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Relative Abundance, Within-Tree Distribution, and Emergence Periods of Insect Species Associated with Mountain Pine Beetle-Infested Lodgepole Pine in Central Idaho and Northeastern Oregon

Mark P. Chatelain and John A. Schenk

ABSTRACT

Relative abundance, and within-tree distribution of insect species associated with mountain pine beetle- (*Dendroctonus ponderosae* Hopkins) infested lodgepole pine (*Pinus contorta*, var. *latifolia* Engelm.) were determined by sampling infested trees in central Idaho and northeastern Oregon at various height intervals. Fifty-four insect species from eight orders were collected, including several species previously unreported. Emergence periods were determined for most of the insect species collected in central Idaho. Feeding habits are discussed.

INTRODUCTION

An annotated list of the parasites, predators and other associates of mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopkins, in lodgepole pine (LPP), *Pinus contorta* var. *latifolia* Engelm., and western white pine, *Pinus monticola* Douglas, was published by DeLeon (1934). The list provided information on feeding habits, seasonal occurrence and abundance of many species. Quantitative data on abundance of many species were lacking, and little information on emergence periods and within-tree distribution was provided. This paper presents additional information on relative abundance, within-tree distribution and emergence periods of insect species associated with MPB-infested LLP in central Idaho and northeastern Oregon. Feeding habits for each species, as reported in the literature (Bushing 1965, Dahlsten and Stephen 1974), also are presented.

The authors are former graduate student, now Department of Natural Resources, Office of Environmental Affairs, Air Quality Division, New Orleans, Louisiana, and Forest Resources Professor, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, respectively.

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METHODS AND PROCEDURES

Sampling was conducted in seven LPP stands located in the Payette National Forest in Idaho and in the Wallowa-Whitman National Forest in Oregon (Table 1). The stands were selected because each contained a declining infestation of MPB, where higher populations of associated entomophagous insect species were expected (Billings 1970).

Most stands were sampled several times during the 3-year study to assure representation of differing generations and developmental periods of MPB in a variety of geographic areas. However, some stands were sampled in only one year. For example, Paddy Flat stands 1-4 were sampled in October 1977, and again in both July and October of 1978 and 1979; the McCubbin stand was sampled in September and November of 1979; and the Sled Springs and McCall stands each were sampled in May 1978.

At each sampling date, two currently infested (brood) trees in each of four, 5-cm diameter (breast height) classes (17, 22, 27 and 32 cm) were felled at 40-m intervals in each of the seven stands. An equal number of emergent trees (from which the beetles had recently emerged) in each of the four DBH classes also were selected in the McCubbin stand in November 1979 to determine whether the incidence of various insect species differed between brood and emergent trees for a given time and stand.

Slab samples (15 x 30 cm) were removed at 2-m intervals along the north-facing aspect of each felled tree in all stands. Three additional slabs from the 0.8, 1.3 and 1.8-m (upper dimensions) levels were removed from the lower bole along the same aspect to increase sampling intensity. Slabs from all but the McCall stand in 1978 were stored at 10°C for subsequent examination, at which time the number, stage and feeding site of each insect species present were recorded to determine relative abundance and within-tree distribution. The slabs obtained in 1978 from the McCall stand were enclosed with nylon screen cages in early June. These were examined at weekly intervals until December 1978 to determine the emergence periods of each species present at the time of caging, and to obtain specimens for identification.

Table 1. Mensurational and site characteristics of mountain pine beetle infested stands, central Idaho and northeastern Oregon.

