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SOIL TRAVERSING ARTHROPOD POPULATIONS AS SAMPLED BY PITFALL TRAPS IN SUNFLOWER AND THREE ADJACENT HABITATS IN NORTHEAST ARKANSAS

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ABSTRACT

Soil traversing arthropod populations were sampled by pitfall traps in sunflower (*Helianthus* spp.) and three adjacent habitats during the months of July, August and September of 1980 and May, June, July and August of 1981. In 1980, four varieties of sunflower (Ellar, Hybrid 670, 891 and S-345) were planted. A single variety of sunflower (Ellar) was planted in 1981. The three adjacent habitats in both 1980 and 1981 were a pine stand, grass border and fence row. Of 1,748 specimens collected in 1980, 17 orders and 48 families were represented. Four orders comprised 78% of the total catch: Hymenoptera (45%), Acari (17%), Collembola (11%) and Coleoptera (5%). In 1981, 20 orders and 64 families were represented in a total of 26,693 trapped specimens. Four orders composed 88% of the total catch: Collembola (57%), Acari (14%), Hymenoptera (11%) and Homoptera (6%). Family composition and seasonal occurrence are discussed and compared for habitats sampled. Weather data are presented and discussed in relation to arthropod activity.

INTRODUCTION

Sunflower (*Helianthus* spp.) is becoming increasingly important as a productive commercial product in the United States, particularly in southern states. Growing areas range from North and South Dakota to California, and from Canada to Mexico. Morrison and Wilson (1980) reported the Red River Valley of North Dakota and Minnesota to possess the largest plantings. In 1977, sunflower yield in the United States increased 25% with a large-scale turnover from open-pollinated varieties to hybrids.

In Minnesota and the Dakotas, sunflower growing since the mid-60's has been found to be profitable and commercially competitive with corn and soybean production. Texas has continually produced substantial sunflower acreage every year since 1975 (Jernigan, 1978).

Studies conducted by Broom and Lyford (1981) revealed a continuing decrease in the water table in northeast Arkansas (Table 1). A considerable drop in the water table during a five year period is shown, particularly in Lawrence, Poinsett, Crittenden and St. Francis counties. Similar studies prior to 1976 show the water table to be decreasing at a greater rate each year. This rapid exhaustion of water resources increases the possibility that rice acreage will diminish in the future and be replaced by alternative cash crops. We feel that sunflower would be a logical choice as an alternative crop in northeast Arkansas.

Table 1. Water table data for northeast Arkansas.

Arkansas Counties	Net Change (m) 1976-1980
Lawrence	-3.90
Craighead	-2.38
Clay	-1.74
Greene	-1.49
Poinsett	-3.23
Mississippi	-1.89
Crittenden	-3.17
Cross	-2.13
St. Francis	-3.08

In 1980, we conducted the preliminary portion of this study in Craighead County, Arkansas, which was undergoing the longest, most extreme hot and dry period on record (Table 2). The sunflowers were planted in late May and virtually no subsequent rainfall of significance was recorded in Craighead County until September, which was well after harvest time for a first crop of sunflowers. Although no yield data were taken, the sunflowers appeared healthy and had large blooms which were filled with seeds at maturity. In 1977, a southeastern drought verified sunflower drought tolerance and thereby strengthened its position as an alternate cash crop (Lynch and Garner, 1980).

Substantial sunflower acreage was planted in southeast and southern states in 1978, with the greatest amounts being grown in Florida, Alabama, South Carolina, Mississippi and Tennessee, which have proven to be successful for sunflower production. In the Cotton Belt States, some farmers and oilseed crushers have already begun looking to sunflower as an alternate cash crop and as a source of new materials for cottonseed processing plants. Sunflower yield is expected to increase as methods for higher oil content and better disease and insect resistance are developed. Sunflower may soon partially replace corn, soybean, and cotton and be planted on land previously planted to barley or wheat (Jernigan, 1978).

Table 2. Weather data for 1980-1981 study.

