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Insect Species Damaging Industrial Wood in Western Black Sea Region of Turkey

Vrste kukaca koje oštećuju industrijsko drvo u Zapadnoj crnomorskoj regiji u Turskoj

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ABSTRACT • *Insect species collected in log depots in Western Black Sea Region of Turkey were identified. The study covered two years, 2015 and 2016, in 21 log depots in seven provinces (Duzce, Bolu, Zonguldak, Bartin, Karabuk, Kastamonu and Sinop). The study area was divided into three sub regions and each sub region was analyzed for insect species, their prevalence and intensities. Overall, four orders, 22 families, 74 genera and 57 species were described in log depots of the study area. Sub region 1 (Düzce-Bolu) showed the highest diversity in terms of insect species and sub region 2 (Zonguldak-Bartin) had the lowest diversity. Dorcus parallelipipedus Linnaeus, 1758 (Coleoptera: Lucanidae) and Rhagium inquisitor Linnaeus, 1758 (Coleoptera: Cerambycidae) were found in all provinces studied. Based on wood species analysis, Scots pine wood had the highest diversity in insect species, followed by fir, oak and beech. The study also described some important wood-destroying insect species from the families Anobiidae, Buprestidae and Cerambycidae. Buprestis dalmatina (Mannerheim, 1837) (Coleoptera: Buprestidae), Leptura aurulenta (Fabricius, 1792) (Coleoptera: Cerambycidae) and Stictoleptura scutellata (Fabricius, 1781) (Coleoptera: Cerambycidae), all wood-destroying insect species, were identified for the first time in the Western Black Sea Region of Turkey.*

Keywords: *log depots, Turkey, Western Black Sea Region, wood-destroying insects, wood species*

SAŽETAK • *U sklopu istraživanja identificirane su vrste kukaca koje su prikupljene na stovarištima trupaca u Zapadnoj crnomorskoj regiji u Turskoj. Studija se provodila tijekom dvije godine, 2015. i 2016., na 21 stovarištu u sedam pokrajina (Duzce, Bolu, Zonguldak, Bartin, Karabuk, Kastamonu and Sinop). Područje istraživanja bilo je podijeljeno u tri podregije u kojima su analizirane vrste kukaca, njihova prevalencija i intenzitet. U skladištima trupaca na istraživanom su području ukupno opisana četiri reda, 22 porodice, 74 roda i 57 vrsta kukaca. U podregiji 1. (Düzce-Bolu) primijećena je najveća raznolikost vrsta kukaca, a u podregiji 2. (Zonguldak-Bartin) zabilježena je najmanja raznolikost. U svim istraživanim pokrajinama pronađeni su Dorcus parallelipipedus Linnaeus, 1758 (Coleoptera: Lucanidae) i Rhagium inquisitor Linnaeus, 1758 (Coleoptera: Cerambycidae). Na temelju analize različitih vrsta drva zaključeno je da je borovina imala najveću raznolikost vrsta kukaca, a slijedile su jelovina, hrastovina i bukovina. U studiji su također opisane neke važne vrste kukaca koji razaraju drvo, a pripadaju porodicama Anobiidae, Buprestidae and Cerambycidae. Kukci vrsta Buprestis dalmatina (Mannerheim, 1837) (Coleoptera: Buprestidae), Leptura aurulenta (Fabricius, 1792) (Coleoptera: Cerambycidae) i Stictoleptura scutellata (Fabricius, 1781) (Coleoptera: Cerambycidae) također razaraju drvo i prvi su put zabilježeni u Zapadnoj crnomorskoj regiji u Turskoj.*

Ključne riječi: *stovarište trupaca, Turska, Zapadna crnomorska regija, kukci koji razaraju drvo, vrste drva*

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1 INTRODUCTION
1. UVOD

Trees and forests, which are essential for the future of human kind, are under threat of many pest species. Among them, insects can be considered the most important. Insects, with the greatest number of species on earth, either have contact with living trees or during the service life of forest product after harvest. These insect species consume wood as food sources or use it as shelter for their larvae. As a result, they can reduce physical, chemical and technological properties of wood within very short time. They cause tremendous economic loss if the necessary precautions are not taken. Each year, the loss of about 500 million USD is reported due to activities of insects, fungi and marine organisms in US alone (FAO, 2010a). Furthermore, each year plants produced on about 35 million ha worldwide are damaged by insects (FAO, 2010b).

Coleoptera can be considered as one of the most important insect orders. The Coleopteran insects feed on almost all plant species and their different parts (Lodos and Tezcan, 1995). They are often found in wood. The most important wood-damaging insect families of this order are Anobiidae, Buprestidae, Cerambycidae, Curculionidae, Elateridae, Lucanidae, Scarabaeidae, Curculionidae/Scolytinae, and Tenebrionidae.

Members of Anobiidae, Buprestidae (Çanakçıoğlu and Mol, 1998; Kaygın, 2007), Cerambycidae and Curculionidae (Brockerhoff *et al*., 2006) are considered as the most invasive species of wood. One fifth of Cerambycids are somewhat related to the timber industry or wood species used in timber industry (Hellrigl, 1974). They are extremely harmful to barked softwood and hardwood logs in field and sawmill depots (Komut *et al*., 2010). Insect from this family can be found on almost all tree species (Gokturk, 2002). It was reported recently that populations of insects from the Cerambycidae and other saproxylic beetles has been decreased (Nieto and Alexander, 2010).

