

Seasonal Abundance of *Temnochila chlorodia* (Mannerheim) (Coleoptera: Trogositidae) Collected in Western Pine Beetle Pheromone-Baited Traps in Northern California¹

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Abstract Bark beetles (Coleoptera: Scolytidae) are commonly recognized as the most important mortality agent in western coniferous forests. In this study, we describe the abundance of bark beetle predators collected in multiple-funnel traps baited with *exo-brevicomin*, *frontalin* and *myrcene* in northern California during 2003 and 2004. A total of 32,903 *Temnochila chlorodia* (Mannerheim), 79 *Enoclerus lecontei* (Wolcott), and 12 *E. sphegeus* (F.) were collected. The seasonal abundance of *E. lecontei* and *E. sphegeus* was not analyzed because too few individuals were collected. In general, *T. chlorodia* was most abundant in late spring, but a second smaller peak in activity was observed in late summer. Overall, the ratio of males to females was 0.82. A significant temporal effect was observed in regard to sex ratios with more males collected during later sample periods. *Temnochila chlorodia* flight activity patterns were similar between years, but activity was generally delayed several weeks in 2003.

Key Words *Dendroctonus brevicomis*, *Temnochila chlorodia*, *Enoclerus lecontei*, *Enoclerus sphegeus*, *Pinus ponderosa*, flight periodicity, seasonal abundance

Bark and ambrosia beetles (Coleoptera: Scolytidae) are a diverse group of subcortical insects consisting of approximately 550 species in North America and over 6,000 species worldwide (Wood 1982). The genera *Dendroctonus*, *Ips* and *Scolytus* are widely recognized as the most important mortality agents in western coniferous forests (Furniss and Carolin 1977). Aggregation pheromones of a few economically important species, such as the western pine beetle, *Dendroctonus brevicomis* LeConte, have been identified and synthesized (Skillen et al. 1997). *Dendroctonus brevicomis* is a major cause of ponderosa pine, *Pinus ponderosa* Dougl. ex Laws, mortality. Under certain conditions, the beetle can aggressively attack and kill apparently healthy trees of all ages and size classes. During host colonization, female *D. brevicomis* produce (+)-*exo-brevicomin* whereas males produce *frontalin*. Both pheromones elicit an aggregation response (Wood et al. 1976, Browne et al. 1979). *Myrcene*, a host monoterpene of *P. ponderosa*, enhances this response (Bedard et al. 1969). The three components are commercially packaged as a tree bait and trap lure (Phero Tech Inc., Delta, BC).

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Over 110 species of insects in 55 families have been identified as associates of *D. brevicomis* (Stephen and Dahlsten 1976). Species richness increases with successive changes in microhabitat from primary brood development (Stephen and Dahlsten 1976) through total tree decomposition (Dahlsten 1970). Many arthropod associates respond kairomonally to individual bark beetle pheromone components or blends (Wood et al. 1968, Wood 1970, Seybold et al. 1992) and host volatiles (Chenier and Philogene 1989, Byers 1992, Joseph et al. 2001). The predatory beetles *Temnochila chlorodia* (Mannerheim) (Coleoptera: Trogositidae) and *Enoclerus lecontei* (Wolcott) (Coleoptera: Cleridae) are among the first insects to respond to *D. brevicomis*-attacked trees (Dahlsten 1970, Stephen and Dahlsten 1976).

Temnochila chlorodia is a common predator of many bark beetle species including such economically important species as *D. brevicomis* (Stephen and Dahlsten 1976), the mountain pine beetle, *D. ponderosae* Hopkins (Struble 1942), and the Jeffrey pine beetle, *D. jeffreyi* Hopkins (Pitman et al. 1969). The larvae develop within the inner bark and feed on bark beetle brood. The adults are also highly predaceous and may be important in regulating bark beetle populations at endemic levels (Furniss and Carolin 1977). *Temnochila chlorodia* is thought to be univoltine in the central Sierra Nevada (Person 1940). Significant numbers have been collected in traps containing *exo-brevicommin* (Pitman and Vité 1971, Bedard et al. 1980).

