

## Predators of bark beetles (Coleoptera) in the Balıkesir region of Turkey

Depredadores de escarabajos de la corteza (Coleoptera) en la región de Balıkesir de Turquía

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**Abstract:** The aim of this study was to determine the diversity of bark beetle predators in the coniferous forests of the Balıkesir Province of Turkey. Six plots were established that each contained five pheromone traps and two log traps. Eight bark beetle predator species: *Aulonium ruficorne*, *Clerus mutillarius*, *Corticeus fraxini*, *Paromalus parallelepipedus*, *Platysoma elongatum*, *Raphidia ophiopsis*, *Temnochila caerulea* and *Thanasimus formicarius*, belonging to six families were found. The six bark beetle predator families found were: Cleridae, Trogossitidae, Laemophloeidae, Tenebrionidae, Zopheridae, Histeridae, and Raphidiidae. Also it is included a description of which bark beetle galleries these predators were found in.

**Key words:** Arthropod, coniferous species, control, distribution.

**Resumen:** El objetivo de este estudio fue determinar la diversidad de los depredadores de los escarabajos de la corteza en los bosques de coníferas de la provincia de Balıkesir en Turquía. Se establecieron seis parcelas que contenían cinco trampas de feromonas y dos trampas de troncos. Se encontraron ocho especies de depredadores de escarabajos de corteza: *Aulonium ruficorne*, *Clerus mutillarius*, *Corticeus fraxini*, *Paromalus parallelepipedus*, *Platysoma elongatum*, *Raphidia ophiopsis*, *Temnochila caerulea* and *Thanasimus formicarius*, pertenecientes a seis familias: Cleridae, Trogossitidae, Laemophloeidae, Tenebrionidae, Zopheridae, Histeridae, Raphidiidae. También se describe en cuáles galerías de escarabajos se encontraban estos depredadores.

**Palabras clave:** Artrópodo, especies de coníferas, control, distribución.

### Introduction

The bark beetles associated with coniferous forests are one of the most destructive groups among the xylophagous species on trees. The feeding on food supply, abundance, reproduction and distribution of these beetles can result in the epidemic outbreaks and the destructions of forest area. The eradication by burning, the silvicultural methods or the natural enemies for the control of bark beetles can be used in infected areas. Predators are important natural enemies against bark beetles. Arthropod predators can use bark beetle pheromones as host-specific kairomones or volatiles and typically arrive before parasitoids to an infested tree (Aukema and Raffa 2004).

The most conspicuous coleopteran predators of bark beetles are species from Cleridae family that include some very important predatory species. The species from *Corticeus* genus associated with conifers are active bark beetle predators (Wegensteiner *et al.* 2015). Adult and larvae of *Aulonium ruficorne* (Oliv.), which is the most noticeable predator of *Orthotomicus erosus* (Woll.), can cause up to 90 % mortality of young *O. erosus* adults and also feed on all immature stages (Podoler *et al.* 1990). Schroeder (1997) stated that *Thanasimus formicarius* (L.) could reduce the size of *Tomicus piniperda* (L.) broods up to 81 %. Martin *et al.* (2013) emphasized that *Temnochila caerulea* (Oliv.) is a predator of *Ips sexdentatus* (Boern.).

Predatory organisms were recently used as an agent for biological control of *Dendroctonus micans* (Kug.), and for pathogenic organisms of *Ips acuminatus* (Gyll.) in Turkey

(Eroglu 1995, Yaman *et al.* 2016). Also, the effects of ecological and silvicultural practices on the bark beetles were handled in Turkish fir ecosystems (Yildiz *et al.* 2007).

