SEASONAL ABUNDANCE OF A PUPAL PARASITOID, *DIAPETIMORPHA INTROITA* (HYMENOPTERA: ICHNEUMONIDAE)

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ABSTRACT

Seasonal abundance of a pupal parasitoid *Diapetimorpha introita* (Cresson) (Hymenoptera: Ichneumonidae) and the beet armyworm *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) was monitored with pheromone-traps. *D. introita* males were caught in wing traps baited with live females, and beet armyworm males were caught in bucket traps baited with synthetic pheromone. The greatest number of *D. introita* adult males was caught during early autumn, approximately one month after the greatest number of beet armyworm males was caught, and represents the most convenient time during which to conduct trapping experiments.

Key Words: sex-attractant, biological control, population dynamics, beet armyworm, fall armyworm, *Spodoptera*, pheromone-trapping

RESUMEN

La abundancia estacional del parásito pupal *Diapetimorpha introita* (Cresson) (Himenóptera: Ichneumonidae) y de *Spodoptera exigua* (Hübner) (Lepidóptera: Noctuidae) fue observada con trampas de feromona. Machos de *D. introita* fueron capturados en trampas de ala con señuelo de hembras vivas, y machos *S. exigua* fueron capturados en trampas de cubo con señuelo de feromona sintética. La mayor captura de machos adultos *D. introita* fue alcanzada durante el comienzo del otoño, aproximadamente un mes después de que el mayor numero de *S. exigua* fue capturado, y representa el tiempo más conveniente para conducir experimentos de trampas.

When the Boll Weevil Eradication Program was initiated in autumn of 1987 over large portions of the southeastern United States, the beet armyworm *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) emerged as the most important threat to cotton production (Haney et al. 1996). Other hosts of economic importance with which the beet armyworm is associated include tomatoes, corn, alfalfa, onions, asparagus, potatoes, and citrus as well as numerous non-economic species (Hendricks et al. 1995). Prior to 1991, Georgia experienced outbreaks during 1977, 1980, 1981, 1988, and 1990 (Douce & McPherson 1991). Difficult to manage, outbreaks have been correlated with less than normal precipitation and disruptive insecticide use (Chandler & Ruberson 1996). Its threat to cotton production has declined in recent years, presumably the result of declining insecticide applications directed at the boll weevil and increased planting of BT-cotton against the beet armyworm (John Ruberson, Department of Entomology, University of Georgia, pers. comm.).

Historically, the fall armyworm *Spodoptera frugiperda* (J. E. Smith) is an important pest of corn, sorghum, and coastal Bermuda grass (Metcalf et al. 1951). It was not recognized as an important threat to cotton production. Recently, however, the importance of fall armyworm to cotton production has increased (Riley et al. 1997) because BT-cotton is not as effective against it as beet armyworm (Adamczyk et al. 1998).

Diapetimorpha introita (Cresson) (Hymenoptera: Ichneumonidae) is a pupal parasitoid native to southern Georgia, and it may be valuable to the biological control of *Spodoptera* spp. if mass propagated and released against incipient populations (Pair & Gross 1989). It has been reared from fall armyworm pupae collected in the field (Pair & Gross 1989). Although *D. introita* has been reared from laboratory strains of the beet armyworm (Carpenter & Greany 1998), a comprehensive survey of pupae in the field has yet to be completed.

Previous attempts to describe population dynamics of *D. introita* have relied upon measuring frequency of parasitism among fall armyworm pupae in the field (Pair & Gross 1989). As investigation of *D. introita* and its importance to the management of *Spodoptera* spp. proceeds, more convenient methods of monitoring populations in the field are needed (Jewett & Carpenter 1998). One possible approach to monitoring *D. introita* concerns pheromone-trapping males. That *D. introita* males use a sex-attractant to find females is supported by data from laboratory and field bioassays (Jewett & Carpenter 1998). Significantly more males were caught in traps baited with live females than in traps baited either with nothing or with live males. Experiments with a related pupal parasitoid, *Ichneumon promissorius* (Hymenoptera: Ichneumonidae) (Erichson), have yielded further insights concerning extraction of a sex-attractant from *D. introita* females (Jewett & Carpenter 1999).

A lure formulated with the sex-attractant of *D. introita* for conveniently monitoring its populations in the field is anticipated. Field bioassays had been completed previously during spring and early summer, and number of males caught in traps was generally low (Jewett & Carpenter 1998). A greater population reservoir from which to trap *D. introita* males would accommodate more replications and greater resolution. The present study was undertaken to describe local seasonal abundance of *D. introita* males, and to identify the most convenient time of year during which they may be trapped.