	Paddy Flat, Idaho				McCall, Idaho	Sled Springs, Oregon	McCubbin, Oregon
	1	2	3	4			
Stand characteristics (year)	1977	1977	1977	1977	1977	1977	1978
Size (ha)	10.1	14.2	6.1	7.7	9.3	2.1	12.1
Crown competition factor	75.1	87.9	106.7	105.9	135.4	115.5	133.2
LLP in basal area (%)	100.0	92.6	95.0	100.0	92.5	97.2	87.6
Mean age of LPP	87.5	83.5	86.4	90.1	88.7	73.2	77.4
Mean DBH of LPP (cm)	23.4	20.8	20.1	21.3	24.5	20.1	17.3
Mean no. LPP trees killed/ha							
- prior to 1977	83.4	126.5	60.2	67.7	61.2	40.1	14.5
- during 1977	28.2	23.9	20.0	15.9	13.5	28.4	20.2
- during 1978	16.1	18.9	69.7	14.6	8.7	–	16.2
- during 1979	–	20.4	46.1	–	–	–	18.6
Site characteristics							
Elevation (m)	1524	1524	1524	1524	1555	1300	1341
Slope (%)	0	0	0	0	0	0	0-10
Aspect	Flat	Flat	Flat	Flat	Flat	Flat	NE
Habitat type[a]	Abla/Vasc	Abla/Vasc	Abla/Vasc	Abla/Vasc	Abla/Vasc	Abla/Libo	Abla/Libo

[a] Abla/Vasc = *Abies lasiocarpa/Vaccinium scoparium;* Abla/Libo = *Abies lasiocarpa/Linnaea borealis*

RESULTS AND DISCUSSION

Fifty-four insect species from 8 orders were collected from the MPB brood trees (Table 2). The six scolytid species were present in substantially greater numbers than all other insect associates, with *Pityopthorus confertus* Swaine the most abundant species. The within-tree distribution for each bark beetle species was fairly constant among trees. However, the abundance of any one species varied among trees even within the same stand. No attempt was made to determine the causes for this variation, but previous studies have shown that such factors as climatic conditions (Safranyik and Jahren 1970), food quantity and quality (Berryman 1976), inter- and intra-specific competition (Cole 1962, 1973 a, b, 1974, 1975) and tree resistance (Berryman 1976) may affect bark beetle host preferences, survival and abundance. These scolytids normally feed on injured, dying and recently dead trees, but when such material is no longer available, they may attack and kill some residual trees (Chamberlin 1935, Furniss and Carolin 1977, Reid 1955, Sartwell et al. 1971).

Fourteen predaceous and 3 parasitoid insect species were collected, in addition to 4 species considered facultative predators by DeLeon (1934). The number of individual predators usually was greater than parasitoids. The most commonly collected entomophagous insect species were: *Medetera aldrichii* (Wheeler), *Lonchaea* sp., *Coeloides rufovariegatus* (Provencher), *Rhopalicus pulchripennis* (Crawford), *Enoclerus sphegeus* (Fabricius) and *Thanasimus undatulus* (Say) (Table 2). These and other entomophagous species often occurred throughout the MPB-infested portions of trees. However, predators were concentrated in the lower to mid-bole, while parasitoids were found more frequently in the upper bole. These distribution patterns may be related in part to varying bark thicknesses along the tree bole. For example, *Rhopalicus pulchripennis* (Crawford), a hymenopterous parasitoid of MPB, prefers to oviposit in smooth rather than rough bark in sugar pine, *Pinus lambertiana* Douglas (Ball and Dahlsten 1973). However, many other factors, such as host density and moisture content of the inner bark surface (Billings 1970), also may have influenced within-tree distribution patterns of these species.

The adult emergence period for many of the entomophagous species lasted several weeks (Table 2), with several beginning before and ending during MPB emergence. In the McCubbin stand, many of the entomophagous insect species were present in samples removed from both brood and emergent trees. This suggests that such species emerging before MPB emergence may oviposit in brood trees attacked the previous year, while individuals of a species emerging during MPB emergence may oviposit either in recently-attacked trees or in trees attacked the previous year. Several entomophagous species (e.g., *Enoclerus sphegeus* F.) were capable of completing development in MPB vacated (emergent) trees, emerging the following year, and ovipositing in trees recently or currently under attack by MPB.

