MICROSPORIDAN AND NEMATODE INCIDENCE IN LIVE-TRAPPED AND REARED SOUTHERN PINE BEETLE ADULTS[1]

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ABSTRACT

A Frontalure-33 baited livetrap that excluded clerid beetle predators was used to capture adult males of the southern pine beetle (SPB), *Dendroctonus frontalis* Zimmermann and estimate the natural incidence of the microsporidan, *Unikaryon minutum* Knell and Allen, and the nematode, *Contortylenchus brevicomi* (Massey) Rühm in trap catches. No significant difference in the incidence of *U. minutum* was found between trapped SPB (♂♂) and SPB (♂♂ and ♀♀) reared from infested trees, but *C. brevicomi* incidence was consistently lower in trapped males. Incidence of the microsporidan and nematode did not differ significantly between reared SPB males and females.

The southern pine beetle (SPB), *Dendroctonus frontalis* Zimmermann (Coleoptera: Scolytidae), is one of the most destructive insect pests of southern pine forests (Thatcher 1960, Dixon and Osgood 1961, Coulson et al. 1972). Although SPB outbreaks have occurred sporadically in Florida, none has persisted (Chellman and Wilkinson 1975). During studies associated with a recent SPB outbreak at Eglin Air Force Base Forest in west Florida (Atkinson 1976), a microsporidan, *Unikaryon minutum* Knell and Allen, and an internal parasitic nematode, *Contortylenchus brevicomi* (Massey) Rühm, were found within the bodies of many adult beetles[2]. Joye (1976) reported *C. brevicomi* was present in 15 of 17 SPB populations collected from 8 southern states. The percent of SPB adults parasitized ranged from 0-43%, with most populations in the 10-20% range. Both *U. minutum* and *C. brevicomi* have recently been found to reduce the reproductive capacity of the SPB[3].

The principal purpose of our study was to determine if the estimated incidence of *U. minutum* and *C. brevicomi* based on samples of live-trapped SPB males differed significantly from the estimated incidence in SPB adults of both sexes reared from infested host trees. A corollary need was to develop a pheromone-baited livetrap that would admit SPB adults, but exclude the checkered beetle, *Thanasimus dubius* (Say) (Coleoptera: Cleridae). This beetle consistently entered our livetraps and sometimes con-

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[1]This research was funded in part by a USDA-sponsored program entitled the "Expanded Southern Pine Beetle Research and Applications Program". USFS Southeastern Forest Exp. Stn. Coop. Agmt. No. 18-472. University of Florida Agricultural Experiment Stations Journal Series Number 1271.

[2]The microsporidan was detected by G. E. Allen, Dept. of Entomology and Nematology, University of Florida, and the nematode by V. G. Perry, now Assistant Dean for Research, IFAS, University of Florida, Gainesville, 32611.

[3]Personal communication from J. D. Knell and A.E. MacGuidwin, Dept. of Entomology and Nematology, University of Florida, Gainesville, 32611.

sumed up to an estimated 80% of the trapped SPB specimens (Atkinson ibid.).

METHODS AND MATERIALS

SAMPLES FROM TRAPS

The "stovepipe livetrap" constructed for our study incorporated many features of a trap developed by L. E. Browne[4] to capture adults of the western pine beetle, *Dendroctonus brevicomis* Le Conte, and also of a "bucket trap" used to capture SPB adults (Moser and Browne 1978). Our first model with loose-fitting lid and 4-mm-diam holes was subject to entry by *T. dubius* predatory beetles and was subsequently modified as shown in Fig. 1. The body of this modified trap consisted of 2 joined 15.2 cm (6 in.) diam x 61 cm (24 in) long stovepipe. Eight vertical rows of 1.5-mm-diam holes[5] were drilled in the upper section to allow outward diffusion of attractant and entry of SPB. Holes within rows were 2 cm apart; rows were 6 cm apart. The exterior of both stovepipe sections was covered with coarse-milled pine bark. The rim of a 1-liter polyethylene funnel was fitted into an existing depression located just above the lower crimped end of the perforated stovepipe section and was secured from below with caulking, after which the inside of both the perforated section and funnel was sprayed with slippery, Teflon®-based material. The top opening of the trap was stopped with a styrofoam disc ca 5 cm thick, cut to fit very tightly in order to exclude *T. dubius* beetles.

