Bark Beetles and their Natural Enemies on Oriental Spruce from the Black Sea Region of Turkey[1]

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ABSTRACT Oriental spruce, *Picea orientalis* (L.) Link. (Pinaceae), is one of the main tree species that naturally grows in the Caucasus Mountains and the northeastern part of Turkey, known as the Black Sea Region. This tree species reaches optimal growth in the mountainous areas of heavy precipitation in Ordu, Giresun, Rize, Trabzon, and Artvin Provinces of the Eastern Black Sea Region of Turkey, but it can tolerate a wide range of climatic zones. The bark beetle species (Coleoptera: Curculionidae: Scolytinae) that attack oriental spruce, and their predators and parasitoids, were studied in Turkey in 2005–2006. Twenty-three species of bark beetles belonging to six subtribes and two tribes of Scolytinae were identified. In addition, 84 predatory species from 21 families and 23 parasitoid species from five families were detected. Identification of these predatory and parasitic species is an important starting point for the biological control of bark beetles attacking oriental spruce in Turkey.

KEY WORDS Pinaceae, Scolytinae, parasitoid, predator, survey

Oriental spruce, *Picea orientalis* (L.) Link. (Pinaceae), is present from Ordu Province in Turkey northeastward to the Black Sea and the Caucasus Mountains in the country of Georgia. This species is semi-tolerant of shade and reaches optimal growth under climactic conditions of year-round heavy precipitation and high humidity. However, oriental spruce is able to grow in semi-drought conditions, but long summer droughts adversely affect growth because sufficient moisture may not be acquired by the shallow root system (Ata 1980). Various species of beetles, including several bark beetles (Coleoptera: Curculionidae: Scolytinae), attack oriental spruce (Bodenheimer 1958). Poor silvicultural practices, such as heavy pasturage, illegal cutting, and precipitous land structure, can promote population increases of bark beetles to epidemic levels (Yüksel 1998). Additionally, the effect of natural enemies could likely explain the drastic fluctuations of bark beetle populations (Reeve 1997, Erbilgin et al. 2002, Gilbert & Grégoire 2003) within this region. In similar systems in North America and Europe, habitat fragmentation can increase the number of pests relative to predators, such as *Thanasimus* spp. (Cleridae), in isolated patches of forests (Ryall & Fahig 2005, Warzée et al. 2006).

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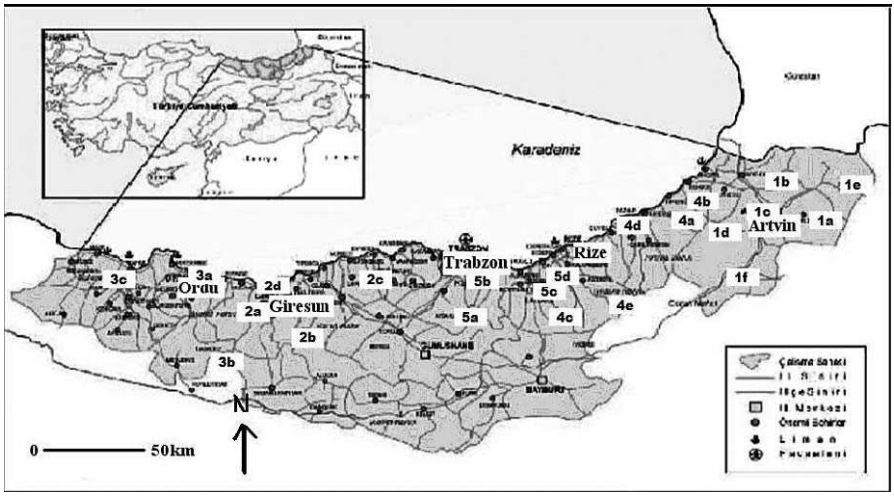