Enoclerus lecontei is more prey specific than *T. chlorodia* and exhibits a strong preference for *D. brevicomis* over congeners (Berryman 1970). The larvae of *E. lecontei* are predaceous on bark beetle larvae, and the adults consume both larvae and adults (Furniss and Carolin 1977). The species is most commonly univoltine in the central Sierra Nevada (Person 1940). Myrcene is attractive to *E. lecontei* (Pitman and Vité 1971). Two closely-related species, *E. spegheus* F. and *Thanasimus undatulus* (Say), occur at low densities in the Sierra Nevada (Hardwood and Rudinsky 1966, Stephen and Dahlsten 1976). *Enoclerus spegheus* is attracted to ipsdienol (Seybold et al. 1992) and *trans-verbenol* (Schmitz 1978). *Thanasimus undatulus* is attracted to frontalin (Pitman and Vité 1970) and frontalin and seudenol (Zhou et al. 2001).

The use of semiochemicals in bark beetle trapping studies provides a unique opportunity to survey associated insects. The objectives of this study were to describe the relative abundance, seasonal abundance, and sex ratios of *T. chlorodia*, *E. lecontei*, *E. spegheus*, and *T. undatulus* responding to traps baited with *D. brevicomis* pheromone components at four locations in northern California.

Materials and Methods

This study was conducted during 2003 and 2004 on the Goosenest Ranger District, Klamath National Forest (41.6° N, 121.9° W; 1502 m mean elevation), McCloud Ranger District, Shasta-Trinity National Forest (41.3° N, 122.0° W; 1184 m), Black's Mountain Experimental Forest, Lassen National Forest (40.7° N, 121.1° W; 1759 m), and Placerville Ranger District, Eldorado National Forest (38.6° N, 120.5° W; 1497 m). These locations were selected on the basis of variation in *D. brevicomis* activity (i.e., Shasta-Trinity > Lassen > Eldorado > Klamath). The forest cover type was Sierra mixed-conifer. Tree species composition and abundance varied among sites, but typically included *P. ponderosa*, white fir, *Abies concolor* (Gond. and Glend.) Hildebr., incense cedar, *Libocedrus decurrens* Torr., sugar pine, *P. lambertiana* Dougl., Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco, Jeffrey pine, *P. jeffreyi* Grev. and Balf.,

lodgepole pine, *P. contorta* Dougl. ex. Laws., and miscellaneous other species. Slopes ranged from <2-35% with all aspects included.

At each location, ten 16-unit multiple-funnel traps (Lindgren 1983; Phero Tech Inc., Delta, BC) were deployed along existing roads at >800 m intervals when each site first became accessible in spring following sufficient snowmelt. This time varied between years and among sites: 1 April and 30 March (Lassen), 9 April and 30 March (Shasta-Trinity), 20 and 2 April (Eldorado), and 5 May and 29 March (Klamath), 2003 and 2004. Traps were hung on 3-m metal poles with collection cups approximately 1 m from the ground, and placed >8 m from any living pine. One western pine beetle tree bait (Phero Tech Inc., Delta, BC) consisting of *exo-brevicomin*, *frontalin* and *myrcene* was attached to each trap (release rates: 1-3 mg/24 h, 1-3 mg/24 h, 15-20 mg/24 h @ 24°C, respectively) and replaced bimonthly. All semiochemicals were released from individual polyethylene tubes (250 µL, 250 µL, and 1.8 ml (2X), respectively). A 3-cm time-released insecticidal Prozap Pest Strip (2,2-dichlorovinyl dimethyl phosphate, Loveland Industries Inc., Greeley, CO) was placed in the trap cup to kill arriving insects, and prevent damage or loss by invertebrate predation.

Insects were collected every 7-10 d and the numbers of *T. chlorodia*, *E. lecontei*, *E. spegheus* and *T. undatulus* were recorded for each sample date and site. We limited descriptions of seasonal abundance and sex ratios to species for which substantial numbers (>250) were caught. *Temnochila chlorodia* were sexed based on the presence of a submental pit on the male (Struble and Carpelan 1941). Voucher specimens are available at the USDA Forest Service Bark Beetle and Common Associates Collection housed in Placerville, CA.

