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Source: Florida Entomologist, 86(3) : 254-289

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/0015-4040(2003)086[0254:PAPOSF]2.0.CO;2

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PARASITOIDS AND PARASITES OF *SPODOPTERA FRUGIPERDA* (LEPIDOPTERA: NOCTUIDAE) IN THE AMERICAS AND CARIBBEAN BASIN: AN INVENTORY

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ABSTRACT

An inventory of parasitoids and parasites of fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), was conducted using references describing parasitized FAW eggs, larvae, pupae and adults collected from different crops or habitats throughout the Americas and the Caribbean Basin. The crops and countries where these parasites were reported occurring in the Americas is also inventoried. Maize was the crop where the FAW was more frequently collected followed by rice. Overall, *Chelonus insularis* (Cresson) had the broadest natural distribution in the Americas. For the North American region *C. insulares*, *Chelonus* sp., and *Euplectrus platyhypenae* (Howard) were the most relevant parasitoids. In Central America, *C. insularis* was the most prevalent parasitoid, and in the South American region the most prevalent parasites were *Archytas incertus* (Macq.), *A. marmoratus* (Tns.), *C. insularis*, and *Meteorus laphygmae* (Viereck). *Diapetimorpha introita* (Cresson) is the most important pupal parasitoid of FAW occurring mainly in North America. An acugutturid, *Noctuidonema guyanense* (Remillet & Silvain), is the most important ectoparasitic nematode attacking adults of FAW and other noctuid moths in South and Southeastern US, and Mexico in North America, Caribbean Basin, Central America, and Northern South America.

Key Words: parasitoids, fall armyworm, *Chelonus insularis*, *Diapetimorpha introita*, *Noctuidonema guyanense*, maize, natural distribution, biological control

RESUMEN

Un inventario de los parasitoides y parásitos del gusano cogollero, *Spodoptera frugiperda* (J. E. Smith) se llevó a cabo usando referencias relacionadas con parásitos de huevos, larvas, pupas y adultos del insecto plaga colectados de diferentes cultivos en su ámbito de distribución. Además, un inventario se realizó de los cultivos y países donde estos parásitos atacaron al gusano cogollero en América. La plaga fue colectada principalmente en el maíz, seguido por el arroz. *Chelonus insularis* (Cresson) fué el parasitoide distribuido más ampliamente en todo el ámbito de distribución del. *C. insulares*, *Chelonus* sp. y *Euplectrus platyhypenae* (Howard) fueron los parasitoides más prevalecientes en Norteamérica. En Centroamérica, *C. insularis* fue el parasitoide más prevalente, y en la región Sudamericana lo fueron *Archytas incertus* (Macq.), *A. marmoratus* (Tns.), *C. insularis* y *Meteorus laphygmae* (Viereck). *Diapetimorpha introita* (Cresson) fue el parasitoide de pupas más importante y éste habitó en Norteamérica, principalmente. Un acugguturido, *Noctuidonema guyanense* (Remillet & Silvain) fue el nematodo ectoparásito más importante atacando adultos de gusano cogollero y otros noctuidos en el Sur y Sureste de los Estados Unidos de América y México en Norteamérica, Cuenca del Caribe, Centroamérica y Norte de Sudamérica.

Descriptores: parasitoides, gusano cogollero, *Chelonus insularis*, *Diapetimorpha introita*, *Noctuidonema guyanense*, maíz, ámbito de distribución, control biológico

Biodiversity in agro-ecosystems can be as varied as the crops, weeds, arthropods, and microorganisms themselves, and may differ according to geographical location, climate, soil, and human factors. Experimental evidence suggests that biodiversity can be used for improved pest management (Altieri 1991). A major problem in all areas of agriculture is the lack of basic research on taxonomy of insect pests and their natural enemies. This problem is greatest in tropical coun-

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tries where the needs are also greater (Claridge 1991). Waage (1991) stated that agricultural systems are generally simpler than the natural habitats from which they are developed. These systems have fewer plant species, fewer primary consumers, and generally fewer natural enemy species. In tropical systems, despite their great biodiversity, natural enemies could be particularly susceptible to local extinction as a result of habitat destruction and unfavorable cropping practices such as indiscriminate use of pesticides (Claridge 1991; Waage 1991).

More than 200 years ago, the fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith), was recognized as a destructive pest of many agricultural crops (Luginbill 1928). In the continental United States the costs for chemical control and losses due to this pest exceeded $300,000,000 during 1977 (Gross & Pair 1986). The biological control of FAW in areas of overwintering and throughout its annual geographical distribution is a highly desirable alternative to conventional control methods (Gross & Pair 1986). Luginbill (1928) and Vickery (1929) recognized the value of parasitoids in reducing larval populations of FAW. Parasitoids and parasites can be highly effective at little or no cost, serve as biotic insecticides in place of chemicals, provide long-term control without the target pest developing significant resistance to them, and impose minimal or no harm to humans or the environment (Wilson & Huffaker 1976; Stary & Pike 1999).

Sivasubramaniam et al. (1997), and Dent (2000) advocated that the first step in any investigation of the role of natural enemies in pest control should involve a field survey to determine which species are present and how their numbers vary in relation to those of the pest insects. Surveys on the FAW parasitoids and other natural enemies in different parts of its range have been conducted because of increasing economic and environmental concerns (Carrillo 1980; Ashley 1986; Castro et al. 1989; Gross & Pair 1991; Cave 1993; Lezama-Gutiérrez et al. 2001; Molina-Ochoa et al. 2001). However, information about distributions and host plants of the FAW and the accompanying parasites and parasitoids are scattered throughout the published literature, and most reviews of FAW parasitoids have emphasized those attacking the egg and larval stages (Ashley 1986). The aim of this paper is to summarize the information and provide an inventory of the known FAW parasites and parasitoids occurring in the Americas and the Caribbean, indicating the host stage attacked, the crops from which parasitized fall armyworm were collected, and the country of collection. In addition, because parasites and parasitoids of the pupal and adult stages of FAW have received little attention in most previous reviews on this subject, we provide an expanded discussion of these natural enemies.

Materials and Methods

Sources of Information

Research was conducted to obtain information, papers, and bibliographic references reporting the collection of parasitized FAW from the field. In the US, we used the Agricola and CAB Abstracts database at the University of Nebraska-Lincoln in Lincoln, Nebraska, and the University of Georgia, Coastal Plain Experiment Station in Tifton, Georgia. We collected references cited in reviews and catalogs of FAW parasites (Guimarães 1971; Marsh 1978; Ashley 1979; Ashley 1986; Andrews 1988) to verify information concerning host plant of parasitized FAW, location of the collected FAW, and stage of FAW attacked. We also used various internet search engines to identify published reports of parasitized FAW collected from the field. In México, we collected papers from Latin American journals and proceedings from meetings of International and Mexican Entomological and Biological Control Societies. Information was also obtained from the libraries in the Facultad de Ciencias Biológicas y Agropecuarias (School of Biological, Agricultural & Animal Sciences) of the Universidad de Colima, and in the Centro Nacional de Referencia de Control Biológico (CNRCB)-Comisión Nacional de Sanidad Agropecuaria-SAGARPA (National Center for Reference on Biological Control) in Tecomán, Colima, México, during 2001 and 2002.

Organization of the Information

The classification (order, family, genus and species) of each parasite and parasitoid collected from FAW is presented in Table 1. The crop from which parasitized FAW were collected, the FAW stage attacked, the country from which parasitized FAW were collected, and the bibliographic references for each record were included in Table 1 whenever the information was available. We preferred to list only original references that report the collection of FAW from the field. Therefore, review articles that contain lists of insects collected by other authors (Guimarães 1971; Marsh 1978; Ashley 1979; Ashley 1986; Andrews 1988) usually are omitted for the entries in Table 1. Because of the quantity involved, all references listed in Table 1 were not cited in the text. Data on FAW parasitoids and parasites from Table 1 have been summarized as the number of species in each taxon reported from different geographical regions (Table 2). Number of species and FAW stage attacked reported from different countries (Table 3), and number of species in each taxon reported from FAW collected from different host plants (Table 4). Omission of pertinent literature from this paper is the authors' responsibility and was unintentional.