Harvested logs are transferred and stockpiled in field depots until sold and shipped to buyers. This raw material is prone to insect and fungal attack, and its economic value of wood and efficiency of the wood industry are significantly reduced (Komut *et al*., 2010).

The Western Black Sea Region of Turkey has an important role in the country's industrial wood production. The Western Black Sea Region covers 33.764 km^2, 27.6 % of the whole Black Sea Region and 4.3 % of the country. According to the General Directory of Forestry, in Turkey a total of 21.537.091 ha is covered with forest land. An important portion of the forest land, about 13 % (2.441.699 ha), lies in the Western Black Sea Region (GDF, 2012).

As of 2012, 2.735.000 m^3 of softwood and 4.190.000 m^3 of hardwood were produced from this region. This amount accounts for 31 % of the industrial wood production of Turkey, which is around 13.400.000 m^3 (GDF, 2012). In addition, saw mill industry, wood-based panel production and furniture industry have been actively established in this region, accounting for 14, 10, 14, 12, 27, 17 and 7 % of the total industrial activity in Bartin, Bolu, Duzce, Karabuk, Kastamonu, Sinop and Zonguldak, respectively.

The purpose of the current study was to identify wood-destroying insect species in logs stored in field depots in the Western Black Sea Region of Turkey. So far, the literature has covered insect species on living trees and forested lands in this region but there is limited information on insect species in log depots. The current study can be considered the first such investigation for the Western Black Sea Region.

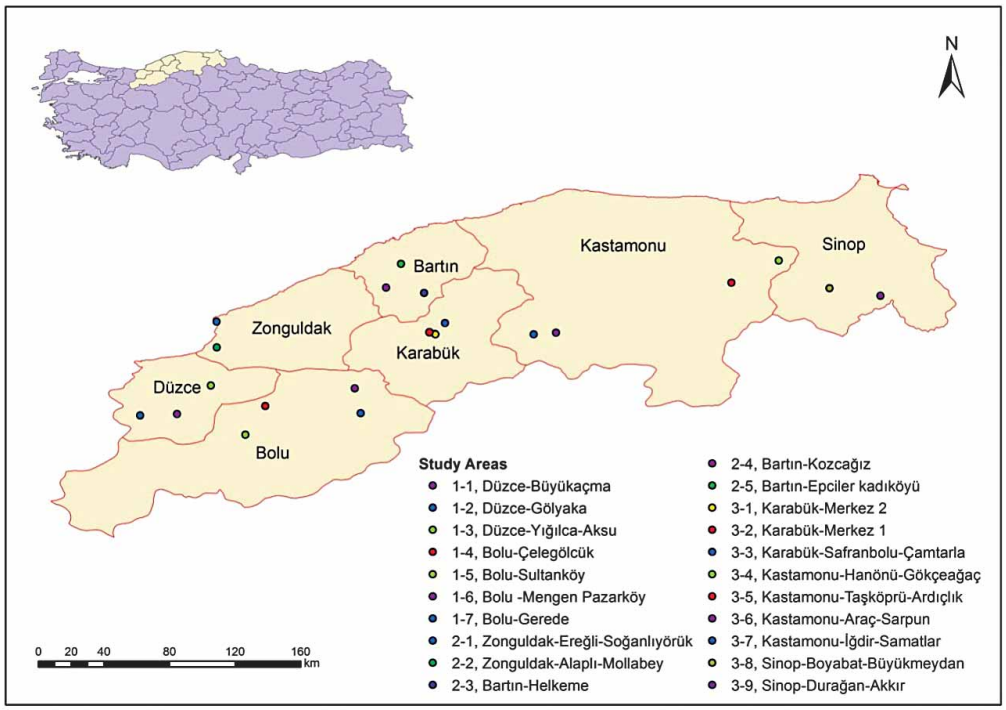

Figure 1 Locations of log depots in the research area
Slika 1. Mjesta skladišta trupaca na istraživanom području

2 MATERIALS AND METHODS
2. MATERIJALI I METODE

2.1 Study areas
2.1. Područja istraživanja

This study covered 21 log depots in different provinces of the Western Black Sea Region (Figure 1). The study area was divided into three sub regions: 1, Duzce-Bolu; 2, Zonguldak-Bartin; and 3, Karabuk-Kastamonu-Sinop, based on the distribution of the forest regional directorates in Turkey. The log depots were selected based on their annual production capacity. The highest production log depots were intentionally chosen. Data loggers were placed in each log depot to record temperature and relative humidity data. Figure 1 shows details of the study area.

