PHYTOPHAGOUS INSECTS ASSOCIATED WITH GOLDENRODS (*SOLIDAGO* SPP.) IN GAINESVILLE, FLORIDA

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ABSTRACT

The insect fauna of four species of goldenrods, *Solidago canadensis* var. *scabra*, *S. fistulosa*, *S. gigantea* and *S. leavenworthii*, was surveyed during four years in and around Gainesville, Florida. The 122 phytophagous species collected are listed and classified according to relative frequency of occurrence, guild, host range, plant part attacked, life stages collected, and associated goldenrod species. Only 14 (11%) of the phytophagous species are known to be restricted to goldenrods and *Aster* (Compositae). Eight insect species are considered as possible biological control agents of *Solidago* spp.

RESUMEN

La fauna de insectos presente en cuatro especies de vara de oro, *Solidago canadensis* var *scabra*, *S. fistulosa*, *S. gigantea* y *S. leavenworthii* fué, estudiada en Gainesville, Florida durante cuatro años. Los 122 specimenes fitófagos colectados, se han listado y clasificado de acuerdo a la frequencia relativa de aparición, asociación, rango de hospedantes, parte de la planta atacada, estado de desarrollo y especies de vara de oro a las que se asociaron. Solamente 14 (11%) de los fitófagos hallados son conocidos como específicos de las vara de oro y *Aster* (Compositae). Ocho especies son consideradas como posibles agentes de control biológico de *Solidago* spp.

Goldenrods (Asteraceae: *Solidago* spp.) are common on roadsides and in open fields throughout the eastern United States. They first attracted the attention of naturalists because of their aesthetic appeal and as a nectar source for pollinators in late fall (Feller-Demalsy & Lamontagne 1979, Hensel 1982). Goldenrods have been studied as sources of natural enemies of field crop pests in a mixed crop system (Altieri 1979) and as competitors with seedlings of woody trees (Norbi & Kozlowski 1980). They can also serve as a reservoir for disease-producing organisms that attack plants of economic importance (Werner et al. 1980). Introduced to Europe and Japan about 1900, goldenrods have become aggressive pests of forest nurseries and reforestation areas (Capek 1971). The high cost and low efficiency of chemical and mechanical control of these weeds have resulted in interest in a biological control program in Russia (O. Kovalev, pers. comm.).

Basic information on the arthropod community structure of goldenrods is relevant if goldenrod populations are to be manipulated either as beneficial plants that should be maintained or even enhanced, or as undesirable plants that should be controlled. This paper lists the phytophagous insect fauna of four species of goldenrods, (*Solidago canadensis* L. var. *scabra* (Muhl) [treated by many as *S. altissima* L.], *S. fistulosa* Miller, *S. gigantea* Aiton, and *S. leavenworthii* Torr. & Gray), in and around Gainesville, Florida. It also gives information on the relative abundance of the different taxa, parts of the plant attacked, and specificity of the phytophagous insects.

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Material and Methods

The insect fauna of goldenrods was surveyed for four consecutive growing seasons. Surveys began in June 1981 and were made on goldenrod populations as they occurred naturally. Plants, including roots, were checked in the field and/or placed in plastic bags and returned to the laboratory for examination. Insect-damaged plant parts were carefully examined under the microscope. Immature insects were reared individually, with information recorded as to the life stage collected, part of the plant damaged, life history, appearance, emergence of adults or parasites, presence of disease, and other relevant information. Flying insects were captured by making 10 sweeps with a sweep net while walking in a straight line through the goldenrod patch. Adults were preserved in alcohol and identified. Plants were sampled at different times of the year and at various growth stages (seedling, flowering and mature). In 1982, 16 populations of the four plant species were selected of which two were surveyed each week following the same procedure. Of the four goldenrod species, *S. canadensis* var. *scabra* was the most common (11 of the 16 populations) and occurred on ditch banks, roadsides, and clearings in woody areas. The second most common species, *S. fistulosa*, occurred in old abandoned fields forming large stands sometimes mixed with blackberries. The single stand of *S. gigantea* was small and located on a poorly drained roadside. The *S. leavenworthii* stand was mixed with many other weeds and was growing on a small ditch bank in a very disturbed area. Growth of all four species started in March; *S. leavenworthii* and *S. gigantea* flowered in late August, *S. fistulosa* in mid-September and *S. canadensis* var. *scabra* in late September. The goldenrod stems were completely dead by the beginning of December. In 1983, three populations of *S. canadensis*, two of *S. fistulosa*, and single populations of *S. gigantea* and *S. leavenworthii*, were selected for in-depth study. The dynamics of the insect fauna in relation to host plant phenology was followed by surveying these seven populations during four periods of the growing season: early (May), middle (July), about 10 days before blooming (August or early September), and shortly after blooming (late September or early October). Collections in 1984 were made only on *S. canadensis* var. *scabra* and *S. leavenworthii*.

