SPIDERS (ARANEAE) OF PECAN ORCHARDS IN THE SOUTHWESTERN UNITED STATES AND THEIR ROLE IN PEST SUPPRESSION

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ABSTRACT

Spiders were sampled in pecan orchards in New Mexico, Texas and Arizona. Of a total of 30 species collected by bark, sticky trap and branch sampling, the sac spider, *Hibana incursa* (Chamberlin), was numerous in Mesilla Valley, New Mexico, orchards and appeared likely to consume pecan aphids and possibly pecan nut casebearers. Initial studies are promising and it is likely that this species and several other sac spiders may be important components in the beneficial complex in pecan orchards in the southwest.

INTRODUCTION

The challenges of estimating the efficiency of spiders as predators of pest arthropods in any agricultural ecosystem is complicated by observations that they can live for long periods of time without food, some spiders have prey capture techniques that cause them to take more beneficial insects and other spiders than pest species, and spiders are difficult to observe feeding in the field. Spiders can be very common predators. McAtee (1907) published the classic figure of 11,000 individuals per acre of woodland and 64,000 per acre in meadows near Washington, DC, but some estimates have gone even higher (Bristowe 1939). Also, the number of spider species in some tree cropping systems is quite large (Muma 1975, Mansour et. al. 1982). Individual spider species differ in their abilities to capture pest insects, and are best considered in guilds of similar prey capture methods (Richman et al. 1990). Some guilds are more likely to suppress certain pest species than others (Mansour et al. 1980, 1982; Richman et al. 1980).

Pecan orchards are often kept in commercial production for many years. That natural enemies, including spiders, can be important in controlling pest insects in tree crop systems like pecans has been reasonably well established (Mansour et al. 1983). Unfortunately, occasional invading pests can upset the dynamic balance of the system, resulting in insecticide treatments that may endanger biological control. Some orchard managers in New Mexico have adopted integrated pest management options since the early 1990s when aphids were the primary pests (LaRock and Ellington 1996). Recent invasions by the pecan nut casebearer, *Acrobasis nuxvorella* Neunzig, and pecan weevil, *Curculio caryae* (Horn), into the Mesilla Valleys may upset the system. In addition, pecans in the Mesilla Valley and elsewhere have been subject to occasional outbreaks of the yellow pecan aphid, *Monelliopsis pecanis* Bissell, blackmargined aphid, *Monellia caryella* (Fitch), and black pecan aphid, *Melanocallis caryaefoliae* (Davis), with the black pecan aphid being the most damaging to production (LaRock and Ellington 1996). Green lacewings, ladybird beetles, and various parasitoids have usually kept these below economic levels.

Spiders have been little examined in regard to any of these pests, except for predation on the blackmargined pecan aphid (Bumroongsook et al. 1992). In addition, studies on other tree and row crops indicate that some sac spiders will recognize and eat insect eggs (Buschman et al. 1977; Richman et al. 1980, 1983). Taylor and Foster (1996) indicate that sugars increase life spans in *Hibana velox* (Becker) individuals feeding at extrafloral nectarines and this could mean that sugar-rich aphids do the same for similar spiders that are native to the Southwest, such as *Hibana incursa* (Chamberlin).

The current study is a first attempt to document the arboreal spider fauna in southwestern pecan orchards and to identify the most likely beneficial species in regard to both the pecan aphid complex and the pecan nut casebearer. The following are observations made in several pecan orchards over the period 1993-2000, concentrating in the Mesilla Valley of New Mexico into El Paso County, Texas, but with additional sampling conducted in orchards in Eddy County, New Mexico, and Pima County, Arizona.

