Insects and Other Arthropods That Feed on Aquatic and Wetland Plants

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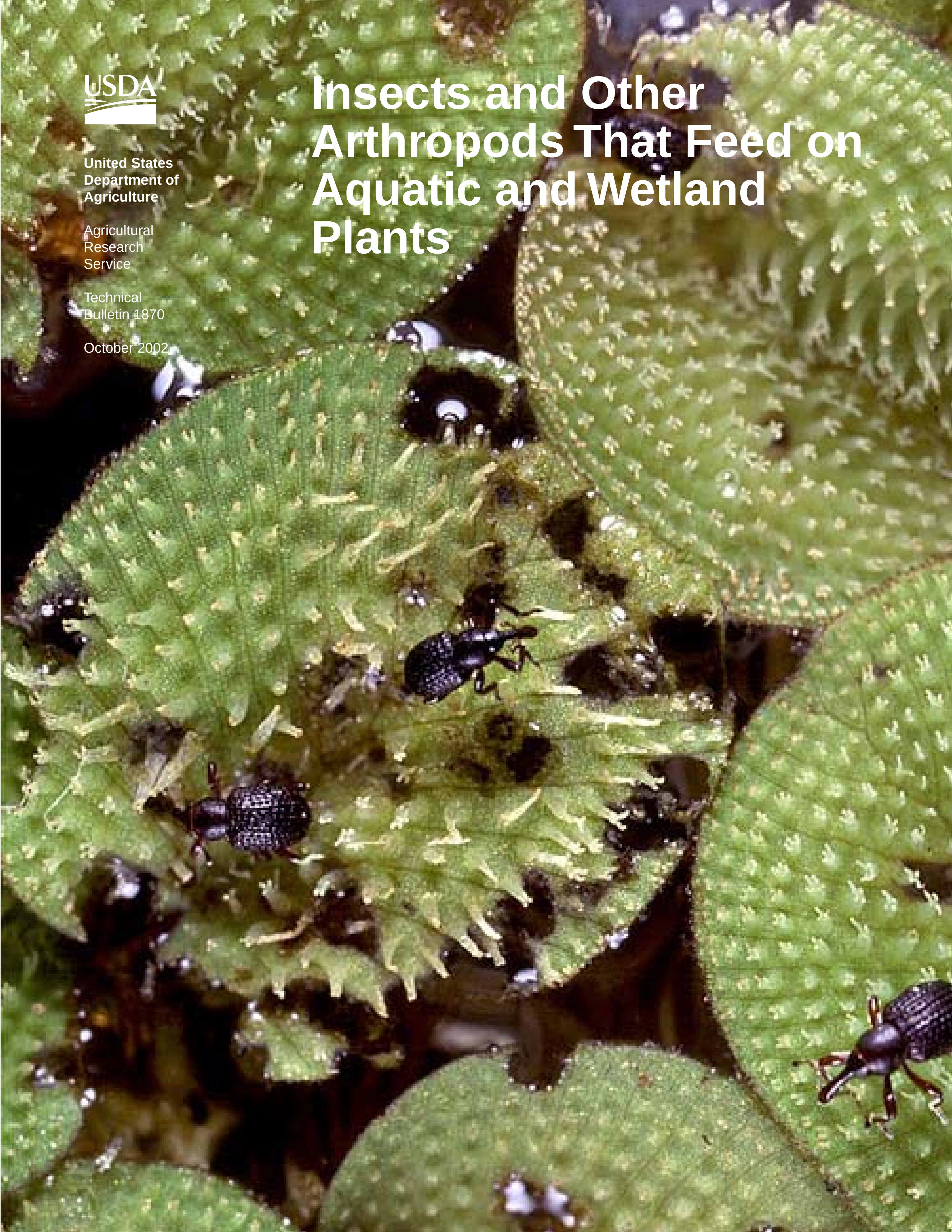

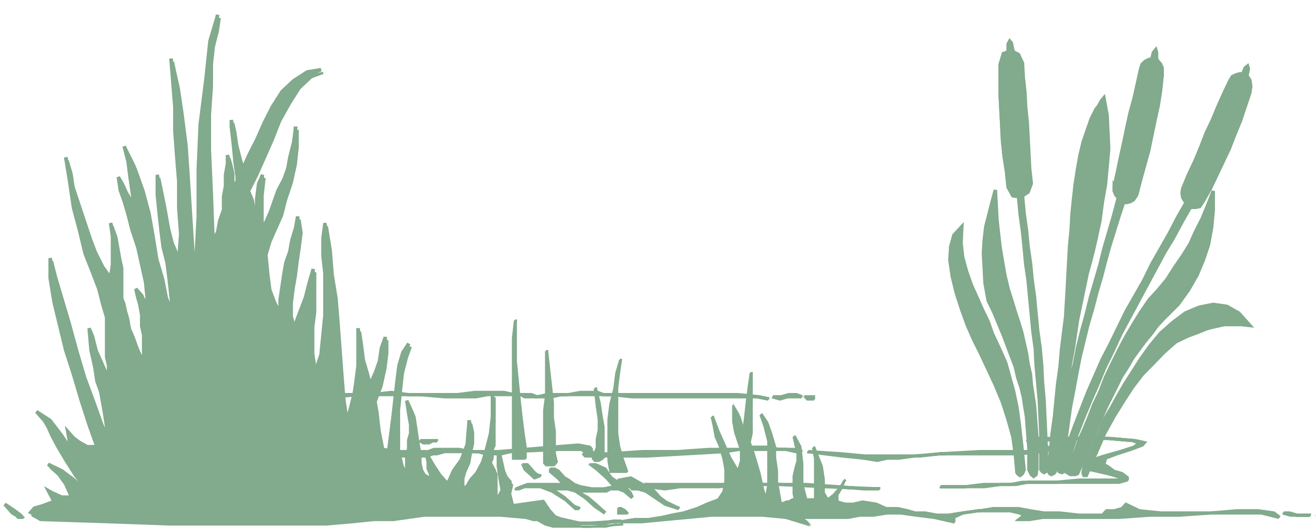

Cover: Adult salvinia weevils on *Salvinia minima*

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Insects and Other Arthropods That Feed on Aquatic and Wetland Plants

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Abstract

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Plant-feeding insects play an often unappreciated but important role in the dynamics of aquatic and wetland ecosystems. Natural resource managers, scientists, and others working in such ecosystems need to be able to recognize these insects and the damage they cause. This manual provides photographs and descriptions of the life stages and feeding damage of about 50 of the most common native plant-feeding insects and naturalized biological control insects found in aquatic and wetland ecosystems in the United States.

Keywords: Biological control, herbivory, insect-plant interaction, insects, phytophagous, weeds.

While supplies last, single copies of this publication can be obtained at no cost from USDA–ARS, Invasive Plant Research Laboratory, 3205 College Ave., Fort Lauderdale, FL 33314.

Copies of this publication may be purchased from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; telephone (703) 605–6000.

Acknowledgments

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Introduction

Plants are common components of the aquatic landscape. Natural resource managers and scientists are very familiar with the plants, both native and nonindigenous, that inhabit the aquatic and wetland ecosystems they seek to conserve. They are often less familiar, however, with biotic factors that help determine the composition and health of the plant communities comprising these ecosystems. Among the most influential of these factors are plant-feeding (phytophagous) insects.

Insects use plants in a variety of ways, with food only being the most obvious. The water in plant tissues, for instance, helps to prevent the insects' dessication. Some insects protect themselves from predation by living inside plant tissues (leaves, stems, roots, bark) while others construct shelters from plant parts. Chemical compounds in plants are incorporated by some insects into defensive secretions that discourage predators. Plants provide oviposition and pupation sites for insects as well.

Host plants also present many challenges to plant-feeding insects. For example, many plants have structures (thorns, hairs, and so forth) that impede attachment to or movement on the plant. Physical barriers and chemical compounds may deter feeding, and digestibility-reducing compounds can inhibit acquisition of adequate food. In addition, the nutritional quality of most plants is quite low, so obtaining adequate nutrition for growth and development is difficult even without all of these impediments. In other words, it's not easy being a phytophagous insect.

Despite the fact that most plant-feeding insects encounter a large number of plant species throughout their lifetimes, relatively few of these plants are fed on or otherwise used as hosts. Sensory inputs, processed by the central nervous system, determine which plants an insect will accept and which it will reject. The process of host acceptance involves a sequence of behaviors, the pattern of which is governed by external stimuli. Each behavior is triggered by a specific environmental cue (for example, flea beetles are attracted to mustard plants by the kairomone allylisothiocyanate) that must attain a minimal level (threshold) to induce the appropriate response. Acceptance at one step then enables progression to the next step if the net stimulus is positive. Thus, in order for a plant to be a suitable host, the insect must (1) discern the plant's presence at long range and move toward it; (2) distinguish the plant at close range from amongst a confusing background of other species and approach it; (3) find suitable sites on the plant for feeding or egg laying; (4) be stimulated to taste the tissue; (5) be stimulated to ingest the tissue and continue feeding or to deposit eggs; (6) obtain adequate nourishment from the tissue to grow and develop; and (7) be able to sexually mature on the diet.

This process, in general, dictates that few of the plants encountered by any particular insect will actually be accepted as hosts. Plant chemical defenses further limit the number of species any given insect can accept as hosts. Chemical defenses are metabolically expensive to overcome, so most insects restrict their diets to plants with similar defenses. Thus, most insects feed and develop on few plant hosts (if stenophagous) or only a single species (if monophagous). Biological control agents provide excellent examples of insects with restricted host ranges. In fact, biological control insects are selected precisely because they typically demonstrate high degrees of host fidelity. The selection of host specialists as biological control insects is critical because protection of nontarget plant species is imperative. No biological control researcher wants to introduce an agent that itself becomes a pest. Consequently, only the most fastidious insects are used as biological control agents.

Plant-feeding insects exploit host plants in four general ways:

- External feeding in which chewing mouthparts are used to bite plant tissue, most notably from the leaves.
- External feeding in which the mouthparts pierce or rasp the plant tissue, after which sucking mouthparts are used to remove cell contents or fluids from the vascular system.
- Internal feeding in which tissues between the leaf surfaces (or inside stems and roots) are grazed, creating burrows or "mines" within the plant tissue.
- Forming of galls.

As a result of these feeding patterns, some insects produce characteristic damage to their host plant. For example, the waterlily leafcutter removes distinct semicircular pieces from the margins of its host's leaves. Transparent tunnels inside hydrilla leaves characterize the presence of leafmining fly larvae. Not all feeding damage is characteristic or obvious, however. Feeding damage from many leafhoppers, for example, is not visible because the holes made by inserting their sucking mouthparts are very small. Also, many phytophagous insects possess different feeding mechanisms at different life stages and could thus be included in more than one category.

The damage produced by plant-feeding insects varies in its effect on the plant. Highly visible damage like that produced by the waterlily leafcutter, for instance, reduces photosynthetic area, disrupts fluid and nutrient transport, induces dessication of the leaf tissue, and opens the leaf to infection by opportunistic pathogens. It is seldom lethal, however, because it usually affects only the leaves. Most plants can recover from even complete defoliation. So long as storage tissues and meristematic tissues remain undamaged, the plant merely compensates for the lost tissue by producing new leaves. Repeated loss of photosynthetic tissues over several growing seasons can, however, severely retard growth or even kill a plant as stored resources become depleted. This loss of reserves affects the plant's ability to withstand stress from herbicides, drought, frost, and so on. Also, even partial defoliation can inhibit flowering and thus cause population-level consequences by reducing seed production.

Organisms that feed internally, particularly on meristematic tissues, often affect the plant more seriously. Larval or adult feeding inside leaves or stems destroys the plant's ability to transport nutrients and fluid throughout the plant, causing desiccation, leaf curling, and wilting. Feeding in plant crowns frequently destroys newly forming leaves, reproductive organs, and vegetative propagules. Loss of meristems decreases the plant's ability to replace damaged tissue, subsequently reducing the overall productivity of the plant. Loss of reproductive structures and vegetative propagules can severely curtail plant population regrowth, which is particularly devastating to annual plants. Further, direct damage to storage organs causes a loss of resources that impedes growth and recovery from other stresses, as discussed in the preceding paragraph. Ultimately, the level of damage sustained by a plant is related both to the number of phytophagous insect species it hosts and the densities these insects achieve.

Phytophagous insects can also vector plant diseases or create circumstances whereby entry of phytopathogens into the plant is facilitated. Many sap-feeding insects transmit viral diseases that are capable of killing plants. The plum aphid associated with waterlettuce, for example, may be involved with the transmission of a viral plant disease. Also, some sap-feeding insects inject toxic saliva into the wound, producing massive necrosis of surrounding tissues.

Biological Control

Most of the phytophagous insects encountered in aquatic and wetlands habitats are native to the region. That is, they were present in these ecosystems long before humans' arrival on this continent. Some, however, have been purposefully introduced by humans in an attempt to control imported plant species gone wild. Although many foreign plants are introduced into this country without negative consequences, some escape cultivation to become serious interlopers in native ecosystems. The most generally accepted explanation for the success of such weeds is that the repressive forces (that is, natural enemies) that held them in check in their native habitats are missing where they were introduced.

Introduced plants, indeed, often lack a full complement of phytophagous insects, whereas native plants in the same area usually host a diverse assemblage of phytophagous insects. Thus, native plant species are subject to more repressive forces than are the exotics. This enables the exotic species to out-compete native species, sometimes becoming highly invasive in natural communities. In these situations, the exotics tend to displace natives and form large, continuous monocultures.

The idea behind biological control is to reduce the vigor of the exotics so that the native plants have a fighting chance. Biological control doesn't strive to duplicate the population regulatory processes of a pest organism's native environment. When natural enemies suppress a native species in natural conditions, multiple species, including both specialists and generalists, are involved. Biological control instead relies on the introduction of only a selected few of these species—specialists capable of repressing the pest population. The biological control insect also lacks its normal repressive forces and so can attain densities much greater than would usually occur in its native range. If the only factor limiting the size of their populations is the food supply, these biological control insects can profoundly affect the abundance, productivity, and vigor of the pest plants. With a decline in productivity, native plants can again compete more favorably with introduced species. Competition with native species then puts additional pressure on the introduced plants, further reducing their productivity and growth potential.

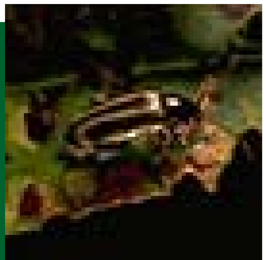
Scope of This Manual

The importance of plant-feeding insects in the dynamics of aquatic and wetland ecosystems is often unappreciated. This is most often due to the unfamiliarity of resource managers, scientists, and others with the plant-feeding insects that are present in these ecosystems. The purpose of this manual is mainly to assist in the recognition of these insects and the damage that they cause. The presence of invasive exotic plants in natural ecosystems means that biological control insects of these weeds will also be found there. Thus, this manual includes not only common native insects of aquatic and wetlands weeds, but also naturalized biological control insects. It is our hope that this work will foster improved recognition of the more common native and introduced plant-feeding insects in aquatic and wetland ecosystems of the southeastern United States. It must be noted, however, that the insects presented on these pages are only a few representatives of a large and diverse entomofauna. Specialists should be consulted when positive identifications are required.

Insects With Restricted Diets

Alligatorweed Insects

Alligatorweed Flea Beetle, *Agasicles hygrophila* Selman and Vogt
(Coleoptera: Chrysomelidae: Halticinae)



General Information and History
The alligatorweed flea beetle was the first insect ever studied for biological control of an aquatic weed. The introduction of this insect into the United States was approved during 1963, but it was not successfully established until 1965. The first successful release was made at the Ortega River near Jacksonville, Florida, during April 1965. These insects were originally obtained from the Ezeiza Lagoon near Buenos Aires, Argentina. Most of the beetles later released elsewhere were progeny of this population.

Agasicles hygrophila has been an extremely effective biological control agent in coastal regions but less so in northern inland areas where winter temperatures eliminate the emergent portions of alligatorweed during the colder months and where the summers are hot and dry. Both adults and larvae feed on leaves, often defoliating the stems. After the leaves are nearly gone, they even chew the epidermis from the stems.

Plant Host
Alligatorweed, *Alternanthera philoxeroides* (Mart.) Griseb. (Amaranthaceae)

Biology and Ecology
Adult alligatorweed flea beetles measure 5–7 mm long and about 2 mm wide. The shiny adults have a black head and thorax and black and yellow wing covers (elytra). The females deposit their eggs in masses on the undersides of alligatorweed leaves. The eggs are arranged in two parallel rows. Each pair of eggs forms a V, creating a chevronlike pattern for the mass. The eggs measure 1.25 mm by 0.38 mm, on average. Each egg mass contains 12–54 eggs (average 32). At the time of deposition the eggs are uniformly light cream in color, but they change to a pale orange yellow by the second day. Successful completion of the egg stage is contingent upon sustained high humidity. The eggs hatch in 4 days at diurnal temperatures between 20 and 30 °C (longer at cooler temperatures).

The larva emerges from the egg by rupturing the chorion (egg covering) along a longitudinal line for a distance of about one-third of its length. The newly emerged larva lacks complete pigmentation, and the head, legs, and body are pale gray. The legs become brown within a few hours. Later instar larvae are light gray with a brown head and legs. The integument of the late third-instar larvae is very dark. The three instars range in length from 1.2 to 2.0 mm, 2.2 to 4.0 mm, and 4.1 to 6.0 mm for first to third instars, respectively. Head capsules measure 0.25, 0.50, and 0.75 mm, respectively.

Feeding damage by young larvae consists of circular pits less than 1 mm diameter in the lower surface of the leaf. The young larvae do not chew entirely through the leaf but leave the upper surface intact. They prefer young leaves. The larvae are gregarious at first but later become solitary as they move away from the egg mass. Later instars consume more leaf tissue, the feeding pits are larger and more irregular, and they may start feeding from either side of the leaf. At diurnal temperatures of 20–30 °C the developmental periods are 3 days, 2 days, and 3 days for the three respective instars, so the larval period is 8 days.

After the larvae are fully grown they search for a suitable pupation site. They pupate within the hollow stem, so stem diameter is critical. They normally descend from the tip to the fourth internode but always pupate above the waterline. They chew a circular hole in the internode and pull themselves into the hollow stem with their head oriented toward the tip. They plug the hole with masticated plant tissue, then seal off a chamber within the internode. The pupa is soft bodied and uniformly pale cream in color. The pupational period is approximately 5 days.

The female begins to lay eggs about 6 days after emergence. Oviposition continues for about 3 weeks during which time the average female lays 1,127 eggs. Adult females live about 48 days. In Argentina, populations annually undergo about five generations, four of which occur during summer. These populations are poorly adapted to freezing temperatures because they lack a winter diapause. In fact, they starve during winter when the alligatorweed is frozen down to the waterline. They also suffer during periods of high temperature, and their fecundity is reduced at temperatures above 26 ^{o}C. In the southeastern United States, two population peaks (spring and fall) occur in the southernmost parts of their range, whereas one (fall) occurs in more northerly areas. Alligatorweed flea beetles do not do well on poor-quality alligatorweed (characterized by thin stems, short internodes, and abnormal coloration) or on terrestrial alligatorweed.

Effects on Host

Alligatorweed flea beetles kill the plant by destroying its stored food and interfering with its ability to produce new food. Large populations of alligatorweed flea beetles can decimate alligatorweed, reducing it to bare stems in a short time.

At a distance, an alligatorweed mat being attacked by large numbers of alligatorweed flea beetles appears yellow, progressing to brown, until finally the plants collapse. This insect is highly effective in reducing populations of alligatorweed, especially when present with the alligatorweed stem borer. Effect time can be as short as 3 months after its introduction.

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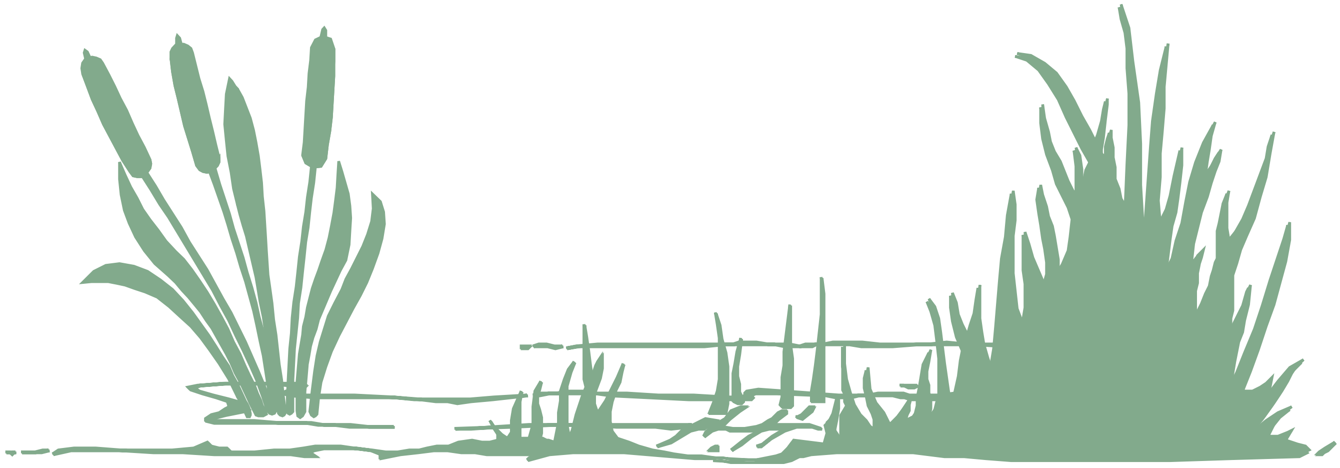


Figure 1. Alligatorweed flea beetle

A, Alligatorweed heavily damaged by *Agasicles hygrophila* intermixed with water pennywort

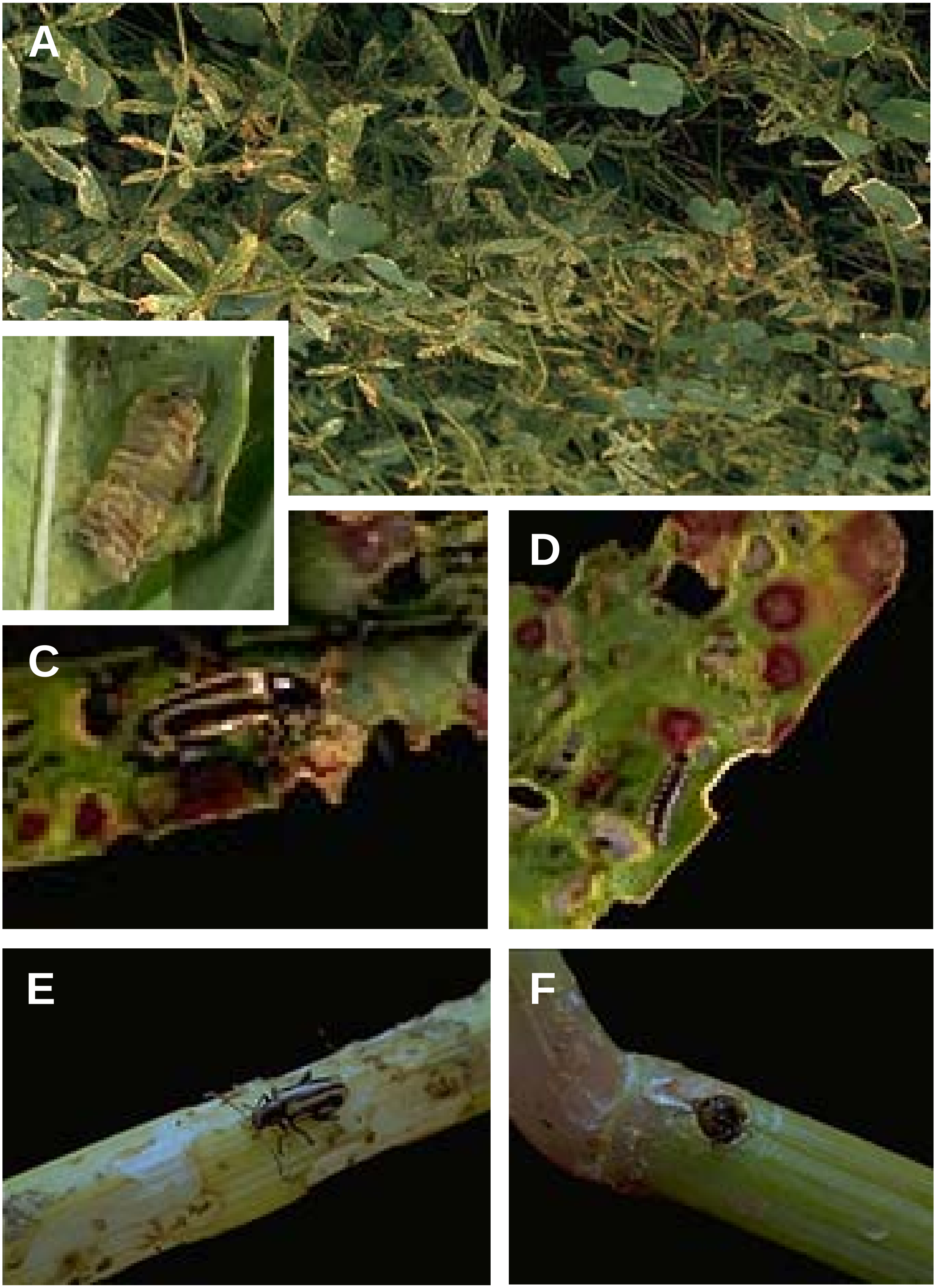
B, Cluster of hatched alligatorweed flea beetle eggs with two first-instar larvae

C, Adult alligatorweed flea beetle

D, Late instar *Agasicles hygrophila* larva on an alligatorweed leaf that shows damage caused by larval feeding

E, Adult *Agasicles hygrophila* on an alligatorweed stem that shows epidermal damage caused by the adult beetles

F, Alligatorweed flea beetle emerging from its pupal chamber in an alligatorweed stem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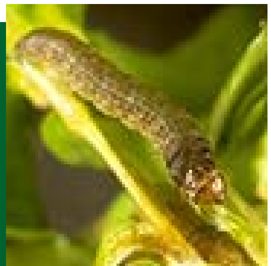
Alligatorweed Stem Borer, *Arcola malloi* (Pastrana)
(Lepidoptera: Pyralidae: Phycitinae)



General Information and History
Dr. George Vogt explored extensively for biological control agents of alligatorweed from 1960 to 1962, particularly in northern Argentina, southern Brazil, and Paraguay. One of the most widespread species that he encountered was an undescribed moth, *Arcola malloi,* the genus of which was originally named in his honor as *Vogtia. A. malloi* is found from tropical Guyana through tropical Brazil to temperate Argentina and appeared to be a potentially effective biological control agent. After further study, approval for its release in the United States was granted in 1970. Releases were made during 1971 in southern Georgia and northern Florida and its effectiveness was apparent by 1972. Unlike the alligatorweed flea beetle, *A. malloi* appears capable of overwintering in northern areas.

Plant Host
Alligatorweed, *Alternanthera philoxeroides* (Mart.) Griseb. (Amaranthaceae)

Biology and Ecology
The adult female alligatorweed stem borer deposits oval eggs (0.7 mm by 0.4 mm) singly on the undersides of young leaves near the leaf margin or the midvein or in the leaf axil. The egg is white at first but becomes yellow as the embryo develops. It hatches in about 6 days. The first-instar larva is about 2.2 mm long with a dark brown head and prothoracic shield and a white or light amber body. In later instars the head is mottled brown and tan with wavy longitudinal lines on the dorsum. The fully grown larva is 18 or 19 mm long and the head capsule is about 1.2 mm wide. The larvae go through five instars over a period of about 24 days (at 23 ^{o}C).

First instars immediately tunnel into the host plant through the first to fourth internodes of the apical stem portion. They then move downward through the hollow stem, feeding on the internal wall as they go. They burrow through the nodal septa to obtain access to lower internodes. Older larvae may enter stems at a lower level and burrow upward, devouring wall tissue nearly to the epidermis. A single larva may destroy five to nine stems during the course of its development. The damage creates a distinctive tip wilt that easily characterizes an infested mat.

Pupation occurs within the stem in a sealed chamber created by the larva. The pupa is formed in a silken cocoon in a cavity in the stem. Prior to pupation the larva bites a circular hole (2 mm diameter) through the stem wall but not through the outer epidermis. This provides egress for the adult. The pupa is initially amber colored but gradually becomes dark brown. The length of the pupa is 9–10 mm and the width is 1.5–2.0 mm. Adults emerge in about 10 days at temperatures of 23 ^{o}C.

The adult moth emerges by rupturing the thin membranous epidermis covering the hole previously created by the larva. Adults of both sexes are pale tan, but females also have a reddish tint. The leading edge of the forewing has five gray spots (less apparent in females than in males). The wings are slender. Males have blunt abdomens with claspers; females have slender, pointed abdomens. Adults of both sexes have a distinctly pointed head. The adult is nocturnal. During the day it is quiescent and rests in an angled position, supporting itself with the four hind legs. Females lay an average of 267 eggs over a 6–8 day period. Females live 6–10 days and males 5–9 days.

Effects on Host
The damage caused by *Arcola malloi* complements that of *Agasicles hygrophila* and is very dramatic. Stems normally remain erect after defoliating attacks of the flea beetle, but

the burrowing of *Arcola* larvae causes them to collapse, giving the mat a flattened appearance. Within a few days of the onset of feeding, stems and leaves wilt and die. Plant declines are observed 3–5 months after the insect is introduced. Alligatorweed mats generally have the capacity to recover from attack by either of these species, but if the two agents occur together in the same mat, rarely do the plants recover. Much of the credit given to the flea beetle for alligatorweed control probably rightly belongs to *A. malloi.*

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Figure 2. Alligatorweed stem borer

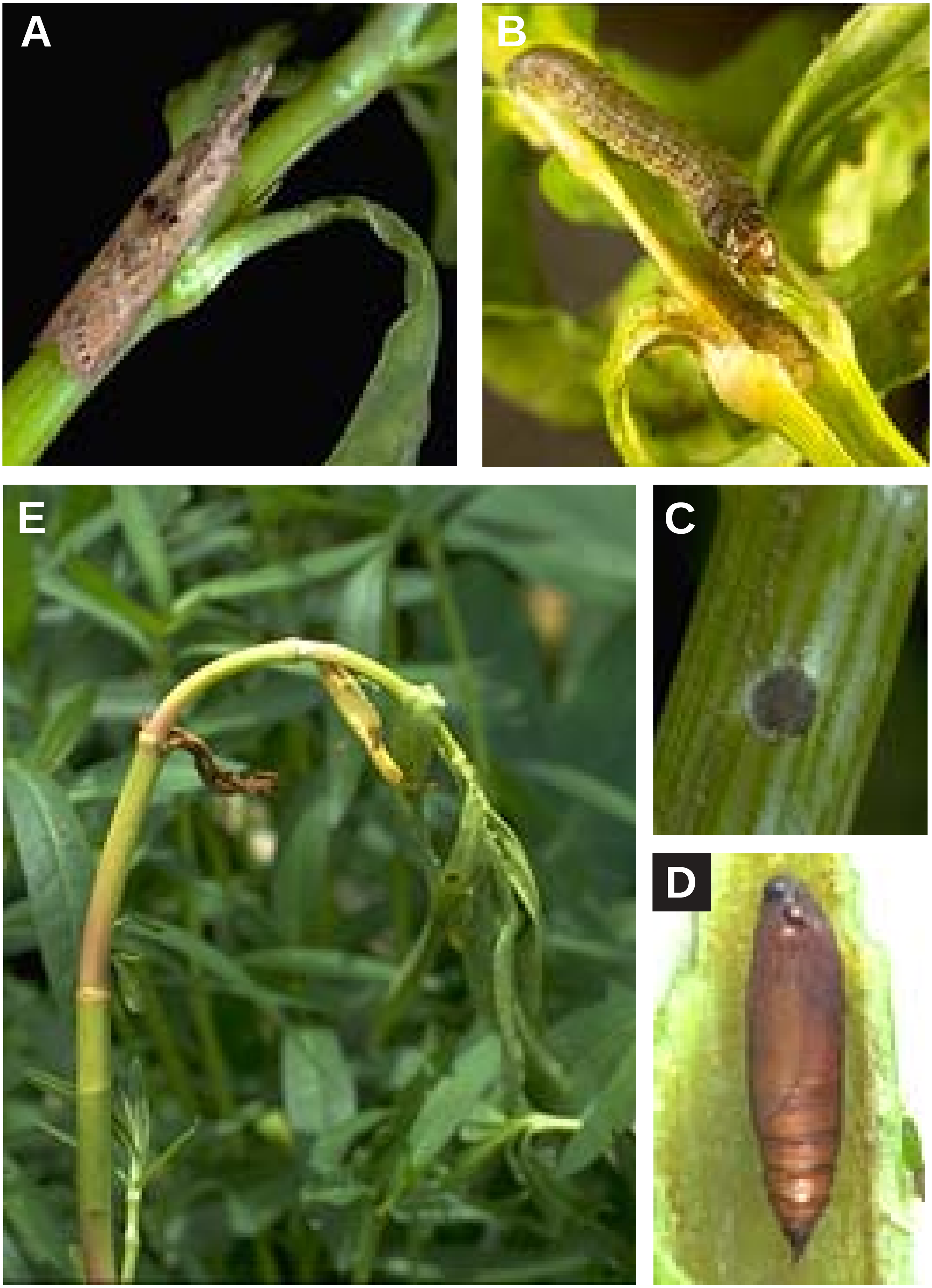
A, Adult alligatorweed stem borer moth

B, Larva of *Arcola malloi*

C, Adult exit hole in an alligatorweed stem at the top end of the pupational chamber

D, Pupa of *Arcola malloi*

E, Alligatorweed shoot showing the tip wilt that characterizes the presence of a larval stem borer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Alligatorweed Thrips, *Amynothrips andersoni* O'Neill
(Thysanoptera: Phlaeothripidae)

General Information and History

The alligatorweed thrips is a South American native that was imported into the United States and released in Florida for biological control of alligatorweed during 1967. Subsequent releases occurred in Georgia, South Carolina, California, Texas, and Mississippi.

Plant Host

Alligatorweed, *Alternanthera philoxeroides* (Mart.) Griseb. (Amaranthaceae)

Biology and Ecology

The adult alligatorweed thrips is shiny and black in color. The female is only about 2.1 mm long, while the male is about 1.7 mm long. Two forms exist, a short-winged (brachypterous) form and a long-winged (macropterous) form. Only the macropterous form is capable of flight. The females undergo a 4-day preovipositional period after which they deposit their eggs on or behind hairs present in leaf axils on stem nodes of alligatorweed. Females lay an average of about 200 eggs. The newly placed eggs are yellowish or amber and become reddish as the embryo matures. The eggs hatch in about 7 days and produce a larva. There are two distinct larval stages. The first larval stage (length 0.6–0.7 mm) is light gray at first, becoming amber as it grows. The second larval stage (length 1.3–1.9 mm) is deep red with black legs.

Larvae are active and feed by piercing meristematic tissues with their mandibular and maxillary stylets. Scarified lesions are produced along the margins of the young leaves, causing the leaves to distort and curl. The larvae often aggregate within these curled leaves, which provide excellent hiding and feeding sites.

As with other species of thrips, *Amynothrips andersoni* development progresses through a prepupal stage before attaining the pupal stage. The total generation time is about 28 days, and the adults live up to 4 months. Females are possibly facultatively parthenogenetic and produce haploid males.

Effects on Host

On floating alligatorweed, *Amynothrips andersoni* has difficulty competing with the alligatorweed flea beetle, which rapidly defoliates the plants. The thrips thrives on rooted alligatorweed, however, which usually is not heavily attacked by flea beetles. The feeding activity of the larvae causes stunting of leaf growth, but thrips populations are sporadic and their distribution seems limited. Some evidence indicates that predators may suppress thrips populations, as does resource competition from flea beetles.

Infested plants appear very similar to plants that have been treated with 2,4–D, appearing to be curling and highly folded. With continued feeding the entire plant appears stunted. Since the feeding of alligatorweed thrips is almost entirely on the newest portion of the plant, they continually prevent the production of healthy functional leaves. This in turn reduces the ability of the plant to produce food, significantly weakening it over time. However, the effect of this insect on alligatorweed, particularly the rooted form, has never been fully evaluated.

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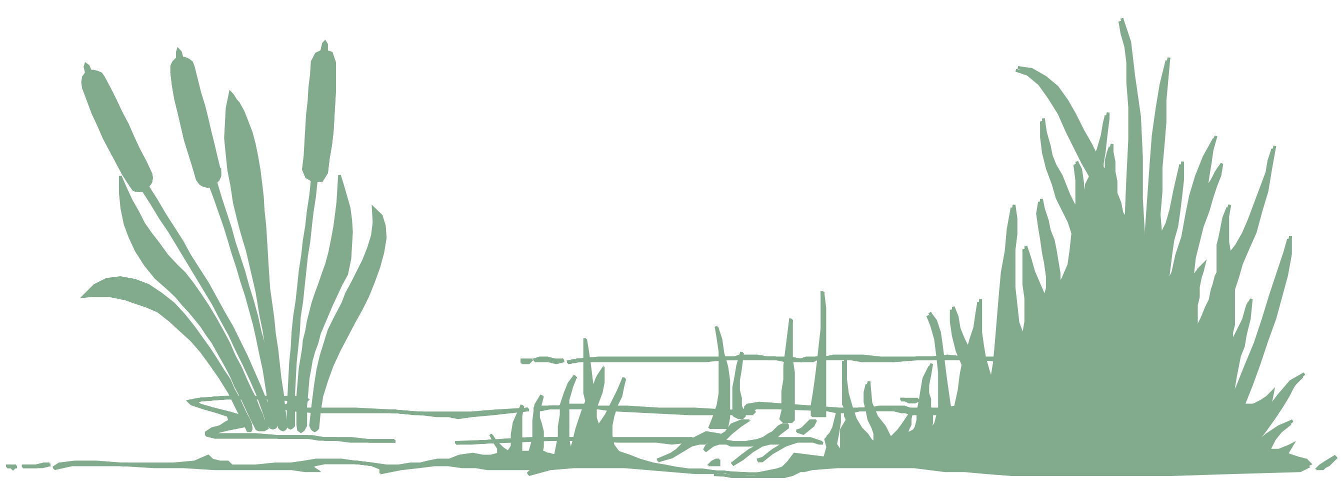
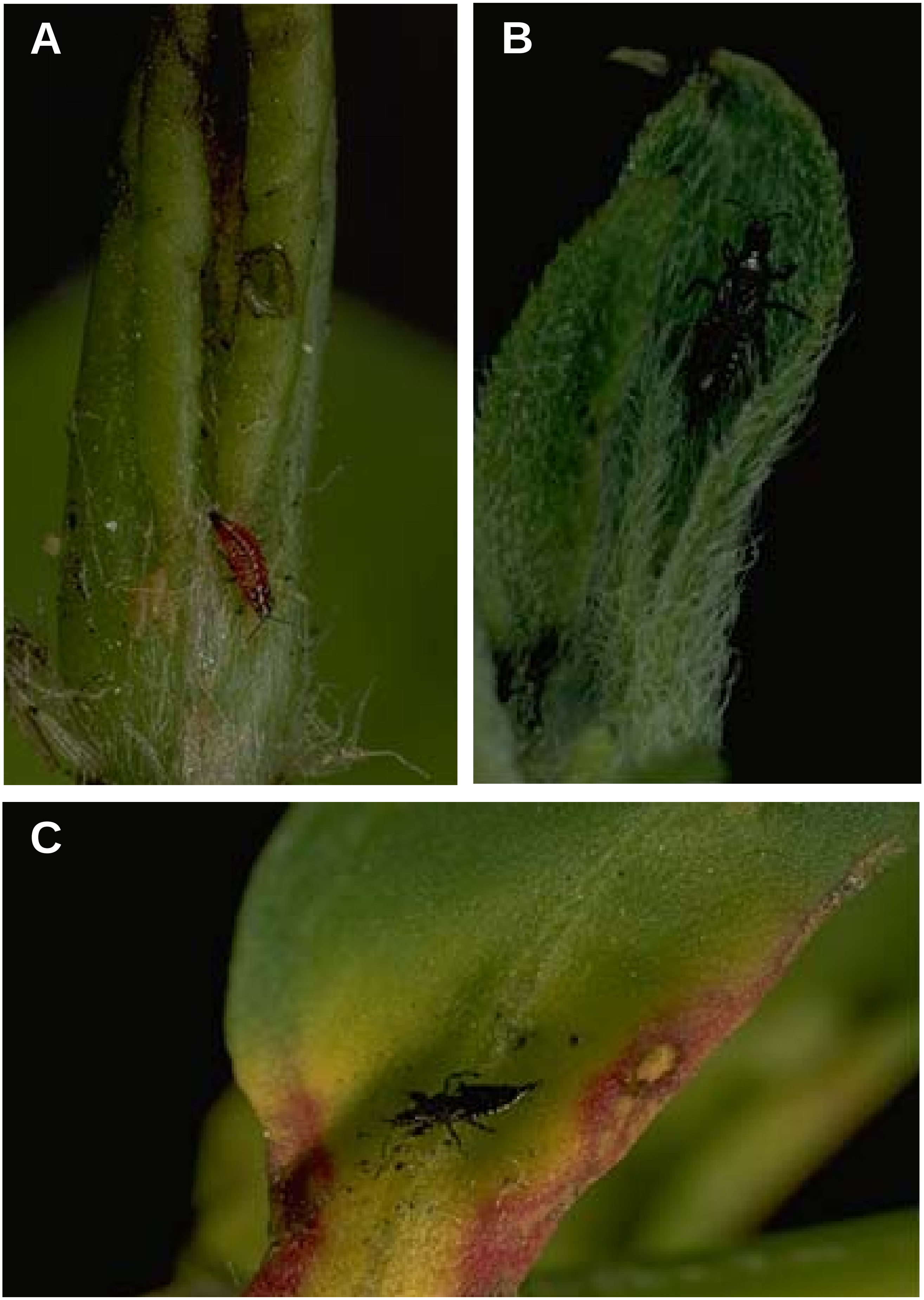


Figure 3. Alligatorweed thrips

A, Eggs of alligatorweed thrips and a second-stage larva

B, Long-winged (macropterous) adult alligatorweed thrips

C, Short-winged (brachypterous) adult alligatorweed thrips on a leaf that has been deformed by thrips feeding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Larger Canna Leafroller, *Calpodes ethlius* (Stoll)
(Lepidoptera: Hesperiidae)

General Information and History

Another common name of the adult of this well-known species is the "Brazilian skipper." It is widely distributed in subtropical and tropical regions of the Americas ranging as far north as eastern New York, southern Ohio, northeastern Illinois, eastern Nebraska, and southern Nevada and south to northern Argentina and Chile.

Plant Hosts

Alligatorflag, *Thalia geniculata* (Marantaceae)
Arrowroot, *Maranta arundinacaea* L. (Marantaceae)
Banana-of-the-Everglades, *Canna flaccida* (Cannaceae), and other *Canna* species.

