

GEOGRAPHICAL DISTRIBUTIONS AND PARASITIZATION LEVELS FOR PARASITOIDS OF THE FALL ARMYWORM, *SPODOPTERA FRUGIPERDA*

TOM R. ASHLEY

Insect Attractants, Behavior, and Basic Biology Research Laboratory
Agricultural Research Service, U.S. Department of Agriculture
Gainesville, FL 32604

ABSTRACT

Literature citations were used to determine geographical distribution data and parasitization levels from larva collections from corn, alfalfa, three species of grass, peanut, and sorghum for the principal parasitoids of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith). The highest parasitization levels found for corn, alfalfa, grass, peanut, and sorghum were 77, 30, 54, 37, and 20%, respectively. *Chelonus insularis* (Cresson) had the highest parasitization rates of all the parasitoids for North and Central America. This parasitoid was not recovered from South America or the Caribbean. *Cotesia marginiventris* (Cresson) had approximately the same geographical distribution as *C. insularis*, but attained its highest parasitization levels in grass rather than corn. None of the parasitoids exerted substantial mortality throughout any major portion of the fall armyworm's range.

RESUMEN

Se usaron citas de la literatura para determinar datos sobre la distribución geográfica y niveles de parasitismo de colecciones de larvas en maíz, alfalfa, tres especies de hierbas, maní, y sorgo, de los principales parasitoides del gusano cogollero, *Spodoptera frugiperda* (J. E. Smith). Los niveles de parasitismo más altos encontrados en maíz, alfalfa, hierbas, maní, y sorgo, fueron de 77, 30, 54, 37, y 20% respectivamente. *Chelonus insularis* (Cresson) tuvo el nivel de parasitismo más alto de todos los parasitoides del Norte y Centro America. Este parasitoide no se encontró en Sudamerica o en el Caribe. *Cotesia marginiventris* (Cresson) tuvo aproximadamente la misma distribución geográfica que *C. insularis*, pero obtuvo su nivel mas alto de parasitismo en hierbas en vez de en maíz. Ninguno de los parasitoides causaron una mortalidad substancial a través ninguna área mayor de la esfera del gusano cogollero.

There are over 1300 literature citations referencing the fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), starting from its initial discovery up to the end of 1983 (Davis, per. comm.). Approximately 2% of these citations provide various types of data relative to the parasitoids of this pest. However, data on parasitoid distributions as well as parasitization levels on different FAW hosts are scattered. The purpose of this paper is to synthesize information on the geographical distributions and parasitization rates of the major FAW parasitoid species encountered in five of the principal host plants. This information may provide a basis for understanding the role played by parasitoids in the population dynamics of the FAW.

MATERIALS AND METHODS

Bibliographic references were not included in the text, but rather have been tabulated by parasitoid species, author, collection location and crop (Table 1) because of the quantity involved. References utilized were only those that contained information on parasitization levels with defined locations where FAW larvae were collected. Corn (*Zea mays* L.), alfalfa (*Medicago sativa* L.), grass, peanut (*Arachis hypogaea* L.), and sorghum (*Sorghum bicolor* (L.) Moench.) represented the five major host plants for the distribution maps (Fig. 1-H) with collections from some additional hosts contained in Table 1. The three plant species in the grass category were broadleaf signalgrass, *Brachiaria platyphylla* (Briseb.) Nash., paragrass, *Brachiaria mutica* (L.), and Bermudagrass, *Cynodon dactylon* (L.). Each star on a distribution map represents a single geographical location where FAW larval collections were made. These distribution maps were not intended to represent the entire range of a particular parasitoid since only collections of FAW larvae were utilized. In several instances more than one paper dealt with collections from the same location. Where necessary, parasitization rates were recalculated so as to have all rates based upon the total number of FAW larvae collected. Parasitization levels in the figures are presented as ranges derived from the highest and lowest levels of parasitization recorded for a particular host plant. A single value for percent parasitization indicates the results from a single collection.

