Major Phytophagous Insects of Selected Weeds in Virginia

by
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For the last few years we have been studying the insect fauna on several important weeds in Virginia (Table 1). These weeds were initially selected to provide a mixture of native and introduced, and annual and perennial plant species, which were also troublesome weeds according to our local weed scientists (Buchanan 1974). By selecting problem weeds, we were obviously also picking out weeds which are not being regulated at a suitable density by any existing herbivore. Nevertheless, the insects attacking these weeds may still be useful biological control agents in other areas where they may be separated from their own regulating agents such as parasitoids, predators, or diseases. This list of weeds was enlarged by inclusion of the *Carduus* thistles, which we were already studying, and by inclusion of the close relatives of several of the plant species originally considered. Thus between 1972-74 surveys were conducted of the insect fauna of the 15 weed species shown in Table 1. The primary method used in the general faunal survey was to invert a large polyethylene bag over the target weed, close the open end around the stem near the soil, uproot the plant and shake excess soil from the roots. Large plants were cut into sections to fit into the bag. Care was taken to dislodge as few active insects as possible. Upon return to the laboratory, half of the samples were examined and dissected as soon as feasible, the remainder were placed in ventilated clear bags and observed daily for the emergence of adult insects. After 21 days the material in these bags were dissected. Based on the collected data and from literature references some of the weeds and insect species were selected for further study and are discussed here.

The criteria used in our selection were 1) the likelihood of a given weed species being suitable for biological control, 2) the existence of phytophagous insect species capable of causing significant plant injury, 3) the insect being in sufficient numbers to provide material for study, and 4) the insect being unlikely to attack beneficial plants.

Ambrosia artemisiifolia and *A. trifida* were selected for further study even though they are native to North America. The are common plants in waste areas and the damage they cause is amplified over a great distance through allergic response of many people to their pollen. While they are not perennial, which is often helpful in a biocontrol target weed, dense populations tend to persist in a given area over several seasons. The insect fauna of certain *Ambrosia* spp. has been documented by Hack (1935) for Kansas, by Harris & Piper (1970) for Ohio and Ontario, by Stegmaier (1971) for Florida, and by Goeden and Ricker (1974a,b, 1975, 1976) for several southern California species.

Larvae of the gelechiid moth, *Chionodes mediofuscella,* feed on and destroy the seeds of *A. trifida.* We have not found it attacking common ragweed,

Table 1. WEED SPECIES STUDIED

COMPOSITAE
- *Ambrosia artemisifolia* L. Common Ragweed native, annual.
- *Ambrosia trifida* L. Giant Ragweed native, annual.
- *Carduus acanthoides* L. Plumeless Thistle introduced, winter annual or biennial.
- *Carduus nutans* L. Musk Thistle introduced, winter annual or biennial.
- *Cirsium vulgare* (Savi) Tenore. Bull Thistle introduced, biennial.

CONVOLVULACEAE
- *Convolvulus arvensis* L. Field Bindweed introduced, perennial.
- *Convolvulus sepium* L. Hedge Bindweed introduced, perennial.
- *Ipomoea hederacea* (L.) Jacq. Ivyleaf Morning-glory introduced, annual.
- *Ipomoea purpurea* (L.) Roth Common Morning-glory introduced, annual.

CYPERACEAE
- *Cyperus esculentus* L. Yellow Nutsedge native-cosmopolitan, perennial.

GRAMINAE
- *Digitaria sanguinalis* (L.) Scop. Large Crabgrass introduced, annual.
- *Panicum dichotomiflorum* Michx. Fall Panicum native, annual.
- *Sorghum halepense* (L.) Pers. Johnsongrass introduced, perennial.

LILIACEAE
- *Allium vineale* L. Wild Garlic introduced, perennial.

SOLANACEAE
- *Solanum carolinense* L. Carolina Horsenettle native, perennial.

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possibly because the seeds are too small. We are aware of no published reports of this insect attacking other plants. We have collected it in moderate to low numbers from giant ragweed seed heads during mid to late September. After the seeds have been hollowed, the larvae leave the plant apparently to hibernate in the soil or litter. By placing partly developed larvae on an artificial diet, we have been able to obtain pupation and adult emergence in the laboratory. We obtained 2 species of hymenopterous parasitoids (*Pristomerus* sp., *Perilampus* sp.) from *C. mediofuscella* larvae while on the diet. However, we did not obtain eggs from the adult moths since suitable host plants were not available.