A phytophagous species was considered common if it was present in at least 50% of the collections, occasional if collected in 15 to 50% of the samples, and rare if present in less than 15% of the samples. Insects collected only once during the four years were excluded, as were those collected often but known to be nectar/pollen feeders or incidental and associated with other plants.

Results and Discussion

Seven orders, encompassing 41 families with 123 species of phytophagous insects (other than nectar/pollen feeders) were found associated with *Solidago* spp. (Table 1). Of these, 60 species (49.2%) bred on these plants, as indicated by the presence of immature stages. The cercopid *Lepyronia quadrangularis* (Say), the cicadellid *Osbornellus clarus* Beamer, and the delphacid *Pissonotus marginatus* Van Duzee were new Alachua County records, and the gracillariid *Cremastobombycia solidaginis* (Frey and Boll.) was a new state record.

Of the phytophagous insect species, 16 (13.1%) fed only on *Solidago* or on *Solidago* and *Aster,* seven (5.7%) fed on these plants as well as other Compositae, 94 (77%) were polyphagous and 5 (4.1%) had unknown hosts. Sucking insects comprised the majority of the phytophagous insects with 35 species of Homoptera and 25 species of Hemiptera collected from leaves, stems and flowers. There were 14 species of cicadellids, six of which were common. The pentatomids and mirids were represented by six species each, and the lygaeids by five.

TABLE 1. PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
DIPTERA						
Agromyzidae						
Agromyzidae sp. 1	C	L,P,A	L	M	c,f,g,l	M
Agromyzidae sp. 2	C	L,P,A	L	M	c,f,g,l	-
Cecidomyiidae						
Asphondylia monacha Osten Sacken	C	L,P,A	L	G	c	M
Asteromyia carbonifera (Osten Sacken)	C	L,P,A	L	G	c,f,g,l	M
Asteromyia sp. nr. *carbonifera* (Osten Sacken)	C	L	L	G	c,f,g,l	M
Dasyneura sp.	C	L	L	G	c,f,g,l	M
Rhopalomyia sp. (prob. new)	O	L,P,A	St	G	f	M
Rhopalomyia solidaginis (Loew)	O	L,P,A	St	G	f,g,l	M
Schizomyia racemicola (Osten Sacken)	O	L,A	F	G	c,f	M
Tephritidae						
Eurosta prob. *comma* (Wied.)	R	L	R	G	f	M
COLEOPTERA						
Cerambycidae						
Strangalia sexnotata Hald	R	A	F	C	f	P
Chrysomelidae						
Arthrochlamys plicatus (Fab.)	R	L	L	C	c,f	P
Colaspis brunnea (Fab.)	R	A	L	C	f	P
Colaspis favosa (Say)	R	A	L	C	c	P
Diabrotica undecimpunctata howardi Barber	R	A	L	C	c,f	P
Diachus auratus Fab.	O	A	L	C	c,f,l	P
Exema canadensis Pierce	C	L,P,A	L	C	c,f,l	P

