# SEMIOCHEMICALS AND *DIAPREPES ABBREVIATUS* (COLEOPTERA: CURCULIONIDAE) BEHAVIOR: IMPLICATIONS FOR SURVEY

W. J. SCHROEDER AND J. B. BEAVERS
U.S. Department of Agriculture, ARS
2120 Camden Road, Orlando, FL 32803

ABSTRACT

The existence of semiochemicals that influence reproductive behavior in the West Indian sugarcane root stalk borer weevil, *Diaprepes abbreviatus* (L.) has been demonstrated. Semiochemicals are produced by both male and female weevils. The aggregation of weevils is interpreted as a pheromone-induced behavior and this specific attractant is produced by the male weevil.

RESUMEN

Se ha demonstrado la existencia de "semiochemicals" que influyen el compartamiento reproductivo de *Diaprepes abbreviiatus* (L.). "Semiochemicals" son producidos por los gorgojos machos y hembras. La agregación de gorgojos es interpretada como un comportamiento inducido por feromonas y que este específico atrayente es producido por el gorgojo macho.

---

Research on the reproductive behavior of *Diaprepes abbreviatus* has been conducted during the last 5 years and is directed at deciphering chemical communication between individuals of the same species. The objective is to identify and develop naturally-occurring attractants derived from the weevil for population survey.

*Diaprepes abbreviatus* L., a sugarcane rootstalk borer weevil, is an important pest of sugarcane, citrus and other crops in the West Indies. The adults feed on foliage of at least 76 plant species in Puerto Rico (Martorell 1976), whereas the larvae are serious root feeders. *D. abbreviatus* was found in Florida in 1964 (Woodruff 1964). By 1982, the weevil was established on 4,000 ha of citrus (total citrus in Florida, 324,000 ha), but it had not been found on sugarcane (total sugarcane in Florida, 132,000 ha). The weevil was, however, established in ornamental nurseries in south Florida less than 10 km from the sugarcane areas (S. A. Alfieri, unpublished data). Several methods for detecting weevil spread have been investigated. Beavers et al. (1979) examined the use of light traps and determined that trap efficiency was not adequate for survey. Later, (1982) Beavers et al. used sticky traps in combination with caged weevils to show an in-flight attraction when traps were placed adjacent to plants with adult weevils.

Adult weevils emerge from the soil in spring (April through June) and in the fall (October through December) and often congregate in large numbers on an individual plant of a given host species, leaving nearby host plants undisturbed (Wolcott 1936, Woodruff 1968). Semiochemicals mediate interactions between organisms, and when the individuals involved are the

same species, the behavior-modifying chemicals are called pheromones. The presence of a pheromone is indicated in the aggregation type of behavior described above. Schroeder (1981), in an outdoor cage study, suggested a possible chemical basis for this behavior by showing that *D. abbreviatus* adults congregated on citrus plants on which one sex was allowed to crawl and feed. Beavers et al. (1982) reported a similar result in a laboratory olfactometer study. However, subsequent efforts to identify a specific behavioral response to frass or associated materials or extracts thereof in the laboratory were unsuccessful. Experiments with various trap designs in combination with weevils and weevil products as bait indicated that frass-encrusted foliage alone was more attractive than other combinations tested. In November 1981, we began field testing a particular trap design using extracts of weevil frass in an effort to develop a detection method.

A trap was developed based on observations of adult *D. abbreviatus* behavior. The trap is an inverted funnel with a cage attached to the top (Schroeder and Jones 1984) and is comparable to that of other insect traps (Leggett and Cross 1971). A highly significant increase in the number of captured weevils occurred when an extract of weevil frass was added to the trap. The extract used in the initial field tests consisted of 20 g of frass from a colony of male and female weevils (1:1) extracted in a blender with 150 ml of chloroform/methanol/water (1:2:0.8) monophasic solvent (Bligh and Dyer 1959). In subsequent studies, chloroform and methanol Soxhlet extracts were used. Schroeder and Jones (1983) demonstrated that location of the trap in a citrus tree and the wick material significantly affected trap capture. In this study, traps in the top of the tree captured more weevils compared to traps in the middle or lower sections of the tree, and glass wool was the best material for release of the attractant (compared to cotton or rubber). In another study, Jones and Schroeder (1984) demonstrated that extracts of frass from male weevils captured more males and females than did extracts of frass from female weevils. With the data from these field trapping studies, we were able to develop a laboratory bioassay.

A laboratory bioassay should reflect, as nearly as possible, the behavior of the natural population. Based on observations of field behavior and on field trapping studies, we determined the following: mating behavior increases from 0400-1200 h; male and female weevils congregate in an area of high pheromone concentration; and the male is the source of the behavior-modifying chemical that results in primary weevil aggregation. The bioassay cage was a 25-cm circular screen (32-cm mesh) cylinder with wood ends. Cages were oriented at a 90° angle to the prevailing breeze and held in a screenhouse that had an opaque roof for diffuse light. A cotton wick with the frass extract was suspended at one end of the cage and a wick with the extract solvent at the other end. Twenty male weevils were placed in each cage at first light in the morning, and the number of weevils within 15 cm of the end of the cage was determined each hour. The number of weevils congregating at the end with the frass extract was significant and increased with time (Table 1). Changes in the bioassay chamber, including air flow and design, are under study. The bioassay should provide a method to follow the isolation of behavior-modifying chemicals in the laboratory.