These preliminary observations of within- and between-tree distributions of the various entomophagous insects, and the suggestion that emergent trees provide a breeding habitat for those species, indicated that emergent trees should be left in the stand for at least one year following MPB emergence. This practice, with the concurrent removal of brood trees during harvest (salvage) or control cuttings, would conserve a proportion of the entomophagous insect population, and reduce MPB populations. Testing the above hypothesis and the efficacy of a pheromone-based control tactic served as objectives for subsequent studies in the same stands.

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Table 2. Relative abundance, within-tree distribution, emergence periods and feedings of insects associated with mountain pine beetle-infested lodgepole pine stands in central Idaho and northeastern Oregon, 1977-79.

	Height found (m)	Emergence[a] period	Abundance[b] category	Feeding habits
		COLEOPTERA		
Scolytidae				
Dendroctonus ponderosae Hopkins	0 – 14.3	7/6 – 8/20	VA	Herbivorous (phloem)
Gnathotrichus retusus (LeConte)	0 – 0.8	7/6 – 7/30	R	Herbivorous (phloem & xylem)
Ips latidens (LeConte)	12.0 – 12.3	6/20 – 7/6	R	Herbivorous (phloem)
Ips mexicanus (Hopkins)	0 – 16.3	6/20 – 8/6	O	Herbivorous (phloem)
Pityogenes knechteli Swaine	1.0 – 24.3	7/16 – 8/6	A	Herbivorous (phloem)
Pityophtorus confertus Swaine	0 – 24.3	6/20 – 8/20	VA	Herbivorous (phloem)
Ips pini (Say)	0 – 24.3	?	A	Herbivorous (phloem)
Staphylinidae				
Aleocharinae[c]	4.0 – 4.3	7/16 – 7/23	R	Predaceous
Aleocharinae[c]	10.0 – 10.3	6/20 – 7/6	R	Predaceous
Quedius laevigatus (Gyllenhal)	1.5 – 2.3	6/20 – 7/6	R	Predaceous
Nitidulidae				
Epuraea sp.[c]	0 – 16.3	6/20 – 8/13	A	Saprophagous
Tenebrionidae				
Corticeus praetermissus (Fall)	1.5 – 20.3	6/20 – 7/6	R	Facultative predator
Corticeus subopacus (Wallis)	0.5 – 0.8	?	R	Facultative predator
Bius estriatus (LeConte)	0 – 0.3	7/16 – 7/23	R	?
Colydiidae				
Lasconotus complex LeConte	10.0 – 10.3	7/6 – 7/23	R	Facultative predator
Lasconotus subcostulatus Kraus	18.0 – 18.3	7/6 – 7/23	R	Facultative predator
Curculionidae				
Rhyncolus sp.	0 – 0.3	?	R	Xylophagous
Rhizophagidae				
Rhizophagus scalpturatus Mannerheim	1.5 – 1.8	6/20 – 7/6	R	Predaceous
Cryptophagidae				
Atomaria sp.[c]	2.0 – 2.3	7/6 – 7/16	R	?
Elateridae sp.[c]				
Ctenicera sp.[c]	0.5 – 0.8	7/7 – 7/16	R	?
Melandryidae				
Xylita laevigata Hell	4.0 – 4.3	7/6 – 7/23	R	?
Lathridiidae				
Corticaria dentigera LeConte	0.5 – 0.8	7/30 – 8/6	R	Saprophagous
Cerambycidae				
Neacanthocinus obliqus LeConte	12.0 – 12.3	8/6 – 8/13	R	Herbivorous (bark & xylem)
Cantharidae[c]	0 – 1.8	?	O	Saprophagous
Cucujidae				
Cucujus clavipes Fabricius	0 – 0.3	8/6 – 8/13	R	Predaceous
Cryptolestes angustulus (Le Conte)	0.5 – 1.8	?	R	Predaceous
Cleridae				
Enoclerus sphegeus (Fabricius)	0 – 14.3	9/1 – 9/20	O	Predaceous
Thanasimus undatulus (Say)	0 – 14.3	5/15 – 9/1	O	Predaceous

