ALTERNATE HOST PLANTS OF COWPEA CURCULIO, (COLEOPTERA: CURCULIONIDAE) IN ALABAMA

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ABSTRACT

Cowpea curculio, *Chalcodermus aeneus* (Boheman), is an important pest of cowpea, *Vigna unguiculata* (L.) Walpers, in the southeastern United States. This insect also feeds on other fabaceous crops and a number of wild host plants. In a field survey done in Alabama during 1992 to 1994, adults of cowpea curculio were collected on 31 alternate host plant species representing 11 plant families, and eggs and larvae were collected on three fabaceous plant species of the subtribe Phaseolinae. Before the cowpea cropping season in the spring, some of the alternate host plants of adults included narrow-leaved vetch, *Vicia sativa* ssp. *nigra* (L.) Erhardt, purple cudweed, *Gnaphalium purpureum* L., heartwing sorrel, *Rumex hastatulus* L., cutleaf eveningprimrose, *Oenothera laciniata* L., and moss verbena, *Verbena tenuisecta* Briquet. In May and June, cowpea curculios reproduced on snapbean pods, *Phaseolus vulgaris* L., before cowpea plants bloomed, indicating that adults from this new generation could infest cowpeas during pod formation. Adults fed on sicklepod, *Senna obtusifolia* (L.) Irwin & Barneby, during the cowpea cropping season. After the end of the cowpea cropping season, cowpea curculio produced an overwintering generation on *Strophostyles umbellata* (L.) Elliott and *S. helvula* (Muhlenburg ex Willdenow) Britton. Adults overwintered in clumps of broomsedge, *Andropogon virginicus* L. Purple cudweed, heartwing sorrel, moss verbena, and sicklepod may represent new host records for cowpea curculio. Destruction of spring alternate hosts and overwintering hosts of cowpea curculio and crop rotation of cowpeas away from snapbeans may help to reduce cowpea curculio infestation in cowpea.

Key Words: insecta, cowpea curculio, *Chalcodermus aeneus*, alternate host plants

RESUMEN

El gorgojo del caupí, *Chalcodermus aeneus* (Boheman), es una plaga importante del caupí, *Vigna unguiculata* (L.) Walpers, en el sureste de los Estados Unidos. Este curculiónido también se alimenta de otros cultivos fabáceos y de un número de hospederos silvestres. Gorgojos adultos fueron obtenidos durante un muestreo de campo realizado en Alabama de 1992 a 1994 de 31 especies de plantas hospederas alternativas representando a 11 familias de plantas, y huevos y larvas del gorgojo fueron colectados en tres especies de plantas fabáceas de la subtribu Phaseolinae. Algunas de las plantas alternativas hospederas para los adultos del gorgojo utilizadas antes de la cosecha de la primavera del caupí incluyeron a *Vicia sativa* ssp. *nigra* (L.) Erhardt, *Gnaphalium purpureum* L., *Rumex hastatulus* L., *Oenothera laciniata* L., y a *Verbena tenuisecta* Briquet. En mayo y en junio, los gorgojos del caupí se reprodujeron en vainas de *Phaseolus vulgaris* L. antes de que las plantas de caupí florecieran, indicando que los adultos de esta nueva generación podrían infestar caupís durante la formación de la vaina. Se observó que gorgojos adultos se alimentaron de *Senna obtusifolia* (L.)

Irwin & Barneby, durante la temporada de la cosecha del caupí. Después de la temporada de la cosecha el curculiónido produjo una generación de invernación en *Strophostyles umbellata* (L.) Elliot y *S. helvula* (Muhlenburg ex Willdenow) Britton. Adultos invernaron en grupos de *Andropogon virginicus*. Es posible que *Gnaphalium purpureum*, *Rumex hastatulus*, *Verbena tenuisecta*, y *Senna obtusifolia* representen hospederos no reportados previamente para esta especie de curculiónido. Destrucción de hospederos alternos de la primavera y de los hospederos utilizados por este gorgojo para su invernación y rotación de cultivos del caupí lejos de *Phaseolus vulgaris* podría ayudar a reducir la infestación del gorgojo del caupí en cultivos del caupí.