For comparison, local seasonal abundance of the beet armyworm also was considered. Although a comprehensive survey of beet armyworm pupae in the field has not been completed, more *D. introita* were reared from beet armyworm pupae than from fall armyworm pupae (Carpenter & Greany 1998). Relative abundance of the fall armyworm was not considered because it is not resident to southern Georgia, but instead migrates annually from Florida (Pair et al. 1986; Wilson 1934). This disposition may be responsible, in part, for inconsistent trapping results and their lacking reliability as indicators of relative abundance (John Ruberson, Department of Entomology, University of Georgia, pers. comm.). Unable to rely upon results of trapping fall armyworm males, beet armyworm was substituted because it is a potential host that responds well to lures.

Materials and Methods

Twenty different sites at Gibbs and Bellflower Farms in Tift Co. were monitored for *D. introita* adult males during two years. Traps were established as described by Jewett and Carpenter (1998). Briefly, wing traps were supported 0.5 m above ground and were baited with two live females (either mated or unmated) (Fig. 1). Number of males caught was recorded once a week, and trap bottoms were replaced. Lures also were replaced once a week or when a female had expired.

Sex-attractant of the beet armyworm is (z)-9-tetradecen-1-ol (2.5%), (z)-9, 12-tetradecadien-1-ol acetate (87.2%), and (z)-11-hexadecen-1-ol acetate (10.3%). It has been used previously to trap beet armyworm adult males (Hendricks et al. 1995; Mitchell & Tumlinson 1994), and is as reliable an indicator of seasonal occurrence of beet armyworm adults in the field as live virgin females (Mitchell & Tumlinson 1994). Beet armyworm adult males were monitored at Gibbs and Rigdon Farms in Tift Co., Georgia with traps established as described by Ruberson and Herzog (1997, 1998). Briefly, bucket traps were suspended 1.5 m from the ground and were baited with lures of synthetic pheromone (Great Lakes IPM Inc., Vestaburg, MI). Number of males caught in traps was recorded once a week and lures were replaced biweekly.

Adult males of both insects were monitored between June 1997 and December 1998. Occasionally, data were not recorded from beet armyworm traps during 1998 or from *D. introita* traps during 1997. Data were not recorded from beet armyworm traps during the last two weeks of December in 1997 and the first two weeks of January in 1998. Data were not collected from *D. introita* traps during January 1997.

Results and Discussion

Although pheromone-traps have been used to detect insects at remarkably low population densities, the number caught often does not reflect actual density (Cardé & Elkinton 1984). However, data from trapping programs often are valuable for relative estimates (Evans 1984). Results of trapping *D. introita* adult males in the present study are generally consistent with those of the previous study by Pair and Gross (1989), although some differences do exist. In the present study, greatest number of *D. introita* males was caught during September and early October of both years (Fig. 2). Pair and Gross (1989) also reported that emergence of *D. introita* from fall armyworm pupae was greatest during September and October. During the present study, twenty one males were caught over 2 days in one trap at Gibbs Farm in October, and two traps caught 23 males each during one week in September at Bellflower Farm (Fig. 2).

D. introita first appeared during May in the study by Pair and Gross (1989), but in the present study, males first appeared during the end of March (Fig. 2). *D. introita* overwinter in their hosts, and this difference in date of appearance may reflect sensitivity of pheromone-traps to low numbers that have emerged after overwintering. Although Pair and Gross (1989) did not detect *D. introita* adults between mid-July and end of August, small numbers were detected during that time in the present study (Fig. 2).

Greatest number of beet armyworm adult males was caught in traps during August and September. Total number caught exceeded 500 on

Fig. 1. In the field, wing trap baited with *Diapetimorpha introita* (Cresson) (Hymenoptera: Ichneumonidae) females.