2.2 Collection of insects and their transfer to the laboratory
2.2. Prikupljanje kukaca i njihov transport do laboratorija

The log depots were visited by the research team of Duzce University every 20 days between April 2015 and October 2016, totaling 16 study visits for each location. Wood species were first identified in each log depot (Table 1). Subsequently a sampling quadrant (20 x 50 cm) was established on selected logs to observe

Table 1 Wood species stored in log depots
Tablica 1. Vrste drva uskladištene na stovarištu trupaca

Name of study area *Ime istraživanog područja*	**Study area (log depot) code** *Oznaka istraživanog područja (stovarište trupaca)*	**Wood species in the study area** *Vrsta drva u istraživanom području*
Duzce - Buyukacma	1-1	Beech (*Fagus orientalis*), oak (*Quercus* sp), poplar (*Populus* sp), Scots pine (*Pinus sylvestris*), Red pine (*Pinus brutia*), fir (*Abies nordmanniana*) hornbeam (*Carpinus betulus*)
Duzce - Golyaka	1-2	Linden (*Tilia* sp), cherry (*Prunus avium*), fir (*Prunus avium*), beech (*Fagus orientalis*), sycamore (*Platanus orientalis*), poplar (*Populus* sp), ash (*Fraxinus angustifolia*)
Duzce - Yigilca - Aksu	1-3	Hornbeam (*Carpinus betulus*), beech (*Fagus orientalis*), oak (*Quercus* sp), fir (*Abies nordmanniana*), chestnut (*Castanea sativa*)
Bolu - Celegolcuk	1-4	Scots pine (*Pinus sylvestris*), fir (*Abies nordmanniana*), beech (*Fagus orientalis*)
Bolu - Sultankoy	1-5	Fir (*Abies nordmanniana*), Scots pine (*Pinus sylvestris*), beech (*Fagus orientalis*), oak (*Quercus* sp)
Bolu - Mengen - Pazarkoy	1-6	Fir (*Abies nordmanniana*), pine (*Pinus* sp)
Bolu-Gerede	1-7	Pine (*Pinus* sp)
Zonguldak - Eregli - Soganliyoruk	2-1	Linden (*Tilia* sp), beech (*Fagus orientalis*), hornbeam (*Carpinus betulus*), oak (*Quercus* sp), alder (*Alnus glutinosa*), chestnut (*Castanea sativa*), red pine (*Pinus brutia*)
Zonguldak - Alapli - Mollabey	2-2	Beech (*Fagus orientalis*), pine (*Pinus* sp), chestnut (*Castanea sativa*), fir (*Abies nordmanniana*), Linden (*Tilia* sp)
Bartin - Helkeme	2-3	Fir (*Abies nordmanniana*)
Bartin - Kozcagiz	2-4	Scots pine (*Pinus sylvestris*), fir (*Abies nordmanniana*), oak (*Quercus* sp)
Bartin - Epciler Kadikoy	2-5	Beech (*Fagus orientalis*), oak (*Quercus* sp), poplar (*Populus* sp), Scots pine (*Pinus sylvestris*), fir (*Abies nordmanniana*)
Karabuk - Merkez - 1	3-1	Hornbeam (*Carpinus betulus*), alder (*Alnus glutinosa*), pine (*Pinus* sp), oak (*Quercus* sp), fir (*Abies nordmanniana*)
Karabuk - Merkez - 2	3-2	Pine (*Pinus* sp), oak (*Quercus* sp), fir (*Abies nordmanniana*), hornbeam (*Carpinus betulus*)
Karabuk - Safranbolu - Camtarla	3-3	Scots pine (*Pinus sylvestris*), black pine (*Pinus nigra*), oak (*Quercus* sp)
Kastamonu - Gokceagac	3-4	Oak (*Quercus* sp)
Kastamonu - Taskopru - Ardiclik	3-5	Pine (*Pinus* sp), oak (*Quercus* sp)
Kartamonu - Arac - Sarpun	3-6	Fir (*Abies nordmanniana*), pine (*Pinus* sp)
Kastamonu - Igdir -Samatlar	3-7	Pine (*Pinus* sp), fir (*Abies nordmanniana*), oak (*Quercus* sp)
Sinop - Boyabat - Buyuk Meydan	3-8	Scots pine (*Pinus sylvestris*), black pine (*Pinus nigra*), oak (*Quercus* sp)
Sinop - Duragan - Akkir	3-9	Scotch pine (*Pinus sylvestris*), beech (*Fagus orientalis*), oak (*Quercus* sp)

Table 2 Determinations for sub region 1, Duzce-Bolu
Tablica 2. Obilježja podregije 1., Duzce-Bolu