Cowpea curculio, *Chalcodermus aeneus* Boheman (Coleoptera: Curculionidae), is one of the most economically important pests of cowpea, *Vigna unguiculata* (L.) Walpers (Fabaceae), in the southeastern United States. This insect caused more than $1.2 million in crop damage and control costs in Georgia in 1991 (Adams & Chalfant 1992). Cowpea is the preferred host plant of the cowpea curculio (Ainslie 1910, Arant 1938, Bissell 1938). Both larvae and adults of cowpea curculio feed on and damage cowpea plant tissue (Arant 1938).

Adults of both sexes damage ripening pods with their rostrum and females oviposit through pod walls into seeds. Larvae feed and develop in the seeds of ripening pods.

In the southeastern U.S., adult cowpea curculios have been collected from at least 21 species of plants from 10 plant families, while eggs and larvae have been collected from four species of the subtribe Phaseolinae (Fabaceae): snapbean, *Phaseolus vulgaris* L., deer pea, *Vigna luteola* L., *Strophostyles umbellata* (Muhlenburg ex Willdenow) Britton and *S. helvula* (L.) Elliott (A single larva was collected from cotton, *Gossypium hirsutum* L., in 1905, but Ainslee (1910) considered it an accidental occurrence) (Ainslee 1910, Arant 1938, Bissell 1938, Bissell 1939, Langston 1939, Bissell 1940, Hetrick 1947, Dupree & Beckham 1955). These alternate host plants may provide important nutritional resources and protective habitat to cowpea curculio before, during, or after the cowpea cropping season. However, little information is available about the seasonal incidence of cowpea curculio on these plants.

Alternate host plants play an important role in the biology of a number of crop pests (Headlee & McColloch 1913, van Emden 1981, Stadelbacher 1986, Fleischer & Gaylor 1987, Jones et al. 1992). Knowledge of the population dynamics of pests on alternate host plants can be used in the development of pest management strategies to reduce crop infestation.

Little is known about the seasonal incidence of cowpea curculio on wild host plants in Alabama. The objective of our three-year study was to identify the alternate host plant complex of cowpea curculio in Alabama, and to determine seasonal occurrence of cowpea curculio on these plants.

MATERIALS AND METHODS

Potential alternate host plants of cowpea curculio were sampled from 1992 to 1994 at the Wiregrass Substation at Headland, AL, the E. V. Smith Research Center at Tallassee, AL, and at Auburn, AL, Gulf Shores, AL, and Fishing River Point, AL. A 0.4 ha field was planted with 'California Blackeye-5' cowpeas using standard agronomic practices, at both Headland and Tallassee in 1992 and 1993. Planting dates for cowpeas were 28 May at Tallassee and 1 June at Headland in 1992, and 30 April at Head-

land and 7 May at Tallassee in 1993. Naturally occurring weed species were allowed to grow unchecked in 20-m field borders around these cowpea fields. Plants in field borders were sampled biweekly, beginning in mid-April, and then weekly after cowpeas were planted. Weedy areas near additional cowpea fields were sampled at the Headland and Tallassee locations as well. Weekly sampling was continued through September in both 1992 and 1993 and through June in 1994. After the cowpea growing season, overwintering host plants were sampled on a monthly basis from November to March in 1992-93, and November to February in 1993-94.

Several species of wild legumes that did not occur at the two experiment stations were sampled. This sampling was done at Auburn (September and November 1993 and August and October 1994), at Gulf Shores (August 1994) and at Fish River Point (October 1992 and August 1994).

More than 127 species of plants from 29 plant families were sampled in this survey. Plant specimens were keyed using the keys of Radford et al. (1968) and Isely (1990). John Freeman, Department of Botany and Microbiology, Auburn University, AL, verified plant identifications.

Sweep net sampling and direct visual observations were used to sample for cowpea curculios on alternate host plants. Selection of sampling method was dependent on plant size, structure, and on the level of homogeneity of plant stands. In homogeneous stands of plants, a standard (38.1 cm diameter) insect net was used to sweep for adult cowpea curculios. The number of sweeps varied with the size of plant stands. When possible, 100 sweeps were taken per plant species. Direct visual observations were used when plant stands were (1) heterogeneous, (2) when physiognomy of plant stands would not permit effective sweep sampling or (3) when sweep sampling yielded adult cowpea curculios. Plants were examined visually for eggs, larvae, and adults of cowpea curculio. At least 10 plants per species were visually sampled when possible. The number of eggs, larvae and/or adults were recorded and specimens were transported to the lab for identification. The data presented herein represent the relative occurrence of cowpea curculio on alternate host plants in Alabama.