TABLE 1. (CONTINUED) PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
Exema sp.	R	L	L	C	c,l	F
Ophraella sexvittata (LeC.)	C	E,L,A	L	C	c,f,g,l	M
Paria sp. nr. *aterrima* (Oliver)	O	A	L	C	c,f	P
Rhabdopterus sp.	R	A	L	C	c	P
Systena elongata (Fab.)	R	A	L	C	c,f	A
Curculionidae						
Centrinaspis picumnus (Herbst)	C	A	L,F	C	c,f,l	P
Epicaerus formidolosus Boheman	R	A	L	C	c,f	P
Limnobaris sp.	O	A	L,F	C	c,f,g	P
Notolomus basalis LeC.	C	A	F	C	c,f,g	P
Pachnaeus opalus (Oliver)	R	A	L	C	c	P
Tanymecus "lacaena (Hbst.)" complex	O	A	L,F	C	c	P
Elateridae						
Conoderus lividus (De Geer)	R	A	L	C	f,l	P
Glyphonyx sp.	R	A	L	C	c	P
Meloidae						
Epicauta sp.	O	A	F	C	c,f	P
Mordellidae						
Mordellistena sp.	R	A	L	C	c,l	-
Phalacridae						
Olibrus sp.	R	A	L	C	c,f	-
Scarabaeidae						
Trigonopeltastes delta (Forst.)	O	A	F	C	c,f,l	P
HEMIPTERA						
Alydidae						
Alydus pilosulus (Herrich-Shaffer)	O	A	L	S	c,g,l	P

TABLE 1. (CONTINUED) PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
Leptocorisa filiformis (Fab.)	R	L,A	F	S	f	P
Coreidae						
Acanthocephala femorata (Fab.)	O	E,L,A	L	S	c,f,l	P
Leptoglossus phyllopus (L.)	C	A	L	S	c,f,g,l	P
Lygaeidae						
Cymonimus notabilis (Distant)	R	A	L	S	c,f	P
Ochrostomus lineoloides Slater	R	A	F,L	S	f,l	P
Ocrimnus mimulus (Stal)	C	L,A	L,S	S	c,f,l	
Oedancala crassimana (Fab.)	R	L,A	L	S	f	P
Pachybrachius bilotatus (Say)	C	L,A	F,L	S	c,g,l	P
Miridae						
Adelphocoris rapidus (Say)	O	A	L	S	c,f,l	P
Lepidopsallus pusillus (Knight)	O	A	L	S	c,f,l	P
Lygus lineolaris (Palisot de Beauvois)	C	A	L	S	f,g,l	P
Polymerus punctipes Knight	R	A	L	S	f	P
Rhinacloa pusillia (Knight)	R	A	F	S	c,l	P
Taylorilygus pallidulus (Blanchard)	C	L,A	L	S	c,f,g,l	P
Pentatomidae						
Euschistus obscurus (Palisot de Beauvois)	R	A	L	S	c,l	P
Euschistus servus (Say)	C	L,A	L	S	c,f,g	P
Holcostethus limbolarius (Stal)	R	A	L,F	S	f,l	P
Nezara viridula (L.)	C	E,L,A	L	S	c,g,l	P
Oebalus pugnax (F.)	R	L,A	L	S	f	P
Thyanta custator (F.)	C	L,A	L	S	c,g,l	P

