

# Impact of *Platysoma parallelum* and *Plegaderus transversus* (Coleoptera: Histeridae) Predation on Developing *Ips calligraphus* and *Ips grandicollis* (Coleoptera: Scolytidae) Brood<sup>1</sup>

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**Abstract** As a group, arthropod natural enemies have been shown to substantially reduce within-tree pine bark beetle populations. However, little is known about the impacts of individual species on bark beetle mortality. In a controlled laboratory study, we measured the effects of two predaceous histerid species, *Platysoma parallelum* (Say) and *Plegaderus transversus* (Say), on *Ips calligraphus* (Germar) and *Ips grandicollis* (Eichhoff) brood mortality. *Platysoma parallelum* was found to have a greater impact on *I. grandicollis* mortality than *Ple. transversus* when only one histerid and prey species were present. No significant differences in *I. calligraphus* mortality were observed for either of the two histerid species. More *I. grandicollis* brood was killed per introduced *Pla. parallelum* adult than per introduced *Ple. transversus* adult likely as a result of the larger size and biomass requirements of *Pla. parallelum*. The results of this experiment indicate that histerids, by themselves, have the ability to lower within-tree bark beetle populations and could have potential use in a bark beetle biological control program.

**Key Words** Histeridae, Scolytidae, *Platysoma parallelum*, *Plegaderus transversus*, *Ips*, predation

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Pine bark beetles cause severe economic injury each year to timber in the southeastern United States (Payne 1980, Price et al. 1998). The most damaging species are the southern pine beetle, *Dendroctonus frontalis* Zimmermann and sympatric *Ips* engraver beetles. Direct control methods, such as removal of infested trees, may be logistically difficult or excessively expensive for many infestations (Billings 1980). Alternative control options, such as biological control, may offer more practical solutions. Native natural enemy species have been shown to impact bark beetle populations considerably. Overall, predation and parasitism can account for 24 to 28% of *D. frontalis* within-tree mortality (Moore 1972, Linit and Stephen 1983) and may regulate *D. frontalis* population cycles (Reeve 1997, Turchin et al. 1999). Natural enemies also can lower *Ips* reproduction rates and brood survival (Riley 1983, Miller 1984a,b, 1986a,b, Riley and Goyer 1986).

One group of natural enemies that has been found associated with multiple pine bark beetle species are the predaceous Histeridae. These beetles comprise 7% of total *D. frontalis* and 6% of total *Ips* spp. predator abundance (Berisford 1980, Kul-

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havy et al. 1989). Because histerid adults and larvae primarily feed on the early life stages of bark beetles (Kovarik and Caterino 2000, W. P. Shepherd, pers. obs.), we hypothesized that they have the potential to significantly lower prey brood populations. Augmentation of histerid populations at bark beetle attack sites may be able to sufficiently lower the number of emerging adults and ultimately lead to area-wide suppression. The objective of this study was to determine, in controlled laboratory experiments, the potential predation impacts of two common histerid species in Louisiana on within-tree *Ips* bark beetle brood populations.

### Materials and Methods

**Insects.** Several loblolly pines, *Pinus taeda* L., were felled at the Louisiana State University AgCenter Idlewild Research Station, approximately 40 km north of Baton Rouge, LA. Natural infestations of these trees by *Ips* spp. occurred within 1 wk of felling, as *Ips* beetles in the area were abundant due to several years of drought conditions in Louisiana. Logs were removed from these trees 2 to 3 wks after initial attack and transferred to the laboratory, where they were sealed inside metal rearing drums, each with a funnel-shaped screen and collection jar attached to the bottom (modified from Overgaard 1968). Emerging adults of *Platysoma parallelum* (Say) and *Plegaderus transversus* (Say), the most abundant histerid species at the site, as well as *Ips calligraphus* (Germar) and *Ips grandicollis* (Eichhoff), were collected from these logs. The histerids were maintained in glass Petri dishes (diam 9 cm) lined with moist filter paper and fed *Ips* spp. larvae twice weekly until initiation of each experiment. Histerids were used within 30 d of emergence from the logs. *Ips* spp. beetles were maintained in 500-ml glass jars containing moist paper towels for up to 6 d prior to their use in experiments. Voucher specimens of the histerids were deposited in the Louisiana State University Arthropod Museum.