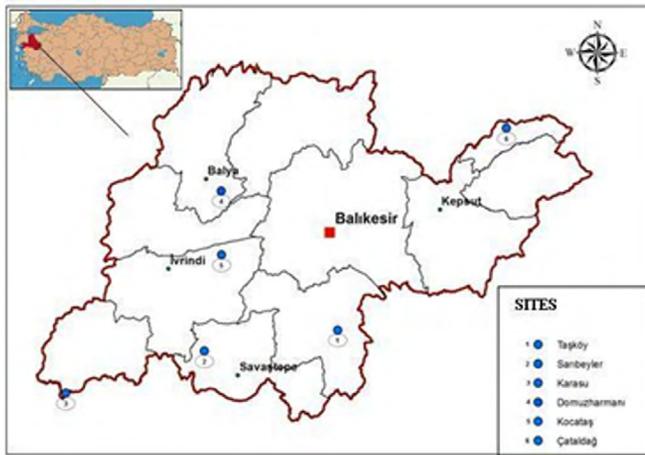
Scolytinae species damaged a forest area of 8730 ha between 2005 and 2015, and only 1105 ha in 2014 in the study site. This damage caused 17803 m<sup>3</sup> production losses in 2014. In Turkey, less information is known about the natural enemies of Scolytinae species in coniferous forests in the Balıkesir Province. The aim of this research was to determine predator species of bark beetles in the coniferous forests in the Balıkesir forests.

### Material and methods

A survey was carried out to identify the predators and Scolytinae species of the Balıkesir Province in northwestern Turkey. This province has coastlines of both Marmara and Aegean Sea and contains extensive forest areas. These species were collected from 6 sampling sites: Taskoy, Saribeyler, Karasu, Domuzharmani, Kocatas and Cataldag (Fig. 1). These sites varied in altitudes that display different forest characteristics (Table 1). Insect specimens were caught with log and pheromone funnel traps including vit-ortero lure (for *Orthotomicus* sp.), vit-ippsex lure (for *Ips* sp.) and vit-pitcur (for *Pityokteines* sp.) were used as pheromone preparations respectively 1, 2 and 4 sites; 3 and 5 sites; 6 site. These lures were bought from the Verim Group. Both vit-ortero lures and vit-ippsex lures were used in sites 1, 2, 3, 4 and 5, and only vit-pitcur lures in site 6. Also, we observed the weakened trees and visually searched the base and trunk

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**Figure 1.** Location of the study sites in Balıkesir forests of Turkey.

of the tree. Five pheromone and two log traps for each site were installed and were spaced 40 m apart. The log traps (15 x 50 cm) consisted of *P. brutia* for sites 1, 2 and 4, *P. nigra* for sites 3 and 5 and *A. nordmanniana* ssp. *bornmülleriana* for site 6. These logs were held in the field along the entire time. Predator specimens were collected from galleries of Scolytinae species and pheromone traps. Collected specimens were labelled and deposited in the Museum of Department of Forest Entomology and Protection at Istanbul University-Cerrahpasa.

## Results

As a result of this study, eight bark beetle predators belonging to six families were found (Fig. 2).

### *Clerus mutillarius* Fabricius, 1775

It was collected from pheromone traps and galleries of *Orthotomicus erosus* (Woll.) and *Tomicus destruens* (Woll.) between April and June in Taskoy and Saribeyler, between May and July in Domuzharmani in *Pinus brutia* forests, from pheromone traps and galleries of *Ips sexdentatus* (Boern.) between May and June in Karasu, on April in Kocatas, from galleries of *Orthotomicus longicollis* (Gyll.) on July

**Table 1.** Coordinates, altitudes and dominant tree species of sampling sites in Balıkesir Province, Turkey.

Site names (No)	Coordinates	Altitud (m)	Tree species
Taskoy (1)	27° 53' 57" N 39° 27' 58" E	225	<i>Pinus brutia</i>
Saribeyler (2)	27° 34' 21" N 39° 25' 45" E	396	<i>Pinus brutia</i>
Karasu (3)	27° 13' 57" N 39° 21' 00" E	1095	<i>Pinus nigra</i>
Domuzharmani (4)	27° 35' 59" N 39° 42' 07" E	589	<i>Pinus brutia</i>
Kocatas (5)	27° 36' 57" N 39° 36' 31" E	583	<i>Pinus nigra</i> <i>Abies nordmanniana</i>
Çataldag (6)	28° 19' 21" N 39° 51' 10" E	1285	subsp. <i>bornmülleriana</i>

in Kocatas in *P. nigra* forests, and from pheromone traps and galleries of *Pityokteines curvidens* (Germ.) between June and July in Çataldag in *Abies nordmanniana* subsp. *bornmülleriana* forests. Host of *C. mutillarius* included *Ips sexdentatus* (Boern.), *Orthotomicus erosus* (Woll.), *Pityokteines curvidens* (Germ.), *P. spinidens* (Reitt.) and *Tomicus destruens* (Woll.) as found in earlier studies (Tosun 1975; Unal and Yuksel 2005; Sarıkaya and Avcı 2009).