Order / Family *Red / porodica*	**Insect species** *Vrsta kukca*	**Log depots** *Stovarište trupaca*	**Dates (Months)** *Datumi (mjeseci)*	**Wood species** *Vrsta drva*	**Wood part** *Dio drva*	**Insect life stage** *Razvojni stadij kukca*	**Total insect number** *Ukupan broj kukaca*
Coleoptera							
Tenebrionidae	*Uloma cypraea* Kraatz, 1873	1-1, 1-2, 1-6	4, 5	F	SW, HW	$A^{4,5}$, L^{4}	21
	Uloma sp.	1-2	4	F	SW	L^{4}	1
	Helops caeruleus Linnaeus, 1758	1-1	8	B*	SW	A^{8}	1
	Menephilus cylindricus Herbst, 1784	1-3, 1-4, 1-5, 1-6	4, 5, 6, 7, 9	F, B, Yp	SW	$L^{4,9}$, $P^{4,6}$, $A^{4,5,6,7,9}$	23
	Euboeus mimonti Boieldieu, 1865	1-1	4	B	SW	L^{4}	1
Elateridae	*Ampedus* sp. Dejean, 1833	1-1, 1-4	4, 5, 8	F, B	SW, B**	L^{4}, P^{5}, $A^{4,8}$	15
	Lacon punctatus Herbst, 1779	1-2,-1-4, 1-5	4	F, C	SW, HW	L^{4}, P^{4}	6
	Lacon sp. Laporte de Castelnau, 1836	1-4	4	C	SW	L^{4}	1
	Ampedus nigroflavus Goeze, 1777	1, 1	4	F	SW	A^{4}	3
	Synaptus filiformis Fabricius, 1781	1-5	4	Yp	SW	L^{4}	1
	Agriotes sp. Eschscholtz, 1829	1-1	5	B	SW	L^{5}	2
Scarabaeidae	*Valgus hemipterus* Linnaeus, 1758	1-2	4, 5	C, F	SW	L^{4}, P^{5}, A^{5}	5
	Cetonia aurata Linnaeus, 1758	1-2, 1-5	5, 8	F	SW	L^{5}, A^{8}	10
	Valgus sp. Scriba, 1790	1-2	4	F	SW	L^{4}, P^{4}	2
Cerambycidae	*Rhagium inquisitor* Linnaeus, 1758	1-1, 1-4, 1-6, 1-7	3, 4	YP, B	SW, B	L^{4}, P^{4}, A^{4}	37
	Stictoleptura scutellata Fabricius, 1781	1-3	5	B	SW	L^{5}, A^{5}	2
	Monochamus galloprovincialis Olivier, 1795	1-4	8	Yp	SW	A^{8}	5
	Ergates faber Linnaeus, 1761	1-5	4	F	SW	L^{4}	1
	Hylotrupes bajulus Linnaeus, 1758	1-1, 1-4, 1-5	6	Yp	SW	L^{6}, A^{6}	25
	Phymatodes testaceus Linnaeus, 1758	1-5	6	Yp	SW	A^{6}	1
	Anastrangalia sanguinolenta Linnaeus, 1761	1-6	4, 6	Bp, F	SW	L^{4}, A^{6}	5
Buprestidae	*Chalcophora detrita* Klug, 1829	1-4	4, 5	F	SW	$L^{4,5}$	2
	Chalcophora mariana Linnaeus, 1758	1-4	6, 9	F, Bp	SW	L^{6}, P^{6}, A^{8}	4
Curculionidae	*Rhyncolus ater* Linnaeus, 1758	1-5, 1-6	3, 4, 5, 6, 10	Bp, F	SW	$A^{3,4,5,6,10}$	34
	Rhyncolus sp. Germar, 1817	1-5	4, 8	F	SW	$L^{4,8}$, P^{8}	4
	Rhyncolus elongates Gyllenhal, 1827	1-6	3	F	SW	A^{3}	34
	Xyleborus sp. Eichhoff, 1864	1-6	3	F	B	L^{3}	1
	Ips sexdentatus Boerner, 1776	1-4	4, 6	Yp	B	$L^{4,6}$, A^{6}	38
Lucanidae	*Dorcus parallelipipedus* Linnaeus, 1758	1-1, 1-2, 1-3, 1-4, 1-5, 1-6	4, 5, 8	F, B, L, O, C, P	SW, HW	$L^{4,5}$, $P^{4,5}$, $A^{4,5}$	80
	Sinodendron cylindricum Linnaeus, 1758	1-4	2	B	SW	L^{2}	20
Cleridae	*Thanasimus formicarius* Linnaeus, 1758	1-4	4	O, Bp	B	A^{4}	5
	Clerus mutillarius Fabricius, 1775	1-4	8	O	B	A^{8}	1
Anobiidae	*Anobium punctatum* De Geer, 1774	1-1, 1-4	6	O	SW, HW	L^{6}	26
	Ptilinus fuscus Geoffroy & Fourcroy, 1785	1-2, 1-6	5, 6	P*	SW	$A^{5,6}$	6
Trogossitidae	*Ostoma ferruginea* Linnaeus, 1758	1-4, 1-5, 1-6	4, 5, 6, 10	F, Bp, Yp	SW	$A^{4,5,6,10}$	54
Cantharidae	*Cantharis fusca* Linnaeus, 1758	1-3	5	Yp	B	A^{5}	1
	Cantharis livida Linnaeus, 1758	1-4	3	Yp	SW	L^{3}	2
Lycidae	*Lygistopterus sanguineus* Linnaeus, 1758	1-1	5	O	SW	L^{5}	1
Hymenoptera							
Formicidae	*Camponotus vagus* Scopoli, 1763	1-1, 1-2, 1-3, 1-4	4, 5, 8, 9	Yp, B, O	HW	L^{4}, $A^{5,8,9}$	98
	Lasius sp. Fabricius, 1804	1-5	4	O	HW	A^{4}	1

