PARASITES ASSOCIATED WITH LEPIDOPTEROUS PESTS
OF ALFALFA IN OKLAHOMA

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CHAPTER I

GENERAL INTRODUCTION

Due to demands for increased agricultural production with high-yielding crop varieties, a transition from a polyculture to a monoculture has occurred in American agriculture. As a result, specialized agroecosystems have been developed centering around major crop plants. In plant breeding, genotypes for high yield and quality have been selected often without adequate consideration of potential pest problems. When susceptible varieties are grown in the appropriate environment, the crops have provided a favorable habitat and virtually an unlimited food supply for pest species. Among these pests, the insects have many characteristics which allow them to exploit habitats in modern day agroecosystems, such as high reproductive potential, short life cycle, mobility, and the ability to habitate in a variety of crops separated in time and space.

A principal method for reducing pest population levels has been chemical insecticide application. As a unilateral approach to insect control, insecticides applied without regard to economic thresholds have precipitated many disruptions in alfalfa crop systems, such as secondary pest outbreaks and destruction of beneficials (due to the non-selective nature of insecticides). Integrated control programs aid producers with efficient pest regulation with a minimum of disruption to the crop system. Such programs promote the use of biological control agents and resistant plant varieties along with chemical pesticides. Resulting decreases in insecticide usage have been important in preserving non-target organisms in the environment. This is an important consideration relating to parasitic insects, such as those involved in my research.

Barfield and Stimac (1980) provide a more complete analysis of pest management, in describing approaches to insect control, such as prevention action and suppression action. Prevention action utilizes resistant plant varieties, crop rotation, attractants and repellents, and conservation of natural control factors, such as parasites I have studied in alfalfa. Means of conservation of natural enemies include preservation of inactive stages, avoidance of harmful cultural practices, and providing alternate hosts (Metcalf and Luckman 1975).

Suppression action involves the use of pesticides, parasites, and microbials (Barfield and Stimac 1980). Augmentation of parasites may be accomplished by mass rearing and releasing through inoculative, supplementary, or inundative releases (Metcalf and Luckman 1975).

Before any conservation and augmentation practices can be effective, basic knowledge of the biology and natural history of both host and parasite is required. Little research has been done with regard to the various species of lepidopterous larvae and their associated parasites in alfalfa ecosystems in the United States and virtually none in the Southern Plains. This thesis research has been conducted to improve basic knowledge of host records and seasonal incidence of parasitic insects associated with lepidopterous larvae in alfalfa.

The alfalfa food web is composed of many interrelated life systems at different trophic levels. Life systems found in this web include that of alfalfa (primary producer), various species of herbivores, which utilize alfalfa as a food source, beneficial entomophagous species (primary carnivores), and incidental organisms. Among the numerous herbivores in the alfalfa ecosystem are several species of cutworms and other foliage feeding larvae, each with a life system consisting of factors which influence population densities. In general, eight lepidopterous larvae comprised the "foliage-feeder complex" in alfalfa in my 3 year study. Among the factors which effect populations in this larval complex are many species of parasites and predators (primary carnivores), some of which are host-specific and others which are associated with a number of the pest species included in this complex. Of these primary carnivores, my study involved parasitic species and the analysis of their impact in the reduction of lepidopterous pest populations.

The objectives of this 3 year study were: (1) to determine the seasonal incidence and relative abundance of the most common lepidopterous pests, (2) determine the seasonal incidence and importance of native parasites reared from lepidopterous hosts, (3) establish a reference collection of the native parasites reared from lepidopterous hosts for use as a basis for future parasite identification.

CHAPTER II

PARASITES ASSOCIATED WITH *EUXOA AUXILIARIS* (GROTÉ) AND *PERIDROMA SAUCIA* (HÜBNER)

Introduction

Infestation of alfalfa, *Medicago sativa* L., by the army cutworm, *Euxoa auxiliaris* (Groté), occurs sporadically over years and localities. Usually, relatively few fields are heavily infested in any year. According to Burton et al. (1980), an outbreak year is preceded by increasing numbers of cutworms for 1-2 years. After damaging population densities have occurred, low numbers are typically found for several years.

Euxoa auxiliaris are univoltine (one generation/year). Oviposition occurs in the fall on the soil surface in fields with little ground cover such as new stands or late harvested established stands. Eggs hatch in the fall and larvae feed until alfalfa is browned by frost. They then overwinter in the soil around plant crowns. As warmer temperatures prevail in spring, *E. auxiliaris* feed on plants near the soil surface primarily in late afternoon and evening (Burton et al. 1980). As damage becomes more severe in spring, plants may be defoliated, after which stems and buds are consumed, leaving no growth from plant crowns. When larvae complete their development, they form cells at a depth of 2-6 cm in soil and pupate (Burton et al. 1980). Adults emerge in May or June, after which they leave the fields.

In limited studies relating parasitization of army cutworms, Snow (1925) found that *Berecyntus bakeri* Howard, *Apanteles laeviceps* Ashmead, and *Ernestia* sp. accounted for 83.0% of all parasites in Utah alfalfa fields. The most abundant parasites reared from *E. auxiliaris* collected in Oklahoma wheat, *Triticum aestivum* L. em. Thell., fields included *Meteorus leviventris* (Wesmael) (37.1% of all parasites), *Apanteles griffini Viereck* (34.8%), and Copidosoma sp. (20.7%) (Burton et al. 1980). No studies have been conducted on parasitization of this species in alfalfa in the Southern Plains.

The variegated cutworm, *Peridroma saucia* (Hübner), also feeds in lower areas of the alfalfa plant canopy near the soil surface. Larval infestations develop in the first crop of alfalfa during April. In Oklahoma, the greatest losses typically occur in regrowth after first harvest, when large larvae are present (Berberet, unpublished). They have the potential to destroy new growth and may delay the second crop as long as 2-3 weeks. Although there is more than one generation/year in Oklahoma, only one generation caused damage to alfalfa in this study.

Roberts et al. (1977) reported that *Meteorus autographae* Muesebeck and *Meteorus* sp. were reared from variegated cutworms collected in Illinois alfalfa fields. Additional parasites which have been reared from *P. saucia* include *Archytas apicifer* (Walker), *Lespesia archippivora* (Riley), *Peleteria texensis* Curran, *Voria ruralis* (Fallen), and *Winthemia rufopicta* (Bigot) (Arnaud 1978). No studies have been conducted on parasites of *P. saucia* in Oklahoma alfalfa fields.

Materials and Methods

Over 50 alfalfa fields were sampled throughout the state during

March, April, and May of each year (1979-81) of this study to locate infestations by cutworms. Whenever population densities exceeded 5-10/ m^2, larval collections were made for parasite retrieval. As larvae generally feed during evening and nighttime hours, it was necessary to search in plant debris and sift soil around alfalfa crowns to find larvae when collecting in daylight. Collections of at least 50 larvae/ field were made whenever possible. After collection, 25-30 larvae were placed in 1 ℓ paper cartons containing alfalfa foliage and transported to the laboratory in coolers to restrict larval activity. In the laboratory, the larvae were put in 30 ml plastic cups with cardboard lids containing a modified pinto bean diet (Burton 1969). Larvae were reared at $22 \pm 3^{o}C$ and development was observed at 2 day intervals. Parasites which exited host larvae and pupated were checked daily for adult emergence. Larvae which died were held for 21-28 days to permit parasites to emerge. The remaining larvae were then dissected to determine if parasites were present and remove larval parasites, which were stored in alcohol for later attempts at identification to order, family, and genus, if possible. Criteria, such as anatomical characteristics, number of parasites/host, size of parasite, and evidence of cocoon formation were utilized. After pinning and labelling, parasite adults were identified by Drs. E. Grissell, P. Marsh, and D. Wilder of the National Museum, Washington, D.C.; J. Barron, M. Ivanochko, and W. Mason in Ottawa, Ontario, Canada, and D. Arnold of Oklahoma State University, Stillwater, Oklahoma.

Rates of parasitism were calculated by dividing the total number of each cutworm species parasitized by the total number of hosts collected. Percentages of total parasite collections comprised by each species were calculated by dividing the total number of each parasite species identified by the total number of parasites retrieved. Parasitic species associated with each host and rates of parasitism over the 3 year period were determined.

Results

Euxoa auxiliaris were collected from seven alfalfa fields and P. saucia were collected from 14 alfalfa fields during 1979-81. Of over 3400 E. auxiliaris collected, the greatest numbers were found in four fields in southern Oklahoma during 1980 and 1981. Although infestations were limited to a relatively low number of fields, numbers of larvae exceeded $100/m^2$ and defoliation was severe in these fields.

Nearly all parasites retrieved from E. auxiliaris were Hymenoptera, and over 50% of all parasites were Braconidae (Table I[1]). The two gregarious endoparasites, M. leviventris and A. griffini comprised ca. 35% of all parasites collected. Numbers of parasites of these species emerging from individual hosts ranged from 4-70 and the average was 25/host. Members of the family Encyrtidae (prob. Litomastix bakeri (Howard)) comprised 7% of all parasites. They are polyembryonic and as many as 2000 parasites emerged from individual hosts. These three groups of parasites emerged from later (larger) instar larvae.

Approximately 94% of all larval P. saucia were collected from a total of nine fields during 1979 and 1981. About one-half of these were collected prior to first cutting with the remainder collected after the first cutting was taken. In contrast to E. auxiliaris, which was parasitized

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[1] All tables located in Appendix A

heavily by Hymenoptera, over 50% of all parasites retrieved from P. saucia were Tachinidae. The most abundant parasites were A. apicifer and P. texensis, which are larval-pupal parasites (Table II). Among members of Hymenoptera, Euplectrus spp. were prevalent in northern Oklahoma, and Ophion spp. were found in the south. Most of the Ophion spp. obtained in this study completely consumed their larval hosts and spun cocoons, but adults did not emerge. Evidently, a factor in the laboratory environment, such as photoperiod or temperature necessary to break diapause was not provided.

No hyperparasitic species were collected from parasites of E. auxiliaris and P. saucia.

A reference collection of adult parasitic species obtained from E. auxiliaris and P. saucia is located in the Entomology Department Museum, 509 Life Sciences West, Oklahoma State University, Stillwater, Oklahoma. These parasites are available for further studies through permission of the museum curator.

Discussion

Although not perennial pests in alfalfa, E. auxiliaris and P. saucia may cause serious damage to new growth in spring or after the first harvest is taken, respectively. As much cutworm feeding occurs when plants have little growth to sustain damage, populations must be regulated at low levels to prevent serious yield reduction. Economic thresholds for small cutworm larvae (≤ 1 cm) are 30-40/m^2 and 20-30/m^2 for 2-3 cm larvae (Oklahoma Cooperative Extension Service 1982). Completely effective natural controls would provide consistent regulations of populations below these expressed economic threshold levels. During this study, heavy infestations were found in a relatively small number of the fields surveyed over the state. However, it appeared that parasitic insects were of relatively minor importance in regulating cutworm populations and preventing more widespread incidence of damaging infestations. With combined rates of parasitism over the 3 years of this study for Hymenoptera and Diptera of 11.4% for E. auxiliaris and 19.2% for P. saucia, impact of these entomophagous species did not appear to be great. Other types of natural controls, such as weather-related factors, apparently have greater influence on cutworm numbers.

Apanteles griffini and M. leviventris, host-specific endoparasites of E. auxiliaris, were present prior to first cutting only. These parasites emerged from later instar larvae. This factor may increase their impact on population densities as they induce mortality after populations have already been reduced due to factors which destroy larvae of early instars. This could enhance the value of these parasites in long-term regulation of E. auxiliaris populations.

The two most common parasites associated with P. saucia were P. texensis and A. apicifer. Of these two species, the most host-specific was P. texensis. Archytas apicifer, by comparison, was observed to parasitize Pseudaletia unipuncta (Haworth), Spodoptera ornithogalli (Guenée), and Spodoptera exigua (Hübner) in addition to P. saucia (see Chapter III). The rates of parasitism were low (Table II), perhaps because members of these species larviposit in the host habitat, such as alfalfa plants, rather than on the host larvae (Hughes 1975). If hosts do not come in contact with parasites, the larvae die within several days. Because cutworms generally are not on foliage during daytime hours, the time interval for contact between hosts and parasites is reduced relative to that for host larvae, which remain on foliage constantly. Also, mortality occurs frequently when maggots fail to penetrate hosts which are contacted as they molt, and are shed with the exuviae (Hughes 1975).

Several other parasites of cutworms, such as Apanteles marginiventris (Cresson) and Campoletis sonorensis (Cameron), which attacked both E. auxiliaris and P. saucia, also parasitized members of the foliage feeder complex, including Heliothis zea (Boddie), P. unipuncta, S. ornithogalli, and S. exigua. As these parasites appeared to be more prevalent later in the season, cutworms may serve as early season hosts for the first generation of these parasites. Other foliage feeding lepidopterous larvae which become available later in the season may be more preferred hosts.

Parasites, such as A. griffini, M. leviventris, and P. texensis may have potential for use as biological agents in integrated control programs. They possess a high degree of host specificity which enhances their value as control agents (Debach 1974).

Insecticides applied for the alfalfa weevil, Hypera postica (Gyllenhal), and aphid species, such as Acyrthosiphon pisum (Harris), A. kondoi Shinji, and Therioaphis maculata (Buckton), undoubtedly destroy many parasites associated with cutworms. The incidence of cutworm populations coincides with that of weevil and aphid populations and use of insecticides is frequently necessary for control of these pests (Coppock 1982), and it is difficult to avoid destruction of beneficials in the first crop of alfalfa. An integrated control program which involves use of parasites for control of cutworms would have to be designed to address this problem.