TABLE 1. PRINCIPAL PARASITOIDS OF THE FALL ARMYWORM WITH ACCOMPANYING REFERENCES INDICATING LARVAL COLLECTIONS IN DIFFERENT GEOGRAPHIC LOCATIONS AND CROPS.¹

Parasitoid	Reference	Geographic location	Crop
<i>Apanteles</i> sp.			
	Lacayo 1977	CA	C,S
	Alam 1979	CR	C
<i>Campoletis flavicincta</i> (Ashmead)			
	Hogg et al. 1982	US	C
	Soteres et al. 1984	US	A
	Wall & Berberet 1975	US	P
	Vickery 1929	US	C
<i>Campoletis grioti</i> (Blanchard)			
	Lucchini & Almeida 1980	SA	C
<i>Campoletis sonorensis</i> (Cameron)			
	Soteres et al. 1984	US	A
<i>Chelonus insularis</i> (Cresson)			
	Ashley et al. 1980, 1982, 1983	US	C,G
	Lacayo 1977	CA	C,S
	Luginbill 1928	US	C
	Mitchell et al. 1984	US	C
	Rohlfis & Mack 1985	US	C,S
	Soteres et al. 1984	US	A
	Vickery 1929	US	C
	Wall & Berberet 1975	US	P
	Wheeler 1985 (per. comm.)	CA	C
<i>Chelonus antillarum</i> (Marshall)			
	Alam 1979	CR	C
	Ryder & Pulgar	CR	C

TABLE 1. (Continued)

Parasitoid	Reference	Geographic location	Crop
<i>Cotesia marginiventris</i> (Cresson)			
	Ashley et al. 1980, 1982, 1983	US	C
	Hogg et al.	US	C
	Lucchini & Almeida 1980	SA	C
	Mitchell et al. 1984	US	C
	Nickle 1976	US	P
	Reed 1980	US	C,Ct,G,S
	Rohlf & Mack 1985	US	C,S
	Soteres et al. 1984	US	A
	Vickery 1929	US	C
	Wall & Berberet 1975	US	P
<i>Euplectrus platyhypenae</i> Howard			
	Alam 1979	CR	C
	Ashley et al. 1980	US	C,G
	Hogg et al. 1982	US	C
	Montoya 1979	MX	C
	Ryder & Pulgar 1969	CR	C
	Vickery 1929	US	C
	Wall & Berberet 1974	US	P
<i>Euplectrus</i> sp.			
	Keller 1980	US	C
	Lacayo 1977	CA	C,S
	Reed 1980	US	G,M
<i>Meteorus autographae</i> Muesebeck			
	Ashley et al. 1980, 1982, 1983	US	C,G
	Nickle 1976	US	P
	Reed 1980	US	C,G
	Rohlf & Mack 1985	US	S
	Soteres et al. 1984	US	A
<i>Meteorus laphygmae</i> Viereck			
	Vickery 1929	US	C
<i>Ophion flavidus</i> Brulle			
	Hogg et al. 1982	US	C
	Reed 1980	US	C,G,M,S
	Rohlf & Mack 1985	US	C,S
<i>Ophion</i> sp.			
	Ashley et al. 1983	US	C,G
	Nickle 1976	US	P
	Wheeler 1985 (per. comm.)	CA	C
<i>Rogas laphygmae</i> Viereck			
	Ashley et al. 1982, 1983	US	C,S
	Reed 1980	US	C,S
	Rohlf & Mack 1985	US	C,S
	Vickery 1929	US	C
<i>Rogas</i> sp.			
	Lacayo 1977	CA	C,S
	Soteres et al. 1984	US	A
	Ryder & Pulgar 1969	CR	C
Tachinidae			
	Alam 1979	CR	C

TABLE 1. (Continued)

Parasitoid	Reference	Geographic location	Crop
	Ashley et al 1980, 1982, 1983	US	C,G
	Bertels 1956	SA	C
	Campos 1965	SA	C
	Fuentes 1973	SA	C
	Hogg et al. 1982	US	C
	Hynes 1942	CA	C
	Lacayo 1977	CA	C,S
	Lucchini & Almeida 1980	SA	C
	Nickle 1976	US	P
	Reed 1980	US	C,G,M,S
	Rohlf & Mack 1985	US	C,S
	Ryder & Pulgar 1969	CR	C
	Soteres et al. 1984	US	A
	Vickery 1929	US	C
	Wall & Berberet 1975	US	P
	Wheeler 1985 (per. comm.)	CA	C
<i>Temelucha difficilis</i> Dasch.			
	Ashley et al. 1980, 1982, 1983	US	C,G
	Mitchell et al. 1984	US	C

Locations: CA—Central America, CR—Caribbean, MX—Mexico, SA—South America, US—United States. Crops: A—Alfalfa, C—Corn, Ct—Cotton, G—Grass, M—Millet, P—Peanut, S—Sorghum.