Wood species: B - beech; Bp - black pine; C - Cherry; F - fir; L - linden; O - Oak; P - poplar; Yp - yellow pine. / *Vrste drva: B - bukovina; Bp - drvo crnog bora; C - trešnjevina; F - jelovina; L - lipovina; O - hrastovina; Yp - drvo žutog bora.*
Wood part: B - between bark and cambium; HW - heartwood; SW - sapwood. / *Dio drva: B - između kore i kambija; HW - srž; SW - bjeljika.*
Insect life stage: A - adult; L - larvae; P - pupae. */ Razvojni stadij kukca: A - odrasli kukac; L - ličinka; P - kukuljica.*
*Superscripted numbers are the month of collection. / **Brojevi u superskriptu označavaju mjesece tijekom kojih su kukci prikupljeni.*

and collect larvae, pupae and adult insects. Several types of knifes, saws and axes were used during the study visits, and small plastic containers with perforated lids were used for collecting the live specimens. Each plastic container was labeled with a number, area, code, date of collection, form of organism (larvae, pupae or adult) and wood species.

Species collected as larvae or pupae were either kept in the piece of wood in which they were found or transferred to fine moist sawdust prepared from the same wood species. The purpose was to make it easier to identify the species of larvae or pupae.

2.3 Species identification
2.3. Identifikacija vrsta kukaca

The live specimens collected were kept in individual containers to keep their body intact for easy and reliable identification. Insect species were identified by experts using a stereo microscope. Adult insect was directly determined, whereas larvae and pupae forms were stored in conditioning rooms under appropriate conditions (20-22 °C and 60-70 % RH) until they reached adulthood (Akbulut *et al.*, 2008). Some species of larvae and pupae were described by using the methods of Cherepanov (1991). Several identification keys (Acatay, 1961) and related books (Freude *et al*., 1981, Freude *et al*., 1983; Bevan, 1987; Borror *et al*., 1989; Bense, 1995; Cherepanov, 1991; Creffield, 1996; Canakcioglu and Mol, 1998; Kaygin, 2007) were used for the classification. After identification, the samples were preserved/mounted for future reference.

2.4 Wood species in study areas
2.4. Vrste drva na istraživanom području

Table 1 lists the wood species of logs stored in the depots in the study areas. The range of wood species varied between depots, with a total of 14 species identified. Almost all species were present in each sub regions. The most abundant tree species (7) were present at the Buyukacma in Duzce and Soganliyoruk in Zonguldak.

3 RESULTS
3. REZULTATI

In the current study, insects were collected in three sub regions recording the species, collection date, wood species, location in wood substrate, and insect life stage and population in sampling quadrants.

Table 2 lists species collected in seven log depots in sub region 1 (Duzce-Bolu). Two orders, 13 families, 42 genera, and 33 species were recorded. Almost all insect species belong to the Coleoptera with the highest diversity in species found in the Cerambycidae. *Cam-*

Table 3 Determinations for sub region 2, Zonguldak-Bartin
Tablica 3. Obilježja podregije 2., Zonguldak-Bartin

Order / Family *Red / porodica*	**Insect species** *Vrsta kukca*	**Log depots** *Stovarište trupaca*	**Dates (Months)** *Datumi (mjeseci)*	**Wood species** *Vrsta drva*	**Wood part** *Dio drva*	**Insect life stage** *Razvojni stadij kukca*	**Total insect number** *Ukupan broj kukaca*
Coleoptera							
Tenebrionidae	*Uloma cypraea* Kraatz, 1873	2-1, 2-2, 2-5	4, 5	O, L, B*	SW	$A^{4,5}$	6
Elateridae	*Ampedus pomorum* Herbst, 1784	2-5	5	B	SW	A^{5}	1
Scarabaeidae	*Valgus hemipterus* Linnaeus, 1758	2-2	4	B	HW	L^{4}	1
Cerambycidae	*Rhagium inquisitor* Linnaeus, 1758	2-2, 2-4	3, 6	Yp	SW	$L^{3,6}$, P^{3}	9
	Hylotrupes bajulus Linnaeus, 1758	2-1, 2,4	3, 4	Yp, Bp	SW	$L^{3,4}$	2
	Aegosoma scabricorne Scopoli, 1763	2-2	4	L	SW	L^{4}	4
	Rhagium sp. Fabricius, 1775	2-2	4	O	SW	L^{4}	1
	Leptura quadrifasciata Scopoli, 1763	2-1	4	L	SW	L^{4}, P^{4}, A^{4}	39
	Leptura aurulenta Fabricius, 1792	2-1	4	L	SW	L^{4}, P^{4}, A^{4}	22
	Arhopalus rusticus Linnaeus, 1758	2-1, 2-2	4, 6	Yp, Bp	SW	L^{4}, P^{6}, A^{6}	3
	Saperda sp. Fabricius, 1775	2-1	4	L	SW	L^{4}	13
	Plagionotus sp. Mulsant, 1842	2-1	4	O	SW	L^{4}	2
Cantharidae	*Cantharis rufa* Linnaeus, 1758	2-4	3	Yp	SW	L^{3}	1
Curculionidae	*Rhyncolus ater* Linnaeus, 1758	2-3	9	F	SW	A^{9}	7
	Ips sexdentatus Boerner, 1776	2-2	4, 6	Yp, L	SW, B**	$A^{4,6}$	4
Lucanidae	*Dorcus parallelipipedus* Linnaeus, 1758	2-1, 2-2, 2-4, 2-5	3, 4, 5, 8	F, L, B	SW, HW	$L^{3,4,5}$, P^{4} $A^{3,4,8}$	42
Cleridae	*Trichodes apiaries* Linnaeus, 1758	2-5	9	Yp	B	A^{9}	1
Colydiidae	*Dechomus sulcicollis* Germar, 1824	2-2	4	Yp	SW	L^{4}, E^{4}	148
Lymexylidae	*Lymexylon* sp. Fabricius, 1775	2-4	3	Yp	SW	L^{3}	2
Hymenoptera							
Formicidae	*Camponotus vagus* Scopoli, 1763	2-5	5	B	HW	A^{5}	1