From my studies, parasites did not have a great impact on cutworm populations, but in consideration with other factors, such as insect predators, viruses, fungi, and birds (Burton et al. 1980), they were effective in reducing incidence of outbreaks by these pests. To aid in conservation of natural enemies, reduction or avoidance of insecticides is necessary. Harvesting sections at a time of large acreages of alfalfa will enhance the survivability of natural enemies by providing hosts for the continuation of the parasites, as well as protection for inactive stages of the beneficials (Debach 1974). Parasites will then be available when the next host generation begins after harvest.

Summary

Euxoa auxiliaris and P. saucia were found in new spring growth or after first harvest, respectively. Heavy infestations were found in approximately 20 fields in a total of ca. 150 sampled during this 3 year study. Of a total of 11 parasitic species for E. auxiliaris, the most common were M. leviventris and A. griffini, which comprised 25% and 10% of all parasites, respectively (Table I). A total of 16 parasitic species was associated with P. saucia, the most common of which were P. texensis and A. apicifer. Percentages of all parasites were 21% and 10% for P. texensis and A. apicifer, respectively (Table II). Parasite collections and host records obtained in this study will provide a good basis for further studies of beneficial insects associated with cutworms in alfalfa in the Southern Plains region.

CHAPTER III

PARASITES ASSOCIATED WITH FOLIAGE FEEDING SPECIES

Introduction

Numerous foliage feeding species of lepidopterous larvae are present during the growing season for alfalfa. This study includes those most common in the Southern Plains. Among these species are the corn earworm, Heliothis zea (Boddie); alfalfa caterpillar, Colias eurytheme (Boisduval); green cloverworm, Plathypena scabra (F.); garden webworm, Achyra rantalis (Guenee); yellow-striped armyworm, Spodoptera ornithogalli (Guenée); fall armyworm, S. frugiperda (J. E. Smith); armyworm, Pseudaletia unipuncta (Haworth); and beet armyworm, S. exigua (Hübner).

Existing records for parasites associated with these species in Oklahoma or other states are numerous when all crops are considered. Because records from alfalfa specifically are less comprehensive, references for studies conducted in several crops are included in this review. Bibby (1942), Butler (1958a), and Smith et al. (1976) report Microplitis croceipes (Cresson) as a parasite of H. zea. Microplitis croceipes accounts for 35.6% of all parasites reared from H. zea in peanut, Arachis hypogaea L., fields of Oklahoma (Wall and Berberet 1975). Bottrell et al. (1968) report that H. zea collected from Oklahoma alfalfa fields are parasitized by Eucelatoria armigera (Coquillett), Lespesia archippivora (Riley), *Euphorocera tachinomoides* Townsend, *Winthemia rufopicta* (Bigot), *Chelonus texanus* Cresson, *M. croceipes*, *Temelucha* sp., and *Pristomerus spinator* (F.). Young and Price (1975) report that *M. croceipes*, *C. texanus*, and *E. armigera* are common parasites of lepidopterous larvae in various crops in Oklahoma and *L. archippivora*, in particular, commonly parasitized those in alfalfa. *Eucelatoria armigera* is also an important parasite of *H. zea* in Oklahoma peanut fields (Wall and Berberet 1975).

Apanteles medicaginis Muesebeck often parasitized *C. eurytheme* (Butler 1958a). *Apanteles flaviconchae* Riley, *Meteorus autographae* Muesebeck, *Hyposoter annulipes* (Cresson), *Winthemia sinuata* Reinhard, and *Euphorocera* sp. are responsible for 47% of all parasitism of this species in Illinois alfalfa fields (Roberts et al. 1977). These authors report that *A. flaviconchae* was responsible for over 87% of all recorded cases of parasitism of *Colias* spp. in alfalfa and soybeans, *Glycine max* (L.) Merrill.

Whiteside et al. (1967) identified *Rogas nolophanae Ashmead*, which parasitized 6.5% of the *P. scabra*, as the most important parasite of this species in legumes grown in Delaware. Barry (1970) reports that *R. nolophanae*, *Apanteles marginiventris* (Cresson), and *Protomicroplitis facetosa* (Weed) parasitize *P. scabra* collected in leguminous crops in Missouri. As further evidence of the importance of *R. nolophanae*, Lentz and Pedigo (1975) found that the species is the most abundant entomophagous parasite in alfalfa, with *W. sinuata* as second most abundant.

Cremnops vulgaris (Cresson), *C. haematoides* (Brulle), and *Cardiochiles explorator* (Say) are reported as parasites of *A. rantalis* in Oklahoma (Krombein et al. 1979).

Bottrell (1969) states that C. texanus and L. archippivora are common species reared from S. ornithogalli in Oklahoma. Wall and Berberet (1975) report that L. archippivora, Campoletis flavicincta (Ashmead), and Euplectrus platyhypenae Howard are important parasites of S. ornithogalli in Oklahoma peanut fields. Apanteles marginiventris, M. autographae, C. flavicincta, and Campoletis oxylus (Cresson) accounted for 36% parasitization of this foliage feeder in central Illinois alfalfa (Roberts et al. 1977).

Parasites observed to attack S. frugiperda in Arizona alfalfa fields included C. texanus (Butler 1958a) and L. archippivora (Butler 1958b). The three most prevalent parasites associated with S. frugiperda in Oklahoma peanut fields are L. archippivora, E. platyhypenae, and W. rufopicta, and these species accounted for 55.4% of all instances of parasitization (Wall and Berberet 1975).

Roberts et al. (1977) retrieved several parasites from the armyworm, P. unipuncta, in central Illinois alfalfa fields, including E. platyhypenae, A. marginiventris, Apanteles militaris (Walsh), M. autographae, Rogas terminalis (Cresson), and C. oxylus. Rate of parasitism for the six species combined was 21.4%.

Butler (1958a) observed that A. militaris parasitized S. exigua. Wall and Berberet (1975) report L. archippivora accounted for 33.3% of the total parasites of S. exigua collected in Oklahoma peanut fields, with P. spinator accounting for 11.1%, and C. texanus for 11.1%.

Materials and Methods

Foliage feeding lepidopterous larvae were field collected and reared for parasite retrieval over a 3 year period from 1979-81. To the extent possible, collections were made only in fields with a full stand of alfalfa (250-300 stems/m^2). Two types of sampling programs were utilized in this study. For the first type, objectives were to obtain collections for the larval population densities and rates of parasitism with known crop intervals or harvest dates. For this sampling plan, lepidopterous larvae were collected in areas of 2-3 ha which received no insecticide applications at Stillwater (northern Oklahoma) and at Chickasha (southern Oklahoma) with ca. 1 week sampling intervals (Figure 1[2]). This sampling interval was selected to allow frequent observation of insect populations throughout the season. The same field was used at Stillwater for all 3 years of the study, but the sampling site at Chickasha was moved after 1980 because of excessive stand decline in the original field.

Larvae were collected from April through October, using pendulum sweeps as described by Armbrust et al. (1969). When possible, collections of at least 50 larvae/pest species were made on each sampling date. Larval population densities were estimated in larvae/10 sweeps. Records were kept of harvest dates so that crop intervals were known. As host populations were disrupted with each crop harvest, species began new generations in regrowth. While sampling from two sites did provide detailed seasonal records, it was not necessarily representative of foliage feeder and entomophagous parasite populations throughout the state.

The objectives for the second sampling program included wider geographical distribution of sampling for increased possibility of collecting species of host larvae and parasites which may not have been found in the two intensive sampling areas. For these statewide surveys, larvae

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[2] All figures located in Appendix B

were collected at approximately monthly intervals to correspond theoretically with crop or harvest intervals of alfalfa. Fields in each of four regions were consecutively sampled in each crop interval. One field in each of approximately seven counties (one field/county) was sampled in the south-central part of the state, after which ca. eight counties were sampled in the southwestern area, seven in the northeastern region, and 12 in the northwestern part of the state, for a total of ca. 30-40 counties sampled during each survey (Figure 1). Samples were taken in fields where regrowth had attained a height of 20-30 cm and there was no evidence of recent insecticide application.

Due to differing harvest dates and stages of regrowth, neither the same fields nor the same counties were surveyed consistently during each season. As a means for standardizing crop intervals, degree day calculations were used for establishing intervals based on the theoretical developmental time for alfalfa. To account for differing temperature conditions particularly in spring and early summer, the state was divided into northern and southern regions for determination of degree day accumulations (Figure 1). At times, accumulations were considerably lower in northern Oklahoma than in the south for some months and theoretical crop maturity came later. Climatological data from the National Weather Service were used for calculations at a centrally located site in each region (Payne Co. - northern Oklahoma; Stephens Co. - southern Oklahoma). Degree day accumulations were calculated from March 1, as the approximate time when alfalfa begins its spring growth. The formula used is:

$$dd = \frac{\text{Max. Temp.} + \text{Min. Temp.}}{2} - \text{Threshold Temp. } (5^{o}C).$$

May 1 was used as a representative first harvest date for southern

Oklahoma, and the interval (March 1-May 1) was calculated for the first crop in the south. This interval ranged from 540-640 C degree days over the 3 years. This number of degree days for each year was then used to determine the theoretical first harvest date in northern Oklahoma for the same year (Table III). Thus, for each year, the same approximate degree day accumulation was used to determine the first crop interval for both regions of the state.

For subsequent intervals, theoretical developmental time for alfalfa (Holt et al. 1975) was used, as it appeared to fit Oklahoma conditions fairly well after the first crop interval. Approximately 450 degree days above $5^{o}C$ are required for growth of alfalfa to the bud stage and 600 C degree days for full bloom. Six hundred seventy degree days were used for crop intervals two through five in this study. This figure is somewhat larger than requirements expressed by Holt et al. (1975) to account in part for the higher temperatures and drier conditions which prevail in Oklahoma as compared to Indiana where their work was done. A total of five theoretical crop intervals were calculated for each season and a fall regrowth period followed the fifth interval and lasted through October.

The maximum temperature used in the formula for degree day calculations was $32^{o}C$, as plant and insect developmental rates are inhibited when temperatures exceed this level (Holt et al. 1975, Logan et al. 1976). The number of degree days accumulated for $32^{o}C$ from the threshold temperature of $5^{o}C$ was 13.6 C degree days and this number of degree days was used for temperatures from $32^{o}C$ - $35^{o}C$ to account for reduced developmental rates. For each degree C above $35^{o}C$, 0.3 C degree days were subtracted from the maximum degree day accumulation of 13.6 degree days. Plant and insect developmental rates may actually be depressed above this temperature (Holt et al. 1975, Logan et al. 1976).

As larvae were collected at Stillwater, Chickasha, or statewide, low numbers (25-30) were placed in 1 ℓ paper cartons containing alfalfa foliage and transported to the laboratory in coolers to restrict larval activity. In the laboratory, the larvae were put in 30 ml plastic cups with cardboard lids containing a modified pinto bean diet (Burton 1969). Larvae were reared at 22 $\pm$ 3^{o}C and development was observed at 2 day intervals for presence of parasites or emergence of moths. Parasites which exited host larvae were checked daily for adult emergence. Hosts which died were held for 21-28 days to permit parasites within to emerge, after which they were dissected to determine if they were parasitized.

Plathypena scabra and C. eurytheme did not feed on artificial diet and were reared on bouquets of alfalfa foliage contained in 18 cm funnels with cloth covers. Bouquets were checked daily for the first 3-5 days for presence of parasites or host pupation and larvae were transferred to fresh alfalfa as needed. Most parasites exited the hosts within the first 5-day period. The majority of host larvae remaining after this time were unparasitized and did not need to be checked daily. When host or parasite pupation occurred, insects were removed from the foliage and placed in 30 ml cups to await adult emergence. All dead hosts were dissected to determine if parasites were present and remove larval parasites, which were then stored in alcohol for later attempts at identification. Larvae were identified to order, and if possible to family and genus, using criteria such as anatomical features, number of parasites/host, size of parasite, and evidence of cocoon formation. After pinning and labelling, parasite adults were identified by Drs. E. Grissell, P. Marsh, and D. Wilder of the National Museum, Washington, D.C.; H. Bisdee, J.

Barron, M. Ivanochko, and W. Mason in Ottawa, Ontario, Canada; and D. Arnold of Oklahoma State University, Stillwater, Oklahoma.

Lepidopterous larval collections were totalled and percentage parasitism calculated to give an analysis of total host numbers collected in the sampling areas and statewide and the rates of parasitism associated with each host for the 3 year study.

All larval collections obtained within known (Stillwater and Chickasha) or theoretical (statewide surveys) crop intervals were totalled for each host species. Data for the sampling sites and statewide collections were calculated separately for comparison of estimates of parasitic activity with the two sampling plans. The overall rate of parasitism was calculated for each host, as well as rates by individual parasitic species. Further analysis included calculating percentages of total parasitism of each Lepidopteran by the various entomophagous species. For this, the number of each species retrieved was divided by the number of total parasite collections in the host. To determine the extent of parasitism by family for each interval, the percentage of total parasites in each of the three major families and all other families combined was computed to observe trends individually for the sampling areas and statewide surveys.