### *Thanasimus formicarius* (Linnaeus, 1758)

It was collected from pheromone traps and galleries of *Orthotomicus erosus* (Woll.) between April and June in Taskoy, between May and September in Saribeyler, between May and July in Domuzharmani, from galleries of *Pityogenes bistridentatus* (Eichh.) between June and July from galleries of *Pityogenes pennidens* Reitt. between July and August in Domuzharmani in *Pinus brutia* forests, from pheromone traps and galleries of *Ips sexdentatus* (Boern.) between May and June in Karasu, on April in Kocatas in *P. nigra* forests, and from galleries of *Pityokteines curvidens* (Germ.) between July and August in Çataldag in *Abies nordmanniana* subsp. *bornmülleriana* forests.

Host of *T. formicarius* included *Cryphalus piceae* (Ratz.), *Dendroctonus micans* (Kug.), *I. acuminatus* (Gyll.), *I. mannsfeldi* (Wachtl), *I. sexdentatus* (Boern.), *I. typographus* (L.), *Orthotomicus erosus* (Woll.), *O. tridentatus* Eggers, *Pityogenes bidentatus* (Herbst), *Pityokteines curvidens* (Germ.), *P. spinidens* (Reitt.), *P. vorontzowi* (Jacob.), *Pityophthorus pityographus* (Ratz.), *Tomicus destruens* (Woll.) and *T. minor* (Hart.) as determined in other studies (Tosun 1975; Yuksel and Akbulut 2002; Yuksel and Alkan 2003; Serin *et al.* 2005; Sarıkaya and Avcı 2009).