RESULTS AND DISCUSSION

Parasitoids have been collected from most of the range of the FAW (Fig. 1A). Combined parasitization rates for all the parasitoids collected indicated that the highest levels occurred in corn followed by grass, peanut, alfalfa, and sorghum. The Braconidae had the greatest overall impact on FAW populations with *Chelonus insularis* (Cresson) having the highest parasitization rates in Central and North America (Fig. 1B). This braconid had its greatest impact in southern Florida where 63% of FAW larvae were parasitized. No collection records were found for *C. insularis* emerging from FAW larvae from South America. *Chelonus antillarum* (Marshall) did not overlap in its distribution with *C. insularis* and was recorded with parasitization rates of 30 and 13% from corn on the islands of Barbados and Cuba, respectively. *Cotesia marginiventris* (Cresson) has been included with *Apanteles* sp. because *C. marginiventris* was a member of this genus. The *Apanteles* sp. were collected in Nicaragua and Barbados (Fig. 1C). The remaining stars indicated the presence of *C. marginiventris*. Both *C. insularis* and *C. marginiventris* had approximately the same distributions. However, *C. marginiventris* appeared to have its greatest impact on FAW populations in grass, whereas *C. insularis* was more prevalent in corn. All of the parasitoid recoveries for the genus *Meteorus* occurred within the continental United States (Fig 1D). *Meteorus laphygmae* Viereck was collected only in Texas. These parasitoids had their greatest impact on the FAW in grass. The genus *Rogas* had the least impact on FAW populations (Fig. 1E). The distribution of *Rogas laphygmae* (Viereck) appeared to be confined to the continental United States. Other members of this genus have been collected in Cuba and Nicaragua. The highest parasitization rates occurred in grass.