**Predation impact in *Ips*-infested logs.** A total of 40 logs (diam 14 to 24 cm, length 48 to 53 cm) were cut from 4 loblolly pine trees and immediately transferred to zipper-sealed cotton pillow covers in the laboratory. The logs were allowed to dry for 3 d after felling before the ends of the logs were sealed with paraffin wax to prevent further desiccation. At that time, 50 *I. grandicollis* adults were released on half of the logs, and 25 to 35 *I. calligraphus* adults were released on the other half over a 1-wk period. Based on previous experience, these numbers of *Ips* spp. were used to achieve attack densities that would exploit most of the phloem resource. Nine d after the *Ips* beetles were initially introduced, either 10 *Pla. parallelum* or 15 *Ple. transversus* adults, starved for 3 d, were placed on each of 5 *I. grandicollis* and 5 *I. calligraphus* infested logs. The remaining logs were left as histerid-free controls. In order to simulate an augmentative biological control effort, a greater number of histerids was introduced on each log than would be expected based on sticky trap captures of histerids at *Ips*-infested logs in the field (Shepherd and Goyer 2003). Over the course of the study, the logs were maintained at ambient environmental temperatures, which ranged from 14°C at night to 35°C during the day.

When *Ips* brood adults began to emerge from the logs approximately 4 wks after the first *Ips* beetles were introduced, the bark was stripped for collection of all larval, pupal and adult *Ips* beetles. Because a small percentage of the *Ips* beetles were concealed within the bark and phloem, the dissected bark was resealed inside the pillow covers, and any remaining beetles were counted as they emerged. *Ips* brood populations were quantified by counting the number of *Ips* adults, pupae, and larvae

on all logs, and subtracting the number of introduced *Ips* beetles from this total. Also, parental gallery length, number of egg niches per 100 cm of parental gallery length, and number of nuptial chambers were recorded to measure the intensity of attack on each log. *Ips* percent mortality and the number of *Ips* beetles killed per histerid were calculated from these data:

$$\text{Ips \% mortality} = \frac{(\# \text{ egg niches} - \# \text{ surviving Ips}) \times 100}{\# \text{ egg niches}}$$

$$\# \text{ Ips killed per histerid} = \frac{[(\text{Ips \% mortality} - \text{mean Ips \% mortality control})/100] \times \# \text{ egg niches}}{\# \text{ introduced histerids}}$$

The number of *Ips* attacks was equated with the number of nuptial chambers.

**Statistical analysis.** We performed all statistical analyses with SAS Version 8.02 (SAS Institute 2001). Our unit of replication was each log. A 2 × 3 factorial analysis of variance (ANOVA; general linear model) with Tukey's multiple comparison test was used to test the significance of *Ips* species and histerid species (including histerid-free control) on *Ips* spp. parental gallery length and mean percent *Ips* spp. mortality (following arcsine square root transformation). A 2 × 2 factorial ANOVA with Tukey's multiple comparison test was used to test the significance of *Ips* species and histerid species on the number of *Ips* spp. killed per introduced predator (following square root [x + 0.5] transformation). All tests were performed at a significance level of  $\alpha = 0.05$ .

## Results

Attack density averaged 0.32 attacks/dm<sup>2</sup> in the *I. calligraphus* infested logs and 0.71 attacks/dm<sup>2</sup> in the *I. grandicollis* infested logs. There were an average of 21 eggs/dm<sup>2</sup> produced in the *I. calligraphus* logs and 45 eggs/dm<sup>2</sup> in the *I. grandicollis* logs. No significant differences were found between mean *I. calligraphus* or *I. grandicollis* parental gallery lengths between the logs with introduced *Pla. parallelum* or *Ple. transversus* adults and corresponding control logs (Table 1).