TABLE 1. (CONTINUED) PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
Tingidae						
Corythucha marmorata (Uhler)	C	E,L,A	L	S	c,f	A
Rhopalidae						
Arhyssus lateralis (Say)	R	A	F	S	c,f	-
Arhyssus nigristernum (Signoret)	O	A	F	S	g,l	P
Harmostes reflexulus (Say)	R	A	F	S	c,f	P
HOMOPTERA						
Aphididae						
Aphis sp.	O	L,A	L	S	c,f	P
Hyperomyzus lactucae (L.)	C	L,A	St	S	c,f,l	P
Uroleucon ambrosiae (C. Thomas)	C	L,A	St	S	c,f,g,l	P
Uroleucon gravicornis (Patch)	C	L,A	St	S	c,f,g,l	P
Cercopidae						
Clastoptera xanthocephala German	C	L,A	St	S	c,f,g,l	P
Lepyronia quadrangularis (Say)	C	L,A	St	S	c,f,l	P
Cicadellidae						
Agallia constricta Van Duzee	R	A	L	S	g,f	P
Chlorotettix viridius Van Duzee	R	A	L	S	f	P
Empoasca sp.	C	L,A	L	S	c,f,g,l	P
Exitianus exitiosus (Uhler)	R	A	L	S	l	P
Graminella sonorus (Ball)	R	A	F	S	l	P
Graphocephala versuta (Say)	C	A	L	S	c,f,g,l	P
Gyponana sp.	C	L,A	L	S	c,f,g,l	P

TABLE 1. (CONTINUED) PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
Homalodisca coagulata (Say)	C	A	L	S	c,f,g,l	P
Homalodisca insolita (Walker)	R	A	L	S	c	P
Oncometopia nigricans (Walker)	C	E,L,A	L	S	c,f,g,l	P
Osbornellus clarus Beamer	O	A	L	S	c,f,g	P
Scaphytopius sp. nr. *acutus* (Say)	C	L,A	L	S	c,f,g	P
Scaphytopius sp. prob. *frontalis* (Van Duzee)	O	A	L	S	c,l	P
Sibovia occatoria (Say)	R	A	L	S	f,l	P
Coccidae						
Coccus hesperidum L.	R	A	L	S	g	P
Delphacidae						
Pissonotus marginatus Van Duzee	R	A	L	S	c,f	P
Sogatella kolophon meridiana (Beamer)	R	A	L	S	c	P
Diaspididae						
Abgrallaspis cyanophylli (Signoret)	R	A	L	S	f	P
Aonidomytilus solidaginis (Hoke)	O	L,A	St	S	c,f	A
Hemiberlesia lataniae (Signoret)	R	A	St	S	f	P
Pseudaulacaspis pentagona (Targ. Tozz.)	R	A	L	S	f	P
Dictyopharidae						
Rhynchomitra sp.	C	L,A	L	S	c,f,g	P
Flatidae						
Ormenoides venusta (Melichar)	R	A	L	S	c	P
Membracidae						
Acutalis tartarea (Say)	C	L,A	St	S	c,f,g,l	P
Entylia bactriana Germar	O	L,A	St	S	c,f	P

TABLE 1. (CONTINUED) PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
Micrutalis calva (Say)	C	A	L	S	c,f,g,l	P
Spissistilus festinus (Say)	O	A	L	S	c,f	P
Psyllidae						
Aphalara sp.	O	L,A	St	S	f,l	P
Craspedolepta veaziei (Patch)	O	A	L	S	f,g	M
LEPIDOPTERA						
Gelechiidae						
Gnorimoschema gallaesolidaginis (Riley)	O	L,P,A	St	G	f,g	M
Trichotaphe flavocostella (Clem.)	C	L,P,A	L	L	c,f	A
Trichotaphe inserrata (Wlsm.)	C	L,P,A	St	B	c	A
Geometridae						
Eupithecia miserulata Grote	O	L,P,A	F	C	c,f	P
Pleuroprucha insulsaria (Guenee)	R	L,A	F	C	f,g	P
Synchlora frondaria (Walk.)	O	L,P,A	L,F	C	c,f,l	P
Gracillariidae						
Cremastobombycia solidaginis (Frey and Boll.)	C	L,P,A	L	M	c,f,g	M
Lyonetiidae						
Bucculatrix solidaginiella Braun	R	P,A	L	M	c	M
Noctuidae						
Schinia nundina (Drury)	R	L,P,A	F,Sd	C	f	M
Pterophoridae						
Oidaematophorus kellicottii (Fish)	C	L,A	St	B	c,f,g,l	A