Results and Discussion

A total of 32,903 *T. chlorodia*, 79 *E. lecontei*, and 12 *E. spegheus* were collected from early April through mid-October 2003-2004 (Table 1). All three species were present at each site. Total predator abundance was highest at Eldorado and represented 39.5% of total trap catches (Table 1). *Thanasimus undatulus* was not collected

Table 1. Bark beetle predators caught in multiple-funnel traps (n = 10 per site) baited with *Dendroctonus brevicomis* LeConte pheromones at four locations in northern California, 2003 and 2004

Location	<i>T. chlorodia</i>	<i>E. lecontei</i>	<i>E. spegheus</i>	Totals
Goosenest RD, Klamath NF*	2,048 (99.8)**	4 (0.2)	1 (0.0)	2,053
	3,496 (99.8)***	4 (0.2)	0 (0.0)	3,500
McCloud RD, Shasta-Trinity NF	5,484 (99.7)	15 (0.3)	3 (0.0)	5,502
	3,135 (99.9)	1 (0.0)	2 (0.1)	3,138
Blacks Mountain Experimental Forest, Lassen NF	3,261 (99.9)	2 (0.0)	3 (0.1)	3,266
	2,488 (99.4)	14 (0.6)	1 (0.0)	2,503
Placerville RD, Eldorado NF	6,588 (99.7)	22 (0.3)	1 (0.0)	6,611
	6,403 (99.7)	17 (0.3)	1 (0.0)	6,421

* RD = Ranger District, NF = National Forest.

** No. caught (% of catch) during 2003.

*** No. caught (% of catch) during 2004.

during this study, however, *T. undatulus* does occur in northern California (Papp 1960) and Oregon (Kline and Rudinsky 1964) and is attracted to frontalinal (Pitman and Vité 1970).

Temnochila chlorodia was the most abundant predator collected representing 99.7% of total trap catch (Table 1), and most commonly collected during late spring (Fig. 1A-D). In general, this trend was consistent among all sites (Fig. 1A-D) and did not appear to be influenced by latitude. Struble (1942) and Rice (1971) reported that *T. chlorodia* is univoltine and overwinters as adults. It is likely the peak in flight activity corresponds with initial adult emergence; whereas, fall activity is most likely associated with foraging and searching for overwintering sites. Gara et al. (1999) reported that *T. chlorodia* occurred most frequently during early to late summer in Montana. Dahlsten et al. (2003) found that *T. chlorodia* captured in traps baited with ipsdienol were also more abundant in early than late summer.

Overall, the ratio of male to female *T. chlorodia* was 0.82. A significant temporal effect was observed regarding sex ratios ($P < 0.001$; Kruskal-Wallis test). Significantly higher sex ratios were observed in September and October than May and June (Table 2) indicating that larger numbers of males were captured. *Temnochila chlorodia* adults typically overwinter in the bark crevices of bark beetle infested trees, and they may be more susceptible to collection while searching for such sites in the fall. In our study, *T. chlorodia* flight activity patterns were similar between years, but delayed by several weeks in 2003 (Fig. 1A-D). In 2003, temperatures were cooler throughout northern California during 1 March – 30 May than in 2004 (e.g., Mt. Shasta, CA (41.4° N, 122.3° W, 1080 m elevation): 7.3 versus 10.3°C mean daily temp.), and likely influenced phenology as well as our ability to access these sites.

Berryman (1967) reported that >90% of the total predator population associated with *D. brevicomis*-attacked trees was represented by *T. chlorodia* and *E. lecontei*. In the central Sierra Nevada, the relative abundance of these two species was variable among generations, but *E. lecontei* outnumbered *T. chlorodia* by greater than 2:1 in all cases (Berryman 1970). Stephen and Dahlsten (1976) reported that *E. lecontei*, *T. chlorodia*, and *Aulonium longum* LeConte (Coleoptera: Colytidae) were the most numerous predatory beetles associated with *D. brevicomis*-attacked trees. We observed large numbers of *E. lecontei* foraging on newly-attacked *P. ponderosa* immediately adjacent to three traps at Shasta-Trinity. The low *E. lecontei* and *E. spegus* trap catches suggest that the *D. brevicomis* bait is not attractive to them and that incidental captures are very low. Myrcene may not function as a *E. lecontei* kairomone as had been previously reported (Pitman and Vité 1971) or perhaps the other bait components exert an inhibitory effect on the response of *E. lecontei* to myrcene. Zhou et al. (2001) did not collect *E. spegus* in traps baited in *exo-brevicomin*, frontalinal and myrcene in eastern Oregon. Cuneo (1995) reported no significant difference in *E. lecontei* trap catch between unbaited traps and traps baited with the *D. brevicomis* pheromone components. Both *E. lecontei* and *E. spegus* respond strongly to ipsdienol, which is produced by male *D. brevicomis* during the colonization process, but has an inhibitory effect on *D. brevicomis* attraction (Byers 1982, Seybold et al. 1992).