Results

Larvae were collected at Chickasha, Stillwater, and throughout the state from 1979-81 (Figure 1). There were four crop intervals in most instances for Chickasha and Stillwater, and theoretically five for the statewide surveys according to degree day accumulations which were calculated to establish intervals (Table III). The rate of parasitism by host for each area and year is presented in Table IV. Table V shows the total number of each lepidopterous species collected over the 3 years and overall rate of parasitism for each in the sampling sites (Chickasha and Stillwater) and statewide surveys. Statewide collections were beneficial, in that some of the pest species, such as A. rantalis and S. ornithogalli which were present in low numbers or not at all in the sampling areas during some crop intervals (Tables VI, VII) were collected in fairly large numbers in the statewide collections (Table VIII). A summary of all parasites associated with each lepidopterous host for all areas and years is given in Table IX.

Unlike the results of weekly sampling shown for Chickasha and Stillwater which give a consistent representation of relative abundance of foliage feeding species (Figures 2, 3), totals for crop intervals from statewide collections are not valid estimates of larval abundance (Figures 4, 5, 6, 7, and Tables VI, VII, VIII). The total for each crop interval is derived from 30-40 collections made during the statewide survey for that interval. Records were not kept for individual fields sampled.

Lepidopterous larvae were not present in every crop of alfalfa, such as in the first part of crop interval 2 at Chickasha in 1980 (Figure 2) or in fall regrowth (R) at Stillwater in 1979 (Figure 3). If the total hosts/10 sweeps were quite high as compared to abundance of the three most common species, H. zea, C. eurytheme, and P. scabra, it is indicative that other species were numerous. For instance, in crop interval 3 at Chickasha in 1979, A. rantalis were present in large numbers and the total larval population was 5/10 sweeps (Figure 2). Spodoptera exigua were particularly abundant in crop interval 3 at Chickasha in 1980 (Figure 2), A. rantalis and S. ornithogalli were common in crop interval 2 at Stillwater in 1979 (Figure 3), S. frugiperda and A. rantalis were abundant in crop interval 4 during 1980 (Stillwater), and A. rantalis and S. ornithogalli created the higher host numbers in crop intervals 2 and 4 in 1981 at Stillwater (Figure 3).

Heliothis zea were collected in the highest numbers at all locations (Table V), and was the most abundant pest collected in crop interval 4 at Chickasha during 1980 (Figure 2) and in crop intervals 3 (1979), 4 (1980) and 4 (1981) at Stillwater (Figure 3).

The rate of parasitism for H. zea varied by year and location (Table IV) from a minimum average annually of 21.2% (Chickasha-1980) to a maximum of 45.2% (Chickasha-1979). Parasitization of this species fluctuated in the sampling areas and statewide (Figures 4, 5, 6) for each year. Statewide, parasitization of H. zea was low in crop intervals 2, 3, and 4 in 1980 as compared to the same intervals for 1979 and 1981. This may have been related to the hot and dry conditions during this year. Microplitis croceipes was the most important parasite attacking this host (Tables VI, VII, VIII). Populations of this species appeared to be building during the early part of the season in all areas and became abundant by crop interval 3 throughout the state (Table VIII) and crop interval 4 at Chickasha (Table VI) and Stillwater (Table VII). This host-specific parasite comprised over 64% of all parasites from H. zea (Table IX). As an example of its importance as a natural enemy, M. croceipes parasitized almost one-half of all H. zea collected in the statewide survey in Oklahoma in fall regrowth during 1980. Perilampis spp., characteristically hyperparasitic, parasitized M. croceipes and Apanteles spp., but the rate of parasitism was never as high as the 10% reported by Wall (1975).

Colias eurytheme were collected consistently throughout the growing season, and frequently the only lepidopterous pest present prior to first cutting. As indicated for Chickasha and Stillwater, the number of this species/10 sweeps was fairly low for all 3 years, and rarely exceeded one larva/10 sweeps (Figures 2, 3).

Parasitization of C. eurytheme fluctuated considerably during the 3 years in the sampling areas and statewide, but was consistently low statewide in 1980 (Figures 4, 5, 6). Parasitization by year at each sampling area and statewide was also quite variable (Table IV). Where the rate of parasitism appeared to be very high in crop interval 2 at Chickasha for 1979 (Figure 4), low numbers of larvae were collected. In 1979, Hymenoptera and Diptera each comprised approximately 50% of the total parasites for both areas. In 1980, Hymenoptera comprised 37% and 25% for Chickasha and Stillwater, respectively, and for 1981, Hymenoptera averaged 95% for both locations. Important parasites of C. eurytheme for all areas were A. flaviconchae, A. medicaginis, and Chetogena "claripennis Macquart" (Tables VI, VII, VIII). In general, A. flaviconchae heavily parasitized C. eurytheme in early season, showed a decline or disappeared during mid-season, and reappeared later in the season. During mid-season, A. medicaginis, Chetogena spp., Winthemia spp., and A. apicifer were present. Apanteles flaviconchae is a host-specific gregarious larval endoparasite. An average of 11 parasites/host emerged from smaller larvae and 18/host for larger instars. Apanteles flaviconchae was hyperparasitized by a member of the family Ichneumonidae, Mesochorus (prob. americanus Cresson). Parasitism of A. flaviconchae by Mesochorus sp. reached a maximum of 5% in crop interval 2 in 1981.

Plathypena scabra were present primarily from crop interval 2 through the regrowth period (Figures 2, 3). This species had the lowest average parasitization rate of all Lepidoptera collected (Tables IV, V, Figures 4, 5, 6), perhaps because larvae react with a vigorous flipping motion whenever they are disturbed. This reaction may dislodge adult parasites before oviposition is completed. Rogas nolophanae was an important parasite in early season, after which members of Tachinidae, such as C. "claripennis Macquart", C. tachinimoides (Townsend), and Plagiomima cognata Aldrich became important (Tables VI, VII, VIII).

Achyra rantalis were present primarily in crop intervals 2-4 during 1979 and 1981. Very few larvae were collected in 1980 (Table IV). Rates of parasitism for A. rantalis at Chickasha and Stillwater were the same, although larval collections for Stillwater were four times greater than at Chickasha (Table V). Overall parasitization throughout the state was considerably lower than that of the sampling areas (Table V), and there was considerable variation by year for each location (Table IV). The majority of parasites reared from the Chickasha location were Diptera, and included Nemorilla psyte (Walker) and C. tachinomoides (Table VI). At Stillwater, most larvae were collected in crop intervals 2, 3, and 4 and were parasitized by C. vulgaris (crop interval 2), N. psyte (crop interval 3), and C. insularis (crop interval 4) (Table VII). These were also the three most important parasites collected in the statewide surveys (Table VIII).

The majority of S. ornithogalli were collected in crop intervals 2-5 in 1981 throughout the state (Table VIII) and in crops 2-4 in 1981 at Stillwater (Table VII). Few larvae of this species were collected at Chickasha during any year and statewide in 1979 and 1980 (Table IV). The overall rate of parasitism was highest for this host in the sampling areas and statewide (Table V). The three most common parasites reared from S. ornithogalli were C. insularis, A. marginiventris, and P. spinator (Tables VI, VII, VIII).

Spodoptera frugiperda occurred primarily in crop intervals 3, 4 and 5 during 1980 in the sampling sites and statewide. During 1979 and 1981, larval populations were sporadic in the fields sampled. Collections for these 2 years were considerably lower than those for 1980 (Table IV). Zele melea (Cresson) and C. insularis were the most abundant parasites collected in all areas in the study (Tables VI, VII, VIII). A species of Rogas was prevalent in fall regrowth at Chickasha (Table VI). A parasite which appeared to be incidental at Stillwater and Chickasha, but occurred as a major parasite in the statewide collection, was A. marginiventris (Table VIII).

Very few P. unipuncta were collected from the sampling areas or statewide. This species occurred primarily in crop intervals 2, 5, and regrowth during 1979. Relatively few were collected in 1980 and 1981 in the statewide surveys as compared to 1979 (Table IV). The early season parasite for all locations was A. militaris, which was also found to be a major parasite of P. unipuncta in Tennessee wheat fields (Breeland 1958). Several other species, such as C. flavicincta, Archytas marmoratus (Townsend), A. apicifer, and Microplitis varicolor Viereck became common parasites in crop interval 5 and regrowth (Tables VI, VII, VIII).

Over 1600 of a total of 1842 S. exigua larvae collected were obtained during 1980 (Table IV). They were present primarily in crop intervals 4, 5, and regrowth throughout the state (Table VIII), and in crop intervals 3 and 4 at Chickasha (Table VI). Major parasites collected from Chickasha and Stillwater were C. insularis and A. marginiventris (Tables

VI, VII). Throughout the state, P. spinator, C. insularis, and L. archippivora were important in crop intervals 3 and 4, after which C. insularis decreased until regrowth. Tachinidae, such as A. apicifer and A. marmoratus became important in crop interval 5 (Table VIII). Wall and Berberet (1975) found L. archippivora to be the major parasite of S. exigua in Oklahoma peanuts.

Braconidae was generally the most common parasitic family associated with the foliage feeders for each sampling site and statewide (Figure 7). A single exception occurred in crop interval 2 at Chickasha, where Tachinidae comprised >46.5% of all parasites, due to the parasitization of C. eurytheme and P. scabra by C. "claripennis Macquart" and parasitization of A. rantalis by N. psyte (Table VI). The greatest proportion of parasites in the family Ichneumonidae occurred for statewide collections in crop interval 1, when this family comprised ca. 45% of all parasites. This was due primarily to parasitization of H. zea by C. sonorensis (Table VIII).

Hyperparasites did not appear to limit natural enemies of the foliage feeding complex to any great extent. Two genera, Mesochorus (prob. americanus Cresson) and Perilampis spp. were obtained in this study and attacked only hymenopterous parasites (Table X). Mesochorus spp. were most abundant in crop interval 2 (44.5% of total) during 1979-81. It was associated with all foliage feeding larvae, except A. rantalis. However, A. rantalis were most often associated with Perilampis spp., particularly in crop intervals 3 and 4 (Table X). A reference collection of hyperparasites is located in the Entomology Department Museum, 509 Life Sciences West, Oklahoma State University, Stillwater, Oklahoma.

A reference collection of approximately 2475 adult parasites associated with the eight foliage feeding species is located in the Entomology Department Museum. These specimens are available for further studies through permission of the museum curator.

Discussion

Detailed seasonal records from the sampling sites (Chickasha and Stillwater) provide relative estimates of host and parasite incidence throughout the alfalfa growing season. Heliothis zea, C. eurytheme, and P. scabra were the most abundant pests collected throughout the 3 year study. Damaging populations of any one of these three species were uncommon, but when additional species, such as A. rantalis, S. frugiperda, or S. exigua were also present, extensive defoliation sometimes occurred. The economic threshold for these foliage feeding larvae has been expressed as 5-10 larvae/sweep (Stern 1965). Severe defoliation occurred at Stillwater during 1980 in crop interval 4, and some financial loss probably occurred (Figure 3). Although no individual sampling date ever exceeded the economic threshold in this crop interval, with high populations (40 larvae/10 sweeps) over several days, damage to the crop did occur. Perhaps the economic threshold expressed by Stern (1965) would have to be adjusted downward for use in Oklahoma.

Ability to estimate parasitization was at times effected by viral pathogens which killed host larvae, such as S. exigua. During 1980, in particular, many of this species were infected and, depending upon larval size when death occurred, parasites may not have been able to complete development. Bottrell (1969) also observed that disease caused mortality in larval and pupal samples of S. ornithogalli in Oklahoma, and may have resulted in the underestimation of actual parasitism in natural populations. Roberts et al. (1977) found various pathogens, such as fungi and viruses, associated with several species of larvae in Illinois alfalfa fields. Actual rates of parasitism for A. rantalis may have been higher than reported, because this insect does not survive well on artificial diet, and parasitized individuals may not have lived long enough for parasites to complete development.

Parasitization rates tended to be highest for H. zea and the four species of armyworms. All five species feed exposed on the leaves of the plants and move fairly slowly, possibly allowing them more vulnerability to parasite attack. By contrast, rates of parasitism for A. rantalis were consistently low in this study, perhaps because of erratic movements of larvae when disturbed. Additionally, A. rantalis spin webs over the foliage, which may afford some protection from parasite attack.

Microplitis croceipes was the most common parasite associated with H. zea. This species has a relatively short generation time of ca. 14 days (Lewis 1970). Each female lays an average of 300 eggs (Lewis and Snow 1971) and oviposition may occur in a range of host instars, but preference is shown for the third instar (Lewis 1970). Other studies have included information on the searching ability of M. croceipes, in that it finds host larvae by use of antennae to follow a fecal trail (Lewis 1970). When parasitized by M. croceipes, a marked decrease in growth rate of H. zea results, especially in the early instar larvae (Jones and Lewis 1971). If mass releases of M. croceipes were deemed to be a practical control measure, the rearing method described by Lewis and Burton (1970) may be helpful.

Campoletis sonorensis was one of several parasites which was not host-specific in this study. It parasitized several foliage feeders, including H. zea, S. ornithogalli, and S. frugiperda. It evidently has potential as an effective natural enemy, as several studies have been conducted on this parasite, including its' searching ability (Wilson et al. 1974), preferred hosts (Lingren and Noble 1972; C. perdistinctus referred to by Lingren and Noble is the same species as C. sonorensis), and most appropriate hosts for mass rearing (Lingren et al. 1970). These authors found that parasites oviposited in 2-4 day old larvae, and they believe parasitization of this host size is beneficial if inundative releases are made because less crop damage is done. Death of the larvae in my study occurred in the early instars.