We have begun monitoring ragweed pollen in the air to form a baseline for comparison in the event that a biological control program against *Ambrosia* can be initiated.

The bindweeds are perennials which have probably been introduced from South America. *Convolvulus sepium* is the primary species in our area. While the bindweeds are primarily important pests of field crops, they are also found commonly along fence rows and field margins which could form a reservoir area for maintenance of a biological control agent.

The leafminer *Bedellia somnulentella* (Lepidoptera: Lyonetiidae) is capable of causing considerable leaf damage to bindweed. If the leaf dries or if the leaf is completely mined, the larva may move in search of another leaf. Upon completion of larval development, which takes about 10 days, the leafminer larvae emerge from the leaf to spin silken cocoons and pupate on the lower leaf surface. The larvae are parasitized by the braconid, *Apanteles bedelliae*. In our area they occur late in the season about mid-August. This could tend to limit their usefulness. This leafminer is reported to occur in Europe, South Asia, North America, Australia, and Hawaii and it has been recorded on the leaves of *Convolvulus* and *Ipomoea* (Meyrick 1927). We are determining the suitability of sweet potato, *Ipomoea batatus*, as a host.

Another insect which attacks bindweed is *Oidaematophorous monodactylus* (Lepidoptera: Pterophoridae). The early season larvae attack the growing tips and leaves, each larva is capable of destroying ca 12 cm^2 of leaf area. About 90% of the feeding injury is caused by the 4th instar. Later in the season they attack and feed inside the developing buds where they abort the flower or destroy the developing seed. After feeding on a bud, they frequently require additional food and move to adjacent leaves. Mohyuddin (1969) reported that 3rd instars of this insect fed in starvation tests on excised leaves of *Convolvulus sepium, C. spithamaea, C. arvensis,* and *Ipomoea batatus,* sweet potato, in the Convolvulaceae, and *Hyoscyamus niger* and *Datura stramonium* in the Solanaceae. We have found that it will oviposite and feed on one variety of sweet potato. This plus its worldwide distribution (Forbes 1923) may limit its usefulness as a potential biological control agent.

The eggs of *O. monodactylus* are usually laid on the under side of the leaves. The females lay ca 135 eggs/individual, and the length of a generation is ca 30 days. There are 2 and a partial 3rd generation in Virginia. *Geocoris uliginosus* has been observed preying on plume moth larvae. *Pnigalio proximus* (Hymenoptera: Eulophidae) and *Oxynops anthricinus* (Diptera: Tachinidae) are parasitoids which attack the larvae.

Yellow nutsedge, *Cyperus esculentus,* is a perennial, cosmopolitan weed. In Virginia we have only yellow nutsedge, though purple nutsedge has been reported from the state in the past. Yellow nutsedge is primarily a pest of row crops, but may also be a problem in turf and orchards. Under the name chufa it has been grown as human food, and small acreages have been grown for swine forage.

The buprestid leafminer, *Taphrocerus agriloides,* is common on yellow nutsedge. No references to the biology of this species are known, but Chapman (1923) has described a similar species. Eggs of *T. agriloides* are laid singly on the upper leaf surface near the midrib. The egg is sealed to the leaf with a dark black cover. This cover may persist for several weeks after the larva has hatched and burrowed directly into the leaf. At a temperature of ca 22°C the development time of the egg is 16 days, larva 26 days, and pupa 8-10 days. Oviposition starts in early June when the nutsedge has about 5-6 leaves and continues for ca 6 weeks. Eggs are not laid on the newest leaves. The first 3-4 leaves do not persist long enough to allow larval maturation; subsequent leaves persist for the 6 weeks or more required for development. A single larva may destroy 4-6 cm^2 of leaf surface or about 1/4 to 1/3 of the surface of a leaf. When more than one egg is laid per leaf cannibalism frequently occurs if the larvae encounter each other. Usually only 1 miner matures per leaf. Since most of the feeding damage is caused by the last instar, there is some question as to whether this

insect severely injures yellow nutsedge. The primary feeding may occur in nearly senescent leaves.