	Mean Temperature					
	Max. °C.		Min. °C.		Rainfall (mm)	
Month	1980	1981	1980	1981	1980	1981
May	27.2	24.7	14.3	13.3	87.9	211.3
June	36.7	31.4	12.2	21.1	26.4	137.7
July	36.6	33.6	23.5	23.1	1.0	49.3
August	36.0	31.1	23.2	20.8	0.0	81.8
September	23.5	33.9	16.0	7.2	107.9	1.5

Kromer (1967) presented a variety of ways that whole or dehulled sunflower seeds may be used in food, fertilizer, fuel and industry, and suggested various uses for sunflower residue materials (hulls, stalks and heads).

Jernigan (1978) stated that for dietary purposes, sunflower oil is better than other vegetable oils due to its high ratio of polyunsaturated to saturated fatty acids. He found that southern sunflower provides a higher percentage of unsaturated oleic acid and less linoleic acid than northern grown sunflower. This improves the oil's flavor and better maintains quality and balance during heating than does oil from northern-grown sunflower.

Sunflower requires less nitrogen than most crops, and may be double cropped in much of the southeast where growing seasons are longer (Lynch and Garner, 1980). It grows on a variety of soil types, ranging from sandy loam to clay. Thus, soils producing good crops of corn, soybeans or cotton will also grow sunflower (Jernigan, 1978).

Several insect species are known to infest sunflower. Early season sunflower is likely to be infested by the armyworm *(Pseudalitia unipuncta)* and by various cutworms (Noctuidae). Jernigan (1978) reported that other potential economic threats include: the sunflower headmoth, *Homoesoma electellum* (Hulst), the sunflower head clipper weevil, *Haplorhynchites aeneus* (Boheman), and the carrot beetle, *Eutheda rugiceps* (LeConte). He also mentioned that tumbling flower beetles (Mordellidae), stink bugs (Pentatomidae) and leaf-footed bugs (Coreidae) may also be occasional pests. According to Lynch and Garner (1980), the corn earworm, *Heliothis zea* (Boddie), the tobacco budworm, *Heliothis virescens* (Fab.) and the soybean looper, *Pseudoplusia includens* (Walker) are likely to become immediate economic threats to sunflower production in southern Georgia. We could find no report of any study concerned with soil traversing arthropods in sunflower. Due to the general paucity of records on arthropod populations associated with sunflower, we undertook this study.

This investigation was conducted in northeast Arkansas, which is an agricultural area. Three varieties of sunflower (Ellar, S-345 and Hybrid 670), a pine stand, grass border and fence row were utilized in the 1980 study while one variety (Ellar), a pine stand, grass border and fence row were used in 1981. Family composition and seasonal occurrence are compared and discussed for pitfall trap catches in these habitats.

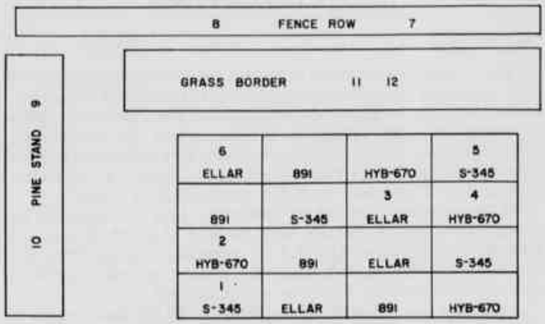

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Figure 1. Diagram of sunflower plots and adjacent habitats showing approximate location of pitfall traps (1-12) in 1980.

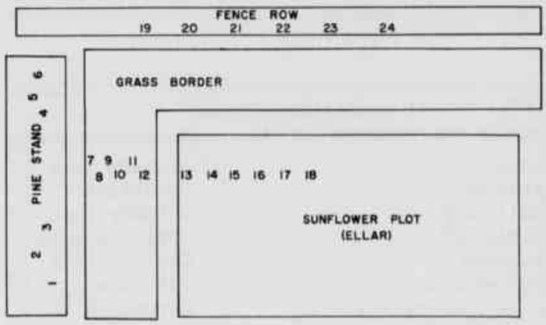

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Figure 2. Diagram of sunflower plot and adjacent habitats showing approximate location of pitfall traps (1-24) in 1981.