Biology and Ecology

The adults of *C. ethlius* are dark brown, medium-sized skippers with a series of translucent spots on both the forewings and the hindwings. Unlike *G. cannalis,* the wings are held vertically over the body in typical "skipper" fashion with the forewings and the hindwings held slightly outward and separated. Adults are fast fliers and strong migrants. Females lay pale greenish eggs (1.25 mm in diameter) singly or clustered (up to seven per cluster) on the leaves of the host plant. Eggs become distinctly pink within a day and larvae eclose within five days. Five larval instars are produced. The yellowish neonates measure about 4 mm in length but grow to about 50 mm when fully developed. The head of the first instar larva is glossy black, enlarged, and dorsally bilobed, giving it a somewhat "horned" countenance. The thoracic shield, legs, and anal shield are also black. The larva moves to the leaf edge soon after eclosion where it cuts a flap, folds it over itself to form a tube, and secures it with silk to the main leaf. The larva remains within the rolled leaf, extending only its head outside of the shelter to feed, and creates new, larger tubes as it grows.

Although the larvae are actually translucent and grayish with a white line on either side of the dorsum of the body, food in the gut causes them to appear green. The head of later instars is yellow to orange with a dark ocellar area. It is distinctly wider than the thorax with a characteristic "neck," as is typical of hesperiid larvae. There is also a dark band behind the head on the prothoracic shield. The prepupal stage, which lasts up to 8 days, is bright bluish green. Pupation occurs within the leaf tube and the bright green chrysalis (36 mm long) sports a distinct black spine at the anterior end. Adults emerge from the chrysalis in about a week.

Effects on Host

The larger canna leafroller is a pest of arrowroot (*Maranta arundinacaea* L., Marantaceae) in the West Indies where defoliation by larvae reduces yield of the edible rhizome. It is also a pest of ornamental cannas (along with *Geshna cannalis*), which are sometimes so severely defoliated that they fail to produce flowers. Impacts on *Thalia geniculata* are unknown.

References

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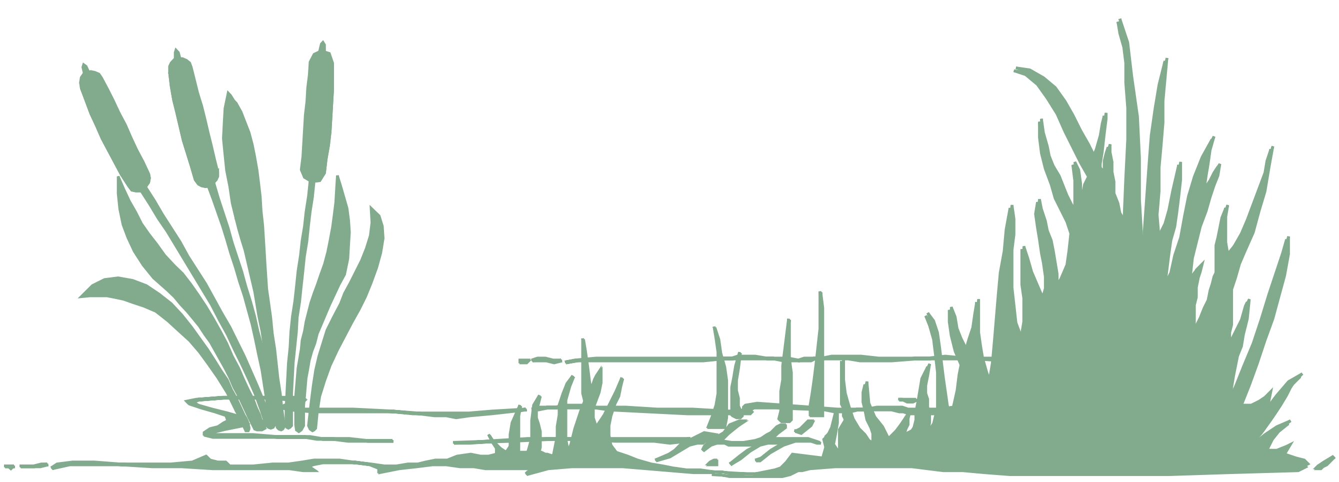


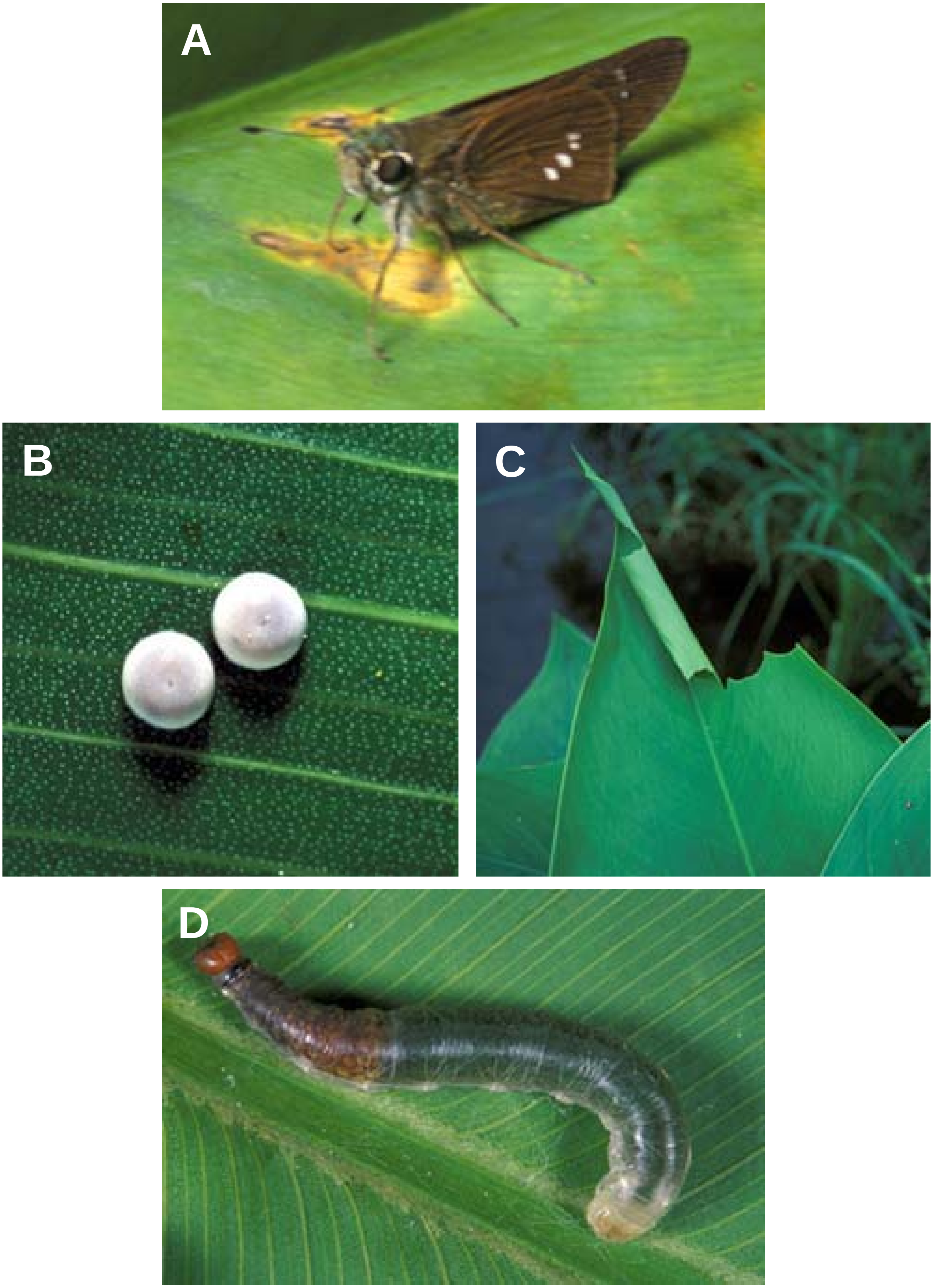
Figure 4. Larger canna leafroller

A, Larger canna leafroller (Brazilian skipper) adult

B, Eggs of the larger canna leafroller on a *Thalia geniculata* leaf

C, Rolled leaf of *Thalia geniculata* created by the larger canna leafroller

D, Larva of the larger canna leafroller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Lesser Canna Leafroller, *Geshna cannalis* (Quaintance)
(Lepidoptera: Pyralidae: Pyraustinae)

General Information and History
Two lepidopterans that commonly attack canna also utilize *Thalia geniculata* as a host. One is the larva of the Brazilian skipper, (*Calpodes ethlius* (Stoll): Hesperiidae). The second is *Geshna cannalis*. Both species are often called "canna leafrollers" because of the larval habitat of rolling the leaves up into long tubes. The larvae feed and pupate within these tubes. To distinguish between them, *C. ethlius* has been named the "larger canna leafroller," while *G. cannalis* has been named the "lesser canna leafroller."

Plant Hosts
Banana-of-the-Everglades, *Canna flaccida* Salisb. (Cannaceae)
Alligatorflag, *Thalia geniculata* Linnaeus (Marantaceae)

Biology and Ecology
The larvae of *Calpodes ethlius* and *Geshna cannalis* are easily distinguished on the basis of familial characteristics. The head of the larva of the Brazilian skipper is distinctly larger than the prothorax, as is characteristic of hesperiid larvae. This is not the case with *G. cannalis*. The larvae of *G. cannalis* are similar to those of the American lotus borer *(Ostrinia pentatalis), Samea multiplicalis*, and the waterhyacinth moth *(Niphograpta albiguttalis),* all of which are members of the same subfamily (Pyraustinae). The adults are also readily distinguished. The adult of *G. cannalis* is a small, brown moth. The wings are held in a horizontal position when at rest, causing it to appear triangular in shape. The skippers are typically very active and often rest with the forewings held at a more vertical angle than the hindwings.

A third moth species commonly associated with *Thalia geniculata* is the Thalia plume moth *Sphenarches anisodactylus* (Walker) (Pterophoridae). The larvae of this species feed on the flowers.

Larval *Geshna cannalis* crate a feeding shelter by tying unfurled leaves with silk to prevent them from opening. They then feed on the inner surface of the leafroll, which destroys the dorsal epidermal and parenchymal tissues, but leaves the ventral epidermis of the leaf intact. Feeding shelters of *G. cannalis* can be distinguished from those of the larger canna leafroller by the presence of copious amounts of dark brown frass.

Effects on Host
We know of no studies describing the effects of these insects on their host plants.

References

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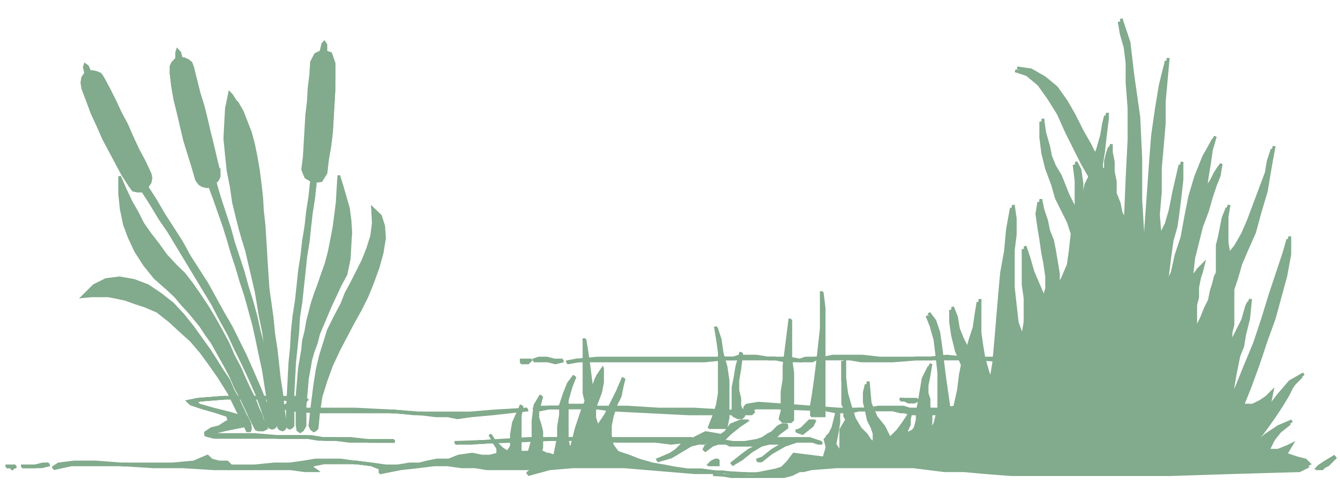

Figure 5. Lesser canna leafroller

A, Adult *Geshna cannalis*

B, Larva of the lesser canna leafroller

C, Thalia geniculata showing a rolled leaf damaged by the lesser canna leafroller

D, Pupa of *Geshna cannalis* that was found in the rolled leaf shown in figure 5C


A
B
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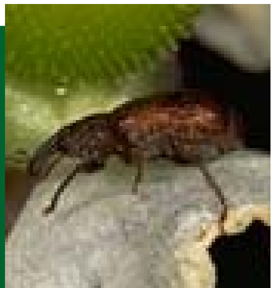
D

Arrowhead Weevils, *Listronotus* spp.
(Coleoptera: Curculionidae: Brachycerinae: Rhytirrhinini)



General Information and History
The weevil genus *Listronotus* is quite large and diverse, with 62 described species from North America north of Mexico. The species in this genus have been associated with numerous species of plants including *Polygonum hydropiperoides, Crinum* spp., *Paspalum distichum, Borrichia frutescens* (Linnaeus) DeCandolle, *Echinodorus cordifolius* (Linnaeus) Grisebach, *Salicornia virginica* Linnaeus, and *Eleocharis macrostachya* Britton. One species, the carrot weevil *(Listronotus oregonensis),* which feeds on carrot and parsnip, is an important pest. The carrot weevil is terrestrial, but most other species are associated with aquatic habitats. The host plants of most species are unknown, however.

Plant Host
Arrowheads, *Sagittaria* spp. (Alismataceae)

Biology and Ecology
The most commonly encountered *Listronotus* species feed on and breed in various species of *Sagittaria* (Alismataceae). These include *L. cryptops* (Dietz) on *S. lancifolia* Linnaeus, *L. neocallosus* O'Brien on *S. engelmanniana* J.G. Smith, *L. rubtzoffi* O'Brien on *S. cuneata* Sheldon, and *L. turbatus* O'Brien (presumed to breed in *Sagittaria* sp.). Biological information is limited, even for the most common species. Eggs (such as those of *L. cryptops*) are generally laid in *Sagittaria* flower stalks (peduncles). The larvae feed and develop within these stalks, which exude copious amounts of a milky white latex through the resultant wounds. Conspicuous globules of hardened latex, which form over the holes created by larval feeding, often signal the presence of the larva within. The fully developed larva pupates within the peduncles and teneral adults (fully formed but not completely hardened) can often be found in the pupal chambers. Some species possibly also feed and develop within the leaf petioles or in the root collars (for example, *L. turbatus, L. neocallosus,* and *L. frontalis*). Adults feed on the flowers and fruits, generally exceed 5 mm in length, and are mottled brown to black.

Effects on Host
We know of no studies describing the effects of these insects on their host plants.

References

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Figure 6. Arrowhead weevils

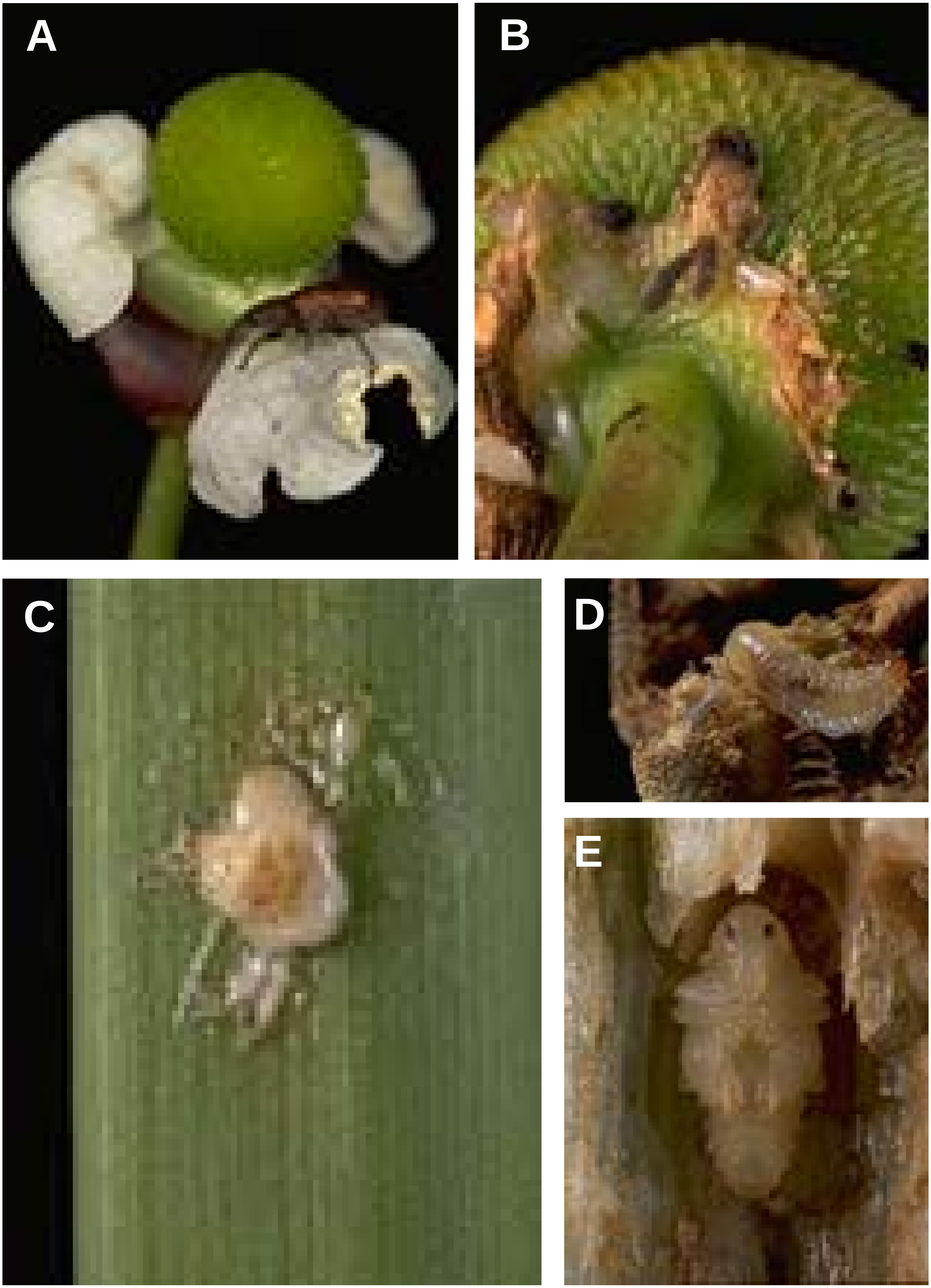
A, Adult *Listronotus* spp. on a *Sagittaria* flower

B, Listronotus spp. egg inserted behind the calyx of a *Sagittaria* flower

C, Typical latex globule exuded from the burrow of a *Listronotus* spp. larva in a *Sagittaria* flower stalk

D, Larva of *Listronotus* spp.

E, Pupa of *Listronotus* spp.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Cattail Borer, *Bellura obliqua* (Walker)

(Lepidoptera: Noctuidae: Amphipyrinae)

General Information and History

The cattail borer is one of three moth species in the genus *Bellura (= Arzama).* The other two are *B. densa,* which feeds on *Pontederia* and *Eichhornia,* and *B. gortynoides,* which feeds on *Nuphar.*

Plant Hosts

Cattail, *Typha latifolia* L. (Typhaceae)
Cattail, *Typha angustifolia* L. (Typhaceae)
Cattail, *Typha domingensis* Pers. (Typhaceae)

Biology and Ecology

The female cattail borer lays her eggs on a young cattail leaf several inches below the tip. As with the other *Bellura* species, the eggs are laid in several-layered masses of 25–40 eggs each. These masses are covered with a thick, yellowish-white material that is composed of an exudate produced by the female moth mixed with scales from her body. The mass is round, about 15 mm in diameter, and convex. Although egg production is variable, individual females produce 225 eggs or more.

Larvae break through the lower surface of the eggs and burrow directly into the cattail leaf. Early instars are leafminers and burrow downward, while scraping parenchyma from below the leaf epidermis. After mining a couple of feet, they molt to the second instar and exit from the leaf. They then crawl down the stem and hide beneath the sheath of one of the outer leaves. As they grow larger they become progressively more solitary and begin to burrow within the stalk. They continue downward through the crown, sometimes even burrowing into the rhizome. This causes the central leaves to die and prevents subsequent flower formation. As with the other two *Bellura* species, the spiracles on the eighth abdominal segment are situated posteriorly and dorsally, instead of laterally. This is presumably an adaptation to life in a burrow.

Fully grown larvae attain lengths of 5 or 6 cm prior to pupation. The larvae hollow out pupal chambers within the cattail stalk and then molt into the pupal stage. Although no cocoon is formed, the chamber is lined with loose strands of silk. The pupa is reddish brown at first and later darkens to become nearly black.

The biology of this insect has never been studied in detail. Little is known about the duration or number of instars or other aspects of its development.

Effects on Host

Feeding damage by *Bellura obliqua* can reduce cattail productivity by up to 55 percent and shift biomass allocation in secondary ramets more toward photosynthetic tissues.

References

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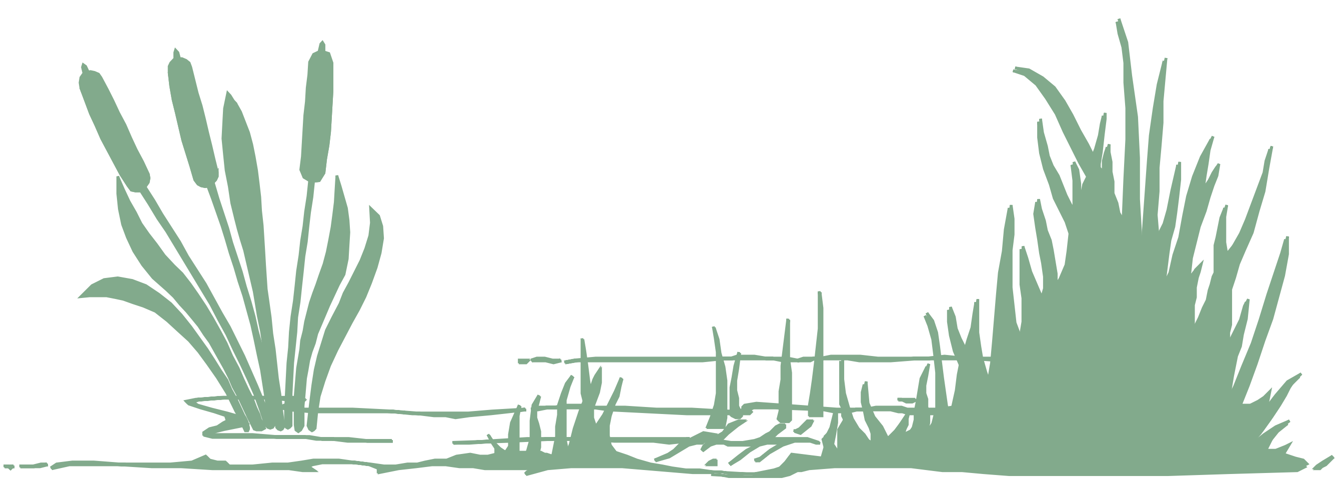

Figure 7. Cattail borer

A, Female (top) and male (bottom) *Bellura obliqua* adults

B, Late-instar cattail borer larva


A


B

Duckweed Fly, *Lemnaphila scotlandae* Cresson
(Diptera: Ephydridae: Notiphilinae: Phyligriini)

General Information and History
The duckweed fly was first reported from Ithaca, New York. It has since been reported from Illinois, Michigan, Ohio, and Florida, but it likely occurs throughout the eastern United States.

Plant Host
Duckweeds, *Lemna* spp. (Araceae)

Biology and Ecology
The duckweed fly is almost certainly one of the smallest insects that attacks an aquatic plant. Adults are small (1.2 mm) black flies with yellow-tipped legs. Unlike most ephydrids, the adults feed on the plant. They rasp the upper surface of duckweed thalli with spines located on their mouthparts, creating distinctive parallel gouges.

Eggs are usually laid singly on the edges of the thalli. The eggs are usually yellowish, measuring 0.3 mm long by 0.08 mm wide, with parallel ridges running lengthwise. The incubation period is about 2 days, after which the larva exits through the bottom surface and enters directly into the thallus. The white larva mines the thalli. It feeds on the mesophyll by tearing it apart with its black mouth hooks and then ingesting the macerated tissue. After completely clearing out one thallus, the larva transfers to an adjacent thallus to continue feeding. The larvae are also capable of swimming to other duckweed plants separated by open water. The larval stage comprises three instars and requires about 10 days.

Two black-tipped, cone-shaped structures on the posterior end of the abdomen are thrust into the lower epidermis of the thallus prior to pupation. Supposedly, this firmly anchors the puparium. The puparium is amber in color and about 1.5 mm long. The pupal stage requires about 4 days. The adult emerges by inflating a specialized bladderlike structure (the ptilium) that then ruptures the anterior end of the puparium. It crawls through this opening, forces apart the epidermal layers of the thallus, and exits onto the outer surface. Feeding begins very soon thereafter, but mating and oviposition are delayed until the second day. Although the insects do fly, flights are usually very low and are more like short hops of a few inches. Adults probably only live about 3 days.

At least three species of wasps (the braconid *Opius lemnaphilae* and the diapriids *Trichopria paludis* and *T. angustipennis*) parasitize this species, with one report indicating parasitization rates up to 50 percent.

Effects on Host
We know of no studies describing the effects of this insect on its host plants.

References

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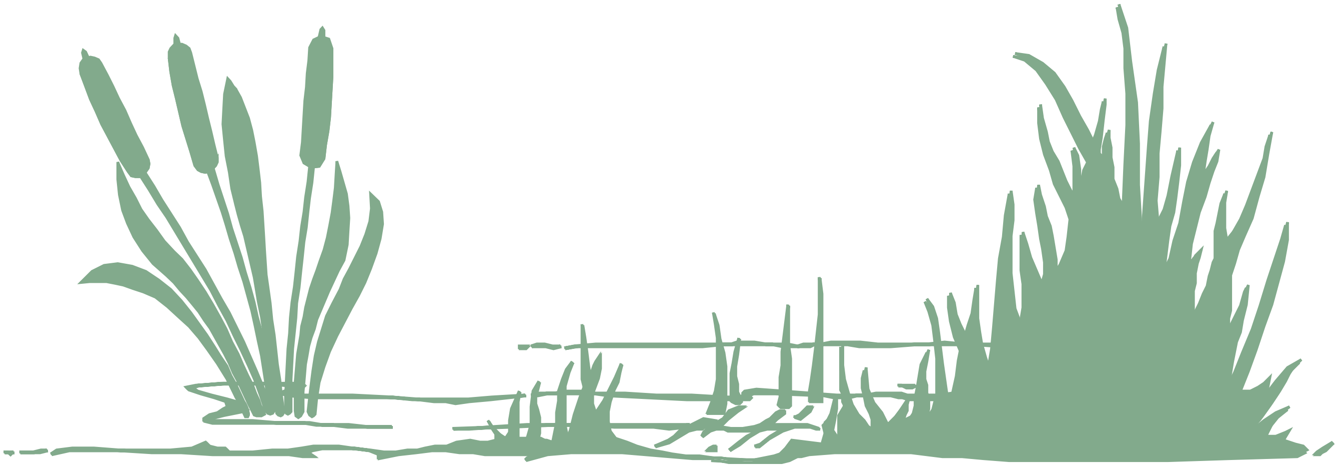
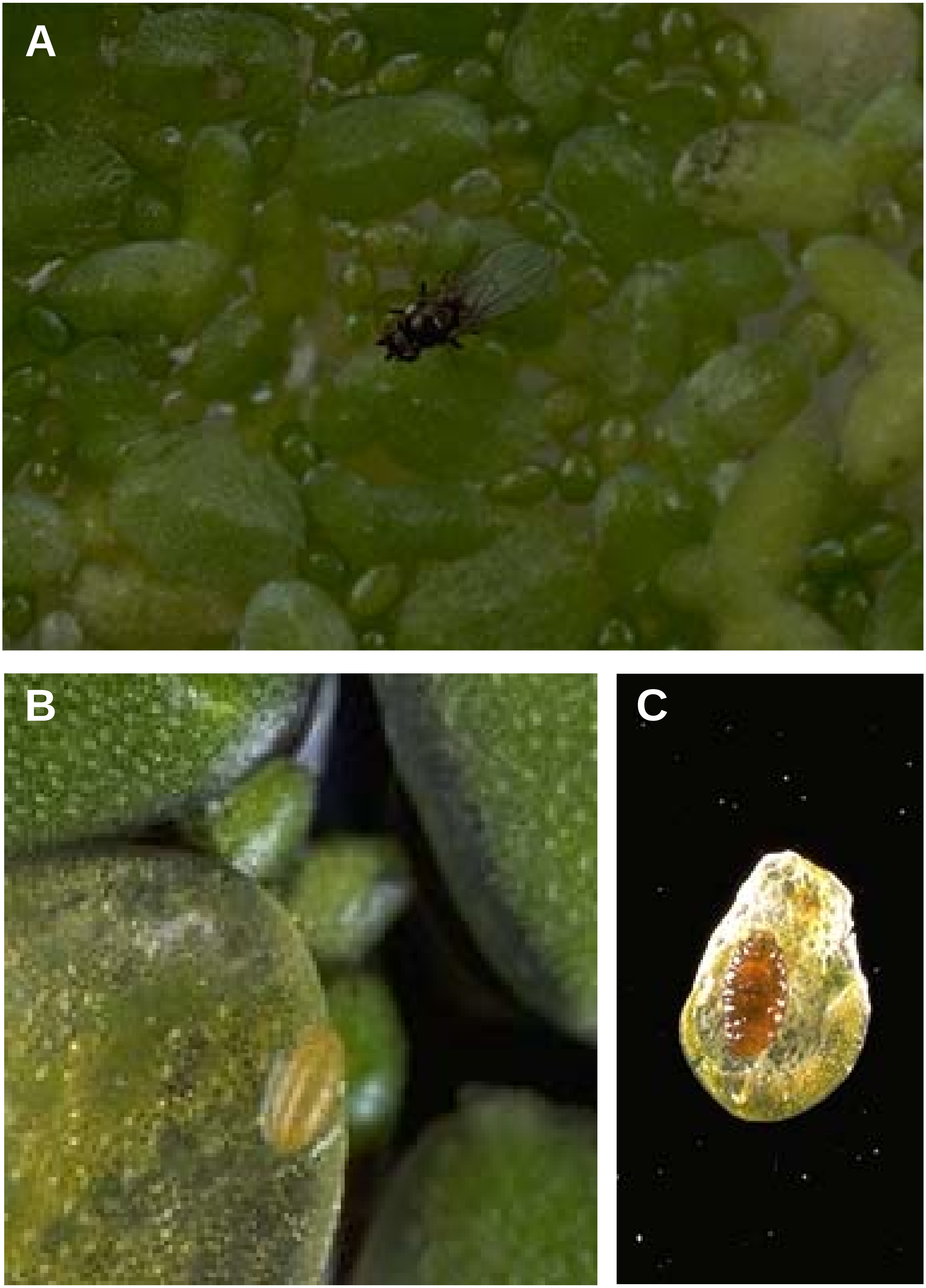


Figure 8. Duckweed fly

A, Adult duckweed fly resting on duckweeds

B, Egg of *Lemnaphila* scotlandae on the edge of a duckweed frond

C, Duckweed frond dissected to show the puparium of *Lemnaphila scotlandae* that it contained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Duckweed Weevil, *Tanysphyrus lemnae* Paykull

(Coleoptera: Curculionidae: Curculioninae: Erirhinini)

General Information and History

One of the most common and widespread duckweed herbivores is the duckweed weevil *Tanysphyrus lemnae.* Although it is a well-known species, very little has been written on its biology and life history. This species was once thought to be conspecific with *Tanysphyrus atra,* but the two are now recognized as distinct species. The host of *T. atra* is the leafy liverwort *Ricciocarpus natans.*

Plant Hosts

Duckweeds, *Lemna* spp. (Araceae)
Duckmeats, *Spirodela* spp. (Araceae)

Biology and Ecology

The female duckweed weevil lays her eggs one by one directly into the thallus through a hole she chews into it. The eggs are inserted from the top surface and generally fill the space between the upper and lower surfaces of the thalli. The female then plugs the hole with a black substance, probably feces. Eggs hatch in about a week. The nearly transparent neonates measure about 0.5 mm in length. They immediately begin to feed. Each larva consumes most of the thallus that contained the egg within 12 hours. If other thalli are contiguous with the first one, the larva burrows directly from one to the other. If not, they swim from one to another. Larvae consume the green contents of the thalli and leave most of the epidermis intact. As the larva grows, it becomes a translucent beige color with a yellow-brown head and lengthens to about 3 mm. Pupation occurs along the shoreline in the soil or under stranded duckweed. The total generation time is about 16–20 days. Adults feed by chewing on the surfaces of the thalli, causing obvious round perforations.

Effects on Host

We know of no studies describing the effects of this insect on its host plants.

References

Scherf, H. 1964. Die entwicklungsstadien der mitteleuropäischen Curculioniden. (Morphologie, bionomie, ökologie). Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 506:1–335.

Scotland, M.B. 1940. Review and summary of insects associated with *Lemna minor.* Journal of the New York Entomological Society 48:319–333.

Tanner, V.M. 1943. A study of the subtribe Hydronomi with a description of new species, (Curculionidae). The Great Basin Naturalist 4(1&2):1–38.

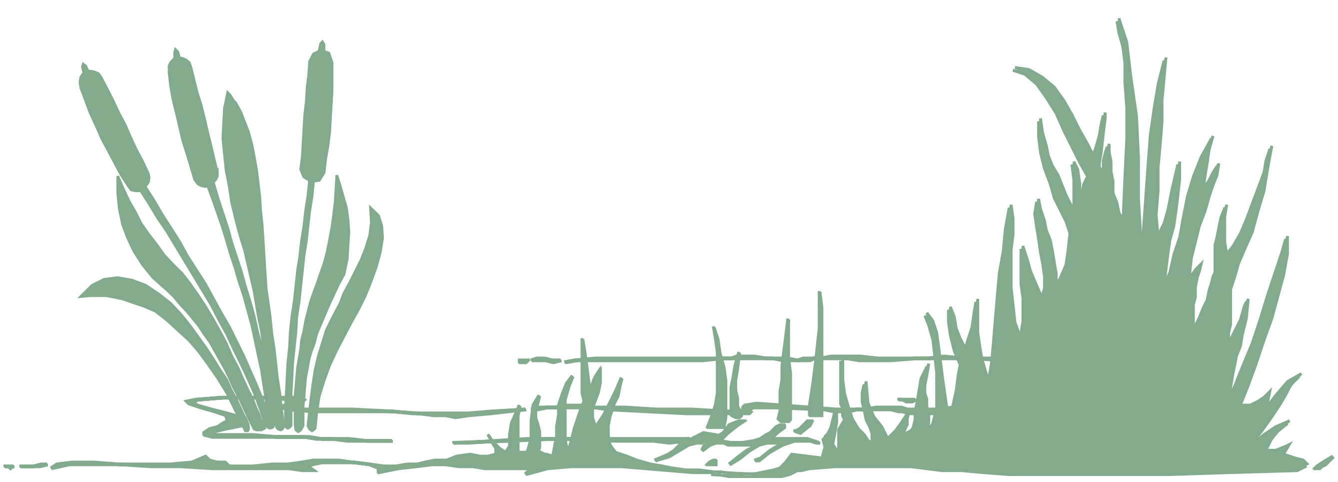


Figure 9. Duckweed weevil

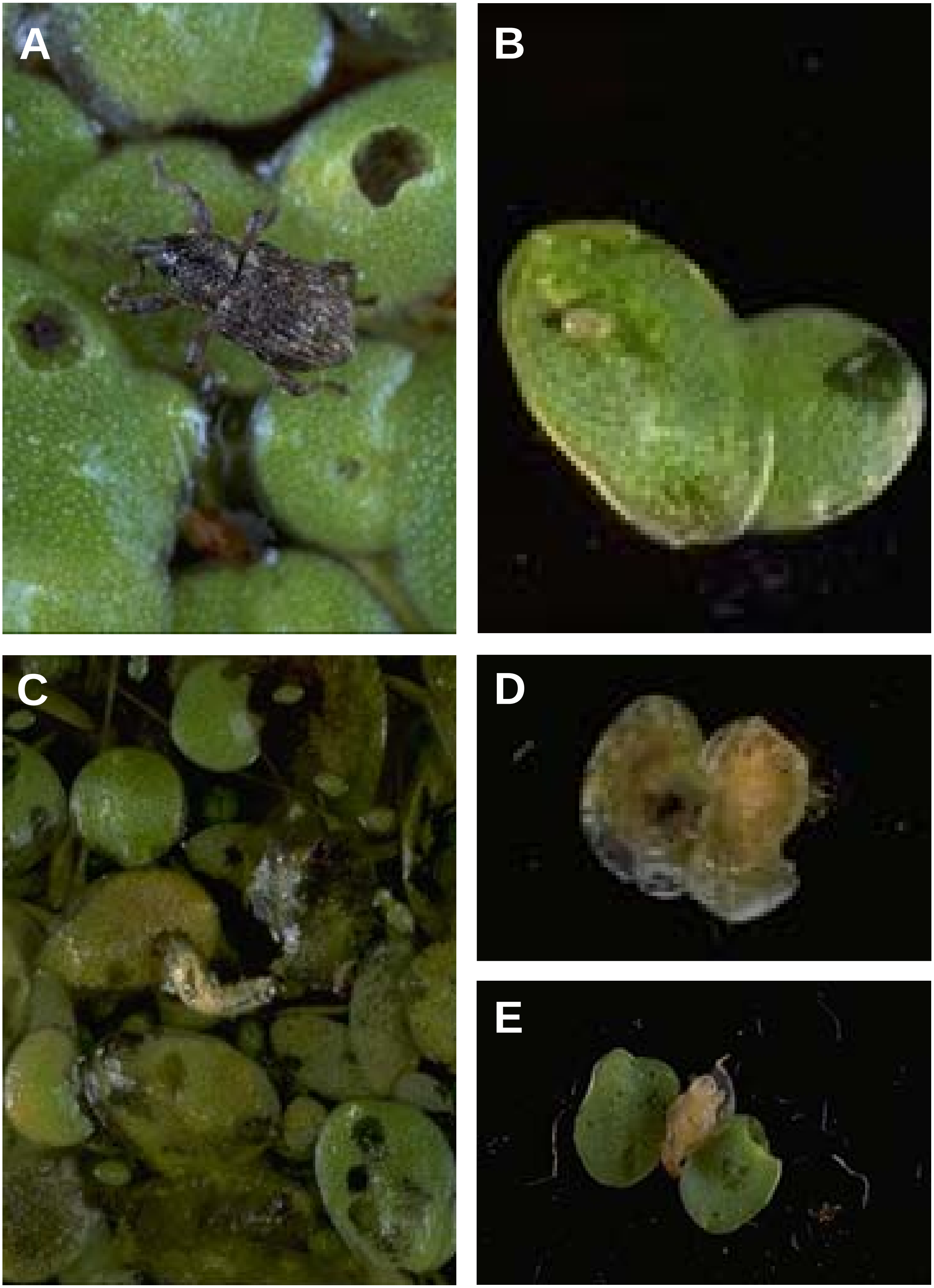
A, Adult duckweed weevil on duckweed

B, Egg of *Tanysphyrus lemnae* in a duckweed thallus

C, Tanysphyrus lemnae larva emerging from a duckweed thallus

D, Tanysphyrus lemnae pupa within a duckweed thallus

E, Tanysphyrus lemnae pupa removed from the thallus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Frog's Bit Weevil, *Bagous lunatoides* O'Brien
(Coleoptera: Curculionidae: Curculioninae: Erirhinini)

General Information and History
Weevils comprise the largest family of insects and are easily recognized by the distinct snout, which is long and slender in most groups, including the bagoines. The snout is actually an extension of the head. Mouthparts are small and located at the end of the snout. Weevils are generally phytophagous, and their diets include every plant part. Most weevil larvae live within the tissues of their host plant. Although a few weevil species are truly aquatic, completing their entire life cycle under water, *Bagous lunatoides* is actually semiaquatic in that adults are typically found on above-water portions of their hosts.

Plant Host
Frog's bit, *Limnobium spongia* (Bosc.) Steud. (Hydrocharitaceae)

Biology and Ecology
Bagous lunatoides feeds and develops exclusively on its host plant, *Limnobium spongia.* Damage caused by both adults and larvae to the leaf blades and petioles is usually conspicuous wherever frog's bit occurs. The adult feeding damage consists of feeding pits in the leaf surfaces, similar to those of the waterhyacinth weevils. The feeding scars are often contiguous, forming rather large, irregular patches.

The adult female chews a hole in a leaf in which to oviposit. As the larva feeds, it creates a long meandering gallery within the tissue. As the damaged tissues ages, it becomes necrotic or desiccates. The larval gallery then becomes evident on the exterior leaf surface as a brown streak or shallow groovelike depression. Pupation occurs at one end of the larval gallery. The adult chews its way out of the pupal chamber after completing development.

Although the biology of this species is poorly known, adults appear to develop rapidly, with a total generation time of perhaps as little as 10 days. The adult weevils are easily found on the undersurface of emergent frog's bit leaves. They are unable to swim but can walk on both the upper and lower sides of the surface film and they commonly clamber about on submersed aquatic plants. We often find adults of this species in hydrilla beds, but we have never ascertained whether or not they actually feed on hydrilla (also a member of the Hydrocharitaceae).

The adult weevils are typically marked with a broad, whitish, crescent-shaped (lunate) band located posteriorly on the elytra (wing covers) between two short tubercles. Color and markings are variable, however, and the lunate band is sometimes lacking.

Effects on Host
We know of no studies describing the effects of this insect on its host plant.