### *Paromalus parallelepipedus* (Herbst, 1792)

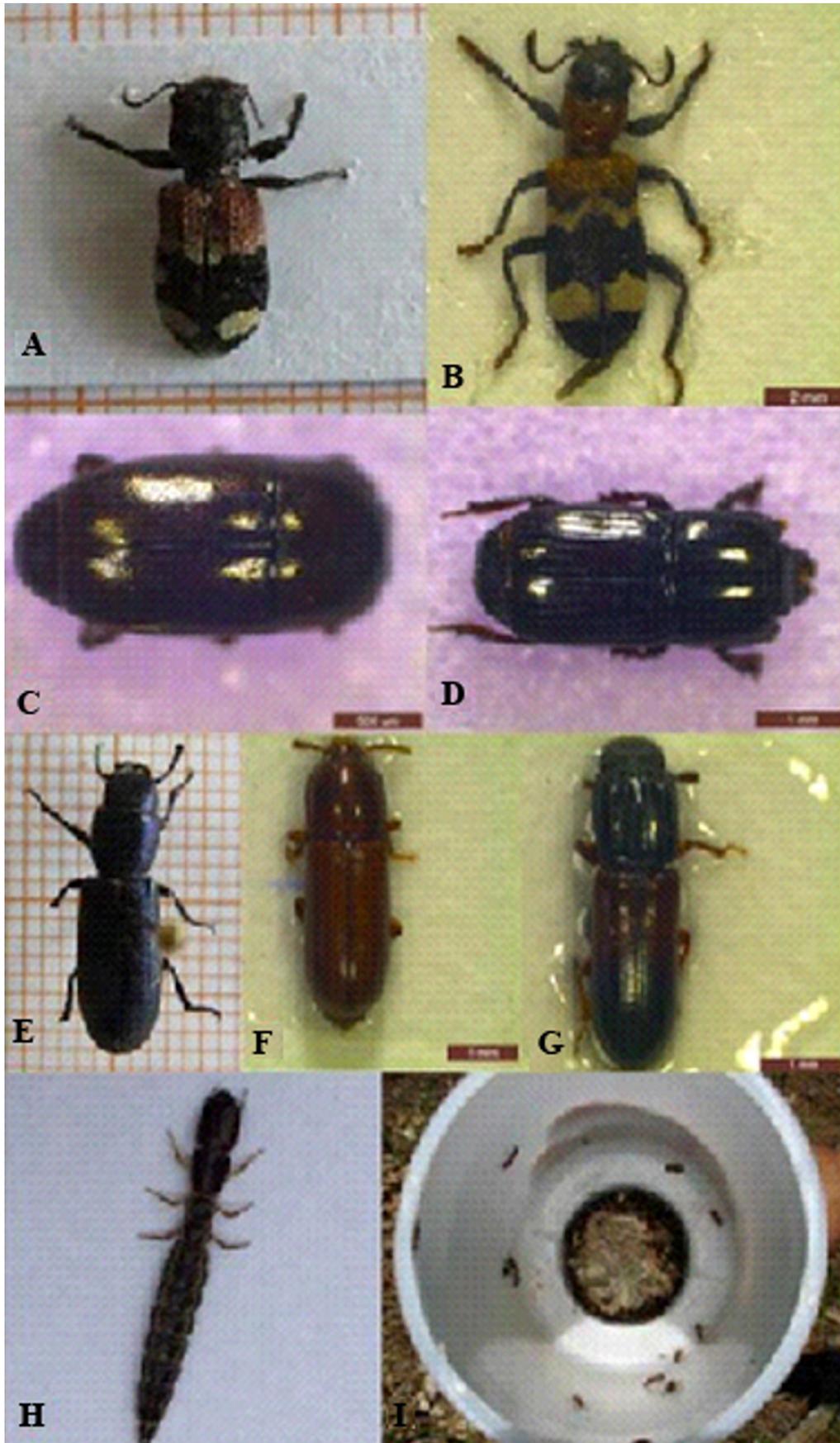
It was collected from pheromone traps of *Orthotomicus erosus* (Woll.) and galleries of *Tomicus destruens* (Woll.) on May 12.05.2014 in Taskoy, Saribeyler and Domuzharmani in *Pinus brutia* forests. Host of *P. parallelepipedus* included *Cryphalus piceae* (Ratz.), *Ips sexdentatus* (Boern.), *I. typographus* (L.), *Orthotomicus erosus* (Woll.) and *Tomicus destruens* (Woll.) as found in earlier studies (Serin *et al.* 2005; Sarıkaya and Avcı 2009).

### *Platysoma elongatum* (Thunberg, 1787)

It was collected from pheromone traps of *Orthotomicus erosus* (Woll.) between May and June in Taskoy, between May and July in Saribeyler, between April and September in Domuzharmani, and from galleries of *Tomicus destruens* (Woll.) on May in Domuzharmani in *Pinus brutia* forests. Host of *P. elongatum* included *Orthotomicus erosus* (Woll.), *O. tridentatus* Eggers, *Tomicus destruens* (Woll.) and *T. piniperda* (L.) as determined in other studies (Tosun 1975; Sarıkaya and Avcı 2009).

### *Raphidia ophiopsis* Linnaeus, 1758

It was collected from galleries of *Orthotomicus erosus* (Woll.) between April and May in Taskoy, between May and September in Saribeyler and Domuzharmani, from galleries of



**Figure 2.** Predator species in the site. (a) *Clerus mutillarius* Fab. (Cleridae), (b) *Thanasimus formicarius* (L.) (Cleridae), (c) *Paromalus parallelepipedus* (Herb.) (Histeridae), (d) *Platysoma elongatum* (Thun.) (Histeridae), (e) *Temnochila caerulea* (Oliv.) (Trogossitidae), (f) *Corticeus fraxini* (Kug.) (Tenebrionidae), (g) *Aulonium ruficorne* (Oliv.) (Zopheridae), (h) *Raphidia ophiopsis* L. (Raphidiidae) and sampling cup for pheromone traps (i).