METHODS AND MATERIALS

A 2023m² plot of land on the Arkansas State University campus served as the study site. The land had lain fallow several years prior to 1980 and had never been planted to sunflower. The 1980 planting was done on May 28. Using a Precision® hand planter, seeds were planted approximately nine cm apart and at a depth of 2.5 cm. Four varieties of sunflower: Ellar, 891, Hybrid 670 and S-345 were each represented once in four tiers of randomly selected plots (Figure 1.). Ellar is a birdseed variety and the other three hybrids are oilseed varieties. The planting area (Figure 1) was 36 x 24 m and included a total of 16 plots, each plot being six m in length. Located between each tier of plots were 1.5 m alleyways. Fertilizer (13-13-13) was applied manually over each row at planting at the approximate rate of 336 kg/ha.

By June 3, 1980, all varieties except 891 were showing good emergence and were ready to be thinned. Laboratory tests of 891 indicated less than two percent germination, so use of this variety was discontinued for this study.

No harmful insect infestation was observed in any variety by July 22, 1980, at which time pitfall traps were installed in the middle of the fifth row of randomly selected plots of the three varieties that had germinated (Ellar, S-345 and Hybrid 670). In addition, two pitfall traps were installed in each of three adjacent habitats (Figure 1).

Pitfall traps consisted of a 10 oz. plastic Dixie Cup® placed inside a wide-mouth pint mason jar. A metal ring was attached to the jar lid. The assembled cup, jar and ring were placed in an 11.1 cm diameter metal cylinder. After installation, the metal ring attached to the jar lid was flush with the soil surface. The twelve traps were operated for 24 hours twice a week from July 23, 1980 to October 1, 1980. Each trap cup was filled approximately one-fourth full with 50% isopropyl alcohol. On collecting days, specimens were transferred to marked vials and taken to the laboratory for later identification. Trap cups were inverted and left empty and dry betwen trap days.

In 1981, the same study site (Figure 2) was used as in 1980 with all procedures and materials being duplicated with the following exceptions. Only one variety of sunflower (Ellar) was planted. Six traps were installed in each habitat as follows: pine stand (traps #1-6), grass border (traps #7-12), sunflower (traps #13-18) and the fence row (traps #19-24).

The single sunflower plot was planted in 101.6 cm rows which were 30.5 m long. In 1981, planting began on May 1 with pitfall traps being installed on May 2. The sampling period consisted of 16 weeks during the months of May, June, July and August.

Pitfall traps were modified in 1981 to consist only of a wide-mouth pint mason jar containing a plastic Dixie Cup® insert. This combination was installed so the rim of the jar was flush with the soil surface.

Borror et al. (1981) was used as a reference for identification of specimens to family or order levels.

Weather data recorded by the Jonesboro Flight Service located approximately 1.5 km from the collecting site were obtained for each 24-hour period and is summarized in Table 2. Data for months during which pitfall traps were not in operation were also presented (Table 2) to provide a total concept of the weather conditions during all the study months of 1980 and 1981.

RESULTS AND DISCUSSION

1980 Study

Table 3 presents a summary of all taxa collected in 1980. A total of 1,748 specimens was collected representing 17 orders and 48 families. Seventy-eight percent of the total 1980 catch was contained in four orders (Hymenoptera, Acari, Collembola and Coleoptera). Hymenoptera was the predominant taxon collected representing 45% of the total number followed by Acari 17%, Collembola 11% and Coleoptera 5%. The remaining 22% of the total catch was contained in 13 orders.

Percentage composition of the 1980 major taxa in each of the six habitats is presented in Table 4. Total numbers of specimens collected per habitat are represented by N. Taxa comprising less than 2% of the total numbers collected were excluded. Largest numbers of specimens were collected from the fence row and pine stand.

Formicidae was the predominant family in all habitats sampled in 1980 representing over 50% of the total catch in Hybrid 670, the fence row and the pine stand. This is a highly successful insect group, occurring in most habitats and outnumbering the majority of other terrestrial animals (Imms, 1957; Borror et al., 1981). Being predominant in 1980 may be attributable to their better adaptation to the atypical weather conditions experienced, as they were not the dominant taxon for any terrestrial habitat in 1981.