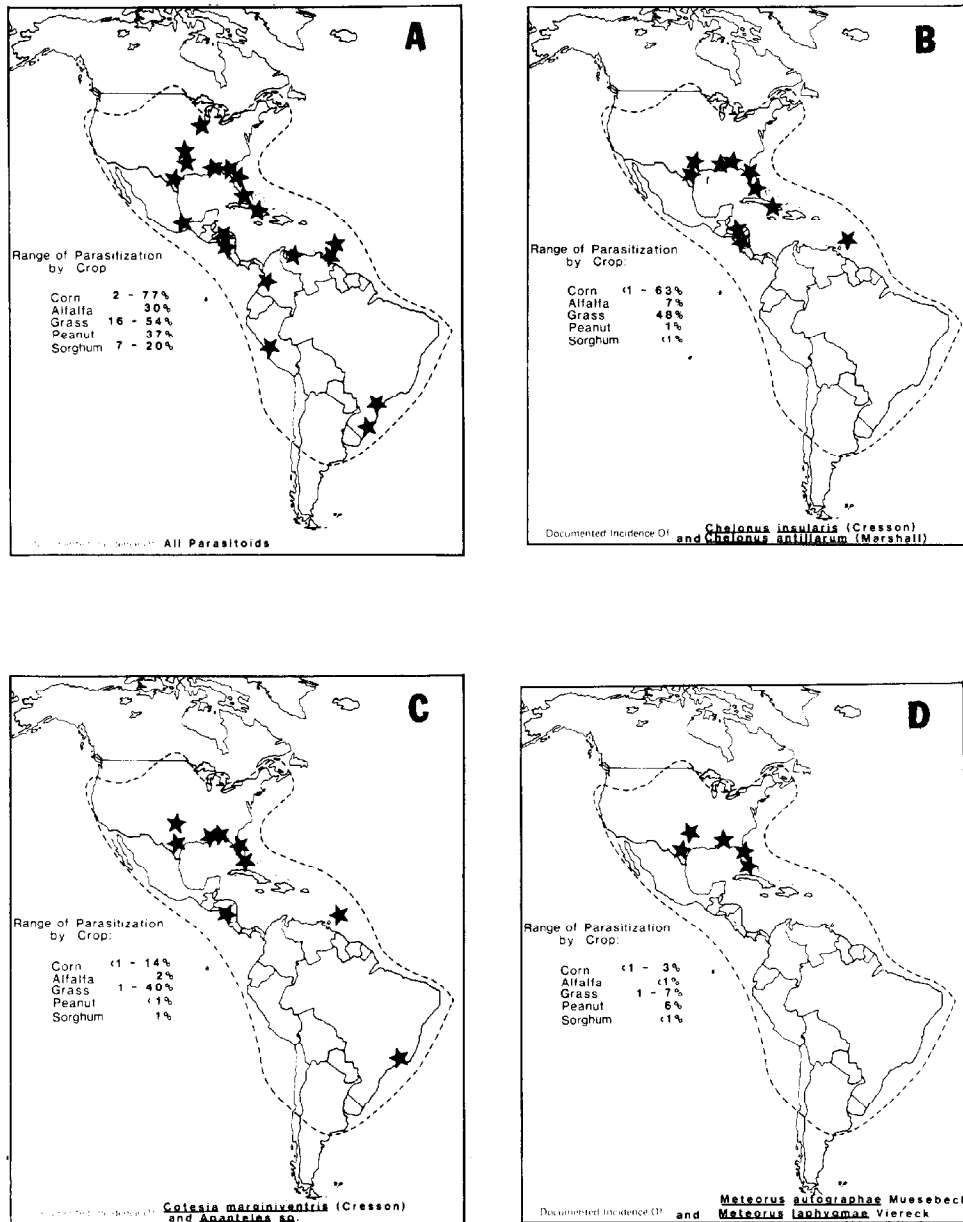
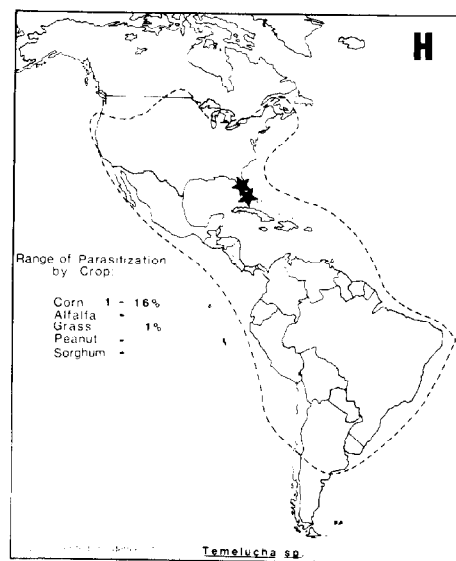
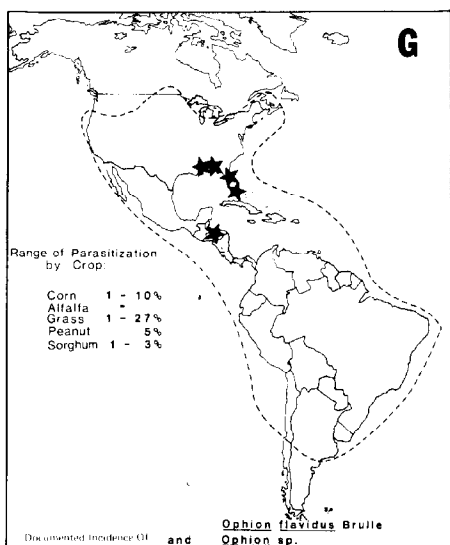
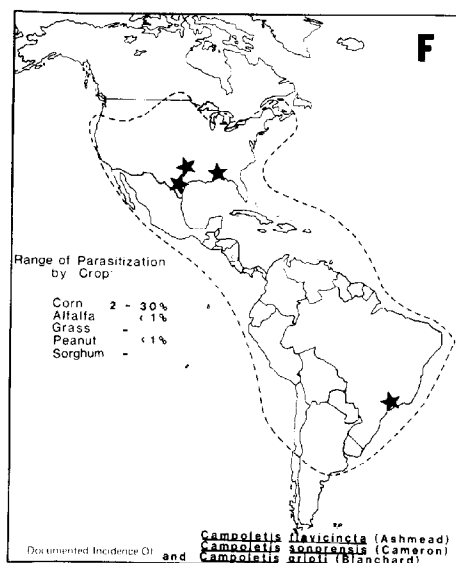
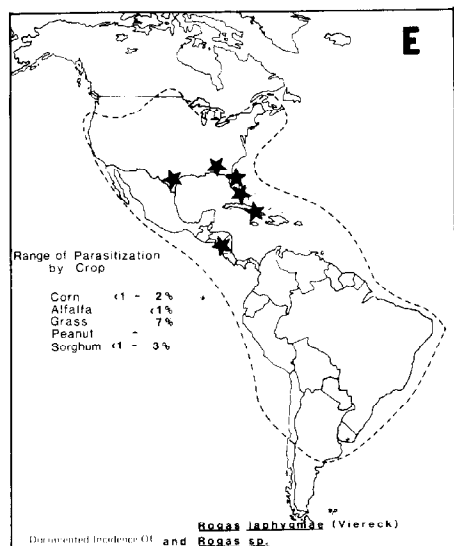
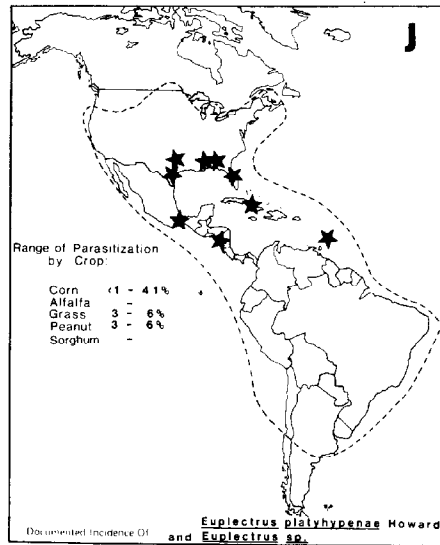
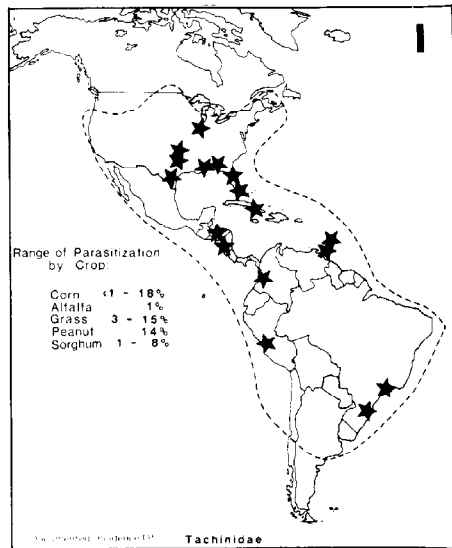