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TABLE 1. FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Diptera: Bombyliidae				
Poecilanthrax (Anthrax) lucifer (Fabricius)	L	US	BG	Allen 1921
Diptera: Phoridae				
Megaselia sp.	L	Honduras	(N/G)	Cave 1993
		Nicaragua	M	Maes 1989
Diptera: Sarcophagidae				
Helicobia morionella (Aldrich)	L	Honduras	(N/G)	Cave 1993
Syn: *Sarcophaga morionella* Aldrich		Nicaragua	M	Maes 1989
Rivinia assidua (Walker)	L	US	(N/G)	Luginbill 1928
Syn: *Sarcophaga assidua* (Walker)				
Sarcophaga georgiana (Weideman)	L	US	M	Dew 1913
Sarcophaga lambens (Weideman)	L	Lesser Antilles	M	Fennah 1947
Sarcophaga sp.	L	US	(N/G)	Enkerlin 1975
		Venezuela	(N/G)	Terán 1974
Sarcodexia sternodontis (Townsend)	L	Honduras	M	Maes 1989; Cave 1993
Diptera: Tachinidae				
Tachinidae sp.	L	Mexico	M,S	Lacayo 1977
		Nicaragua	M	Ryder & Pulgar 1969; Ashley 1986
Acroglossa vetula (Reinhard)	L	Brazil	(N/G)	Guimarães 1977
Syn: *Spallanzania vetula* (Reinhard)		Honduras	(N/G)	Cave 1993
		Venezuela	M	Notz 1972
			(N/G)	Terán 1974
Admontia degeerioides (Coquillett)	L	US	(N/G)	Luginbill 1928
Archytas analis Fabricius	L	Argentina	M	Virla et al. 1999
		Barbados	M	Alam 1979
		Honduras	M,R,O,T	Cave 1993
		Mexico	M	Ravlin & Stehr 1984
		Nicaragua	M	Maes 1989
		US	(N/G)	Luginbill 1928
		Venezuela	(N/G)	Terán 1974
Archytas apicifer (Walker)	L	US	(N/G)	Ravlin & Stehr 1984
Archytas incasana Townsend	L	Argentina	M	Virla et al. 1999
Syn: *Archytas divisus* (Walker)		Brazil	(N/G)	Guimarães 1977
		Chile	M	Etcheverry 1957
		Venezuela	(N/G)	Terán 1974

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TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Archytas incertus (Macquart)	L	Argentina	M	Virla et al. 1999
			SY	Molinari & Avalos 1997
			(N/G)	Parker et al. 1953
		Barbados	M	Alam 1979
		Brazil	M	Lucchini & Almeida 1980; Patel & Habib 1982, 1984, 1986; Silveira et al. 1987; Valicente 1989; Silva et al. 1997
			(N/G)	Parker et al. 1953; Guimarães 1977; Milward et al. 1991a,b,c,d,e
		Chile	M	Etcheverry 1957
		Mexico	SC	Curran 1927
		Puerto Rico	SC	Van Dine 1913
			SC,M	Jones 1913
		Suriname	M,PN	Segeren & Sharma 1979
		Trinidad	M	Hynes 1942
		US	M,PN	Vickery 1929
			(N/G)	Luginbill 1928
		Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
Archytas marmoratus (Townsend)	L	Argentina	M	Valicente & Barreto 1999; Virla et al. 1999
			SY	Molinari & Avalos 1997
			(N/G)	Avalos 1988
		Barbados	M	Alam 1979
		Brazil	M	Valicente 1989
			(N/G)	Guimarães 1977
		Chile	(N/G)	Valencia & Valdivia 1973
		Cuba	(N/G)	Bruner et al. 1975
		Ecuador	Ve	Benzing et al. 2000
		Guadeloupe	M	Malausa 1981, 1983
		Honduras	M	Canas & O'Neil 1998
			P,S,M	Cave 1993
		Lesser Antilles	M	Fennah 1947
		Mexico	M,S	Pair et al. 1986
		Nicaragua	M	Huis 1981; Maes 1989; Lacayo 1977
		Peru	M	Sarmiento & Razuri 1978
		Puerto Rico	R	Pantoja et al. 1985; Pantoja & Fuxa 1992
		Suriname	N/G)	Van Dither 1960
		Trinidad	M	Yaseen 1979
		US	A	Soteres et al. 1984

TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Archytas marmoratus (Townsend)	L		(M	Campos 1965; Enkerlin 1975; Hogg et al. 1982; Gross & Pair 1986, 1991; Riggin et al. 1992, 1993
			M,C	Tingle et al. 1994
			M,S	Rohlfs & Mack 1985; Pair et al. 1986; McCutcheon 1991
			C,A,M,S	Butler 1958a
			M,BG,Mi	Reed 1980
			(N/G)	Ravlin & Stehr 1984
		Venezuela	M	Notz 1972; Fernández & Clavijo 1984
			(N/G)	Terán 1974
Archytas plangens Curran	L	Argentina	M	Virla et al. 1999
		Brazil	(N/G)	Guimarães 1977
		Honduras	M	King & Saunders 1984
			(N/G)	Cave 1993
		Nicaragua	M	Estrada 1960
		Trinidad	M	Hynes 1942
Archytas sp.	L	Argentina	M	Vera et al. 1995
			SY	Molinari & Avalos 1997
		Brazil	(N/G)	Guimarães 1977
		Chile	PN	Enkerlin 1975
		Honduras	M	Wheeler et al. 1989
		Mexico	M	Carrillo 1980
		Nicaragua	M	Estrada 1960
		US	PN	Nickle 1976
Chetogena sp.	L	Honduras	M	Cave 1993
Cuphocerini sp.	L	Argentina	(N/G)	Parker et al. 1953
Eucelatoria armigera (Coquillett)	L	Cuba	(N/G)	Bruner et al. 1975
		US	PN	Wall & Berberet 1975; Nickle 1976
		Venezuela	(N/G)	Terán 1974
Eucelatoria australis (Townsend)	L	Peru	(N/G)	Enkerlin 1975
Eucelatoria bryani Sabrosky	L	Honduras	S	Cave 1993
		Nicaragua	M	Maes 1989
		US	S,PN	Sabrosky 1981
Eucelatoria guimaraesi	L	Brazil	S,PN	Sabrosky 1981
Eucelatoria rubentis (Coquillet)	L	US	M	Ashley et al. 1980
			M,C	Tingle et al. 1994
			S,PN	Sabrosky 1981

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Eucelatoria sp.	L	Barbados	M	Alam 1979
		Brazil	M	Silveira et al. 1987; Valicente 1989
			(N/G)	Guimaraes 1977
		Chile	PN	Enkerlin 1975
		Nicaragua	M	Maes 1989; Gladstone 1991
		Venezuela	M	Fernández & Clavijo 1984
			(N/G)	Terán 1974
Euphorocera floridensis Townsend	L	Honduras	(N/G)	Cave 1993
Euphorocera tachinomoides (Townsend) Syn: *Chetogena tachinomoides*	L	US	PN	Wall & Berberet 1975
Euphorocera sp.	L	Brazil	M	Goncalves & Goncalves 1973; Silva et al. 1997
			(N/G)	Guimarães 1977
		US	(N/G)	Nickle 1976
Exorista mella (Walker)	L	US	PN	Wall & Berberet 1975
Gonia capitata DeGeer	L	US	(N/G)	Luginbill 1928
Gonia crassicornis (Fabricius)	L	Brazil	(N/G)	Goncalves & Goncalves 1973; Guimarães 1977
		Honduras	S	Cave 1993
		Lesser Antilles	M	Fennah 1947
		Puerto Rico	SC	Van Dine 1913
			SC,M	Jones 1913
		US	(N/G)	Luginbill 1928
		Venezuela	(N/G)	Terán 1974
Gonia (Reaumuria) pacifica Townsend	L	Brazil	(N/G)	Guimarães 1977
		Peru	(N/G)	Enkerlin 1975
Gonia texensis Reinhard	L	Cuba	(N/G)	Bruner et al. 1975
Gonia sp.	L	Chile	(N/G)	Enkerlin 1975
		Nicaragua	(N/G)	Maes 1989
Hyphantrophaga hyphantriae (Townsend) Syn: *Exorista ceratomiae* (Coquillet)	L	US	(N/G)	Luginbill 1928
Hyphantrophaga collina (Reinhard) Syn: *Zenillia blanda*	L	Cuba	(N/G)	Bruner et al. 1975
Incamyia chilensis (Aldrich)	L	Argentina	(N/G)	Blanchard 1963
		Brazil	(N/G)	Guimarães 1977
		Chile	M	Etcheverry 1957
			(N/G)	Enkerlin 1975
		Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
Lespesia affinis (Townsend)	L	Brazil	M	Guimarães 1983; Silva et al. 1997

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Lespesia aletiae (Riley)	L	Honduras	(N/G)	Cave 1993
		US	PN	Wall & Berberet 1975
			M,S	Pair et al. 1986
			M,BG,Mi	Reed 1980
Lespesia archippivora (Riley)	L	Argentina	M	Virla et al. 1999
Syn: *Achaetoneura archippivora* (Wile)		Brazil	M	Patel & Habib 1984, 1986; Guimarães 1983; Valicente 1989
Syn: *Frontina archippivora* (Scudder)			(N/G)	Guimarães 1977
		Chile	M	Etcheverry 1957
		Cuba	(N/G)	Parker et al. 1953; Ryder & Piedra 1968; Bruner et al. 1975
		Guadeloupe	M	Malausa 1981, 1983
		Guatemala	M,Te	Painter 1955
		Honduras	M	Canas & O'Neil 1998
			M,S	Cave 1993
		Lesser Antilles	M	Fennah 1947
		Mexico	M	Carrillo 1980
		Nicaragua	M	Estrada 1960; Huis 1981; Maes 1989; Gladstone 1991; Lacayo 1977
		Puerto Rico	SC	Van Dine 1913
			SC,M	Jones 1913
		US	A	Soteres et al. 1984
			C	Tingle et al. 1994
			M	Gross & Pair 1986; Riggin et al. 1992, 1993
			PN	Wall & Berberet 1975; Nickle 1976
			PN, M	Vickery 1929
			M,S	Pair et al. 1986
			C,A,M,S	Butler 1958a
			M,BG,Mi,S	Reed 1980
			(N/G)	Luginbill 1928
		Uruguay	M	Silveira & Ruffinelli 1956
				Notz 1972; Fernández & Clavijo 1984
		Venezuela	(N/G)	Terán 1974, 1977
Lespesia frenchi (Williston)	L	US	(N/G)	Luginbill 1928
Lespesia grioti (Blanchard)	L	Argentina	M	Virla et al. 1999
			(N/G)	Blanchard 1963
		Brazil	(N/G)	Guimarães 1977