Other parasites, such as C. insularis and A. marginiventris also parasitized more than one pest in the foliage feeder complex (Table IX). However, as members of this complex are similar in feeding habits and damage caused, when a parasite eliminates a proportion of several pest species, it could have as much value as a control agent as a host-specific parasite. The need for a parasite to be restricted in its host selection to a single species in order to be an effective natural control regulator is not critical in this situation. Chelonus insularis parasitized low percentages of individual species, such as A. rantalis, S. ornithogalli, S. frugiperda, and S. exigua. However, when these percentages were combined and total effects of the parasite on several members of the complex were determined, the value of this parasite was more evident. Combined rates of parasitism for C. insularis on the four hosts previously mentioned were 19.7% for Stillwater in crop interval 4 (Table VII) and 8.4% statewide in crop interval 3 (Table VIII). Parasitization of S. ornithogalli, S. frugiperda, and S. exigua by C. insularis totalled 38.0% for Chickasha in crop interval 4 (Table VI).

Apanteles marginiventris also parasitized several hosts in this study. Combined rates of parasitism for H. zea, P. scabra, S. ornithogalli, and S. exigua were 19.0% for Chickasha in crop interval 4 (Table VI), 12.9% by this parasite for H. zea, P. scabra, and S. ornithogalli at Stillwater in crop interval 2 (Table VII), and 7.5% for H. zea, P. scabra, S. ornithogalli, and S. frugiperda statewide in crop interval 4 (Table VIII). In addition, these parasites were reared from other species (Table IX).

The parasites discussed above have some attributes which are described by Debach (1974) for effective natural enemies. Among them are host specificity and searching capabilities, which have been described for several species. Ehler and Miller (1978) have referred to effective natural enemies such as these species as r-strategists because of the attributes mentioned above and high reproductive potential. In order to be effective in alfalfa, however, the r-strategists must be able to survive habitat disruption and recolonize fields following crop harvest to aid in reducing or controlling the lepidopterous pests, which seemingly have the ability to survive crop harvest (Figures 2, 3). These larvae possess r-selected traits, including the ability to feed on various cultivated and wild plants (Ehler and Miller 1978), as well as higher reproductive rates and short generation time (Conway 1976).

No literature was found with regard to the biology and natural history of A. flaviconchae, R. nolophanae, and C. vulgaris, the most common and host-specific parasites associated with C. eurytheme, P. scabra, and A. rantalis, respectively. Because of the potential of these lepidopterous pests to inflict damage on the alfalfa plant, more information is needed on the factors associated with the life systems of these parasites.

Summary

The most abundant lepidopterous species collected in Oklahoma were *H. zea*, *C. eurytheme*, and *P. scabra*. Damaging populations of one species by itself were uncommon, but when present in combination or with other species, crop defoliation occurred. A total of 28 parasitic species attacked *H. zea*. Of these, *M. croceipes* was the most important parasite (64% of all parasites). *Colias eurytheme* were parasitized by 14 species, the most important of which were *A. flaviconchae* (47.8%) and *C.* "claripennis Macquart" (9.4%). A total of 16 species parasitized *P. scabra* in Oklahoma. *Rogas nolophanae* represented 31.3% of all parasites, followed by *C.* "claripennis Macquart" (8.6%). *Microplitis croceipes*, *A. flaviconchae*, and *R. nolophanae* were host-specific in this study. Parasitization of *H. zea* by *M. croceipes* definitely had an impact on limiting host populations, as rates of parasitism were as high as 36.5% for this parasitic species alone (Table VIII). *Apanteles flaviconchae* and *R. nolophanae* may have potential for limiting populations of *C. eurytheme* and *P. scabra*, respectively. More information is needed on factors associated with their life systems.

Natural enemies are effective regulators of pests as indicated by the low incidence of damaging outbreaks. Those parasites which attack and develop on more than one member of the foliage feeder complex aid in reducing these populations in alfalfa ecosystems.

The seasonal incidence and relative abundance of the eight most common foliage feeding pests, as well as the incidence and relative importance of native parasites were determined in the study conducted from 1979-81. A total of ca. 50 parasitic species was associated with these foliage feeding larvae, and a reference collection of 2475 adult parasites is available for further studies in the Entomology Department Museum.

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APPENDIXES

APPENDIX A

TABLES

TABLE I

PARASITES OF *EUXOA AUXILIARIS*[3] IN OKLAHOMA ALFALFA, 1979-81

PARASITE	% PARASITIZATION	% OF TOTAL PARASITES
BRACONIDAE		
Apanteles griffini Viereck	1.1	10.1
Apanteles marginiventris (Cresson)	0.1	1.0
Apanteles militaris Walsh	0.03	0.3
Apanteles spp.	0.3	2.3
Chelonus insularis Cresson	0.1	1.3
Meteorus leviventris (Wesmael)	2.8	24.7
Microplitis feltiae Muesebeck	0.2	1.5
Microplitis melianae Viereck	0.1	1.3
Microplitis spp.	0.1	0.5
Rogas spp.	0.2	1.8
Zele melea (Cresson)	0.2	1.8
Unidentified species	0.9	8.0
ICHNEUMONIDAE		
Campoletis flavicincta (Ashmead)	0.2	1.5
Campoletis sonorensis (Cameron)	0.1	0.5
Campoletis spp.	0.1	1.0
Unidentified species	0.8	7.0
Unidentified ENCYRTIDAE	0.8	7.0
Unidentified HYMENOPTERA	2.5	21.9
TACHINIDAE		
Chetogena "claripennis Macquart"	0.4	3.4
Chetogena spp.	0.3	2.6
Gonia spp.	0.1	0.8
Unidentified species	0.1	1.0
Unidentified BOMBYLIIDAE	0.1	0.8
Total parasites - 388		

[3] Total hosts collected - 3413

TABLE II

PARASITES OF *PERIDROMA SAUCIA*[4] IN OKLAHOMA ALFALFA, 1979-81

PARASITE	% PARASITIZATION	% OF TOTAL PARASITES
BRACONIDAE		
Apanteles hyphantriae Riley	0.04	0.2
Apanteles marginiventris (Cresson)	0.1	0.6
Apanteles spp.	0.1	0.4
Microplitis feltiae Muesebeck	0.1	0.6
Microplitis spp.	0.04	0.2
Zele melea (Cresson)	0.1	0.4
Unidentified species	0.2	1.5
ICHNEUMONIDAE		
Campoletis sonorensis (Cameron)	0.1	0.4
Campoletis spp.	0.1	0.6
Ophion spp.	1.4	7.5
Unidentified species	0.5	2.8
EULOPHIDAE		
Euplectrus spp.	1.4	7.3
Unidentified HYMENOPTERA	2.0	10.5
TACHINIDAE		
Archytas apicifer (Walker)	1.9	9.8
Archytas marmoratus (Townsend)	0.1	0.4
Chetogena "claripennis Macquart"	0.6	3.0
Chetogena tachinomoides (Townsend)	0.1	0.4
Chetogena spp.	0.04	0.2
Copecrypta ruficauda (Wulp)	0.1	0.4
Gonia spp.	0.04	0.2
Lespesia archippivora (Riley)	0.04	0.2
Lespesia spp.	0.04	0.2
Peleteria texensis Curran	4.1	21.4
Peleteria spp.	0.9	4.9
Winthemia rufopicta (Bigot)	0.04	0.2
Unidentified species	4.9	25.4
Total parasites - 468		

[4] Total hosts collected - 2440

TABLE III

DEGREE DAY ACCUMULATIONS[5] BY CROP INTERVAL FOR NORTHERN AND SOUTHERN OKLAHOMA, 1979-81

NORTH					SOUTH				
			DD Accum					DD Accum	
Year	Crop Interval	Harvest Date	Interval	Seasonal	Year	Crop Interval	Harvest Date	Interval	Seasonal
1979	1	5-09	587	587[6]	1979	1	5-01	579	579[6]
	2	6-20	679	1266		2	6-14	680	1259
	3	7-22	668	1934		3	7-15	676	1935
	4	8-23	674	2608		4	8-16	674	2609
	5	9-30	672	3280		5	9-20	678	3287
1980	1	5-08	540	540[6]	1980	1	5-01	534	534[6]
	2	6-16	668	1208		2	6-10	669	1203
	3	7-18	671	1879		3	7-13	682	1885
	4	8-19	674	2553		4	8-14	681	2566
	5	9-21	681	3234		5	9-14	677	3243
1981	1	5-02	656	656[6]	1981	1	5-01	640	640[6]
	2	6-14	668	1324		2	6-12	672	1312
	3	7-16	678	2002		3	7-14	686	1998
	4	8-17	669	2671		4	8-14	667	2665
	5	9-24	682	3353		5	9-17	669	3334

[5] Calculated from threshold temperature of 5°C

[6] Degree Day Accumulations (DD Accum) from March 1

TABLE IV

PARASITISM OF FOLIAGE FEEDING SPECIES COLLECTED IN ALFALFA IN OKLAHOMA FOR EACH YEAR, 1979-81

LARVA	NUMBER COLL.	% PARA-SITISM	NUMBER COLL.	% PARA-SITISM	NUMBER COLL.	% PARA-SITISM
			Chickasha			
	1979		1980		1981	
H. zea	93	45.2	500	21.2	208	37.0
C. eurytheme	110	11.8	200	13.0	148	11.5
P. scabra	100	11.0	47	17.0	180	1.1
A. rantalis	86	12.8	8	12.5	64	26.6
S. ornithogalli	37	75.7	18	22.2	18	44.4
S. frugiperda	4	25.0	179	34.6	25	24.0
P. unipuncta	10	40.0	21	38.1	3	33.3
S. exigua	0	-	519	31.2	17	23.5
			Stillwater			
H. zea	789	21.9	580	32.9	1227	27.1
C. eurytheme	68	5.9	64	6.3	279	34.4
P. scabra	152	8.6	140	4.3	317	6.3
A. rantalis	279	17.9	22	0.0	520	19.4
S. ornithogalli	154	40.3	56	19.6	422	46.9
S. frugiperda	29	34.5	351	6.6	111	38.7
P. unipuncta	50	16.0	43	51.2	25	40.0
S. exigua	7	42.9	14	28.6	12	16.7
			Statewide Survey			
H. zea	1448	39.6	4168	28.6	4801	41.5
C. eurytheme	450	26.9	1766	13.8	1050	26.8
P. scabra	685	9.2	497	6.8	948	4.3
A. rantalis	999	12.4	157	8.3	2674	11.9
S. ornithogalli	187	44.4	206	19.4	965	37.0
S. frugiperda	193	44.0	784	35.5	397	31.0
P. unipuncta	584	25.9	33	30.3	61	36.1
S. exigua	23	21.7	1085	25.6	165	21.2

TABLE V

PARASITISM OF FOLIAGE FEEDING SPECIES COLLECTED IN ALFALFA IN OKLAHOMA, 1979-81

LARVA	NUMBER COLLECTED	NUMBER PARASITIZED	% PARASITISM
	Chickasha		
H. zea	801	225	28.1
C. eurytheme	458	56	12.2
P. scabra	327	21	6.4
A. rantalis	158	29	18.4
S. ornithogalli	73	40	54.8
S. frugiperda	208	69	33.2
P. unipuncta	34	13	38.2
S. exigua	536	166	31.0
	Stillwater		
H. zea	2596	696	26.8
C. eurytheme	411	104	25.3
P. scabra	609	39	6.4
A. rantalis	821	151	18.4
S. ornithogalli	632	271	42.9
S. frugiperda	491	76	15.5
P. unipuncta	118	40	33.9
S. exigua	33	9	27.3
	Statewide Survey		
H. zea	10417	3756	36.1
C. eurytheme	3266	646	19.8
P. scabra	2130	138	6.5
A. rantalis	3830	454	11.9
S. ornithogalli	1358	480	35.3
S. frugiperda	1374	486	35.4
P. unipuncta	678	183	27.0
S. exigua	1273	318	25.0

TABLE VI

MOST COMMON PARASITES ASSOCIATED WITH FOLIAGE FEEDING SPECIES IN ALFALFA, CHICKASHA, OKLAHOMA, 1979-81

	HOST SPECIES							
	H. zea		*C. eurytheme*		*P. scabra*		*A. rantalis*	
	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.
CROP INTERVAL 1	N[7] = 35		N = 63		N = 30		N = 0	
	C. sonorensis	2.9	*A. flaviconchae*	20.6	No parasites		No parasites	
CROP INTERVAL 2	N = 43		N = 48		N = 81		N = 37	
	M. croceipes	4.7	*C.* "claripennis Macquart"	6.3	*C.* "claripennis Macquart"	4.9	*N. psyte*	18.9
	Campoletis spp.	2.3	*A. flaviconchae*	4.2	*R. nolophanae*	1.2	*C. tachinomoides*	2.7
			A. medicaginis	4.2			*C. vulgaris*	2.7
CROP INTERVAL 3	N = 288		N = 114		N = 60		N = 113	
	M. croceipes	5.6	*C.* "claripennis Macquart"	2.6	*C.* "claripennis Macquart"	1.7	*N. psyte*	6.2
	C. sonorensis	0.3	*A. medicaginis*	0.9	*C. tachinomoides*	1.7	*P. spinator*	0.9
	C. tachinomoides	0.3	*Chetogena* spp.	2.6	*R. nolophanae*	1.7		
CROP INTERVAL 4	N = 280		N = 55		N = 132		N = 8	
	M. croceipes	28.6	*A. flaviconchae*	1.8	*C. tachinomoides*	0.8	*N. psyte*	12.5
	A. marginiventris	4.3	*C.* "claripennis Macquart"	1.8	*A. marginiventris*	0.8		
	Euplectrus spp.	2.5	*Chetogena* spp.	3.6	*P. facetosa*	0.8		
FALL REGROWTH	N = 155		N = 178		N = 24		N = 0	
	M. croceipes	27.1	*A. medicaginis*	1.1	*R. nolophanae*	4.2	No parasites	
	P. spinator	1.3	*A. flaviconchae*	0.6				
	E. bryani	1.3	*P. spinator*	0.6				