**Table 2.** Distribution of predators according to sites, Balikesir forests of Turkey.

Predators	Sites					
	Taskoy	Saribeyler	Karasu	Domuzharmani	Kocatas	Cataldag
<i>Aulonium ruficorne</i>	+	+	+	+	+	+
<i>Clerus mutillarius</i>	+	+	+	+	+	+
<i>Corticus fraxini</i>	+	+	+	+	+	-
<i>Paromalus parallelepipedus</i>	+	+	-	+	-	-
<i>Platysoma elongatum</i>	+	+	-	+	-	-
<i>Raphidia ophiopsis</i>	+	+	+	+	+	-
<i>Temnochila caerulea</i>	+	+	+	+	+	+
<i>Thanasimus formicarius</i>	+	+	+	+	+	+

*Tomicus destruens* (Woll.) on May in Domuzharmani in *Pinus brutia* forests, from galleries of *Ips sexdentatus* (Boern.) on April in Kocatas, on May in Karasu, and from galleries of *T. minor* (Hart.) between April and May in Karasu in *P. nigra* forests. Host of *R. ophiopsis* included *Cryphalus piceae* (Ratz.), *Dendroctonus micans* (Kug.), *Ips sexdentatus* (Boern.), *I. typographus* (L.), *Orthotomicus erosus* (Woll.), *Pityogenes bidentatus* (Herbst), *Pityokteines curvidens* (Germ.), *Pityophthorus pityographus* (Ratz.), *Tomicus destruens* (Woll.) and *T. minor* (Hart.) as found in earlier studies (Tosun 1975; Selmi 1998; Yuksel and Akbulut 2002; Yuksel and Alkan 2003; Serin *et al.* 2005; Sarikaya and Avci 2009).

#### *Corticus fraxini* (Kugelann, 1794)

It was collected from pheromone traps and galleries of *Orthotomicus erosus* (Woll.) between April and June in Taskoy, on May and September in Saribeyler, between May and July in Domuzharmani, from galleries of *Tomicus destruens* (Woll.) on May, from galleries of *Hylurgus ligniperda* Fabr. on April in Domuzharmani in *Pinus brutia* forests, from pheromone traps and galleries of *Ips sexdentatus* (Boern.),

*Tomicus minor* (Hart.) and *T. piniperda* (L.) between May and June in Karasu, on April in Kocatas, and from galleries of *Hylurgus micklitzi* Wachtl on May in Kocatas in *P. nigra* forests. Host of *C. fraxini* included *Ips acuminatus* (Gyll.), *I. sexdentatus* (Boern.), *I. mansfeldi* (Wachtl), *Orthotomicus erosus* (Woll.), *O. tridentatus* Eggers, *Tomicus destruens* (Woll.), *T. minor* (Hart.) and *T. piniperda* (L.) as determined in other studies (Schimitschek 1944; Yuksel *et al.* 2000; Sarikaya and Avci 2009).

#### *Temnochila caerulea* (Olivier, 1790)

It was collected from pheromone traps and galleries of *Orthotomicus erosus* (Woll.) between April and June in Taskoy, between May and September in Saribeyler, between May and July in Domuzharmani, from galleries of *Tomicus destruens* (Woll.) on May in Domuzharmani in *Pinus brutia* forests, from pheromone traps and galleries of *Ips sexdentatus* (Boern.) between May and June in Karasu, on April in Kocatas in *P. nigra* forests, and from galleries of *Pityokteines curvidens* (Germ.) and *Pityokteines vorontzowi* (Jacob.) between June and July in Cataldag in *Abies nordmanniana*