Results and Discussion

Of the 127 plant species sampled in the survey, 360 specimens of cowpea curculio (eggs, larvae and/or adults) were found on 31 species representing 11 plant families (Table 1). Adults were found on all 31 alternate host plant species either before, during, or after the cowpea cropping season. Eggs and larvae were found on only three fabaceous host plant species which were all members of the subtribe Phaseolinae (Iseley 1990). Average counts of cowpea curculio were difficult to compare statistically among plant species due to differences in sampling methods, phenology of host plants, physiognomy of host plant stands, homogeneity of host plant stands, and size of host plant populations.

Spring (before cowpea pod formation)

Alternate host plants provided food and/or shelter for cowpea curculio adults as they emerged from overwintering sites. In the spring, we collected adult cowpea curculios from 21 plant species or about two thirds of all of the plant hosts recorded in the survey (Table 1). More than half of all adults collected in this survey (total = 190), were found in the spring. Adults were observed resting at the base of plants and feeding on stems, flowers, pollen, pods, and extra-floral nectaries of the plants.

One of the first spring hosts on which adults were found was narrow-leaved vetch, *Vicia sativa* ssp. *nigra* (L.) Ehrhardt (Fig. 1). Narrow-leaved vetch was in vegetative

TABLE 1. PLANT SPECIES FROM WHICH *C. AENEUS* (CC) WAS COLLECTED IN ALABAMA, 1992-1994.

Family	Host Plant	Common Name	Dates of Collection	CC	Stage[1]	Site[2]
Poaceae	*Agropyron repens* (L.) Beauvois	quackgrass	29 Apr.-10 Sep.	5	A	H
(Gramineae)	*Andropogon virginicus* L.	broomsedge	23 Oct.-20 May	62	A	H, T
	Aristida stricta Michaux	wiregrass	25 Feb.-29 Apr.	7	A	H
	Digitaria sanguinalis (L.) Scopoli	large crabgrass	12 Aug.	10	A	T
	Paspalum urvillei Steudel	Vasey grass	7 Nov.-25 Mar.	3	A	T
Cyperaceae	*Cyperus esculentus* L.	yellow nutsedge	27 May, 10 Sep.	2	A	H
Polygonaceae	*Rumex hastatulus* Baldwin ex Elliott	sheep sorrel	27 Apr.-11 May.	25	A	H
Amaranthaceae	*Amaranthus retroflexus* L.	redroot pigweed	12 Aug	1	A	T
	Amaranthus spinosus L.	spiny amaranth	12 Aug	7	A	H, T
Fabaceae	*Cyamopsis tetragonoloba* (L.) Taub	guar	14 Sep.-24 Oct.	5	A	H
(Leguminosae)	*Desmodium tortuosum* (Swartz) D.C.	Florida beggarweed	2 Jun.-20 Aug.	8	A	H
	Lathyrus hirsutus L.	hairy pea	3 Jun.	5	A	T
	Phaseolus vulgaris L.	common bean	13 May-16 Jun.	46	E, L, A	H
	Senna obtusifolia (L.) Irwin & Barneby	sicklepod	18 Jun.-20 Aug.	12	A	H
	Strophostyles helvula (L.) Elliott	wild bean	20-23 Aug.	48	E, L, A	GS, F
	Strophostyles umbellata (Muhlenburg ex Willdenow) Britton	wild bean	28 Aug.-23 Oct.	30	E, L, A	AU
	Trifolium incarnatum L.	crimson clover	27 Apr-13 May	7	A	T
	Vicia sativa ssp. *nigra* (L.) Ehrhardt	narrowleaf vetch	22 Apr.-2 Jun.	32	A	H, T
	Vicia tetrasperma (L.) Schreber	wild lentil	22 Apr.-6 May	2	A	T

[1]E = eggs, L = larvae, A = adults.
[2]AU = Auburn, F = Fish River Point, GS = Gulf Shores, H = Headland, T = Tallassee.

TABLE 1. (CONTINUED) PLANT SPECIES FROM WHICH *C. AENEUS* (CC) WAS COLLECTED IN ALABAMA, 1992-1994.