TABLE VI (Continued)

	HOST SPECIES							
	S. ornithogalli		S. frugiperda		P. unipuncta		S. exigua	
	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.
CROP INTERVAL 1	N = 1		N = 0		N = 4		N = 2	
	No parasites		No parasites		A. militaris	50.0	No parasites	
CROP INTERVAL 2	N = 9		N = 4		N = 5		N = 10	
	A. marginiventris	11.1	C. flavicincta	50.0	A. militaris	40.0	C. sonorensis	10.0
	C. insularis	11.1					P. spinator	10.0
	L. archippivora	11.1					Apanteles spp.	10.0
CROP INTERVAL 3	N = 54		N = 97		N = 0		N = 162	
	A. marginiventris	20.4	C. insularis	8.2	No parasites		A. marginiventris	0.6
	P. spinator	3.7	Z. melea	2.1			Chelonus spp.	0.6
	C. insularis	1.9	Apanteles spp.	3.1				
CROP INTERVAL 4	N = 9		N = 57		N = 8		N = 282	
	A. marginiventris	11.1	C. insularis	7.0	C. flavicincta	12.5	C. insularis	19.9
	C. insularis	11.1	Z. melea	1.8	Apanteles spp.	12.5	A. marginiventris	2.8
	Netelia sp.	11.1	P. spinator	1.8			A. marmoratus	1.8
FALL REGROWTH	N = 0		N = 50		N = 17		N = 80	
	No parasites		C. insularis	8.0	A. militaris	35.3	C. insularis	11.3
			Rogas spp.	12.0	A. marginiventris	5.9	A. marginiventris	3.8
							L. archippivora	2.5

7 N = Number of individual hosts examined for parasites

TABLE VII

MOST COMMON PARASITES ASSOCIATED WITH FOLIAGE FEEDING SPECIES IN ALFALFA, STILLWATER, OKLAHOMA, 1979-81.

	HOST SPECIES							
	H. zea		*C. eurytheme*		*P. scabra*		*A. rantalis*	
	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.
CROP INTERVAL 1	N = 68		N = 72		N = 14		N = 0	
	M. croceipes	4.4	*A. flaviconchae*	12.5	No parasites		No parasites	
	C. sonorensis	1.5	*A. medicaginis*	4.2				
	C. flavicincta	1.5	*C. flavicincta*	1.4				
CROP INTERVAL 2	N = 313		N = 137		N = 110		N = 217	
	M. croceipes	3.5	*A. flaviconchae*	44.5	*R. nolophanae*	9.1	*C. vulgaris*	2.8
	A. marginiventris	2.6	*A. medicaginis*	2.9	*A. marginiventris*	2.7	*P. spinator*	0.9
	C. flavicincta	2.2	*C. sonorensis*	0.7				
CROP INTERVAL 3	N = 747		N = 72		N = 191		N = 361	
	M. croceipes	4.8	*A. apicifer*	1.4	*P. cognata*	1.6	*N. psyte*	2.5
	M. melianae	0.5	*Winthemia* spp.	1.4	*C. ruficauda*	1.0	*C. insularis*	1.1
	A. marmoratus	0.5	*Chetogena* spp.	1.4	*R. nolophanae*	1.0	*C. haematoides*	1.1
CROP INTERVAL 4[8]	N = 1169		N = 30		N = 256		N = 243	
	M. croceipes	22.8	*L. archippivora*	3.3	*R. nolophanae*	0.8	*C. insularis*	6.2
	A. marmoratus	3.7			*A. marginiventris*	0.4	*N. psyte*	3.3
	A. marginiventris	0.6			*C.* "claripennis Macquart"	0.4	*H. hyphantriae*	1.2
FALL REGROWTH	N = 299		N = 100		N = 38		N = 0	
	M. croceipes	22.1	*A. flaviconchae*	2.0	No parasites		No parasites	
	E. bryani	3.7	*Apanteles* spp.	1.0				
	C. sonorensis	1.7						

TABLE VII (Continued)

	HOST SPECIES							
	S. ornithogalli		S. frugiperda		P. unipuncta		S. exigua	
	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.
CROP INTERVAL 1	N = 1		N = 0		N = 16		N = 1	
	No parasites		No parasites		A. militaris	12.5	No parasites	
CROP INTERVAL 2	N = 238		N = 0		N = 29		N = 5	
	A. marginiventris	7.6	No parasites		A. militaris	3.4	A. apicifer	20.0
	C. flavicincta	5.9			Chetogena spp.	3.4		
	P. spinator	5.9						
CROP INTERVAL 3	N = 222		N = 186		N = 9		N = 3	
	C. insularis	14.4	Z. melea	2.2	Apanteles spp.	11.1	A. marginiventris	33.3
	A. marginiventris	5.4						
	A. apicifer	2.7						
CROP INTERVAL 4[8]	N = 165		N = 235		N = 30		N = 19	
	C. insularis	4.8	C. insularis	3.4	C. flavicincta	10.0	A. marmoratus	5.3
	A. apicifer	3.6	Z. melea	2.1	A. marmoratus	10.0	C. insularis	5.3
	Z. melea	2.4	A. marginiventris	0.9	A. apicifer	6.7	A. marginiventris	5.3
FALL REGROWTH	N = 6		N = 70		N = 34		N = 5	
	No parasites		C. insularis	12.9	A. militaris	23.5	Chelonus spp.	20.0
			P. spinator	8.6	C. flavicincta	14.7		
			A. marginiventris	5.7	A. marginiventris	2.9		

[8] Includes crop interval 5 for 1979

TABLE VIII

MOST COMMON PARASITES ASSOCIATED WITH FOLIAGE FEEDING SPECIES IN ALFALFA, STATEWIDE SURVEY, 1979-81

	HOST SPECIES							
	H. zea		*C. eurytheme*		*P. scabra*		*A. rantalis*	
	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.
CROP INTERVAL 1	N = 160		N = 110		N = 16		N = 0	
	C. sonorensis	10.0	*A. flaviconchae*	23.6	No parasites		No parasites	
	M. croceipes	1.9	*A. medicaginis*	1.8				
	C. flavicincta	1.3	*C. flavicincta*	0.9				
CROP INTERVAL 2	N = 1472		N = 866		N = 507		N = 697	
	C. sonorensis	3.7	*A. flaviconchae*	21.2	*R. nolophanae*	8.3	*C. vulgaris*	5.5
	M. croceipes	3.3	*A. medicaginis*	2.1	*A. marginiventris*	0.6	*C. insularis*	1.9
	M. melianae	1.5	*C.* "claripennis Macquart"	2.0	*C.* "claripennis Macquart"	0.2	*N. psyte*	0.6
CROP INTERVAL 3	N = 1778		N = 714		N = 442		N = 1428	
	M. croceipes	17.3	*A. flaviconchae*	4.6	*C. tachinomoides*	1.1	*C. vulgaris*	1.8
	M. melianae	2.8	*C.* "claripennis Macquart"	2.8	*C.* "claripennis Macquart"	0.9	*N. psyte*	1.3
	A. marginiventris	1.1	*C. tachinomoides*	1.0	*C. ruficauda*	0.5	*C. insularis*	0.8
CROP INTERVAL 4	N = 3476		N = 916		N = 363		N = 1245	
	M. croceipes	26.9	*C.* "claripennis Macquart"	2.6	*A. marginiventris*	0.6	*N. psyte*	3.1
	P. spinator	0.8	*A. flaviconchae*	2.5	*C.* "claripennis Macquart"	0.6	*C. vulgaris*	1.0
	A. marginiventris	0.7	*A. medicaginis*	1.1	*C. tachinomoides*	0.3	*C. insularis*	0.9
CROP INTERVAL 5	N = 1603		N = 322		N = 612		N = 449	
	M. croceipes	36.5	*A. flaviconchae*	3.7	*C.* "claripennis Macquart"	0.7	*N. psyte*	3.6
	A. marginiventris	1.5	*C.* "claripennis Macquart"	2.2	*R. nolophanae*	0.3	*C. vulgaris*	0.2
	A. marmoratus	1.2			*W. sinuata*	0.3	*C. insularis*	0.2
FALL REGROWTH	N = 865		N = 338		N = 190		N = 11	
	M. croceipes	35.6	*A. flaviconchae*	4.4	*P. facetosa*	0.5	Tachinidae	9.1
	S. eruficinctus	1.5	*A. medicaginis*	0.9				
	E. bryani	1.5	*C. tachinomoides*	0.3				

TABLE VIII (Continued)

	HOST SPECIES							
	S. ornithogalli		S. frugiperda		P. unipuncta		S. exigua	
	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.	PARASITE	% PARASIT.
CROP INTERVAL 1	N = 2		N = 0		N = 18		N = 1	
	No parasites		No parasites		Rogas spp.	5.6	No parasites	
CROP INTERVAL 2	N = 174		N = 22		N = 444		N = 28	
	P. spinator	9.2	C. flavicincta	13.6	A. militaris	12.8	A. marginiventris	7.1
	A. marginiventris	6.9	A. marginiventris	9.1	P. texensis	0.7	P. spinator	3.6
	C. sonorensis	6.9	Z. melea	9.1	A. apicifer	0.5	Rogas sp.	3.6
CROP INTERVAL 3	N = 326		N = 374		N = 2		N = 32	
	A. marginiventris	8.6	Z. melea	8.8	No parasites		P. spinator	6.3
	C. insularis	3.4	A. marginiventris	1.6			C. insularis	3.1
	M. autographae	2.1	C. insularis	1.1			L. archippivora	3.1
CROP INTERVAL 4	N = 593		N = 383		N = 3		N = 946	
	A. marginiventris	4.4	C. insularis	9.4	No parasites		C. insularis	5.9
	C. insularis	3.0	Z. melea	3.1			P. spinator	2.5
	C. sonorensis	0.7	A. marginiventris	1.8			L. archippivora	0.9
CROP INTERVAL 5	N = 254		N = 424		N = 117		N = 107	
	A. marginiventris	5.9	C. insularis	5.7	C. flavicincta	8.5	A. apicifer	4.7
	A. apicifer	3.5	A. marginiventris	3.5	A. militaris	7.7	A. marmoratus	0.9
	C. insularis	2.0	Z. melea	2.8	A. apicifer	4.3	L. archippivora	0.9
FALL REGROWTH	N = 9		N = 171		N = 94		N = 159	
	A. marginiventris	22.2	C. insularis	23.4	M. varicolor	5.3	C. insularis	12.6
	Chelonus spp.	33.3	P. spinator	4.7	A. militaris	4.3	A. apicifer	0.6
			A. marginiventris	1.8	Z. melea	3.2	A. marmoratus	0.6

TABLE IX

RELATIVE IMPORTANCE OF PARASITES ASSOCIATED WITH FOLIAGE FEEDING SPECIES IN OKLAHOMA ALFALFA, 1979-81

HOST	PARASITE	% OF TOTAL PARASITES
H. zea	BRACONIDAE	
	Apanteles marginiventris (Cresson)	2.6
	Apanteles militaris (Walsh)	0.04
	Apanteles paranthrenidis Muesebeck	0.04
	Apanteles spp.	1.6
	Chelonus insularis Cresson	0.3
	Chelonus spp.	0.2
	Macrocentrus sp.	0.02
	Meteorus autographae Muesebeck	0.04
	Meteorus campestris Viereck	0.02
	Microplitis croceipes (Cresson)	64.0
	Microplitis melianae Viereck	2.3
	Microplitis spp.	1.0
	Rogas perplexus Gahan	0.4
	Zele melea (Cresson)	0.1
	Unidentified species	3.4
	ICHNEUMONIDAE	
	Campoletis flavicincta (Ashmead)	0.7
	Campoletis sonorensis (Cameron)	2.1
	Campoletis spp.	1.9
	Pristomerus spinator (Fabricius)	1.8
	Sinophorus eruficinctus (Walkley)	0.5
	Unidentified species	1.9
	EULOPHIDAE	3.7
	Unidentified HYMENOPTERA	5.1
	TACHINIDAE	
	Archytas apicifer (Walker)	0.02
	Archytas marmoratus (Townsend)	2.1
	Chetogena "claripennis Macquart"	0.3
	Chetogena tachinomoides (Townsend)	0.1
	Chetogena spp.	0.1
	Eucelatoria bryani Sabrosky	1.0
	Lespesia aletiae (Riley)	0.1
	Lespesia archippivora (Riley)	0.2
	Lespesia spp.	0.04
	Nemorilla psyte (Walker)	0.1

TABLE IX (Continued)