T. agriloides pupates within the leaf. Upon emerging, the adults feed on the leaf edge causing little damage to the plant. There is one generation per year. They probably winter in litter as adults. No parasitoids of the eggs have been found. In the laboratory ca 99% of the eggs have been viable. Some larvae were found dead in the mines, as a result of disease, predation by hemipterans, or parasitoid stings.

No information is available regarding host range, though *T. agriloides* has not been collected in our surveys of other sedges. This insect has not been mentioned in lists of insects found on nutsedge in Mississippi (Dr. K. E. Frick-pers. comm.) or in California (Poinar 1964). It has a very localized distribution in our study area.

Horsenettle, *Solanum carolinense,* is a native perennial which is an important weed in both pastures and row crops. Adults of the overwintering generation of *Frumenta nundinella* become active in late May and early June. Larvae attack the growing tips of horsenettle resulting in the formation of a gall or capsule formed from the apical leaves folding together and fusing at the tip. The larva feeds head-down in the capsule, which is apparently maintained by secretions produced by the larva. Nearby leaves are also affected and appear somewhat gnarled or poorly formed. The larva pupates inside the capsule after preparing a weakened area in the side of the capsule. This is used as an exit hold for the emerging adult. Immature development takes ca 1 month. Larval feeding resulting in capsule formation slows plant growth, although lateral branch development still occurs.

When the plant starts fruiting, newly hatched larvae burrow into the developing berries destroy all the seeds. They pupate in the berry. *F. nundinella's* ability to compete with the pepper maggot, *Zonosemata electa,* which also develops within the berry is not known. Studies of *F. nundinella* parasitoids have shown both in Indiana (Montgomery 1933), and in Virginia that a different complex of parasitoids attack the larva in the capsule and in the berry. *F. nundinella* is known only from the eastern, southern, midwestern, and north central portions of North America and we know of no record of it attacking any other plant (Foott 1967).

Leptinotarsa juncta also has been studied as an insect which attacks horsenettle. It resembles the Colorado potato beetle both in appearance and biology. It lays its eggs in masses on the underside of leaves and the larvae defoliate the plant. It begins oviposition ca. mid May and appears to have about 3 generations per year. *L. juncta* is one of the more host specific attacks nightshade, *Solanum dulcamara* but does not attacks potato. We have found that it will oviposite on eggplant, *Solanum melangena,* in the presence of horsenettle and that the larvae will mature on eggplant.

The Carduus thistles are the most important pasture weeds in Virginia. They are introduced winter annuals. Without good pasture management these thistles can take over a pasture. Drs. Kok and Surles have earlier discussed other aspects of our thistle research program.

In our survey of the naturally occurring insects on thistles we found moderately heavy populations of *Cassida rubiginosa in the* northeast corner of Virginia. This leaf-feeding insect was accidentally introduced into North America from Europe and was first discovered in Quebec, Canada in 1901 (Fyles 1902). From Quebec it has spread across much of eastern Canada and northeastern U.S.A.

Although Zwölfer and Eichhorn (1966) showed that *C. rubiginosa* would attack artichoke, *Cynara scolymus,* it has not been reported as being a pest on any valuable plants grown in Northeastern North America. Therefore, we decided to investigate the possibilities of using *C. rubiginosa* as a biological control agent in other portions of Virginia.

Biological investigations in the field and in the laboratory (Ward 1976) indicated that it was univoltine, layed an average of 815 eggs per female, and that development from egg to adult at 21°C required 41 days. Five species of parasitoids which attack the larvae were recovered from cassid beetles collected in northern Virginia: *Tetrastichus rhosaces, Eucelatoripsis dimmocki, Spilochalcis albefrons, Eupelmella vesicularis* and *Itoplectis conquisitor.* Only *T. rhosaces* and *E. dimmocki* were found in significant numbers. The first is an obligate, gregarious endoparasitoid, while the others are native facultative parasitoids.