MATERIALS AND METHODS

The original study involved the determination of the role played by spiders in the suppression of the pecan aphid complex. Beginning in 1993, spiders were sampled at Stahmann Farms in Doña Ana Co., New Mexico. Because there is a bottleneck period for aphid populations in the winter and because some spiders might be able to feed on aphid eggs, the first sampling centered on bark spiders during winter and on possible ballooning spiders during the winter and spring. The presence of silk draglines on the trees, even in mid winter, provided the impetus for these studies. Two winter bark samples were collected in 1993 and 1994. One hundred and fifty trees in ten orchards (15 per orchard) were selected by using a random number table. The orchards were also randomly selected and included Stahmann Orchard Number 1, 4, 7, 30, 60, 67, 68, 85, 93, and 100. Each tree was stripped of loose bark and all spiders were collected, along with any other arthropods present. The four ballooning traps were all set in one orchard and a bordering lot so that we would have a good coverage in and out of the orchard. One trap on each site faced north-south and the other trap at each site faced east-west. The traps were 20 ft. high and 5 ft. wide and consisted of a steel frame with a set of paired rectangular wooden panels covered with 0.5-in. square screens. The screens were treated with various sticky substances (Richman and Pomerinke, unpublished). While these traps did catch a number of insects, few spiders were collected during the periods they were maintained (June-August), which missed the peak time of ballooning, probably December to March, depending on the local weather conditions that year. To correct this difficulty, a much simpler trapping method was used in 2000, involving delta pheromone traps. The traps were opened and fastened, sticky side up, around a branch with a compatible diameter. With two exceptions (orchards 30 and 67 were replaced with orchards 13 and 15) these sticky traps were placed in the same orchards where the bark samples were collected. The sampling was conducted over ten weeks from January through March 2000.

In 1996, six sites in four counties and three states were selected for relatively mature (bearing) trees and were sampled by beating one terminal branch five times from 30 randomly selected trees. These included Green Valley Orchards, Pima Co., Arizona - 20 July, 3, 14, 31 August, 21 September, 20 October; St. Christopher's Episcopal Church "Riverside", El Paso Co., Texas - 29 May, 4, 12, 19, 25 June, 2, 8, 16, 25, 31 July, 8, 13, 23, 30 August, 5, 19, 24 September, 4, 15 October; Stahmann Farms, Doña Ana Co., New Mexico - 31 May, 7, 18 June, 15, 23 July, 1, 9, 22, 29 August, 3, 18 September, 3, 11, 18 October; and the last three from Eddy County, New Mexico including Calvani – 27 July, 7, 24 August, 12, 27 October; Malone- 21 June, 9, 26 July, 7, 24 August, 12, 27 October and Moutray Orchards "Seven Rivers"- 21 May, 5, 20 June, 1, 9, 27 July, 7, 24 August, 12, 27 October. This represents a total of 61 samples of 30 trees each or a total of 1830 sampled branches. All spiders and pecan aphids were

identified and counted for each sample. Five Delta pheromone traps were placed at each site during each sampling period to record relative numbers of adult male pecan nut casebearer; an important established pest in the Pecos Valley and a recent threat to the Mesilla Valley pecans.

Insecticide treatment data for 1996 was unavailable for Green Valley, but both Malone and Riverside sites were never sprayed; one of Dipel® was made at Calvani in May, one spray of Lorsban® at "Seven Rivers" on 22-25 May, and one spray of Thiodan® at 1 pt/acre at Stahmann Farms on 12 June and another on 23 August with 1 pt/acre Lorsban®. Rates and types of rigs involved were not provided except at Stahmann.

To check the incidence of the spiders versus trap numbers of pecan nut casebearers, samples from 100 nutlet clusters were made at Stahmann Farms during 1997. Both living *H. incursa* and their exuviae were counted, as were pecan nut casebearer infested clusters and the average daily number of pecan nut casebearer adult males in the nearest pheromone trap.

RESULTS AND DISCUSSION

Spiders identified from all six orchards during 1993-2000 are listed in Table 1. These include a total of 30 species in 16 families. Bumroongsook et al. (1992) reported about 40 species in 13 families for pecan orchards in Burleson County, Texas. The relative abundance, probable importance in pest suppression, and location of each species is noted in Table 1. From this table the fauna found on the pecan trees appears to be primarily arboreal, with few non-arboreal species occurring. Most species appear to be native (based on published distributional data) and are probably derived from an indigenous river bosque fauna, which merely switched from cottonwoods and willows to pecan trees. A few widespread species may have entered the state on nursery stock long ago, or may have been in the area already, before the introduction of pecan trees. That spiders can be numerous, even in winter, is demonstrated by using the surface area of the Delta sticky traps at Stahmann Farms and the calculated average trunk and branch surface area to derive numbers of spiders per tree per week. These reached over 1,200 spiders per tree per week in January 2000.