HOST	PARASITE	% OF TOTAL PARASITES
	Peleteria texensis Curran	0.02
	Plagiomima cognata Aldrich	0.1
	Plagiomima spinosula (Bigot)	0.1
	Voria ruralis (Fallen)	0.02
	Winthemia rufopicta (Bigot)	0.04
	Unidentified species	1.9
	Total parasites - 4677	
C. eurytheme	BRACONIDAE	
	Apanteles flaviconchae Riley	47.8
	Apanteles marginiventris (Cresson)	0.1
	Apanteles medicaginis Muesebeck	6.5
	Apanteles spp.	3.8
	Unidentified species	5.6
	ICHNEUMONIDAE	
	Campoletis flavicincta (Ashmead)	1.1
	Campoletis sonorensis (Cameron)	0.1
	Campoletis spp.	0.3
	Pristomerus spinator (Fabricius)	0.4
	Unidentified species	0.1
	PTEROMALIDAE	
	Pteromalus eurymi Gahan	0.3
	Unidentified HYMENOPTERA	2.9
	TACHINIDAE	
	Archytas apicifer (Walker)	0.1
	Chetogena "claripennis Macquart"	9.4
	Chetogena tachinomoides (Townsend)	2.6
	Chetogena spp.	7.8
	Hyphantrophaga hyphantriae (Townsend)	0.1
	Lespesia aletiae (Riley)	0.1
	Lespesia archippivora (Riley)	0.8
	Lespesia spp.	0.1
	Winthemia spp.	0.1
	Unidentified species	10.0
	Total parasites - 806	
P. scabra	BRACONIDAE	
	Apanteles marginiventris (Cresson)	5.6
	Apanteles spp.	2.5
	Protomicroplitis facetosa (Weed)	2.0
	Rogas nolophanae Ashmead	31.3

TABLE IX (Continued)

HOST	PARASITE	% OF TOTAL PARASITES
	Rogas spp.	5.0
	Unidentified species	2.0
	ICHNEUMONIDAE	
	Charops annulipes Ashmead	0.5
	Microcharops sp.	0.5
	Pristomerus spinator (Fabricius)	0.5
	Unidentified species	0.5
	Unidentified HYMENOPTERA	16.7
	TACHINIDAE	
	Archytas apicifer (Walker)	0.5
	Archytas marmoratus (Townsend)	0.5
	Chetogena "claripennis Macquart"	8.6
	Chetogena tachinomoides (Townsend)	4.5
	Chetogena spp.	3.0
	Copecrypta ruficauda (Wulp)	2.5
	Hyphantrophaga hyphantriae (Townsend)	0.5
	Lespesia aletiae (Riley)	0.5
	Lespesia archippivora (Riley)	0.5
	Peleteria spp.	0.5
	Plagiomima cognata Aldrich	2.0
	Winthemia sinuata Reinhard	1.0
	Winthemia spp.	0.5
	Unidentified species	12.1
	Total parasites - 198	
A. rantalis	BRACONIDAE	
	Apanteles marginiventris (Cresson)	0.5
	Chelonus insularis Cresson	8.8
	Chelonus spp.	2.2
	Cremnops haematoides (Bruelle)	1.9
	Cremnops vulgaris (Cresson)	13.9
	Cremnops spp.	2.2
	Meteorus autographae Muesebeck	0.2
	Meteorus campestris Viereck	0.3
	Zele melea (Cresson)	0.2
	Unidentified species	9.9
	ICHNEUMONIDAE	
	Campoletis flavicincta (Ashmead)	0.5
	Campoletis sonorensis (Cameron)	0.2
	Pristomerus spinator (Fabricius)	2.5
	Unidentified species	0.5
	Unidentified HYMENOPTERA	27.0

TABLE IX (Continued)

HOST	PARASITE	% OF TOTAL PARASITES
	TACHINIDAE	
	Chetogena "claripennis Macquart"	0.6
	Chetogena tachinomoides (Townsend)	0.2
	Chetogena spp.	0.6
	Hyphantrophaga hyphantriae (Townsend)	1.4
	Lespesia archippivora (Riley)	1.3
	Lespesia spp.	0.6
	Nemorilla psyte (Walker)	17.4
	Phryxe pecosensis (Townsend)	0.3
	Unidentified species	6.9
	Total parasites - 634	
S. ornithogalli	BRACONIDAE	
	Apanteles marginiventris (Cresson)	16.3
	Apanteles spp.	9.8
	Chelonus insularis Cresson	10.1
	Chelonus spp.	1.1
	Meteorus autographae Muesebeck	1.5
	Rogas sp.	0.1
	Zele melea (Cresson)	4.1
	Unidentified species	3.2
	ICHNEUMONIDAE	
	Campoletis flavicincta (Ashmead)	3.7
	Campoletis sonorensis (Cameron)	2.8
	Campoletis spp.	3.9
	Netelia sp.	0.3
	Ophion sp.	1.9
	Pristomerus spinator (Fabricius)	5.1
	Unidentified species	6.6
	EULOPHIDAE	4.9
	Unidentified HYMENOPTERA	13.9
	TACHINIDAE	
	Archytas apicifer (Walker)	4.1
	Archytas marmoratus (Townsend)	0.4
	Chetogena "claripennis Macquart"	1.6
	Chetogena tachinomoides (Townsend)	0.3
	Chetogena spp.	0.1
	Lespesia archippivora (Riley)	1.1
	Lespesia spp.	0.3
	Nemorilla psyte (Walker)	0.1
	Winthemia rufopicta (Bigot)	0.5
	Unidentified species	2.2

TABLE IX (Continued)

HOST	PARASITE	% OF TOTAL PARASITES
	Total parasites - 791	
S. frugiperda	BRACONIDAE	
	Apanteles marginiventris (Cresson)	6.5
	Apanteles spp.	4.4
	Chelonus insularis Cresson	21.7
	Chelonus spp.	13.2
	Meteorus autographae Muesebeck	1.0
	Rogas spp.	1.1
	Zele melea (Cresson)	11.6
	Unidentified species	11.3
	ICHNEUMONIDAE	
	Campoletis flavicincta (Ashmead)	1.1
	Campoletis sonorensis (Cameron)	0.8
	Campoletis spp.	0.2
	Netelia sp.	0.2
	Pristomerus spinator (Fabricius)	4.3
	Unidentified species	1.3
	EULOPHIDAE	1.7
	Unidentified HYMENOPTERA	16.5
	TACHINIDAE	
	Archytas marmoratus (Townsend)	1.1
	Chetogena "claripennis Macquart"	0.3
	Chetogena spp.	0.2
	Lespesia archippivora (Riley)	0.5
	Nemorilla psyte (Walker)	0.3
	Winthemia rufopicta (Bigot)	0.2
	Unidentified species	0.8
	Total parasites - 631	
P. unipuncta	BRACONIDAE	
	Apanteles marginiventris (Cresson)	1.3
	Apanteles militaris (Walsh)	39.0
	Apanteles spp.	2.5
	Chelonus insularis Cresson	0.4
	Microplitis varicolor Viereck	2.1
	Rogas spp.	6.4
	Zele melea (Cresson)	1.3
	Unidentified species	3.0
	ICHNEUMONIDAE	
	Campoletis flavicincta (Ashmead)	8.9

TABLE IX (Continued)

HOST	PARASITE	% OF TOTAL PARASITES
	Enicospilus spp.	2.1
	Unidentified species	4.7
	EULOPHIDAE	2.5
	Unidentified HYMENOPTERA	10.6
	TACHINIDAE	
	Archytas apicifer (Walker)	4.2
	Archytas marmoratus (Townsend)	2.5
	Chetogena "claripennis Macquart"	0.8
	Chetogena spp.	0.4
	Peleteria texensis Curran	1.3
	Peleteria sp.	0.4
	Unidentified species	5.5
	Total parasites - 236	
S. exigua	BRACONIDAE	
	Apanteles marginiventris (Cresson)	4.3
	Apanteles spp.	3.2
	Chelonus insularis Cresson	29.0
	Chelonus spp.	17.4
	Rogas sp.	0.2
	Zele melea (Cresson)	0.2
	Unidentified species	5.9
	ICHNEUMONIDAE	
	Campoletis sonorensis (Cameron)	0.8
	Netelia sp.	0.2
	Pristomerus spinator (Fabricius)	6.9
	Unidentified species	0.4
	EULOPHIDAE	6.7
	Unidentified HYMENOPTERA	15.8
	TACHINIDAE	
	Archytas apicifer (Walker)	1.6
	Archytas marmoratus (Townsend)	2.4
	Chetogena "claripennis Macquart"	0.2
	Chetogena spp.	0.4
	Lespesia archippivora (Riley)	2.8
	Lespesia sp.	0.2
	Unidentified species	1.2
	Total parasites - 493	

TABLE X

HYPERPARASITES ASSOCIATED WITH PRIMARY PARASITES IN OKLAHOMA ALFALFA, 1979-81

Hyperparasite	Lepidopterous Host	Primary Parasite	Crop Interval(s)	Instances of Hypers.
Mesochorus spp. (prob. *americanus* Cresson)	*H. zea*	*Apanteles* spp.	3,5	5
		M. croceipes	4,5,R	19
		M. melianae	5	1
		Unident. Braconidae	2,3,4,5,R	5
		Unident. Ichneumonidae	2,R	5
		Unident. Hymenoptera	2,3,R	8
Mesochorus spp. (prob. *americanus* Cresson)	*C. eurytheme*	*A. flaviconchae*	2,3,5	21
		Apanteles spp.	1,2,5,R	19
		Unident. Braconidae	R	1
Mesochorus spp. (prob. *americanus* Cresson)	*P. scabra*	*R. nolophanae*	2	2
		Unident. Braconidae	2,5	2
	S. ornithogalli	*Apanteles* spp.	2,3	12
		Chelonus sp.	5	1
		Unident. Ichneumonidae	2	5
		Unident. Hymenoptera	2	6
Mesochorus spp. (prob. *americanus* Cresson)	*S. frugiperda*	*Apanteles* spp.	4,5,R	6
		Unident. Ichneumonidae	2	1
		Unident. Hymenoptera	2,R	2
Mesochorus spp. (prob. *americanus* Cresson)	*P. unipuncta*	*Apanteles* sp.	2	1
		Rogas sp.	5	1
		Unident. Ichneumonidae	R	2
		Unident. Hymenoptera	R	1

TABLE X (Continued)

Hyperparasite	Lepidopterous Host	Primary Parasite	Crop Interval(s)	Instances of Hypers.
Mesochorus spp. (prob. *americanus* Cresson)	*S. exigua*	*Apanteles* sp.	5	1
		Unident. Hymenoptera	2	1
Perilampis spp.	*H. zea*	*Apanteles* sp.	3,5	2
		M. croceipes	4	1
		Unident. Braconidae	3,4,5	5
		Unident. Hymenoptera	2	1
Perilampis spp.	*A. rantalis*	Unident. Braconidae	2,3,4	8
		Unident. Ichneumonidae	3	1
		Unident. Hymenoptera	3,4,5	32
Perilampis spp.	*S. ornithogalli*	*Apanteles* spp.	3,4,5	8
		Chelonus sp.	4	1
		Unident. Braconidae	4	1
		Unident. Hymenoptera	3,4	2
Perilampis spp.	*S. frugiperda*	*Apanteles* spp.	5,R	2
Perilampis spp.	*S. exigua*	Unident. Braconidae	4	3

APPENDIX B

FIGURES

Figure 1. Areas of Oklahoma in Which Alfalfa Pests were Collected in 1979 - 81. (Arrows indicate the boundary between northern and southern regions.)