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Lespesia sp.	L	Argentina	M	Virla et al. 1999
			(N/G)	Parker et al. 1953
		Brazil	M	Lucchini & Almeida 1980
			(N/G)	Goncalves & Goncalves 1973; Guimarães 1977
		Colombia	R	Vargas & Sanchez 1983
		Cuba	(N/G)	Ryder & Pulgar 1969
		Honduras	M	Wheeler et al. 1989
		Nicaragua	M	Maes 1989
		Puerto Rico	R	Pantoja et al. 1985; Pantoja & Fuxa 1992
		US	M	Ashley et al. 1980
			M,S	McCutcheon 1991
		Uruguay	(N/G)	Parker et al. 1953
		Venezuela	M	Notz 1972
			(N/G)	Terán 1974
Linnaemya annalis (Townsend)	L	Venezuela	M	Terán 1977
Linnaemya comta (Fallen)	L	Honduras	(N/G)	Cave 1993
Linnaemya sp.	L	Ecuador	M	Benzing et al. 2000
Nemorilla pyste (Walker)	L	US	A	Soteres et al. 1984
Syn: *Exorista pyste* (Walker)			C	Wilson 1923
			(N/G)	Luginbill 1928
Parasetigena sp.	L	Brazil	(N/G)	Guimarães 1977
		Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
Patelloa similis (Townsend)	L	Brazil	M	Patel & Habib 1984, 1986
			(N/G)	Guimarães 1977
Patelloa sp.	L	Argentina	M	Virla et al. 1999
			(N/G)	Parker et al. 1953
		Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
Peleteria robusta Wiedeman	L	Chile	(N/G)	Etcheverry 1957
Phorocera claripennis (Macquart)	L	US	A	Soteres et al. 1984
Syn: *Chetogena claripennis* (Macquart)			(N/G)	Luginbill 1928
		Venezuela	(N/G)	Terán 1974
Phorocera floridensis (Townsend)	L	Brazil	M	Valicente 1989
Syn: *Chetogena floridensis* (Townsend)		Honduras	(N/G)	Cave 1993
		Nicaragua	(N/G)	Maes 1989
		US	PN	Enkerlin 1975
			(N/G)	Luginbill 1928
		Venezuela	(N/G)	Terán 1974

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TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Pronemorilla mima Townsend	L	Venezuela	M	Notz 1972
			(N/G)	Terán 1974
Pseudokea sp.	L	Brazil	(N/G)	Costa-Lima 1949
		Chile	M	Etcheverry 1957
Voria ruralis (Fallen)	L	Argentina	M	Virla et al. 1999
			SY	Molinari & Avalos 1997
			(N/G)	Parker et al. 1953
		Brazil	M	Guimarães 1971
			(N/G)	Guimarães 1977
		US	C,A,M,S	Butler 1958a
		Uruguay	M	Silveira & Ruffinelli 1956
Winthemia leucanae (Kirkpatrick) Syn: *Nemorea leucanae* (Kirkpatrick)	L	US	M,S,BG,SY,C	Dew 1913
Winthemia mima (Reinhard)	L	Argentina	M	Virla et al. 1999
		Brazil	(N/G)	Guimarães 1977
Winthemia quadripustulata Fabricius	L	Chile	M	Etcheverry 1957
		US	(N/G)	Walton 1913; Luginbill 1928
		Venezuela	(N/G)	Terán 1974
Winthemia reliqua	L	Chile	(N/G)	Valencia & Valdivia 1973
Winthemia roblesi	L	Chile	(N/G)	Valencia & Valdivia 1973
Winthemia rufopicta (Bigot)	L	US	A	Soteres et al. 1984
			C	Tingle et al. 1994
			M	Hofmaster & Greenwood 1949; Ashley et al. 1980; Riggin et al. 1992, 1993
			PN	Wall & Berberet 1975
			M,S	Rohlfs & Mack 1985; Pair et al. 1986
			PN,BG	Enkerlin 1975
			C,A,M,S	Danks 1975
			M,BG,Mi,S	Reed 1980
Winthemia sinuata (Reinhard)	L	US	PN	Wall & Berberet 1975
Winthemia trinitatis (Thompson)	L	Argentina	M	Virla et al. 1999
		Brazil	M	Valicente 1989
			(N/G)	Guimarães 1977
Winthemia sp.	L	Argentina	M	Vera et al. 1995; Virla et al. 1999
		Brazil	M	Escalante 1974; Patel & Habib 1984, 1986; Silva et al. 1997
			(N/G)	Guimaraes 1977

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TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Winthemia sp.	L	Chile	M	Etcheverry 1957; Campos 1965
			M,PN	Enkerlin 1975
		Colombia	R	Vargas & Sánchez 1983
		Honduras	M,S	Cave 1993
		Lesser Antilles	(N/G)	Fennah 1974
		Mexico	M	Guevara et al. 1979
		Peru	M	Sarmiento & Razuri 1978
		Trinidad	(N/G)	Yaseen 1979; Hynes 1942
		US	PN	Wall & Berberet 1975
			M,S	McCutcheon 1991
		Venezuela	(N/G)	Terán 1974
Hymenoptera: Bethylidae				
Perisierola sp.	L	US	M	Bianchi 1944
Hymenoptera: Braconidae				
Agathis stigmatera (Cresson)	E	Argentina	M	De Santis 1967; De Santis & Esquivel 1966; Virla et al. 1999
			(N/G)	Parker et al. 1953
Aleiodes caphimal Syn: *Rogas caphimal*	L	Nicaragua	(N/G)	Andrews 1988
Alieodes laphygmae (Viereck)	L	Brazil	M	Cruz et al. 1997b
Syn: *Rogas laphygmae* (Viereck)		Chile	A,M,C	Etcheverry 1957
		Honduras	M	Wheeler et al. 1989; Canas & O'Neil 1998
			M,S	Cave 1993
		Mexico	M	Molina-Ochoa et al. 2001
			M,S	Pair et al. 1986
		Nicaragua	M	Estrada 1960; Huis 1981; Maes 1989; Gladstone 1991
		Puerto Rico	R	Pantoja & Fuxa 1992
		US	M	Vickery 1929; Bianchi 1944; Ashley et al. 1982; Mitchell et al. 1984; Gross & Pair 1986; Riggin et al. 1992, 1993
			S	Rohlfs & Mack 1985
			M,S	Reed 1980; Pair et al. 1986; Isenhour 1988; McCutcheon 1991
			M,BG,PG	Ashley et al. 1983
			(N/G)	Luginbill 1928; Muesebeck et al. 1951
Aleiodes terminalis (Cresson)	L	Canada	A,M,C	Muesebeck et al. 1951
Syn*: Rogas terminalis* (Cresson)		US	A,M,C	Muesebeck et al. 1951
			(N/G)	Luginbill 1928; Marsh & Shaw 2001

TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Aleiodes vaughani (Muesebeck)	L	Honduras	M	Cave 1993; Passoa 1983; Wheeler et al. 1989; Canas & O'Neil 1998
Syn: *Rogas vaughani* Muesebeck		Nicaragua	M	Huis 1981; Maes 1989
Aleiodes sp.	L	Argentina	M	Virla et al. 1999
Syn: *Rogas* sp.		Cuba	M	Ryder & Pulgar 1969; Ryder & Piedra 1968
		Honduras	M	Passoa 1983
		Nicaragua	M	Estrada 1960; Maes 1989; Lacayo 1977
		US	A	Soteres et al. 1984
Bassus sp.	L	Argentina	(N/G)	Parker et al 1953
		Honduras	(N/G)	Cave 1993
Bracon kirkpatricki Wilkinson	L	Mexico	(N/G)	Moya 1980; Pena 1980
Cardiochiles nigriceps (Viereck)	L	US	C	Tingle et a. 1994
Chelonus antillarum (Marshall)	E	Barbados	M	Alam 1979
		Nicaragua	M	Ryder & Pulgar 1969
Chelonus cautus Cresson	E	Honduras	M	Cave 1993; Canas & O'Neil 1998
Syn: *Microchelonus cautus* (Cresson)		Mexico	M,S	Molina-Ochoa et al. 2001
		Nicaragua	M	Huis 1981
Chelonus formosanus (Sonan)	E	Barbados	(N/G)	Alam 1979
		Trinidad	M	Yaseen 1979
Chelonus insularis (Cresson)	E	Argentina	M	Virla et al. 1999
Syn: *Chelonus texanus* (Cresson)			(N/G)	Parker et al. 1953
		Barbados	(N/G)	Alam 1979
		Brazil	M	Patel & Habib 1982, 1984, 1986; Valicente 1989; Rezende et al. 1995a,b; Cruz et al. 1997a,b; Silva et al. 1997
			M,C	Rezende et al. 1994
		Chile	A,M,C	Etcheverry 1957
		Colombia	M	Medina et al. 1988
			R	Vargas & Sánchez 1983
		Cuba	BG	Myers 1932
			M	Ryder & Pulgar 1969
			(N/G)	Ryder & Piedra 1968; Bruner et al. 1975;
		Haiti	BG	Myers 1932
		Honduras	M	Wheeler et al. 1989; Canas & O'Neil 1998
			M,S	Castro et al. 1989; Cave 1993
		Lesser Antilles	M	Fennah 1947