TABLE 1. (CONTINUED) PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
Tortricidae						
Platynota flavedana Clem.	R	L	L	C	c	P
Platynota rostrana (Walk.)	R	L,P	F	C	c	P
Sparganothis distincta (Walsing.)	C	L,P,A	L	L	c,f,g,l	M
ORTHOPTERA						
Acrididae						
Aptenopedes sphenarioides Scudder	C	L,A	L	C	c,f,g	P
Melanoplus sp.	C	L	L	C	c,f,g,l	P
Paroxya atlantica Scudder	C	L,A	L	C	f,g,l	P
Schistocerca damnifica (Saussure)	R	A	L	C	f	P
Blatellidae						
Cariblatta lutea (Saussure Zehntner)	O	L,A	L	C	c	P
Grylliidae						
Hapithus brevipennis (Saussure)	C	L,A	L	C	c,f,g,l	P
Oecanthus celerinictus Walker	O	L,A	L	C	c,f	P
Orocharis luteolira Walker	R	A	L	C	c	P
Tettigoniidae						
Amblycorypha prob. *floridana* Rehn Hebard	R	L,A	L	C	c	P
Belocephalus subapterus Scudder	O	L	L	C	c,g	P
Odontoxiphidium apterum Morse	O	A	L	C	c,f	P
Scudderia sp.	O	A	L	C	c,f	P
THYSANOPTERA						

TABLE 1. (CONTINUED) PHYTOPHAGOUS INSECT FAUNA OF *SOLIDAGO* SPP. IN THE VICINITY OF GAINESVILLE, FL

	Relative Freq.[1]	Stages Coll.[2]	Plant Part(s)[3]	Guild[4]	*Solidago* spp.[5]	Host Spec.[6]
Phlaeothripidae						
Elaphrothrips sp.	R	A	L	S	l	-
Thripidae						
Microcephalothrips abdominalis (Crawford)	R	A	L	S	l	A
Thrips tabaci Lindeman	R	A	L	S	c	P

[1]C = common; O = occasional; R = rare.
[2]E = eggs; L = larvae; P = pupa; A = adult.
[3]L = leaves; St = stem; F = flowers; R = roots; Sd = seeds.
[4]C = chewing; G = gallmaker; M = miner; B = borer; S = sucking; L = leaftier.
[5]c = *Solidago canadensis* var. *scabra*; *f* = *S. fistulosa*; g = *S. gigantea*; l = *S. leavenworthii*.
[6]M = monophagous: feed only on *Solidago* and *Aster*; A = feed on *Solidago* and on other genera of Asteraceae; P = Polyphagous: feed also on families other than Asteraceae.

Two mirids and three pentatomids are associated with economic damage to cultivated plants. *Lygus lineolaris* Palisot de Beauvois, the tarnished plant bug, causes serious damage by feeding on the tender growing or fruiting parts of a variety of wild and cultivated plants (Borror et al. 1976, Metcalf & Flint 1951). Adults of this insect were collected from May to October on *S. fistulosa*, *S. gigantea*, and *S. canadensis* var. scabra. *Taylorilygus pallidulus* (Blanchard) attacks a variety of wild plants and, when abundant, can be a pest of ornamentals (F. W. Mead, pers. comm.). It fed and bred on all four species of goldenrod and was very common throughout the growing season. Among the pentatomids, the southern green stink bug, *Nezara viridula* (L.), is the most important because it is a pest of soybeans and other crops (Todd & Herzog 1980). It fed and bred from May to July on three of the four species of goldenrod. *Euschistus servus* (Say) and *Oebalus pugnax* (Fab.) also can cause damage to many crops.