Acari was the second most common taxon and was represented in all habitats sampled. Acari represented less than one percent of the specimens collected in the pine stand, thereby excluding them from the major taxa in that habitat.

Entomobryidae and Sminthuridae were found to be present in all six habitats although they were not present in large numbers as compared to 1981. Extremely dry conditions may have limited the collembolan population since moist areas are a preferred habitat for this group.

Carabidae, though collected from all habitats sampled, was not a major taxon in S-345 and the grass border. Large numbers of carabids in the pine stand concurs favorably with studies done by Allen and Thompson (1977) who concluded that pine stands were a more preferred habitat compared to others such as oak-hickory and bottomland hardwoods.

Extreme weather conditions of 1980 are believed to have been a factor contributing to the small number of specimens collected. The sunflower plots were constantly in direct sunlight and subject to the effects of the extreme heat. Since soil surrface temperature normally is higher than the temperature immediately above the soil surface level, it is quite probable that this factor may have influenced the occurrence of the soil traversing arthropods in the study area. The metal ring, which was present on each pitfall trap in 1980, undoubtably had a higher temperature than the soil surrounding the pitfall-trap. The ring may have prevented at least some arthropods from entering the trap.

Table 3. Summary of all 1980 taxa collected.

Acari	Coleoptera cont'd.
Araneae	Carabidae
Chilopoda	Cerambycidae
Diplopoda	Chrysomelidae
Isopoda	Cicindelidae
Collembola	Cleridae
Entomobryidae	Curculionidae
Poduridae	Cucujidae
Sminthuridae	Elateridae
Orthoptera	Scarabaeidae
Acrididae	Staphylinidae
Blattidae	Lepidoptera
Gryllidae	Arctiidae
Psocoptera	Noctuidae
Liposcelidae	Diptera
Mallophaga	Calliphoridae
Menoponidae	Cecidomyiidae
Thysanoptera	Chironomidae
Phlaeothripidae	Culicidae
Hemiptera	Muscidae
Lygaeidae	Phoridae
Miridae	Psychodidae
Nabidae	Simuliidae
Pentatomidae	Tachinidae
Homoptera	Hymenoptera
Aleyrodidae	Apidae
Aphididae	Chalcidae
Cicadellidae	Cynipidae
Membracidae	Encyrtidae
Neuroptera	Formicidae
Chrysopidae	Ichneumonidae
Coleoptera	Pompilidae
Bostrichidae	Vespidae

Table 4. Percentage composition of major taxa in each of six habitats (1980).

Taxon	S-345	Hybrid 670	Ellar	Fence Row	Grass Border	Pine Stand
Formicidae	35.9	50.9	38.2	56.2	23.1	58.7
Diptera larvae	*	*	*	*	14.4	*
Carabidae	*	3.1	6.2	6.9	*	7.6
Cicadellidae	*	*	6.6	*	8.3	*
Entomobryidae	3.2	*	*	6.3	9.8	7.6
Sminthuridae	4.0	5.9	5.8	3.5	*	14.4
Acari	23.8	25.3	26.3	11.2	21.6	*
Araneae	14.1	2.8	*	*	*	3.2
N	248	289	259	347	264	341

* Values less than 2.00%.

Table 5. Summary of all 1981 taxa collected.

Acari	Hemiptera cont'd.	Diptera
Araneae	Tingidae	Acroceridae
Isopoda	Homoptera	Bibionidae
Chilopoda	Aleyrodidae	Cecidomyidae
Diplopoda	Aphididae	Chironomidae
Phalangida	Cercopidae	Culicidae
Collembola	Cicadellidae	Empididae
Entomobryidae	Fulgoridae	Ephydridae
Isotomidae	Psyllidae	Muscidae
Poduridae	Neuroptera	Mycetophilidae
Sminthuridae	Chrysopidae	Phoridae
Diplura	Coleoptera	Psychodidae
Orthoptera	Bruchidae	Scatopsidae
Acrididae	Carabidae	Stratiomyidae
Blatellidae	Chrysomelidae	Tipulidae
Blattidae	Coccinellidae	Siphonaptera
Gryllidae	Curculionidae	Pulicidae
Isoptera	Elateridae	Hymenoptera
Rhinotermitidae	Histeridae	Apidae
Psocoptera	Nitidulidae	Braconidae
Pseudocaeiliidae	Ptiliidae	Chalcidae
Thysanoptera	Scarabaeidae	Formicidae
Thripidae	Staphylinidae	Proctotrupidae
Phlaeothripidae	Tenebrionidae	Scelionidae
Hemiptera	Lepidoptera	Sphecidae
Cydnidae	Arctiidae	Tiphiidae
Lygaeidae	Geometridae	Vespidae
Pentatomidae	Noctuidae	
Reduviidae	Lasiocampidae	