To operate the trap, a hollow polyethylene vial-stopper was loaded with 20 drops of the SPB attractant, Frontalure-33[6], a proprietory mixture of 33% frontalin in *alpha*-pinene. A 14.2-ml (4-dr) vial filled with gum spirits turpentine (not shown) was suspended together with the vial-stopper from the styrofoam top. SPB adults were collected in a 1-liter paper carton which was filled with moistened strips of kraft paper towelling in order to separate and maintain viability of the specimens. Traps were hung from hardwood tree branches about 2 m above the ground and were spaced at 50-m-intervals around the periphery of a SPB infestation. From 5-15 traps were used during September 1975, October 1975, and February 1976 at Eglin AFB Forest, FL, and during September 1976 near Athens, GA.

SAMPLES FROM INFESTED TREES

Samples of within-tree populations were taken on the same dates and at the same places as the traps were operated. Whenever possible, 5 medium-sized (20-to-30-cm-diam) trees containing pupae and/or teneral SPB adults were located and felled. Thirty-cm-long bolts were taken from the center of the top-, middle-, and bottom-1/3 of the infested portion of each tree bole (total of 15 bolts per sample date). Bolts were then held in cans with side emergence jars until all adults had emerged. On 3 February 1976 at Eglin AFB forest, only 3 small trees (9-to-12-cm-diam) could be found with live

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[4]Personal communication from L. E. Browne, Division of Entomology, University of California, Berkeley 94720.

[5]Hole diameter was selected such that individual *T. dubius* adult beetles could not pass through the holes under controlled laboratory conditions.

[6]Chemsampco, Box 20305, Columbus, OH 43220.

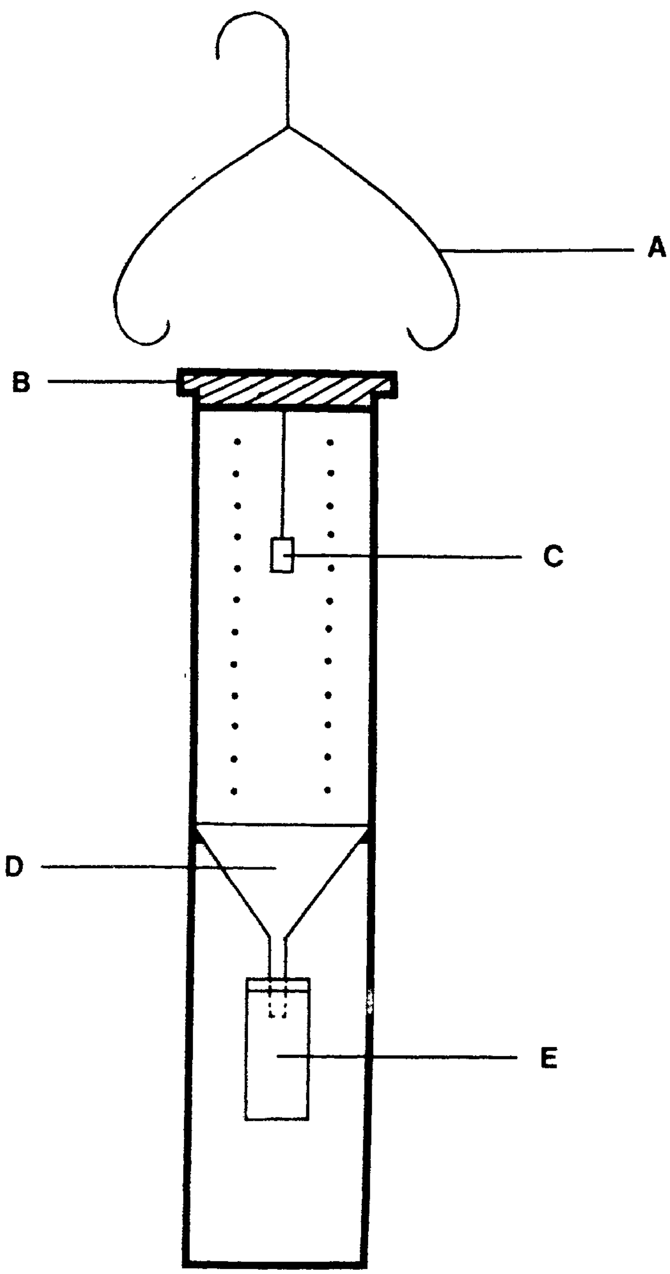

Fig. 1. "Stovepipe" trap used for capturing live southern pine beetle adult males. A. hanger, B. styrofoam top, C. Frontalure-33 in vial-stopper, D. funnel, E. collecting container.