Most of the chewing insects were polyphagous. Of 12 species of chrysomelids, apparently only *Ophraella sexvittata* (LeConte) was restricted to *Solidago*, although LeSage (1986) reported adults were reared from larvae on march elder, *Iva frutescens* L. sp. *oraria* (Bart.) R. C. Jackson (Asteraceae). *Systena elongata* (Fab.) was rare and collected only on *S. canadensis* var. *scabra* and *S. leavenworthii*. It feeds only on plants in the Asteraceae. *Diabrotica undecimpunctata howardi* Barber, the spotted cucumber beetle, was the only economic species of chrysomelid collected on *Solidago*. Adults were collected several times on *S. canadensis* var. *scabra* and *S. fistulosa*. Polyphagous Lepidoptera collected were restricted to three geometrid and two tortricid species. All species of Orthoptera collected were polyphagous. The most abundant insect feeding only on *Solidago* and other Asteraceae was the tingid *Corythucha marmorata* (Uhler). Its' eggs, nymphs and adults were found on *S. canadensis* var *scabra* and *S. fistulosa* throughout the growing season. The pterophorid *Oidaematophorus kellicottii* (Fish) was common on all four species. This moth laid its' eggs on the growing tip of young goldenrod plants. The new larvae bored downward into the soft stem. Before reaching the apparent third instar, it left the upper part of the plant stem through a lateral hole and moved down to the mature, wider stem. Here it made another hole, about 10 cm above the ground, and bored downward toward the roots. Pupation occurred inside the stem near this entrance hole, through which the adult emerged later. The part of the plant above where the young larva bored, wilted and

died. Infested plants could be recognized by the dried tips. Young larvae were collected in May and mature ones were found as late as October.

Other common insects were the gelechiids *Trichotaphe flavocostella* (Clem.) and *T. inserrata* (Wlsm.). These species caused considerable damage to goldenrods; the former as a leaftier and the latter as a borer inside the growing tip, a behavior that interrupted the terminal growth of the plant. Most of the species restricted to *Solidago* were endophagous: eight Diptera and one Lepidoptera made galls on leaves, flowers, stem or roots, and one Diptera and one Lepidoptera were leaf miners. The others were *Schinia nundina* (Drury), a flower and seed feeder, *Craspedolepta veaziei* (Patch), a sapsucker, *Sparganothis distincta* (Walsingham), a leaftier and *Ophraella sexvittata* (LeC.), a leaf chewer,. Biological information on the latter two insects can be found in Fontes (1985). The others are discussed below.

The black or white leaf blister galls of *Asteromyia carbonifera* (Osten Sacken) were found frequently on the four goldenrod species during this study. The number of galls per leaf varied from one to many and sometimes covered the entire leaf. The relationship between *A. carbonifera* and the fungus that inhabits its gall was discussed by Batra (1964). The galls were caused by both fungus and insect activity. *Asteromyia carbonifera* associates with leaves of goldenrod already infected by the fungus *Sclerotium asteris* (Schw.). Two or three midge larvae developed between layers of the fungus which forms a stroma on either side of the larval chamber. Weis (1982) showed that the formation of this stroma is an important mechanism for protection from the parasite *Torymus capite* (Huber). Also, the gall midge larvae were frequently parasitized by *Tetrastichus* sp. 1, *T. homeri* (Girault), and *T. tesserus* Burks, (Eulophidae).

Another leaf blister gall found occasionally on leaves of goldenrod was caused by a midge identified as *Asteromyia* sp. nr. *carbonifera* (Osten Sacken). The circular galls are greenish, often surrounded by a purplish necrotic area. The midges were heavily parasitized by a eupelmid, probably *Anastatus* sp. *Asphondylia monacha* Osten Sacken made galls in developing buds. It established itself between the surface of the leaves while they were still in the bud and caused the adjacent tissues to form an oval cell between the two surfaces. The leaves continued their normal development but attached to each other where the gall developed. A common parasite of this species was *Galeopsomyia haemon* (Walker) (Eulophidae). Similar damage was caused by a midge (*Dasyneura* sp.) on the four goldenrod species, although the only injury observed was to the developing, opposed leaves of the growing bud. No adults were reared from the reddish larvae, so the species could not be determined. Another gall midge, *Rhopalomyia solidaginis* (Loew) attacked buds, transforming them into globular masses of deformed leaflets. In the center of the mass, a cylindrical chamber with tapered apex sheltered the yellowish larva. This gall was seen occasionally on all goldenrod species except *S. canadensis* var. *scabra*. It was also parasitized by *G. haemon*. *Rhopalomyia* new sp. was collected occasionally on *S. fistulosa*. The larvae developed inside individual globular galls with a tapered apex. These galls developed together forming an agglomeration on the stem. The parasitic wasp *Torymus* sp. nr. *duplicatus* (Hübner), probably a new species, was reared several times from this gall.