Fig. 1. The survey locations in the eastern Black Sea Region of Turkey—1a: Ardanuç District, Artvin Province; 1b: Borçka District, Artvin Province; 1c: Merkez District, Artvin Province; 1d: Murgul District, Artvin Province; 1e: Şavşat District, Artvin Province; 1f: Yusufeli District, Artvin Province; 2a: Bulancak District, Giresun Province; 2b: Dereli District, Giresun Province; 2c: Espiye District, Giresun Province; 2d: Merkez District, Giresun Province; 3a: Merkez District, Ordu Province; 3b: Mesudiye District, Ordu Province; 3c: Ünye District, Ordu Province; 4a: Ardeşen District, Rīze Province; 4b: Fındıklı District, Rīze Province; 4c: İkizdere, Rīze Province; 4d: Pazar District, Rīze Province; 4e: Çamlıhemşin District, Rīze Province; 5a: Maçka District, Trabzon Province; 5b: Merkez District, Trabzon Province; 5c: Sürmene District, Trabzon Province; and 5d: Of District, Trabzon Province.

For years, bark beetle control using mechanical and chemical methods has had limited success in Turkey (Selmi 1989). Mechanical methods of control (e.g., trapping with pheromone traps) are difficult to implement and chemical control methods (i.e., pesticides) may cause ecological and environmental problems. Recently, genetic and biological methods of control have come into prominence. Conservation and enhancement of natural enemies is a promising approach for decreasing the detrimental effects of bark beetle populations (Bodenheimer 1958). In this study, we surveyed the bark beetle species and their predators and parasitoids on oriental spruce in the eastern Black Sea Region of Turkey.

Materials and Methods

This study presents a survey of bark beetles and their natural enemies on oriental spruce in the Black Sea Region of Turkey in 2005–2006. Survey locations are marked on Figure 1.

Fifty vertical and horizontal trap trees were used to monitor bark beetle species (Christiansen & Bakke 1988). The vertical trap trees were either trees that were

Table 1. Bark beetle species (Coleoptera: Curculionidae: Scolytinae) collected from the Black Sea Region of Turkey (collection sites listed in Figure 1).

Subfamily	Tribe	Genus & species	Collection site
Hylesinini	Hylastina	*Hylastes angustatus*	5a
		Hylastes ater	1b,1e,3a,5a
		Hylastes cunicularis	1b,1e,5a
		Hylurgops glabratus	1a,1c,1e,5a
		Hylurgops palliatus	1a,1b,1c,1e,2a, 2d,3a,5a
		Blastophagus Tomicus minor	5a
		Blastophagus Tomicus piniperda	1e,5a
		Dendroctonus micans	1a,1b,1c,1d,1e,1f, 2a,2b,2c,2d,4b,4d
Scolytini	Crypturgina	*Crypturgus pusillus*	1a,1b,1e,1f, 2d,3a,3b,5a
	Cryphalina	*Cryphalus abietis*	1a,1b,1e,1f, 2d,3a,3b,5a
		Cryphalus piceae	1a,1b,1c,1d,1e,3a,5a
	Pityophthorina	*Pityophthorus pityographus*	1b,1c,1e,1f,5a,5c
		Pityophthorus pubescens	1e
	Ipina	*Pityogenes bidentatus*	1a,1b,1c,1e,2a,2b, 2d,3a,3b,3c, 4b,4d,5a,5c
		Pityogenes bistridentatus	1e
		Pityogenes chalcographus	1b,5b
		Pityogenes quadridens	1e
		Pityokteines spinidens	1a,1b,1c,1d, 1e,1f,2d,5a,5c
		Orthotomicus erosus	1a,1d,1f,3b,4a, 4c,4d,5a,5b
		Ips acuminatus	1a,1b,1e,1f,5a
		Ips sexdentatus	1a,1b,1c,1e,1f,2c, 2d,3a,3b,4a,4b, 4c,4d,4e,5a,5c
		Ips typographus	1a,1b,1c,1d,1e,1f
	Xyloterina	*Xyloterus lineatus*	1a,1b,1c,1e,1f,2a, 2d,3a,5a,5c,5d

dying due to bark beetle damage or trees that were killed by a ligature placed tightly around the trunk 1–2 m above the roots. The horizontal trap trees were trees that were left on the ground after logging (legally and illegally), and trees that had fallen over due to storms, snow, or winds. The trap trees were located in pure and mixed (with *Pinus* spp.) stands of oriental spruce (Bodenheimer 1958).