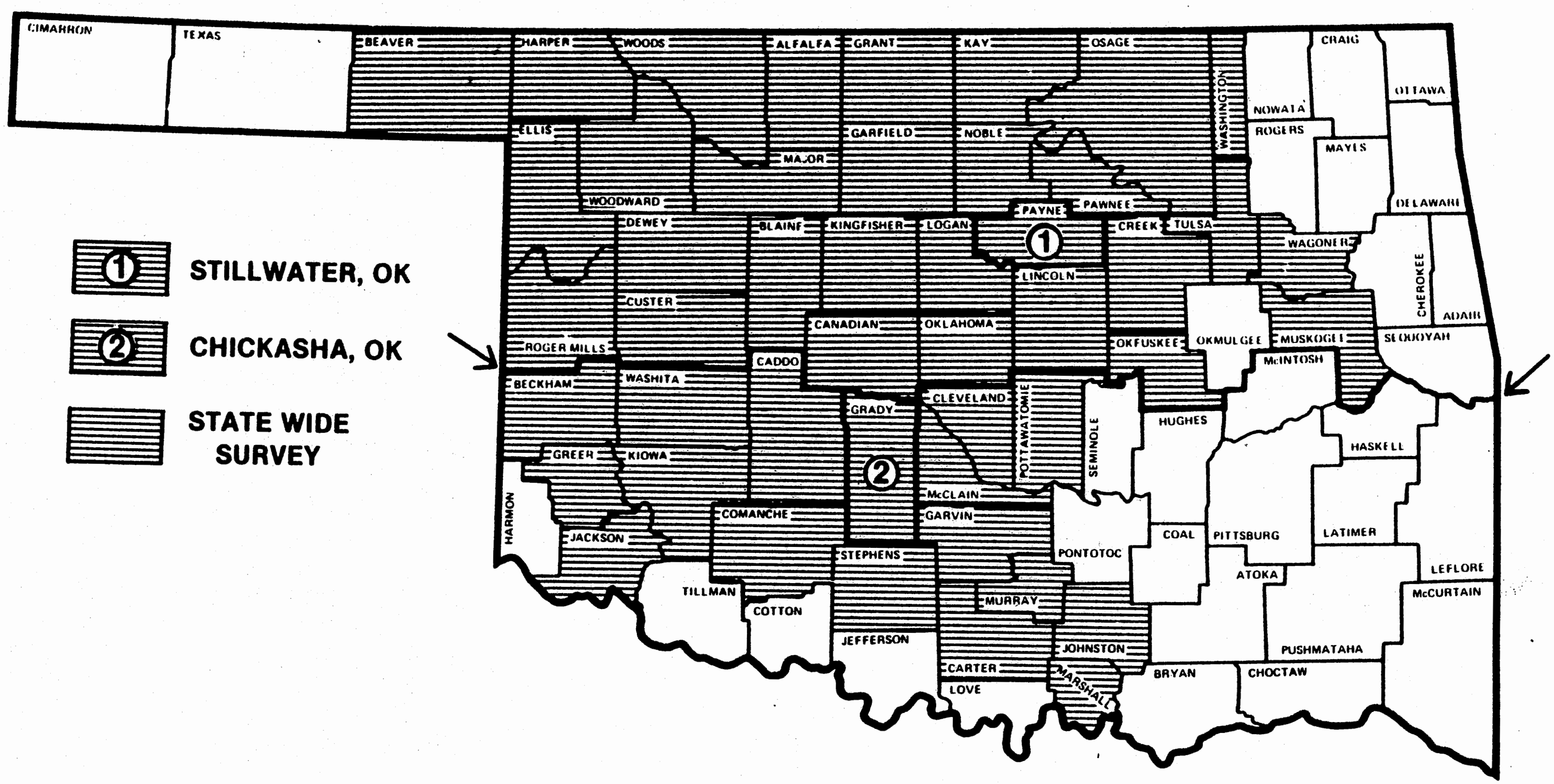

CIMARRON
TEXAS
BEAVER
HARPER
WOODS
ALFALFA
GRANT
KAY
OSAGE
WASHINGTON
CRAIG
NOWATA
OTTAWA
ROGERS
MAYES
ELLIS
GARFIELD
NOBLE
MAJOR
WOODWARD
PAYNE
PAWNEE
DELAWARE
DEWEY
BLAINE
KINGFISHER
LOGAN
CREEK
TULSA
WAGONER
1
LINCOLN
CHEROKEE
ADAIR
CUSTER
CANADIAN
OKLAHOMA
OKFUSKEE
OKMULGEE
MUSKOGEE
SEQUOYAH
ROGER MILLS
CADDO
McINTOSH
BECKHAM
WASHITA
GRADY
CLEVELAND
POTTAWATOMIE
SEMINOLE
HUGHES
HASKELL
GREER
KIOWA
2
HARMON
McCLAIN
COMANCHE
GARVIN
JACKSON
COAL
PITTSBURG
LATIMER
STEPHENS
PONTOTOC
ATOKA
LEFLORE
TILLMAN
COTTON
MURRAY
McCURTAIN
JEFFERSON
JOHNSTON
PUSHMATAHA
CARTER
BRYAN
CHOCTAW
LOVE
MARSHALL
1 STILLWATER, OK
2 CHICKASHA, OK
STATE WIDE SURVEY

Figure 2. Populations of Foliage Feeding Species in Crop Intervals 1 - 4 and Fall Regrowth (R), Chickasha, Oklahoma, 1979 - 81.

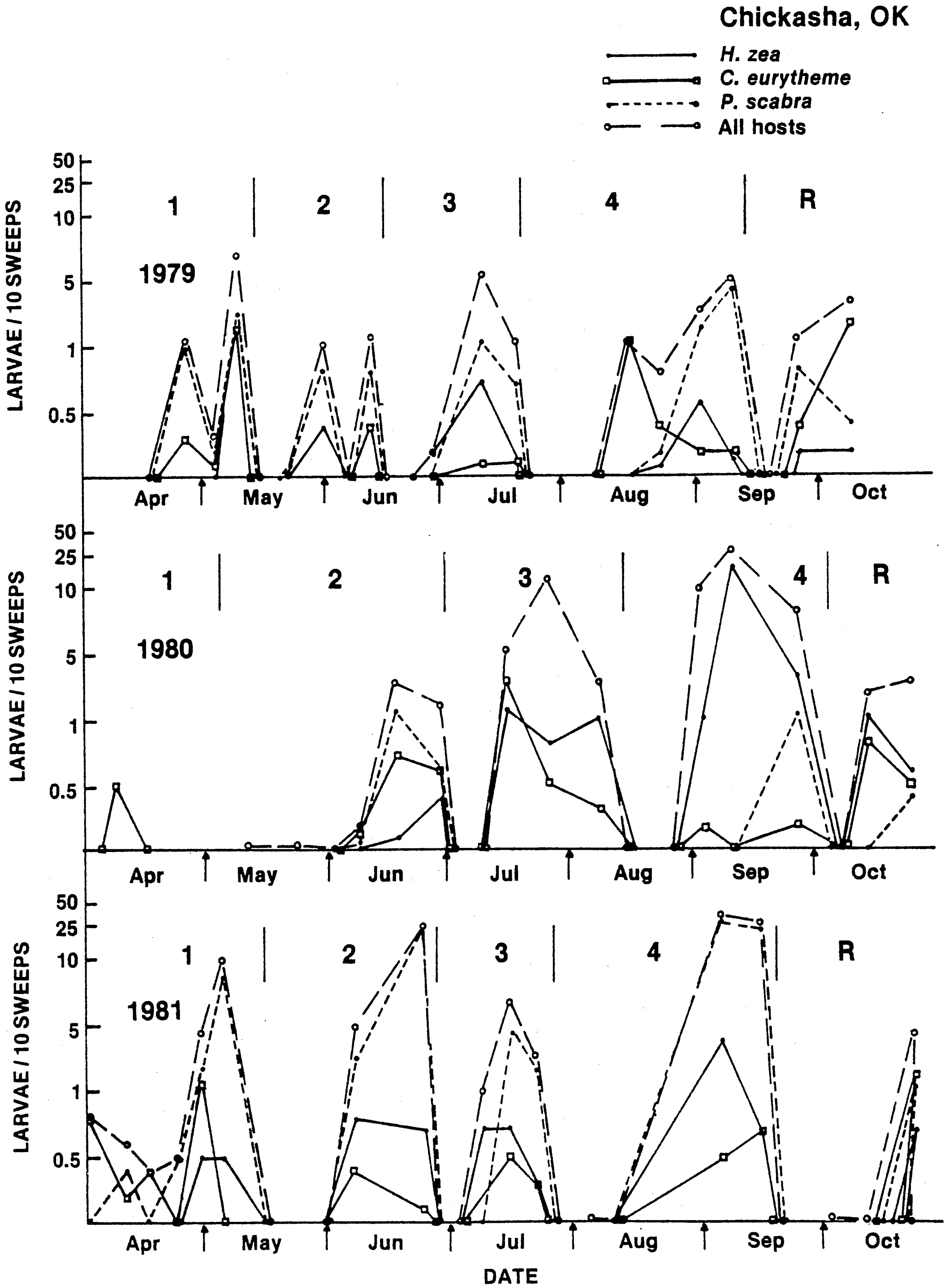

Chickasha, OK
H. zea
C. eurytheme
P. scabra
All hosts
1979
1980
1981
1
2
3
4
R
LARVAE / 10 SWEEPS
50
25
10
5
1
0.5
Apr
May
Jun
Jul
Aug
Sep
Oct
DATE

Figure 3. Populations of Foliage Feeding Species in Crop Intervals 1 - 4 and Fall Regrowth (R), Stillwater, Oklahoma, 1979 - 81. (There were 5 Crop Intervals in 1979.)

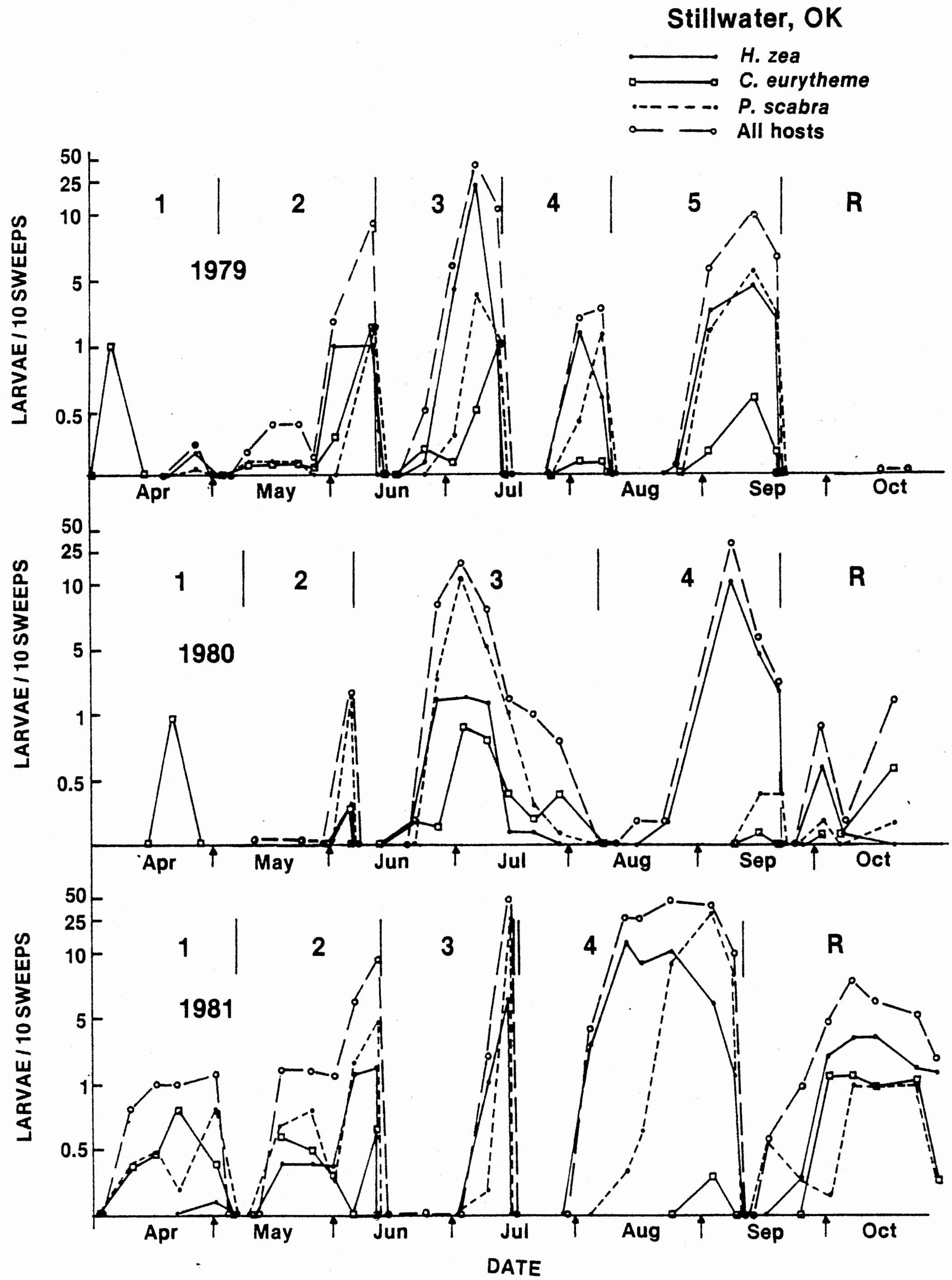

Stillwater, OK
H. zea
C. eurytheme
P. scabra
All hosts
LARVAE / 10 SWEEPS
50
25
10
5
1
0.5
1979
1
2
3
4
5
R
Apr
May
Jun
Jul
Aug
Sep
Oct
1980
1
2
3
4
R
1981
1
2
3
4
R
DATE

Figure 4. Parasitization of Foliage Feeding Species, Chickasha, Oklahoma, 1979 - 81.