Family	Host Plant	Common Name	Dates of Collection	CC	Stage[1]	Site[2]
Geraniaceae	*Geranium carolinianum* L.	carolina geranium	11 May	2	A	H
	Sida spinosa L.	prickly sida	12 Aug.	1	A	T
Onagraceae	*Oenothera laciniata* Hill	cutleaf eveningprimrose	5 May-2 Jun.	10	A	H, T
Convolvulaceae	*Ipomoea lacunosa* L.	pitted morningglory	16 Sep.	1	A	T
Verbenaceae	*Verbena tenuisecta* Briquet	moss verbena	20 May-2 Jun.	13	A	H
Asteraceae	*Acanthospermum hispidum* D.C.	bristly starbur	27 May-14 Aug.	5	A	H
(Compositae)	*Conyza canadensis* (L.) Cronquist	horseweed	12 Aug.	2	A	T
	Erigeron strigosus Muhlenburg ex Willdenow	daisy fleabane	13 May	2	A	H
	Eupatorium capillifolium (Lamarck) Small	dogfennel	25, 27 May	1	A	T
	Gnaphalium purpureum L.	purple cudweed	29 Apr.-27 May	22	A	H, T
	Hypochoeris elata L.	cat's ear	22 Apr.-11 May	5	A	H
	Taraxicum officinale Wiggers	dandelion	5 May	1	A	T

[1]E = eggs, L = larvae, A = adults.
[2]AU = Auburn, F = Fish River Point, GS = Gulf Shores, H = Headland, T = Tallassee.

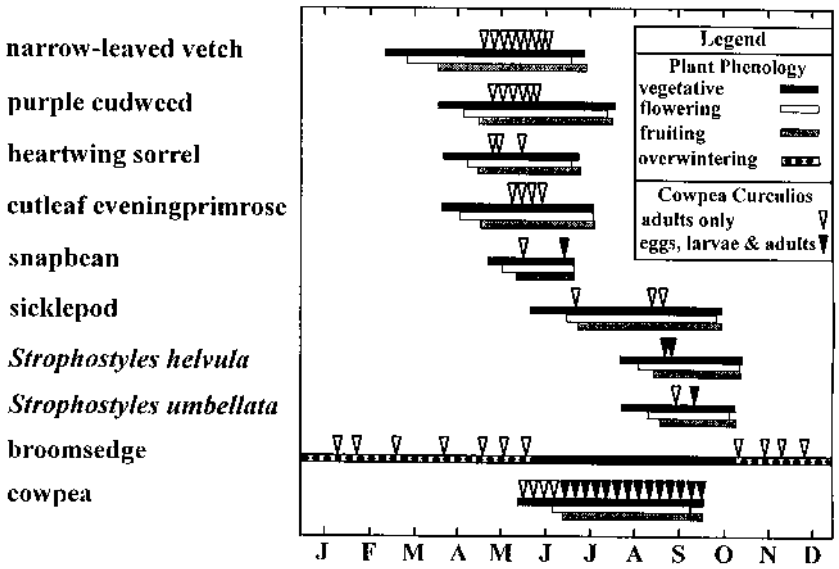

Fig. 1. Seasonal occurrence of *Chalcodermus aeneus* on selected host plant species and host plant phenology in Alabama, 1992-1994.

stage as early as late February and pod formation began as early as March. The earliest that adults were found on narrow-leaved vetch in this study was 22 April, the same date that Arant (1938) first found cowpea curculio adults on wild hosts at Auburn in the 1930's. Thirty-two adults were found on this plant from 22 April to 2 June, representing about 9% of the total adults collected. Adults occurred on narrow-leaved vetch before the formation of cowpea pods in mid-June (Fig. 1). The greatest number of adults per vetch plant was recorded in early May in 1993 and 1994 (Fig. 2). We found adults resting at the base of narrow-leaved vetch, feeding on pods, seeds, and nectar from extra-floral nectaries. Adults damaged pods and seeds, but no eggs or larvae were found in pods of narrow-leaved vetch during the survey. Some oviposition may have occurred in pods in the field, but it would be difficult for larvae to complete their cycle on narrow-leaved vetch due to rapid pod development and subsequent shattering of pods. The nectar and pods of narrow-leaved vetch may be a nutritional maintenance source for adults emerging from diapause in the spring before cowpea pod formation. Arant (1938) noted that it is important that adult curculios have access to alternate host plants in the spring because starvation is one of the leading mortality factors for adult curculios emerging from overwintering diapause. Narrow-leaved vetch plants often sprouted and grew among clumps of broomsedge, which provided overwintering sites for adults.