Wood species: B - beech; Bp - black pine; C - Cherry; F - fir; L - linden; O - Oak; P - poplar; Yp - yellow pine. / *Vrste drva: B - bukovina; Bp - drvo crnog bora; C - trešnjevina; F - jelovina; L - lipovina; O - hrastovina; Yp - drvo žutog bora.*
Wood part: B - between bark and cambium; HW - heartwood; SW - sapwood. / *Dio drva: B - između kore i kambija; HW - srž; SW - bjeljika.*

Table 4 Determinations for sub region 3, Karabuk-Kastamonu-Sinop
Tablica 4. Obilježja podregije 3., Karabuk-Kastamonu-Sinop

Order / Family *Red / porodica*	**Insect species** *Vrsta kukca*	**Log depots** *Stovarište trupaca*	**Dates (Months)** *Datumi (mjeseci)*	**Wood species** *Vrsta drva*	Wood part *Dio drva*	**Insect life stage** *Razvojni stadij kukca*	**Total insect number** *Ukupan broj kukaca*
Coleoptera							
Tenebrionidae	*Menephilus cylindricus* Herbst, 1784	3-1	3	F, Yp	SW	A^{3}	3
	Corticeus sp. Pillar & Mitterpacher, 1783.	3-6	8	O	B	A^{8}	2
	Opatrum sabulosum Linnaeus, 1761	3-5	5	Yp	SW	L^{5}, A^{5}	2
	Neatus sp. Le Conte, 1862	3-1	3	Bp, Yp	SW	L^{3}, A^{3}	4
	Corticeus pini Panzer, 1799	3-6	3, 6	Bp, Yp	SW	$A^{3,6}$	10
Elateridae	*Ampedus* sp. Dejean, 1833	3-5, 3-6	5	F, O	SW	A^{5}	3
	Lacon punctatus Herbst, 1779	3-7, 3-9	3, 5, 8	F, Rp	SW	$L^{3,5,8}$, A^{3}	5
	Ampedus elegantulus Schönherr, 1817	3-7	3	F	SW	A^{3}	1
Scarabidae	*Trichius sexualis* Bedel, 1906	3-4	5	O	SW	L^{5}	1
Cerambycidae	*Rhagium inquisitor* Linnaeus, 1758	3-3, 3-6, 3-7	3, 5	Bp, Yp	SW	$L^{3,5}$, A^{5}	9
	Hylotrupes bajulus Linnaeus, 1758	3-5, 3-6	3	Yp	SW	A^{3}	3
	Aegosoma scabricorne Scopoli, 1763	3-5	5	Yp	SW	L^{5}	2
	Rhagium bifasciatum Fabricius, 1775	3-5, 3-6	3, 5	Yp	SW	L^{3}, A^{5}	2
	Clytus arietis Linnaeus, 1758	3-2	5	H	SW	A^{5}	4
Buprestidae	*Chalcophora detrita* Klug, 1829	3-9	3	Rp	SW	L^{3}	2
	Buprestis dalmatina Mannerheim, 1837	3-9	5	Yp	SW	L^{5}	1
	Buprestis octoguttata, Linnaeus, 1758	3-9	3	F	SW	L^{3}	2
Curculionidae	*Rhyncolus ater* Linnaeus, 1758	3-1, 3-2	5	Yp	SW	A^{5}	1
	Rhyncolus elongates Gyllenhal, 1827	3-2	5	Yp	SW	A^{5}	1
	Xyleborus sp. Eichhoff, 1864	3-7	5	O	B	A^{5}	2
	Ips sexdentatus Boerner, 1776	3-4, 3-5, 3-7, 3-8, 3-9	3, 6	F, Yp	B, SW	L^{6}, $P^{,6}$ $A^{3,6}$	51
	Hylastes sp. Erichson, 1836	3-7	3	F	B	L^{3}	3
	Xyleborus eurygraphus Ratzeburg, 1837	3-3	3	O, Bp	B	L^{3}, A^{3}	4
	Orthotomicus erosus Wollaston, 1857	3-3	5	Bp	B	L^{5}	3
Lucanidae	*Dorcus parallelipipedus* Linnaeus, 1758	3-4, 3-6	3, 5	B, Yp, O	SW	$L^{3,5}$, P^{8}	3
Anobiidae	*Anobium punctatum* De Geer, 1774	3-7	3	Yp	SW	L^{3}	4
Trogossitidae	*Temnochila caerulea* Olivier, 1790	3-6	5	B	B	A^{5}	1
Rhysodidae	*Rhysodes sulcatus* Fabricius, 1787	3-2	3	Yp	SW	A^{3}	1
Melandrydae	*Rushia parreyssi* Mulsant, 1856	3-1, 3-2	3	Yp	SW	A^{3}	2
Dasytidae	*Aplocnemus alpestris* Kiesenwetter, 1861	3-5	5	Yp	SW	A^{5}	1
Silvanidae	*Uleiota planata* Linneaus, 1761	3-9	8	Bp	B**	A^{8}	1
Lepidoptera							
Cossidae	*Zeuzera pyrina* Linnaeus, 1761	3-9	3	B*	SW	L^{3}	1
Blattodea							
Rhinotermitidae	*Reticulitermes* sp. Holmgren, 1913	3-9	6	Yp	SW	A	60