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TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Chelonus insularis (Cresson)	E	Mexico	M	Bahena & García 1991; Nava & Castro 1991; Arce & Garcia 1995; Molina-Ochoa et al. 2001
Syn: *Chelonus texanus* (Cresson)			M, S	Pair et al. 1986
		Nicaragua	M	Estrada 1960; Huis 1981; Ashley 1986; Maes 1989; Gladstone 1991
			M,S	Lacayo 1977
		Puerto Rico	R	Pantoja & Fuxa 1992
		Trinidad	M	Yaseen 1979
			(N/G)	Yaseen et al. 1981
		US	A	Soteres et al. 1984
			C	Tingle et al. 1994
			M	Pierce & Holloway 1912; Vickery 1929; Bianchi 1944; Muesebeck et al. 1951; Ashley et al. 1980, 1982; Ashley 1983, 1986; Mitchell et al. 1984; Gross & Pair 1986; Riggin et al. 1992
			PN	Wall & Berberet 1975
			M,BG	Ashley et al. 1983
			M,PN	Enkerlin 1975
			M,S	Waddill & Whitcomb 1982; Rohlfs & Mack 1985; Pair et al. 1986; McCutcheon 1991
			C,A,M,S	Butler 1958b
			(N/G)	Luginbill 1928
		Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
		Venezuela	M	Notz 1972; Fernández & Clavijo 1984
Chelonus sp.	E	Brazil	M	Valicente 1989
		Mexico	M	Loya-Ramírez 1978; Coronado & Ruíz 1991; Cortez & Trujillo 1994; Sánchez-García et al. 1998; Carrillo 1980
			M,S	Molina-Ochoa et al. 2001
		Peru	C	Herrera-Aranguena 1998
Cotesia (Apanteles) congregata (Say)	E,L[3]	Honduras	(N/G)	Cave 1993
		Nicaragua	M	Maes 1989
Cotesia (Apanteles) glomeratus (Linnaeus)	E,L[3]	Barbados	M	Alam 1979
Cotesia (Apanteles) marginiventris (Cresson)	E,L[3]	Argentina	M	Wheeler et al. 1989; Virla et al. 1999
Syn: *Apanteles grenadensis* (Ashmead)				Lucchini & Almeida 1980; Patel & Habib 1982, 1984,
Syn: *Protapanteles harnedi* (Viereck)		Brazil	M	1986; Cruz et al. 1997b
Syn: *Apanteles laphygmae* (Ashmead)		Chile	A,M,C	Etcheverry 1957
		Honduras	M	Cave 1993
		Lesser Antilles	M,S	Fennah 1947

TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Cotesia (Apanteles) marginiventris (Cresson)	E,L[3]	Mexico	M	Marsh 1978
Syn: *Apanteles grenadensis* (Ashmead)			M,S	Pair et al. 1986; Molina-Ochoa et al. 2001
Syn: *Protapanteles harnedi* (Viereck)		Nicaragua	M	Estrada 1960; Huis 1981; Maes 1989; Gladstone 1991
Syn: *Apanteles laphygmae* (Ashmead)		Puerto Rico	R	Pantoja & Fuxa 1992
		Suriname	M,PN	Segeren & Sharma 1979
			(N/G)	Van Dither 1960
		US	A	Soteres et al. 1984
			C	Tingle et al. 1994
			M	Muesebeck 1921; Vickery 1929; Bianchi 1944;Hofmaster & Greenwood 1949; Muesebeck et al. 1951; Marsh 1978; Ashley et al. 1980, 1982; Hogg et al. 1982; Ashley 1983, 1986; Mitchell et al. 1984; Gross & Pair 1986; Riggin et al. 1992, 1993, 1994; Hamm et al. 1994; Ruberson & Whitfield 1996
			M,S	Rohlfs & Mack 1985; Pair et al. 1986; McCutcheon 1991
			PN	Wall & Berberet 1975; Nickle 1976
			M,BG	Ashley et al. 1983
			M,S,C,Mi	Reed 1980
		Uruguay	(N/G)	Luginbill 1928
			(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
		Venezuela	M	Notz 1972; Fernández & Clavijo 1984
			SY,To	Terán 1980
Cotesia (Apanteles) ruficrus (Haliday)	E,L[3]	Trinidad & Tobago	M	Yaseen 1979*
Syn: *Microplitis manilee* (Ashmead)		US	(N/G)	McCutcheon et al. 1983**; Rajapakse et al. 1985***
Cotesia (Apanteles) sp.	E,L[3]	Barbados	M	Alam 1979
		Brazil	M	Patel & Habib 1984, 1986; Silva et al. 1997
		Colombia	R	Vargas & Sánchez 1983
			M	Medina et al. 1988
		Guyana	M	Sinha 1982
		Nicaragua	M	Maes 1989
			M,S	Lacayo 1977
		Peru	C	Herrera-Aranguena 1998
		Trinidad	M	Yaseen 1979
		US	M	Hofmaster & Greenwood 1949
Distatrix sp.	L	Honduras	M	Cave 1993
Glyptapanteles militaris (Walsh)	L	Honduras	M	Cave 1993
		US	S	Rohlfs & Mack 1985
			(N/G)	Muesebeck et al. 1951

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TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Gnathopleura sp.	L	Honduras	(N/G)	Cave 1993
Homolobus truncator (Say)	L	Honduras	M,S	Cave 1993
Syn: *Zele mellea* (Cresson)		Nicaragua	M	Huis 1981; Maes 1989
		US	A	Soteres et al. 1984
			M	Vickery 1929; Wall & Berberet 1975; Riggin et al. 1992, 1993
			M,S	Pair et al. 1986; McCutcheon 1991
			M,S,C	Reed 1980
			(N/G)	Luginbill 1928
Macrocentrus sp.	L	Barbados	(N/G)	Alam 1979
		Brazil	M	Silva et al. 1997
Meteorus arizonensis (Muesebeck)	L	Honduras	(N/G)	Cave 1993
		Nicaragua	M	Maes 1989
Meteorus autographae (Muesebeck)	L	Mexico	M,S	Pair et al. 1986
		US	A	Soteres et al. 1984
			C	Tingle et al. 1994
			M	Ashley et al. 1980, 1982; Mitchell et al. 1984; Gross & Pair 1986; Riggin et al. 1992, 1993
			PN	Nickle 1976
			S	Rohlfs & Mack 1985
			M,S	Pair et al. 1986; McCutcheon 1991
			M,BG,Mi	Reed 1980
			M,BG,PG	Ashley et al. 1983
			(N/G)	Luginbill 1928; Muesebeck et al. 1951
Meteorus laphygmae (Viereck)	L	Chile	M	Etcheverry 1957
		Colombia	M	Medina et al. 1988
			R	Vargas & Sánchez 1983
			C,S	Ortegón et al. 1988
		Honduras	M,S	Cave 1993
		Mexico	M	Molina-Ochoa et al. 2001
			S	Ciceros et al. 1995
		Nicaragua	(N/G)	Gladstone 1991
		Suriname	M,PN	Segeren & Sharma 1979
			(N/G)	Van Dither 1960
		US	M	Vickery 1929; Bianchi 1944
			M,BG	Enkerlin 1975
			(N/G)	Luginbill 1928

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Meteorus laphygmae (Viereck)	L	Venezuela	M	Notz 1972; Terán 1980; Fernández & Clavijo 1984; Fernández & Terán 1990a,b
Meteorus vulgaris (Cresson)	L	US	(N/G)	Luginbill 1928; Muesebeck et al. 1951
Meteorus sp.	L	Mexico	M	Peraza-Lizarraga 1982; Coronado & Ruíz 1991
			M, S	Molina-Ochoa et al. 2001
		Peru	C	Herrera-Aranguena 1998
Microplitis sp.	L	Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
Palinzele sp.	L	Trinidad	M	Yaseen 1979
Stantonia sp.	L	Honduras	(N/G)	Cave 1993
		Nicaragua	M	Maes 1989
Hymenoptera: Chalcididae				
Brachymeria ovata (Say)	P	Argentina	M	Virla et al. 1999
			(N/G)	Parker et al. 1953
		US	M	Ashley 1979
Brachymeria robusta (Cresson)	P	US	C	Wilson 1923
			(N/G)	Luginbill 1928
Conura (Spilochalcis) femorata (Fabricius)	L	Honduras	(N/G)	Cave 1993
		Nicaragua	(N/G)	Maes 1989
		US	C	Wilson 1923
			(N/G)	Luginbill 1928
Conura (Ceratosmicra) hirtifemora (Ashmead) Syn: *Splilochalcis hirfitemora* (Ashmead)	L	US	M	Riggin et al. 1992, 1993
Conura (Ceratosmicra) immaculata (Cresson)	L	Honduras	(N/G)	Cave 1993
Syn: *Conura fulvomaculata* (Cameron)		Nicaragua	M	Maes 1989
Conura (Ceratosmicra) meteori (Burks)	L	US	M	Hofmaster & Greenwood 1949
Conura igneoides (Kirby)	L	US	C	Wilson 1923
Syn: *Splilochalcis vittata* (Ashmead)			(N/G)	Luginbill 1928; Muesebeck et al. 1951
Hymenoptera: Eulophidae				
Euplectrus comstockii Howard	L	Nicaragua	M	Maes 1989
		US	(N/G)	Luginbill 1928
Euplectrus furnicus Walker	L	Argentina	M	De Santis 1979; De Santis 1989; De Santis & Fidalgo 1994; Virla et al. 1999
		Puerto Rico	R	Pantoja & Fuxa 1992
Euplectrus hircinus (Say)	L	Panama	(N/G)	Andrews 1988
Euplectrus insularis Howard	L	Honduras	M	Wheeler et al. 1989
		Nicaragua	(N/G)	Huis 1981