Adults were frequently collected from purple cudweed, *Gnaphalium purpureum,* in the spring (Fig. 1). Purple cudweed is one of the most commonly occurring spring weeds in southern Alabama (Jones 1961). This plant often grew near broomsedge and cowpea fields during this study, and we sampled it from April through June. Adults were found on purple cudweed at the base of the plant, on stems and feeding in the inflorescences on floral parts, pollen and/or nectar. A total of 22 adults were collected from purple cudweed from 29 April to 27 May, (Fig. 1), or about 6% of all curculios col-

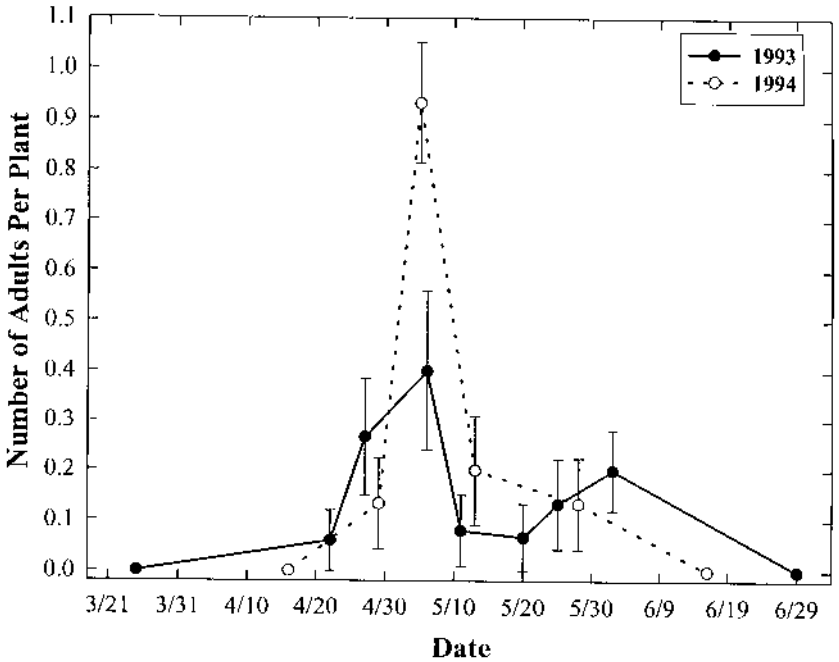

Fig. 2. Seasonal incidence of *Chalcodermus aeneus* on narrow-leaved vetch, *Vicia sativa* ssp. *nigra*, in Alabama, 1993-1994.

lected in the survey. The greatest number of adults per plant was 0.6 on 20 May in 1993 (Fig. 3). Cowpea curculio has not previously been recorded on purple cudweed. This plant may be another nutritional maintenance source for adults before the cowpea growing season.

In May and June, we also found adult curculios feeding on inflorescences of moss verbena, *Verbena tenuisecta* Briquet, and rough fleabane, *Erigeron strigosus* Muhlenburg ex Willdenow. These plant species were not previously documented as hosts for cowpea curculio.

Heartwing sorrel, *Rumex hastatulus* Baldwin ex Elliott is one of the most commonly occurring spring weeds in southern Alabama (Jones 1961). This annual plant species is closely related to the perennial sheep sorrel, *R. acetosella* L. Arant (1938) reported that adult curculios ". . . fed sparingly on sheep sorrel and evening primrose but the plants could hardly be considered a suitable source of food except in the early spring." Sheep sorrel did not occur in our study area, but we did sample heartwing sorrel around cowpea fields from late March to late June. We found a total of 25 adults on this species from 27 April to 11 May, representing about 7% of all curculios collected (Fig. 1). Most adults were found on the plant stems just below the soil surface.

Adult curculios were also collected from cutleaf evening-primrose in the spring from 5 May to 2 June. This plant was abundant around cowpea fields and is also a common spring weed in southern Alabama (Jones 1961). Adults were found at the base of the plant and feeding on the stems. Arant (1938) observed that adult curculios fed sparingly on this species in the early spring. We found a total of 10 adults on cut-