Reference

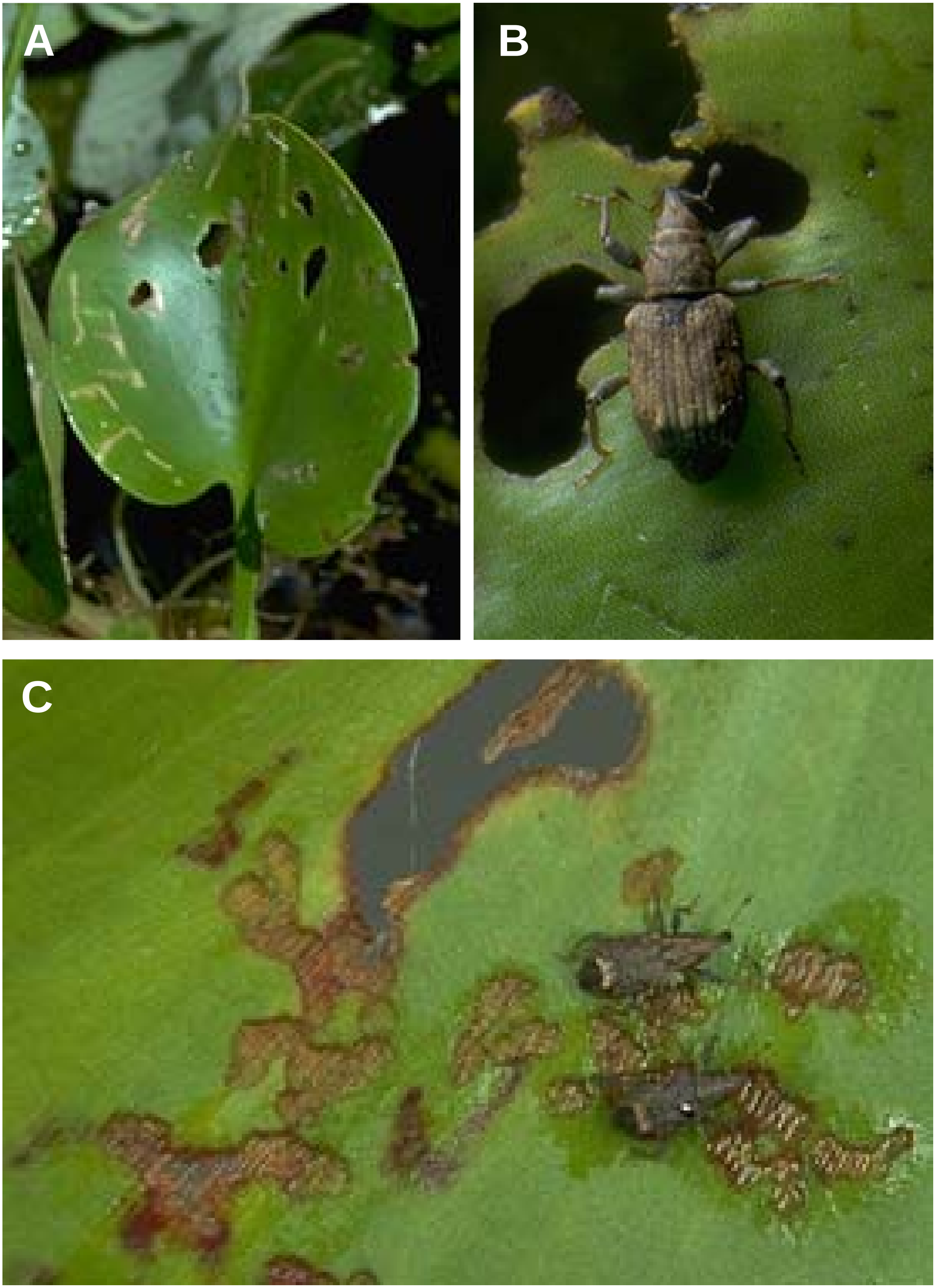
O'Brien, C.W., and G.B. Marshall. 1979. U.S. *Bagous,* bionomic notes, a new species, and a new name (Bagoini, Erirrhininae, Curculionidae, Coleoptera). The Southwestern Entomologist 4:141–149.

Figure 10. Frog's bit weevil

A, Larval galleries (light streaks) of *Bagous lunatoides* on frog's bit leaves. The holes in the leaves were caused by moth larvae.

B, B. lunatoides adult

C, Adult frog's bit weevils and feeding scars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Mimosa Seed Beetle, *Acanthoscelides quadridentatus* (Schaeffer)

(Coleoptera: Bruchidae)

General Information and History

Mimosa pigra is a thorny, leguminous shrub or small tree that is native to the Neotropics from extreme southern Texas to South America. It was introduced into Australia in the late 1800s (Miller and Lonsdale 1987), where it persisted at relatively innocuous levels until the late 1970s. It then explosively increased and now occupies nearly 450 km^2 of seasonally inundated flood plains (Braithwaite et al. 1989).

The consequences have been disastrous to native ecosystems. In fact, Braithwaite et al. (1989) suggest that the resultant structural change from native sedgeland to tall shrubland has more severely affected associated fauna than the clearing of native woodlands for replacement by introduced pine plantations. *Mimosa pigra* has also created severe problems in wetlands of Southeast Asia (Napompeth 1982). It has been found in several southern Florida counties and its eventual spread into southern wetlands is a subject of great concern.

The high reproductive potential of *Mimosa pigra* and the persistence of seeds in the soil accounts for its weedy nature (Lonsdale et al. 1988). Seed banks in Australia may contain 12,000 seeds/m^2, two orders of magnitude higher than in Mexico, within the plant's native range (Lonsdale et al. 1988). This led the Australians to consider the introduction of seed predators (Harley 1985). As a result, two bruchid species, *Acanthoscelides quadridentatus* (Schaeffer) and *A. puniceus* Johnson, were released in 1983 (Kassulke et al. 1990). Recently, *A. quadridentatus* adults were reared from seeds collected near Jupiter in Martin Co., Florida. This constituted the first record for this species in this state.

Plant Host

Giant sensitive plant, *Mimosa pigra* L. (Fabaceae)

Biology and Ecology

The only information available on the biology of *Acanthoscelides quadridentatus* is from studies conducted in Australia (Kassulke et al. 1990). The ovoid eggs (0.6 mm by 0.2 mm) are deposited on the surfaces of mature pods. The eggs are laid singly, usually flat on the pod surface between the erect vertical hairs and often near intersegmental sutures or the pod margin. The eggs hatch in 7–12 days (at 25 ^{o}C). Larvae tunnel through the pod wall, frequently choosing instead to enter through the thin-walled septum that separates the seeds within the pod. Once within the pod, they enter the seed. Each larva develops within a single seed. The seed is completely hollowed out and thus rendered nonviable. Final-instar larvae create a window in the seed coat to facilitate adult emergence. The duration of the larval period is 14–18 days, followed by a 1-day prepupal period. They then pupate for 5–7 days within the larval feeding cavity. Adults remain within the seeds for at least 4–8 days and then emerge by chewing out the remainder of the window. A preovipositional period of 7–10 days is required before the females begin to lay eggs. Adults survive in the laboratory as long as 144 days, and the average life cycle (egg to adult) is about 40 days. Females lay about 20 eggs per week during the first week of their ovipositional period and fewer than 5 eggs per week thereafter.

Effects on Host

We know of no studies describing the impacts of this insect on its host plants.

References

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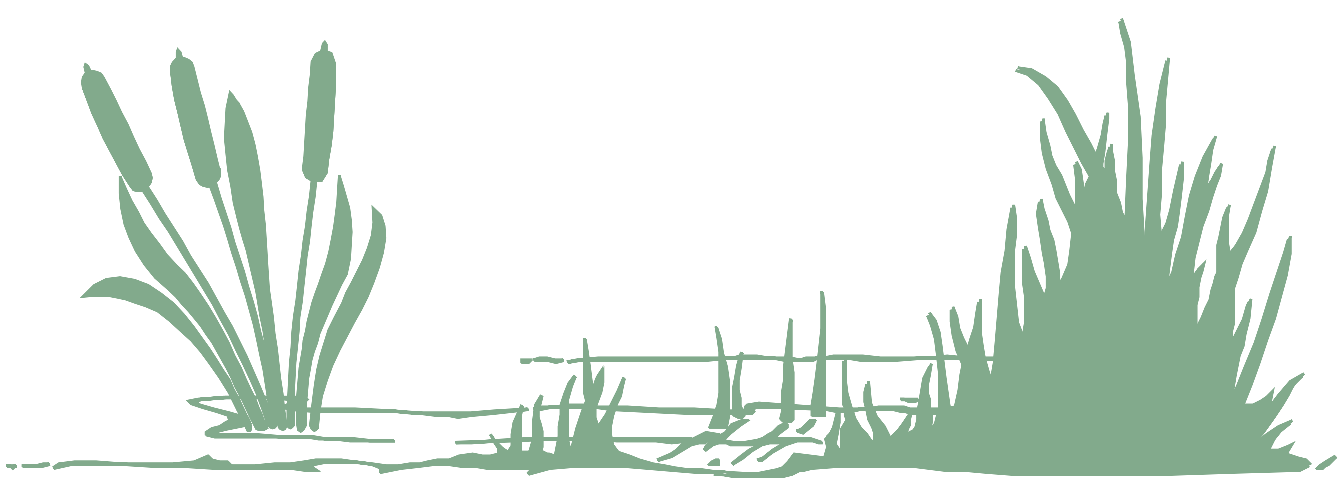


Figure 11. Mimosa seed beetle

A, Adult mimosa seed beetle *(Acanthoscelides quadridentata)*

B, Mimosa pigra seed containing an adult mimosa seed beetle in the process of chewing its way out

C, Mimosa pigra seed from which a mimosa seed beetle has emerged

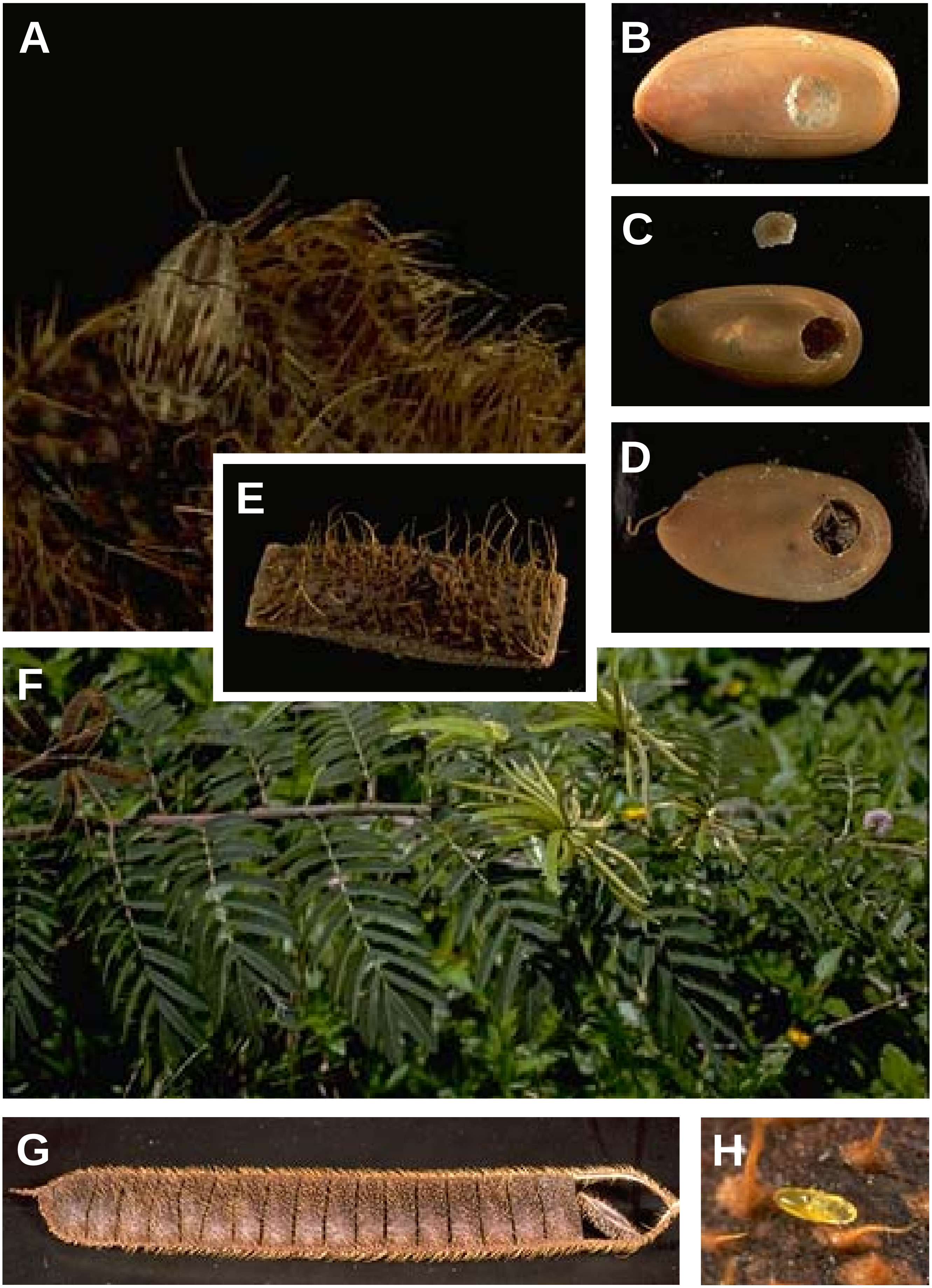
D, Adult mimosa seed beetle in the process of emerging from a *Mimosa pigra* seed

E, Adult mimosa seed beetle (in middle) emerging through a *Mimosa pigra* pod segment

F, Immature pods on a branch of *M. pigra*

G, Mature *Mimosa pigra* pod showing the separating pod segments

H, An egg of the mimosa seed beetle deposited on the surface of a pod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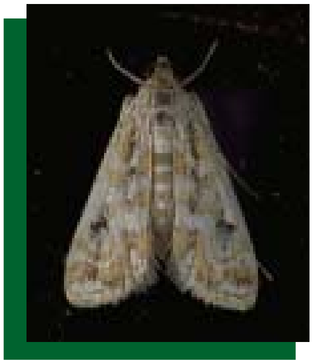
Asian Hydrilla Moth, *Parapoynx diminutalis* Snellen

(Lepidoptera: Pyralidae: Nymphulinae: Nymphulini)



General Information and History

The subfamily Nymphulinae comprises a group of moths that are almost all aquatic. Most members of the tribe Nymphulini are plant feeders. Caterpillars in the genus *Parapoynx* can be distinguished from other aquatic species by the presence of branched gills on all segments of the body except the head and prothorax. Four native species of *Parapoynx* are common in the southeastern United States: *P. maculalis* (Clemens), *P. obscuralis* (Grote), *P. seminealis* (Walker), and *P. allionealis* Walker.

Paranoynx diminutalis is an Asian species that was first reported in 1976 from Florida and probably arrived with the hydrilla trade. This species was once considered a potential biological control agent because it severely damaged cultivated hydrilla, but it only occurs sporadically and produces minimal damage to hydrilla in the field.

Plant Host

Hydrilla, *Hydrilla verticillata* (L. f.) Royle (Hydrocharitaceae)

Biology and Ecology

The female Asian hydrilla moths lay their eggs in masses of about 30 eggs. The eggs are placed on hydrilla leaves and stems that are exposed at the surface of the water. Eggs hatch in 4-6 days. The whitish, translucent, newly hatched larvae are about 1 mm long and lack tracheal gills. Gills are present on the second instar, however, and the numbers present increase on each successive instar. The larval stage consists of seven instars and the fully grown larva attains a length of 8–14 mm. The head is light brown with several scattered dark spots that are not present on the first instar. Larval development requires 21–35 days at 27 °C, but this varies inversely with temperature.

Neonates feed by scraping the leaf surface or by notching the leaf margin. First and second instars sometimes feed from within a simple case made by attaching a small piece of leaf over themselves. Later instars make tubular cases from stems or leaves that they attach to one another with silk. The larvae browse on hydrilla from within these cases, often consuming entire leaves as well as portions of the stems.

Pupae are formed in white, silken cocoons within a case made of leaves and are tightly attached to the stem. The prepupal period lasts 1–2 days, and pupation requires about a week. Adults emerge, mate, oviposit, and die within 3–7 days. Total generation times range from 25 to 41 days at 27 °C.

Effects on Host

When larval populations are high, they completely defoliate hydrilla stems. This most often occurs on plants under cultivation, however. Predators presumably keep field populations in check. Nonetheless, complete defoliation of large patches of hydrilla at field sites sometimes creates holes in hydrilla beds. Closer examination usually reveals that the hydrilla remains in these holes but that the stems are leafless. The defoliated stems usually recover.

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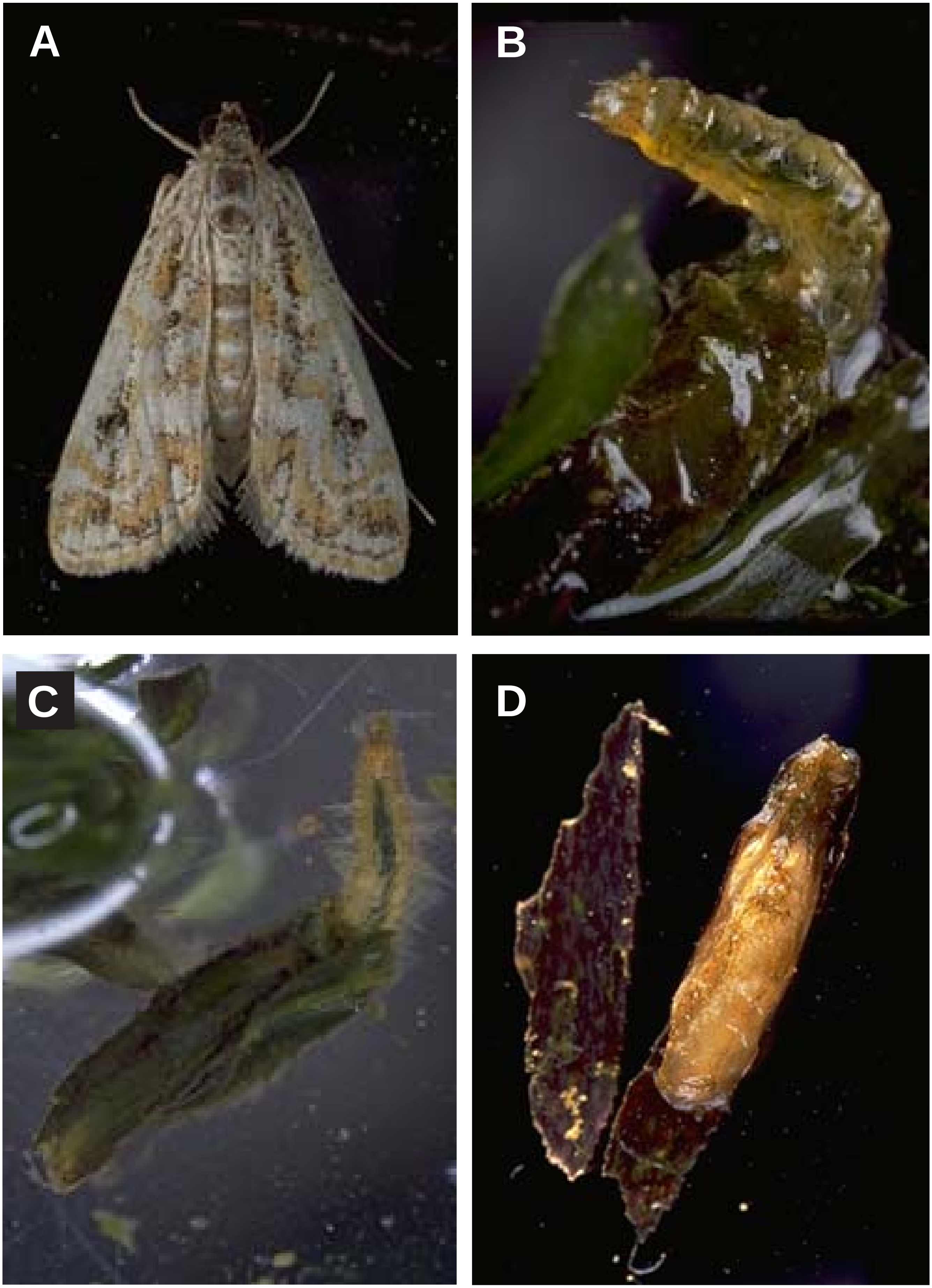
Figure 12. Asian hydrilla moth

A, Adult *Parapoynx diminutalis*

B, Parapoynx diminutalis larval case attached to a sprig of hydrilla

C, Parapoynx diminutalis larva extending out of its case

D, Parapoynx diminutalis cocoon sandwiched between hydrilla leaves (with the outer leaf removed)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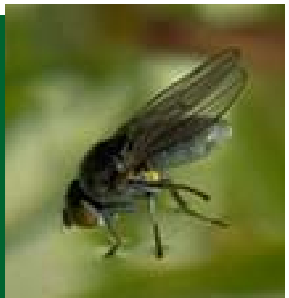
Hydrilla Leafmining Flies, *Hydrellia balciunasi* Bock, *H. bilobifera* Cresson, *H. discursa* Deonier, and *H. pakistanae* *Deonier*

(Diptera: Ephydridae: Notiphilinae: Hydrelliini)



General Information and History

At present 140 *Hydrellia* species have been described worldwide, about 25 of which are known from the southeastern United States. Larvae of members of this genus are aquatic and mine in the leaves of hydrophytes. Adults are not aquatic. *Hydrellia bilobifera* and *H. discursa* larvae feed in leaves and stems of hydrilla and pondweeds.

Hydrellia balciunasi and *H. pakistanae* larvae mine only in hydrilla leaves. *H. bilobifera* and *H. discursa* are native to the southeastern United States. *H. balciunasi* is an Australian native that was imported into the United States as a biocontrol agent of hydrilla. It was first released during 1989 in Florida, but the only established population derives from later releases near Houston, Texas. *H. pakistanae* is an Asian native that was also imported as a biocontrol agent. It was first released during 1987 in Florida and is now established in Florida, Alabama, Tennessee, and Texas.

Plant Host

Hydrilla, *Hydrilla verticillata* (L. f.) Royle (Hydrocharitaceae)

Biology and Ecology

Hydrellia balciunasi and *H. pakistanae* are small (1–2 mm in length) flies with light yellow or golden faces. In both species the lower third to half of the face is slightly flattened (planate), but the epistoma of *H. pakistanae* is broadly and deeply concave in contrast to the slightly concave epistoma of *H. balciunasi.* A few other members of the genus have similar features and structures. *H. bilobifera* and *H. discursa* are slightly larger (1.6–2.3 mm long). Males of both imported species have abdomens about equal in length to the thorax, whereas abdomens of the two native species are 1.5–2.0 times as long as the thorax. *H. balciunasi* males have large, distally flattened macrochaetae, whereas in *H. pakistanae* they are small and needle-shaped. *H. bilobifera* males can be distinguished from *H. discursa* by the two prominent lobes at the end of the former species' abdomen. Also, the macrochaetae are tufted in the former species but not the latter. Female *H. bilobifera* and *H. discursa* are difficult to distinguish because both have small, rounded cerci, whereas the cerci is triangular or arrow-shaped in *H. balciunasi* and hooked or L-shaped in *H. pakistanae.* Descriptions of North American *Hydrellia* may be found in Deonier (1971) and of *H. pakistanae* in Deonier (1978).

Females of these species deposit one to several white or pale yellowish gray, cigar-shaped eggs about 0.5 mm long on hydrilla or other plants at the water surface. The eggs hatch in 3–4 days. The neonates abandon ovipositional hosts that are unsuitable for development in search of a more acceptable host. The larval stage lasts 8–17 days in *Hydrellia balciunasi,* 14–31 days in *H. bilobifera,* and 9–16 days in *H. pakistanae.* Prior to pupation, *H. balciunasi* larvae damage 7 or 8 leaves, *H. bilobifera* larvae damage about 20 leaves, and *H. pakistanae* larvae damage about 12.

Pupae are formed at the bases of mined leaves. The puparium is 3–4.5 mm long. Adult *H. pakistanae* emerge from the puparia 6–15 days following pupation and float to the water surface in a bubble. Empty puparia are a translucent, pale yellowish brown. Adults live on the water surface where they feed on periphyton and dead insects.

Effects on Host

Larval mining activity produces distinct, transparent tunnels in the leaves. Larvae usually mine all leaves in a whorl before moving to another whorl.

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Figure 13. Hydrilla leafmining flies

A, Adult *Hydrellia pakistanae* resting on the water surface

B, Eggs of *Hydrellia pakistanae* on a hydrilla leaf

C, Hydrellia pakistanae larva mining within a hydrilla leaf

D, Hydrellia pakistanae puparium attached to a hydrilla stem in a leaf axil

E, Hydrellia bilobifera puparium in a hydrilla stem (right) and *H. pakistanae* puparium in a leaf axil (left)

F, Tip of the abdomen of a female *Hydrellia pakistanae* showing the boomerang-shaped external genitalia

G, Tip of the abdomen of a female *Hydrellia bilobifera* showing the rounded external genitalia


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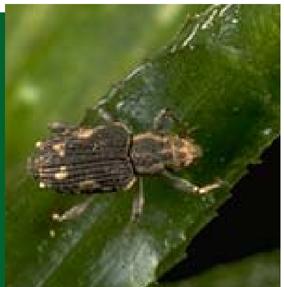
Hydrilla Stem Weevil, *Bagous hydrillae* O'Brien
(Coleoptera: Curculionidae: Curculioninae: Erirhinini)



General Information and History
Bagous hydrillae is a small Australian weevil that was introduced into the United States as a biological control of hydrilla. The first releases occurred during 1991 in Florida; it has since been released in Texas. *B. hydrillae* populations have temporarily established at sites in both states, but each eventually declined until the weevils were undetectable. Thus long-term persistence has not been demonstrated.

Plant Host
Hydrilla, *Hydrilla verticillata* (L. f.) Royle (Hydrocharitaceae)

Biology and Ecology
Adult *Bagous hydrillae* are dark brown with a distinctly mottled appearance. Many individuals have 2–4 light spots posteriorly on the elytra. Adults feed externally, chewing on the leaves and stems of plants submersed in the water or stranded along the shoreline. This feeding behavior creates small holes in the leaves and notches in the stems. The female inserts her eggs into the stem, usually at a leaf node. The eggs hatch and the resultant larvae burrow lengthwise in the stem, causing decay and fragmentation. Third-instar larvae may destroy as much as a 15-cm length of stem. After the larvae attain full size, they chew through the stem and float to shore in stem fragments. After the stem fragments wash up onto the strand line, the fully grown larvae exit from the stem and pupate in the underlying soil or the drying mound of plant material.

The life cycle of *B. hydrillae* requires 17–21 days. Development from egg to adult requires 12–14 days. The freshly emerged females pass through a 3–10 day preovipositional period. Females lay their eggs singly. Each female lays an average of about 80 eggs at a rate of 3 eggs per day (up to 30 eggs per day). The eggs are usually inserted into submersed hydrilla stems, although the females might also oviposit on stranded plants. The first-instar larva ecloses from the egg in 3 or 4 days and larval development proceeds through three instars. Each larval stadium lasts 3–4 days. The third-instar larva stops feeding and vacates its burrow to search for a pupational site. A naked pupa is formed after a 1- or 2-day prepupal period. The pupal period lasts 3–4 days. Adults spend daylight hours below the surface of the water where they crawl about, feed, and oviposit on the hydrilla stems. They emerge from the water and fly at dusk. Adults live 60–80 days.

Effects on Host
Severing of hydrilla stems by *B. hydrillae* larvae reportedly "mows" the plants in Australia, removing nearly all of the hydrilla from the surface to a depth of 100 cm. This has not been demonstrated in the United States.

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Figure 14. Hydrilla stem weevil

A, Adult hydrilla stem weevil and feeding damage on a hydrilla sprig

B, Egg of the hydrilla stem weevil in a leaf node

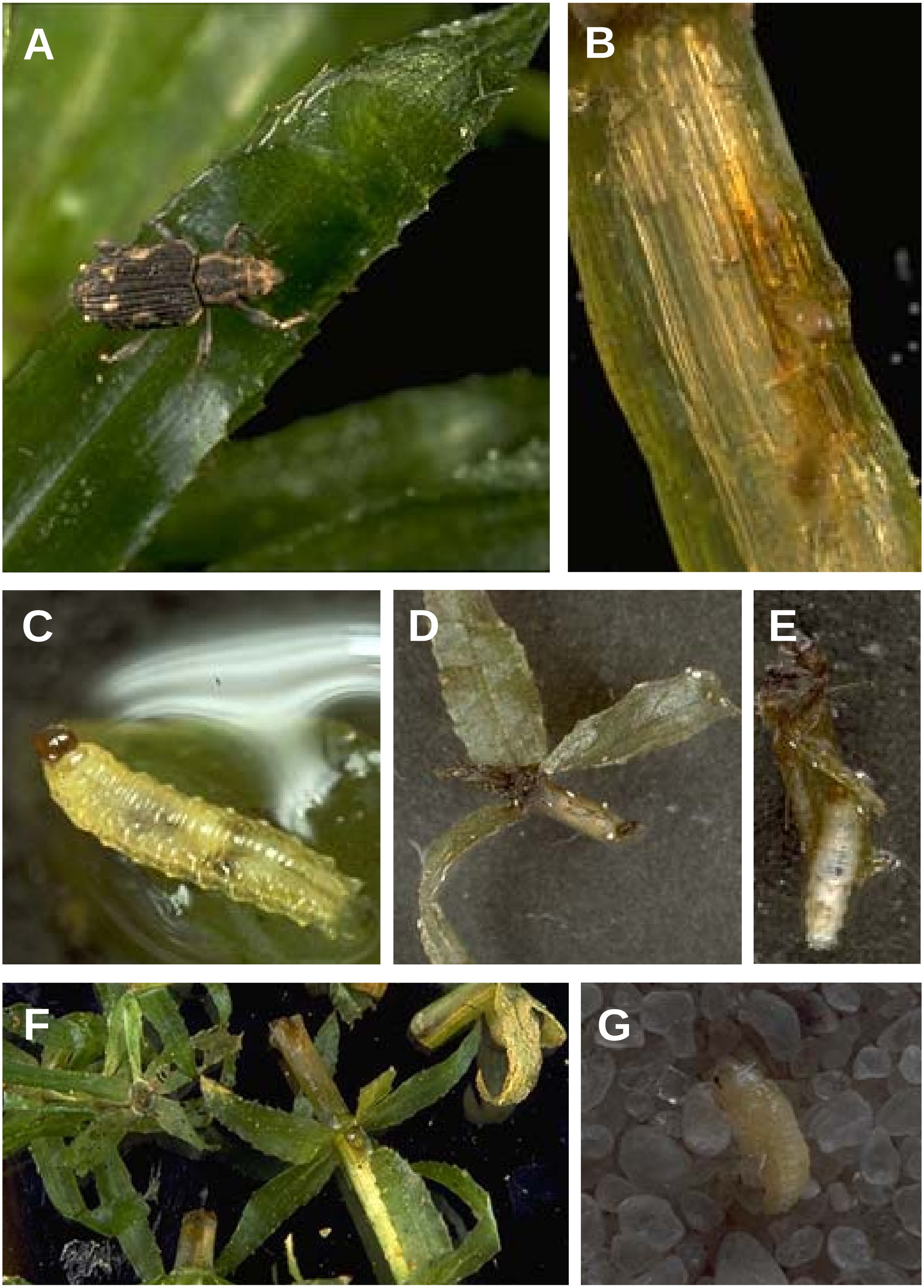
C, Fully grown hydrilla stem weevil larva

D, Hydrilla fragment harboring a fully grown hydrilla stem weevil larva

E, Stem fragment dissected to show the enclosed larva

F, Hydrilla damaged by hydrilla stem weevil larvae and adults

G, Bagous hydrillae pupa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Hydrilla Tuber Weevil, *Bagous affinis* Hustache
(Coleoptera: Curculionidae: Curculioninae: Erirhinini)

General Information and History
The genus *Bagous* is cosmopolitan and includes at least 130 species, 33 of which are present in the United States. *Bagous affinis* was imported into the United States as a biological control of hydrilla and has been released at several sites in Florida and California. Unfortunately, permanent populations have not become established. *B. affinis* has been reported only from India and Pakistan, and its host range is restricted to hydrilla.

Plant Host
Hydrilla, *Hydrilla verticillata* (L. f.) Royle (Hydrocharitaceae)

Biology and Ecology
Female hydrilla tuber weevils deposit their eggs on hydrilla tubers and stems or moist wood but apparently not on submersed material. Eggs hatch after 3–4 days and neonates crawl through the soil in search of tubers. Larvae generally feed and pupate within a single tuber. However, if a tuber is destroyed, larvae will search for a new tuber. There are four instars, and total duration for the larval stage is 8–14 days (at 27 ^{o}C).

Pupation usually occurs within the tuber but can also take place in moist wood. Duration of the pupal stage is 4–6 days (at 27 ^{o}C). Newly emerged (teneral) adults remain inside the tuber for 2–3 days while their exoskeletons harden. Some females oviposit within 2–7 days of emergence, while others appear to develop flight muscles upon emergence. Females do not simultaneously have flight muscles and eggs; they histolize their flight muscles and form eggs within 8 days of flight.

Females produce up to 649 (average 232) eggs over an average lifespan of 128 days. Males live an average 149 days. Overall, adult longevity ranges up to 272 days. Adults are most active at night and burrow into the soil or hide among dried hydrilla or other materials when not active.

Adults eat hydrilla tubers, but the damage caused by adult feeding is apparently inconsequential relative to larval destruction of tuber populations. Larvae attack tubers up to 10 cm deep in the soil and have reportedly infested high percentages of the tubers present in small ponds in their native range. Neither larvae nor adults are able to withstand submergence for more than a few days.

Effects on Host
We know of no studies describing the impacts of this insect on its host plants.

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Figure 15. Hydrilla tuber weevil

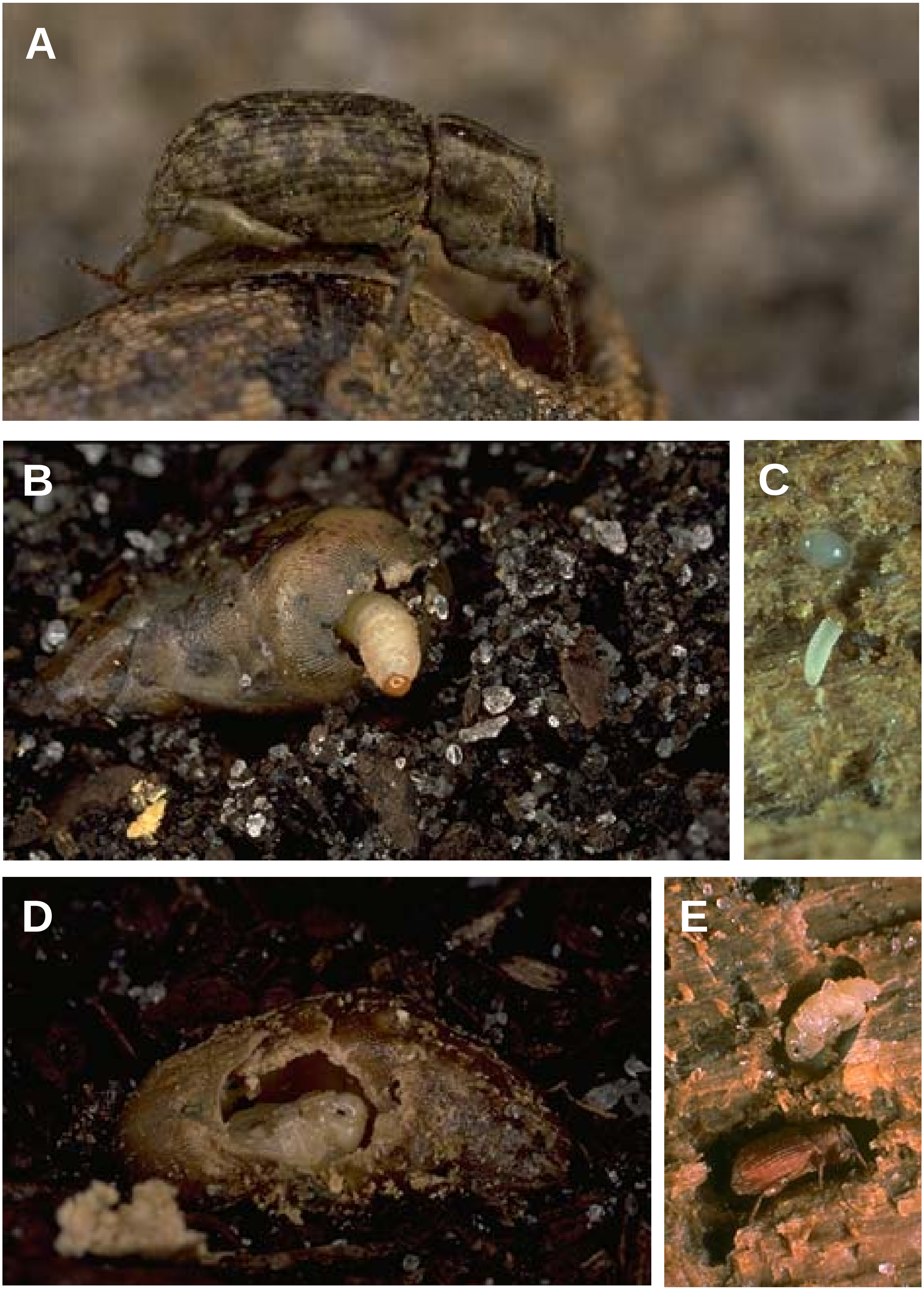
A, Adult hydrilla tuber weevil

B, Bagous affinis late-instar larva emerging from a destroyed hydrilla tuber

C, Egg and neonate larva of the hydrilla tuber weevil in waterlogged wood

D, Pupal stage of *Bagous affinis* in a hollowed-out hydrilla tuber

E, Bagous affinis pupa and teneral adult in waterlogged wood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Melaleuca psyllid, *Boreioglycaspis melaleucae* Moore

(Hemiptera: Sternorrhynicha: Psylloidea: Psyllidae: Spondyliaspidinae)

General Information and History

Psyllids (sill-lids) are sometimes called "jumping plant lice" because of their propensity to jump when disturbed and because they feed by sucking juices from their host plants. Nymphs of many species, including the melaleuca psyllid, are free-living and produce copious amounts of a white waxy secretion (flocculence). Other species produce hard coverings (lerps) over themselves and some, such as the one commonly seen on bay leaves, live within plant galls. Adults superficially resemble cicadas but are more like aphids in their feeding behavior. Most psyllids have very specific food-plant relationships, being restricted to one or a few related host-plant species. The family includes several important pests including the pear psyllid, the apple psyllid, two species of citrus psylla, the potato (or tomato) psyllid, the cottony alder psyllid, the eucalyptus psyllid, the peppertree psyllid, the boronia psyllid, and several others. Some species transmit plant viruses such as the citrus greening disease, which is vectored by the two citrus-feeding species.

Only a few psyllid species have been used for biological control of weeds despite their noted ability to debilitate host plants and their high degree of host specificity. These include the Scotch broom psyllid [*Arytainilla spartiophila* (Förster)], the sensitive plant psyllid (*Heteropsylla spinulosa* Muddiman, Hodkinson, & Hollis), and the Australian melaleuca psyllid. The melaleuca psyllid was released in south Florida during 2002 as a potential biological control agent of the Australian tree *Melaleuca quinquenervia* (Cav.) S.T. Blake, a pernicious invader of Everglades ecosystems.

Plant Hosts

Melaleuca (broad-leaved paperbark), *Melaleuca quinquenervia* (Cav.) S.T. Blake.

Biology and Ecology

The adult melaleuca psyllid is a small (about 3 mm), rather plain looking yellowish insect. Its wings are transparent with yellow veins and are held tent-like over the back. Two finger-like protuberances (genae) extend outward and slightly downward from below the eyes giving the appearance of "cheeks." Males and females are easily distinguishable based on genitalic characteristics and the shapes of their abdomens (narrower and pointed in males, plumper and rounded in females). The adults often jump when disturbed, flying upwards then spiraling downwards, often returning near their starting point. The large genal processes and venation of the wings distinguish this species from others with which it might be confused.

Females lay about 80 eggs during their relatively short life span (2-3 weeks) on either the surface of the leaf blades (often at the edges), the leaf petioles, or the stems. Each egg bears a pedicel (a spine-like projection) near one end that the female inserts into the leaf tissue as she deposits the eggs. This pedicel anchors the egg and imbibes water, thus inhibiting desiccation. Small nymphs eclose after about 14 days and, after wandering a while, soon insert their piercing mouth parts into the leaf tissue through a stomate to feed from the phloem. Nymphal development of the five instars requires about 4 weeks for completion. Nymphs produce honeydew while feeding, which appears as hardened crystalline droplets issuing from the posterior end of their abdomens. The nymphs also exude coverings over themselves of white waxy filaments that appear as cottony masses on the plant surface. Nymphs often aggregate under a communal covering on the same leaf. This substance protects them from predators and provides a modulated environment favoring growth and development.

Effects on Host

Both adults and nymphs feed in the phloem through the stomata, but adults cause no apparent damage. Nymphs purportedly inject saliva during feeding, producing a phytotoxic effect that causes a distinctive yellowing of the tissue. Feeding damage kills heavily infested, small melaleuca trees (75 cm) held in a laboratory environment within a few weeks. Leaves, which become yellow soon after flocculence first appears (third instar), later turn brown and wither. The saplings then drop their damaged leaves and ultimately die. This has not yet been observed in the field.