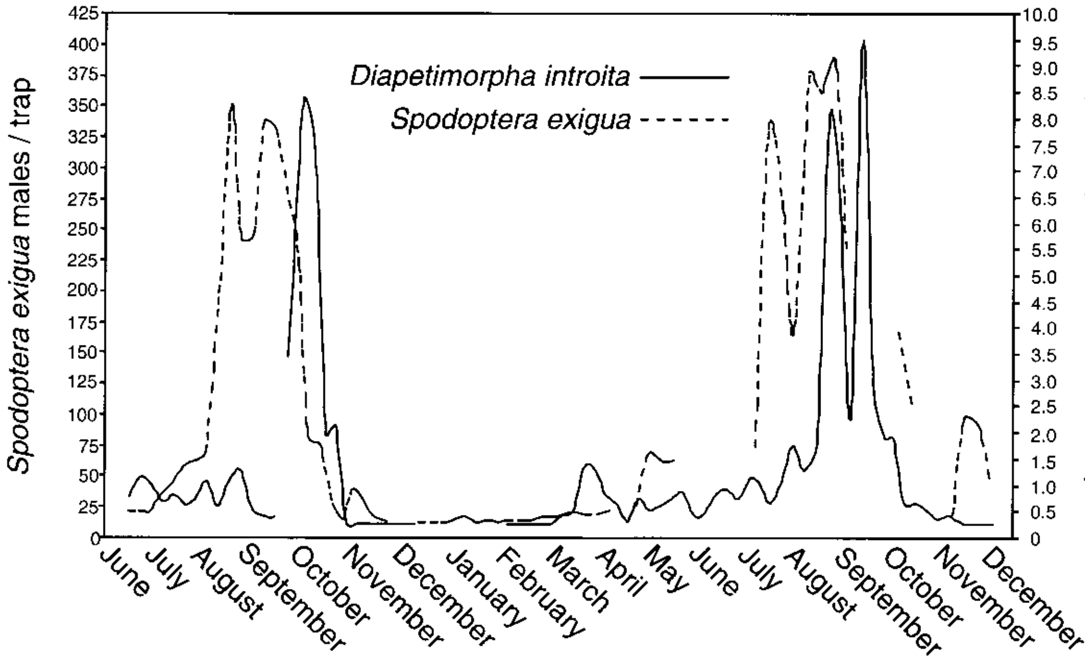

Fig. 2. Average number of *Diapetimorpha introita* (Cresson) (Hymenoptera:Ichneumonidae) males caught in wing traps baited with live females (solid line) and average number of beet armyworm *Spodoptera exigua* (Hübner) (Lepidoptera: Noctuidae) males (intermittent line) caught in bucket traps baited with synthetic pheromone. Breaks in either line represent weeks during which data were not collected.

only 4 dates in 1997, but never exceeded 1,000 as it had in previous years (Ruberson & Herzog 1998). Total number caught in 1998 was comparable to 1997 (Ruberson & Herzog 1997, 1998).

DeBach and Smith (1941) demonstrated that oscillations are inherent to host-parasitoid systems. They predicted that if a parasitoid is host-specific and more successful at finding abundant hosts, then reduction in host numbers would result in decreased number of parasitoids, permitting host numbers to rise (DeBach & Smith 1941). Relative abundance of the beet armyworm and *D. introita* males reflects oscillations predicted by DeBach and Smith (1941) (Fig. 2). Greatest number of *D. introita* males trapped for both years followed the greatest number of beet armyworm males trapped by approximately one month, which is consistent with combined development times of beet armyworm and *D. introita* (Wilson 1934; Pair 1995).

Pair and Gross (1989) concluded that abundance of *D. introita* reflects availability of its host. Although a direct host-parasitoid relationship between the beet armyworm and *D. introita* has not been formally demonstrated in the field, it is supported by their population curves in the present study and the successful rearing of *D. introita* on laboratory strains of the beet armyworm (Carpenter & Greany 1998). Furthermore, the fall armyworm is migratory from Florida (Pair et al. 1986; Wilson 1934) and the beet armyworm could satisfy any requirement *D. introita* has for an alternate host in southern Georgia.

As investigation of their importance to biological control of *Spodoptera* spp. proceeds, more convenient methods of monitoring *D. introita* in the field are needed. The development of lures for monitoring the relative abundance of males is anticipated, but a need for populations large enough to accommodate the convenient testing of different formulations has been expressed. Results of the present study suggest that the best time during which to test different formulations of lures is during early autumn, approximately one month following greatest relative abundance of beet armyworm adult males.

ACKNOWLEDGMENTS

We thank John Ruberson (Entomology Department, University of Georgia, Tifton, GA) for providing beet armyworm trap data. Also, we thank R. Caldwell and S. Drawdy (Insect Biology and Population Management Research Laboratory, USDA, ARS, Tifton, GA) for their assistance. We are especially grateful for the leadership of C. Rogers, former Laboratory Director of the Insect Biology and Population Management Research Laboratory.

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