Wood species: B - beech; Bp - black pine; C - Cherry; F - fir; L - linden; O - Oak; P - poplar; Yp - yellow pine. / *Vrste drva: B - bukovina; Bp - drvo crnog bora; C - trešnjevina; F - jelovina; L - lipovina; O - hrastovina; Yp - drvo žutog bora.*
Wood part: B - between bark and cambium; HW - heartwood; SW - sapwood. / *Dio drva: B - između kore i kambija; HW - srž; SW - bjeljika.*

Table 5 Correlation coefficients for ecological factors and insect species diversity and density
Tablica 5. Koeficijenti korelacije za ekološke čimbenike, raznolikost i gustoću vrste kukaca

		Insect species diversity *Gustoća vrste kukaca*	**Mean insect density** *Srednja gustoća kukaca*	**Total insect density** *Ukupna gustoća kukaca*	**Altitude** *Visina*	**Mean temperature** *Srednja temperatura*	**Mean relative humidity** *Srednja relativna vlažnost zraka*
Insect species diversity *Gustoća vrste kukaca*	R^2	1	**0.840****	**0.904****	0.042	-0.443	**0.575***
	P		0.000	0.000	0.865	0.058	0.010
Total insect density *Ukupna gustoća kukaca*	R^2	**0.904****	**0.920****	1	-0.070	-0.312	**0.574***
	P	0.000	0.000		0.775	0.193	0.010

ponotus vagus, while *D. parallelipipedus* had the greatest population and distribution. *Agriotes sp., A. sanguinolenta, E. faber, E. mimonti, S. filiformis, S. cylindricum* and *S. scutellata* were found only in this sub region.

Table 3 lists species collected in five log depots in sub region 2 (Zonguldak-Bartin). Three orders, 12 families, 21 genera and 15 species were recorded. Again, the highest diversity in terms of species was found in the Cerambycidae. *Dorcus parallelipipedus* had the highest population, and *A. scabricorne, L. quadrifasciata* and *Lymexylon sp.* were only found in this sub region.

Table 4 lists species collected in nine log depots in sub region 3 (Karabuk-Kastamonu-Sinop). Three orders, 15 families, 33 genera and 27 species were recorded. Ips sexdentatus was the most common and widely distributed species. *Aplocnemus alpestris, C. arietis, B. octoguttata, O. sabulosum, R. parreyssi, R. sulcatus, Reticulitermes* sp*., U. planata, Xyleborus* sp. and *Z. pyrina* were only found in this sub region.

Correlation analysis was performed based on insect diversity and density, temperatures and relative humidity of study areas and altitude from the sea level. Based on the current findings, a positive relationship was detected between insect diversity and density and relative humidity (Table 5). Insect diversity and density increased with the increase of relative humidity of the study area. On the other hand, effects of temperature and altitude from the sea level on insect diversity and density were found insignificant.

4 DISCUSSION
4. RASPRAVA

Bolu Province had the highest diversity with 20 species, whereas Sinop Province had the lowest diversity with only six species. Several reasons might account for this difference, including the range of wood species and the quantity of logs in depots (Irmler *et al.,* 1996; Okland *et al.,* 1996). Sinop Province had four wood species, while Bolu Province had five (Table 1) and the quantity of wood held in depots in Bolu was higher than in Sinop.

Akbulut *et al*. (2008) studied wood-destroying insects in forest depots in Duzce Province. In their study, insects were categorized as detrimental or not detrimental, with *A. punctatum, H. bajulus* and *Xestobium rufovillosum* (De Geer, 1774) being considered economically important insect species for wood. They also found some insect species, which were also found in our study, including *A. punctatum, I. sexdentatus, H. bajulus, M. galloprovincialis, P. curvidens, T. formicarius, V. hemipterus* and *Xyleborus* sp. However, in our study, some insect species, namely *C. vagus, D. parallelipipedus, P. fuscus, S. scutellate* and *U. cypraea*, were not found in Duzce Province.

Unal *et al.* (2008) studied wood-destroying insects in old historical Ottoman houses in Kastamonu Province. They found *A. punctatum* and *H. bajulus* as wood-destroying insects. In Yildiz (2012), 23 bark beetle species were determined in Bartin and Karabuk provinces, and *O. erosus* bark beetle was reported for the first time in Bartin province.