SPB brood and the entire infested boles of these trees were held for emergence. On 9 September 1976, within-tree samples were obtained from C. W. Berisford who had cut several infested trees from the Athens, GA trapping site. Both Florida and Georgia SPB populations decreased to endemic levels during our study or shortly afterwards.

Diagnosis of infestations

Beetles were sexed (Barras 1967) and dissected to determine the presence or absence of *U. minutum* and *C. brevicomi*[7]. Squash-mounts were made of the entire abdominal contents and examined at 400x. A total of 1,164 beetles was dissected; 217 from traps and 947 from infested trees.

Chi-square tests of homogeneity (1 df) were performed on the data from each sample date for both the microsporidan and nematode in order to compare their incidence in SPB males caught in traps with incidence in males and females reared from trees. A chi-square analysis using linear models (Grizzle et al. 1969) was also performed on the *C. brevicomi* data in order to compare the incidence of this nematode in trapped and reared adults over all sample dates.

Comparison of traps

Lastly, a comparison of SPB and *T. dubius* catches in original- and modified- stovepipe traps was made by setting out 5-each traps of both types at Athens, GA on 9 September 1976. Traps were hung about 5 m apart in pairs and pairs were spaced at about 50-m-intervals along the edge of a SPB infestation.

Results and Discussion

All SPB adults captured in our stovepipe traps were males; Moser and Browne (1978) similarly found that 99% of 1,512 SPB adults captured in Frontalure-33-baited bucket traps were males. Since the incidence of the microsporidan and nematode did not differ significantly (X^2, 1 df) between males and females reared from naturally-infested host material in our tests, a basic assumption was made that the incidence of both these organisms in flying males was a valid estimate of their respective incidence in flying adults of both sexes. This hypothesis should be tested further.

Although the proportion of beetles infected by *U. minutum* microsporida ranged widely between locations (2-87.5%), the observed incidence for any sample date was similar between traps and trees and in no case were the differences significant (Table 1). These results suggest that infection by *U. minutum* did not adversely affect SPB male flight for relatively short distances to a source of attraction (it is estimated that our traps were all located within 100 m of known SPB-infested trees).

In contrast, the proportion of beetles parasitized by *C. brevicomi* nematodes did not range as widely between locations (4.9-20%), but there was a significant difference between trapped and reared beetles on 3 February

[7]Descriptions of *U. minutum* have been given by Knell and Allen (in press) and of *C. brevicomi* by Massey (1974). Identifications were periodically verified by Knell and Allen and by V. G. Perry or L. G. Joye.

TABLE 1. PROPORTIONS (%) OF *Dendroctonus frontalis* (SPB) ADULTS WITH *Unikaryon minutum* MICROSPORIDA AND *Contortylenchus brevicomi* NEMATODES IN SAMPLES TAKEN BY LIVE-TRAPPING AND BY REARING FROM INFESTED TREES (SAMPLES: A, B, C, EGLIN AFB, FL ON 18-IX-75, 20-XI-75, 3-II-76; D, ATHENS, GA ON 9-IX-76).

		Incidence in Beetles				
		Trapped (♂♂ only)		Reared (♂♀)		
Sample	No. traps	Proportion	%	Proportion	%	Chi-square
		(Microsporida)				
A	5	14/16	87.5	281/395	71.1	2.032 n.s.
B	10	34/50	68.0	309/462	66.9	0.025 n.s.
C	10	61/82	74.4	23/29	79.3	0.282 n.s.
D	15	1/50	2.0	1/50	2.0	0.000 n.s.
		(Nematodes)**				
A	5	2/35	5.7	53/406	13.1	1.590 n.s.
B	10	6/50	12.0	77/462	16.7	0.723 n.s.
C	10	4/82	4.9	5/29	17.2	4.395*
D	15	5/50	10.0	10/50	20.0	1.961 n.s.

*Significant at 5% level.
**Nematode incidence was significantly (X^2, $p = .01$) lower in trapped SPB males than in reared adults of both sexes, considering all sample dates (method of Grizzle et al. 1969).