TABLE 1. MEAN NUMBER OF *D. Abbreviatus* MALES WITHIN THE 15-CM AREAS AT EACH END OF THE BIOASSAY CAGE FOR 1-7 H POSTTREATMENT.

| Hour posttreatment | Time | Replications | $\bar{x}$[1] No. weevils in 15-cm area | |
|---|---|---|---|---|
| | | | Treated | Control |
| 1 | 0800 | 23 | 4.1 | 3.2 |
| 2 | 0900 | 23 | 4.4 | 2.9 |
| 3 | 1000 | 23 | 5.8 | 3.2 |
| 4 | 1100 | 23 | 5.6 | 3.5 |
| 5 | 1200 | 18 | 6.3 | 3.1 |
| 6 | 1300 | 8 | 8.0 | 3.5 |
| 7 | 1400 | 8 | 7.3 | 3.6 |

[1]Means for 2-7 h posttreatment are significantly different ($P<0.01$, paired Student's $t$ test).

## CONCLUSION

Although data from field trapping and laboratory bioassay are by no means definitive, it is apparent that weevil excrement, or associated materials, contain active behavior-modifying chemical compounds which are extractable in chloroform and methanol. The field trap data also suggest that there is more than 1 active chemical in frass from male and female weevils. Traps containing extracts of male frass captured more total insects than other treatments. Aggregation of weevils on individual plants as described by Wolcott (1936) is therefore interpreted as pheromone-induced behavior. The laboratory bioassay, shown effective when applied to males, has not shown a significant migration of mated female weevils. Unmated female weevils have not yet been available for testing.

Additional research is needed before definitive statements can be made about other behavior-modifying chemicals of *D. abbreviatus*. Preliminary information has been accumulated and research on semiochemicals is continuing.

## REFERENCES CITED

BEAVERS, J. B., T. P. MCGOVERN, AND V. E. ADLER. 1982. *Diaprepes abbreviatus*: laboratory and field behavioral and attractancy studies. Environ. Ent. 11: 436-9.

———, J. M. STANLEY, H. R. AGEE, AND S. A. LOVESTRAND. 1979. *Diaprepes abbreviatus* response to light traps in field and cage tests. Florida Ent. 62: 136-9.

BLIGH, C. G., AND W. J. DYER. 1959. A rapid method of total lipid extraction and purification. Can. J. Biochem. Physiol. 37: 911.

JONES, I. F., AND W. H. SCHROEDER. 1984. Capture of *Diaprepes abbreviatus* (Coleoptera: Curculionidae) in frass extract-baited traps in citrus. J. Econ. Entomol. 77: 334-336.

LEGGETT, J. E., AND W. H. CROSS. 1971. A new trap for capturing boll weevils. Coop. Econ. Insect Rep. 21: 773-4.

MARTORELL, L. F. 1976. Annotated food plant catalog of the insects of Puerto Rico. Agric. Exp. Stn., Univ. P. R. 303 pp.

SCHROEDER, W. J. 1981. Attraction, mating, and oviposition behavior in field populations of *Diaprepes abbreviatus* on citrus. Environ. Entomol. 10: 898-900.

————, AND I. F. JONES. 1984. A new trap for capturing *Diaprepes abbreviatus* (Coleoptera: Curculionidae). Florida Ent. 67: 312-314.

————, ————. 1983. Capture of *Diaprepes abbreviatus* (Coleoptera: Curculionidae) in traps: effects of location in a citrus tree and wick materials. J. Econ. Entomol. 76: 1312-1314.

WOLCOTT, G. N. 1936. The life history of *Diaprepes abbreviatus* at Rio Piedras, Puerto Rico. J. Agric. Univ. P.R. 20: 882-914.

WOODRUFF, R. E. 1964. A Puerto Rican weevil new to the United States (Coleoptera: Curculionidae). Florida Dep. Agric., Div. Plant Ind., Entomol. Circ. 30: 1-2.

————. 1968. The present status of a West Indian weevil (*Diaprepes abbreviatus* (L.)) in Florida (Coleoptera: Curculionidae). Florida Dep. Agric., Div. Plant Ind., Entomol. Circ. No. 77: 1-4.

# SUSCEPTIBILITY OF *ARTIPUS FLORIDANUS* TO DIFFERENT ISOLATES OF *BEAUVERIA BASSIANA*

C. W. MCCOY, G. M. BEAVERS AND C. A. TARRANT
University of Florida, IFAS
Citrus Research and Education Center
700 Experiment Station Road
Lake Alfred, FL 33850 USA

ABSTRACT

Literature on the entomopathogens of adult and larval root weevils is reviewed. A quantitative study to determine the pathogenicity and sporulation on larvae of 34 isolates of *Beauveria bassiana* to neonatal larvae of *Artipus floridanus* is reported. Six isolates were determined as potentially superior for microbial control of citrus root weevils. Difference in pathogenicity between fungal types was more pronounced at the lower conidial concentration. Sporulation per cadaver increased with an increase in virulence. No consistent differences in pathogenicity to neonatal larvae of *A. floridanus* could be detected between exotic and indigenous isolates, insect host, or location.

RESUMEN

Se revisa la literatura de patógenos entomológicos de gorgojos de raíces adultos y de las larvas. Se reporta un estudio cuantitativo para determinar la patogenicidad y la esporulación en larvas de 34 aislados de *Beauveria bassiana* hacia larvas neonatales de *Artipus floridanus*. Se determinó que 6 aislados eran potencialmente superiores para el control microbial de gorgojos de raíces en cítricos. Diferencia en patogenicidad entre tipos de hongos fue más pronuncida en baja concentracion de conidias. Esporulación por cadáver aumentó con un aumento en virulencia. No se pudo detectar diferencias consistentes en patogenicidad hacia larvas neonatales de *A. floridanus* entre aislados exóticos o indígenos, insectos hospederos, o localidad.