**Table 3.** Predation in galleries of bark beetle species in sites, Balikesir forests of Turkey.

Bark beetle species in Balikesir region	Predators							
	<i>Aulonium ruficorne</i>	<i>Clerus mutillarius</i>	<i>Corticus fraxini</i>	<i>Paromalus parallelepipedus</i>	<i>Platysoma elongatum</i>	<i>Raphidia ophiopsis</i>	<i>Temnochila caerulea</i>	<i>Thanasimus formicarius</i>
<i>Hylastes angustatus</i>	-	-	-	-	-	-	-	-
<i>Hylastes linearis</i>	-	-	-	-	-	-	-	-
<i>Ips sexdentatus</i>	+	+	+	-	-	+	+	+
<i>Orthotomicus erosus</i>	+	+	+	+	+	+	+	+
<i>Orthotomicus longicollis</i>	-	+	-	-	-	-	-	-
<i>Pityogenes bistridentatus</i>	-	-	-	-	-	-	-	+
<i>Pityogenes pennidens</i>	-	-	-	-	-	-	-	-
<i>Pityokteines curvidens</i>	+	+	-	-	-	-	+	+
<i>Pityokteines vorontzowi</i>	+	-	-	-	-	-	+	-
<i>Phloeosinus aubei</i>	-	-	-	-	-	-	-	-
<i>Hylurgus ligniperda</i>	-	-	+	-	-	-	-	-
<i>Hylurgus micklitzi</i>	-	-	+	-	-	-	-	-
<i>Tomicus destruens</i>	-	+	-	+	+	+	+	+
<i>Tomicus minor</i>	-	-	+	-	-	+	-	-
<i>Tomicus piniperda</i>	-	-	+	-	-	-	-	-

subsp. *bornmülleriana* forests. Host of *T. caerulea* included *Ips sexdentatus* (Boern.), *Orthotomicus erosus* (Woll.), *Pityokteines curvidens* (Germ.), *Tomicus destruens* (Woll.) and *T. minor* (Hart.) as found in earlier studies (Tosun 1975; Sarikaya and Avci 2009).

### *Aulonium ruficorne* (Olivier, 1790)

It was collected from pheromone traps and galleries of *Orthotomicus erosus* (Woll.) between April and June in Taskoy, between April and September in Saribeyler, between May and July in Domuzharmani in *Pinus brutia* forests, from pheromone traps and galleries of *Ips sexdentatus* (Boern.) between May and June in Karasu, on April in Kocatas in *P. nigra* forests, and from pheromone traps of *Pityokteines curvidens* (Germ.) and *P. vorontzowi* (Jacob.) between April and August in Cataldag in *Abies nordmanniana* subsp. *bornmülleriana* forests. Host of *A. ruficorne* included *Ips acuminatus* (Gyll.), *I. sexdentatus* (Boern.), *Orthotomicus erosus* (Woll.), *O. tridentatus* Eggers, *Phloeosinus aubei* Perr., *Pityogenes bidentatus* (Herbst), *P. calcaratus* (Eichh.), *Pityokteines curvidens* (Germ.) and *Tomicus destruens* (Woll.) as determined in other studies (Tosun 1975; Yuksel and Akbulut 2002; Unal and Yuksel 2005; Sarikaya and Avci 2009).

### Discussion

Eight predator species were identified this study. The four species including *Aulonium ruficorne* (Oliv.), *Clerus mutillarius* Fab., *Temnochila caerulea* (Oliv.) and *Thanasimus formicarius* (L.) were very abundant and others were in relatively small numbers in the site (Table 2). All of predators were largely concerned with *Ips* sp., *Orthotomicus* sp. and *Tomicus* sp (Table 3). Observations for predators of *A. ruficorne* (Oliv.) on *P. vorontzowi* (Jacob.), *C. mutillarius* Fab. on *O. longicollis* (Gyll.), *C. fraxini* (Kug.) on *H. ligniperda* and *H. micklitzi* Wachtl, *T. formicarius* (L.) on *P. bistridentatus* (Eichh.) and *P. pennidens* Reitt. represent the first records in Turkey. Three bark beetles, *H. angustatus* (Herbst), *H. linearis* Erich. and *P. aubei* Perr. were attracted by pheromone traps. Predator species were identified in all traps but not in their galleries. In another words, although predators and their hosts were found together in pheromone traps but they were not observed together in the galleries.

### Conclusion

This study gives information about relationship between predators and their host predator complex to control bark beetle population in Balikesir forests of Turkey. This ecological relationship is very important to design control population growth of the bark beetle while reducing hazards on the forests.

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