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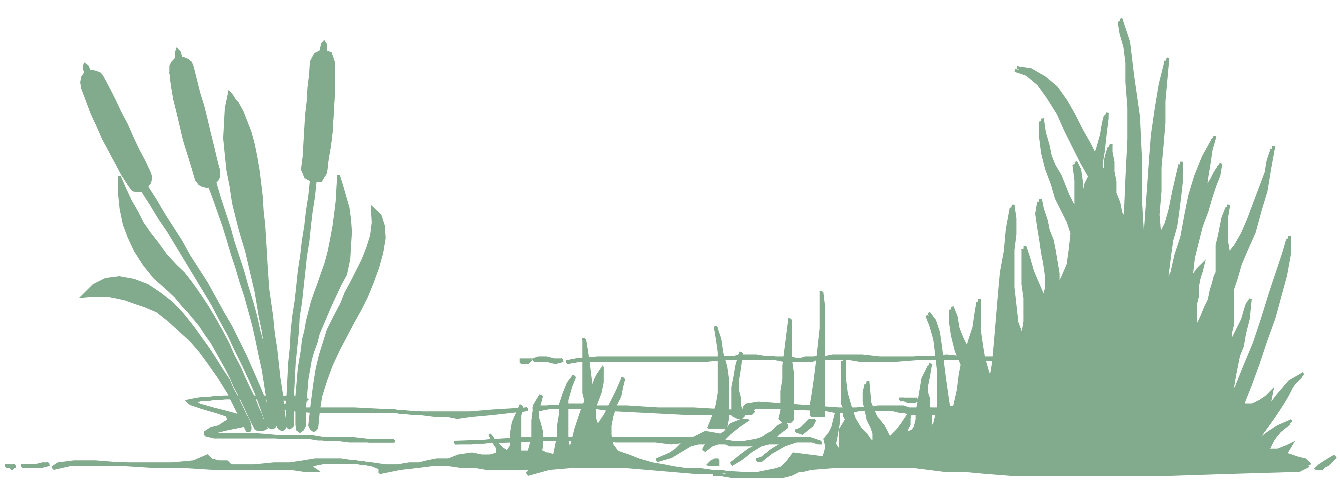


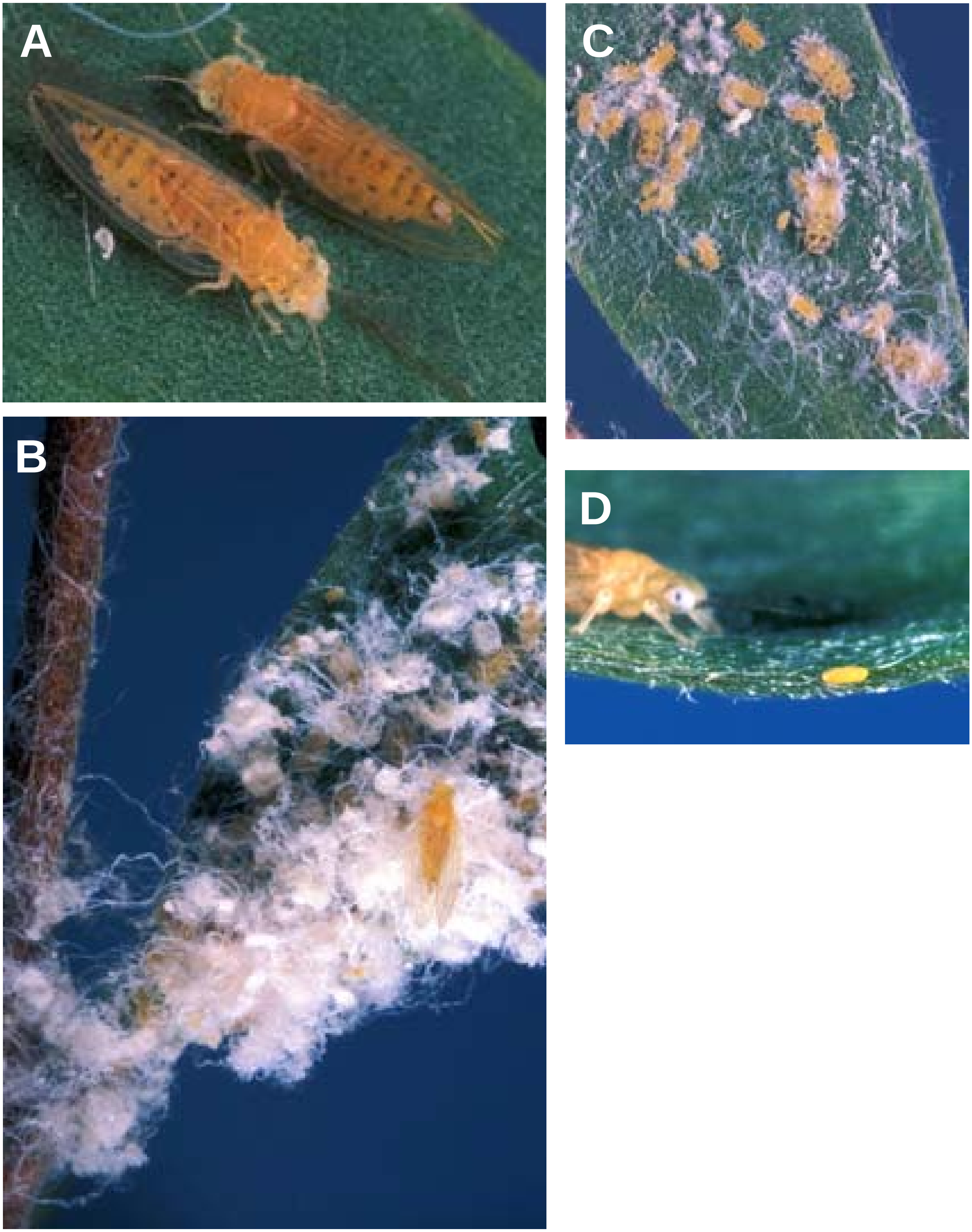
Figure 16. Melaleuca psyllid

A, Melaleuca psyllid adults

B, Melaleuca psyllid nymphs (various instars)

C, Flocculence on a melaleuca stem caused by a psyllid colony

D, Melaleuca psyllid egg on the edge of a melaleuca leaf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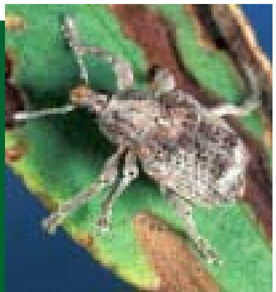
Melaleuca Snout Beetle, *Oxyops vitiosa* Pascoe
(Coleoptera: Curculionidae: Gonipterinae)



General Information and History

Weevils in the genus *Oxyops* are native to Australia where most species feed on *Melaleuca* and *Eucalyptus.* They are similar to species in the genus *Gonipterus,* which are often associated with *Eucalyptus. Gonipterus scutellatus* Gyll. was accidently introduced from Australia into Africa, New Zealand, and South America, where it became a severe pest in exotic eucalyptus plantations. *Oxyops vitiosa* was an obscure, little-known species until research on its use as a biological control agent began in the 1980s. It was released in south Florida during 1997 after intensive study to insure that it would not damage desireable plants or native vegetation. It widely established in dry or seasonally wet habitats but failed to establish in fully aquatic habitats due to a lack of suitable pupation sites.

Plant Hosts

Melaleuca (broad-leaved paperbark), *Melaleuca quinquenervia* (Cav.) S.T. Blake.

Biology and Ecology

Adult melaleuca snout beetles are medium-sized (9 mm), stocky weevils. The color and pattern of the integument, which is pinkish brown when newly emerged turning gray with age, closely matches the color of melaleuca bark and seed capsules. The long-lived adults (up to 1 year) persist on their host plant year round, but larvae are rare during summer periods when young foliage is scarce. Development from egg to adult requires about 48 days. Eggs are laid singly, often on the tips of newly emerging leaves or on small branches and twigs. Females extrude a brownish to black substance (possibly feces mixed with glandular material) that covers the eggs, presumably affording protection from predators or the elements. Larvae eclose in about 6-10 days and first instars feed on the youngest, most tender foliage available within open furrows or grooves in the leaf tissue. Later instars feed externally, scraping tissue from the leaf surfaces. As the larvae grow larger, they more readily consume somewhat older leaves and may be found further from the tips, but they consistently prefer the tender new growth. Larvae excrete a slimy coating over themselves that contains essential oils derived from the host foliage. These oils impart a reddish orange color to freshly molted larvae. As they feed, however, the larvae incorporate fecal material into this coating, turning it black. This covering has been shown to deter predators such as fire ants and mice. Adherence of a strand of fecal material at the posterior end of the larva sometimes gives it the appearance of bearing a long tail.

Developmental times of each of the four larval instars averages 4 to 5 days. Fully grown larvae drop from the foliage to the soil, where they form a loosely constructed chamber from soil particles or adjacent debris in which to pupate. They undergo a fairly long prepupal period of about 12 days followed by the pupal stage, which lasts an equivalent time. Adults sometimes remain in the pupal capsules for several days before emerging.

Effects on Host

Adult feeding produces distinctive serpentine grooves on the surface of melaleuca leaves but doesn't cause much harm to the plants. Larvae defoliate new foliage, hindering the tree's ability to flower and grow. Defoliated tips dry out, become brittle, and break off. Lateral buds often produce new shoots to compensate for this loss, but they too soon become defoliated. As this process continues, trees begin to appear bushier due to the proliferation of stem tips. Older, hardened leaves suffer little damage and may persist on the trees for 2-4 years, but the subsequent lack of replacement foliage causes the trees to be denuded shortly thereafter. Reduction of seed production by as much as 90 percent due to damage by *O. vitiosa* has been documented.

References

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Turner, C.E., T.D. Center, D.W. Burrows, and G.R. Buckingham. 1998. Ecology and management of *Melaleuca quinquenervia,* an invader of wetlands in Florida, U.S.A. Wetlands Ecology and Management 5:165-178.

Wheeler, G.S., L.M. Massey, and I.A. Southwell. 2002. Antipredator defense of biological control agent *Oxyops vitiosa* is mediated by plant volatiles sequestered from the host plant *Melaleuca quinquenervia.* Journal of Chemical Ecology 28:297-315.

Figure 17. Melaleuca snout beetle

A, Adult melaleuca snout beetle, *Oxyops vitiosa,* on a melaleuca leaf. The brown areas on the leaf are feeding scars made by the adult weevils.

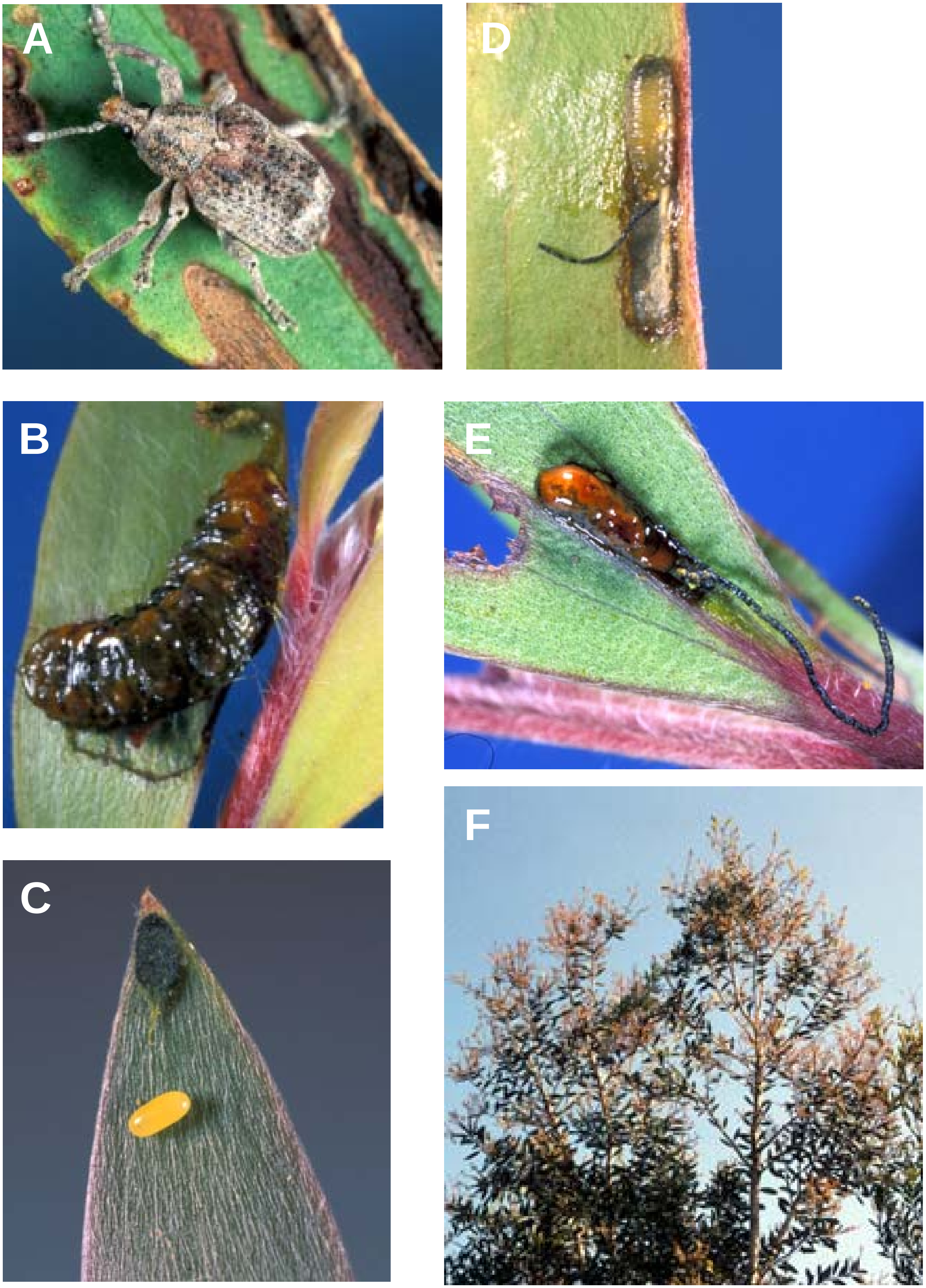
B, Fourth instar *O. vitiosa* larva covered in the oily exudate composed of melaleuca oils, which are excreted as the larvae feed on the foliage

C, O. vitiosa egg removed from the black covering shown at the tip of the leaf

D, First instar *O. vitiosa* in the typical furrow that it has made on a melaleuca leaf

E, Third instar *O. vitiosa* larva showing the typical “tail” of fecal material

F, Melaleuca tree that has been severely damaged by *O. vitiosa* larvae, which have removed nearly all of the young terminal foliage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Waterfern Flea Beetle, *Pseudolampsis guttata* (LeConte)
(Coleoptera: Chrysomelidae: Alticinae)

General Information and History
The waterfern flea beetle is the sole member of its genus in the United States. Like most members of the flea beetle subfamily (Alticinae), *Pseudolampsis guttata* has enlarged hind femora that greatly enhance its jumping ability. Flea beetles are the largest group of leaf beetles (chrysomelids) in terms of numbers of species and numbers of crop pests.

Plant Host
Mosquito fern, *Azolla caroliniana* Willd. (Azollaceae)

Biology and Ecology
Waterfern flea beetles are small (2–2.5 mm) and generally move slowly, although when disturbed they are strong jumpers. The adults are light brown with a darker brown thorax and are covered with gold-colored setae. The adults eat the upper lobes of the fronds of *Azolla caroliniana* Willd., sometimes leaving only the membranous lower lobes. (*Azolla* fronds have a transparent membranous lower lobe that floats on the water and a green or red inflated dorsal lobe that projects upward.) Newly emerged females feed for several days before laying eggs. They deposit their eggs between the overlapping lower lobes of the fronds. The bright yellow eggs are elliptical and laterally compressed when freshly laid but become ovate and clear as the embryo matures. Incubation requires 6–7 days.

The larval stage has three instars. Neonates measure about 0.7 mm, and fully grown third instars measure about 4.9 mm. Larvae appear black but are actually deep green with black setae and large dark brown sclerotized plates. The mature larvae form a light brown hemispherical cocoon on the fronds, often in an area where all of the frond lobes have been eaten. The pupal stage lasts 3–5 days, and the adults remain in the cocoon for a day or two before emerging.

A female beetle produces 670 eggs during a 132-day oviposition period. The adults live up to 200 days, and the total generation time is 24–34 days.

Effects on Host
Damage from this and other insects can be devastating to beds of *Azolla.* A single adult waterfern flea beetle can eat as many as 250 frond lobes per day, nearly the total number on a plant (about 310 lobes).

References

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Casari, A.S., and C.N. Duckett. 1997. Description of immature stages of two species of *Pseudolampsis* (Coleoptera: Chrysomelidae) and the establishment of a new combination in the genus. Journal of the New York Entomological Society 105(1–2):50–64.

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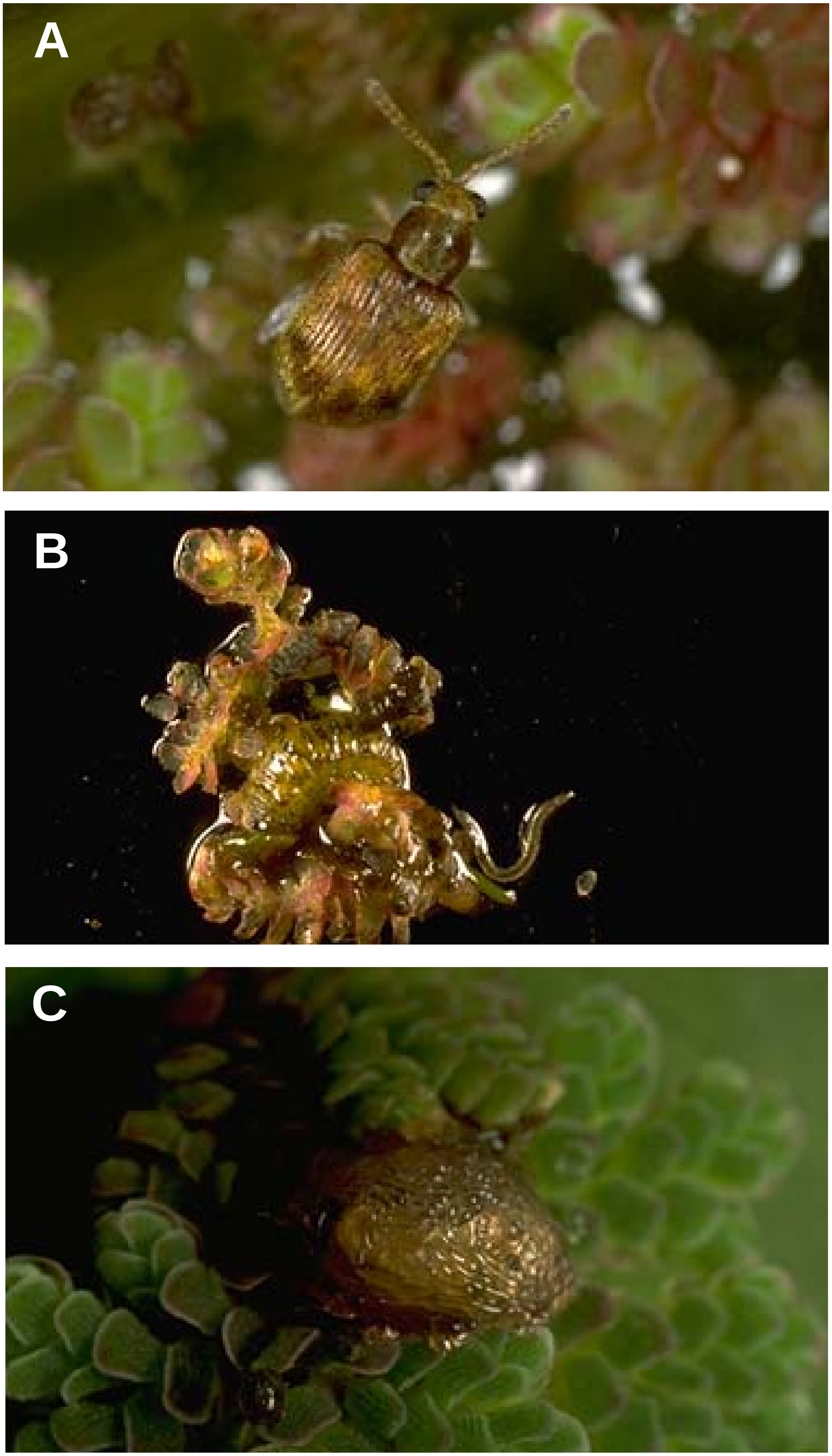
Figure 18. Waterfern flea beetle

A, Adult waterfern flea beetle

B, Pseudolampsis guttata larva feeding on an extensively damaged *Azolla caroliniana* plant

C, The brown, parchmentlike cocoon of the waterfern flea beetle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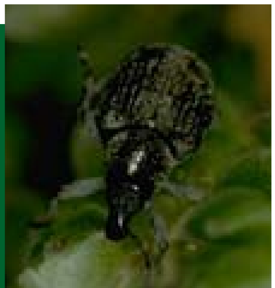
Waterfern Weevil, *Stenopelmus rufinasus* Gyllenhal
(Coleoptera: Curculionidae: Curculioninae: Erirrhinini)



General Information and History
The small, semiaquatic waterfern weevil occurs throughout the southern and western United States. It lives and feeds exclusively on floating aquatic ferns in the genus *Azolla.*

Plant Hosts
Mosquito fern, *Azolla filiculoides* Lam. (Azollaceae)
Mosquito fern, *Azolla caroliniana* Willd. (Azollaceae)

Biology and Ecology
The shiny, yellow-orange eggs of the waterfern weevil are laid singly in shoot tips in holes chewed by the female weevil. This hole is slightly deeper than the length of the egg and is plugged with a black substance, so the egg is well concealed. The eggs are slightly oval and measure about 0.3 mm in length. The incubation period is 4–5 days.

The color of the larva varies from yellow orange to red, depending on the color of the *Azolla* that it eats. The head of the larva is black, and a divided black prothoracic shield is present behind the head. The legless larvae range in size from 0.7 mm for the neonates to 3.7 mm for fully developed individuals. The larval stage is composed of three instars and development requires 4–7 days.

First-instar larvae form mines in the upper lobes of the fronds and are difficult to see. Later instars feed externally and are more obvious. Third instars often carry a droplet of semifluid excrement on their dorsal surface, which effectively conceals them. Older larvae consume several plants per day. The larvae are not able to swim and sometimes drown if they eat all of the *Azolla.*

The larvae transform into pupae within a black, ovoid, cocoonlike structure that is constructed on top of an *Azolla* plant. This case is composed of an anal secretion. The larva first chews a depression in the plant tissue and then forms the pupal chamber over itself, gradually building up the dome-shaped cocoon around itself. The material composing the cocoon is clear at first then gradually darkens, becoming opaque and black within 24 hrs. The pupational period requires about 5–7 days.

The adults are very small, measuring only about 1.7 mm in length. The body is a deep gray black and is covered with red, black, and white scales in a variable pattern. The legs and tip of the rostrum are reddish. The adults do not swim and reside mainly on the surface of the plants. They are able to walk on the surface of the water.

Effects on Host
Both *Stenopelmus rufinasus* and the waterfern flea beetle *(Pseudolampsis guttata)* are known to devastate mats of *Azolla* and probably greatly reduce the weedy potential of these species. It has been an extremely effective biological control agent of *A. filicoloides* in South Africa.

Reference

Richerson, P.J., and A.A. Grigarick. 1967. The life history of *Stenopelmus rufinasus* (Coleoptera: Curculionidae). Annals of the Entomological Society of America 60:351–354.

Figure 19. Waterfern weevil

A, Adult waterfern weevils on their food plant *Azolla caroliniana*

B, Closeup of *Stenopelmus rufinasus*


A
B

Pickerelweed Borer, *Bellura densa* (Walker)
(Lepidoptera: Noctuidae: Amphipyrinae)

General Information and History
Bellura densa is a moth that is indigenous to the United States. It is closely related to the spatterdock borer *(B. gortynoides)* and the cattail borer *(B. obliqua).* The native host of *B. densa* is pickerel weed *(Pontederia cordata)* but, at times, possibly when pickerelweed is scarce or the moth populations are high, they also feed on waterhyacinth.

Plant Hosts
Pickerelweed, *Pontederia cordata* L. (Pontederiaceae)
Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)
Taro, *Colocasia escuelenta* Schott (Araceae)

Biology and Ecology
The adult female pickerelweed borer deposits a mass of approximately 40 eggs on the abaxial surface of a pickerelweed or waterhyacinth lamina. The egg mass is covered with cream-colored, hairlike scales from a tuft on the tip of the female's abdomen. The scales adhere to the egg mass by way of a mucouslike secretion. The planoconvex egg mass is about 10 mm in diameter. Each egg is about 1 mm in width and length, and a single female produces up to 300 eggs. This clustering mode of oviposition seems to protect the eggs in the inner portion of the mass from a scelionid parasitoid (*Telenomus arzamae* Riley).

The eggs hatch in about 6 days, and the first instars are about 2 mm long, have a conspicuous black head about 0.5 mm in diameter, a black prothoracic shield, and a light brown to somewhat pinkish body. Second and third instars have yellowish-brown heads and grayish prothoracic shields, with amber-colored dorsal body surfaces and whitish ventral surfaces. The second instar's head is about 0.7 mm in diameter. Third instars have a head about 1.0 mm in diameter and, by the end of the stage, attain a length of about 2.0 cm. Fourth instars have a yellowish head about 2.3 mm in diameter, brown cervical shields, yellowish-brown dorsums and white ventrums, and attain lengths of about 3.0 cm. The color gradually darkens through to the seventh-instar larvae, which have dark reddish-brown heads about 3.3 mm in diameter, brown prothoracic shields, very dark brown to charcoal-gray dorsums, and pale cream-colored ventrums and attain lengths of 6.0 cm.

Pupation occurs within a burrow in a leaf petiole following a 3-day prepupal period, and the pupa is not enclosed in a cocoon. The pupa is large (about 3.0 cm) and dark reddish brown. Pupation requires about 10 days. The adults are brown to reddish brown, rather stout, and somewhat fuzzy in appearance. Females are typically larger and lighter in color than males, and have rounded instead of pointed abdomens. Complete development from egg to egg requires about 50 days.

Effects on Host
The damage to waterhyacinth created by *Bellura densa* is similar to that caused by *Niphograpta albiguttalis* but is more severe. Early-instar larvae scrape the leaf epidermis, causing extensive abrasions. Later instars burrow extensively within the petioles, and the larger larvae may create deep burrows within the rhizome and kill the shoot. *B. densa* damage is readily distinguished from that of *N. albiguttalis* by the larger galleries and the coarser texture of the frass.

Extensive damage to waterhyacinth is rare because of the large complex of diseases and parasitoids that severely reduce *B. densa* populations (Vogel and Oliver 1969a,b, Center

1976). However, experimental studies suggest that large *B. densa* infestations can cause reductions in plant height and leaf density and can increase turnover rates.

References

Baer, R.G., and P.C. Quimby, Jr. 1981. Laboratory rearing and life history of *Arzama densa,* a potential native biological control agent against waterhyacinth. Journal of Aquatic Plant Management 19:22–26.

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Vogel, E., and A.D. Oliver, Jr. 1969b. Life history and some factors affecting the population of *Arzama densa* in Louisiana. Annals of the Entomological Society of America 62:749–752.

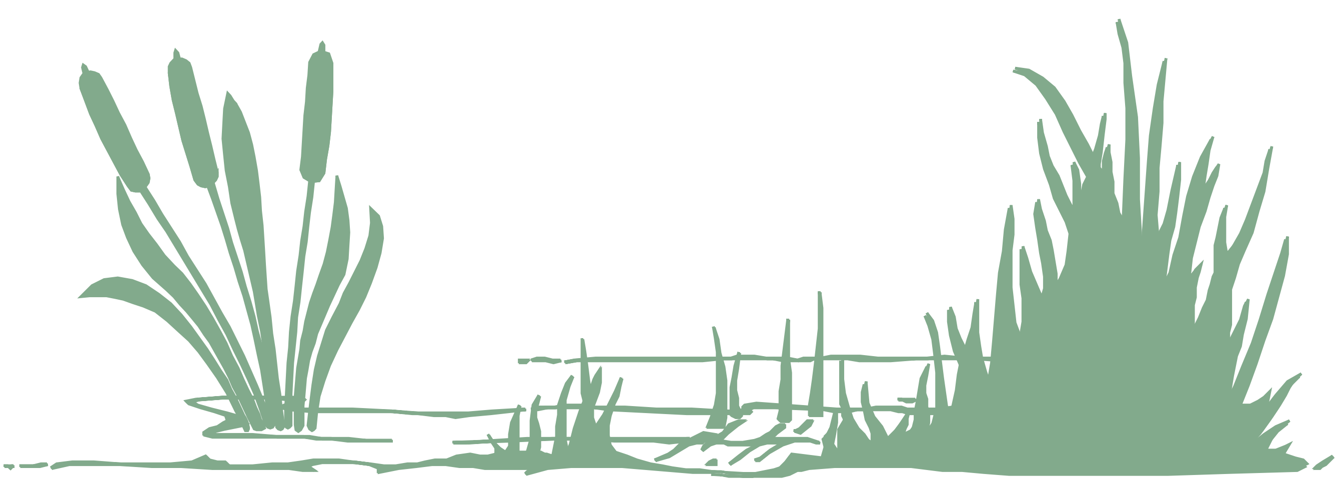


Figure 20. Pickerelweed borer

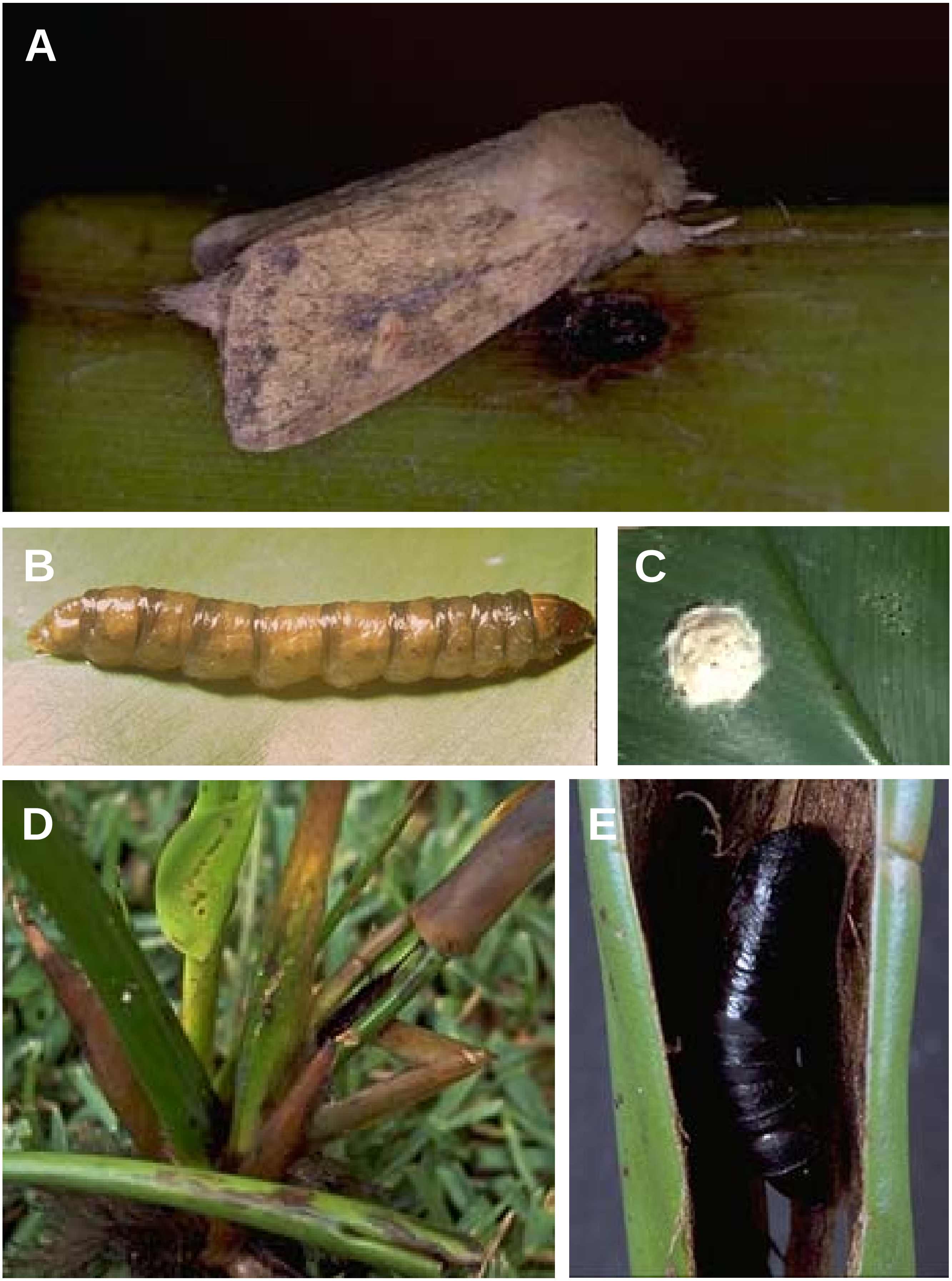
A, Bellura densa adult

B, Late-instar *Bellura densa* larva

C, Bellura densa egg mass

D, Waterhyacinth plant showing the typical crown damage caused by feeding of a *Bellura densa* larva

E, Bellura densa pupa within a waterhyacinth leaf petiole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Pickerelweed Weevil, *Onychylis nigrirostris* (Boheman)
(Coleoptera: Curculionidae: Curculioninae: Erirhinini)

General Information and History
The pickerelweed weevil is distributed throughout eastern North America from Florida to Ontario, west to South Dakota, and south into Mexico. Board (1972) separated these into three major populations: the northern population (Virginia to Ontario, west to South Dakota and Nebraska); the southeastern population (Florida Keys to North Carolina, along the Gulf Coast to Alabama); and the Texas population (Texas to Mexico). He also described morphological characteristics useful for distinguishing individuals from these populations.

Plant Hosts
Arrowheads, *Sagittaria* spp. (Alismataceae)
Pickerelweed, *Pontederia cordata* L. (Pontederiaceae)
Spatterdock, *Nuphar advena* (Aiton) Aiton f. (Nymphaeaceae)
Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)

Biology and Ecology
Very little is known about the biology of *Onychylis nigrirostris.* The adults feed on the surfaces of the leaves in a manner similar to *Neochetina.* This species is easily distinguished by the appearance of its feeding damage. Waterhyacinth weevil feeding damage is usually evident as distinct spots that are about as wide as they are long or as broad lines usually less than 10 times as long as wide. Pickerelweed weevil feeding scars are evident as thin lines (especially on waterhyacinth), usually many times longer than wide. Also, because waterhyacinth weevils are larger (3.2–4.5 mm) than pickerelweed weevils (2.5–3.0 mm), the feeding scars are proportionately larger. Although adults of *O. nigrirostris* feed on waterhyacinth, spatterdock, and arrowheads, pickerelweed is probably the only larval host.

The larvae and larval biology of *O. nigrirostris* are unknown. Board (1972) speculates that small larvae feed on lateral rootlets in the ground, then burrow into larger roots as the larvae grow. He also suggests that eggs are laid in the soil near the roots and that they pupate in the soil in the vicinity of the larval host.

Effects on Host
We know of no studies describing the impacts of this insect on its host plants.

References

Board, V.V. 1972. Taxonomy and biology of *Endalus* Laporte and *Onychylis* Le Conte in America north of Mexico. Ph.D. dissertation in entomology, Texas Agricultural and Mechanical University, College Station.

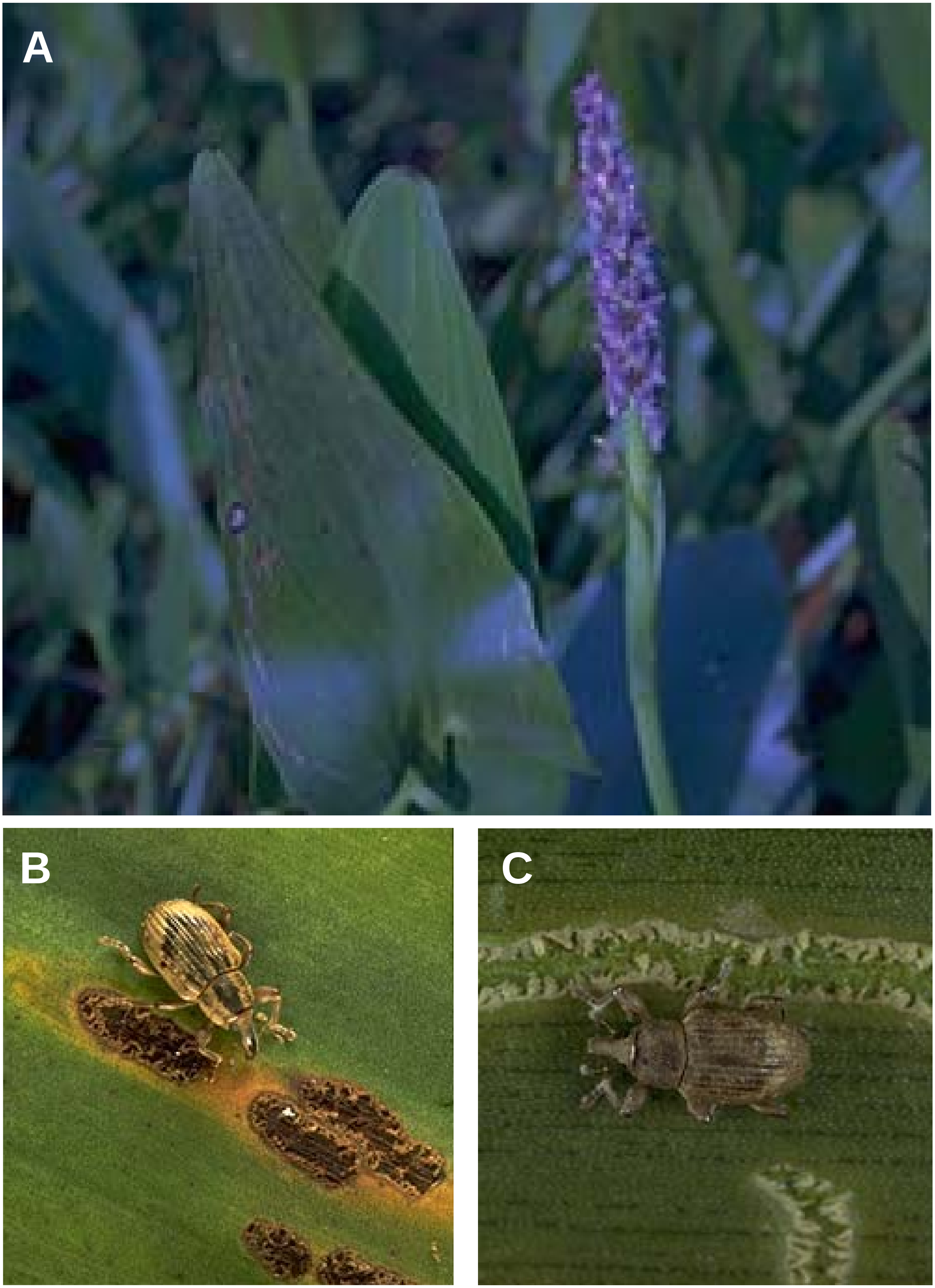
Tanner, V.M. 1943. A study of the subtribe Hydronomi with a description of new species, (Curculionidae). Great Basin Naturalist 4(1&2):1–38.

Figure 21. Pickerelweed weevil

A, Typical leaf scarring caused by the feeding of adult pickerelweed weevils

B, Adult pickerelweed weevil on a *Pontederia cordata* leaf

C, Adult pickerelweed weevil on a waterhyacinth leaf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Disonychine Flea Beetles, Disonycha conjugata (Fabricius), *D. glabrata* Fabricius, and *D. pennsylvanica* (Illiger)

(Coleoptera: Chrysomelidae: Alticinae)

General Information and History

Several native flea beetles resemble the alligatorweed flea beetle (*Agasicles hygrophila* Selman and Vogt) and are often mistaken for it. This has led to numerous erroneous reports of attack by the host-specific alligatorweed flea beetle on other plants, particularly amaranths and smartweeds. The most common species found on *Amaranthus* is actually *Disonycha glabrata,* whereas *D. pennsylvanica* and *D. conjugata* feed on smartweeds. Although *D. glabrata* can often be found on smartweeds, another likely host in aquatic habitats is southern waterhemp [*Amaranthus australis* (Gray) Sauer.].

Plant Hosts

Of *Disonycha conjugata* and *D. pennsylvanica:*
Smartweed, *Polygonum densiflorum* Meissner (Polygonaceae)
Smartweed, *Polygonum punctatum* Elliot (Polygonaceae)

Of *D. glabrata:*
Amaranth, *Amaranthus spinosus* L. (Amaranthaceae)
Amaranth, *Amaranthus retroflexus* Linnaeus (Amaranthaceae)

Biology and Ecology

Disonychine flea beetles are easily distinguished from the alligatorweed flea beetle if examined closely. The pronotum of the alligatorweed flea beetle is black. In contrast, the pronotum of *Disonycha pennsylvanica* is pale yellow with a black spot, and the pronotum of *D. glabrata* is shiny yellow with one to three black spots. *D. conjugata* is very similar to *D. pennsylvanica* except that the black spot on the pronotum and elytra of *D. pennsylvanica* is replaced, in varying degrees, with a rufous coloration and the legs are reddish yellow. Some authors consider *D. conjugata* to be a subspecies of *D. pennsylvanica.*

Very little information is available on the biology of these three species. Generally speaking, though, their life histories and behavior are probably very similar to *Agasicles hygrophila.* Unlike *A. hygrophila,* which pupates in the alligatorweed stems, most *Disonycha* species probably pupate in soil. *D. conjugata,* however, does seem to pupate in smartweed stems, at least in aquatic habitats. One South American species, *D. argentinensis* Jacoby, has been introduced (but has apparently not established) into Australia and New Zealand for the biological control of alligatorweed.

Other species of *Disonychus* are known from *Amaranthus* spp., including *D. collata* Fabr., *D. triangulatus* Say, and *D. xanthomelas* Dalman. Other species recorded from *Polygonum* spp. include *D. admirablis* Blatch., *D. procera* Casey, and *D. uniguttata* Say.

Effects on Host

We know of no studies describing the impacts of these insects on their host plants.

References

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Buckingham, G.R., K.H. Haag, and D.H. Habeck. 1986. Native insects of aquatic macrophytes. Beetles. Aquatics 8(2):28,30,31,34.

Heppner, J.B., and D.H. Habeck. 1977. Insects associated with *Polygonum* (Polygonaceae) in north central Florida. II. Insects other than Lepidoptera. Florida Entomologist 60:167–170.