The results for the orchards in New Mexico, Texas and Arizona sampled in 1996 are shown in Figs. 1-4. Because of uneven sampling dates, only the samples taken at the end of each month are shown to make the data as comparable as possible. The Delta trap data for male pecan nut casebearers at Stahmann Farms show almost no infestation during 1996. Higher infestations were seen in the Pecos River Valley, primarily Calvani (350 per five traps in August and 150 in October) and Seven Rivers (over 100 per five traps in October). None were collected at the Arizona site. As noted earlier, several of the sites in the Pecos River Valley were treated for pecan nut casebearer during 1996. Aphid numbers varied considerably among orchards, with Stahmann Farms having a high of over 400 adult and immature yellow pecan aphids per 30 branches in late June (Fig. 1) and "Riverside" had nearly 175 black pecan aphids per 30 branches in August, having less than 10 per 30 branches in September, and over 125 per 30 branches in October (Fig. 2). Interestingly, spiders were usually less common in Eddy County, except for the Calvani site, than at Doña Ana, El Paso or Pima County sites (Fig. 3), with *H. incursa* almost non-existent in any of the Pecos Valley orchards (Fig. 4). This may in part be a function of the much "cleaner" orchards, with often little or no understory plants. However, Malone had an almost meadow-like understory of plants and yet was low on spiders on the trees. One interesting and suggestive result was that "Riverside" orchard in El Paso County had both large numbers of *H. incursa* (0.5 per branch) and black pecan aphids (5 per branch) in August (Fig. 2 and 4).

TABLE 1. Spiders Associated with Pecan Orchards in New Mexico, West Texas and Arizona.

Family	Species	Habitat or Capture Method	Location
Theridiidae	*Latrodectus hesperus* Chamberlin & Ivie	Branches, trunk	NM: DA
	Theridion sp.*	Winter sticky trap	NM: DA; TX: EP
Linyphiidae	*Erigone* sp.**	Winter sticky trap	NM: DA
	Grammonota cf. *pictilis* (0. P.-Cambridge)**	Winter sticky trap	NM: DA
Tetragnathidae	*Tetragnatha laboriosa* Hentz**	Winter sticky trap	NM: DA, ED
Araneidae	*Larinia* sp.	Branches	NM: ED
	Metepeira sp.	Branches, trunk	NM: DA
	Neoscona oaxacensis (Keyserling)	Branches, trunk, understory	NM: DA
Lycosidae	*Pardosa sternalis* (Thorell)	Winter sticky trap	NM: DA
Agelenidae	Unknown	Trunk	NM: DA
Dictynidae	*Dictyna* sp.	Summer sticky trap	NM: DA
Oxyopidae	*Hamataliwa grisea* Keyserling	Branches, trunk	NM: DA; TX: EP
	Oxyopes salticus Hentz	Winter sticky trap	NM: DA
Clubionidae	*Cheiracanthium inclusum* (Hentz)**	Trunk, branches	NM: DA
Anyphaenidae	*Hibana incursa* (Chamberlin)**	Winter and summer sticky trap, branches, bark sampling, understory	AZ: PI; NM: DA, ED; TX: EP
	Anyphaena n. sp.**	Branches	NM: DA
Liocranidae	*Agroeca* sp.	Trunk, branches	NM: DA
Corinnidae	*Castianeira* sp.	Trunk, ground	NM: DA
Gnaphosidae	*Herpyllus cockerelli* (Banks)	Trunk, ground, winter sticky trap	NM: DA
Philodromidae	*Philodromus californicus* (Keyserling)	Winter sticky trap	NM: DA
Thomisidae	*Bassaniana versicolor* (Keyserling)*	Trunk	NM: DA
	Misumenops sp.*	Leaves	NM: DA, ED; TX: EP
Salticidae**	*Habronattus* sp.	Trunk, ground, grasses	NM: DA; AZ: PI
	Metacyrba taeniola (Hentz)	Trunk	NM: DA
	Metaphidippus chera (Chamberlin)	Branches	NM: ED
	Paramarpissa albopilosa (Banks)	Branches, trunk	NM: DA, ED
	Pelegrina sp.	Leaves, branches, trunk	NM: DA, ED; AZ: PI; TX: EP
	Phidippus audax (Hentz)	Branches, trunk	NM: DA
	Platycryptus sp.	Trunk	NM: DA
	"Pseudicius" siticulosus Peckham & Peckham	Branches, trunk	NM: DA
	Thiodina n. sp.	Leaves, branches, trunk	NM: DA

DA = Doña Ana County, ED = Eddy County, EP = El Paso County, PI = Pima County. Species marked with * are abundant and those with ** are both abundant and probably important in pest suppression.