This study provided the first description of seasonal abundance patterns for *T. chlorodia* in northern California and may have important implications to the integrated management of *D. brevicomis*. The use of mass trapping to reduce the amount of bark beetle-caused tree mortality has been conducted for several species. In California, the first such attempt yielded >1,000,000 *D. brevicomis* collected in a 5.2 km² area (Bedard et al. 1979). Ideally, mass trapping efforts should be conducted in such

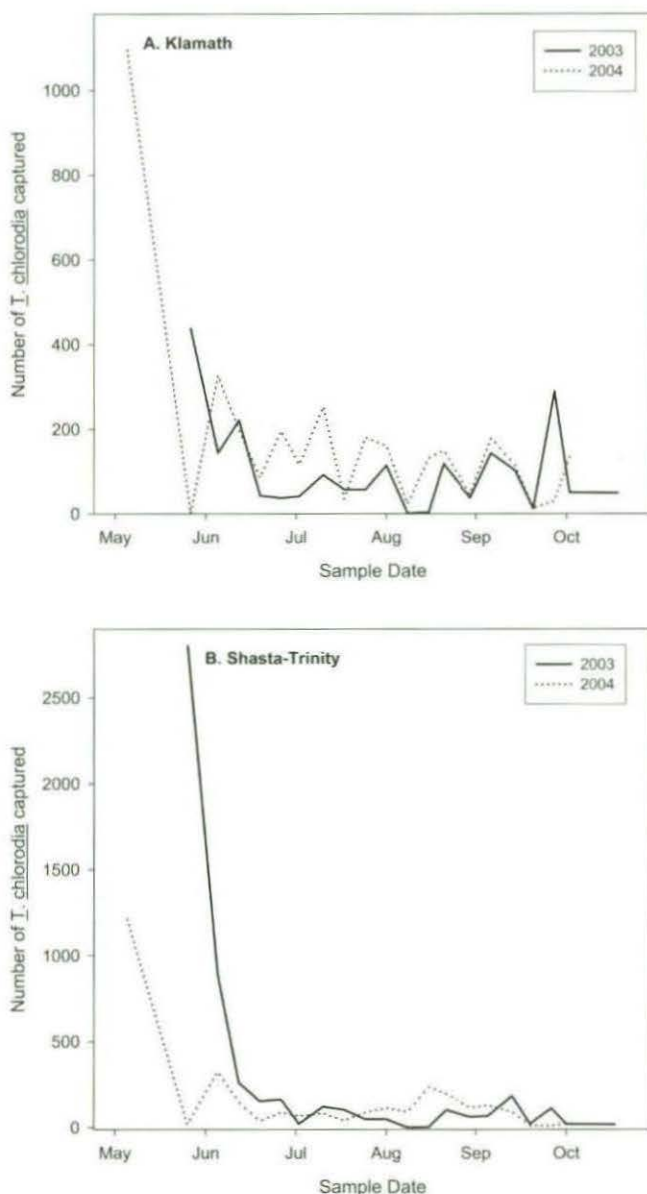


Fig. 1. Seasonal abundance of *Temnochila chlorodia* (Mannerheim) captured in multiple-funnel traps ($n = 10$ per site) baited with *Dendroctonus brevicomis* Leconte pheromones at (A) Klamath (41.6° N, 121.9° W), (B) Shasta-Trinity (41.3° N, 122.0° W), (C) Lassen (40.7° N, 121.1° W), and (D) Eldorado National Forests (38.6° N, 120.5° W), California, 2003 and 2004. Note difference in scale between sites.