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Euplectrus marginatus Ashmead	L	Nicaragua	M	Maes 1989
Euplectrus plathypenae Howard	L	Barbados	M	Alam 1979
		Brazil	(N/G)	Costa-Lima 1962
		Chile	M	Etcheverry 1957
		Colombia	M	Vargas & Sánchez 1983
		Cuba	Pm&Pb	Myers 1932
			(N/G)	Ryder & Piedra 1968; Bruner et al. 1975
		Guyana	M	Sinha 1982
		Lesser Antilles	M	Fennah 1947
		Mexico	M	Guevara et al. 1979; Montoya-Burgos 1980; Gutiérrez-Rodriguez 1982; Molina-Ochoa et al. 2001
		Nicaragua	M	Ryder & Pulgar 1969
		Puerto Rico	R	Pantoja & Fuxa 1992
		Trinidad	(N/G)	Yaseen 1979
		US	M	Vickery 1929; Muesebeck et al. 1951; Ashley et al. 1980, 1982; Hogg et al. 1982; Riggin et al. 1992, 1993
			PN	Wall & Berberet 1974, 1975
			(N/G)	Luginbill 1928
		Venezuela	M	Marín-Acosta 1966
			S,C	Guagliami 1962
Euplectrus ronnai (Brethes)	L	Brazil	M	De Santis 1980
Euplectrus sp.	L	Brazil	M	Lucchini & Almeida 1980
		Cuba	BG	Myers 1932
		Honduras	M	Cave 1993
		Mexico	M	Montoya-Burgos 1979, 1980; Cortez & Trujillo 1994
			M,S	Pair et al. 1986
		Nicaragua	M	Huis 1981
			M,S	Lacayo 1977
		US	BG	Reed 1980
			M	Keller 1980
			M,S	Pair et al. 1986
			(N/G)	Enkerlin 1975
Trichodischia caerulea	L	Brazil	(N/G)	Guimaraes 1977
Trichodischia soror (Bigot)	L	Argentina	M	Virla et al. 1999
			(N/G)	Parker et al. 1953; Blanchard 1963
		Brazil	(N/G)	Cortes 1980
Trichospilus pupivora (Ferriere)	P	Barbados	M	Alam 1979
Trichospilus sp.	L	Argentina	(N/G)	Parker et al. 1953

TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Hymenoptera: Ichneumonidae				
Amblyteles sp.	L	Brazil	(N/G)	Costa-Lima 1949
		Chile	M	Etcheverry 1957
Ancyloneura sp.	L	Argentina	(N/G)	Parker et al. 1953
Anomalon ejuncidum (Say)	L	US	M,S	Pair et al. 1986
Campoletis chloridae (Vierech)	L	Barbados	M	Alam 1979
Campoletis curvicauda (Blanchard)	L	Peru	M	Ayqui-Vilca 1993
Campoletis flavicincta (Ashmead)	L	Brazil	M	Patel & Habib 1982, 1984, 1986; Cruz et al. 1997a,b
		Honduras	(N/G)	Cave 1993
		Mexico	M,S	Molina-Ochoa et al. 2001
		Nicaragua	M	Huis 1981; Maes 1989
		US	A	Soteres et al. 1984
			M	Hogg et al. 1982
			PN	Wall & Berberet 1975
		Uruguay	(N/G)	Parker et al. 1953; Yaseen et al. 1981
Campoletis grioti (Blanchard)	L	Argentina	M	Virla et al. 1999
		Brazil	M	Lucchini & Almeida 1980; Silveira et al. 1987; Cruz et al. 1997b
		US	M	Ashley 1983
		Uruguay	M	Morey 1971
Campoletis oxylus (Cresson)	L	US	M	Muesebeck et al. 1951
Syn: *Sagaritis oxylus* (Cresson)			M,S	Pair et al. 1986
			(N/G)	Luginbill 1928
Campoletis sonorensis (Cresson)	L	Brazil	M	Cruz et al. 1997b
		Chile	M	Machuca et al. 1989
		Honduras	M	Canas & O'Neil 1998
			M,S	Cave 1993
		Mexico	M,S	Pair et al 1986
		US	A	Soteres et al. 1984
			M	Gross & Pair 1986; Riggin et al. 1992, 1993
			M,S	Pair et al. 1986; Isenhour 1988
Campoletis sp.	L	Argentina	M	Vera et al. 1995
		Brazil	M	Silva et al. 1997; Silveira et al. 1987; Valicente & Barreto 1999
			(N/G)	Cruz et al. 1999
		Nicaragua	M	Maes 1989
		US	M,S	McCutcheon 1991

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TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Campoplex sp.	L	Brazil	M	Silva et al. 1997
Cryptus albitarsis (Cresson)	P	US	M	Pair & Gross 1989
Diadegma sp.	L	Argentina	M	Porter 1998; Virla et al. 1999
		Brazil	M	Silva et al. 1997
		Cuba	M	Ayala-Sifontes et al. 1978
		Mexico	M	Flores-Dávila et al. 1991
Diapetimorpha introita (Cresson)	P	Honduras	M	Cave 1993
		US	M	Pair & Gross 1984, 1989
			M,S	Pair et al. 1986
Eiphosoma annulatum (Cresson)	L	Venezuela	M	Notz 1972
Eiphosoma vitticole (Cresson)	L	Bolivia	M	Ashley 1979
			(N/G)	Yaseen et al. 1981
		Brazil	M	Patel & Habib 1982, 1984, 1986; Valicente 1989; Silveira et al. 1987; Cruz et al. 1997b
		Colombia	M	Medina et al. 1988
		Honduras	M	Wheeler et al. 1989; Canas & O'Neil 1998
			M,S	Cave 1993
		Mexico	M,S	Pair et al. 1986
		Nicaragua	M	Huis 1981
		US	M	Ashley 1983
		Venezuela	(N/G)	Giraldo-Vanegas & Garcia-R. 1992, 1994a,b, 1995
Eiphosoma sp.	L	Brazil	M	Cruz et al. 1997a; Silva et al. 1997
		Mexico	M	Cortez & Trujillo 1994
		Trinidad	M	Hynes 1942
			(N/G)	Yaseen et al. 1981
		Venezuela	M	Fernández & Clavijo 1984
Enicospilus flavus (Fabricius)	L	US	C	Wilson 1923
Syn: *Enicospilus concolor* (Cresson)			(N/G)	Luginbill 1928
Enicospilus merdarius (Gravenhorst)	L	Argentina	M	Muesebeck et al. 1951
Syn: *Enicospilus purgatus* (Say)		Cuba	M	Bruner et al. 1975
		Honduras	(N/G)	Cave 1993
		Nicaragua	M	Maes 1989
		US	C,M	Dew 1913
			(N/G)	Luginbill 1928
Goryphina sp.	L	Brazil	M	Silva et al. 1997
Hyposoter sp.	L	Honduras	M	Cave 1993
		Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956

TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Ichneumon ambulatorius Fabricius	P	US	M	New record (JEC)
Ichneumon promissorius (Cresson)	P	US	M	New record (JEC)
Isdromas lycaenae (Howard)	L	US	M	Riggin et al. 1992, 1993
Mesochorus disceitergus (Say)	L	US	M	Hofmaster & Greenwood 1949; Riggin et al. 1992, 1993
Microcharops anticarsiae (Gupta)	L	Honduras	M	Wheeler et al. 1989
			S	Cave 1993
Netelia sayi (Cushman)	L	US	C	Tingle et al. 1994
Netelia sp.	L	Peru	M	Escalante 1974
		US	A	Soteres et al. 1984
Parania (Atrometus) tricolor (Morley)	L	Uruguay	(N/G)	Parker et al. 1953; Silveira & Ruffinelli 1956
Pristomerus spinator (Fabricius)	L	Brazil	M	Patel & Habib 1984, 1986
Syn: *Neopristomerus appalachianus* (Viereck)		Honduras	M	Wheeler et al. 1989; Canas & O'Neil 1998
			M,S	Cave 1993
		Mexico	M	Carrillo 1980
			M,S	Pair et al. 1986; Molina-Ochoa et al. 2001
		Nicaragua	M	Estrada 1960; Huis 1981; Gladstone 1991; Maes 1989; Lacayo 1977
		US	A	Soteres et al. 1984
			C	Tingle et al. 1994
			M	Vickery 1929; Bianchi 1944
			PN	Wall & Berberet 1975
			M,S	Pair et al. 1986
			(N/G)	Luginbill 1928
Ophion ancyloneura (Wichsee)	L	Argentina	M	De Santis 1967; Virla et al. 1999
			(N/G)	Parker et al. 1953
		Uruguay	(N/G)	Silveira & Ruffinelli 1956
Ophion bilineatus (Say)	L	Chile	M	Etcheverry 1957
		US	M	Vickery 1929
			PN	Enkerlin 1975
			(N/G)	Luginbill 1928
Ophion flavidus (Brulle)	L	Argentina	M	Virla et al. 1999
		Brazil	M	Goncalves 1973; Patel & Habib 1982, 1984, 1986; Silveira et al. 1987
		Honduras	M	Wheeler et al. 1989; Canas & O'Neil 1998
			M,S	Cave 1993
			(N/G)	Passoa 1983

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TABLE 1. (CONTINUED) FALL ARMYWORM, *Spodoptera frugiperda* (J. E. SMITH) (LEPIDOPTERA: NOCTUIDAE), PARASITES AND PARASITOIDS IN THE AMERICAS AND CARIBBEAN BASIN WITH ACCOMPANYING REFERENCES INDICATING FAMILY, HOST STAGE ATTACKED, CROPS FROM WHICH FALL ARMYWORM WERE COLLECTED AND COUNTRIES OF COLLECTION.

Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Ophion flavidus (Brulle)	L	Mexico	M	Molina-Ochoa et al. 2001
			M,S	Pair et al. 1986
		Nicargua	M	Maes 1989; Gladstone 1991
		US	M	Hogg et al. 1982; Gross & Pair 1986, 1991; Riggin et al. 1992, 1993
			M,S	Rohlfs & Mack 1985; Pair et al. 1986
			M,BG,Mi,S	Reed 1980
Ophion merdarius (Gravenhorst)	L	Nicaragua	M	Maes 1989
Syn: *Enicospilus purgatus* (Gravenhorst)		US	(N/G)	Luginbill 1928
Ophion sp.	L	Argentina	M	Vera et al. 1995
		Brazil	M	Silva et al. 1997
		Mexico	M	Ashley 1986
		Nicaragua	M	Huis 1981; Maes 1989
		Peru	M	Escalante 1974
		US	C	Tingle et al. 1994
			M	Mitchell et al. 1984
			PN	Nickle 1976
			M,PG	Ashley et al. 1983
		Uruguay	(N/G)	Parker et al. 1953
Sagaritis dubitatus (Cresson)	L	US	M	Vickery 1929
			(N/G)	Luginbill 1928
Trachysphyrus cleonis (Viereck)	L	Peru	M	Escalante 1974
Temelucha difficilis (Dasch.)	L	US	M	Mitchell et al. 1984; Gross & Pair 1986
				Pair et al. 1986
			M,S	
Temelucha grapholithae (Cushman)	L	Honduras	M	Canas & O'Neil 1998
			M,S	Cave 1993
		Nicaragua	M	Gladstone 1991
Temelucha sp.	L	Honduras	M	Wheeler et al. 1989
		Nicaragua	M	Maes 1989
		US	M	Ashley et al. 1980, 1982, 1983
Vulgichneumon brevicintor (Say)	P	US	M	Pair & Gross 1989
Hymenoptera: Perilampidae				
Perilampus hyalinus (Say)	L	Honduras	M	Cave 1993
(Reported as hiperparasitoid)		Venezuela	M	Notz 1972

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Hymenoptera: Pteromalidae				
Catalaccus aeneoviridis (Girault)	L	US	M	Hofmaster & Greenwood 1949
Trichomalopsis viridescens (Walsh) Syn: *Eupteromalus viridescens*	L	US	M	Hofmaster & Greenwood 1949; Riggin et al. 1992, 1993
Hymenoptera: Scelionidae				
Telenomus remus (Nixon)	E	Antigua	M	Irving 1978
		Barbados	M	Alam 1979
		Brazil	M	Correa-Figueiredo et al. 1999
		Colombia	M	Alvarez & Roa 1995
		Dominican Republic	(N/G)	Yaseen et al. 1981
		Guadeloupe	(N/G)	Yaseen et al. 1981
		Guyana	M,S	Sinha 1982
		Honduras	M	Cave & Acosta 1999
		Nicaragua	M	Maes 1989
		Puerto Rico	(N/G)	Wojcik et al. 1976
		Suriname	M	Segeren & Sharma 1979
		Trinidad	M	Yaseen 1979
		US	M,S	Waddill 1977; Waddill & Whitcomb 1982
			(N/G)	Wojcik et al. 1976
		Venezuela	M	Hernández et al. 1989; Hernandez & Díaz 1995, 1996a,b; Gonzalez-Narvaez & Zocco 1996; Ferrer 1998a,b
Telenomus sp.	E	Brazil	M	Cruz et al. 1999
		Colombia	M	Alvarez & Roa 1995
			R	Vargas & Sánchez 1983
		Cuba	M	Armas-García & Ayala-Sifontes 1987; Ayala-Sifontes et al. 1992
		Guadeloupe	M	Malausa 1983
		Mexico	M	Montoya-Burgos 1979; Morales-Pérez 1982; Canseco-Román 1988; García-Lagunas 1988; Barilla-Vera 1989
Hymenoptera: Trichogrammatidae				
Trichogramma demoraesi (Zucchi)	E	Chile	M	Pratissoli et al. 1999
Trichogramma fasciatum Perkins	E	Barbados	M	Alam 1979
		Nicaragua	M	Maes 1989
Trichogramma minutum Riley	E	Nicaragua	M	Maes 1989
		US	M	Muesebeck et al. 1951
			(N/G)	Luginbill 1928

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Trichogramma pretiosum (Riley)	E	Brazil	M	De Sa & Parra 1994; Zucchi et al. 1991
		Nicaragua	M	Huis 1981
Trichogramma sp.	E	Argentina	M	Virla et al. 1999
		Brazil	M	De Sa & Parra 1994
			(N/G)	Cruz et al. 1999
		Colombia	R	Vargas & Sánchez 1983
		Cuba	M	Armas-García & Ayala-Sifontes 1987; Ayala-Sifontes et al. 1988
		Guadeloupe	M	Malausa 1983
			(N/G)	Yaseen et al. 1981
		Mexico	M	Loya-Ramírez 1978; Montoya-Burgos 1979, 1980; Guevara et al. 1979; Rodríguez-Luna 1982; Wong-Arevalo 1982; Johannes-Toonders & Carrillo-Sánchez 1987 Bahena & García 1991
			(N/G)	Huis 1981; Maes 1989; Mulock et al. 1990
		Nicaragua	M	Waddill & Whitcomb 1982
		US	M,S	
Nematoda: Acugutturidae				
Noctuidonema guyanense Remillet & Silvain	A	Bahamas	(N/G)	Simmons & Rogers 1990b
		Belize	(N/G)	Simmons & Rogers 1990b
		Bermuda	(N/G)	Simmons & Rogers 1990b; Simmons et al. 1991
		Cayman Islands	(N/G)	Simmons & Rogers 1990b
		Colombia	(N/G)	Simmons & Rogers 1990b
		Costa Rica	(N/G)	Simmons & Rogers 1990b
		Dominica	(N/G)	Simmons & Rogers 1990b
		El Salvador	(N/G)	Simmons & Rogers 1990b
		French Guiana	(N/G)	Remillet & Silvain 1988; Marti et al. 1990; Rogers et al. 1990a, 1991, 1993; Silvain & Remillet 1993; Marti et al. 2000
		Grenada	(N/G)	Simmons & Rogers 1990b; Simmons et al. 1991
		Guadeloupe	(N/G)	Marti et al. 2000
		Honduras	(N/G)	Simmons & Rogers 1990b
		Martinique	(N/G)	Simmons & Rogers 1990b; Marti et al. 1990
		Mexico	(N/G)	Simmons & Rogers 1990b
		Panama	(N/G)	Simmons & Rogers 1990b; Simmons et al. 1991
		Puerto Rico	(N/G)	Simmons & Rogers 1990b; Simmons et al. 1991

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Classification of parasite and parasitoid	Host stage attacked[1]	Country of collection	Crop[2]	Reference
Noctuidonema guyanense Remillet & Silvain	A	Suriname	(N/G)	Simmons & Rogers 1990b
		Trinidad	(N/G)	Simmons & Rogers 1990b
		US	(N/G)	Marti et al. 1990; Simmons & Rogers 1990b; Rogers et al. 1990b, 1991, 1993, 1996; Simmons et al. 1991; Simmons & Rogers,1990a,b, 1991, 1994; Marti et al. 2000; Rogers & Marti 1994, 1996
			M	Simmons & Marti 1992
			M, S	Rogers & Marti 1992a,b, 1993a; Marti & Rogers 2000
		Virgin Island	(N/G)	Simmons & Rogers 1990b

*Imported from Pakistan, ** Imported from Australia, *** Imported from Thailand & Imported from India.

[1]Host stage attacked: E (Egg), L (Larva), P (Pupa), A (Adult).

[2]A = Alfalfa (*Medicago sativa* L.), BG = Bermudagrass (*Cynodon dactylon* L.), C = Cotton (*Gossypium* spp.), M = Maize (*Zea mays* L.), Mi = Millet (*Panicum miliaceum* L.), O = Onion (*Allium cepa* L.), P = Hot pepper (*Capsicum annuum* L.), Pb = (*Panicum barbinode* L.), PG = Paragrass (*Brachiarie mutica* L.), Pm = (*P. maximum* L.), PN = Peanut (*Arachis hypogaea* L.), R = Rice (*Oryza sativa* L.), S = Sorghum (*Sorghum bicolor* L. (Moench.)), SC = Sugarcane (*Saccharum officinarum* L.), SY = Soybean (*Glycine max* L.), T = Tomato (*Lycopersicum esculentum* L.), Te = Teosinte (*Euchlaena mexicana* Schard), To = Tobacco (*Nicotiana tabacum* L.), Ve = Vegetable Crops, (N/G) = Not given.

[3]Reported attacking eggs and larva (no confirmation).

TABLE 2. NUMBER OF SPECIES IN EACH TAXON REPORTED FROM DIFFERENT REGIONS.