Fig. 1. Geographical distributions and parasitization ranges of the principal parasitoids (A-J) of the fall armyworm, *Spodoptera frugiperda*. Stars indicate parasitoid recoveries from larval collections and the dashed line defines the known range of the fall armyworm.

The ichneumonids were represented by three genera. Three species were collected from the genus *Campoletis* (Fig. 1F). *Campoletis grioti* (Blanchard) was collected in Brazil from FAW larvae feeding on corn. The remaining two species, *C. flavicincta* (Ashmead) and *C. sonorensis* (Cameron), occurred within the United States. The major impact of this genus on FAW occurred in corn and no collections were made from grass,



or sorghum. Members of the genus *Ophion* were recovered principally from the southeastern United States with one collection of an *Ophion* sp. occurring in Honduras (Fig. 1G). The greatest impact of the ophions occurred on grass, followed by corn. No members of this genus have been found parasitizing the FAW in alfalfa. The remaining ichneumonid attacking FAW was *Temelucha difficilis* Dasch. (Fig. 1H). This parasitoid has been recovered only from larval collections in Florida with the highest parasitization rates being recorded from corn.



Euplectrus platyhyphenae Howard was the only Eulophidae found attacking the FAW (Fig. 1I). Its greatest impact occurred on corn and it was recovered also from FAW larvae feeding on grass and peanuts. *Euplectrus* sp., not identified as *E. platyhyphenae*, was collected from the United States in Alabama and Florida and in Central America from Nicaragua.