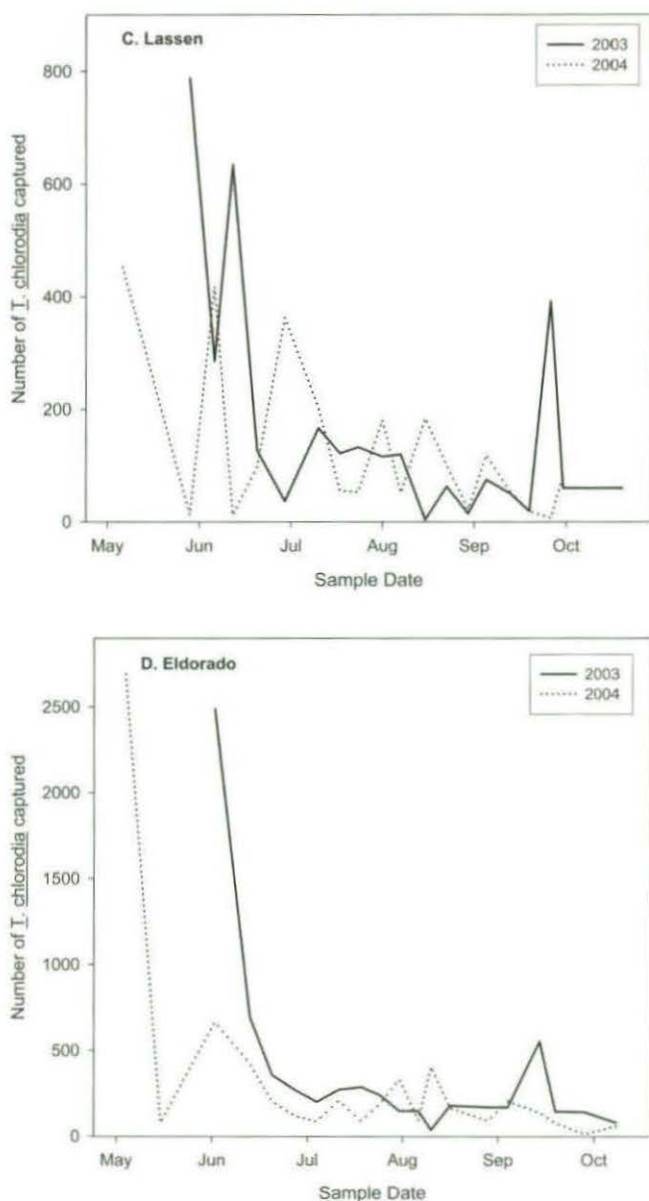


Fig. 1. Continued.

a manner to reduce or exclude the collection of natural enemies (Bedard and Wood 1981, Dahlsten et al. 2003) that may play an important role in regulating bark beetle populations (Reeve 1997). The removal of natural enemies during trap-out may adversely affect management objectives. In this study, 70% of *T. chlorodia* captures

Table 2. Temporal variation in sex ratios (M:F) of *Temnochila chlorodia* (Mannerheim) captured in multiple-funnel traps baited with *Dendroctonus brevicomis* LeConte pheromones in northern California, 2003 and 2004

Month	N*	Mean $\pm$ SEM*
May	83	0.86 $\pm$ 0.05 a
June	263	0.90 $\pm$ 0.03 a
July	293	1.06 $\pm$ 0.05 ab
August	173	1.09 $\pm$ 0.06 ab
September	218	1.21 $\pm$ 0.06 bc
October	49	1.57 $\pm$ 0.14 c

* Number of observations per month exclusive of those containing zero values.

** Means followed by the same letter are not significantly different ($P > 0.05$; Dunn's method).

occurred prior to 30 June (Fig. 1A-D). *Dendroctonus brevicomis* is active April through November with peak activity occurring in June and July in much of the Sierra Nevada (Fettig et al. 2005). Therefore, mass trapping efforts for *D. brevicomis* using *exo-brevicomin*, *frontalin* and *myrcene* could be confined to late summer and early fall to minimize *T. chlorodia* losses. During this time, more males than females will be collected (Table 2). Few *E. lecontei* and *E. sphegeus* will be captured (Table 1) and will likely have no adverse effect on their populations. Conducting trapping after 30 June will reduce negative impacts on the *T. chlorodia* community whereas locally increasing predator to prey ratios.