Table 2. Continued

	Height found (m)	Emergence[a] period	Abundance[b] category	Feeding habits
Trogositidae				
Temnochila sp.[c]	0 – 1.8	?	R	Predaceous
Corticotomus sp.[c]	0 – 1.8	?	R	?
Dermestidae				
Megatoma cylindrica Kirby	0 – 1.3	?	R	Saprophagous
Ptinidae				
Ptinus fur (L.)	1.5 – 1.8	?	R	?
Carabidae				
Promius pioeus Dej.	1.0 – 1.3	?	R	?
		COLLEMBOLA		
Entomobryidae				
Entomobrya nivalis	0.5 – 0.8	6/20 – 7/16	R	Saprophagous
		DIPTERA		
Cecidomyiidae				
Micromya sp.[c]	0.5 – 2.3	6/20 – 7/16	R	Saprophagous
Cecidomyia sp.[c]	6.0 – 8.3	6/20 – 7/16	R	Saprophagous
Lonchaeidae				
Lonchaea sp. *corticis* group	0 – 12.3	6/20 – 8/6	A	Predaceous
Dolichopodidae				
Medetera aldrichii Wheeler	0 – 10.3	7/6 – 8/13	A	Predaceous
Phoridae				
Megaselia sp.[c]	0 – 12.3	7/16 – 7/23	R	Saprophagous
Sciaridae				
Bradysia sp.[c]	0 – 1.3	?	R	Saprophagous
Xylophagidae				
Xylophagus sp.[c]	0.5 – 0.8	?	?	Predaceous
		PSOCOPTERA		
Psocidae				
Amphigerontia bifasciata (Latr.)	6.0 – 6.3	7/23 – 7/30	R	Saprophagous
Loensia maculosa (Banks)	1.5 – 1.8	8/13 – 8/20	R	Saprophagous
		NEUROPTERA		
Raphidiidae				
Raphidia (+Agulla) sp.[c]	0 – 14.3	7/6 – 8/13	R	Predaceous
Coniopterygidae				
Parasemidalis fuscipennis (Reuter)	18.0 – 18.3	6/20 – 7/6	R	Saprophagous
Hemerobiidae				
Hemerobius sp.[c]	6.0 – 6.3	7/6 – 7/16	R	?
		HEMIPTERA		
Anthorcoridae[c]	0 – 14.3	?	C	Predaceous

Table 2. Continued

	Height found (m)	Emergence[a] period	Abundance[b] category	Feeding habits
		HYMENOPTERA		
Braconidae				
Coeloides rufovariegatus (Provencher) (= *C. dendroctoni*)	0 – 0.3	6/20 – 8/13	C	Parasitic
Dendrosoter scaber Mues.	12.0 – 24.3	8/6 – 8/13	R	Parasitic
Pteromalidae				
Rhopalicus pulchripennis (Crawford)	0 – 16.3	6/20 – 7/30	C	Parasitic
Siricidae				
Sirex juvencus californicus Ashmead	1.0 – 1.3	?	R	Saprophagous
		LEPIDOPTERA		
Gelechiidae[c]	8.0 – 20.3	7/6 – 8/6	R	Saprophagous
Nemapoginae[c]	1.5 – 1.8	?	R	?
		DERMAPTERA		
Forficulidae				
Forficula auricularia L.	0 – 2.3	?	O	Saprophagous

[a]Determined for McCall stands only

[b]R = rare, 1-5 indiv.; O = occasional, 6-19 indiv.; C = common, 20-49 indiv.; A = abundant, 50-200 indiv.; VA = very abundant, >200 indiv.

[c]Species unidentified.

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