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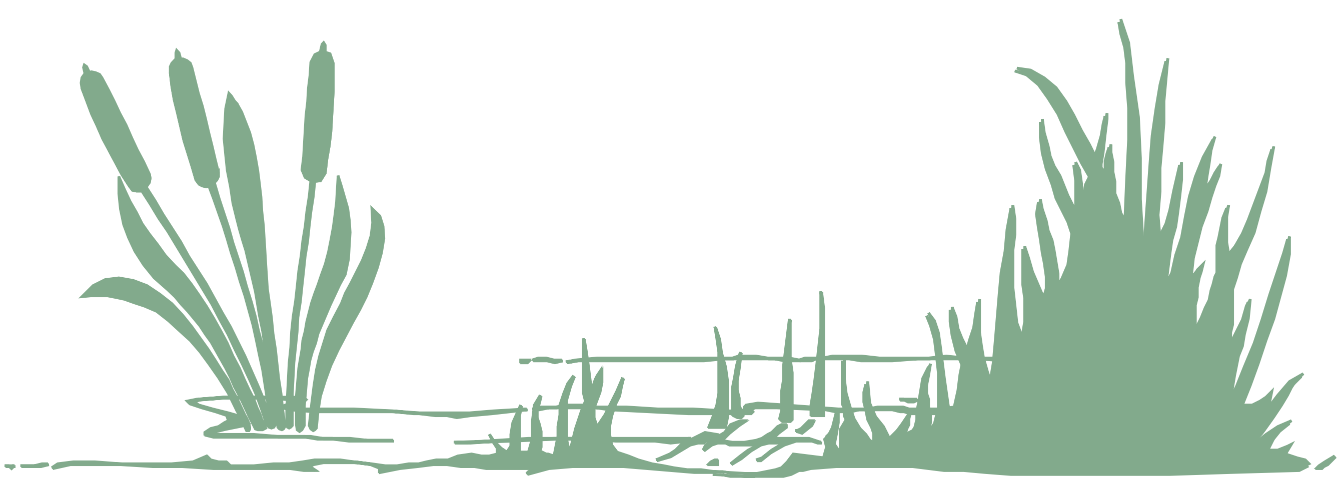


Figure 22. Disonychine flea beetles

A, Disonycha conjugata larva and adult on a smartweed leaf

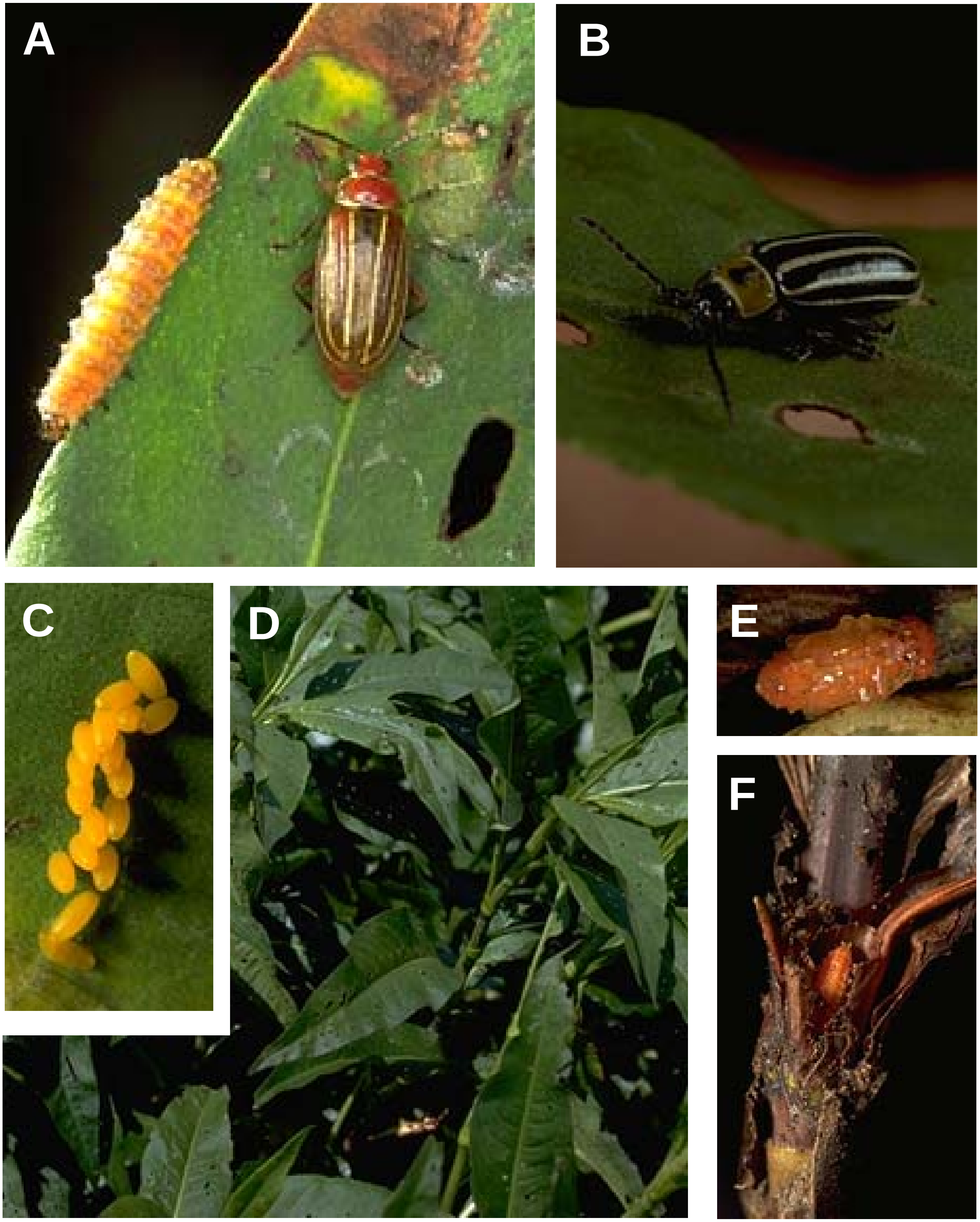
B, Adult amaranth flea beetle, *Disonycha glabrata*

C, Eggs of *Disonycha conjugata*

D, Feeding injury to the leaves of *Polygonum densiflorum* caused by larvae and adults of *Disonycha conjugata*

E, The pupa of *Disonycha conjugata*

F, Disonycha conjugata pupa within the stem of *Polygonum densiflorum*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Smartweed Node Weevil, *Rhinoncus longulus* LeConte
(Coleoptera: Curculionidae: Curculioninae Ceutorhynchini)

General Information and History

The association between *Rhinoncus* spp. and *Polygonum* spp. is apparently widespread. European species *R. albicinctus, R. perpendicularis, R. bruchoides,* and *R. pericarpius* all reportedly feed and develop on several species from the Polygonaceae, including *Polygonum.*

Plant Hosts

Smartweed, *Polygonum densiflorum* Meissner (Polygonaceae)
Smartweed, *Polygonum punctatum* Elliot (Polygonaceae)

Biology and Ecology

The small smartweed node weevil is very common in stands of smartweeds. The adults feed on the leaves. The female deposits single eggs in concealed spaces near a leaf node, such as the tubelike sheathing stipules (ocreae) at the bases of leaves. The larvae burrow into the thickened nodes, or knots, that characterize the so-called “knot-weeds.” A single larva apparently completes development within one node. It then excavates the node to create a pupal chamber and forms a small, naked, whitish pupa within this chamber. Upon completion of development, the adult chews its way out of the node, leaving a small emergence hole.

Effects on Host

In feeding, adult smartweed node weevils create small punctures that penetrate both surfaces of the leaves. Larval damage to the node disrupts the vascular tissue of the stem, causing infested plants to wilt. The appearance of numerous wilted tips in smartweed stands often signals the presence of this weevil.

References

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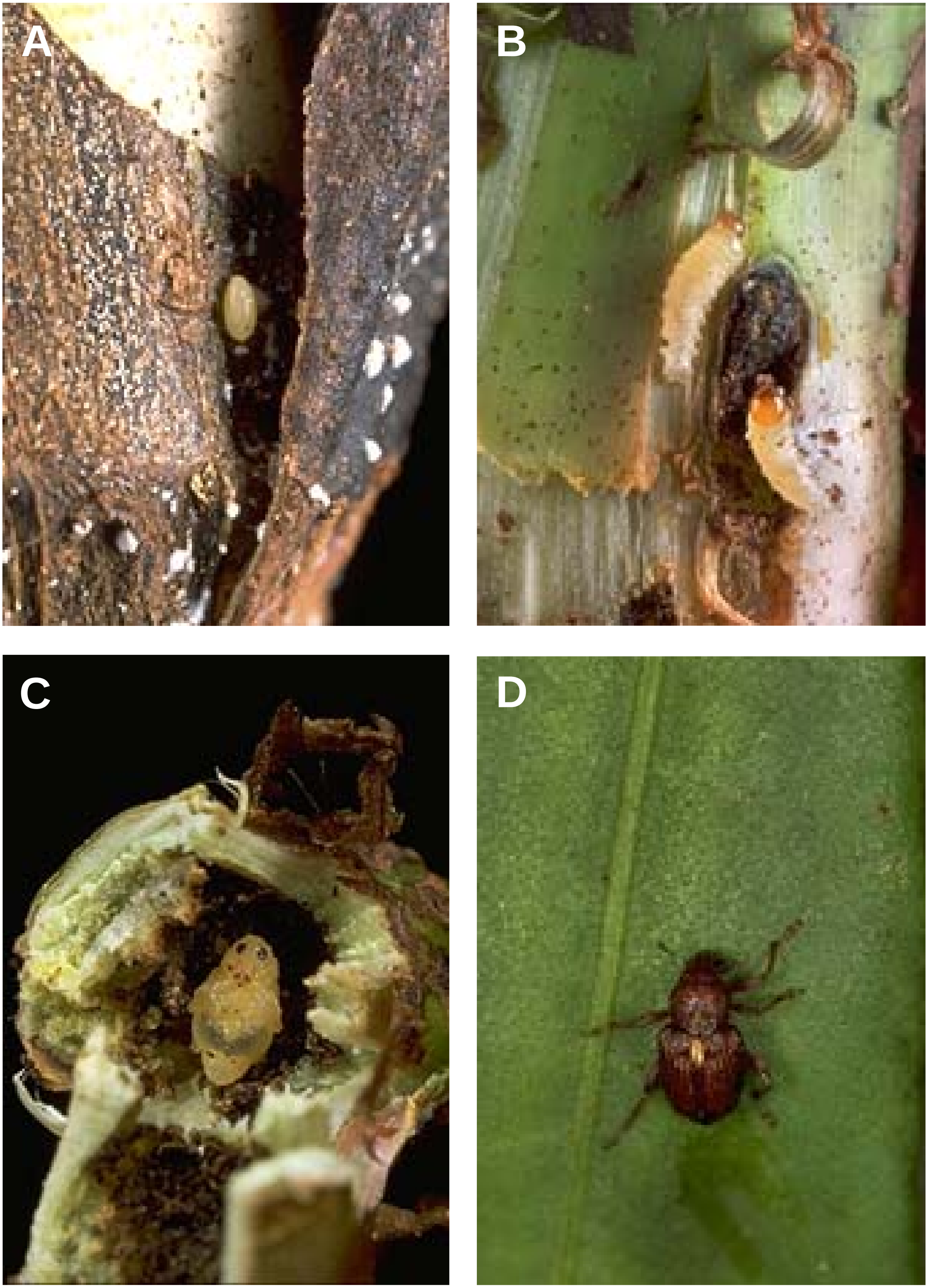
Figure 23. Smartweed node weevil

A, Egg of the smartweed node weevil under the leaf base of *Polygonum densiflorum*

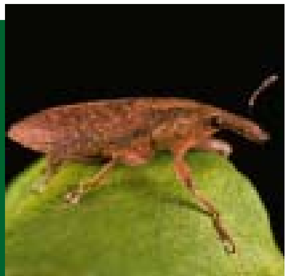
B, First-instar *Rhinoncus longulus* larvae

C, Rhinoncus longulus pupa in its pupal chamber in a stem node

D, Adult smartweed node weevil


A
B
C
D

Smartweed Stem Weevils, *Lixus merula* Suffr. and *L. punctinasus* LeConte
(Coleoptera: Curculionidae: Curculioninae: Lixini)



General Information and History

Weevils in the genus *Lixus* are known as pests of numerous economic plant species throughout the world. Examples include the bitterleaf weevil (*L. camerunus* Kolbe) on *Vernonia amygdalina* (Compositae) in Nigeria, the faba bean stem borer (*L. algirus* L.) on *Vicia faba* in Syria and Morocco, *L. juncii* Boheman and *L. scabricollis* Boheman on sugar beets in Spain, *L. brachyrrhinus* Boheman on niger grain (*Guizzota abyssinica* (L.f.) Cass.) in India, *L. diatraeae* on sugarcane in Southeast Asia, *L. iridis* on cowparsnip (*Heracleum* sp.) in the Ukraine, and the rhubarb weevil (*L. concavus* Say) on rhubarb in North America. One species (*L. cribricollis* Boheman) has been introduced into Australia for biological control of the weeds *Emex australis* Steinheil, *E. spinosa* (L.), and *Rumex crispus* L., all of which are members of the Polygonaceae.

Plant Hosts

Smartweed, *Polygonum densiflorum* Meissner (Polygonaceae)
Smartweed, *Polygonum punctatum* Elliot (Polygonaceae)

Biology and Ecology

At least two *Lixus* species feed on smartweeds in the Southeast. These are *L. merula* and *L. punctinasus.* The biologies of these two native weevils have not been studied. Both seem to be restricted to the smartweeds (*Polygonum* spp.). *Lixus merula* has been reared from both *P. punctatum* and *P. densiflorum,* whereas *L. punctinasus* has only been reared from *P. punctatum.* Both larvae and adults feed on the host plant. Larvae are stem borers. Adults feed on and perforate the leaves. The adults of *L. merula* are commonly seen on young leaves at the tips of *P. densiflorum* plants.

Effects on Host

We know of no studies describing the impacts of these insects on their host plants.

Reference

Heppner, J.B., and D.H. Habeck. 1977. Insects associated with *Polygonum* (Polygonaceae) north central Florida. II. Insects other than Lepidoptera. Florida Entomologist 60:167–170.

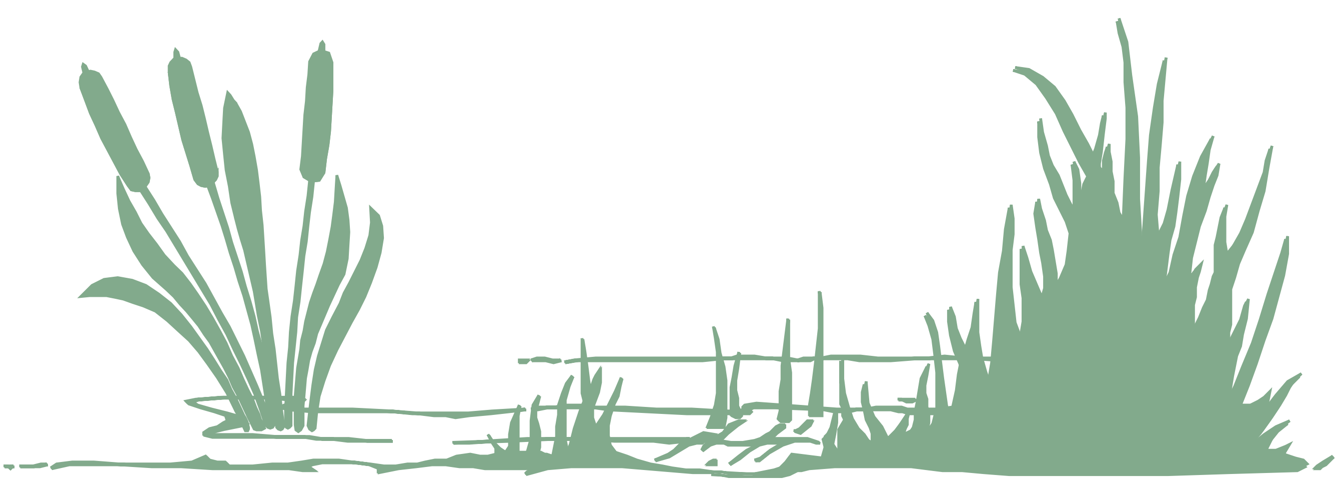
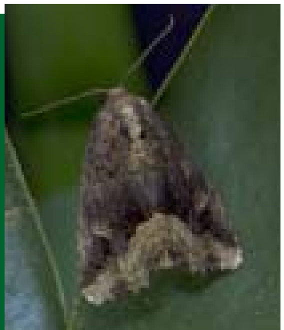


Figure 24. Smartweed stem weevils

A, Adult *Lixus* weevil

B, Leaf punctures on *Polygonum densiflorum* caused by feeding of adult *Lixus* weevils

Waterlily Moth, *Homophoberia cristata* Morr.
(Lepidoptera: Noctuidae: Acontiinae)



General Information and History

The larvae of two moth species are commonly encountered on spatterdock. One is the yellow waterlily borer, *Bellura gortynoides,* and the other is the waterlily moth, *Homophoberia cristata.*

Plant Host

Spatterdock, *Nuphar advena* (Aiton) Aiton f. (Nymphaeaceae)

Biology and Ecology

The caterpillar of the waterlily moth can commonly be found feeding above water on the lower surface of spatterdock (yellow waterlily) leaves or on the upper surface usually within a folded-over portion of the leaf. The female typically deposits eggs on the upper leaf surface. The dome-shaped eggs may be placed singly or in irregular groups. A single female will lay as many as 900 eggs. Although the female moths may lay eggs for up to 12 days, most are laid within 2 or 3 days of emergence from the pupa (as many as 300 eggs per night) and the ovipositional rate declines thereafter. The average adult life span (in the laboratory) is 6 days, and the maximum is 13 days.

The first-instar larvae eclose from the egg by chewing through the chorion (egg shell), excising a circular piece which it then pushes open. The newly emerged larvae are pale, translucent green with numerous spots and measure about 2 mm in length. During development, the larvae progress through 5 larval instars. The average diameters of the head capsules are 0.29, 0.51, 0.86, 1.41, and 2.17 mm for the five progressive instars. Larval development requires about 26 days (range 24–31 days) at room temperature (about 25 ^{o}C). Late-instar larvae are pale green with dark red markings on the sides toward the dorsal surface and measure up to 32 mm in length. Just prior to pupation, the mature larvae turn deep red.

Fully grown larvae reportedly swim to shore to pupate in the soil, but they are not truly aquatic. Swimming is accomplished in a porpoiselike fashion, with the posterior third of the body bent downward then quickly thrust backward for propulsion. Upon reaching the shore they create a pupal chamber in the soil and thinly line it with silk. The dark brown pupa measures about 14 mm in length, and the pupational period requires about 9 days. Contrary to published information, we frequently find pupae within amorphous white cocoons on the upper surfaces of spatterdock leaves under the rolled edges or on the leaves of nearby emergent plants.

The wingspread of adult moths measures 2.7–3.3 mm. The forewings are dark grayish brown, and the hind wings are whitish.

Effects on Host

We know of no studies describing the impacts of this insect on its host plants.

References

Dyar, H.G. 1909. Description of the larva of *Eustrotia caduca* Grote (Lepidoptera, Noctuidae). Proceedings of the Entomological Society of Washington 11:200.

Habeck, D.H. 1976. Life cycle of *Neoerastria caduca* (Lepidoptera: Noctuidae). Florida Entomologist 59:101–102.

Habeck, D.H., K. Haag, and G. Buckingham. 1986. Native insect enemies of aquatic macrophytes—moths. Aquatics 8(1):17–19, 22.

Figure 25. Waterlily moth

A, Adult waterlily moth

B, Late-instar *Homophoberia cristata* larva

C, Homophoberia cristata cocoon on the rolled edge of a spatterdock leaf


A
B
C

Yellow Waterlily Borer, *Bellura gortynoides* Walker
(Lepidoptera: Noctuidae: Amphipyrinae)

General Information and History
The larvae of the yellow waterlily borer commonly infest *Nuphar advena* throughout the eastern United States. It is closely related to the pickerelweed borer *(Bellura densa)* and the cattail borer *(B. obliqua).*

Plant Host
Spatterdock, *Nuphar advena* (Aiton) Aiton f. (Nymphaeaceae)

Biology and Ecology
Bellura gortynoides females deposit their eggs in clusters on *Nuphar* leaf blades (both upper and lower surfaces) and occasionally on emergent leaf petioles. Hairlike scales from the tip of the female's abdomen are used to cover the egg masses, which are roundish to oval, 3–5 mm in diameter, and resemble a bird dropping. Each mass contains up to 20 eggs deposited in one to three layers. The adult female lays an average of 392 eggs in 21 egg masses.

Eggs hatch in 5 or 6 days. After eclosing from the eggs, the young larvae chew through the leaf epidermis, usually from below the egg mass, and burrow into the underlying parenchyma. The larvae mine the leaf blades during the first three larval stages (about 10 days). The epidermis turns brown and disintegrates in the area adjacent to these mines, sometimes destroying two-thirds of the leaf blade.

After the larvae attain a diameter larger than the thickness of the leaf blade, they begin to burrow into the petiole, either directly or via the midrib. Entry is always above the waterline. The petiole tunnels, however, extend below the waterline, the larvae often feeding with their head below the water but with the tail above. Two large dorsoposteriorly oriented spiracles near the end of the abdomen provide for respiration while the larva is submersed in this fashion. The larvae also feed entirely below the water, occasionally backing up to expose their spiracles to the air.

Although the petiole burrows may extend the entire length of the petiole, the larvae do not burrow into the rhizome. Larvae often emerge from their burrows at night to feed on the leaf surfaces. In so doing, they create deep gouges in the lamina surface or notches in the leaf margins. They also move from leaf to leaf during active feeding. The larval period lasts 44–47 days (at 24 ^{o}C), on average, and the larvae progress through six or seven instars.

Last instars have orange heads and a dark brown cervical shield with a white medial line. The dorsal surface is olive brown with dark bands at the posterior end of each segment. The ventral surface is whitish. They measure 41 mm in length with a head capsule width of 2.8 mm.

The fully grown larvae pupate within the petiole burrow. The dark brown pupa floats suspended within the burrow, with its head and thorax above water and oriented toward the surface. The adults emerge in about 9 days for a total laboratory developmental period (egg to adult) of about 60 days.

The adult moths are generally yellowish with yellow-olive to yellow-orange forewings. Hindwings are usually pinkish with a small brown spot on the underside. Females have a broad, blunt abdomen tipped with white or dark brown hairs. The male's abdomen is more slender and pointed. Wingspreads average 42–45 mm for females and 35–39 mm for males.

Effects on Host

We know of no studies describing the impacts of this insect on its host plants.

Reference

Levine, E., and L. Chandler. 1976. Biology of *Bellura gortynoides* (Lepidoptera: Noctuidae), a yellow water lily borer, in Indiana. Annals of the Entomological Society of America 69:405–414.

Figure 26. Yellow waterlily borer

A, Larval *Bellura gortynoides* feeding scars on spatterdock leaf

B, Adult *Bellura gortynoides*

C, Bellura gortynoides larva burrowing in spatterdock stem prior to pupation

D, Bellura gortynoides pupa in *Nuphar advena* stem


A
B
C
D

Salvinia Weevil, *Cyrtobagous salviniae* Calder & Sands
(Coleoptera: Curculionidae: Curculioninae: Erirhinini)

General Information and History

The genus *Cyrtobagous* Hustache was originally thought to be monotypic, containing only *C. singularis*. This species is known to feed on various South American *Salvinia* species.

Having long been considered as a potential biological control agent of the aquatic weed *S. molesta* Mitchell, *C. singularis* was subsequently introduced from Trinidad into Botswana and Zimbabwe. However, it failed to control *S. molesta* (then thought to be *S. auriculata* Aubl.). Subsequently, what was presumed to be the same species from Brazil was introduced into Australia. In Australia it performed exceedingly well, achieving complete control of *S. molesta* at some sites within 18 months. The reason for this success was at first thought to be the correct identification of the target plant as *S. molesta* instead of *S. auriculata* and the introduction of a *C. singularis* biotype collected from *S. molesta.* Later taxonomic studies, however, revealed that the weevils introduced into Australia were actually a new, distinct species, *C. salviniae* Calder & Sands.

An important difference between the two species—their feeding characteristics—explained the differential effects realized in Africa and Australia. The larvae of *C. salviniae* tunnel within the rhizomes, causing them to disintegrate, and the adults eat buds, thus suppressing growth. The larvae and adults of *C. singularis* feed on the leaves and other tissues but don't affect the rhizomes or meristems. Hence, the former species was very effective while the latter species was ineffective. This project is a classic illustration of the importance of careful taxonomic study of both the weed and the insects for successful biological control.

Cyrtobagous salviniae (as *C. singularis*) was first recorded from the United States in Florida at Archbold Biological Station (Highlands County) in 1962. It is assumed to have been accidentally introduced from South America because of the lack of U.S. records.

Plant Host

Waterferns, *Salvinia* spp. (Salviniaceae)

Biology and Ecology

Adults are small (2–3 mm), black, subaquatic weevils that reside on or beneath leaves. A thin film of air adheres to the ventral surface of their abdomen and provides for respiration when the adults are submersed. Eggs are laid singly in cavities chewed by the female into floating leaves (the "roots" are actually modified submersed leaves). Eggs hatch in about 10 days.

The larvae are white and attain lengths of only about 3 mm. When fully grown they construct a cocoon beneath the water amongst the submersed leaves ("roots"). Larval development requires 3–4 weeks, while the prepupal and pupal periods combined require about 2 weeks.

Effects on Host

This insect has been used successfully as a biological control of *Salvinia* in India, Africa, Sri Lanka, Southeast Asia, Papau New Guinea, and Australia. Larvae tunnel in the rhizomes and adults eat buds, causing the ferns to disintegrate. The weevils have dramatically reduced large *Salvinia* infestations.

References

Forno, I.W., D.P.A. Sands, and W. Sexton. 1983. Distribution, biology and host specificity of *Cyrtobagous singularis* Hustache (Coleoptera: Curculionidae) for the biological control of *Salvinia molesta.* Bulletin of Entomological Research 73:85–95.

Kissinger, D.G. 1966. *Cyrtobagous* Hustache, a genus of weevils new to the United States fauna (Coleoptera: Curculionidae: Bagoini). Coleopterists' Bulletin 20:125–127.

Sands, D.P.A. 1983. Identity of *Cyrtobagous* sp. (Coleoptera: Curculionidae) introduced into Australia for biological control of salvinia. Journal of the Australian Entomological Society 22:200.

Sands, D.P.A., M. Schotz, and A.S. Bourne. 1983. The feeding characteristics and development of larvae of a salvinia weevil *Cyrtobagous* sp. Entomologia Experimentalis et Applicata 34:291–296.

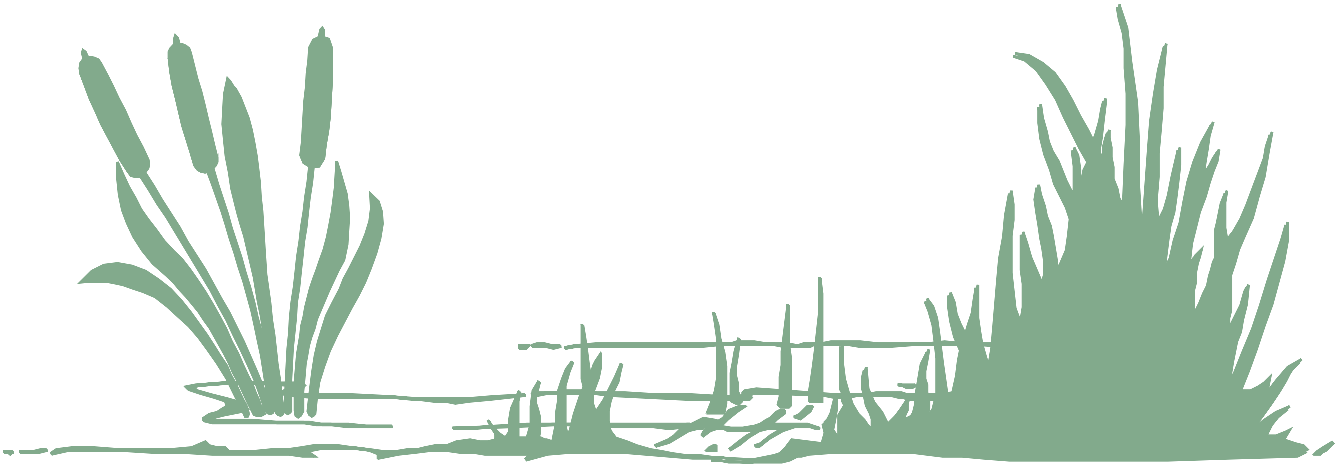


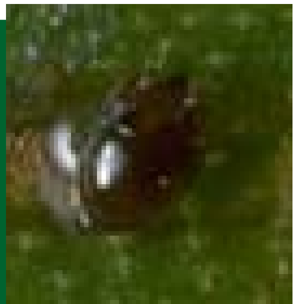
Figure 27. Salvinia weevil

A, Adult *Cyrtobagous salviniae* on *Salvinia minima*

B, Several adult salvinia weevils on *Salvinia minima.* Note the feeding damage to the fronds


A
B

Waterhyacinth Mite, *Orthogalumna terebrantis* Wallwork
(Acari: Actinedida: Oribatida: Galumnidae)



General Information and History

The waterhyacinth mite, *Orthogalumna terebrantis,* is believed to be native to the United States. It is a member of the Acarina (arachnids) and thus has four pairs of legs like its relatives, spiders and ticks. *O. terebrantis*, like other mites, have piercing mouthparts with which they suck juices from their hosts.

Plant Hosts

Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)
Pickerelweed, *Pontederia cordata* L. (Pontederiaceae)

Biology and Ecology

Adult waterhyacinth mites are shiny black, about 0.3 mm wide by about 0.5 mm long, teardrop shaped, and narrowed anteriorly. Females cut a small round hole in the surface of a waterhyacinth lamina in which to oviposit. Oviposition occurs primarily on very young leaves. Eggs hatch in 7–8 days (at 25 °C) and produce small (less than 0.24 mm), whitish, slow-moving larvae that bear three pairs of legs. Nymphs bear four pairs of legs and are amber colored. The three nymphal stages (proto-, deuto-, and tritonymphs) are distinguishable primarily on the basis of size (maximum length 0.32 mm, 0.39 mm, and 0.50 mm, respectively). Total development through larval and nymphal stages requires about 15 days (at 25 °C).

Feeding damage by the mites is restricted to the laminae. The larvae produce small reddish spots on the abaxial leaf surface, and the nymphs produce galleries that extend distally toward the leaf apex. These galleries are located between the parallel leaf veins and attain maximum lengths of 6 mm. The adults emerge from the galleries through small, round exit holes at the distal end of the gallery.

Effects on Host

When mite populations are high, large numbers of galleries (up to 2,500 per lamina) may be present. These high numbers cause desiccation of the leaf and result in the lamina turning brown. Severe damage, however, is usually confined to a small area or a few plants. Rarely is damage extensive enough to effectively control waterhyacinth populations.

References

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Bennett, F.D., and H. Zwolfer. 1968. Exploration for natural enemies of the waterhyacinth in northern South America and Trinidad. Hyacinth Control Journal 7:44–52.

Cordo, H.A., and C.J. DeLoach. 1975. Ovipositional specificity and feeding habits of the waterhyacinth mite, *Orthogalumna terebrantis,* in Argentina. Environmental Entomology 4:561–565.

Cordo, H.A., and C.J. DeLoach. 1976. Biology of the waterhyacinth mite in Argentina. Weed Science 24:245–249.

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Del Fosse, E.S., H.L. Cromroy, and D.H. Habeck. 1975. Determination of the feeding mechanism of the waterhyacinth mite. Hyacinth Control Journal 13:53–55.

Gordon, R.D., and J.R. Coulson. 1969. Report on field observation of arthropods on waterhyacinth in Florida, Louisiana, and Texas, July 1969. Unpublished.

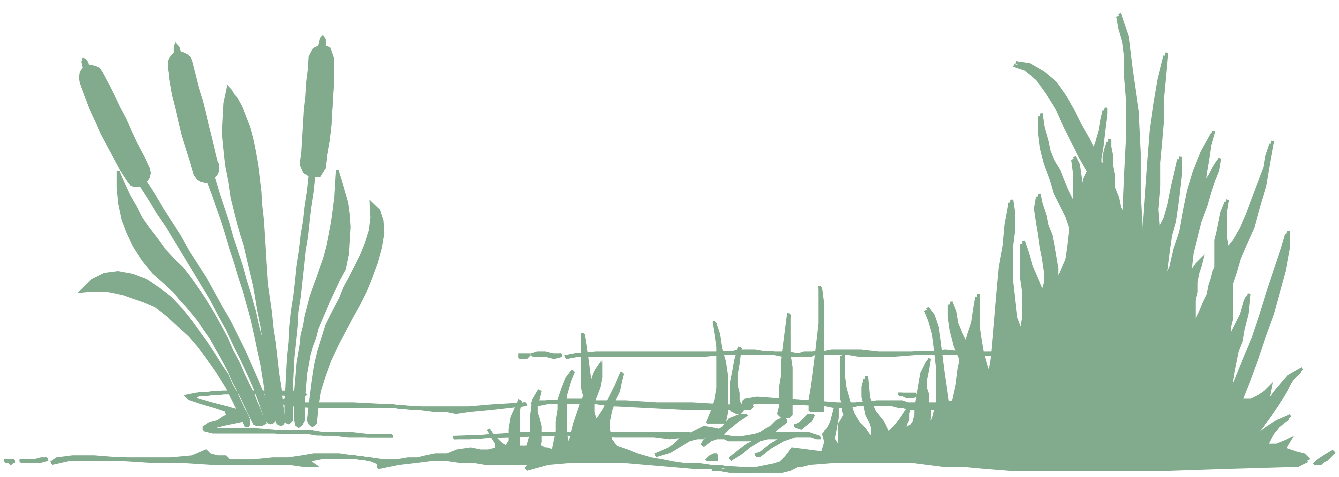
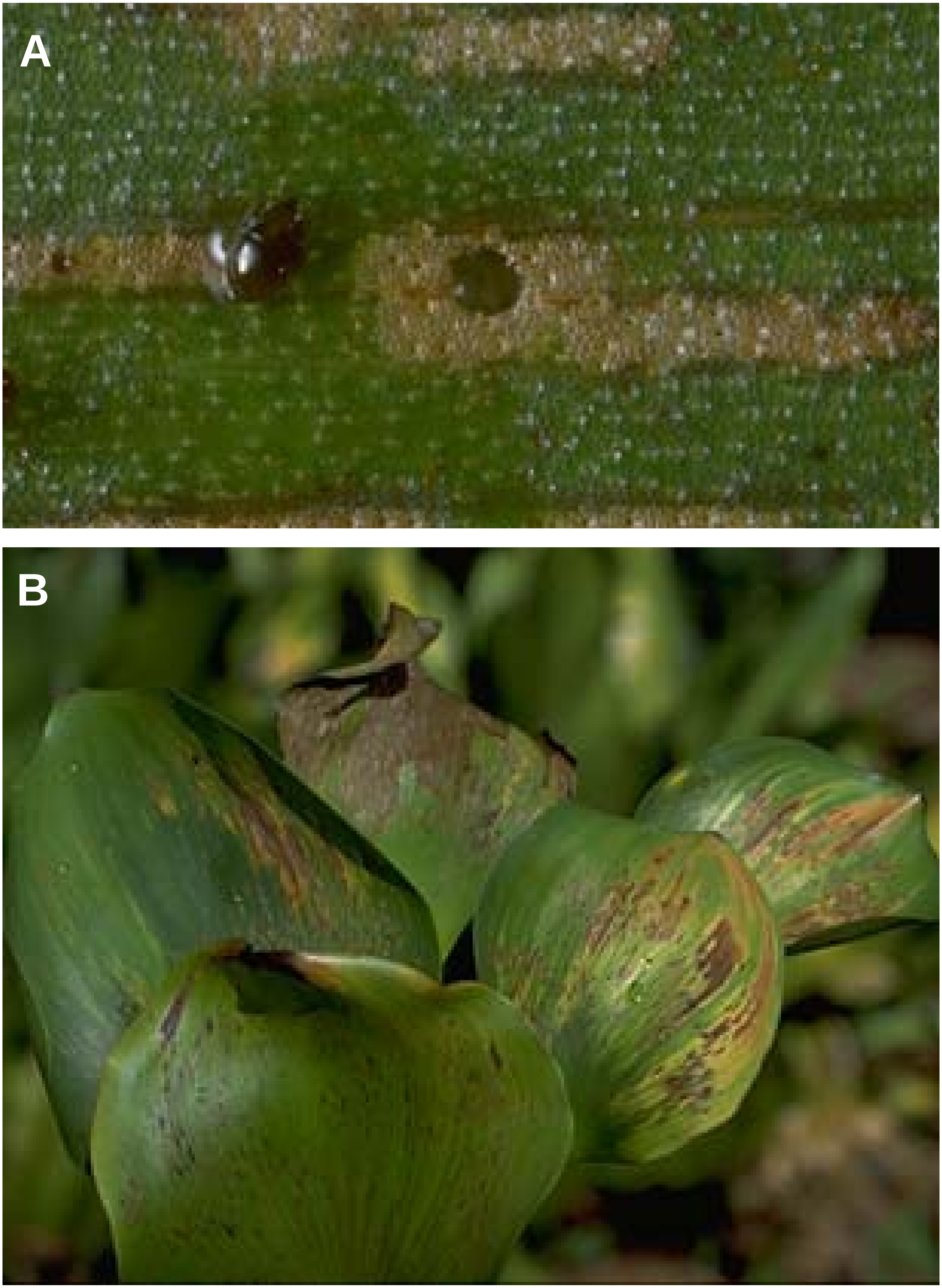


Figure 28. Waterhyacinth mite

A, Adult waterhyacinth mite on a waterhyacinth leaf next to an emergence hole from a larval gallery

B, Orthogalumna terebrantis nymphal galleries on waterhyacinth leaves


A
B

Waterhyacinth Moth, *Niphograpta albiguttalis* (Warren)
(Lepidoptera: Pyralidae: Pyraustinae)

General Information and History
The waterhyacinth moth is native to the Amazonian Basin of South America. It was imported into the United States for biocontrol of waterhyacinth. The first releases occurred during 1977 in Florida.

Plant Host
Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)

Biology and Ecology
The eggs of *Niphograpta (=Sameodes) albiguttalis* are small (about 0.3 mm), spherical, and creamy white. The shape of the eggs is often irregular because they become distorted when the adult female pushes them into cracks and crevasses in the plant. As the embryo develops, the egg becomes progressively darker. Just prior to hatching, it appears black due to the visibility of the head of the larva. Complete development of the embryo requires 3–4 days at 25 ^{o}C.

The newly emerged larva measures about 1.5 mm in length and is brownish with darker spots. Its head is black to dark brown. Larval development progresses through five instars. The fully grown fifth-instar larva is about 2 cm long, has a dark orange head and a cream-colored body, and is covered with conspicuous dark brown spots. Completion of the five larval stages requires about 2 weeks.

When the larva is fully grown, it seeks out a fairly large, relatively intact waterhyacinth leaf petiole and burrows into it. It excavates an elliptically shaped cavity in the middle of the petiole with a tunnel extending from one end. This tunnel leads from the cavity to just beneath the outside surface of the petiole, but the end remains covered by the leaf epidermis. The larva then forms a cocoon that lines the cavity and extends up the tunnel. Soon afterward, it sheds its last instar larval skin and pupates. It is inactive during this stage (which lasts 7–10 days) while complex internal changes take place that alter its structure to that of an adult moth. After transformation is complete, it breaks through the head end of the pupal skin, crawls through the silk-lined tunnel, and bursts through the leaf epidermis to exit from the petiole. The exit tunnel is necessary because the adults lack chewing mouthparts and could not otherwise escape from within the petiole.

The adult moths frequently rest on the underside of waterhyacinth leaves. The females are generally darker than the males, but color is extremely variable in both sexes. The forewings range in color from brown to golden, with the hindwings more consistently golden. There is usually a distinct white spot at midlength toward the leading edge of the forewing and a dark spot in the center of the hindwing. The hind edges of the segments of the body are almost always white, giving the appearance of white rings around the abdomen. The adults probably live no more than a week to 10 days and many fall prey to dragonflies, spiders, lizards, frogs, and other predators.

Mating occurs shortly after emergence from the pupa, and the female lays the majority of her eggs the following night. An average female will deposit about 450 eggs, but up to 600 is not unusual. The entire life cycle requires 3–4 weeks.

A few other species of lepidopteran larvae feed on waterhyacinth, but the one most likely to be confused with *Niphograpta albiguttalis* is *Samea multiplicalis* (Guenée). The larvae of this species also have conspicuous brown spots, but these are generally not as dark as those on *N. albiguttalis*. Curiously, when *S. multiplicalis* feeds on other host plants, such as *Pistia stratiotes* L. (as they are likely to do), the spots may not be conspicuous. A fully grown *S. multiplicalis* larva is smaller (about 13 mm) than *N. albiguttalis* (about 18 mm) and has a pale brownish head instead of a dark brown or orange one. The pupae and mode of pupation are also similar in both species, as are the adults. See Center et al. (1982) for characteristics useful in separating these two species.

Effects on Host

Feeding by neonate larvae creates irregularly shaped lesions that penetrate the epidermis and underlying parenchyma but not the vascular tissue. Within a day or two, larvae burrow into a petiole and begin to eat the parenchyma just below the epidermis. This often creates transparent areas in the petiole. Late-instar larvae burrow into the central portion of the rosette, destroying the petiole of the youngest leaves and often devouring the apical meristem.

References

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DeLoach, C.J., and H.A. Cordo. 1978. Life history and ecology of the moth *Sameodes albiguttalis,* a candidate for biological control of waterhyacinth. Environmental Entomology 7:309–321.

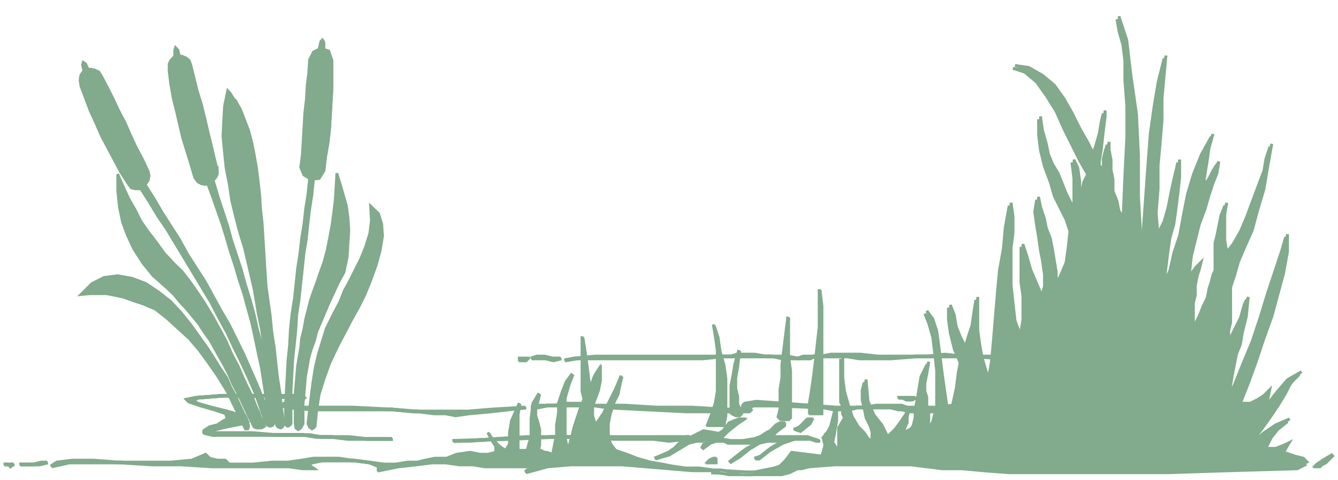


Figure 29. Waterhyacinth moth

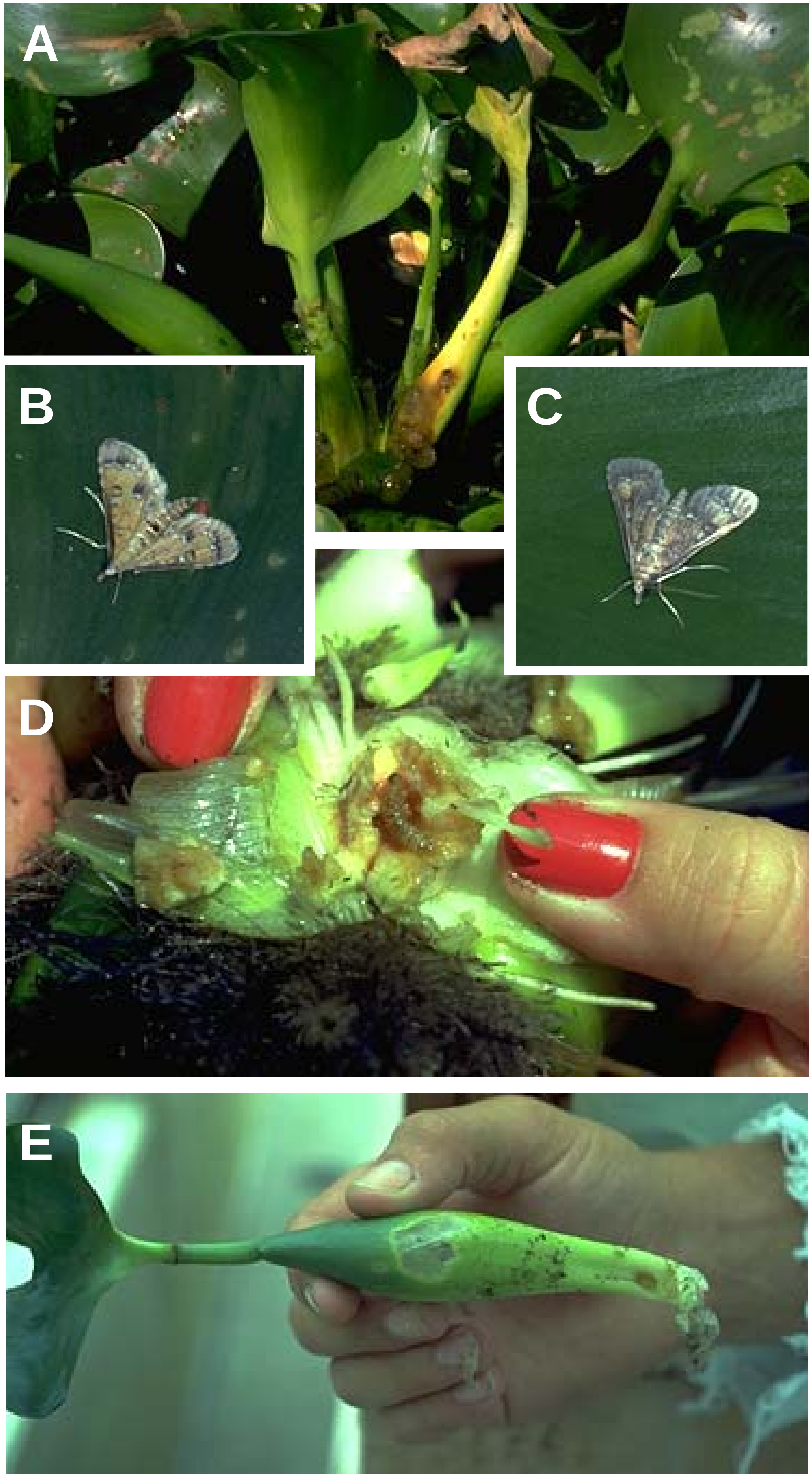
A, Waterhyacinth plant showing crown damage and the wilted central leaf caused by *Niphograpta albiguttalis* larval feeding

B, Adult male waterhyacinth moth

C, Adult female waterhyacinth moth

D, Late-instar *Niphograpta albiguttalis* feeding on the apical bud of a waterhyacinth rosette

E, Typical damage done to a waterhyacinth leaf petiole by early-instar *Niphograpta albiguttalis* larvae


A
B
C
D
E

Waterhyacinth Weevils, *Neochetina eichhorniae* Warner and *N. bruchi* (Hustache)

(Coleoptera: Curculionidae: Curculioninae: Erirrhinini)

General Information and History

The genus *Neochetina* comprises six species whose native range is primarily South and Central America (O'Brien 1976). All are semiaquatic, are covered with a layer of very dense, water-repellent scales, and feed only on species of plants in the family Pontederiaceae. Two species of *Neochetina* were imported into the United States as biological controls of waterhyacinth. *N. eichhorniae* was first released during 1972 in Florida; its congener, *N. bruchi,* was first released during 1974, also in Florida. These two species now occur throughout the range of waterhyacinth in the United States.