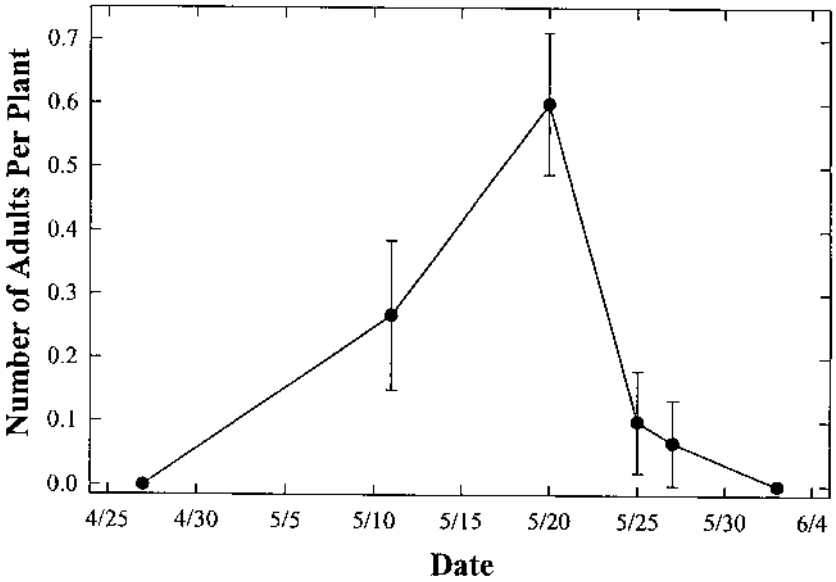

Fig. 3. Seasonal incidence of *Chalcodermus aeneus* on purple cudweed, *Gnaphalium purpureum*, in Alabama, 1993.

leaf evening-primrose from 5 May to 2 June, representing about 3% of all curculios collected (Fig. 1).

Snapbean, *Phaseolus vulgaris* L., was the only cultivated alternate host species from which we collected cowpea curculio. Snapbean is closely related to cowpea and belongs to the same family and subtribe. Cowpea curculio reproduces on snapbean and we found adults and the first eggs and larvae of the season on it. Pod formation had occurred on snapbean by 13 May when we collected 40 adults per 20 plants. On that date, adults were feeding on pods and hypocotyls and mating on the plants. Females oviposited on snapbean pods on or before 13 May which coincided with the earliest emergence of cowpea seedlings. Eggs and larvae were found in snapbean pods on 16 June when cowpea pods were beginning to form. These larvae eventually dropped out of the pods, pupated in the soil, and emerged as adults in July, when they infested cowpea fields. Other researchers have suggested rotating cowpea fields away from areas previously planted with snapbeans to avoid emerging adult curculios (Arant 1938, Hetrick 1947).

Summer (from cowpea pod formation to senescence)

Cowpea curculios were collected from 13 plant species during the period of cowpea pod formation and maturity (Table 1.). Only one adult cowpea curculio was found on each of eight of these species. In the summer, cowpea curculios were observed feeding on four alternate plant species: sicklepod, *Senna obtusifolia* (L.) Irwin & Barneby; *Strophostyles helvula* (L.) Elliott; *S. umbellatta* (Muhlenberg ex Willdenow) Britton; and guar, *Cyamopsis tetragonoloba* (L.) Taub. Few cowpea curculios were collected from alternate hosts during the period of peak cowpea pod formation from mid-June

to mid-August. Alternate host plants may have been less attractive to cowpea curculios during this period due to the presence cowpea pods.

Adults fed on sicklepod, one of the most commonly occurring summer weeds in southern Alabama (Jones 1961), in mid-June and mid-August (Fig. 1). Sicklepod occurred in and around cowpea fields and formed pods from early July to September. Adults were observed feeding on pods and stems in August, but no eggs or larvae were found in pods. Cowpea curculio has not previously been recorded from sicklepod.

Towards the end of the cowpea cropping season, cowpea curculio on *Strophostyles helvula* was found in late August at Gulf Shores and Fish River Point. Cowpea curculio was also found on *S. umbellata* at Auburn from late August to October. Eggs, larvae, and adults were collected on *S. helvula* and *S. umbellatta* wherever these plants occurred. About 21% of all cowpea curculios in this survey were collected from these two species (Table 1). Cowpea curculio successfully reproduces on *S. helvula* and *S. umbellatta* but the new generation of adults produced on this plant emerges after the cowpea harvest. However, *S. helvula* and *S. umbellatta* can act as a reproductive sink for cowpea curculios to produce the overwintering generation (Bissell 1938).