Order	Family	Region		
		North America (Mexico-US)	Central America & Caribbean Basin	South America
Diptera				
	Bombyliidae	1		
	Phoridae		1	
	Sarcophagidae	3	3	1
	Tachinidae	29	24	38
Hymenoptera				
	Bethylidae	1		
	Braconidae	18	22	11
	Chalcididae	6	2	1
	Eulophidae	3	8	7
	Ichneumonidae	27	18	21
	Perilampidae		1	1
	Pteromalidae	2		
	Scelionidae	2	2	2
	Trichogrammatidae	2	4	3
Nematoda				
	Aphelenchoididae	1	1	1

RESULTS AND DISCUSSION

A great diversity of parasitoids and parasites of FAW has been reported occurring in the Americas and the Caribbean basin. In this inventory, approximately 150 species of parasitoids and parasites have been recorded from 14 families, nine in Hymenoptera, four in Diptera and one in Nematoda (Table 1). Ichneumonids and braconids were the most diverse families in Hymenoptera, represented by 36 and 28 species, respectively. The most diverse family in Diptera, as well as overall, was Tachinidae with 55 species.

Distribution among the taxa was highly variable. Three of the 14 families were only reported from one country, and five of the 14 families were reported from two or fewer countries. Bethylid and bombyliid parasitoids were only reported in the United States (US) during the 1920s and 1940s (Table 1). Of the ≈150 species, 74 were reported from only one country, and 102 were reported from only one geographical region. In contrast, nine of the 14 families and 18 of the ≈150 species were reported from all geographical regions (North America, Central America and the Caribbean, and South America), and eight species were reported from 10 or more countries (Tables 1 and 2).

The number of parasitoid and parasite species reported from each FAW stage attacked in each country is summarized in Table 3. The highest number of parasitoid species attacking FAW larvae was reported from the US (75), followed by Brazil (45), Honduras (43) and Nicaragua (42). Parasitoid species that attack FAW eggs were more prevalent in Nicaragua (11) Brazil (8), Barbados (7) and Mexico (6). Parasitoid species that attack FAW pupae were reported from only 4 countries, with the greatest number of these species collected from the US (6).

Parasitized FAW were collected from 19 different host plants (Table 4). FAW collected from corn were parasitized by species from all families except Bombyliidae. The number of parasite and parasitoid species attacking FAW was greatest for FAW collected from corn (134), sorghum (40), cotton (28), peanut (24), alfalfa (17), rice (13), and Bermuda grass (11). Six of the 14 parasitoids and parasite families were recovered from FAW that had been collected from a single host plant species. Ten of the 14 parasitoids and parasite families were recovered from FAW that had been collected from three or fewer host plant species. The most diverse parasitoid families also were recovered from more FAW host plant species. Tachinids, braconids, eulophids, and ichneumonids were recovered from FAW collected from 15, 11, 8 and 8 FAW host plant species, respectively.

A considerable number of parasitoid species (≈33%) were reported only from one geographical region (Table 1). These findings emphasize the need for more surveys and taxonomical studies of the natural enemies in the different habitats of the natural distribution of the pest (Molina-Ochoa et al. 2001). It is important to consider the different developmental stages of the pest and the growing season of the crop to determine if differ-

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TABLE 3. NUMBER OF SPECIES OF PARASITOIDS AND STAGE HOST ATTACKED REPORTED FROM DIFFERENT COUNTRIES.

	Number of parsitoid species			
Country	Egg	Larval	Pupae	Adult
Antigua	1			
Argentina	4	28	1	
Bahamas				1
Barbados	7	9	1	
Belize				1
Bermuda				1
Bolivia		1		
Brazil	8	45		
Cayman Is.				1
Canada		1		
Chile	3	19		
Colombia	5	6		1
Costa Rica				
Cuba	3	11		
Dominica				1
Dominican Republic	1			
Ecuador		2		
El Salvador				1
French Guinea				1
Grenada				1
Guadeloupe	3	2		1
Guatemala		1		
Guyana	2	2		
Haiti	1			
Honduras	5	43	1	1
Lesser Antilles	2	8		
Martinique				1
Mexico	6	22		
Nicaragua	11	42		
Panama		1		
Peru	2	10		
Puerto Rico	3	9		1
Suriname	2	4		1
Tobago	1	1		
Trinidad	4	9		1
United States	3	75	7	1
Uruguay	1	16		
Venezuela	2	29		
Virgin Is.				1

ences in natural distribution of the parasitoids exist (Ashley 1979; Molina-Ochoa et al. 2001) or if the records related to unique occurrence are due to inadequate surveys. It also is important to determine if the occurrence of FAW parasitoids is associated with the developmental stage of the pest and the host plant. Studies related to tritrophic interactions are needed to elucidate the role of the plant metabolites on the susceptibility of the pest to parasitoids and pathogens, as well as their suitability (Molina-Ochoa et al. 1999). A high diversity of FAW parasitoids has been reported in its natural distribution exerting significant mortality on egg and larval populations. An understanding of induced parasitization of the complex of parasitoids is needed to determine the species with higher capability to attack each stage of the FAW. It is necessary to unite institutional efforts to establish programs of release of FAW parasitoids in overwintering areas and to reduce the migration of the pest northward (Gross & Pair 1986). Because much of the published work does not include environmental data with the collections, we encourage authors to include this information in the future. These data would help select candidate parasitoids for a specific or broad region.

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TABLE 4. NUMBER OF PARASITOID SPECIES IN EACH TAXON REPORTED FROM FAW COLLECTED FROM DIFFERENT HOST PLANTS.

		FAW host plants																	
Order	Family	A	BG	C	M	Mi	O	P	Pb	PG	Pm	PN	R	S	SC	SY	T	Te	To	Ve
Diptera																				
	Bombyliidae		1																	
	Phoridae				1															
	Sarcophagidae				4															
	Tachinidae	6	4	7	34	4	1	1				15	4	13	3	5	1	1		1
Hymenoptera																				
	Bethylidae				1															
	Braconidae	7	4	12	24	2				2		4	5	11		1			1	
	Chalcididae			3	4															
	Eulophidae		1	1	9				1		1	1	2	2						
	Ichneumonidae	4	1	5	36	1				1		4		11						
	Perilampidae				1															
	Pteromalidae				2															
	Scelionidae				2								1	1						
	Trichogrammatidae				5								1	1						
Nematoda																				
	Acuguttuidae				1									1						

A = Alfalfa, BG = Bermuda grass, C = Cotton, M = Maize, Mi = Millet, O = Onion, P = Hot Pepper, Pb = *Panicum barbinode*, PG = Para grass, Pm = *P. maximum*, PN = Peanut, R = Rice, S = Sorghum, SC = Sugarcane, SY = Soybean, T = Tomato, Te = Teosinte, To = Tobacco, Ve = Vegetable crops

Parasites and Parasitoids of *Spodoptera frugiperda* Pupae and Adults

Spodoptera frugiperda pupae and adults are attacked by several parasite and parasitoid species. Five species of Ichneumonidae: *Diapetimorpha introita* (Cresson), *Cryptus albitarsis* (Cresson), *Ichneumon promissorius* (Erichson), *Ichneumon ambulatorius* and *Vulgichneumon brevicinctor* (Say) have been reported attacking pupae of *S. frugiperda* and other noctuids (Bechinski & Pedigo 1983; Pair & Gross 1984; Wilson 1983; Pair & Gross 1989; Fitt & Daly 1990; Pavuk & Stinner 1991). Two generalist pupal parasitoids of Chalcididae, *Brachymeria ovata* (Say) and *B. robusta* (Cresson), have been collected from *S. frugiperda* (Wilson 1923; Luginbill 1928; Parker et al. 1953; Ashley 1979; Virla et al. 1999). Only one eulophid species, *Trichospilus pupivora* (Ferriere), has been reported as a generalist parasitoid of Lepidopteran pupae, including *S. frugiperda* (Alam 1979, Anantanarayanan 1934). Also, only one species (the ectoparasitic nematode, *Noctuidonema guyanense* Remillet & Silvain (Remillet & Silvain 1988)), has been observed parasitizing *S. frugiperda* adults.

Studies on *Diapetimorpha introita*

Diapetimorpha introita, a parasitoid which attacks FAW in the pupal stage, was reported for first time by Pair & Gross (1984) in Tifton, Georgia. The levels of parasitization in six trials ranged from 0.0 to 23.7%, and the percent of intact pupae that were parasitized during that study averaged 13.5%. Later, Gross & Pair (1986) emphasized the need for more efforts to explore the role of species of parasitoids that employ similar strategies. Pair & Gross (1989) reported the seasonal incidence of *D. introita* with rates of parasitism that averaged 5.2% (range 0-23.7%) and 8.4% (range 0-50.0%), respectively, during 1983 and 1984, with the highest rate occurring during September to November of each year. Because male *D. introita* are attracted to chemicals emitted by the female wasps (Jewett & Carpenter 1998) sticky traps baited with live female wasps were used to study the seasonal abundance of *D. introita* (Jewett & Carpenter 2001). The highest number of adult males was caught during early autumn which corresponded to the rates of parasitism reported by Pair and Gross (1989). As the investigation of their importance to biological control of *Spodoptera* spp. proceeds, more convenient methods of monitoring *D. introita* in the field are needed.