Members of the family Tachinidae, having been collected from North, Central, and South America as well as the Caribbean, had a greater geographical distribution than any of the other parasitoid families (Fig. 1J). Even though the tachinids did not have the highest parasitization rates in any of the individual crops, they parasitized more FAW larvae over a greater range of crops than any of the other parasitoids.

Parasitoids of the FAW occurred throughout its range and exerted substantial mortality on larval populations. The data indicated that the FAW was parasitized in various agricultural crops and geographic locations by different complexes of parasitoids. There did not appear to be a single parasitoid species that exerted significant mortality throughout any major portion of the FAW's range. This condition may be one of the principal reasons why the FAW continues to be a serious agricultural pest.

ACKNOWLEDGEMENT

Sincere appreciation is expressed to Ms. Pamela Wilkening for her efforts in gathering and organizing this information.

REFERENCES CITED

- ALAM, M. M. 1979. Attempts at the biological control of major insect pests of maize in Barbados, W. I. Proc. Caribbean Food Crops Soc., Symp. on Maize and Peanut, Paramaribo, November 13-18, 1978, pp. 127-135.

- ASHLEY, T. R., E. R. MITCHELL, N. C. LEPLA, AND E. E. GRISSELL. 1980. Parasites attacking fall armyworm larvae, *Spodoptera frugiperda* in late planted field corn. Florida Ent. 63: 136-142.
- , V. H. WADDILL, E. R. MITCHELL, AND J. RYE. 1982. Impact of native parasites on the fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae), in South Florida and release of the exotic parasite, *Eiphosoma vitticole* (Hymenoptera: Ichneumonidae). Environ. Ent. 11(4): 833-37.
- , C. S. BARFIELD, V. H. WADDILL, AND E. R. MITCHELL. 1983. Parasitization of fall armyworm larvae on volunteer corn, Bermudagrass, and paragrass. Florida Ent. 66(2): 267-271.
- BERTELS, A. 1956. Pragas do milho, metodos de defesa. Boletim Technico do Instituto Agronomico do Sul. 16: 1-18.
- CAMPOS P., J. 1965. Investigaciones sobre el control biologico del "colgollero" del maiz, *Spodoptera frugiperda* (J. E. Smith) y otros noctuides. Revista Peruana de Ent. 8: 126-131.
- FUENTES J., R. 1973. Dipteros parasitos de larvas de lepidopteros en algunos municipios del valle del Cauca. Acta Agronomica 23: 7-50.
- HOGG, D. B., R. E. ANDERSON, AND H. N. PITRE. 1982. Early-season parasitization of fall armyworm (Lepidoptera: Noctuidae) larvae in Mississippi. Florida Ent. 65: 584-585.
- HYNES, H. B. N. 1942. Lepidopterous pests of maize in Trinidad. Tropical Agric. 29: 194-202.
- KELLER, M. A. 1980. Effects of Temperature and Corn Phenology on Fall Armyworm Biology. Masters Thesis, University of Florida, 83 pp.
- LACAYO, L. 1977. Especies parasiticas de *Spodoptera frugiperda* Smith, *Diatraea lineolata* (Wer) y *Trichoplusia ni* (Hbn) en zonas de Managua y Masatepe. XXIII Reunion Anual del PCCMCA, Panama 1977, 28 pp.
- LUCCHINI, F., AND A. A. ALMEIDA. 1980. Parasital da *Spodoptera frugiperda* (Smith & Abbot, 1797) (Lep., Noctuidae), lagarta do cartucho do MI LHO encontrado em pnota grossa. An. Soc. Ent. Bras. (Brazil) 9: 115-122.
- LUGINBILL, P. 1928. The fall armyworm. U.S. Dept. Agric. Tech. Bull. 34, 91 pp.
- MITCHELL, E. R., V. H. WADDILL, AND T. R. ASHLEY. 1984. Population dynamics of the fall armyworm (Lepidoptera: Noctuidae) and its larval parasites on whorl stage corn in pheromone-permeated field environments. Environ. Ent. 13: 1618-1623.
- MONTAYA, J. A. 1979. Estudio preliminar del ectoparasito del genero Euplectrus del gusano cogollero *Spodoptera frugiperda*. VII Reunion Nacional de Control Biologico, Veracruz, Ver. pp. 81-84.
- MOREY, C. S. 1971. Biologia de *Campoletis grioti* (Blanchard) (Hymen.: Ichneumonidae) parasito de la "lagarta cogollera del maiz" *Spodoptera frugiperda* (J. E. Smith). Rev. Per. Ent. 14: 263-271.
- NICKLE, D. A. 1976. The peanut agroecosystem in Central Florida. Ph.D. Dissertation, University of Florida, Gainesville, 131 pp.
- NOTZ, A. 1972. Parasitismo de Diptera e Hymenoptera sobre larvas de *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae) recolectadas en maiz, Maracay, Venezuela. Rev. Fac. Agron. 6: 5-16.
- PARKER, H. L. 1953. Miscellaneous notes on South American dipterous parasites. Lab. de Ent. Agric. "Felippo Silvestri" May-Aug, pp. 45-73.
- PAIR, S. D., AND H. R. GROSS, JR. 1984. Field mortality of pupae of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), by predators and a newly discovered parasitoid, *Diapetimorpha introita*. J. Georgia Ent. Soc. 19: 22-26.
- REED, D. J. 1980. Toxicological and parasitological studies on the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), in Alabama. M.S. Thesis, Auburn University, Auburn, Alabama, 55 pp.