Plant Host

Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)

Biology and Ecology

The adults of *Neochetina bruchi* and *N. eichhorniae* can usually be distinguished by the color and pattern of the scales covering the elytra (Warner 1970, DeLoach 1975, O'Brien 1976). *N. bruchi* ranges in color from uniform tan or brown with no distinct markings to brown with a broad, crescent-shaped or chevronlike tan band across the elytra. *N. eichhorniae* never has the tan band and is usually gray mottled with brown. The color pattern is associated with the scales, and specimens may be difficult to identify if the scales are missing or the specimens are dirty or wet. Both species have two short, shiny, dark lines on the elytra on either side of the midline. This short line is actually a tubercle or ridge and its position varies between the two species. On *N. bruchi* the tubercles are situated very near midlength. Although the position of the tubercles is more variable on *N. eichhorniae,* they are usually situated further forward, in front of midlength.

A more subtle character separating these two species concerns the lines (striae) that run lengthwise and nearly parallel to one another on the elytra. These striae are actually shallow grooves. On *N. bruchi* the striae are relatively fine, whereas on *N. eichhorniae* they are relatively coarse. This gives *N. bruchi* an overall smoother textural appearance than *N. eichhorniae.* For further information on the identification of these two species, consult Warner (1970), DeLoach (1975), or O'Brien (1976).

The eggs, larvae, and pupae of both species are very similar and virtually indistinguishable from one another. Identification of the immature stages is difficult.

Eggs are whitish, ovoid, and about 0.75 mm in length. Because they are embedded in the plant tissue, they can usually only be found by dissecting the plant while using a microscope.

Larvae are white or cream colored, with a yellow-orange head. They have no legs or prolegs, only enlarged swellings with setae (small hairs) where the legs should be. The posterior end of the abdomen is blunt, and a pair of spiracles (breathing tubes) project upward, somewhat spurlike, from the last abdominal segment. These spurlike spiracles presumably allow the larva to obtain oxygen by inserting them into the plant tissue. When the larvae first emerge from the egg they are very small (about 2 mm in length) and cylindrical in shape. The fully grown third-instar larva is somewhat grublike, C-shaped, and about 8–9 mm in length.

Pupae are white and resemble the adults. The pupa is enclosed in a cocoon formed among the lateral rootlets and attached to the main root axis below the water surface.

These appear as small balls or nodules about 5 mm in diameter on the roots usually near the rhizome.

Eggs of both species of *Neochetina* are deposited directly in the plant tissue. The female chews a hole into the lamina or petiole in which to lay eggs. *N. eichhorniae* deposits only one egg in each hole, whereas *N. bruchi* deposits several. Either species may also place eggs around the edge of leaf abrasions created by the feeding of the adults. DeLoach and Cordo (1976a) reported that *N. bruchi* preferred to oviposit in leaves with inflated petioles and especially those at the periphery of the plant, while *N. eichhorniae* preferred tender central leaves or the ensheathing stipules at the leaf bases. Eggs of *N. eichhorniae* are rare in the youngest leaves and are usually found in those of intermediate age. Eggs are most prevalent in the basal portion of the petioles where the stipules are somewhat open and a space is available for the adults to congregate.

The eggs hatch within 7–10 days at 24 ^{o}C. The first-instar larvae, which are very small (head diameter of about 0.3 mm), burrow under the epidermis and work their way toward the base of the leaf. They pass through a total of three larval instars. The first molt occurs when the larvae are about 10 days old and the second about 2 weeks later. As the larvae grow larger, their galleries, or feeding burrows, become larger. Third instars are generally located at the petiole bases and may enter the stem (rhizome) and excavate small pockets at the point of insertion of the leaf. They occasionally burrow up the stem to enter the base of younger petioles and sometimes reach the stem apex and destroy the apical bud. The larval period probably requires 30–45 days, with *N. bruchi* developing somewhat faster than *N. eichhorniae.*

The fully developed larvae burrow out the stem and move to the upper root zone just under the surface of the water. They cut off the small lateral roots and form a spherical, parchmentlike cocoon around themselves. This cocoon is attached to one of the main roots. Curiously, at the point of attachment, the larva chews a notch into the root. This notch supposedly functions in gas exchange between the hollow inside of the cocoon and lacunar system of the plant. After the cocoon is formed, the larva molts a third time and becomes a pupa. This is the inactive stage during which the transition from larva to adult occurs. It is not known with certainty how long this stage lasts, but best estimates indicate about 30 days.

As the adults emerge, they split the cocoon, push the opening wider with their legs, and pull themselves out through the split. After they are out, they climb up onto the emergent leaves of the plant to feed and mate. The female weevils begin to lay eggs within a few days after emerging from the pupa, and most eggs are deposited within the first week. A single female *N. bruchi* will deposit up to 300 eggs; *N. eichhorniae* deposits up to 400. DeLoach noted that about 90 percent of the eggs are deposited within a month after the female emerges, although the adults may live over 9 months. For further details on the biology of these species, see the articles by DeLoach and Cordo (1976a,b).

Effects on Host

Feeding adult waterhyacinth weevils leave characteristic circular scars about 2 mm in diameter. The adults also girdle the leaf petioles at the base of the lamina. Severe infestations result in leaves that are desiccated, are nearly covered with feeding scars, and have curled laminae. Moderate to severe infestations result in shorter plants with smaller leaves, fewer offsets and flowers, lower tissue nutrient content, and less overall vigor than uninfested or lightly infested plants.

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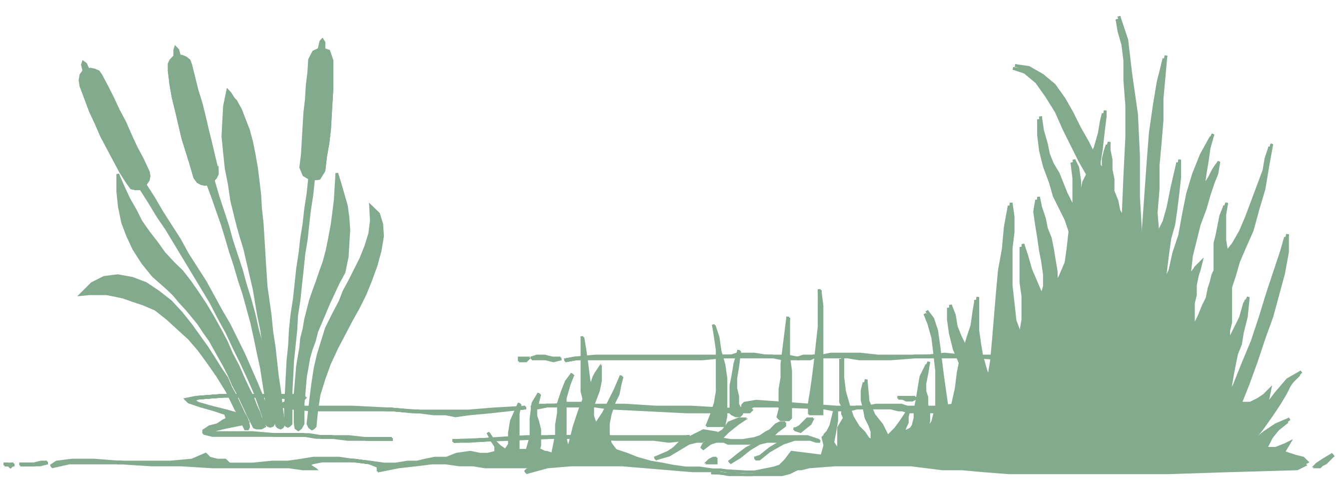


Figure 30. Waterhyacinth weevils

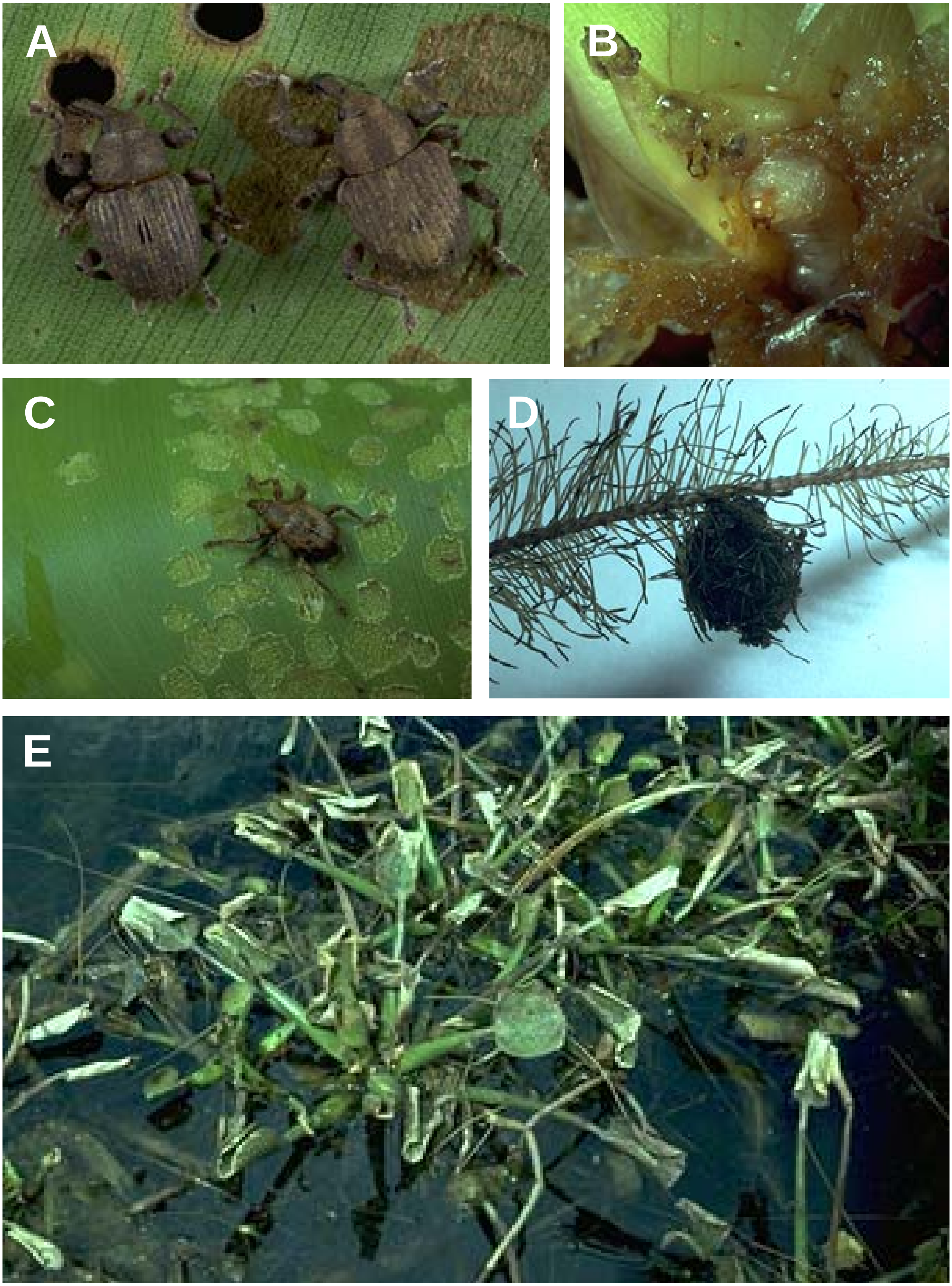
A, Adult *Neochetina eichhorniae* (left) and *N. bruchi* (right)

B, Neochetina larva feeding on the base of an axillary bud

C, Neochetina adult and the typical adult feeding “pits” on a waterhyacinth leaf

D, Neochetina cocoon on a waterhyacinth root

E, Waterhyacinth plants severely stressed by weevil attack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Asian Waterlettuce Moth, *Spodoptera pectinicornis* (Hampson)

(Lepidoptera: Noctuidae: Amphipyrinae)

General Information and History

Very little information is available on the biology and life history of *Spodoptera* (formerly *Namangana*) *pectinicornis.* George (1963) provided a few notes based upon observations in Kerala, India. However, most of the available information is provided in a thesis by Suasa-ard (1976), who studied the insect in Thailand.

This noctuid is widely distributed, occurring in India, Indonesia, Bangladesh, Papua New Guinea, Thailand, and doubtless other countries of Asia and the Indo-Pacific region. The first release of *S. pectinicornis* in Florida was made during late 1990, but persistent field populations are not yet established.

Plant Host

Waterlettuce, *Pistia stratiotes* L. (Araceae)

Biology and Ecology

Female Asian waterlettuce moths oviposit on both surfaces of waterlettuce leaves. Eggs are laid in masses of up to 150 eggs each (average 94 eggs per mass). The egg masses are covered by scales from the female's abdomen. The ovipositional period lasts 2–6 days (average 3.6 days) and each female lays up to 990 eggs (average 666 eggs). The incubation period ranges from 3 to 6 days (average 4.4 days). Eggs are subspherical, about 0.03 mm in diameter, greenish when newly deposited, and yellow later.

First instars are creamy white and feed within the leaf on the spongy tissues. Larval development progresses through seven instars and requires 17–20 days (average 18 days). Fully grown larvae attain lengths of up to 25 mm. They pupate in a leaf base between the leaves or between the thick ribs on the underside of the leaf. The prepupal period lasts 1–2 days and the pupational period lasts 3.5–5.5 days. The total generation time is about 30 days.

Effects on Host

Plant destruction is caused by the feeding activity of the caterpillars. Although considerable damage accrues on the leaves, this alone would probably not kill the plants. The larvae also destroy the meristematic tissue preventing leaf replacement and impeding offset production. George (1963) estimated that 100 caterpillars from one average-sized egg mass could destroy the waterlettuce within a 1-m^2 area. He also calculated that a single caterpillar, during its larval development, eats two sizable waterlettuce rosettes at a rate of one leaf per day.

In India, periods of peak occurrence of *Spodoptera pectinicornis* coincide with the monsoons and with periods of rapid waterlettuce growth. During these periods, moth infestations occur at a high percentage of sites and the destruction to waterlettuce mats is frequently over 75 percent. During dry periods, fewer sites are infested and smaller proportions of the waterlettuce populations are affected. However, moth populations are reportedly present all year, and they produce continuous, overlapping generations.

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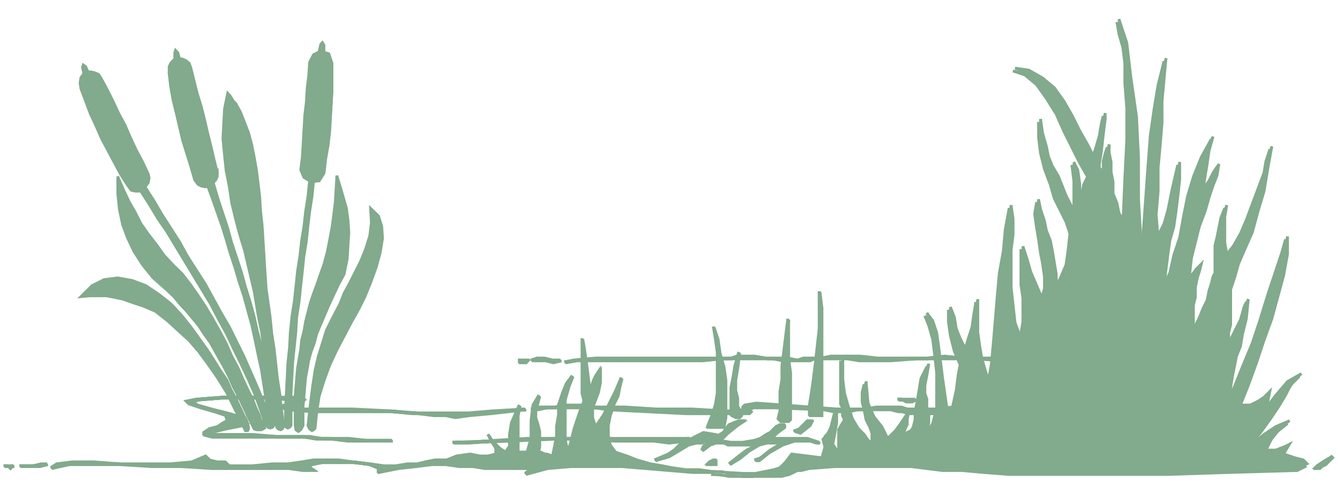


Figure 31. Asian waterlettuce moth

A, An adult Asian waterlettuce moth

B, Spodoptera pectinicornis egg mass covered with scales from the female moth

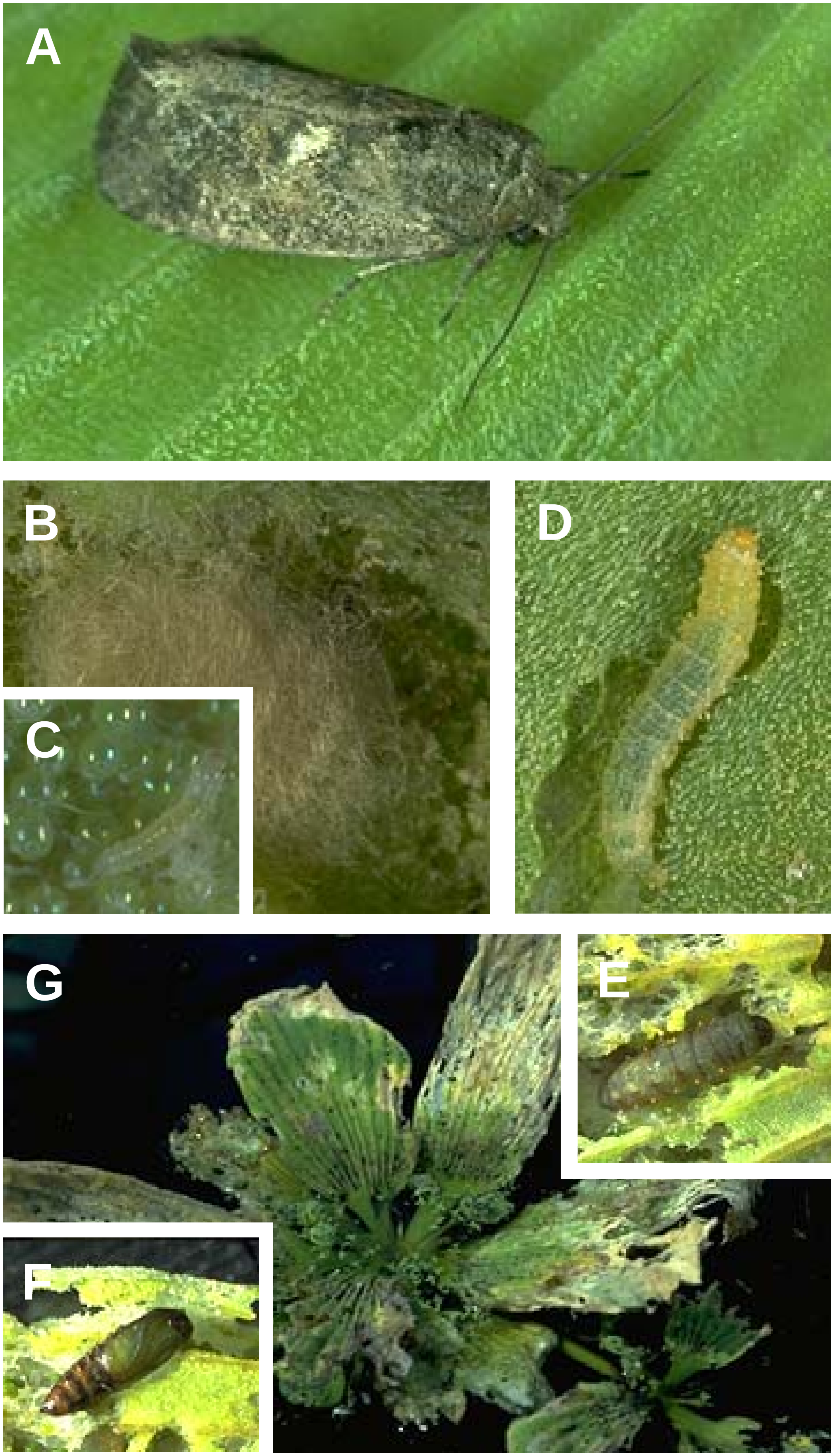
C, Egg mass with the scales removed and a neonate larva

D, Late-instar *Spodoptera pectinicornis* larva

E, Prepupa of *Spodoptera pectinicornis*

F, Pupa of *Spodoptera pectinicornis*

G, Waterlettuce plant severely damaged by *Spodoptera pectinicornis*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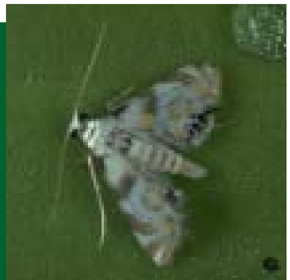
Waterlettuce Root Moth, *Argyractis drumalis* (Dyar)
(Lepidoptera: Crambidae: Nymphulinae)



General Information and History
Argyractis drumalis (Monroe 1972) adults have been known (as *Petrophila*) for decades, but the immature stages were only recently discovered. Dissimilarities with the biologies of other *Petrophila* species (they occur on rocks in fast-flowing streams) and similarities with the habits of the South American *Argyractis subornata* led to a review of the taxonomy of this species. It was subsequently transferred into the genus *Argyractis.*

Plant Host
Waterlettuce, *Pistia stratiotes* L. (Araceae)

Biology and Ecology
Argyractis drumalis is a small moth (forewings are about 5 mm long). It has narrow, white wings crossed by bands of gold. The hindwings have metallic spots along the rear edge. Adults generally are most active at night, preferring to rest on the undersurface of waterlettuce leaves during the day unless disturbed.

The biology of *A. drumalis* is poorly known, but habits of the immature stages are similar to *A. subornata* (Hampson). *A. drumalis* larvae construct shelters on the main (adventitious) roots of waterlettuce plants in canals, lakes, and slow-flowing streams. Larval shelters are 0.5–2 mm wide and 5–10 mm long and are constructed by loosely weaving lateral roots together with silken threads. These shelters serve as pupation chambers and as refuges from which the larvae emerge to feed.

A. drumalis larvae clip lateral roots from adventitious roots, cut these into small segments, and crush these segments as they pass through the mouthparts. It is unclear whether the larvae derive their nutrition directly from these root segments or from attached periphyton.

Effects on Host
The waterlettuce root moth’s habit of clipping lateral roots produces “shaven” areas along the main root axis that characterize the presence of this moth, but the impact of this damage has not been investigated.

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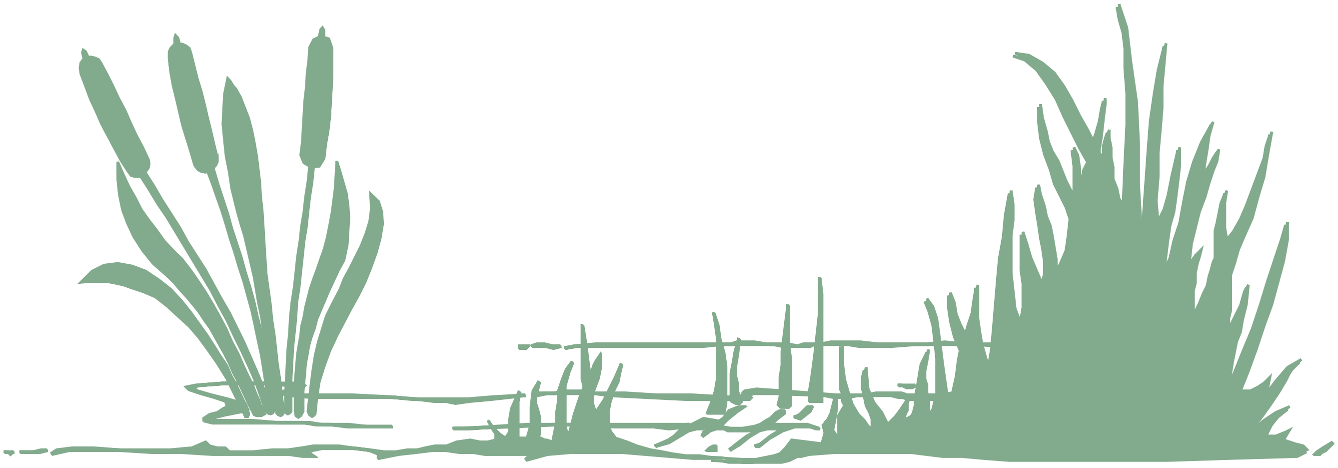
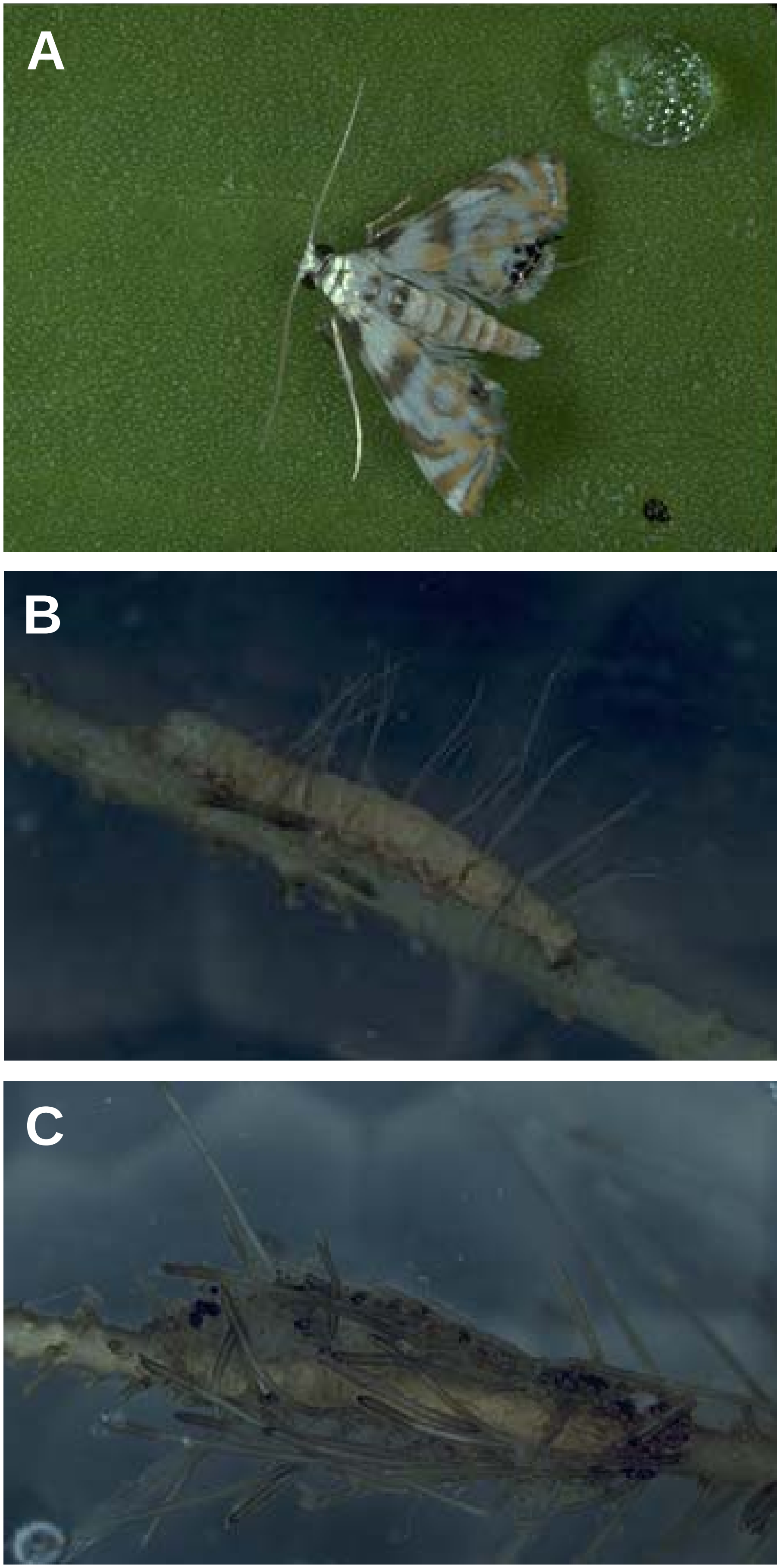


Figure 32. Waterlettuce root moth

A, Adult *Argyractis drumalis* moth

B, Larva of *Argyractis drumalis* on a waterlettuce root that has been denuded of lateral roots by larval feeding

C, Loosely woven cocoon of a *Argyractis drumalis* pupa on a waterlettuce root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Waterlettuce Weevil, *Neohydronomus affinis* Hustache
(Coleoptera: Curculionidae: Curculioninae: Erirhinini)

General Information and History

Neohydronomus comprises three species whose native range is primarily South and Central America (O'Brien and Wibmer 1989). All are semiaquatic, are covered with a layer of dense scales (not water-repellent), and feed on a single plant species, *Pistia stratiotes,* in the family Araceae.

Neohydronomus affinis was imported into Florida for biological control of waterlettuce. The first releases occurred during 1987 at Torry Island and Kreamer Island at the south end of Lake Okeechobee. The weevil is now widespread in peninsular Florida and has also been reported from Louisiana.

Plant Host

Waterlettuce, *Pistia stratiotes* L. (Araceae)

Biology and Ecology

Adult *Neohydronomus affinis* are small (3 mm long) and have a nearly straight rostrum that is strongly constricted ventrally at the base. *N. affinis* ranges in color from uniform bluish grey to reddish brown with a tan, chevronlike band across the elytra. The color pattern is associated with scales and may be difficult to distinguish if the scales are wet, dirty, or missing. Further information on the identification of this species may be found in DeLoach et al. (1976) or O'Brien and Wibmer (1989).

Eggs are cream colored and subspherical (0.33 by 0.4 mm). Females chew a hole about 0.5 mm diameter in the leaf (usually on the upper surface near the leaf edge), deposit a single egg inside this puncture, and close the hole with a black substance. The eggs hatch within 4 days (at temperatures above 24 ^{o}C). The young larvae, which are very small (head diameter of 0.2 mm), burrow under the epidermis and work their way toward the spongy portions of the leaf at a rate of about 1.5–2.0 cm/day.

Larval mines are often plainly visible in the outer third of the leaf where tissues are thin but are less apparent in the central and basal portions of the leaf. The first molt occurs when larvae are about 3 days old and the second, 3–4 days later. Second-instar larvae have heads 0.25–0.27 mm in diameter; third-instar larvae are 2.5–3.0 mm long and have heads 0.32–0.37 mm in diameter. The larval stages last 11–14 days total.

Third instars are generally found excavating the spongy portions of the leaf where they molt to become naked pupae. Under optimal temperatures, 4–6 weeks are required for *N. affinis* to complete the transition from egg to adult. Adults chew holes (about 1.4 mm in diameter) in the leaf surface and burrow in the spongy tissues of the leaf. The characteristic round feeding holes are easily observed when weevil populations are large (several hundred insects per square meter) but may be concentrated near leaf edges and more difficult to observe when populations are small.

Effects on Host

Waterlettuce under stress from *Neohydronomus affinis* feeding and tunneling are typically smaller, have fewer leaves, and grow less rapidly than unaffected plants. Consequently, large weevil infestations result in reduced standing crops and surface area coverage in affected waterlettuce populations. Severe infestations have caused dramatic plant diebacks at some, but not all, affected sites.

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Figure 33. Waterlettuce weevil

A, Reddish-brown form of the waterlettuce weevil

B, Bluish-gray form of the waterlettuce weevil

C, Egg of *Neohydronomus affinis*

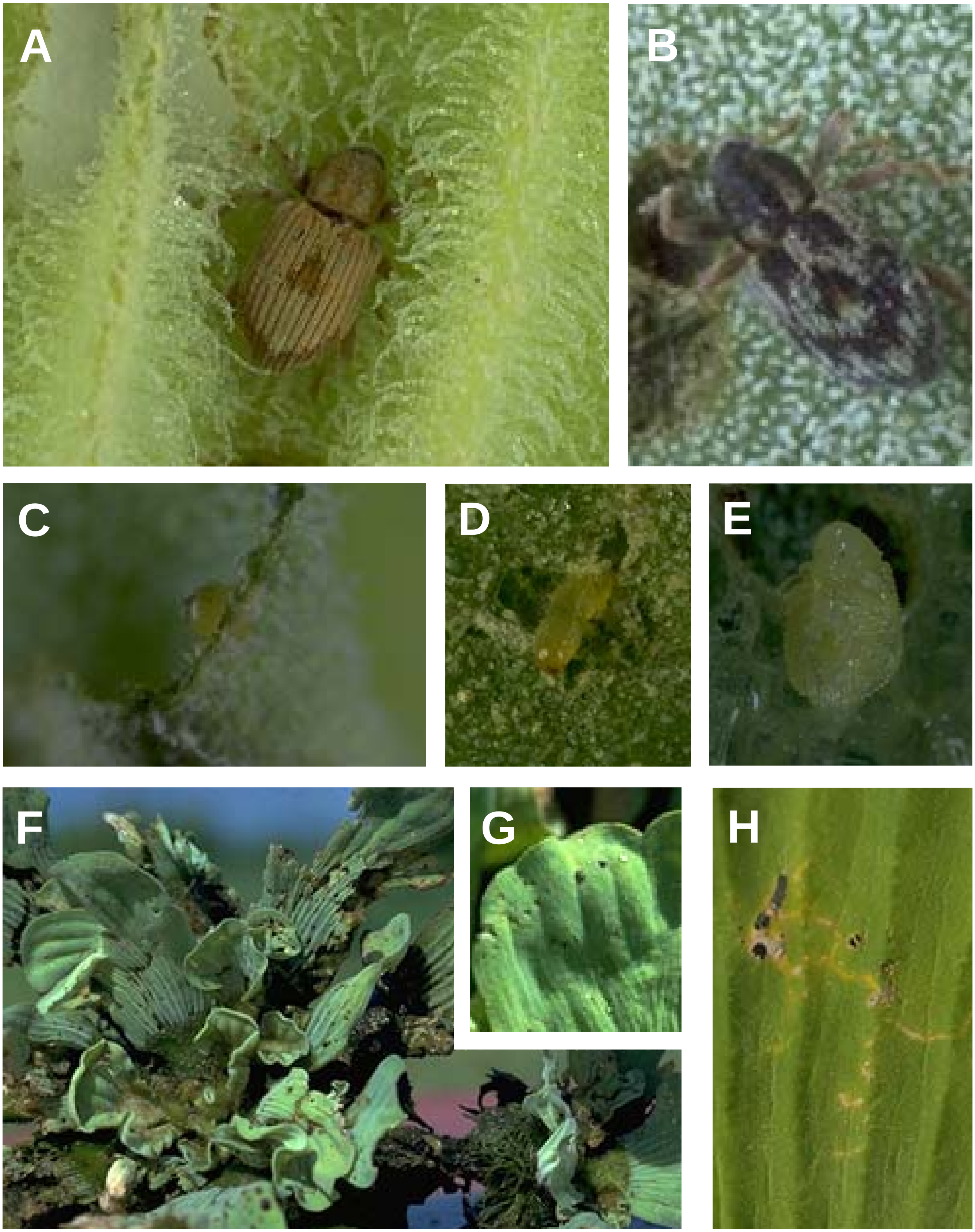
D, Larva of *Neohydronomus affinis*

E, Pupa of *Neohydronomus affinis*

F, Waterlettuce plant showing extensive leaf and crown damage caused by feeding of *Neohydronomus affinis*

G, Leaf punctures typical of feeding by adult *Neohydronomus affinis*

H, Typical *Neohydronomus affinis* larval galleries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Banded Sphinx Moth, *Eumorpha fasciata* (Sulzer)
(Lepidoptera: Sphingidae: Macroglossinae)

General Information and History
The sphinx moths (Sphingidae) comprise a diverse group of heavy-bodied, sometimes colorful moths. The adults possess long, narrow front wings. Their bodies are usually spindle shaped and taper at both ends. About 124 North American species are known, some of which are serious pests. Familiar examples include the five-spotted hawk moth (or tomato hornworm), *Manduca quinquemaculata* (Haw.), and the Carolina sphinx (or tobacco hornworm), *Manduca sexta* (L.). The largest sphinx in North America is the giant sphinx, which feeds on pond apple. It has a wingspread of 11–15 cm. The smallest species is Grote's sphinx, with a wingspread of 2.8–4.0 cm. Both of these species occur in Florida.

Plant Host
Water-primrose, *Ludwigia octovalvis* (Jacq.) Raven (Onagraceae)

Biology and Ecology
The sphinx moths are strong, fast fliers. The adults feed on nectar by hovering near flowers and extending their long tongues into the floral tubes. Some species are active only at night, some only during crepuscular periods (dawn or dusk), and some during the day. Many plant species produce flowers adapted for pollination by a single species of sphinx moth. The flying moths are sometimes mistaken for bumblebees or hummingbirds while feeding because of their extremely rapid wing beats and hovering behavior.

The larvae of sphinx moths are usually naked and most have a prominent, stiff, pointed process (anal horn) on the dorsal surface of the posterior end of the abdomen (hence the name "hornworm"). The often large larvae feed externally on the host plant, sometime severely defoliating it. Most species pupate either in the soil or among litter. The proboscis of the pupa sometimes forms a loop, giving the pupa a pitcherlike appearance. Small braconid wasps frequently parasitize sphinx moth larvae. The wasps pupate externally, forming rows of small, white cocoons on the caterpillars.

The larval hosts of the banded sphinx are water primrose *(Ludwigia octovalvis)* and possibly other members of the Onagraceae (evening primrose family). The coloration of the larvae is variable and changes from green to pink, apparently affected by the species of food plant. The spatial distributions of the two-color morphs tends to differ. Green forms usually rest during the day under the leaves, whereas pink forms are usually found on the stems.

After the larvae attain full size, they wander away from the food plant in search of suitable pupation sites. The pupa is formed on the ground, probably in the soil. Its proboscis is fused to the body and does not form the juglike loop so typical of other species. The adult is very similar to the vine sphinx, *Eumorpha vitis* (L.), which feeds on grapes but can be distinguished by the presence of a pink border along the outer margin of the hind wing.

Effects on Host
We know of no studies describing the impacts of this insect on its host plants.