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References Cited

- Bedard, W. D., P. E. Tilden, D. L. Wood, R. M. Silverstein, R. G. Brownlee and J. O. Rodin. 1969. Western pine beetle: field response to its sex pheromone and a synergistic host terpene, myrcene. *Sci.* 164: 1284-1285.
- Bedard, W. D., D. L. Wood and P. E. Tilden. 1979. Using behavior modifying chemicals to reduce western pine beetle-caused tree mortality and protect trees, Pp. 159-163. *In* W. E. Waters (ed.), Current topics in forest entomology. U.S. Forest Service General Technical Report WO-8.
- Bedard, W. D., D. L. Wood, P. E. Tilden, K. Q. Lindahl Jr., R. M. Silverstein and J. O. Rodin. 1980. Field responses of the western pine beetle and one of its predators to host and beetle-produced compounds. *J. Chem. Ecol.* 6: 625-641.
- Bedard, W. D. and D. L. Wood. 1981. Suppression of *Dendroctonus brevicomis* by using mass trapping, Pp. 103-114. *In* Mitchell, E. R. (ed.), Management of insect pests with semiochemicals: concepts and practice. Plenum Press, NY.
- Berryman, A. A. 1967. Estimation of *Dendroctonus brevicomis* (Coleoptera: Scolytidae) mortality caused by insect predators. *Can. Entomol.* 99: 1009-1014.
1970. Evaluation of insect predators of the western pine beetle, Pp. 102-112. *In* Stark, R. W.

- and D. L. Dahlsten (eds.), Studies on the population dynamics of the western pine beetle, *Dendroctonus brevicornis* LeConte (Coleoptera: Scolytidae). University of California, Berkeley.
- Browne, L. E., D. L. Wood, W. D. Bedard, R. M. Silverstein and J. R. West. 1979.** Quantitative estimates of the western pine beetle attractive pheromone components, *exo-brevicornin*, *frontalin*, and *myrcene* in nature. *J. Chem. Ecol.* 5: 397-414.
- Byers, J. A. 1982.** Male specific conversion of the host plant compound, *myrcene*, to the pheromone, (+)-*ipsdienol*, in the bark beetle, *Dendroctonus brevicornis*. *J. Chem. Ecol.* 2: 363-371.
- 1992.** Attraction of bark beetles, *Tomicus piniperda*, *Hylurgops palliates*, and *Trypodendron domesticum* and other insects to short-chain alcohols and monoterpenes. *J. Chem. Ecol.* 18: 2385-2402.
- Chenier, J. V. and J. R. Philogene. 1989.** Field responses of certain forest coleoptera to conifer monoterpenes and ethanol. *J. Chem. Ecol.* 15: 1729-1745.
- Cuneo, T. D. 1995.** Response of arthropod predators to semiochemicals associated with pine bark beetles (Coleoptera: Scolytidae) in California. M.S. Thesis. University of California, Davis. 96 p.
- Dahlsten, D. L. 1970.** Parasites, predators, and associated organisms reared from western pine beetle infested bark samples, Pp. 75-79. In Stark, R. W. and D. L. Dahlsten (eds.), Studies on the population dynamics of the western pine beetle, *Dendroctonus brevicornis* LeConte (Coleoptera: Scolytidae). University of California, Berkeley.
- Dahlsten, D. L., D. L. Six, N. Erbilgin, K. F. Raffa, A. B. Lawson and D. L. Rowney. 2003.** Attraction of *Ips pini* (Coleoptera: Scolytidae) and its predators to various enantiomeric ratios of *ipsdienol* and *lanierone* in California: implications for the augmentation and conservation of natural enemies. *Environ. Entomol.* 1115-1122.
- Fettig, C. J., P. J. Shea and R. R. Borys. 2005.** Seasonal flight patterns of four bark beetle species (Coleoptera: Scolytidae) along a latitudinal gradient in California. *Pan-Pacific Entomol.* 80: 4-17.
- Furniss, R. L. and V. M. Carolin. 1977.** Western forest insects. U. S. Dept. of Agric. For. Serv. Misc. Pub. 1339.
- Gara, R. L., D. R. Millegan and K. E. Gibson. 1999.** Integrated pest management of *I. pini* (Col., Scolytidae) populations in south-eastern Montana. *J. Appl. Entomol.* 123: 529-534.
- Hardwood, W. G. and J. A. Rudinsky. 1966.** The flight and olfactory behavior of checkered beetles (Coleoptera: Cleridae) predatory on the Douglas-fir beetle. *Oregon State Univ. Tech. Bull.* 95. 36 p.
- Joseph, G., R. G. Kelsey, R. W. Peck and C. G. Niwa. 2001.** Response of some scolytids and their predators to ethanol and 4-allylanisole in pine forests of central Oregon. *J. Chem. Ecol.* 27: 697-713.
- Kline, L. N. and J. A. Rudinsky. 1964.** Predators and parasites of the Douglas-fir beetle: description and identification of immature stages. *Oregon State Univ. Tech. Bull.* 79. 52 p.
- Lindgren, B. S. 1983.** A multiple funnel trap for scolytid beetles (Coleoptera). *Can. Entomol.* 115: 299-302.
- Papp, C. S. 1960.** The Cleridae of North America. Part I. The geographical distribution of Cleridae of North America, north of the Panama Canal. *Bull. Southern Calif. Acad. Sci.* 59: 76-88.
- Person, H. L. 1940.** The clerid *Thanasimus lecontei* (Wolc.) as a factor in the control of the western pine beetle. *J. For.* 38: 390-396.
- Pitman, G. B., J. P. Vite, G. W. Kinger and A. F. Fentiman Jr. 1969.** Specificity of population-aggregating pheromones in *Dendroctonus*. *J. Insect Physiol.* 15: 363-366.
- Pitman, G. B. and J. P. Vite. 1970.** Field response of *Dendroctonus pseudotsugae* (Coleoptera: Scolytidae) to synthetic *frontalin*. *Ann. Entomol. Soc. Am.* 63: 661-664.
- 1971.** Predator-prey response to western pine beetle attractants. *J. Econ. Entomol.* 64: 402-404.