1981 Study

In 1981, 26,693 specimens were collected, representing 20 orders and 64 families (Table 5). Predominant orders (Collembola, Acari, Hymenoptera and Homoptera) comprised 88% of the total catch. Substantially larger numbers of collembolans (57%) were collected, followed by Acari (14%), Hymenoptera (11%) and Homoptera (6%). The remaining 12% of the total catch were contained in 16 orders as shown in Table 5.

Four orders (Phalangida, Diplura, Siphonaptera and Isoptera) were collected only in 1981 as compared to one order (Mallophaga) collected only in 1980. These taxa were represented by insignificant numbers. A single mallophagan (family Menoponidae) found in one trap is believed to have been dislodged from one of the many birds observed to frequent the sunflowers and pine stand.

Although Carabidae were present in larger numbers than the other 11 families of Coleoptera collected in 1981, only 0.55% of the total number of specimens collected were in this family. We expected to find more carabids, particularly in the sunflower and pine stand since this is a large family common to northeast Arkansas and because of the soil traversing habits of the family.

Figures 3-6 indicate weekly percentage composition of major taxa collected in 1981 during the 16-week sampling period in each of the four habitats. Collembolans were dominant in each habitat, generally followed by Acari, Formicidae and Cicadellidae. Collembola was the most abundant taxon in 1981, representing 57% of the total number of specimens trapped. More nearly typical temperatures and rainfall amounts may be credited for their dominant numbers in 1981 as compared to lower numbers found in 1980. Borror et al. (1981) reported that collembolan populations often are large (up to 100,000 per m^3 of surface soil). Maynard (1951) reported that collembolans are a cosmopolitan group and are likely to occur in virtually any terrestrial habitat that contains enough moisture for plant growth. Extreme hot and dry weather conditions (Table 2) may have substantially reduced the nubmer of collembolans collected in 1980 (Table 4). Collembolans are economically important pests of several major agricultural crops such as alfalfa, mushrooms, truck garden crops, forage and cereal crops, according to Maynard (1951). Although the collembolan population could build to economic levels in sunflower, we do not presently foresee them as a serious threat, primarily because of their habits of feeding on decaying plant material, fungi and bacteria. Due to the large numbers found in all habitats in 1981, we feel that further study of this group and its relationship to sunflower is warranted.

As in 1980, Acari were again found to be a major taxon in 1981 (Table 4). Acari are ubiquitous arthropods, abundant in soil and organic debris and often outnumbering other arthropods (Borror et al., 1981). Acari were found to occupy the second ordinal position in both the grass border and sunflower areas during most study weeks (Figures 4, 5). Anthophyta blooming throughout the course of the study may be credited with Formicidae abundance in the fence row (Figure 6).

Of a total of 1,614 cicadellids, 1,069 were collected from sunflower. Since cicadellids are economic pests of several agricultural crops, they could become potential pests of sunflower due to their phytophagous food habits and disease-vectoring capabilities. Cicadellids were noticeably low in number in the pine stand and fence row. This is as expected because the plant composition was unsuitable for this group in these habitats. Cicadellids began to increase near the end of the study between weeks 14-16, particularly in the sunflower (Figure 5). We feel that cicadellids would have reached economic proportions if a second sunflower crop had been planted. Due to the known destructive habits of this taxon, we believe that more detailed studies should be conducted to determine the influence of leafhoppers on sunflower.