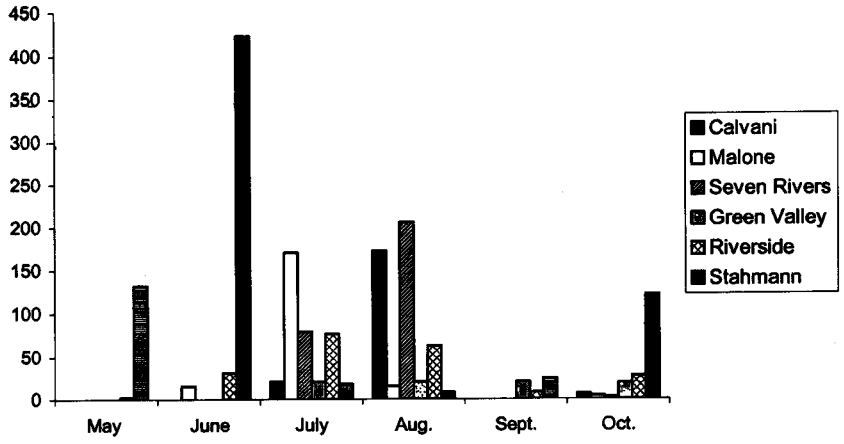

FIG. 1. Adult and immature yellow pecan aphid complex counts per 30 branch samples during 1996 in New Mexico, Texas and Arizona pecan orchards. Only samples used from last half of each month used because of better coverage.

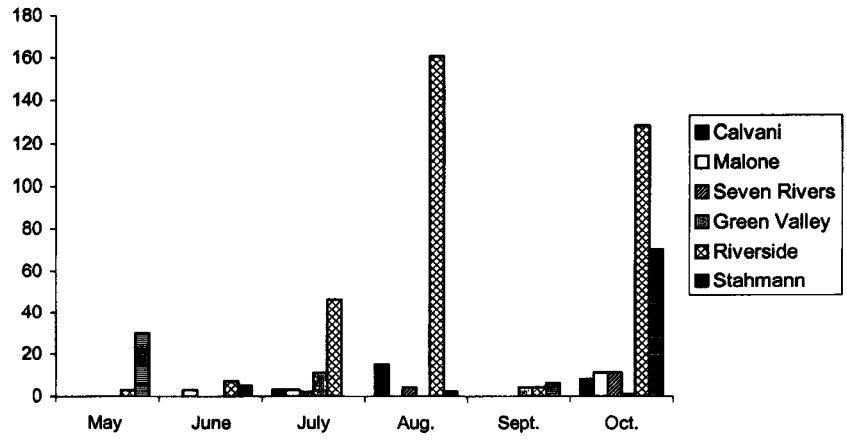

FIG. 2. Adult and immature black pecan aphid counts per 30 branch samples during 1996 in New Mexico, Texas and Arizona pecan orchards. Only samples used from last half of each month used because of better coverage.

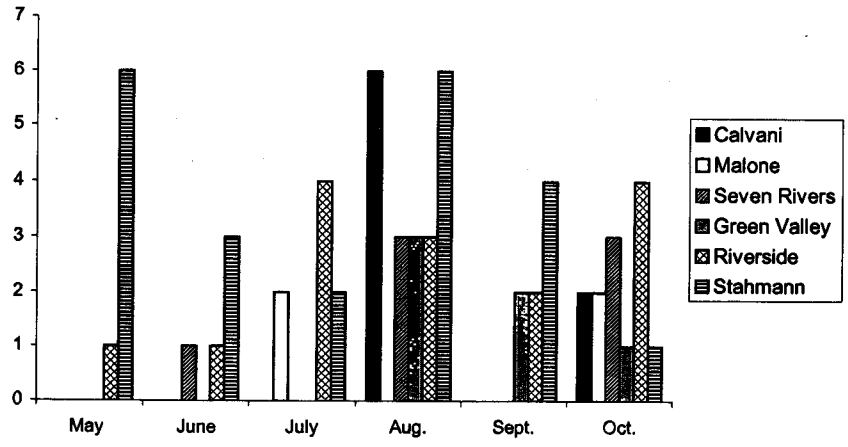

FIG. 3. Adult and immature spider (not including *Hibana incursa*) counts per 30 branch samples during 1996 in New Mexico, Texas and Arizona pecan orchards. Only samples used from last half of each month used because of better coverage.