In 1973 and 1974 cassid beetles were released at 10 sites in southwestern Virginia ca. 100 miles from any known field population of *C. rubiginosa,* thus isolating it from its major obligate parasitoid, Tetrastichus rhosaces (Ward 1976). It appears that all releases will become established. One of our objectives is to determine whether *C. rubiginosa is* a more significant thistle regulating agent in the absence of one of its major para-

sitoids. The other major parasitoid *E. dimmocki*, appears to be dependent on other shield bettles for overwintering hosts and thus may not be capable of regulating *C. rubiginosa* populations.

In the future we anticipate continued biological studies of naturally occurring insects attacking important weeds, and the possible introduction of exotic insect biological control agents. We feel that the ragweeds, horsenettle, bindweed, nutsedge and johnsongrass may be appropriate target weed species.

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REFERENCES

Buchanan, G. A. 1974. Category J. Weed Survey—Southern States. Research Report, Southern Weed Sci. Soc. pp. 215-49.

Chapman, R. N. 1923. Observations on the life history of *Taphrocerus gracilis* (Say). Cornell A.E.S. Mem. 67: 3-13.

Foott, W. H. 1967. Occurrence of *Frumenta nundinella* (Lepidoptera: Gelechiidae) in Canada. Can. Entomol. 99: 443-4.

Forbes, W. T. M. 1923. Lepidoptera of New York and neighboring states. Cornell Univ. A.E.S. Mem. 68: 647-51.

Fyles, T. W. 1902. A tortoise beetle new to Quebec, Can. Entomol. 34: 273-4.

Goeden, R. D. and D. W. Ricker. 1974a. The phytophagous insect fauna of the ragweed, *Ambrosia acanthicarpa*, in southern California. Environ. Entomol. 3: 827-34.

Goeden, R. D. and D. W. Ricker. 174b. The phytophagous insect fauna of the ragweed, *Ambrosia chamissonis*, in southern California. ibid. 3: 835-9.

Goeden, R. D. and D. W. Ricker. 1975. The phytophagous insect fauna of the ragweed, *Ambrosia concertiflora*, in southern California. ibid. 4: 301-6.

Goeden, R. D. and D. W. Ricker. 1976. The phytophagous insect fauna of the ragweed, *Ambrosia dumosa*, in southern California. ibid. 5: 45-50.

Hack, L. 1935. Insects of the giant ragweed (*Ambrosia trifida* Linn.). M.S. thesis, Univ. Kansas. 106 pp.

Harris P. and G. L. Piper. 1970. Ragweed (*Ambrosia* spp.: Compositae): its North American insects and the possibilities for its biological control. Commonwealth Inst. of Biol. Contr. Tech. Bull. No. 13: 117-40.

Hsiao, T. H. 1974. Chemical influence on feeding behavior of *Leptinotarsa* beetles. pp. 237-48 *in* Experimental Analysis of Insect Behavior. L. Barton-Brown (Ed). Springer-Verlag, Berlin and New York.

Meyrick, E. 1927. A revised handbook of British Lepidoptera. Watkins and Doncaster. 914 pp.

Mohyuddin, A. I. 1969. The biology and host spectrum of some stenophagous insects found on *Convolvulus* and *Calystegia* spp. at Bellville, Ontario. C.I.B.C. Tech. Bull. No. 12: 131-46.

Montgomery, B. E. 1933. Preliminary studies of insect parasites in Indiana. Can. Entomol. 65: 185-90.

Poinar, G. O., Jr. 1964. Studies on nutgrass insects in southern California and their effectiveness as biological control agents. J. Econ. Entomol. 57: 379-83.

Stegmaier, C. E. 1971. Lepidoptera, Diptera, and Hymenoptera associated with *Ambrosia artemisiifolia* (Compositae) in Florida. Entomol. 54: 259-72.

Ward, R. H. 1976. Biological studies on *Cassida rubiginosa* Müller, a thistle-feeding shield beetle. PhD. dissertation, Virginia Polytechnic Institute & State Univ. Blacksburg, Va. 134 pp.

Zwölfer, H. and O. Eichhorn. 1966. The host ranges of *Cassida* spp. (Col.: Chrysomelidae) attacking Cynareae (Compositae) in Europe. Z. Angew. Entomol. 58: 394-7.