The mean percent *I. calligraphus* and *I. grandicollis* mortality levels in the histerid-free control logs were not significantly different (Fig. 1). In logs with introduced *Pla.*

**Table 1. Mean parental gallery length (cm) for logs infested by either *I. calligraphus* or *I. grandicollis* with either *Pla. parallelum*, *Ple. transversus*, or no histerid adults added.**

<i>Ips</i> species	Histerid Species	Mean Parental Gallery Length ± SE (cm)
<i>I. calligraphus</i>	<i>Pla. parallelum</i>	248.0 ± 25.3
<i>I. calligraphus</i>	<i>Ple. transversus</i>	276.2 ± 14.2
<i>I. calligraphus</i>	None (control)	239.9 ± 15.9
<i>I. grandicollis</i>	<i>Pla. parallelum</i>	317.4 ± 19.6
<i>I. grandicollis</i>	<i>Ple. transversus</i>	298.6 ± 6.9
<i>I. grandicollis</i>	None (control)	299.4 ± 8.2

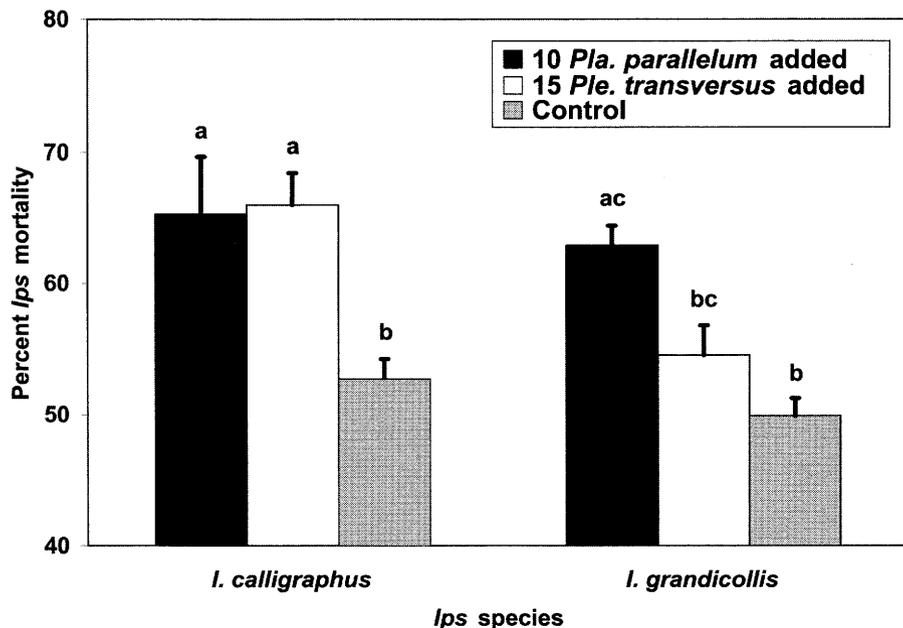


Fig. 1. Mean percent *Ips* mortality for logs with added *Pla. parallelum* adults, logs with added *Ple. transversus* adults, and control logs. Different letters above the bars indicate significantly different means at a significance level of  $\alpha = 0.05$ . Error bars depict standard errors of the means.

*parallelum* adults, the mean percent mortality levels of *I. calligraphus* and *I. grandicollis* were significantly greater ( $P = 0.0023$ ) than in the control logs (Fig. 1). Mean percent *I. calligraphus* mortality in the logs with *Ple. transversus* was significantly higher ( $P = 0.0015$ ) than in the histerid-free logs, but there was no significant difference ( $P = 0.6917$ ) for mortality in the logs infested by *I. grandicollis* in comparison to the histerid-free logs (Fig. 1). *Ips calligraphus* mean percent mortality was significantly higher ( $P = 0.0276$ ) than *I. grandicollis* in logs with added *Ple. transversus* beetles (Fig. 1).

On average, more *I. grandicollis* individuals were killed for each *Pla. parallelum* adult introduced than for each *Ple. transversus* adult introduced ( $P = 0.0053$ ) (Fig. 2). Within histerid species there was no significant difference in the mean number of *I. calligraphus* and *I. grandicollis* killed per introduced predator. In all logs to which *Pla. parallelum* and *Ple. transversus* were added, active adult and larval histerids were observed at the time of bark stripping.