- Reeve, J. D. 1997. Predation and bark beetle dynamics. *Oecologia* 112: 48-54.
- Rice, R. E. 1971. Flight characteristics of *Enoclerus lecontei*, *Temnochila virescens*, and *Tomiscobia tibialis* in central California. *Pan-Pacific Entomol.* 47: 1-8.
- Schmitz, R. F. 1978. Taxonomy and bionomics of the North American species of *Thanasimus* Latreille (Coleoptera: Cleridae). Ph.D. Diss., Univ. Idaho, Moscow.
- Seybold, S. J., S. A. Teale, A. Zhang, F. X. Webster, K. Q. Lindahl Jr., D. L. Wood and I. Kubo. 1992. The role of lanierone in the chemical ecology of *Ips pini* (Coleoptera: Scolytidae) in California. *J. Chem. Ecol.* 18: 2305-2330.
- Skillen, E. L., C. W. Berisford, M. A. Camann and R. C. Reardon. 1997. Semiochemicals of forest and shade tree insects in North America and management implications. U.S. Dept. of Agric. For. Serv. FHTET-96-15.
- Stephen, F. M. and D. L. Dahlsten. 1976. The arrival sequence of the arthropod complex following attack by *Dendroctonus brevicomis* (Coleoptera: Scolytidae) in ponderosa pine. *Can. Entomol.* 108: 283-304.
- Struble, G. R. 1942. Biology of two native predators of the mountain pine beetle in sugar pine. *Pan-Pacific Entomol.* 18: 97-107.
- Struble, G. R. and L. H. Carpelan. 1941. External sex characters of two important native predators of the mountain pine beetle in sugar pine. *Pan-Pacific Entomol.* 17: 153-156.
- Wood, D. L. 1970. Pheromones of bark beetles, Pp. 301-316. In D. L. Wood, R. M. Silverstein and M. Nakajima (eds.), *Control of Insect Behavior*. Academic Press, New York.
- Wood, D. L., L. E. Browne, W. D. Bedard, P. E. Tilden, R. M. Silverstein and J. O. Rodin. 1968. Responses of *Ips confusus* to synthetic sex pheromones in nature. *Sci.* 1373-1374.
- Wood, D. L., L. E. Browne, B. Ewing, K. Q. Lindahl, W. D. Bedard, P. E. Tilden, K. Mori, G. B. Pitman and P. R. Hughes. 1976. Western pine beetle: specificity among enantiomers of male and female components and attractant pheromone. *Sci.* 192: 896-898.
- Wood, S. L. 1982. The bark and ambrosia beetles of North and Central America (Coleoptera: Scolytidae), a taxonomic monograph. Great Basin. Nat. Mem. No. 6.
- Zhou, J., D. W. Ross and C. G. Niwa. 2001. Kairomonal response of *Thanasimus undatulus*, *Enoclerus sphegeus* (Coleoptera: Cleridae), and *Temnochila chlorodia* (Coleoptera: Trogos-tidae) to bark beetle semiochemicals in eastern Oregon. *Environ. Entomol.* 30: 993-998.