Logs of vertical or horizontal trap trees containing live larvae or pupae were collected from the field and placed into plastic boxes with small holes to allow

Table 2. Predator species and their reported prey insects in the Black Sea Region of Turkey (collection sites listed in Figure 1).

Species	Order	Family	Known prey species	Locality
Litargus connexus (Geoffr.)	Coleoptera	Mycetophagidae	*Hylastes ater*	5a
			Orthotomicus erosus	
			Ips sexdentatus	
Trigoderma versicolor (Creutz)		Dermestidae	*Dendroctonus micans*	1f
Nathrenus verbasci (Linnaeus)			*Pityokteines spinidens*	5b
Calyptomerus alpestris (Redt.)		Clambidae	*Pityophthorus pityographus*	1c
Rhizophagus grandis (Gyll.)		Rhizophagidae	*Dendroctonus micans*	1a,1b,1c,1d,1e,1f,
			Ips typographus	
Rhizophagus depressus (F.)			*Pityogenes bidentatus*	1e,5a
			Orthotomicus erosus	
			Ips acuminatus	
			Ips sexdentatus	
Rhizophagus dispar (Payk.)			*Hylurgops palliatus*	1a,1b,1c,1e,2a,
			Dendroctonus micans	3a,3b,3c,4a,4b,5a,5c
			Pityogenes bidentatus	
			Pityokteines spinidens	
			Orthotomicus erosus	
Rhizophagus ferruqineus (Payk.)			*Ips sexdentatus*	3a
Thanasimus formicarius (L.)		Cleridae	*Hylurgops palliatus*	1a,1b,1c,1e,1f,2a,
			Dendroctonus micans	2b,2c,2d,3a,3b,3c,5a,5c
			Cryphalus abietis	
			Cryphalus piceae	
			Pityophthorus pityogrophus	
			Pityogenes bidentatus	
			Pityokteines spinidens	
			Orthotomicus erosus	
			Ips acuminatus	
			Ips sexdentatus	
			Ips typographus	

Table 2. Continued.

Species	Order	Family	Known prey species	Locality
Clerus mutillarius (F.)			*Pityokteines spinidens*	1e
Nemosoma elongatum (L.)		Ostomidae	*Hylurgops palliatus*	1a,1c,1e,5a,5b
			Dendroctonus micans	
			Cryphalus piceae	
			Pityophthorus pityographus	
			Pityogenes bidentatus	
			Pityogenes bistridentatus	
			Pityokteines spinidens	
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	
Temnochila coerulea O.			*Cryphalus piceae*	1a,1c,1e
			Pityophthorus pityographus	
			Orthotomicus erosus	
			Ips acuminatus	
			Ips sexdentatus	
Thymalus limbatus (F.)			*Hylurgops palliatus*	1f,2d
			Cryphalus abietis	
			Pityogenes bidentatus	
			Ips typographus	
Ostoma ferruginea (L.)			*Hylurgops palliatus*	1c,2b
Cylister oblongum (F.)		Histeridae	*Orthotomicus erosus*	1e,1f,5a,5c
			Ips sexdentatus	
Cylister lineare (Er.)			*Ips sexdentatus*	5a
Plegaderus otti (Mars)			*Hylastes ater*	1b,1c,1f,5a
			Pityophthorus pityographus	
			Orthotomicus erosus	
			Ips sexdentatus	
Paromalus parallelepipedus (Hrbst.)			*Orthotomicus erosus*	1e,3c,5a
			Ips sexdentatus	

Table 2. Continued.