## Discussion

The addition of *Pla. parallelum* or *Ple. transversus* adults onto infested logs increased *Ips* bark beetle brood mortality in the absence of other natural enemies. This higher mortality was likely the result of predation by both introduced histerid adults

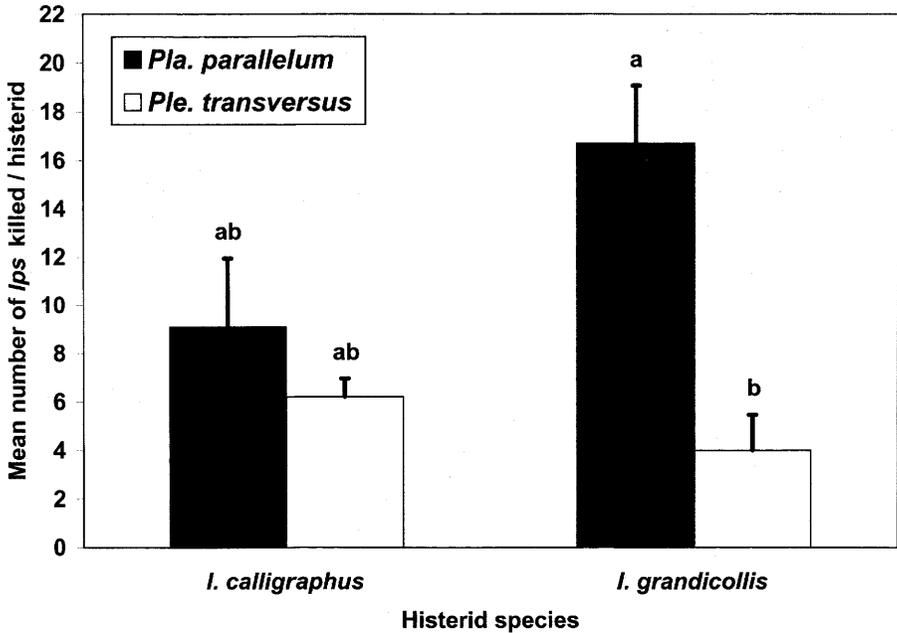


Fig. 2. Mean number of *Ips* beetles killed per introduced *Pla. parallelum* and *Ple. transversus* histerid. Different letters above the bars indicate significantly different means at a significance level of  $\alpha = 0.05$ . Error bars depict standard errors of the means.

and their larval progeny. A successful biological control agent must have the ability to reduce pest populations. Several studies have found that other natural enemy species can have significant predation effects on bark beetle populations. The clerid predator, *Thanasimus dubius* (F.), has been shown to cause significant *D. frontalis* mortality in the United States (Reeve 2000). Aukema and Raffa (2002) observed that *T. dubius* larvae each killed 20 to 49 within-tree *Ips pini* (Say) individuals in Wisconsin, which is higher than the average number of *Ips* brood killed per introduced histerid predator. Another clerid, *Thanasimus formicarius* (L.), preying upon *Ips typographus* (L.) in Sweden (Weslien 1994), and a colydiid, *Aulonium ruficorne* Olivier, preying upon *Orthotomicus erosus* (Wollaston) in Israel (Podoler et al. 1990) also caused significant bark beetle mortality.

The absence of significant differences in *Ips* parental gallery lengths between logs with introduced histerids and control logs suggests that the addition of *Pla. parallelum* or *Ple. transversus* had negligible effects on adult *Ips* gallery construction. In addition, no evidence of predation on adult *Ips* was observed in the dissected logs. Dead adult *Ips* beetles were whole and undamaged. Therefore, mortality differences in these logs were attributed solely to histerid predation on *Ips* eggs and larvae.

No external predator or parasitoid contamination was observed in the histerid-free control logs. Thus, the high rates of bark beetle mortality in these logs (52.7% for *I. calligraphus* and 49.9% for *I. grandicollis*) were most probably the result of intraspe-

cific competition, predaceous mites and/or disease. Linit and Stephen (1983) found *D. frontalis* mortality to be as high as 69% in portions of pine trees with mechanical exclusion of natural enemies. Reproductive success of bark beetles has been shown to decrease at larger population densities (Beaver 1974, Berryman 1982, Light et al. 1983, Anderbrant et al. 1985, De Jong and Grijpma 1986, Mills 1986, Robins and Reid 1997). The limited surface area of the phloem resource on our experimental logs may have resulted in mortality in excess of that occurring in natural colonizations of whole trees.