1976 (Table 1). This particular difference might be explained as the result of rearing a relatively small number of beetles from 3 very small trees. Host material 5-10 cm diam or less is rarely attacked by the SPB (Thatcher 1960, Dixon and Osgood 1961). Probable host unsuitability on 3 February 1976 does not explain why the incidence of nematodes was consistently and significantly lower in trapped SPB males over all sample dates ($X^2 = 7.762$, 1 df, $p = .01$; method of Grizzle et al. 1969). Some possible reasons for this consistently lower incidence are that *C. brevicomi* adversely reduces the flight ability of SPB males, alters their response to Frontalure-33, and/or increases their susceptibility to mortality factors. Further research is needed to determine if and how *C. brevicomi* affects SPB behavior.

Lastly, our modified stovepipe trap excluded *T. dubius* beetles without significantly reducing SPB catches. The mean catch of SPB males in modified traps (21.0) was not significantly different from the mean in original traps (22.4) (paired t-test, $p = .05$) at Athens, GA; *T. dubius* beetles were not caught in modified traps, but a mean of 6.4 *T. dubius* beetles was caught in the original traps. Two other modifications relating to use of SPB livetraps are suggested; (1) Frontalure-33 (without turpentine) should be used as the sole bait (cf. Payne et al. 1978) and (2) the simple device developed by Gammill et al. (1978) for slow release of SPB attractant should be tested as a means of extending the period of attraction. Admission of *T. dubius* beetles into bucket traps (Moser and Browne 1978) can probably also be prevented by reduction of entry hole size to 1.5-mm-diam. If SPB catches are not adversely affected, bucket traps can probably be modified to serve as relatively cheap and effective livetraps.

In summary, livetraps can be used to estimate the incidence of the microsporidan, *U. minutum*, and to detect the presence of the nematode, *C. brevicomi*. If this nematode is detected in a given SPB population, its incidence can be estimated more closely by examination of SPB adults reared from infested host material. Whatever its present limitations, live-trapping is a relatively economical method for obtaining SPB adults in the viable condition necessary for identification of organisms such as *U. minutum* and *C. brevicomi*.

ACKNOWLEDGMENTS

We are indebted to J. C. Moser (USDA, Forest Service, Pineville, LA) and L. E. Browne (Division of Entomology, University of California, Berkeley, CA); also to G. E. Allen, V. G. Perry, J. D. Knell, and A. E. MacGuidwin (Department of Entomology and Nematology, University of Florida, Gainesville, FL) for permission to cite communicated information or for identifications. The field assistance of Robert Britt, Ronald Mize, and Steve Seiber (Natural Resource Division, Directorate of Civil Engineering, Eglin Air Force Base, FL) and C. W. Berisford (Department of Entomology, University of Georgia, Athens, GA) is gratefully acknowledged. Thanks are due to A. J. Semago for excellent technical assistance and illustration and to F. G. Martin for special assistance with statistical analyses.

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PREDACEOUS ARTHROPODS ASSOCIATED WITH MEXICAN TEA IN NORTH FLORIDA[1]

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ABSTRACT

Twenty-eight species of predatory insects and 9 species of spiders were observed feeding on herbivorous insects associated with Mexican tea, *Chenopodium ambrosioides* L., in north Florida. Mexican tea served as an important alternate feeding site for some predaceous arthropods (i.e. *Perillus bioculatus* (Fab.), *Zelus cervicalis* (Stal.), *Callida decora* (Fab.), *Lebia viridis* Say, *Coleomegilla maculata* De Geer) prior to the appearance of pest species in nearby corn fields. Predaceous Pentatomidae, Carabidae, Coccinellidae and spiders were the most abundant predators found on Mexican tea. Forty-three percent of the predator species observed on Mexican tea also were collected in nearby corn fields.

Determining the source of predators of crop pests is an intriguing problem. Most row crops are grown annually as extensive monocultures with intervening fallow periods. Generally, weeds and natural border vegetation are greatly restricted in these types of cropping systems. The few studies dealing with predator colonization (van Emden 1965, Rabb et al. 1976, Mayse and Price 1978) show that general predators need to re-enter the field each year from refuge sites located within the surrounding natural matrix. Perrin (1975) and Altieri et al. (1977) suggested that the presence of certain weeds in the surrounding fields determine to a considerable extent what species of predators will inhabit a particular crop field. For this reason it is important to determine the species of predaceous arthropods which are associated with specific weeds in a given area. The present paper reports on the predators present on Mexican tea (*Chenopodium ambrosioides* L.) in north Florida and their prey relationships.

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[1]*Chenopodium ambrosioides* L. Florida Agricultural Experiment Station Journal Series No. 1458.