Species	Order	Family	Known prey species	Locality
Epuraea abietina (Sahl.)		Nitidulidae	*Hylurgops palliatus*	1c,1e,1f
			Dendroctonus micans	
			Pityogenes bidentatus	
			Ips sexdentatus	
			Ips typographus	
Epuraea pusilla (Illig.)			*Hylurgops palliatus*	1a,5a,5c
			Ips sexdentatus	
			Ips typographus	
Pityophagus ferrugineus (L.)			*Ips sexdentatus*	3a
Ipidia quadrimaculata (Q.)			*Ips sexdentatus*	
Glishrochilus quadripunctatus (L.)			*Ips sexdentatus*	1e,5a
Aulonium ruficorne (Ol.)		Colydiidae	*Crypturgus pusillus*	1a,1e,1f,5a
			Pityogenes bidentatus	
			Orthotomicus erosus	
			Ips acuminatus	
			Ips sexdentatus	
Colydium elongatum (F.)			*Cryphalus piceae*	1a,1c,1e
			Orthotomicus erosus	
			Ips typographus	
Ditoma crenata (F.)			*Pityophthorus pityographus*	1a,1b,1e,1f,2d,3a
			Pityogenes bidentatus	
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	
Cerylon impressum (F.)			*Hylastes ater*	1b,2d,5a
			Hylurgops palliatus	
			Pityophthorus pityographus	
Endophloeus markovichianus (Pill.)			*Hylurgops palliatus*	1a,5c
			Ips sexdentatus	
Penthelipsa inexpecta (Duv.)			*Hylastes ater*	1b,2d,5a
			Hylurgops palliatus	
			Dendroctonus micans	
			Ips sexdentatus	
			Orthotomicus erosus	

Table 2. Continued.

Species	Order	Family	Known prey species	Locality
Silvanus bidentatus (F.)		Cucujidae	*Hylurgops palliatus*	1a,1c,1e,5a
			Crypturgus pusillus	
			Cryphalus piceae	
			Pityokteines spinidens	
			Orthotomicus erosus	
Pediacus dermestoides (F.)			*Hylurgops palliatus*	2d,3a,5a
			Pityogenes bidentatus	
Cryptolestes alternans (Er.)			*Crypturgus pusillus*	1a,1e,5a
			Cryphalus piceae	
			Pityophthorus pityographus	
			Pityogenes bidentatus	
Laemophloeus testaceus (F.)			*Pityogenes bidentatus*	5a
			Orthotomicus erosus	
Hypophloeus unicolor (Piller and Mitterp.)		Tenebrionidae	*Ips sexdentatus*	1b,2a,2c,2d
Paraphloeus longulus (Gyll.)			*Orthotomicus erosus*	1a,1e,5a
			Ips acuminatus	
			Ips sexdentatus	
			Ips typographus	
Paraphloeus fraxini (Kug.)			*Orthotomicus erosus*	1e,1f
			Ips sexdentatus	
			Ips typographus	
Paraphloeus linearis (Fabr.)			*Dendroctonus micans*	1a,1c,1e,5a
			Crypturgus pusillus	
			Cryphalus piceae	
			Pityophthorus pityographus	
			Pityogenes bidentatus	
			Pityokteines spinidens	
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	

Table 2. Continued.