Our study has shown that large numbers of histerids released at the time of early signs of *Ips* attack have the potential to lower within-tree bark beetle populations. Combined with additional mortality from other natural enemies, competition, disease, and environmental factors, this increased histerid predation could slow the spread of bark beetle infestations by reducing the number of emerging progeny that colonize adjacent trees. Within-tree mortality may not necessarily equate with area-wide pest population decline, and further research is needed to determine whether such a link exists between histerid predation and bark beetle population dynamics. A *D. frontalis* population model predicted that removal of natural enemies, including the histerid species used in this study, would result in significantly higher infestation growth and tree mortality (Stephen et al. 1989).

If histerids are to be used as biological control agents, predator species must be precisely matched with prey species to ensure maximum benefit. While both *Pla. parallelum* and *Ple. transversus* had a significant impact on *I. calligraphus* within-tree populations, only *Pla. parallelum* inflicted significant mortality on *I. grandicollis*. *Platysoma parallelum* also was able to kill more *I. grandicollis* brood per introduced predator. Because of their smaller size, *Ple. transversus* adults and larvae maintain a lower biomass and likely eat fewer prey than *Pla. parallelum*. Although *Ple. transversus* individuals killed significantly similar numbers of both *Ips* species brood per introduced predator, they were unable to consume enough of the more abundant *I. grandicollis* brood to affect overall mortality. *Ips grandicollis* adults produced more than twice as many eggs on average as *I. calligraphus*. In an augmentative biological control program, greater numbers of *Ple. transversus* adults would need to be released to approach the level of predation observed with *Pla. parallelum*. Although fewer *Pla. parallelum* individuals may be necessary for bark beetle control, higher prey requirements for the larger predators during mass rearing may offset any potential cost savings.

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### References Cited

- Anderbrant, O., F. Schlyter and G. Birgersson. 1985. Interspecific competition affecting parents and offspring in the bark beetle *Ips typographus*. *Oikos* 45: 89-98.