References

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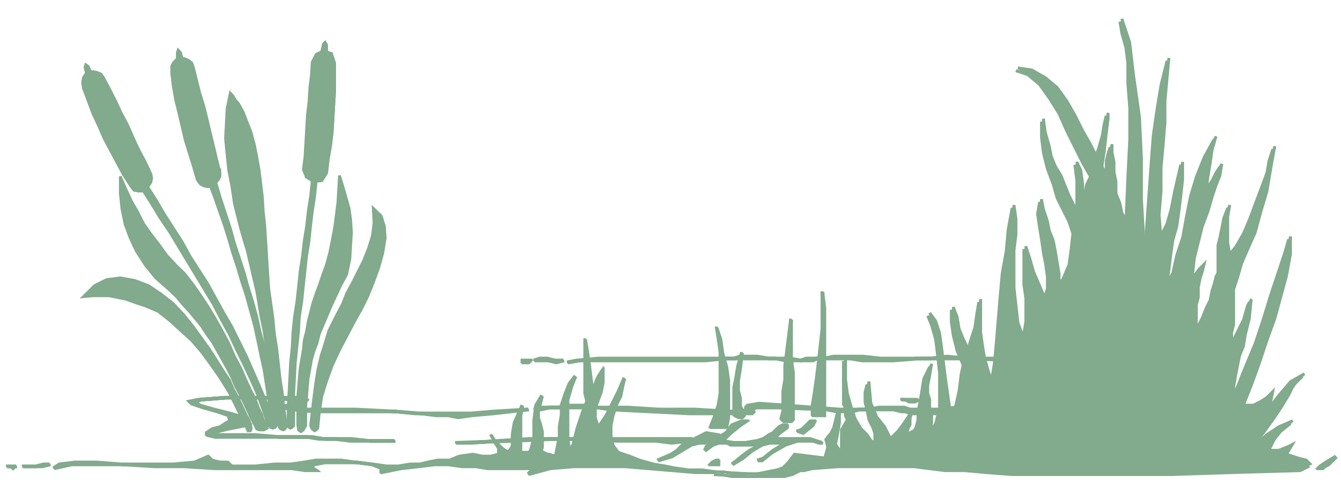
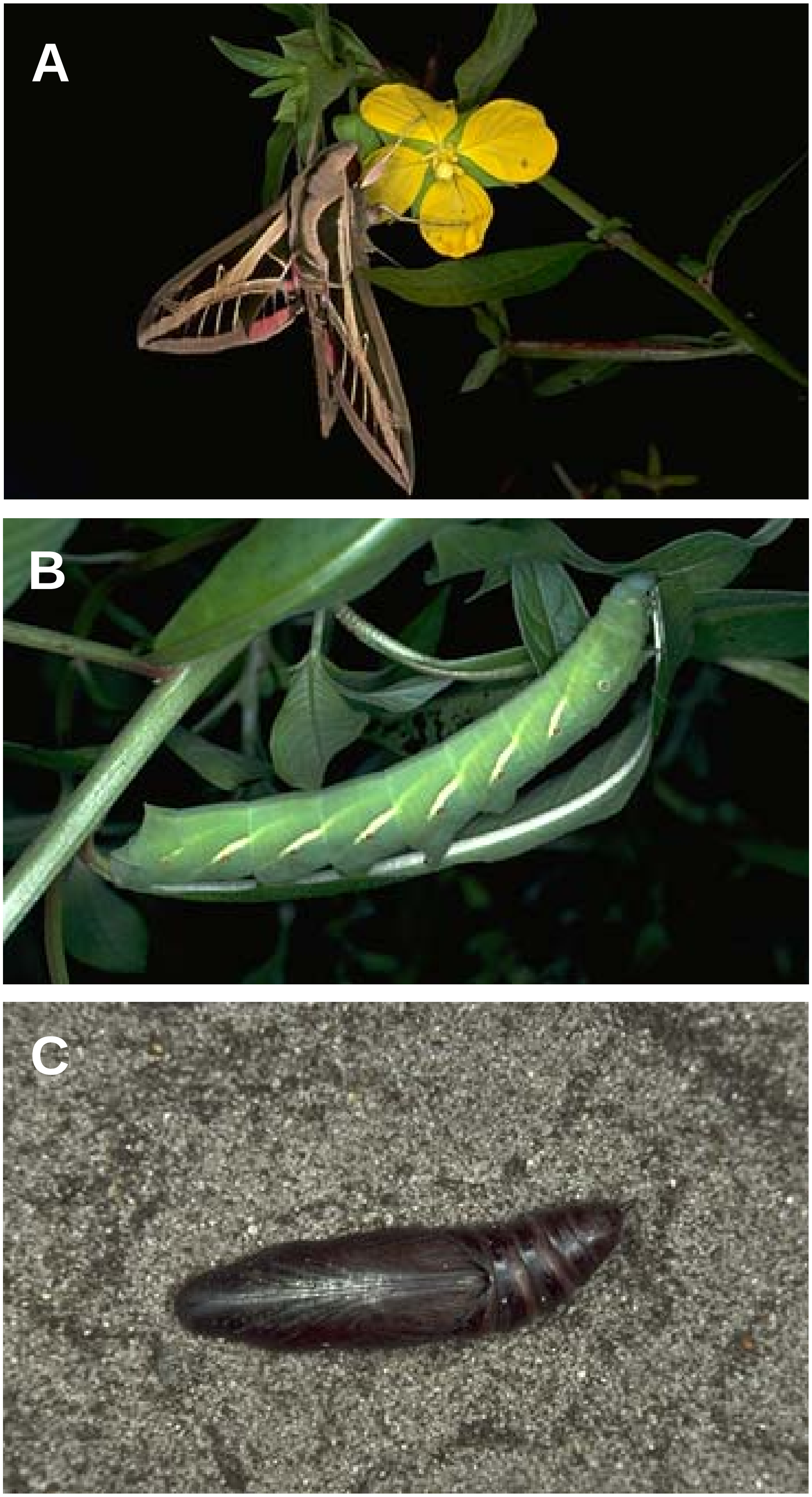


Figure 34. Banded sphinx moth

A, Adult banded sphinx moth on its larval food plant, *Lugwigia octovalvis*

B, Green morph of a banded sphinx moth larva

C, Pupa of the banded sphinx moth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Water-Primrose Flea Beetle, *Altica litigata* Fall
(Coleoptera: Chrysomelidae: Halticinae)

General Information and History
This dark metallic blue-green water-primrose flea beetle is, at times, common on the foliage of *Ludwigia octovalvis* in south Florida, although the only host recorded in the literature is *L. palustris.* It has recently been reported from the invasive weed *Lythrum salicaria.*

Plant Hosts
Water-primrose, *Ludwigia octovalvis* (Jacq.) Raven (Onagraceae)
Water-primrose, *Ludwigia palustris* (L.) Ell. var. *americana* (DC) Fern. (Onagraceae)
Purple loosestrife, *Lythrum salicaria* L. (Lythraceae)

Biology and Ecology
Adult water-primrose flea beetles feed on the leaves, creating irregularly shaped, somewhat circular holes. The small, yellowish, oblong eggs are laid in loosely organized groups on the leaf surface. Larvae have black heads but otherwise are greenish yellow with conspicuous black plates on their bodies. Larvae also feed on the leaves. After the larva attains full size, it crawls down the host plant and burrows into the soil to pupate. It forms a naked, yellow pupa in a loosely constructed chamber usually located just below the soil surface.

Effects on Host
Feeding by *Altica litigata* larvae skeletonized purple loosesrife foliage and caused large reductions in seed production and number of seed per capsule.

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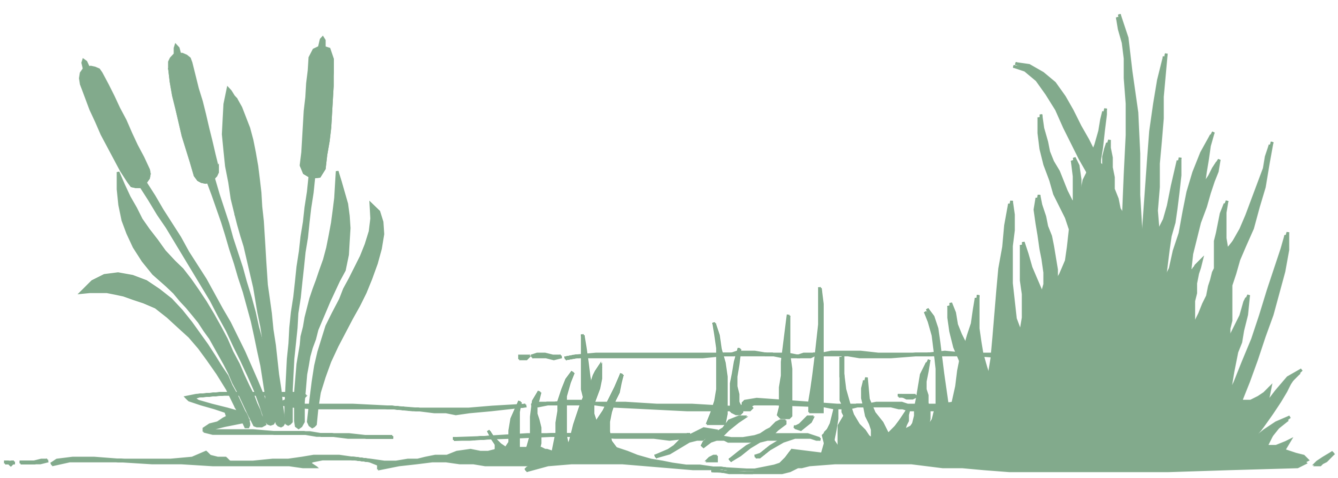
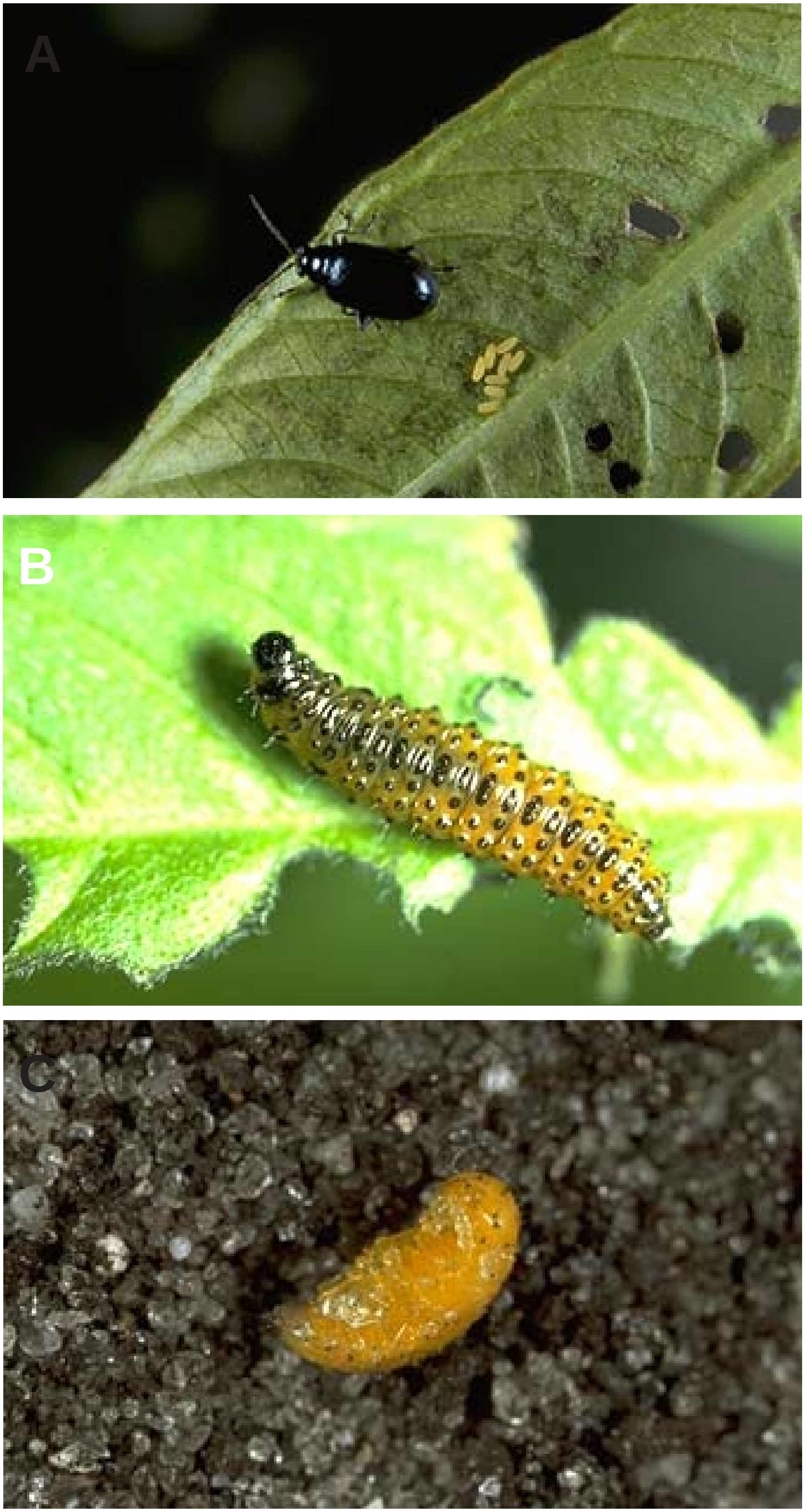


Figure 35. Water-primrose flea beetle

A, Adult *Altica litigata* with a cluster of eggs on a *Ludwigia octovalvis* leaf

B, Fully grown larva of the water-primrose flea beetle

C, Pupa of *Altica litigata*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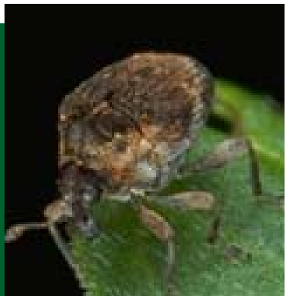
Water-Primrose Leaf Weevil, *Perigaster cretura* (Herbst)
(Coleoptera: Curculionidae: Curculioninae: Ceutorhynchini)



General Information and History
The small water-primrose leaf weevils are usually found on the leaves of their host plants during the day. They feed externally, usually on the upper leaf surfaces. When disturbed, the adults jump readily and take flight at the slightest provocation. They also reportedly stridulate (create a creaking sound by rubbing ridged surfaces of their body together) when handled.

Plant Hosts
Water-primrose, *Ludwigia octovalvis* (Jacq.) Raven (Onagraceae)
Water-primrose, *Ludwigia peploides* (HBK) Raven (= *Jussiaea repens* Forst.) (Onagraceae)
Water-primrose, *Ludwigia repens* Forst (= *L. natans* Ell.) (Onagraceae)
Seedbox, *Ludwigia alternifolia* L. (Onagraceae)

Biology and Ecology
Perigaster cretura is a small (less than 3 mm long) weevil, brown to reddish brown in color but mottled with white and black. They are roundish in outline and, when handled, tuck their rostrum and legs tightly against their bodies. The location of ovipositional sites is unknown, but the larvae feed on the upper leaf surface. During larval development they progress through three larval instars, but the duration of these stages is also unknown. The larvae are yellow with a yellowish-brown head, but they are usually covered with a viscous secretion that contains excrement. As the larvae feed they flex the posterior portion of their abdomens forward and defecate onto their backs. Their body movements then cause this material to spread out over the entire surface. The resultant black, shiny covering effectively conceals the larva. Their feeding activity creates numerous holes in the leaf surface.

After the larvae attain full size (third instars are 4–6 mm long), they create a pupal cell directly on the leaf surface. The whitish cell is spherical and parchmentlike, with bits of leaf material and other debris incorporated into it. The pupal stage lasts about a week. The adult emerges by chewing a hole through the upper portion of the cell.

Effects on Host
We know of no studies describing the impacts of this insect on its host plants.

Reference

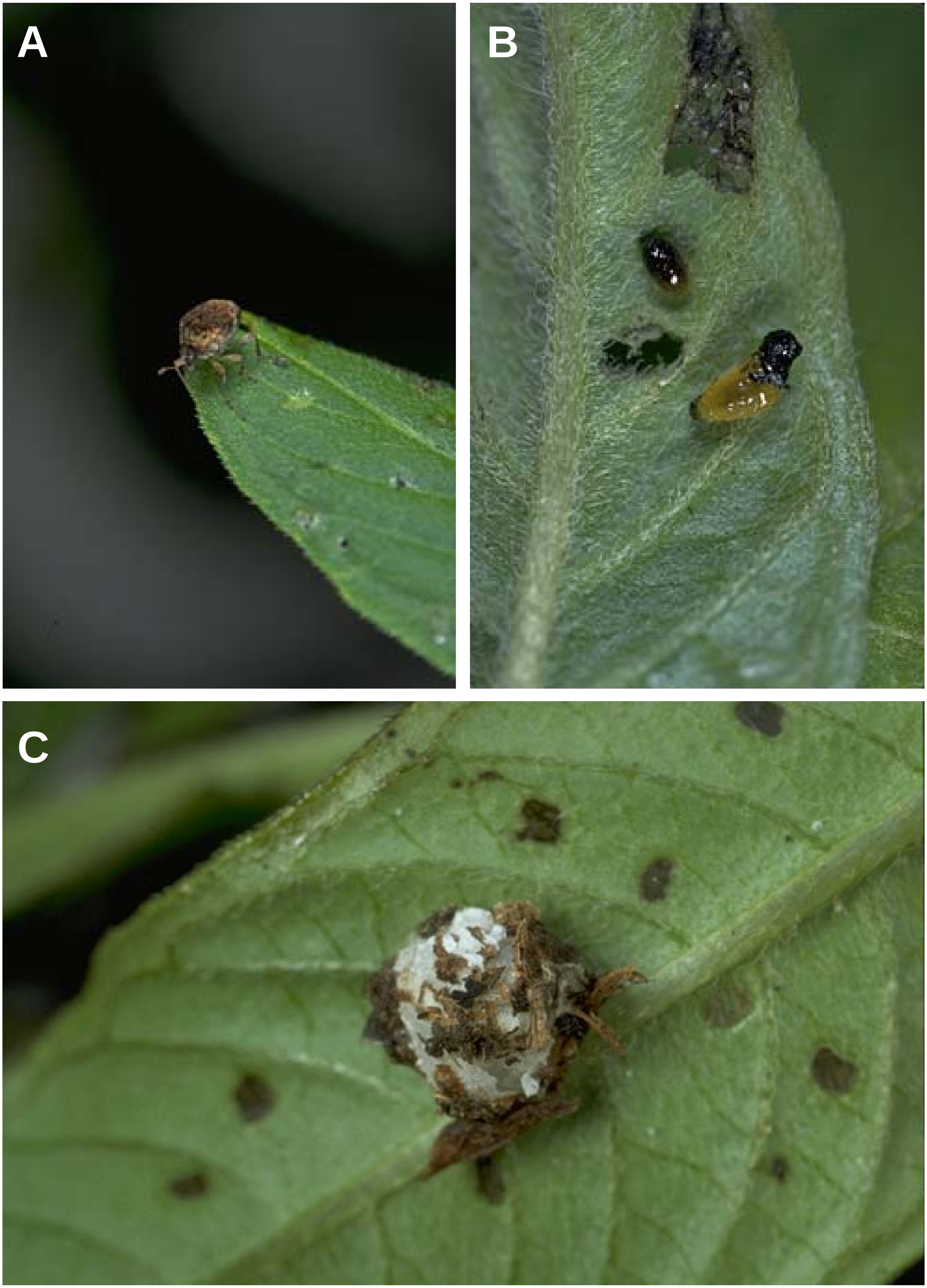
Clark, W.E. 1976. Notes on the life history and habits of *Perigaster cretura* (Herbst) (Coleoptera: Curculionidae) with descriptions of the larva and pupa. Coleopterists' Bulletin 30:159–165.

Figure 36. Water-primrose leaf weevil

A, Adult *Perigaster cretura*

B, Larvae of *Perigaster cretura* with (top) and without (bottom) the viscous protective covering

C, Cocoon of *Perigaster cretura* on a *Ludwigia octovalvis* leaf


A
B
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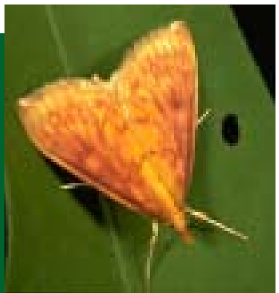
American Lotus Borer, *Ostrinia penitalis* (Grote)
(Lepidoptera: Pyralidae: Pyraustinae)



General Information and History
The American lotus borer *(Ostrinia penitalis)* often occurs abundantly in association with its preferred host plant American lotus *(Nelumbo lutea).* This species also feeds on various species of smartweeds *(Polygonum)* and may use other plant species as refugia. Individuals from smartweeds were once thought to represent a distinct species, *O. obumbratalis* (Lederer) or *O. ainsliei* Heinrich. These are now considered conspecific. The lotus borer is also closely related to the European corn borer, *O. nubilalis* (Hübner).

Plant Hosts
American lotus, *Nelumbo lutea* (Willd.) Pers. (Nymphaeaceae)
Smartweed, *Polygonum* L., sp. indet. (Polygonaceae)
Smartweed, *Polygonum densiflorum* Meissner (Polygonaceae)
Smartweed, *Polygonum hydropiper* L. (Polygonaceae)
Smartweed, *Polygonum punctatum* Elliot (Polygonaceae)

Biology and Ecology
Female American lotus borer moths deposit eggs in masses on the upper surface of lotus leaves. The masses are covered by an amber-colored substance and contain about 60 eggs.

Freshly eclosed larvae measure about 1.5 mm in length. After eclosion, the young larvae feed on the outer surface of the lotus leaf. The feeding areas are irregular in outline and vary in size. When fresh, the scars are light greenish but they soon turn brown.

The young larvae attach fine silken threads to the leaf. These anchor strands help them to persist on the leaf surface and avoid being dislodged by wind or wave action. Later, the larvae feed on the surface under a silk net. Often this net is pulled across the leaf with sufficient tension to create a depression in the leaf surface. This depression provides shelter for the actively feeding larva. This presumably prevents the larva from being washed from the leaf, and it may provide protection from natural enemies or climatic extremes. Larvae that feed near the periphery of the leaf often pull the edge over themselves and attach the curled edge to the leaf surface. This leaf-rolling behavior also provides refugia.

After the larvae reach a length of about 14 mm, surface feeding ceases and they begin to tunnel in the petiole. A silken net is often constructed over the excavation while the larva works on the burrow. Although the length of the burrow varies, it is usually less than 7 cm and slightly larger in diameter than the larva. The burrow apparently is more of a refugium than a feeding site. It is not extended indefinitely and, as a result, is rarely more than twice the length of the occupying larva. After construction of the burrow, the larva feeds on the upper leaf surface within the zone that it can reach from its burrow. This causes radial scars evident on the leaf surface adjacent to the leaf-petiole junction. Larvae that occupy petiole burrows tend to be territorial and may physically defend the burrows against intruding larvae. Intruders will sometimes displace the resident larva and then occupy its burrow.

Pupation takes place within the petiole. Prior to molting, the fully grown larva caps the burrow with a silken plug. It then spins a strong cocoon and molts into the pupal stage. Occasionally, an *O. penitalis* larva will chew through the plug, enter the burrow, destroy the upper end of the resident pupa, and then occupy the burrow. The larvae are excellent swimmers. This ability enables them to move from leaf to leaf even when leaves are not contiguous.

Effects on Host

Damage to lotus beds by larvae of *Ostrinia penitalis* is often devastating. Extensive damage often occurs over the entire leaf surface, causing the leaf to turn brown and deteriorate. The emergent seed heads are often attacked by larvae, which even devour the immature seeds. This damage can be widespread and extensive. Plant injury from this insect is sometimes mistakenly attributed to herbicide usage.

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Figure 37. American lotus borer

A, Adult of the American lotus borer resting on the mature receptacle (“seed head”) of a water lotus flower

B, Stand of American water lotus devastated by *Ostrinia penitalis*

C, Larva of the American water lotus borer near the entrance to its burrow in a leaf petiole

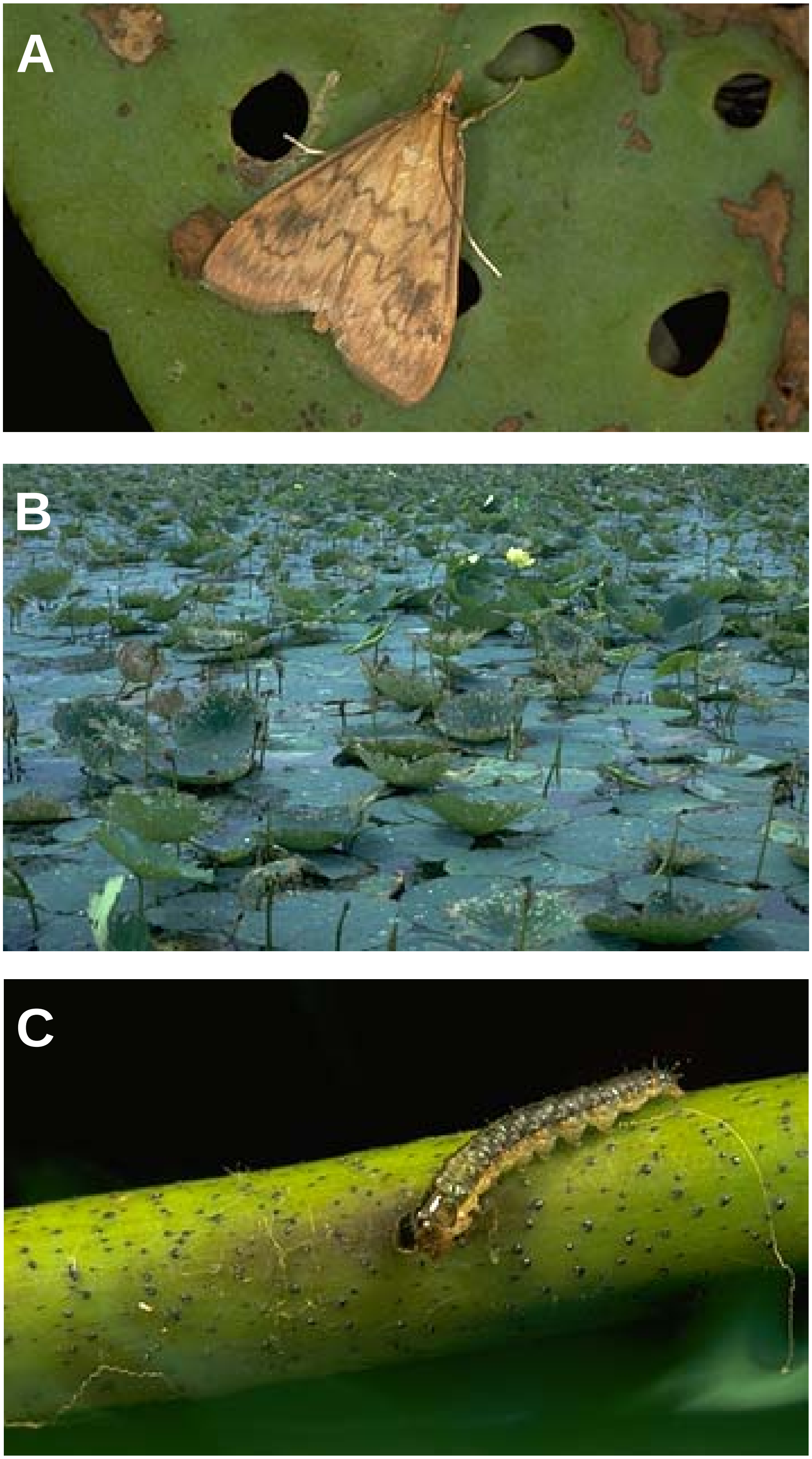
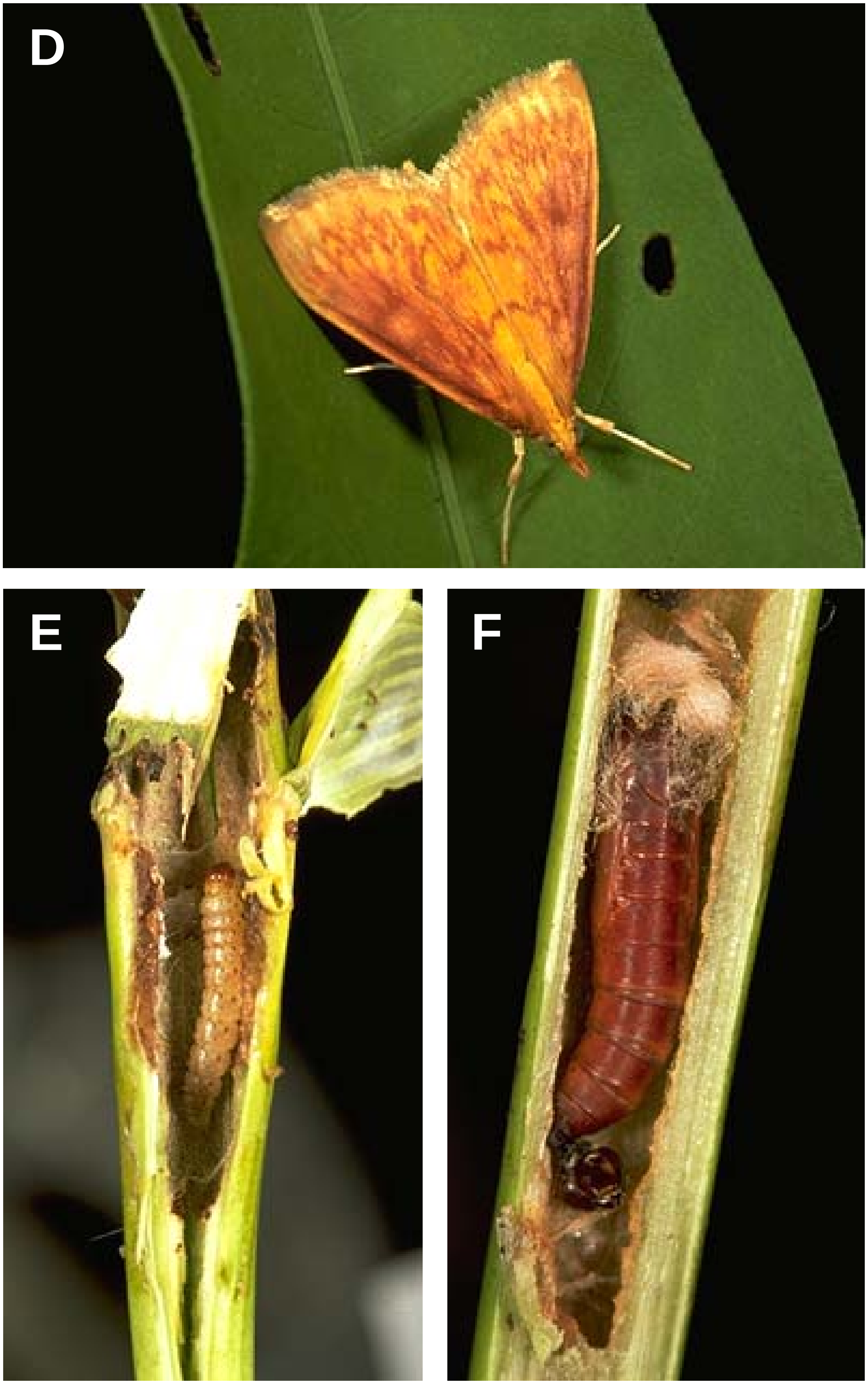

A
B
C

Figure 37—continued. American lotus borer

D, Adult American water lotus borer on a smartweed *(Polygonum densiflorum)* leaf

E, Larva of *Ostrinia penitalis* in a burrow in a smartweed stem

F, Water lotus borer pupa in a stem of smartweed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Cattail Caterpillar, *Simyra henrici* (Grote)
(Lepidoptera: Noctuidae: Acronictinae)

General Information and History
Simyra henrici is a common, widespread species that feeds on cattails. It has also been reported from numerous other hosts, although the accuracy of some of these records is questionable.

Plant Hosts
Cattails, *Typha* spp. (Typhaceae)
Buttonbush, *Cephalanthus occidentalis* Linnaeus (Rubiaceae)
Poplars, *Populus* spp. (Salicaceae)
Smartweeds, *Polygonum* spp. (Polygonaceae)
Willows, *Salix* spp. (Salicaceae)
Sedges and grasses

Biology and Ecology
The grayish-white eggs of *Simyra henrici* are flattened and about 1 mm in diameter. They are laid in batches of 60 to more than 150 eggs per batch. The batches are composed of up to seven overlapping rows of eggs. Individual females sometimes lay over 1,700 eggs. Eggs hatch in 5 days (at about 27 ^{o}C).

The larval stage comprises seven instars, and the period of larval development is about 1 month. Larvae occur throughout the year in south Florida. Neonates measure about 1.5 mm in length, and fully grown larvae measure up to 50 mm. The mature larvae are orange and brown above, light brown below, and covered with hairs. Conspicuous orange bumps or tubercles arranged in two bands are present on the back. Two yellow stripes are present on each side of the back and on each side below the spiracles. The black head is marked with two white stripes on top and a light-colored, inverted V on the front.

The larva uses silk to tie two adjacent cattail leaves together as a pupational site. A silken cocoon is then formed between these two leaves, and the insect pupates within the cocoon. The pupational period is 2–3 weeks.

Adults have white forewings that are marked with light brown streaks between the veins. The hind wings and the body are white. The wingspan is 34–45 mm. The total generation time is about 6–7 weeks.

Effects on Host
Cattail caterpillar larva feed on the leaf tips and edges or devour entire leaves. Extensive feeding damage interrupts water transport, causing distal portions of leaves to turn brown. In Florida, it often destroys large expanses of cattail stands.

References

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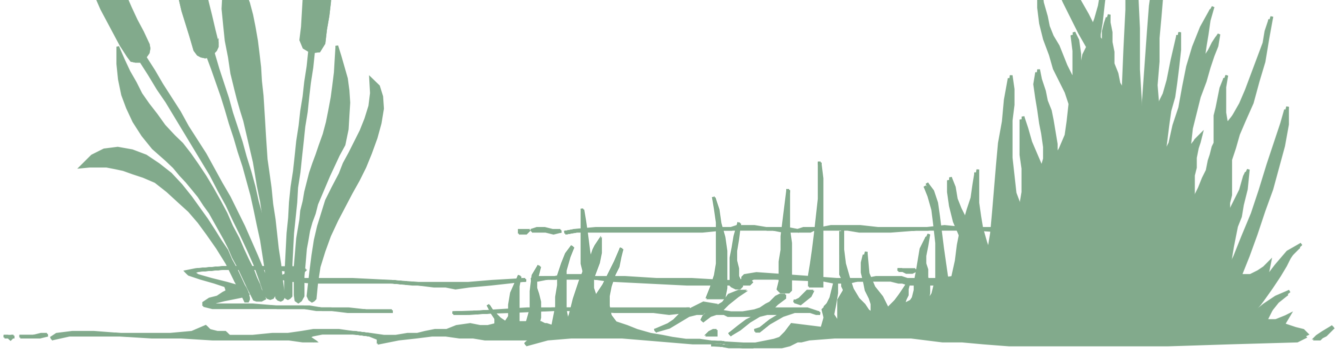


Figure 38. Cattail caterpillar

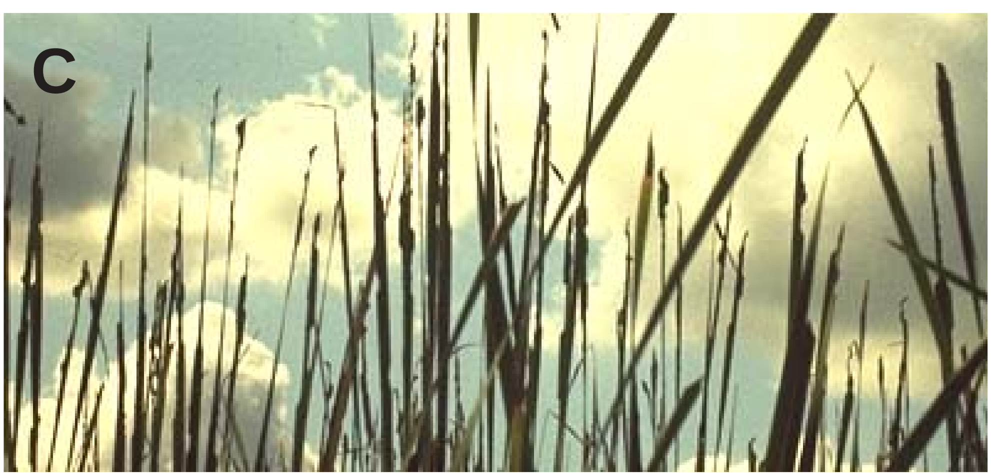
A, Adult *Simyra henrici*

B, Larva of *Simyra henrici*

C, Cattail stand with extensive damage caused by *Simyra henrici* larvae


A


B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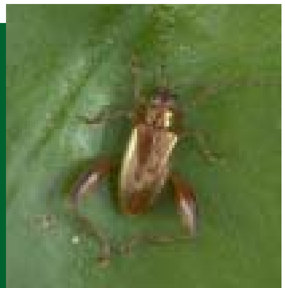
Longhorned Leaf Beetles, *Donacia* spp.

(Coleoptera: Chrysomelidae: Donaciinae)



General Information and History

The longhorned leaf beetles constitute the largest group of aquatic Chrysomelidae in North America. Despite this, details of their life histories are sketchy. Most of the 31 species of *Donacia* in North America occur in the southeastern United States.

Plant Hosts

At least 50 aquatic plants

Biology and Ecology

Adult longhorned leaf beetles are 5–15 mm long and are often colored metallic green, blue, or bronze. Adults feed on the emergent leaves and flowers of *Nuphar* and *Nymphaea;* some may feed on pollen. Overall, *Donacia* species feed on nearly 50 aquatic macrophytes. A few species are limited to a single host, but most feed on several aquatic plants.

Females show great diversity in their manner of oviposition. Some lay their eggs in concentric rows on the undersides of floating leaves. They accomplish this by pushing their abdomens through holes chewed in the leaves. Other species glue egg masses between the overlapping leaves of adjacent plants. Still others insert single eggs directly into the leaf tissue. *Donacia* eggs are oblong in shape, 0.7–1.5 mm long, 0.3–0.7 mm wide, and range from white to yellow in color.

Larvae eclose from the eggs 1–3 weeks after oviposition. Some then migrate to the sediments where they feed on the roots and rhizomes of their host plants. Others feed on submersed leaves and stems. Larvae have two black spines near the end of their abdomens. These spines reportedly are inserted into plant tissues and serve as a conduit for oxygen. The larval stage is completed in a few weeks for some species but requires nearly a year for others. The latter generally become dormant during colder months and then resume activity as water temperatures warm.

Prior to pupation, the larvae make slits in the roots or submersed stems. Brown, silken cocoons are then constructed over these slits. Oxygen escaping the plants through the slits becomes trapped in the cocoons, thus keeping the pupae well supplied. Duration of the pupal stage is highly variable. Some species overwinter as pupae. Others emerge as adults a few weeks after pupation. Still others complete development in a few weeks but delay emergence for several months. Most species are believed to live at least 2 years.

Effects on Host

We know of no studies describing the impacts of this insect on its host plants.

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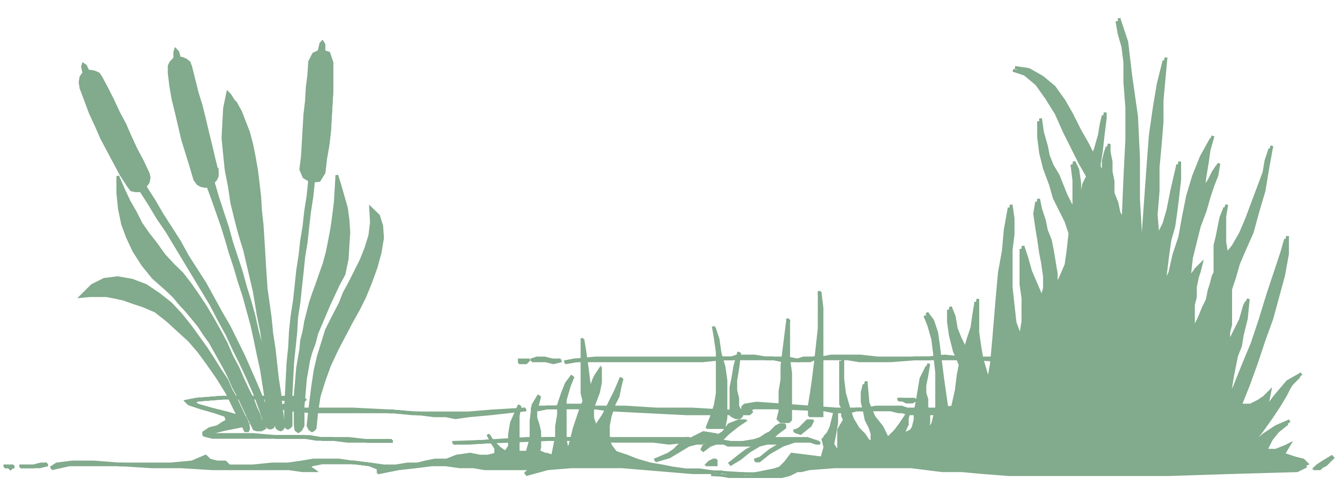
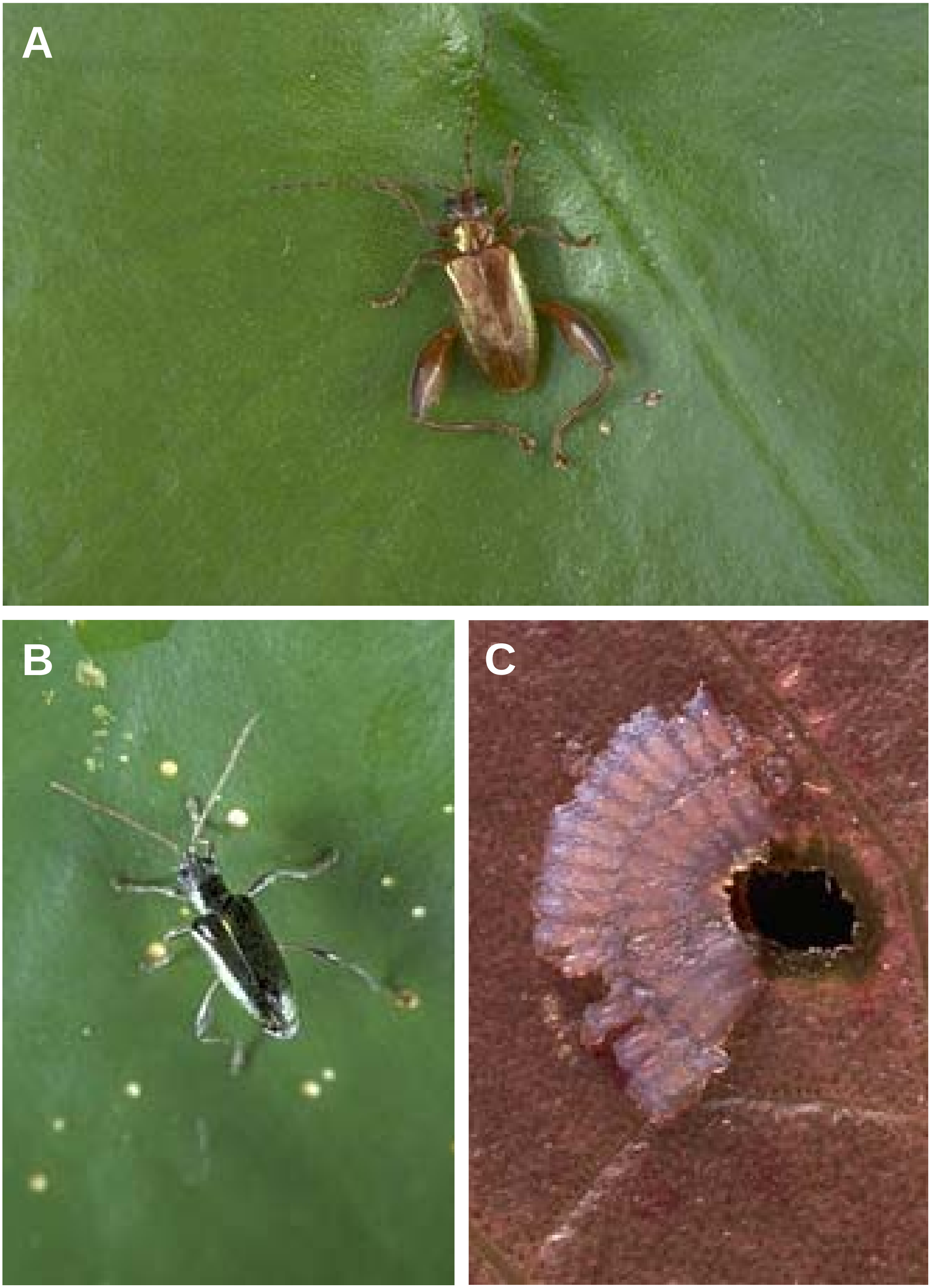


Figure 39. Longhorned leaf beetles

A, Adult longhorned leaf beetle *Donacia militaris*

B, Adult longhorned leaf beetle *Donacia cincticornis*

C, Donacia eggs surrounding a hole on the lower surface of a waterlily leaf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Red Spider Mite, *Tetranychus tumidus* Banks
(Acarina: Acariformes: Actinedida: Tetranychidae)

General Information and History
Spider mites are rather large mites with plump bodies. Many species of spider mites severely damage economically important crops. They form colonies in “webs” that often envelop the foliage of their host plant. The red spider mite, *Tetranychus tumidus,* is native to the United States.