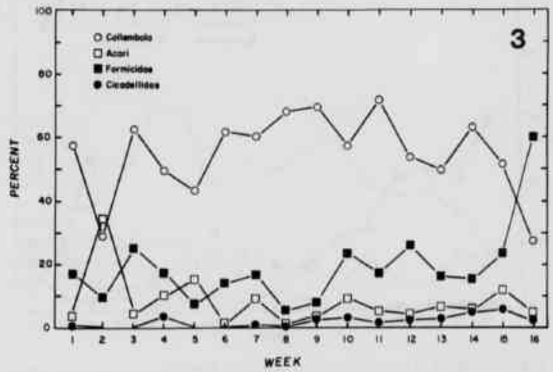

Figure 3. Weekly percentage composition of major taxa in pine stand.

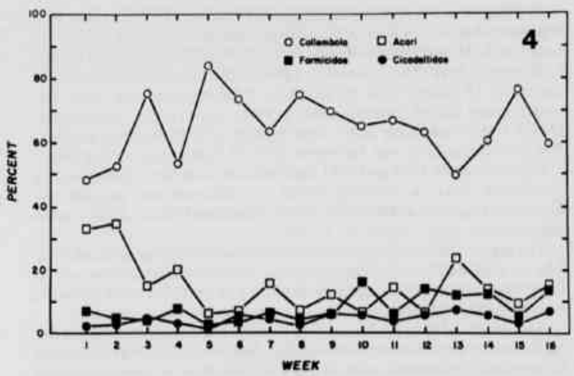

Figure 4. Weekly percentage composition of major taxa in grass border.

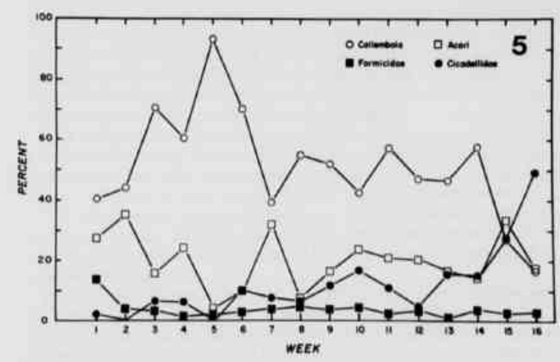

Figure 5. Weekly percentage composition of major taxa in sunflower.

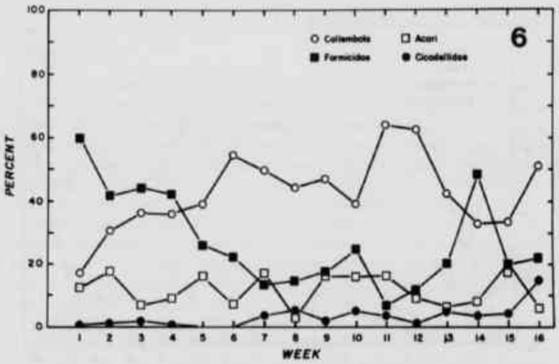

Figure 6. Weekly percentage composition of major taxa in fence row.

SUMMARY AND CONCLUSIONS

In 1980, of 1,748 specimens collected, 17 orders and 48 families were represented of which four orders and 22 families contained 78% of the total catch: Hymenoptera (45%), Acari (17%), Collembola (11%) and Coleoptera (5%). The remaining 22% of the total number was contained in 13 orders and 26 families. Predominant taxa were Entomobryidae (42%), Sminthuridae (15%), Acari (14%), Formicidae (11%) and Cicadellidae (6%), representing 88% of the total number. The remaining 12% was represented in 19 orders and 60 families.

Comparison of 1980 and 1981 data indicates that hot and dry weather conditions have a limiting effect on collembolan populations. Collembolans were collected in larger numbers (57%) in 1981 than in 1980 (10%).

The major soil traversing pests of sunflower appear to be cicadellids. The greatest number of cicadellids were trapped from sunflower. Few beneficial insects were found in this study. Carabidae were collected in both 1980 and 1981, but not in large numbers.

As a result of this study, we feel there is need for further research on the influence of Collembola and Cicadellidae on sunflower. The role of beneficial arthropods, such as the Carabidae, ou the control of other soil traversing arthropod populations in sunflower also merits additional attention.

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