Species	Order	Family	Known prey species	Locality
Menephilus cylindricus (Hrbst.)			*Ips sexdentatus*	1e
Hoplocephala haemorrhoidalis (Fabr.)			*Dendroctonus micans*	2b
Dromius quadrimaculatus (L.)		Carabidae	*Dendroctonus micans*	1e
Cis hispidus (Gyll.)		Cisidae	*Pityophthorus pityographus*	5a
Anisotoma humeralis (F.)		Liodidae	*Ips sexdentatus*	5c
Agathidium nigripenne (F.)			*Hylurgops palliatus*	3c,5a
			Ips sexdentatus	
Agathidium seminulum (L.)			*Hylurgops palliatus*	1b,2d,3a,5a,5c
			Pityogenes bidentatus	
			Ips sexdentatus	
			Ips typographus	
Rhinosimus ruficollis (L.)		Pythidae	*Ips sexdentatus*	3c
Platichna scutellaris (Charp.)		Erotylidae	*Hylurgops palliatus*	3a
Megalelophorus aquaticus (L.)		Hydraenidae	*Pityogenes bidentatus*	5a
Goerius olens (Müll.)		Staphylinidae	*Ips sexdentatus*	1e,2b,3a,5a
Staphylinus caesareus (Ced.)			*Ips sexdentatus*	5a
Megarthrus depressus (Payk.)			*Hylurgops palliatus*	5a
Omalium rivulare (Payk.)			*Hylurgops palliatus*	1d,2d,3a
			Pityophthorus pityographus	
Omalium exiguum (Gyll.)			*Hylurgops palliatus*	5a
Stenus scrutator (Er.)			*Orthotomicus erosus*	1e
Paedoris litoralis (Grav.)			*Orthotomicus erosus*	1b,1e,5a
			Ips sexdentatus	
			Ips typographus	
Stilicus mixtus (Lohse)			*Ips sexdentatus*	5a
Scopaeus bicolor (Baudi)			*Hylurgops palliatus*	5a
Achenium depressum (Grav.)			*Ips sexdentatus*	5a
Metoponcus brevicornis (Er.)			*Pityokteines spinidens*	1b,1c,5a
			Ips sexdentatus	

Table 2. Continued.

Species	Order	Family	Known prey species	Locality
Nudobius umbratus (Motsch.)			*Pityophthorus pityographus*	1a,1b,1c,1e,2b,2d,
			Pityogenes bidentatus	3a,3c,4c,5a
			Pityokteines spinidens	
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	
Nudobius sp.			*Ips typographus*	1e
Playtdracus chalcocephalus (F.)			*Ips sexdentatus*	5a
Microsaurus lateralis (Grav.)			*Dendroctonus micans*	1a,1b,1e,5a,5c
			Pityogenes bidentatus	
			Ips sexdentatus	
			Ips typographus	
Microsaurus vexans (Epph.)			*Ips sexdentatus*	1e,3c
			Ips typographus	
Microsaurus sp.			*Hylurgops palliatus*	1e
			Ips typographus	
Quedius curtipennis (Bernh.)			*Ips sexdentatus*	3a
Raphirus sp.			*Ips sexdentatus*	3a
Bryocharis cingulata (Mannh.)			*Hylurgops palliatus*	5a
Conosoma littoreum (L.)			*Ips typographus*	1e
Conosoma immaculatum (Steph.)			*Ips sexdentatus*	3a
Drymoporus elongatus (Gyll.)			*Hylurgops palliatus*	1a
Tachinus laticollis (Grav.)			*Hylurgops palliatus*	2d,5a
Placusa complanata (Er.)			*Hylurgops palliatus*	1a,1c,1e,2d,3a,5a
			Dendroctonus micans	
			Crypturgus pusillus	
			Pityogenes bidentatus	
			Pityokteines spinidens	
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	

Table 2. Continued.