Cowpea curculio adults were found on guar, *Cyamopsis tetragonoloba* L., at Headland at the end of the cropping season. A total of five adults were found feeding on this plant (two on 14 September, and three on 24 October 1992). Adults fed on the pods of this plant which resemble cowpea pods. They were the only green pods available in the area after cowpeas had senesced. Cowpea curculio eggs or larvae were not found in guar pods. This species is not naturalized in the southeastern United States (Isely 1990) and cowpea curculio has not previously been recorded from this plant. Guar occurred only at the Wiregrass Substation as an adventive volunteer from previous variety trials and is probably not an important population sink for cowpea curculios in Autumn.

Overwintering

In the Autumn, adult curculios were found in cowpea leaf litter, and in clumps of vaseygrass, *Paspalum urvillei* Steudel, wiregrass, *Aristida stricta* L., and broomsedge, *Andropogon virginicus* L. (Table 1). Vasey grass and wiregrass have not previously been recorded as overwintering sites for cowpea curculio. Overwintering cowpea curculios were found on vaseygrass and wiregrass on only two dates for each species. Most of the overwintering adults in this survey were found in clumps of broomsedge; an observation also made in Georgia (Bissell 1940). Clumps of *Andropogon* spp. may provide protection from cold weather for several species of overwintering insects (Headlee & McCulloch 1913, Roach 1991). Sixty-two adults were collected from broomsedge at the Alabama study sites, representing 17% of all cowpea curculios collected in the survey. The mean number of adults per plant never exceeded 1.4 (Fig. 4). Overwintering adults were found in clumps of broomsedge from October to May but not during the cowpea cropping season when they are found in cowpea fields (Fig. 4). Adults were often found overwintering in the same clumps of broomsedge which had been overwintering sites in the previous year. It is unlikely that these were the same adults that overwintered the previous year because adults are not known to live for more than one year (Dupree and Beckham 1955). Several of the spring hosts such as narrow-leaved vetch and purple cudweed grew near clumps of broomsedge in the spring. Adults may move from these overwintering sites to adjacent spring nutritional hosts to renew the cycle.

Alternate host plants are important in the seasonal cycle of cowpea curculio and could be managed to reduce their abundance on cowpea. Our survey suggests that

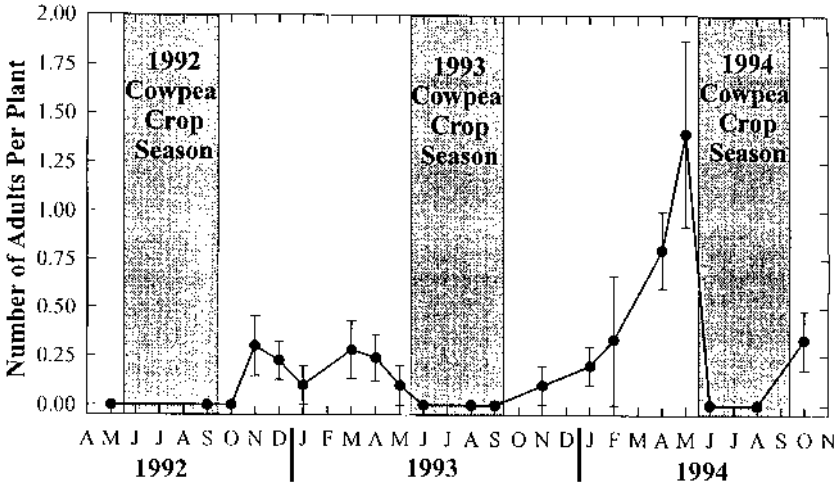

Fig. 4. Seasonal incidence of *Chalcodermus aeneus* on broomsedge, *Andropogon virginicus*, in Alabama, 1992-1994.

cowpea curculios use a variety of plants during their life cycle. Destruction of early-season hosts such as narrowleaf vetch and purple cudweed around cowpea fields might reduce the cowpea curculio's nutritional maintenance sources in the spring and break the link between overwintering diapause and the cowpea cropping season. Destruction of overwintering hosts such as broomsedge might reduce potential infestation sources and therefore reduce infestations in nearby cowpea fields. The rotation of cowpea fields away from snapbean fields might also reduce the infestation of cowpeas by the generation of cowpea curculios produced on early-season snapbeans. Future research could be directed towards testing optimal vegetational management strategies such as tillage, mowing, and herbicide application in alternate hosts and evaluating optimal crop rotation strategies.

ENDNOTE

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