The only flower gall observed in this study was made by the midge *Schizomyia racemicola* (Osten Sacken). It produced a rounded gall with tapered apex (frequently reddish) on the racemes of *S. canadensis* var. *scabra* and *S. fistulosa*. The larvae were orange-red and left the gall when disturbed. Gagne (1989) provides keys and descriptions for most of the cecidomyiids on *Solidago* in North America. The conspicuous galls of *Gnorimoschema gallaesolidaginis* (Riley) were occasionally seen on the stems of *S. fistulosa* and *S. gigantea*. A complete description of the biology of this insect is given by Leiby (1922). It is widely distributed and has also been reported from *S. canadensis* var. *scarbra, S. nemoralis Aiton,* and *S. serotina* Retz. Fully grown galls were found from July through the winter in Gainesville. In North Carolina, this insect hibernates in the egg stage (Leiby 1922), but in Florida it apparently overwin-

ters as a pupa inside the gall. Two adults emerged from screened galls in February, just when goldenrod seeds were sprouting.

The rarest gall collected was made on the roots by *Eurosta* prob. *comma* (Wied.). A large white maggot developed inside an elliptical, potato-like gall on the rhizomes of *S. fistulosa*. No adults of this species were obtained. The leaf mines of the gracillariid moth, *Cremastobombycia solidaginis*, were very common on the underside of leaves of *S. canadensis* var. *scabra*, *S. fistulosa* and *S. gigantea*. They were found from early May to early October. The tiny larva made an irregular, roundish blotched mine, usually centered on the underside of the leaves. As the larva grew the mine became elongate. By pupation, the leaf was folded in the damaged region and the mine became wrinkled. The elongate, white cocoon in which the larva pupated was suspended inside the fold by silken threads. This is a common species in the United States (Braun 1908).

Bucculatrix solidaginiella Braun is a lyonetiid moth whose larvae feed in the growing tips or mine the leaves of various species of *Solidago* (Braun 1963). Only pupae and adults of this species were collected from the leaves of *S. canadensis* var *scabra*. The brightly colored yellowish larvae of the noctuid *Schinia nundina* were well concealed in the flower heads of *S. fistulosa*, where they fed on the developing seeds. Adults of this species occur from late July to late September in central and eastern U.S. (Forbes 1948). No adults were collected and the larvae were observed in October and early November. The jumping plant-louse, or psyllid, *Craspedolepta veaziei* has been reported from *Solidago* sp. (Caldwell 1938) and *Aster* (Crawford 1914). Adults were occasionally collected on leaves of *S. fistulosa* and *S. gigantea* from July to November.

Eight of the species recorded as feeding only on *Solidago* and *Aster* could be considered for introduction into Europe or Japan for the biological control of goldenrods: one attacks roots, *Eurosta* prob. *comma;* two are leaf chewers, *Ophraella sexvittata* and *Sparganothis distincta*; two are leaf miners, Agromyzidae sp. 1 and *Cremastobombycia solidaginis*; one is a leafgaller, *Asteromyia carbonifera*; and two attack flowers and seeds, *Schizomyia racemicola* and *Schinia nundina*. Before release, these insects would have to be tested to make certain that they do not feed on any cultivated *Aster* or other Asteraceae.

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