Species	Order	Family	Known prey species	Locality
Baptolinus affinis (Payk.)			*Hylurgops palliatus*	1b,1e,1f,2d,3a,5a
			Dendroctonus micans	
			Pityophthorus pityographus	
			Crypturgus pusillus	
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	
Homalota plana (Gyll.)			*Pityophthorus pityographus*	1c
Bolitochora lucida (Grav.)			*Hylurgops palliatus*	1f
Exochomus illaesicollis (Roubal)		Coccinellidae	*Dendroctonus micans*	1c
Formica rufa (L.)	Hymenoptera	Formicidae	*Dendroctonus micans*	1a,1c,1e,3a
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	
Myrmica ruginodis (Nyl.)				1b
Raphidia ophiopsis (L.)	Raphidioptera	Raphidiidae	*Hylurgops palliatus*	1a,1e,1f,5a
			Dendroctonus micans	
			Crypturgus pusillus	
			Cryphalus piceae	
			Pityophthorus pityographus	
			Pityogenes bidentatus	
			Orthotomicus erosus	
			Ips sexdentatus	
			Ips typographus	
			Tetropium castaneum	
Lyctocoris campestris (Fall.)	Heteroptera	Anthocoridae	*Cryphalus abietis*	1f
			Pityophthorus pityographus	
			Pityogenes bidentatus	
			Pityokteines spinidens	
Scoloposcelis angusta (Reitt.)			*Cryphalus abietis*	1b
			Pityophthorus pityographus	

ventilation and prevent dampness and mildew. The logs were kept in glass rearing cages in the laboratory and the live larvae and pupae were reared until adult emergence. Adults collected from the collected logs were used for identification.

Identification of the bark beetles and their natural enemies were based on Bernhard (1935), Essig (1958), Freude et al. (1967, 1974, 1979), Postner (1974), Grüne (1979), Schedl (1980), Selmi (1989), Weslien et al. (1989), Wermelinger (2004), and Sariyildiz et al. (2008). Furthermore, specialists (Temel Sariyildiz, Kastamonu University, Kastamonu, Turkey, and Erdal Selmi, Istanbul University, Istanbul, Turkey) were contacted for identifications of these species and confirmed identifications.

Results and Discussion

Twenty-three species of bark beetles from six subtribes and two tribes of Scolytinae were found in the oriental spruce stands in this study (Table 1). Twelve of the 23 species are known as primary bark beetle species of spruce. They are *Hylurgops glabratus* (Zett.), *Hylurgops palliatus* (Gyll.), *Hylastes cunicularius* (Erich.), *Dendroctonus micans* (Kug.), *Crypturgus pusillus* (Gyll.), *Pityophthorus pityographus* (Ratz.), *Pityogenes bidentatus* (Herb.), *Pityokteines spinidens* (Reiit.), *Ips sexdentatus* (Boern.), *Ips typographus* (L.), *Orthotomicus erosus* (Woll.), and *Xyloterus lineatus* (Erich.) (Schedl 1980).

Cryphalus piceae (Ratz.) and *Pityokteines spinidens* generally develop in the upper parts of the trees on thin boughs, but they also can attack larger branches or trunk during an outbreak (Schimitschek 1953). *Hylastes ater* (Payk.) can develop on roots that break through the ground and on the adjacent trunk (Milligan 1978). *Ips sexdentatus* generally prefers older trees (Schimitschek 1947). *Ips acuminatus* (Gyll.) damages younger trees or thin boughs of old trees (Postner 1974). *Ips typographus* prefers young trees (Sariyildiz et al. 2008). *Hylastes ater* and *H. cunicularis* can suffice on thicker ancillary roots that appear on the ground after storm damage (Akkuzu & Guner 2008).

Cryphalus abietis (Ratz.) and *C. piceae* do not kill spruces but they severely weaken trees and create opportunities for other bark beetles (Bodenheimer 1958). *Crypturgus* species compete with more harmful bark beetles, such as *I. sexdentatus,* preventing their development and causing death. Hence, *Crypturgus* species can be viewed as both harmful and beneficial species. Under optimal conditions, *Pityogenes bidentatus* populations can quickly grow to large numbers and cause serious harm to younger spruces (Christiansen & Bakke 1988). The tunnels of *X. lineatus* can turn black, which reduces the quality and value of the lumber (Yüksel 1998).