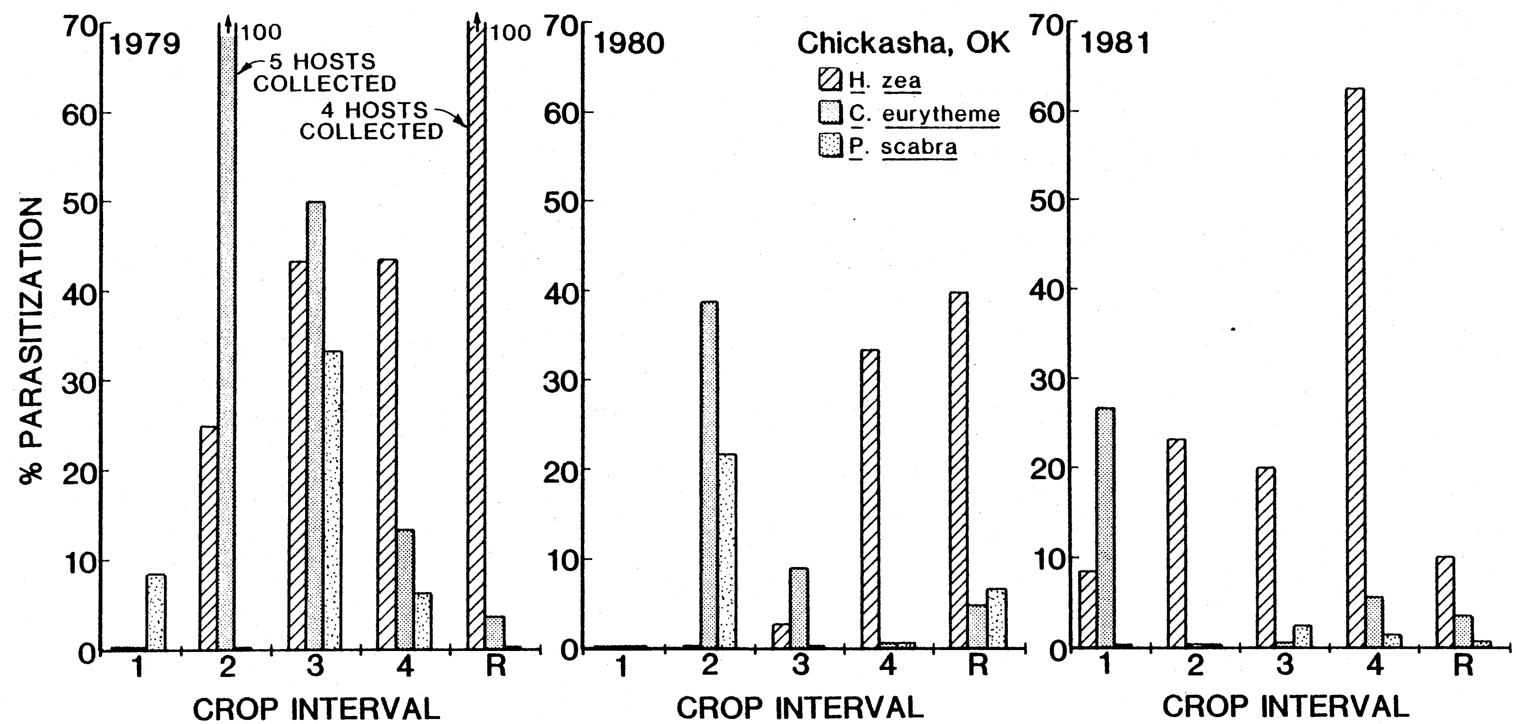
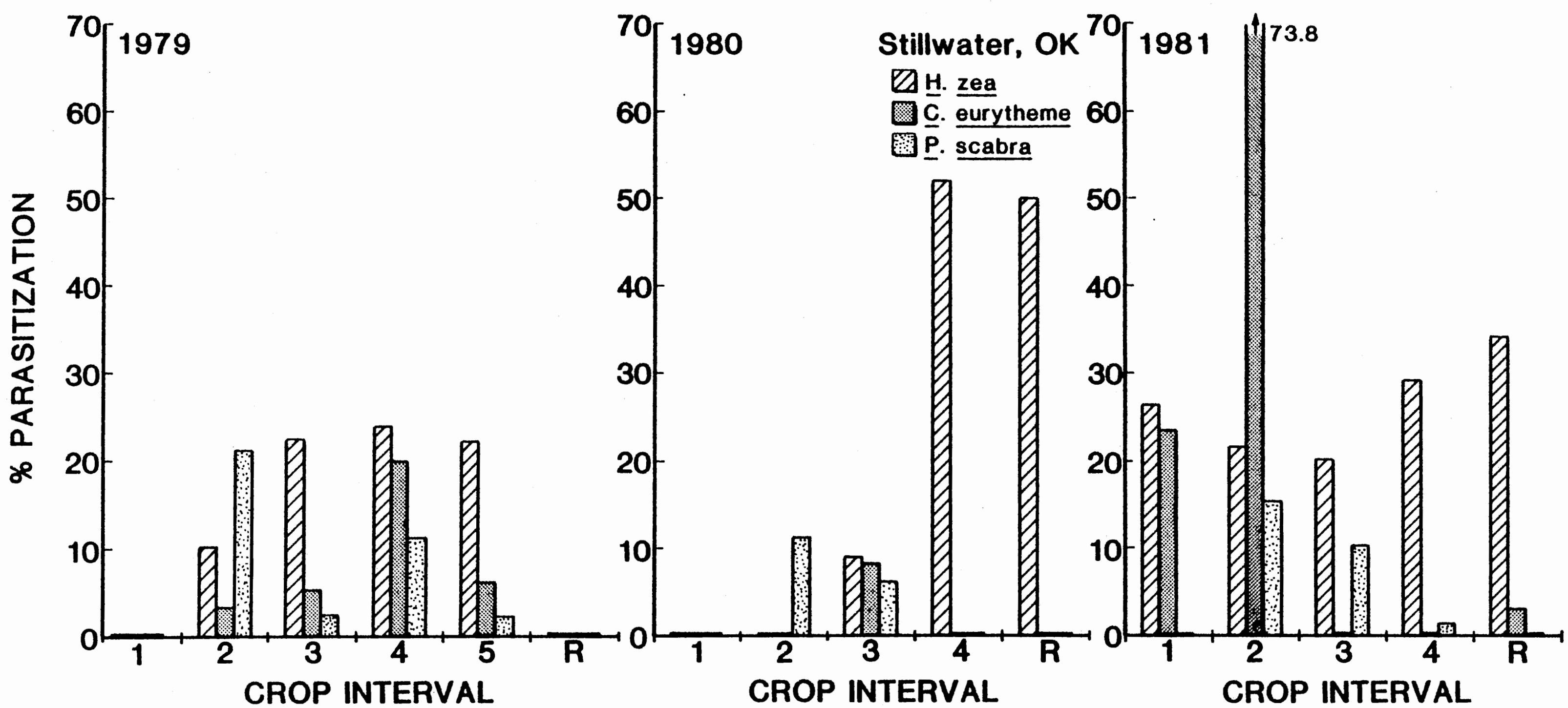
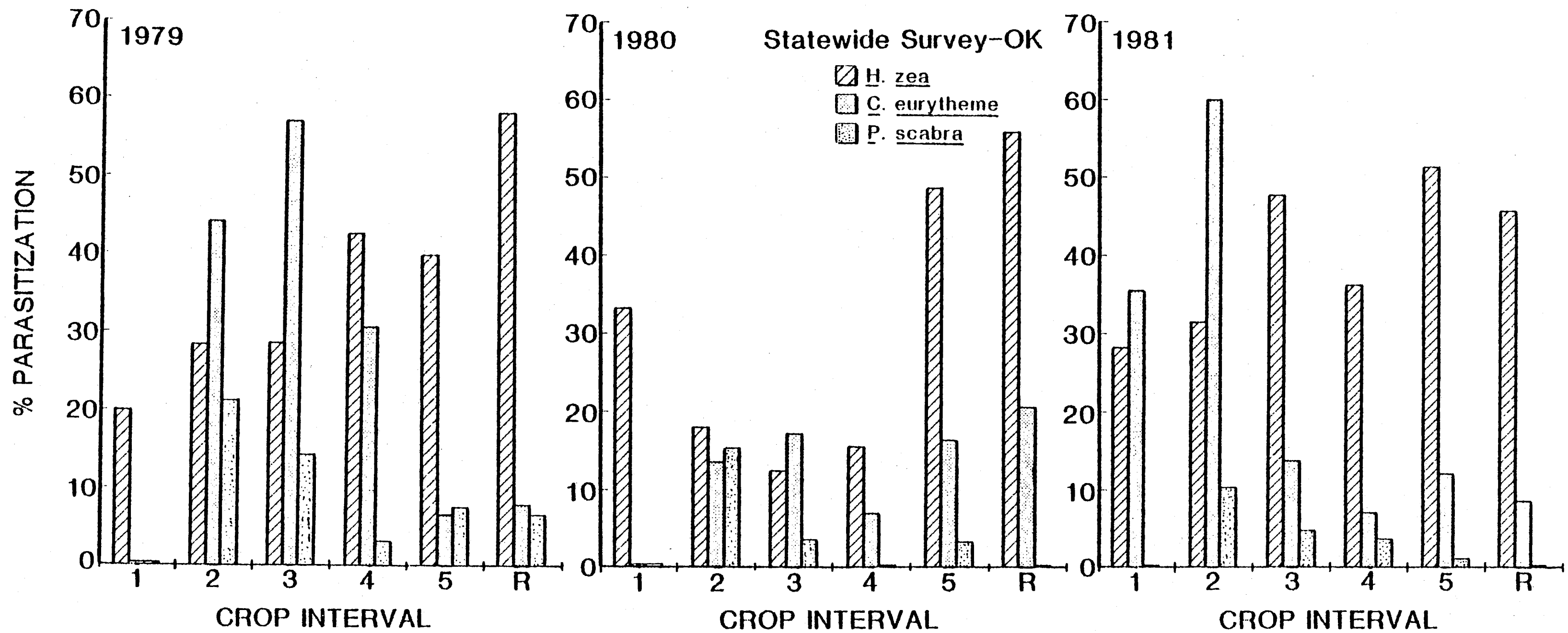

1979
1980
1981
Chickasha, OK
H. zea
C. eurytheme
P. scabra
% PARASITIZATION
CROP INTERVAL
5 HOSTS COLLECTED
4 HOSTS COLLECTED
100
0
10
20
30
40
50
60
70
1
2
3
4
R

Figure 5. Parasitization of Foliage Feeding Species, Stillwater, Oklahoma, 1979 - 81.



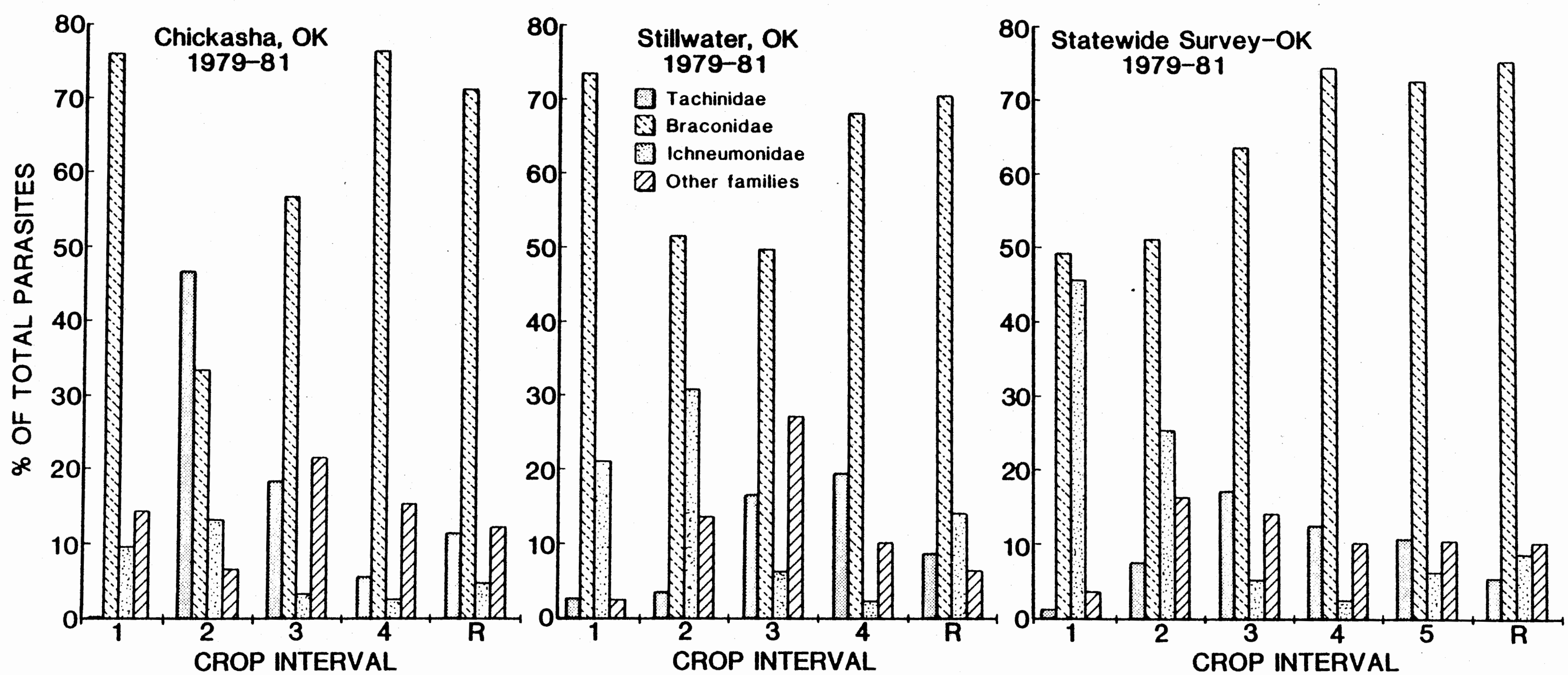
% PARASITIZATION
1979
1980
1981
Stillwater, OK
H. zea
C. eurytheme
P. scabra
73.8
CROP INTERVAL
CROP INTERVAL
CROP INTERVAL

Figure 6. Parasitization of Foliage Feeding Species, Statewide Survey, Oklahoma, 1979 - 81.



% PARASITIZATION
1979
1980
1981
Statewide Survey-OK
H. zea
C. eurytheme
P. scabra
0
10
20
30
40
50
60
70
1
2
3
4
5
R
CROP INTERVAL

Figure 7. Proportion of Parasitization of Foliage Feeding Larvae in Alfalfa by Principal Parasitic Families, Sampling Areas and Statewide, 1979 - 81.



Chickasha, OK
1979-81
Stillwater, OK
1979-81
Tachinidae
Braconidae
Ichneumonidae
Other families
Statewide Survey-OK
1979-81
% OF TOTAL PARASITES
0
10
20
30
40
50
60
70
80
1
2
3
4
5
R
CROP INTERVAL

VITA

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