Larvae, pupae and adults of some insect species were detected in all or most of the study areas. *Dorcus parallelipipedus* and *R. inquisitor* were recorded in the seven provinces studied, with *D. parallelipipedus* detected in 12 log depots and *R. inquisitor* in nine log depots. These species belong to the Lucanidae and Cerambycidae, respectively. *Rhagium inquisitor*, in particular, has been reported to be common in the region due to extensive hardwood (oak, beech and birch) and softwood (spruce, fir and pine) production (Bily and Mehl, 1989; Kolk and Starzyk, 1996). Previous studies also found that and *D. parallelipipedus* and *R. inquisitor* are common species in Turkey (Kaygin, 2007; Ozdikmen and Turgut, 2010).

Furthermore, *C. vagus* (three provinces and six log depots), *H. bajulus* (five provinces and seven log depots), *I. sexdentatus* (four provinces and seven log depots) and *L. punctatus* (four provinces and five log depots) can be considered as extensively distributed. While there is no common reason for the abundance of these species in the region, the density and number of pine species might affect *H. bajulus* population, and the storage of fire wood and pine wood with bark might contribute to *I. sexdentatus* numbers. The sizable populations of *S. rubra* might attract its predator *L. punctatus* (Canakcioglu and Mol, 1998; Kaygin, 2007; Merkl *et al.,* 2010).

Insects were also evaluated for wood preference. Beech, fir, oak and Scotch pine occurred in almost all log depots studied (Table 1). Other wood species varied between locations. The highest insect species diversity was found on Scots pine with 32 species, followed by fir, oak and beech with 23, 17 and four species, respectively. Wood species preference of in-

sects depends on extractive substances of wood species and their toxic and anti-insecticide effects (Moore, 1979; Klepzig *et al*., 1995; Tascioglu *et al*., 2013). The sapwood ratio of woods is also an important factor in wood preference, since sapwood and starch are positively related in most wood species (Sivrikaya, 2008). The results of the current study suggest that most destruction due to insects occurs in the sapwood of logs (Tables 2-4). In addition, it is thought that insect species diversity and density found in Scots pine, fir, oak and beech wood occurred because these species are present in almost all log depots in the region and are stored for long periods.

When wood insect species and wood species relationship are evaluated, the main reasons for insect to invade wood are considered to feed and shelter (Jonsson *et al*., 2005). Especially predator insects tunnel into wood to feed on their prey species, usually other harmful insect species (Drees *et al.,* 2017). Even though these insect species are not directly feeding on wood, their tunneling causes damage (Wermelinger *et al*., 2013).

When evaluating wood preferences of insects, *D. parallelipipedus* species were determined on seven wood species including both hardwoods and softwoods. Predator species, like *Ampedus* sp.*, L. punctatus* and *O. ferruginea*, were collected from three wood species. This phenomenon could not be explained by the chemical and physiological features of wood but rather by wood preference of the prey insect.

According to previous reports, *L. aurulenta* was observed in Gumushane Province (Alkan and Eroglu, 2001) and in Istanbul Province (Turgut *et al.,* 2010; Albayati *et al.*, 2016), and *B. dalmatina* and *S. scutellata* were found in Sakarya and Istanbul Provinces, respectively (Sakalian, 2003; Albayati *et al*., 2016), so these are the first records for the Western Black Sea Region.

Jaworski and Hilszczanski (2013) indicated that certain increases in temperatures and relative humidity in the area would result in an increase in insect diversity and density. However, the present study only supported the effect of relative humidity, while the effect of temperature was not found significant.

Members of the Elateridae and Tenebrionidae are generally known to be predator insects (Sarikaya and Avci, 2009; Andersson *et al.,* 2015). Species of these predator families were observed tunneling in both bark and wood during their pupa, larva or adult stage causing major damage to the technological features of wood (Tables 2-4). Especially *C. vagus* and *Lasius* sp. make galleries and nests in wood. Although these species do not use wood as a food source, they feed on wood-destroying insects within the wood.

In conclusion, four orders, 22 families, 74 genera and 57 species of insects were determined in the Western Black Sea Region. Some of these species, namely, *A. rusticus, H. bajulus and M. galloprovincialis in the Cerambycidae, C. detrita, B. dalmatina,* and *B. octoguttata* in the Buprestidae, and A. punctatum in the Anobiidae, are considered to be leading wood destroyers.

Also, *B. dalmatina, L. aurulenta* and *S. scutellata* were recorded for the first time in the Western Black Sea Region.

Dorcus parallelipipedus and *R. inquisitor* were found widely spread in the region. *Ampedus* sp*., D. parallelipipedus, L. punctatus O. ferruginea* and *V. hemipterus* were found in a wide range of wood species. The highest insect diversity and density was found in Duzce-Bolu with 42 genera and 40 species. Most insect species were observed in wood stored in field depots for 2 years or more, indicating that storage time is an important contributor to insect diversity and population density. Thus, logs should be processed as soon as possible without extended periods of storage time to prevent spread and infestation of pest species.

Storing newly harvested wood together with old logs stored for extended periods due to legal problems represents a major problem. This storage practice can help spread some insect species from older material to newly harvested raw material. The best solution would be to improve procedures to have older raw material sold and removed as soon as possible.

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