- ROHLFS, W. M., AND T. P. MACK. 1985. Seasonal parasitism rates, host size, and adult emergence pattern of parasitoids of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), with emphasis on *Ophion flavidus* Brulle (Hymenoptera: Ichneumonidae). Ann. Ent. Soc. America 78: 217-220.
- RYDER, W. D., AND N. PULGAR. 1969. A note on parasitism of the fall armyworm, *Spodoptera frugiperda*, on maize. Rev. Cubana Cienc. Agric. (English ed.) 3: 267-271.
- SMITH, R. C. 1921. Observations on the fall armyworm (*Laphygma frugiperda* Smith & Abbott) and some control experiments. J. Econ. Ent. 14: 300-305.
- SOTERES, K. M., R. C. BERBERET, AND R. W. MC NEW. 1984. Parasitic insects associated with lepidopterous herbivores on alfalfa in Oklahoma. Environ. Ent. 13: 787-793.
- VICKERY, R. A. 1929. Studies on the fall armyworm in the Gulf Coast district of Texas. U.S. Dept. Agric. Tech. Bull. 138, 63 pp.
- WALL R., AND R. C. BERBERET. 1975. Parasitoids associated with lepidopterous pests on peanuts; Oklahoma fauna. Environ. Ent. 4: 877-882.
- WALTON, W. R. 1913. Efficiency of tachinid parasite on the last instar of *Laphygma*. Proc. Ent. Soc. Washington 15: 128-131.

INCIDENCE AND HOST RANGE OF A NEW ASCOVIRUS ISOLATED FROM FALL ARMYWORM, *SPODOPTERA FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE)

J. J. HAMM, S. D. PAIR, AND O. G. MARTI, JR.

Insect Biology and Population Management Research Laboratory, USDA-ARS,
Tifton, GA 31793-0748

ABSTRACT

A new virus disease caused by an ascovirus was found in larvae of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith), collected in south Florida and Georgia. The host range of the ascovirus from *S. frugiperda* was compared to ascoviruses from *Trichoplusia ni* (Hübner), *Autographa precationis* (Gn.), *Heliothis zea* (Boddie), and *H. virescens* (F.) by hemocoelic inoculation of the following species, *S. frugiperda*, *S. exigua* (Hübner), *S. eridania* (Cramer), *S. ornithogalli*, (Guenée), *Heliothis zea* (Boddie), and *Feltia subterranea* (F.). The ascovirus from *S. frugiperda* infected only the four species of *Spodoptera*. The ascoviruses from *T. ni*, *H. zea*, and *H. virescens* infected all of the species tested. The ascovirus from *A. precationis* infected *S. frugiperda*, *S. exigua*, *S. ornithogalli*, and *F. subterranea* but not *S. eridania* or *H. zea*. Eleven passages *per os* in fall armyworm failed to produce a persistently high rate of infection by this route. Moths from the surviving larvae in the eleventh passage *per os* did not transmit the ascovirus to their progeny.