1		
Hymenalia graeca (Seidlitz)	3		
Hymenalia morio (Redtenbacher)	40	x	x
Hymenalia sp	17	x	x
Isomira nitidula (Kiesenwetter)	16		
Mycetochara graciliformis (Reitter)		x	
Mycetochara laticornis (Reitter)	1		
Mycetochara linearis (Illiger)		x	x
Mycetochara n. sp.	45		
Mycetochara quadrimaculatus (Latreille)		x	x
Mycetochara sulcipennis (Reitter)	1	x	x
Mycetocharina orientalis (Faust)			x
Neatus inaequalis (Reitter)		x	x
Odocnemis dasypus (Küster)		x	
Opatroides judaeus (Piochard de la Brûlerie)	2		
Palorus depressus (Fabricius)		x	x
Pentaphyllus testaceus (Hellwig)			x
Prionychus ater (Fabricius)			x
Prionychus cisteloides (Seidlitz)	1		
Prionychus dellagrangei (Fairmaire)			x
Prionychus nitidissimus (Pic)	4		
Prionychus sp	1		
Probaticus bodemeyeri (Reitter)			x
Pseudocistela ceramboides (Linnaeus)		x	
Tenebrio obscurus (Fabricius)		x	x

(*Allecula*), Elateridae and Cerambycidae). In total, 20 species new to science were described in these studies (SCHILLHAMMER et al. 2007, NOVAK et al. 2011, PLATIA et al. 2011, SAMA et al. 2011), showing how poorly studied this habitat is in Turkey. None of these species was found in our study. The only larger published study on the beetle fauna on old oaks in Turkey is by JANSSON & COŞKUN (2008). They conducted their study at two sites with old oaks 200 km SW from our study site. If we compare the number of species from the families identified in both studies (i.e. 10, Table 1), it is very similar (66-68), but the reason for the small overlap (29%) may have several explanations. One parameter explaining this large difference in species composition could have been the composition of oak species, but the dominant species at the other studied sites were also *Quercus cerris* and *Q. infectoria*.

A beetle species in hollow trees in Turkey and found in the study by JANSSON & COŞKUN (2008) and TEZCAN & PEHLIVAN (2001), and which we expected to find in our study but did not, is the large Scarabaeid beetle *Propomacrus bimucronatus* (Pallas). A related beetle from the family Euchiridae, of similar size, living in the same microhabitat and with a similar biology, is *Osmoderma eremita* (L.). RANIUS (2002) found that *O. eremita* had a positive effect on the species richness of other saproxylic beetles in the cavities on old oaks in Sweden. JÖNSSON et al. (2004) estimated the amount of nitrogen and phosphorus in wood mould and compared the coarse fraction which consists of the frass of *O. eremita* with the finer fraction of wood mould, and found that the nutrient richness was higher in the frass. *O. eremita* larvae have a fermentation chamber that harbours nitrogen fixing bacteria. As the levels of absorbable nitrogen are a limiting factor in insect growth, an increase in nutrient richness is one of several possible explanations why the species richness of saproxylic beetles is higher in hollow oaks where *O. eremita* is present compared to similar trees where the beetle is absent (RANIUS 2002). If *Propomacrus bimucronatus* has a similar effect to *O. eremita* on the other species, this might be a possible explanation for the low similarity between our species composition and that of JANSSON & COŞKUN (2008). On the other hand, it has recently been shown that other cetoniid beetles have a similar effect on the nutrient richness as does *Osmoderma eremita* (MICO et al. 2011).

The most probable parameter explaining the difference in species composition in our case is the altitude, as the other studied sites were situated in an altitude of 1100-1400 m and ours at only 400 m. This difference in altitude probably causes a large difference in both summer and winter temperatures, but the length of the season will also differ.

Because of the difference in species composition in different situations (e.g. temperature, precipitation, *Quercus* species), and because of the small area left of the habitat with old oaks and the high rate at which it is being transformed into other types of forest, there is a need to protect some of the last remaining oak areas to prevent many of the unique and often endemic species (SCHILLHAMMER et al. 2007, NOVAK et al. 2011, PLATIA et al. 2011, SAMA et al. 2011) from going extinct in Turkey.

Patches with old oaks in the landscape are probably also positive for the surrounding productive forests. The predators in the oak forests, such as woodpeckers, parasitic wasps and beetles like *Calosoma sycophanta* (Weber, 1881), can help in regulating the pest species in plantations of pine and cedar, for instance (KANAT & ÖZBOLAT 2006). But further studies in this field are needed.

Acknowledgements. We want to thank Paolo AUDISIO, Marco BOLOGNA, Boris BÜCHE, Robert CONSTANTIN, Michael EIFLER, Julio FERRER, Roland GERSTMEIER, Jiri HAVA, Marcin KADEJ, Bernard KLAUSNITZER, Ralf KLINGER, Sergey KURBATOV, Georgy LYUBARSKI, Slawomir MAZUR, Manfred NIEHUIS, Nikolay NIKITSKY, Vladimir NOVAK, Giuseppe PLATIA, Gianfranco SAMA and Pierre-Hubert TAUZIN for help with determination of parts of the collected beetle material. We would also like to thank Beyhan ALTINTAŞ for help and information in making it possible to conduct the field work, and Vikki BENGTSSON for reading and editing the English in this paper. Some of the work has been funded through the ERASMUS exchange program and Swedish WWF.

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