- Aukema, B. H. and K. F. Raffa. 2002.** Relative effects of exophytic predation, endophytic predation, and intraspecific competition on a subcortical herbivore: consequences to the reproduction of *Ips pini* and *Thanasimus dubius*. *Oecologia* 133: 483-491.
- Beaver, R. A. 1974.** Intraspecific competition among bark beetle larvae (Coleoptera: Scolytidae). *J. Anim. Ecol.* 43: 455-467.
- Berisford, C. W. 1980.** Natural enemies and associated organisms, Pp. 31-52. *In* R.C. Thatcher, J.L. Searcy, J. E. Coster and G. D. Hertel, [eds.], *The southern pine beetle*. USDA Forest Service Tech. Bull. No. 1631.
- Berryman, A. A. 1982.** Population dynamics of bark beetles, Pp. 264-314. *In* J.B. Mitton and K.B. Sturgeon, [eds.], *Bark beetles in North American conifers*. University of Texas Press, Austin, TX.
- Billings, R. F. 1980.** Direct control, Pp. 179-192. *In* R.C. Thatcher, J. L. Searcy, J. E. Coster and G. D. Hertel, [eds.], *The southern pine beetle*. USDA Forest Service Tech. Bull. No. 1631.
- De Jong, M. C. M. and P. Grijpma. 1986.** Competition between larvae of *Ips typographus*. *Entomol. Exp. Appl.* 41: 121-133.
- Kovarik, P. W. and M. S. Caterino. 2000.** Histeridae, Pp. 212-227. *In* R. H. Arnett and M. C. Thomas, [eds.], *American Beetles*, Vol. 1. CRC Press, Boca Raton, FL.
- Kulhavy, D. L., R. A. Goyer, J. W. Bing and M. A. Riley. 1989.** *Ips* spp. natural enemy relationships in the Gulf coastal states, Pp. 157-167. *In* D. L. Kulhavy and M. C. Miller, [eds.], *Potential for biological control of Dendroctonus and Ips bark beetles*. Stephen F. Austin State University Press, Nacogdoches, TX.
- Light, D. M., M. C. Birch and T. D. Paine. 1983.** Laboratory study of intraspecific and interspecific competition within and between two sympatric bark beetle species, *Ips pini* and *I. paraconfusus*. *Z. Ang. Entomol.* 96: 233-241.
- Linit, M. J. and F. M. Stephen. 1983.** Parasite and predator component of within-tree southern pine beetle mortality. *Can. Entomol.* 115: 679-688.
- Miller, M. C. 1984a.** Effect of exclusion of insect associates on *Ips calligraphus* (Germ.) (Coleoptera, Scolytidae) brood emergence. *Z. Ang. Entomol.* 97: 298-304.
- 1984b.** Mortality contribution of insect natural enemies to successive generations of *Ips calligraphus* (Germar) (Coleoptera, Scolytidae) in loblolly pine. *Z. Ang. Entomol.* 98: 495-500.
- 1986a.** Survival of within-tree *Ips calligraphus* (Col.: Scolytidae): effect of insect associates. *Entomophaga* 31: 39-48.
- 1986b.** Within-tree effects of bark beetle insect associates on the emergence of *Ips calligraphus* (Coleoptera: Scolytidae). *Environ. Entomol.* 15: 1104-1108.
- Mills, N. J. 1986.** A preliminary analysis of the dynamics of within tree populations of *Ips typographus* (L.) (Coleoptera: Scolytidae). *J. Appl. Entomol.* 102: 402-416.
- Moore, G. E. 1972.** Southern pine beetle mortality in North Carolina caused by parasites and predators. *Environ. Entomol.* 1: 58-65.
- Overgaard, N. A. 1968.** Insects associated with the southern pine beetle in Texas, Louisiana, and Mississippi. *J. Econ. Entomol.* 61: 1197-1201.
- Payne, T. L. 1980.** Life history and habits, Pp. 7-28. *In* R. C. Thatcher, J. L. Searcy, J. E. Coster and G. D. Hertel, [eds.], *The southern pine beetle*. USDA Forest Service Tech. Bull. No. 1631.
- Podoler, H., Z. Mendel and H. Livne. 1990.** Studies of the biology of a bark beetle predator, *Aulonium ruficorne* (Coleoptera: Colydiidae). *Environ. Entomol.* 19: 1010-1016.
- Price, T. S., C. Doggett, J. M. Pye and B. Smith. 1998.** A history of southern pine beetle outbreaks in the southeastern United States. Georgia For. Comm., Macon, GA.
- Reeve, J. D. 1997.** Predation and bark beetle dynamics. *Oecologia* 112: 48-54.
- 2000.** Complex emergence patterns in a bark beetle predator. *Agric. For. Entomol.* 2: 233-240.
- Riley, M. A. 1983.** Insect enemies of *Ips calligraphus* (Germar) on felled loblolly (*Pinus taeda* L.) and slash (*P. Elliottii* Englemann) pines in Louisiana. M.S. Thesis, Louisiana State Univ., Baton Rouge.
- Riley, M. A. and R. A. Goyer. 1986.** Impact of beneficial insects on *Ips* spp. (Coleoptera;

- Scolytidae) bark beetles in felled loblolly and slash pines in Louisiana. *Environ. Entomol.* 15: 1220-1224.
- Robins, G. L. and M. L. Reid. 1997.** Effects of density on the reproductive success of pine engravers: is aggregation in dead trees beneficial? *Ecol. Entomol.* 22: 329-334.
- SAS Institute, Inc. 2001.** Version 8.02. SAS Institute, Inc., Cary, NC.
- Shepherd, W. P. and R. A. Goyer. 2003.** Seasonal abundance, arrival and emergence patterns of predaceous hister beetles (Coleoptera: Histeridae) associated with *Ips* engraver beetles (Coleoptera: Scolytidae) in Louisiana. *J. Entomol. Sci.* 38: 612-620.
- Stephen, F. M., M. P. Lih and G. W. Wallis. 1989.** Impact of arthropod natural enemies on *Dendroctonus frontalis* (Coleoptera: Scolytidae) mortality and their potential role in infestation growth, Pp. 169-185. *In* D. L. Kulhavy and M. C. Miller, [eds.], Potential for biological control of *Dendroctonus* and *Ips* bark beetles. Stephen F. Austin State University Press, Nacogdoches, TX.
- Turchin, P., A. D. Taylor and J. D. Reeve. 1999.** Dynamic role of predators in population cycles of a forest insect: an experimental test. *Science* 285: 1068-1071.
- Westien, J. 1994.** Interactions within and between species at different densities of the bark beetle *Ips typographus* and its predator *Thanasimus formicarius*. *Entomol. Exp. Appl.* 71: 133-143.