Pair (1995) studied the biology and rearing of *D. introita* on host and non-host noctuid pupae, *Spodoptera* spp., *Helicoverpa zea* (Boddie), and *Heliothis virescens* (F.) to identify factors that influence the reproduction and developmental rate of *D. introita*. This parasitoid was successfully reared in the laboratory on *S. frugiperda* pupae. Carpenter & Greany (1998) compared the developmental time, weight, fecundity, longevity, and ability to parasitize hosts for *D. introita* wasps developing on artificial diet and wasps reared on *S. frugiperda* pupae. They conclude that the ability to rear *D. introita* on an inexpensive, artificial diet significantly enhances the potential of mass rearing this parasitoid for inundative releases against species in the genus *Spodoptera*.

Studies on *Ichneumon promissorius* and Collection of *Ichneumon ambulatorius*

I. promissorius was collected in Australia from *Helicoverpa armigera* (Hübner), and *H. punctigera* (Wallengren) pupae (Chadwick & Nikitin 1976; Wilson 1983; Fitt & Daly 1990). The parasitoid was imported into the US and released in Arkansas, Georgia, Oklahoma, and Texas from 1992 to 1997 (J. E. C. et al., unpublished data). Following releases of *I. promissorius* in ear-stage corn in the lower Rio Grande valley in Texas during 1993 and 1994, feral noctuid pupae, including FAW, were removed from the soil. During 1993, 575 FAW pupae were collected, 8 of which were parasitized by *I. promissorius*. Of the 13 FAW pupae collected in 1994, none were parasitized by *I. promissorius*. A similar study was conducted in a cornfield in Rabun County, Georgia. During 1993, 141 of the 300 FAW pupae collected were parasitized by *I. promissorius* and 24 were parasitized by *I. ambulatorius*, a new host record. Only 5 FAW pupae collected in 1994. Two of these FAW pupae were parasitized by *I. promissorius* and one was parasitized by *I. ambulatorius*.

Carpenter et al. (1994) compared several indigenous lepidopteran species in Tifton, GA, for *I. promissorius* acceptance and development. Pupae of *H. zea*, *H. virescens* (F.), *H. subflexa* (Guenée), *S. frugiperda*, *S. exigua* (Hübner), *Trichoplusia ni* (Hübner), *Agrotis ipsilon* (Hufnagel), and *Anticarsia gemmatalis* (Hübner) were used as hosts. Ninety pupae/species were tested, resulting in 74, 72, 68, 66, and 62 wasps emerging from *T. ni*, *A. ipsilon*, *H. suflexa*, *S. exigua*, and *S. frugiperda*, respectively. Lowest emergence of wasps was obtained on *A. gemmatalis* (6). The most acceptable hosts of *I. promissorius* were *H. zea* and *H. virescens*, as expected because *I. promissorius* was collected in Australia from heliothid species (Fitt & Daly 1990). Carpenter et al. (1994) considered that *H. zea* should be the primary host species of this pupal parasitoid in the US.

Carpenter (1995) examined the influence of host species, host availability, and mating status on *I. promissorius* fecundity and oviposition. The results from this study suggest that the females budget their energy expenditures and regulate oogenesis to maximize their reproductive potential. Host size, as well as the host species, may

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have contributed to differences in weight of the wasps, and contributed to differences in fecundity, longevity, and oviposition between wasps reared on *S. exigua* and *H. zea* pupae. Virgin females reared on *S. exigua* pupae laid fewer eggs than virgin females reared on *H. zea* pupae.

Studies on *Vulgicheumon brevicinctor* and *Cryptus albitarsis*

Two *V. brevicinctor* were recovered from FAW pupae collected in 1982 from a cornfield near Tifton, GA (Pair & Gross 1989). Five *V. brevicinctor* were recovered from a sample of 300 FAW pupae collected from a corn field in Rabun County, GA, in 1993, and one *V. brevicinctor* was recovered from a sample of 3 FAW pupae collected from the same field in 1994 (J. E. C., unpublished data). *V. brevicinctor* also has been reported from other noctuids and species of other lepidopteran families (Carlson 1979). For example, Bechinski & Pedigo (1983) studied the population dynamics of the green cloverworm (*Plathypena scabra* F.) in soybeans in Iowa during 1979 and 1980. They and found that *V. brevicinctor* acted in a delayed density-dependent manner on green cloverworm pupal mortality. Pavuk & Stinner (1991) reported that *V. brevicinctor* was reared from pupae of an arctiid, *Cisseps fulvicollis* (Hübner), and pupae from a pyralid, *Ostrinia nubilalis* (Hübner).

Pair & Gross (1989) collected *C. albitarsis* in Tifton, GA, from a single sample taken November 2, 1984. Four *C. albitarsis* also were recovered from a sample of 300 FAW pupae collected from a corn field in Rabun County, GA, in 1993 (J. E. C., unpublished data). Pair & Gross (1989) reported that *C. albitarsis* had been established in a laboratory colony in Tifton, GA. *C. albitarsis* cohorts from this laboratory colony were successfully reared on an artificial diet devoid of any host components (Greany and Carpenter 1998).

Studies on Ectopasitic Nematodes Attacking Adults of *Spodoptera frugiperda*

Remillet & Silvain in 1982 discovered and reported an ectoparasitic nematode, *Noctuidonema guyanense* Remillet & Silvain infecting *Spodoptera androgea* (Cramer) in French Guiana. It was subsequently described as a new genus and species (Remillet & Silvain 1988) most commonly found on moths of FAW, *Spodoptera latifascia* (Walker), *S. marima* (Schaus), *Anicla infecta* (Ochsenheimer), and *Leucania* spp. (Remillet & Silvain 1988).

Rogers et al. (1990a) determined the life cycle and host range for *N. guyanense* in French Guiana. They collected moths using a white sheet illuminated by UV light, by pheromone traps, and sweeping vegetation from a variety of habitats in Northeastern French Guiana. Moths in five families, Lasiocampidae, Noctuidae, Notodontidae, Pyralidae, and Sphingidae were naturally infested with this nematode species. Twenty-five species of Noctuidae were infected by *N. guyanense*, the hosts most commonly infected were *Lesmone formularis* (Hübner), *S. dolichos* (F.), *S. frugiperda*, and *Xanthopastis timais* (Cramer) (Rogers et al. 1990a). Using the same methodologies, Rogers et al. (1990b) determined that multiple species of *Mocis* and *Spodoptera* were parasitized by the nematode in Florida and Georgia, and it was the first record of this parasite in North America. Simmons & Rogers (1990a) determined the distribution and prevalence of the nematode in tropical Americas, occurring in northern South America, Mexico, Texas, Florida, Bermuda, most of the Caribbean basin countries, and Central America.

Since 1990, numerous studies have been conducted on this nematode including biology (Simmons & Rogers 1994; Marti & Rogers 2000), pathological effects on the host (Marti et al. 1990; Rogers et al. 1993), infestation dynamics (Rogers & Marti 1992a; Silvain & Remillet 1993; Rogers & Marti 1993b), geographical distribution (Rogers et al. 1993; Rogers et al. 1991; Simmons et al. 1991; Rogers et al. 1997; Marti et al. 2000), ecology (Silvain & Remillet 1993), population profiles (Rogers & Marti 1992a, 1994), mating behavior (Simmons & Marti 1992), prevalence (Simmons & Rogers 1990b), maintenance of colonies (Rogers & Marti 1993a, b), host range (Simmons & Rogers 1996; Rogers & Marti 1996; Marti et al. 2000), and the bionomics of host insects of *N. guyanense* (Rogers et al. 1996; Marti et al. 2000). Subsequently however, a study on the speciation in Acugutturidae shows that *N. guyanense* is limited to the lepidopteran genera Spodoptera and Pseudaletia (Marti et al. 2002).

Simmons et al. (1991) studied the seasonal chronology of the nematode in the tropical and subtropical America, and determined that host parasitism and nematode population density varied among locations and over time. Examples include higher parasitism on male moths in Grenada (77%) than in Texas (1%), and higher nematode populations at lower latitudes than higher latitudes. Simmons & Rogers (1991) also studied the dispersal and seasonal occurrence of *N. guyanense* on FAW adults in the US. They found that nematode populations and parasitism of FAW males were higher in Eastern States than in the Plains, Midwestern, and Central states, and that the percent parasitism and the number of nematodes per infested FAW changed over time at each location.

Acknowledgments

The authors thank J. J. Hamm and O. G. Marti (USDA-ARS-Crop Protection & Management Research Laboratory, Tifton, GA), for their critical review of earlier versions of this manuscript, and thank O. G. Marti for providing information on ectoparasitic nematodes.

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The authors appreciate the assistance of Duncan McClusky (University of Georgia Libraries, Tifton, GA), and Marco Antonio Mellín-Rosas (CNRCB, Tecomán, Colima, México) in obtaining scientific literature. The authors gratefully acknowledge and thank Susan Drawdy (USDA-ARS-Crop Protection & Management Research Laboratory, Tifton, GA) for her exceptional technical assistance and dedication to this project. Insect identifications and verification of insect classifications were provided by several scientists associated with the USDA/ARS Systematic Entomology Laboratory, including B. Carlson, E. E. Grissell, P. Marsh, N. E. Woodley, and N. W. Gates. This paper is a contribution of the University of Nebraska Agricultural Research Division, Lincoln, NE 68583. Journal Series No. 13681, Department of Entomology, University of Nebraska-Lincoln. The authors thank Universidad de Colima, and CONACYT-Mexico for supporting the senior author.

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