Eighty-six predator species from 23 families were collected from oriental spruce forests in the Black Sea Region of Turkey (Table 2). The predatory species that are most effective and have the highest populations can be arranged in the following order of importance: *Thanasimus formicarius* (L.), *Rhizophagus depressus* (F.), *R. grandis* (Gyll.), *R. dispar* (Payk.), *Silvanus bidentatus* (F.), *Paraphloeus longulus* Gyll., *Raphidia ophiopsis* L., *Formica rufa* L., *Nemosoma elongatum* (L.), and *Paraphloeus linearis* F. (Postner 1974, Essig 1958, Grüne 1979, Schedl 1980).

In addition, 23 parasitoid species from five families were collected during this study (Table 3). Many of these natural enemies may prove useful in the biological control of bark beetles in Turkey (Wermelinger 2004). Successful biological

Table 3. Parasitoid species (all Hymenoptera) and host insect species in the Black Sea Region of Turkey (collection sites listed in Figure 1).

Family	Species	Known host insect	Locality
Pteromalidae	*Pteromalus lanceolatus* (Ratz.)	*Ips sexdentatus*	5a
	Rhopalicus suspencus (Ratz.)	*Orthotomicus erosus*	5a
		Ips sexdentatus	
		Ips typographus	
	Rhopalicus tutela (Walker)	*Dendroctonus micans*	1e
		Pissodes notatus	
		Pityokteines curvidens	
	Entedon pineterum (Ratz.)	*Ips sexdentatus*	5a
	Roptrocerus brevicornis (Thorns.)	*Crypturgus pusillus*	1f
		Pityophthorus pityographus	
		Pityogenes bidentatus	
		Orthotomicus erosus	
	Roptrocerus sp.	*Hylurgops palliates*	1f
		Crypturgus pusillus	
		Cryphalus piceae	
		Pityophthorus pityographus	
		Pityokteines spinidens	
		Ips typographus	
	Dinotiscus eupterus (Walk.)	*Cryphalus abietis*	1f
		Cryphalus piceae	
		Pityophthorus pityographus	
	Macromesus ampfiretus (Walk.)	*Cryphalus abietis*	1f
	Macromesus sp.	*Cryphalus abietis*	1c
		Pityogenes bidentatus	
Torymidae	*Monodontomerus opsoletus* (Fabr.)	*Pityogenes bidentatus*	1a
Pteromalidae	*Dibrachys boarmiae* (Walk.)	*Hylastes ater*	1c
Cleonymidae	*Cheiropachys colon* (L.)	*Ips sexdentatus*	1a, 5a

Table 3. Continued.

Family	Species	Known host insect	Locality
Ichneumonidae	*Endasys* sp.	*Pityophthorus pityographus*	1f
	Megastylus sp.	*Pityogenes bidentatus*	1f
Bethylidae	*Scleroderma* sp.	*Dendroctonus micans*	1b
Braconidae	*Coeloides bostrichorum* (Gir.)	*Pityokteines curvidens*	1a,1e
	Coeloides abdominalis (Zett.)	*Ips sexdentatus*	1e,5a
	Dendroster middendorffii (Ratz.)	*Ips sexdentatus*	1e,1f,2d,5a
	Dendroster middendorffii (Ratz.var Schmitscheki F.)	*Ips sexdentatus*	5a
	Dendroster protuberans (Nees.)	*Dryocoestes minör*	5a
		Ips sexdentatus	
	Calyptrus atricornis (Ratz.)	*Ips sexdentatus*	1c
	Meteorus sp.	*Cryphalus piceae*	1c
		Ips typographus	
	Meteorus varinervis (Tobias)	*Cryphalus piceae*	1c
		Pityophthorus pityographus	

control programs require that the appropriate predators and parasitoid species be chosen for each pest species (Yüksel 1998). Increasing predator populations could be achieved by releasing predatory species that are likely to control bark beetle outbreaks (Reeve 1997). For instance, *T. formicarius* could be released through augmentative releases of adults (Hopkins 1899), or by using eggs deposited on or nearby infested trees (Weslien & Regnander 1992, Costa & Reeve 2012) during *Ips* outbreaks.

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