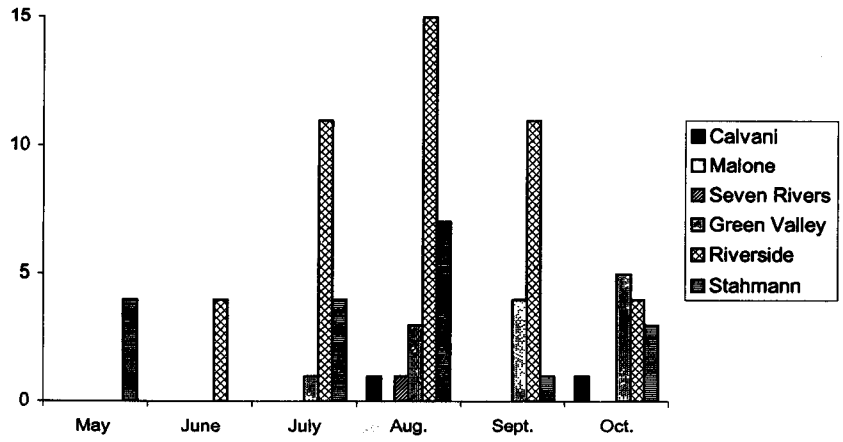

FIG. 4. Adult and immature *Hibana incursa* counts per 30 branch samples during 1996 in New Mexico, Texas and Arizona pecan orchards. Only samples used from last half of each month used because of better coverage.

Hibana incursa individuals fed in the laboratory readily ate pecan aphids. When feeding on aphids in the yellow pecan aphid complex the abdomens of the spiders were decidedly yellow and became darkened when feeding on black pecan aphids. It was observed that specimens caught in the pecan groves often showed this difference in abdominal colors. This is taken as circumstantial evidence that this species does feed on members of the pecan aphid complex. Feeding on blackmargined aphids by *Hibana* (=*Aysha*) *gracilis* (Hentz) was documented by Bumroongsook et al. (1992), and it is thus not surprising that *H. incursa* also readily feeds on aphids.

The possibility that *H. incursa*, or some related sac spider, might also be an important predator of the pecan nut casebearer was initially suggested by Brad Lewis, who observed an unidentified spider feeding on a diapaused larva in 1997 (personal observation) in one orchard in Doña Ana County, NM. Table 2 shows the distribution of *H. incursa* at one orchard ("Riverside" in El Paso County, Texas) in relation to nutlet clusters. This places the spiders in a good position to capture larvae, and adults, and even eggs.

TABLE 2. Number of *Hibana incursa* Spiders and Exuviae, and Pecan Nut Casebearer (PNC) Infested Nutlet Clusters per 100 Clusters at Eight Different Orchards in Stahmann Farms, Doña Ana County, New Mexico in 1997.

Date	# of *H. incursa*	# of *H. incursa* exuviae	# of nutlet clusters infested by PNC	Average number of adult male PNC per trap per day (nearest trap)
8/28[a]	20	10	2	2.0
8/28[a]	6	2	10	7.0
9/12	1	3	20	5.5
9/15	3	3	2	0.3
9/18	2	0	20	4.5
9/23	2	0	22	4.3
9/24	0	0	29	12.0
10/1	0	5	24	1.5

[a] Two orchards were sampled on 8/28.

The foregoing data indicate that there is a substantial arboreal spider fauna in southwestern pecan orchards and that at least some of the species present are important components of the predatory complex attacking pecan aphids and possibly the pecan nut casebearer. Some spiders are undoubtedly attacking and eating beneficial insects, or other spiders, and others may have little impact in that their hunting techniques place them in parts of the orchard seldom frequented by pest species (Wise 1993). However, certain spiders, such as *Hibana incursa*, *Cheiracanthium inclusum* (Hentz) and *Anyphaena* n. sp., as well as those in the erigonine Linyphiidae, Oxyopidae, Salticidae and Tetragnathidae, may have some impact in suppressing pest species (current study and Bumroongsook et al. 1992). Unfortunately there are occasional outbreaks despite these beneficial arthropods and (as can be seen from the data in the current study) some orchards may lack large populations of the most beneficial spiders. In addition, there are no effective biological control agents for the pecan weevil, which has recently invaded the Rio Grande (Mesilla) Valley. Probably spiders are best maintained in the trees by having borders of understory plants, but not fully covered soil surfaces, which might cause the populations of spiders to become diffuse. Pest outbreaks are then best controlled by treating with chemicals least affecting the spiders and other beneficials, either by being more targeted to a specific pest or by timing the spray period for periods least likely to cause disruption.

Future research needs to be done on quantifying the feeding of the most important spider species on pest insects. Currently we are conducting research on the chemical identification of pest proteins in spider gut contents for both *H. incursa* and *Anyphaena* n. sp. From this study it may soon be possible to analyze wild caught spiders for what they have been feeding upon.

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