Plant Host
Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)
Plantain, *Musa acuminata* Colla (Musaceae)
Mango, *Mangifera indica* L. (Anacardiaceae)
Corn, *Zea mays* L. (Poaceae)
Sweet potato, *Ipomoea batatas* (L.) Lam. (Convolvulaceae)
Citrus, *Citrus* spp. (Rutaceae)

Biology and Ecology
Red spider mite eggs are small and spherical and normally hatch in 3–5 days. Development (epimorphosis) progresses through four stages: larva, protonymph, deutonymph, and adult. A quiescent resting stage occurs between each of the three immature stages. The resting stages are referred to as the nymphochrysalis, deutochrysalis, and teliochrysalis, respectively. Males develop from unfertilized eggs, whereas females develop from fertilized eggs. Males and females differ greatly in their rates of development. The males mature quickly and remain near female teliochrysalises until the females hatch. Copulation occurs almost immediately after the young female hatches.

Spider mites feed on plant juices by piercing the epidermis of the leaf with two sharp, slender, whiplike structures (cheliceral stylets) attached to the mouth. The damage is first noticeable as small, diffuse, tan-colored patches on the leaf surface. The patches are made up of small, scratchlike stippling.

The species of spider mite most commonly found on waterhyacinth is *Tetranychus tumidus* Banks. Gordon and Coulson (1969) also listed *T. gloveri* Banks from waterhyacinth. However, Boudreaux (1978) noted that while it can be reared on waterhyacinth in the laboratory, *T. gloveri* has never been collected from this plant. Eggs of *T. tumidus* are red, while those of *T. gloveri* are clear (Boudreaux 1978).

Effects on Host
Red spider mite populations increase rapidly and may ultimately cause wilting and drying of afflicted leaves. In severe cases, the plants appear to be burnt. Damage is normally very sporadic and patchy, however, and waterhyacinth recovers quickly after the mites are gone.

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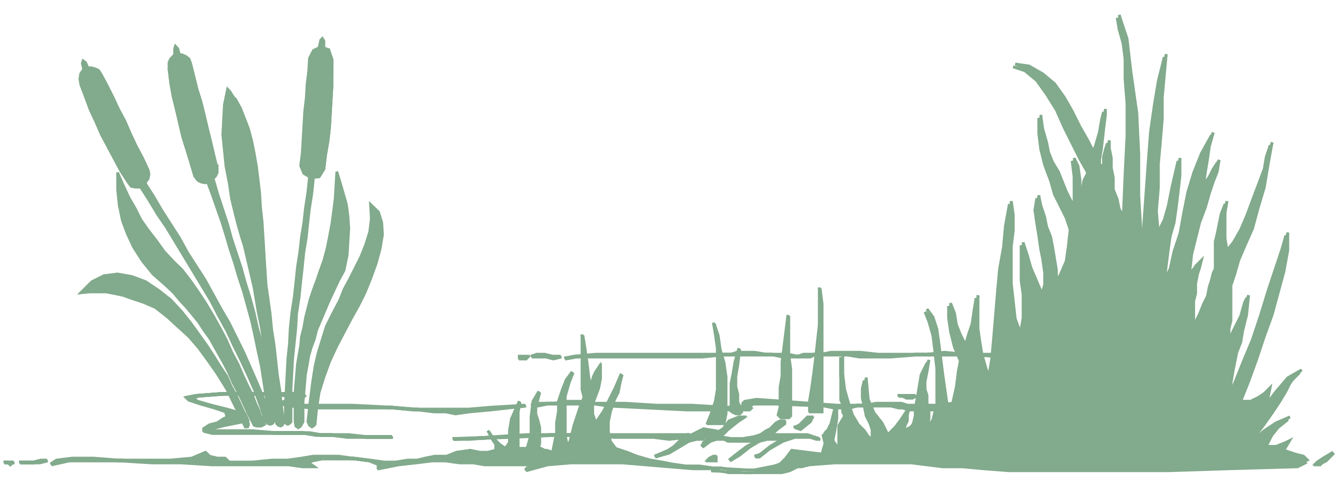
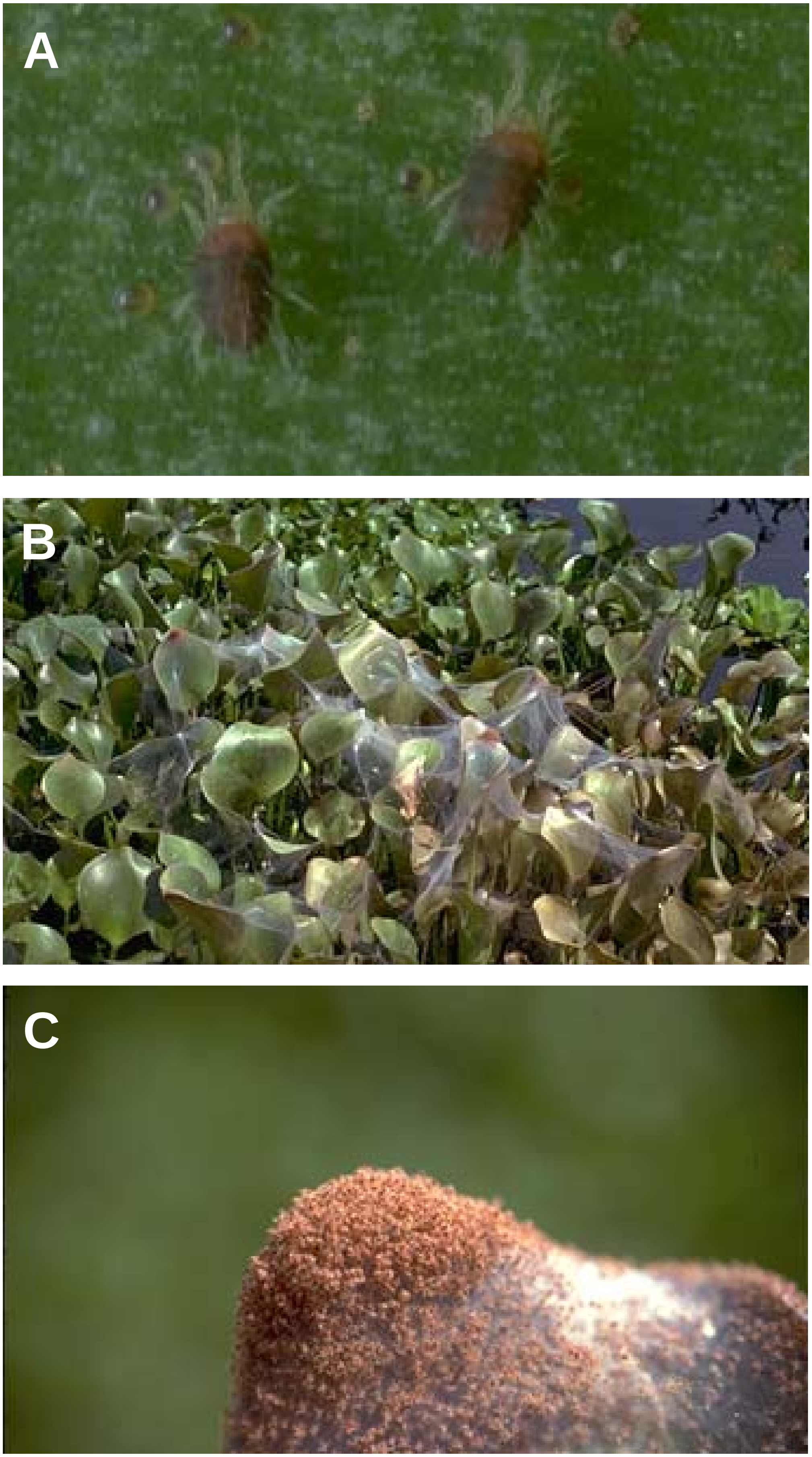


Figure 40. Red spider mite

A, Adult red spider mites *(Tetranychus tumidus*), with their clear, reddish eggs, on a leaf of their host plant

B, Waterhyacinth plants covered with typical spider mite "webs"

C, Closeup of the tip of a waterhyacinth leaf showing a massive aggregation of spider mites


A
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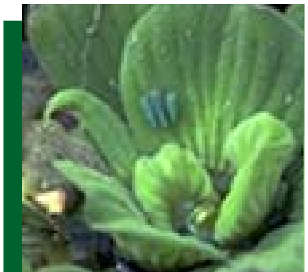
Waterlettuce Leafhopper, *Draeculacephala inscripta* Van Duzee

(Homoptera: Cicadellidae: Cicadellinae)



General Information and History

The leafhoppers constitute one of the largest insect families, comprising about 2,000 genera and 15,000 described species. All feed on plants using piercing-sucking mouthparts to penetrate the plant tissues and suck the juices. Most are restricted to a definite plant species or genus.

Plant Hosts

Waterlettuce, *Pistia stratiotes* L. (Araceae)
Water-primrose, *Ludwigia peploides* (HBK) Raven (Onagraceae)

Biology and Ecology

The biology of *Draeculacephala inscripta* is not well known. It has been recorded from *Ludwigia peploides* (as *Jussiaea diffusa*) in the literature (DeLong 1948). However, this probably constitutes a food plant only for adults. Haag et al. (1986) indicate that it can be found on leaves of waterhyacinth, spatterdock, grasses, and sedges but do not imply that these are hosts. We have reared it on waterlettuce, so this is apparently the only verified host plant. However, because of the extensive distribution of this species (southeast north to Ohio and southern Illinois) well beyond the range of waterlettuce, other hosts are likely.

The female leafhopper deposits elongate, oval eggs directly into the spongy, aerynchymatous waterlettuce leaf tissue. Although we are uncertain of the incubation period, it probably ranges from 4 to 6 days. The first–instar nymphs wriggle out through the upper end of the egg and the surrounding plant tissue until they succeed in freeing their legs. They then use their legs to pull the rest of their body free. Development progresses through five nymphal instars, each lasting 4–6 days. The total immature period, from eclosure from the egg to adult, is about 28 days (at 21.3 ^{o}C). The life span of the adults is unknown, but most leafhoppers live for several weeks.

The rate of egg production by the females is also unknown, but some leafhoppers lay for about a month, during which time they produce about 75 eggs. This varies greatly among species, however, so it is difficult to generalize.

Effects on Host

Many species are crop pests that damage their host plants in numerous ways. The excessive removal of sap causes collapse of leaf tissues and characteristic spotting of the leaves. Continual feeding by large numbers of leafhoppers causes the leaves to turn chlorotic and then necrotic, often debilitating the plant. Some leafhoppers plug the vascular tissue in the leaves, interfering with the transport of water, nutrients, and photosynthate. Injury also occurs coincident with their insertion of eggs into green tissues. Many species are vectors of phytopathogenic organisms such as viruses, spiroplasmas, mycoplasmas, and bacteria. In fact, some of the worst plant diseases are transmitted by leafhoppers.

We have often noticed that waterlettuce mats heavily infested with *Draeculacephala inscripta* acquire a yellow or gold coloration. This may be symptomatic of a viral disease or it may merely be due to leaf degradation caused by excessive sap loss. Nonetheless, these leafhoppers, at least occasionally, do cause significant damage to *Pistia stratiotes.* A related species (*D. portola* Ball) is a pest of sugarcane and other grasses in southern Florida.

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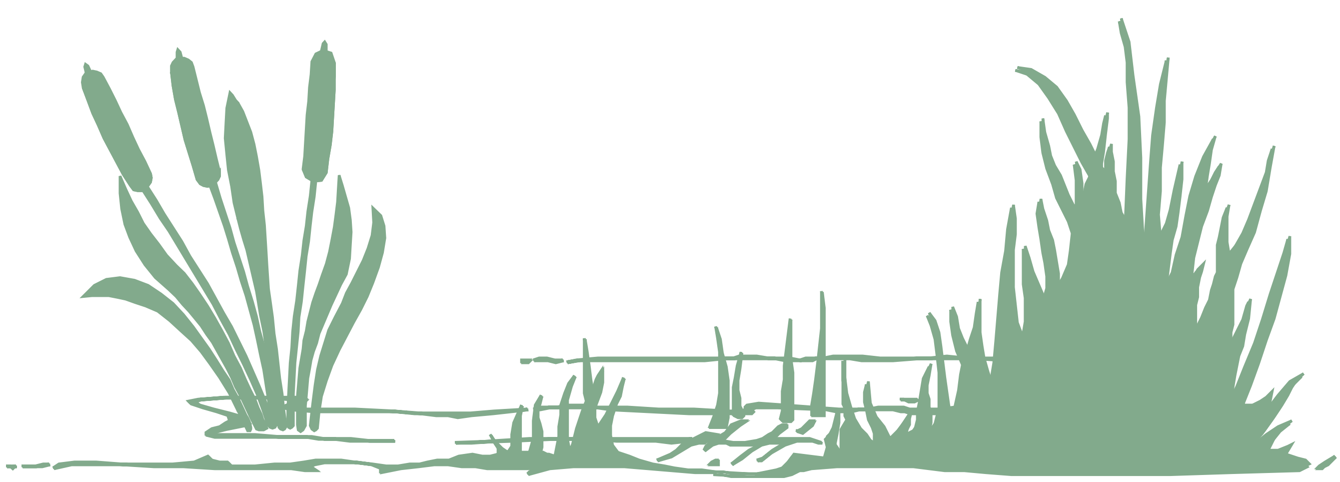
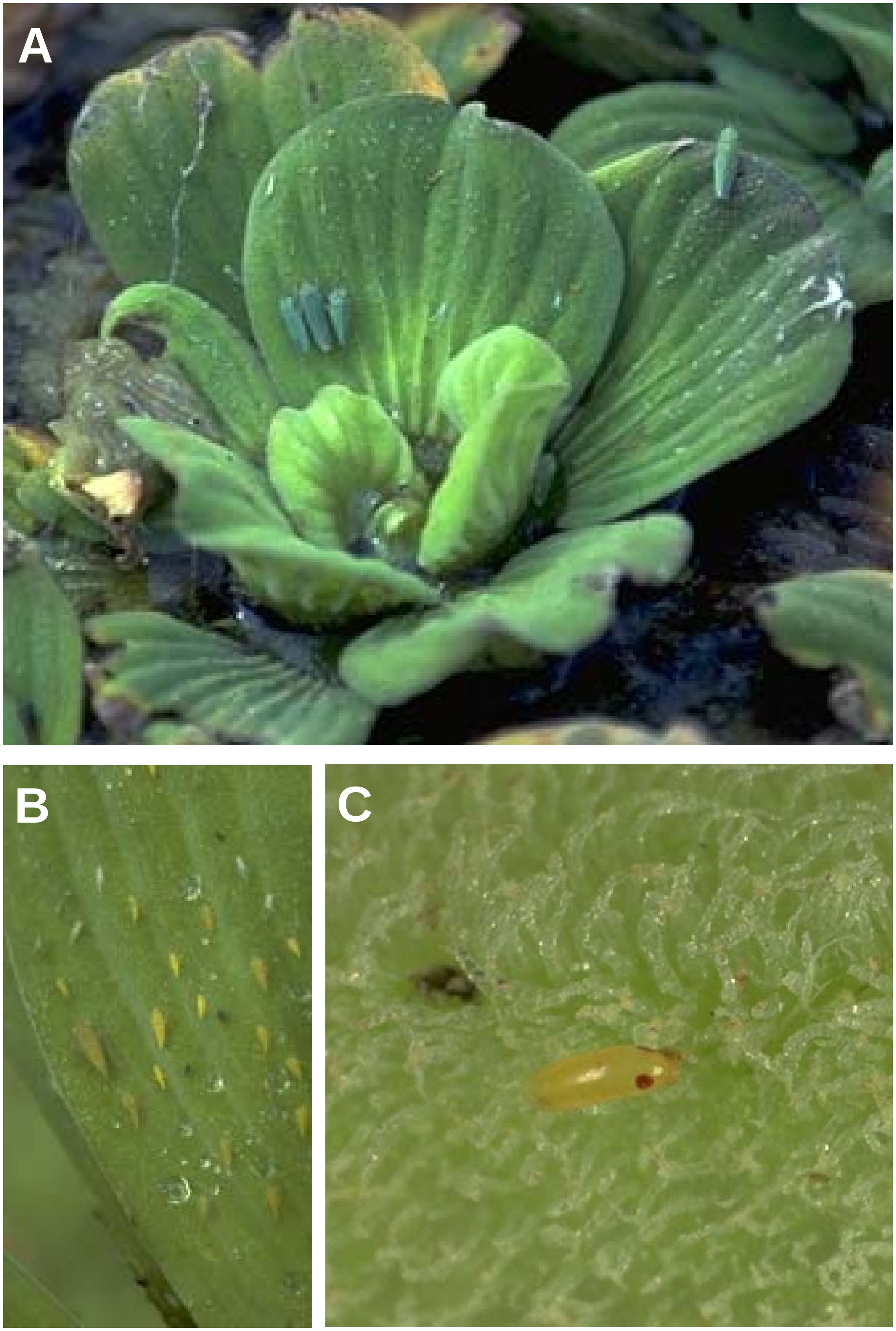


Figure 41. Waterlettuce leafhopper

A, Adult *Draeculacephala inscripta* on a waterlettuce plant

B, Various *Draeculacephala inscripta* nymphal instars

C, Draeculacephala inscripta egg that has been removed from within the plant tissue and is lying on the surface of a leaf


A
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C

Waterlettuce Moth, *Samea multiplicalis* (Guenée)
(Lepidoptera: Pyralidae: Pyraustinae)

General Information and History

Larvae and adults of *Samea multiplicalis,* a small pyralid moth, are very similar to those of the waterhyacinth moth, *Niphographta (=Sameodes) albiguttalis.* In fact, these species are closely related. Center et al. (1982) described how to separate larvae of the two species. *Samea multiplicalis* was originally described from Brazil, where it was observed feeding on waterhyacinth. It is widely distributed throughout warmer regions of North and South America. In Florida it is most commonly found on waterlettuce but can also easily be found on *Azolla caroliniana* and *Salvinia minima.* It is occasionally abundant on small waterhyacinth plants, where it feeds mainly within inflated leaf petioles. This species was introduced into Australia for biological control of both *Salvinia molesta* and *Pistia stratiotes.*

Plant Hosts

Waterlettuce, *Pistia stratiotes* L. (Araceae)
Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)
Waterferns, *Salvinia* spp. (Salviniaceae)
Mosquito fern, *Azolla caroliniana* Willd. (Azollaceae)

Biology and Ecology

Adult waterlettuce moths are small (wingspread about 17 mm) and tan, with dark markings on fore and hind wings. They resemble small, faded *Niphograpta (=Sameodes) albiguttalis* adults. Females each lay about 150 eggs during their brief life span (4–7 days). Eggs are most often laid singly among the epidermal host plant hairs on the lower surfaces of waterlettuce leaves or the upper surface of *Salvinia* leaves, or they may be lodged between the scalelike leaves of *Azolla.*

Eggs hatch in about 4 days (at 28 ^{o}C). Larvae may feed from within a refugium made of silk and hairs of the host plant attached to the external leaf surface, or from galleries within the leaves (waterlettuce). The refugium, when present, consists of a silk canopy stretched across the surface of the leaf. Larvae periodically extend the area covered to reach fresh leaf material. Larger larvae feed on the buds of the plants, often killing the growing apex. Larvae will also eat maturing waterlettuce fruits and consequently destroy the enclosed seeds. The larval stage is composed of 5–7 instars, which require 15–16 days for development at 28 ^{o}C when fed waterlettuce or *Salvinia minima* and 21–35 days at 26 ^{o}C when fed *S. molesta*.

Pupation occurs within a silken cocoon. On waterlettuce, this cocoon is usually formed within the spongy portion of a leaf, but on *S. molesta* it is constructed among old leaves. The pupational duration has been reported to be 4–7 days at 28 ^{o}C on waterlettuce and 8–9 days at 26 ^{o}C on *S. molesta.* The reported total developmental times (egg to adult) are 25 and 42 days under the two respective temperature-host regimens.

Effects on Host

Populations of *Samea multiplicalis* tend to be sporadic, possibly due to high parasitism rates. Nonetheless, densities can become exceedingly high during intervals of peak abundance. If this coincides with cooler periods and correspondingly slow waterlettuce growth, massive destruction of the mat results. Nonetheless, because of this species' lack of persistence, the waterlettuce mats normally recover later during the growing season.

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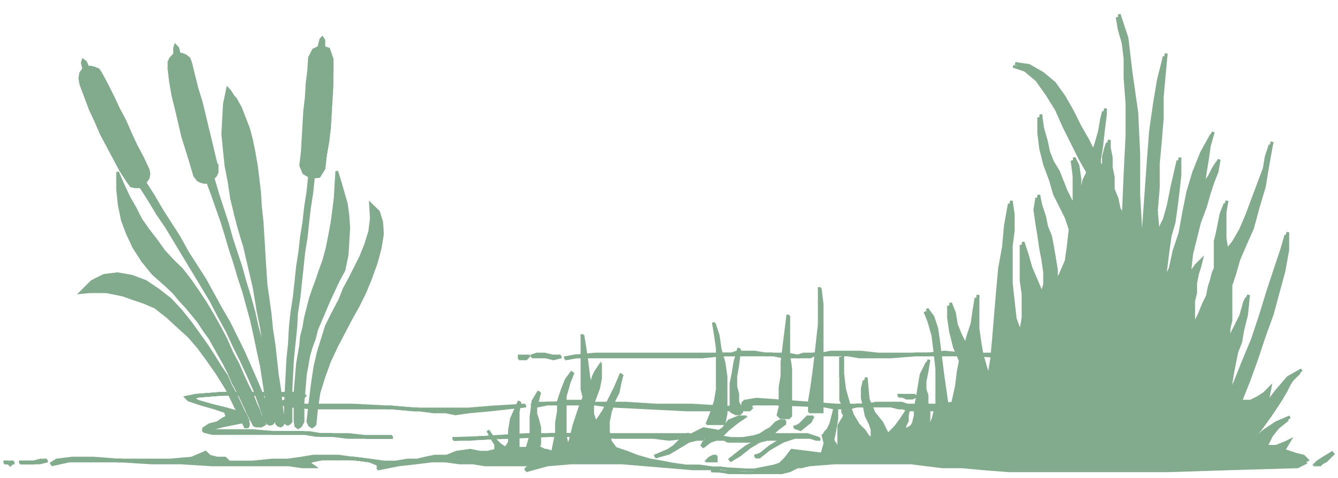


Figure 42. Waterlettuce moth

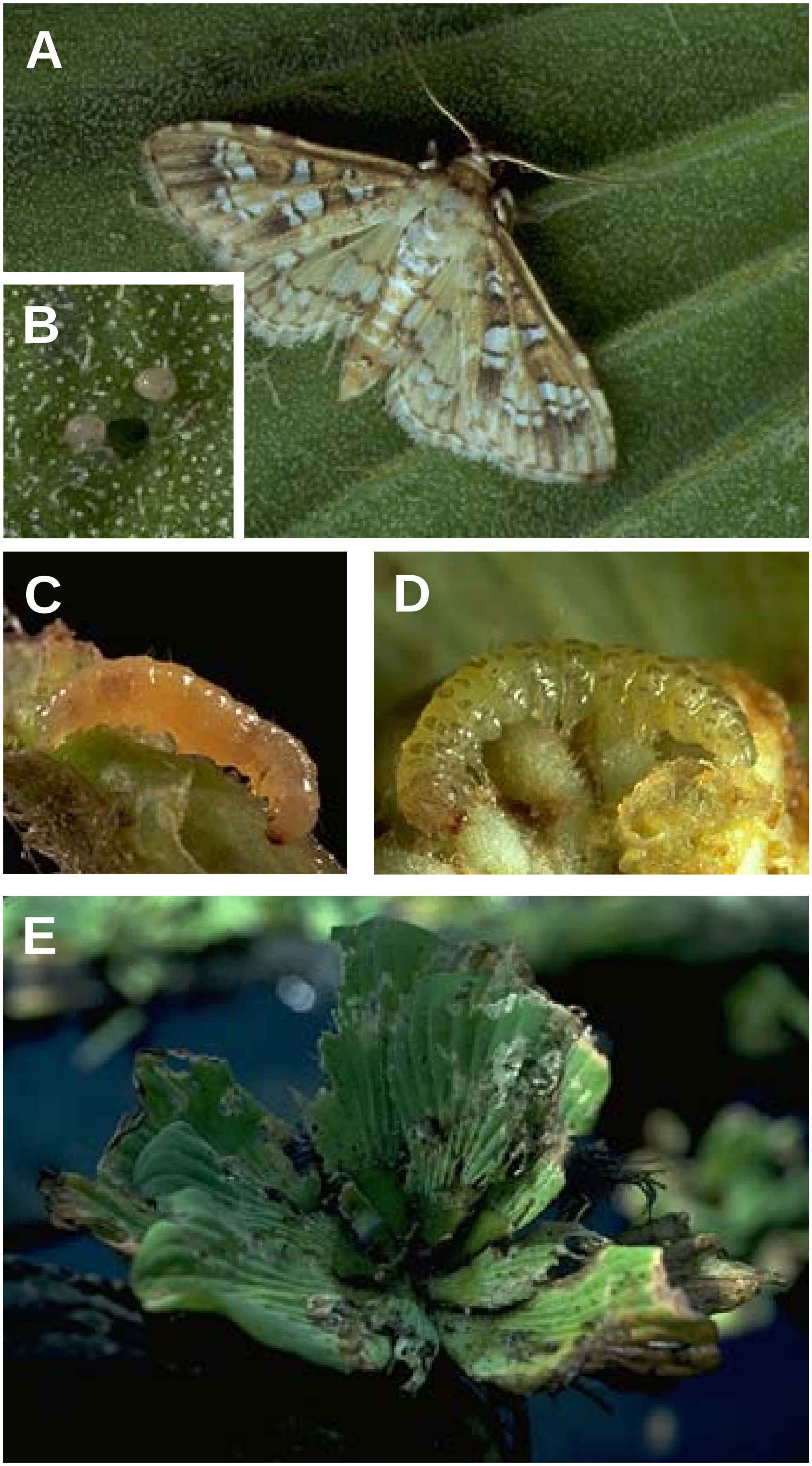
A, Adult *Samea multiplicalis* moth

B, Eggs of *Samea multiplicalis* nestled within the pubescence of a waterlettuce leaf

C, Early instar larva of *Samea multiplicalis* on a waterlettuce fruit

D, Typical late instar *Samea multiplicalis* larva

E, Waterlettuce rosette that has been severely damaged by *Samea multiplicalis* larvae


A
B
C
D
E

Waterlily Aphid, *Rhopalosiphum nymphaeae* (Linnaeus)
(Homoptera: Aphididae)

General Information and History

The name "waterlily aphid" is a misnomer for this species. Although it is quite common on spatterdock and waterlilies, it feeds on numerous other species. Another common name for *Rhopalosiphum nymphaeae* is the "reddish-brown plum aphid." This name is derived from its association with fruit trees, particularly during winter in temperate regions.

The distribution of *Rhopalosiphum nymphaeae* is cosmopolitan, and it has long been known as a pest of cultivated aquatic plants, transmitting the abaca mosaic, cabbage black ringspot, cauliflower mosaic, cucumber mosaic, and onion yellow dwarf viruses.

Plant Hosts

American lotus, *Nelumbo lutea* (Willd.) Pers. (Nelumbonaceae)
Arrowheads, *Sagittaria* spp. (Alismataceae)
Bladderworts, *Utricularia* spp. (Lentibulariaceae)
Cattails, *Typha* spp. (Typhaceae)
Duckweeds, *Lemna* spp. (Araceae)
Pickerelweed, *Pontederia cordata* L. (Pontederiaceae)
Pondweeds, *Potamogeton* spp. (Potamogetonaceae)
Rice, *Oryza sativa* L. (Poaceae)
Spatterdock, *Nuphar luteum* (L.) Sibth. & Sm. (Nymphaeaceae)
Waterhyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae)
Waterlettuce, *Pistia stratiotes* L. (Araceae)
Watermilfoils, *Myriophyllum* spp. (Haloragaceae)
Numerous cultivated fruit and crop plants

Biology and Ecology

Winged adult *Rhopalosiphum nymphaeae* migrate from aquatic habitats to fruit trees in late fall. The females lay eggs on the trees, and these eggs constitute the overwintering stage. Subsequent generations spend the spring and early summer on the fruit trees. Then, in mid- to late summer, they migrate to aquatic plants. While they are on fruit trees, they are oviparous (egg laying) but after migrating to hydrophytes, they become ovoviviparous (retain eggs in their oviducts until the eggs hatch and then give birth to living young). The ovoviviparous females are wingless, but those that migrate to and from fruit trees are winged.

The waterlily aphid readily walks on the water surface, often crawling down emergent plant parts to feed underwater. Specialized "hairs" on their bodies trap and hold air while the aphids are underwater. When large numbers of individuals aggregate in a submersed location, the entrapped air bubble sometimes covers the entire colony.

After colonizing aquatic sites, the aphids reproduce quickly, often virtually blanketing the hydrophytes present. The developmental period from the birth of the first instar to the adult stage ranges from 7 to 10 days, depending upon temperature (optimal temperatures range from 21 to 27 ^{o}C). Each female produces up to 50 nymphs at an average rate of two to four nymphs per day. The nymphs normally progress through five instars during the course of their development, although they will occasionally produce a sixth instar.

Effects on Host

The waterlily aphid is extremely destructive in aquatic gardens and nurseries and is known to transmit at least five plant viruses. Several authors have remarked on the ability of this insect to regulate primary production in aquatic habitats. Outbreaks of large aphid populations are sporadic and unpredictable, however. When large populations do develop, the aphids become heavily parasitized. Ladybird beetles and their larvae, as well as other typical aphid predators, also consume ample quantities. Despite these heavy losses, aphid populations usually recover quickly because of their high fecundity and short generation time.

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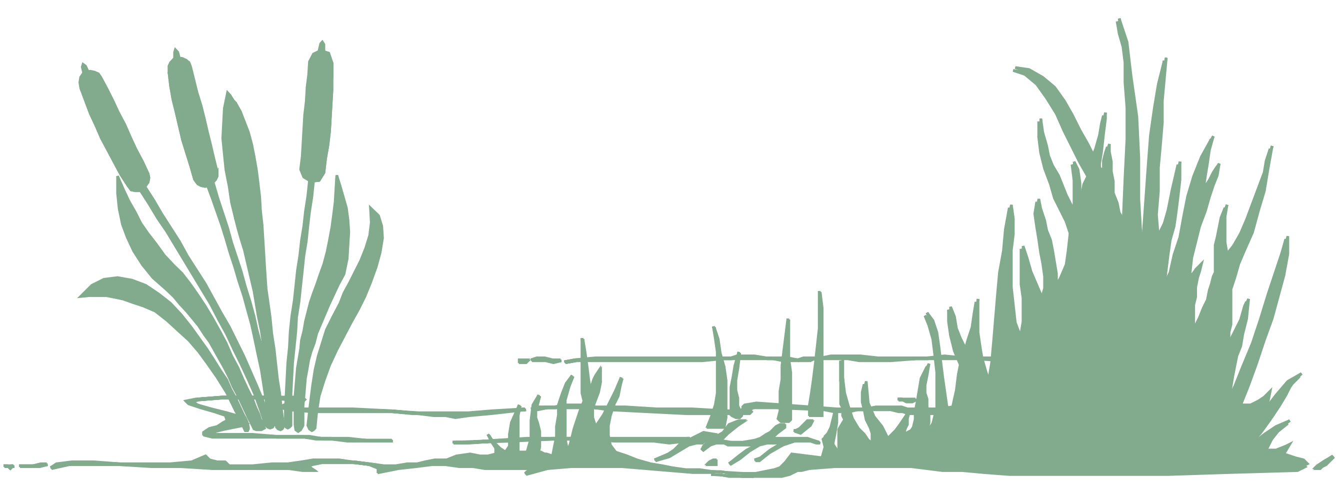

Figure 43. Waterlily aphid

A, Adult female and two nymphs of the waterlily aphid

B, Relatively dense waterlily aphid colony on the underside of a waterlettuce leaf


A


B

Waterlily Leaf Beetle, *Pyrrhalta (= Galerucella) nymphaeae* (Linnaeus)

(Coleoptera: Chrysomelidae: Galerucinae)

General Information and History

The preferred larval host of *Pyrrhalta nymphaeae* is *Nuphar luteum*, but adults reportedly feed on a variety of species.

Plant Hosts

Spatterdock, *Nuphar advena* (L.) Sibth. & Sm. (Nymphaeaceae)
Waterlilies, *Nymphaea* spp. (Nymphaeaceae)
Smartweed, *Polygonum hydropiperoides* Michx. (Polygonaceae)
Smartweed, *Polygonum amphibium* L. (Polygonaceae)
Sweet gale, *Myrica gale* L. (Myricaceae)
Water shield, *Brasenia schreberi* J.F. Gmel. (Cabombaceae)
Arrowheads, *Sagittaria* sp. (Alismataceae)
Willows, *Salix* sp. (Salicaceae)
Water chestnut, *Trapa natans* L. (Trapaceae)

Biology and Ecology

Waterlily leaf beetles lay their eggs arranged in closely spaced rows in single-layered masses on the upper surface of spatterdock leaves. The individual eggs are oblong with rounded ends and measure about 0.6 mm long by 0.5 mm thick. Each mass contains about 16 eggs (range 6–20), on average, and is attached to the leaf surface with an adhesive substance. When freshly laid, the eggs are bright yellow, but they quickly change to an ivory coloration. Female beetles lay about 10 eggs per day. The incubation period of the eggs is 4–5 days.

The larval stage comprises three instars and requires about 9 days (range 7–19 days). First instars measure about 1.6 mm in length and development requires 3–5 days. Second instars are about 3.4 mm long and require 2–7 days for development. Fully grown third instars require 2–7 days for development and reach lengths of 6–7 mm.

The head of the larva is black. The thorax and abdomen are black above except at the sutures, where fine whitish lines separate the black into distinct areas. The legs are also blackish except at the sutures.

The pupa is about 7 mm long and is black except on the ventral surfaces of the abdomen and thorax and the basal portion of the legs. The apical segment of the abdomen is covered by the molted larval skin. The legs, wing pads, and antennae are not closely appressed to the body. Pupae are attached to the upper leaf surface and the pupational period lasts about 5 days. Total generation time is about 3 weeks.

Both the brownish adults and larvae feed on the upper leaf surface, creating gouges in the epidermis. This grazing damage exposes the interior of the leaf to microbial attack, and greatly accelerates leaf turnover rates, and increases nutrient cycling.

Effects on Host

Severe defoliation of spatterdock reportedly can reduce plant populations and shift competitive balance in favor of other aquatic macrophytes. Less severe damage stimulates increased leaf production and turnover rates. *Pyrrhalta nymphaeae* have been reported to consume 5–17 percent of the net primary production by spatterdock in a single growing season.

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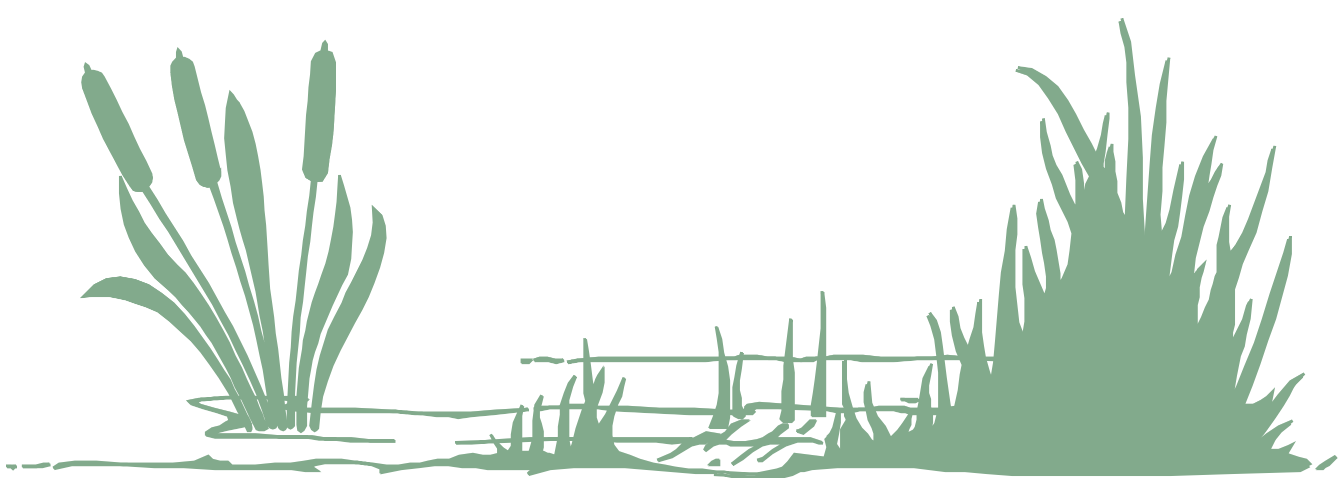
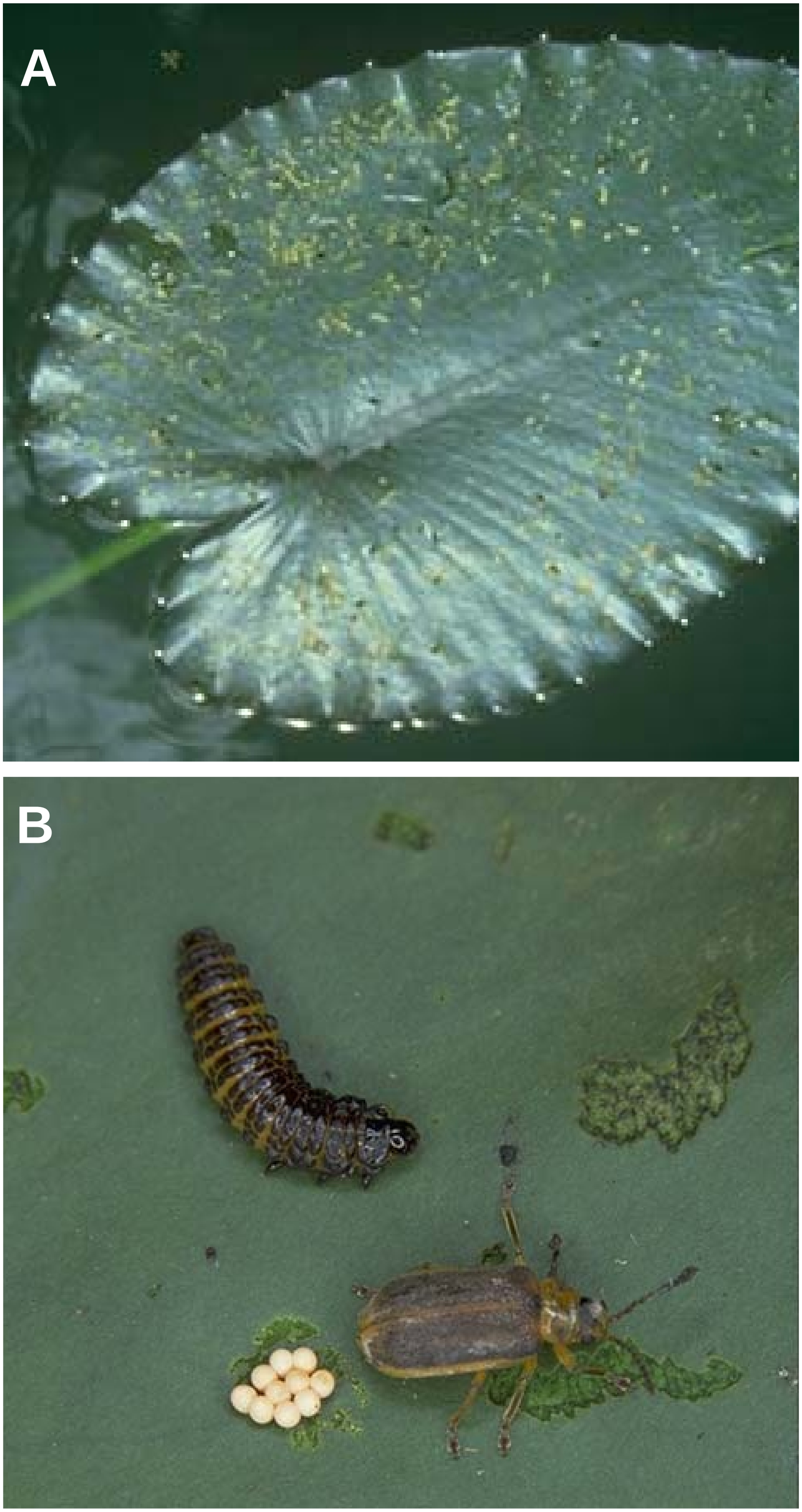


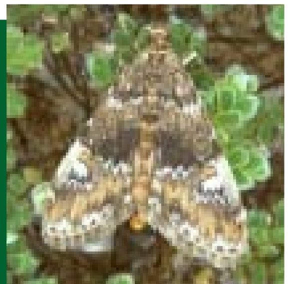
Figure 44. Waterlily leaf beetle

A, Nuphar luteum leaf that has been scarred by feeding of *Pyrrhalta nymphaeae* larvae and adults

B, Eggs (bottom left), a late-instar larva (top), and an adult (bottom right) waterlily leaf beetle


A
B

Waterlily Leafcutter, *Synclita obliteralis* (Walker)
(Lepidoptera: Pyralidae: Nymphulinae: Nymphulini)



General Information and History
The waterlily leafcutter is an inappropriate common name for this insect because its diet is not restricted to waterlilies. It feeds on numerous aquatic plants including *Hygrophila*, *Sagittaria*, *Amaranthus*, *Hydrocotyle*, *Pistia*, *Myriophyllum*, *Hydrilla*, *Lemna*, *Brasenia*, *Nuphar*, *Nelumbo*, *Nymphaea*, *Ludwigia*, *Polygonum*, *Eichhornia*, *Potamogeton*, *Azolla*, *Salvinia*, *Bacopa*, and several others. The total food plant list encompasses 23 plant families, so this is an example of a truly polyphagous insect.

Three other species of *Synclita* have been recognized. The only other Florida species is *S. tinealis* Munroe, which is a very small species that feeds on duckweeds (*Lemna* spp.).

Plant Hosts
More than 60 aquatic plant species

Biology and Ecology
Adult waterlily leafcutters are small moths, with the males distinctly smaller (wingspread 11–13 mm) than the females (wingspread 15–19 mm). The wings of the male are dark but interspersed with brown and white markings. The wings of the females are paler grayish brown with orange and dark markings.

The whitish eggs are oval and flattened, appearing domelike. They are laid near edges of submersed leaf surfaces of aquatic plants and are placed singly or slightly overlapping, often in ribbonlike masses.

The larva resides between two roundish pieces of leaves that form a sandwichlike portable case. When feeding on small plants, these cases can consist of whole leaves or even whole plants. Cases are usually constructed from the plant species on which the larva is feeding, but it is not unusual for different plant species to be used. The cases made by young larvae are apparently water filled, and the larvae obtain oxygen cutaneously. The cases of older larvae are air filled. The larvae extrude the anterior portion of their bodies out of the case while feeding to reach the surrounding plants. They abandon the smaller cases as they grow larger and then cut pieces from new leaves to construct larger cases.

Unlike most nymphulines, the larvae of *Synclita obliteralis* lack tracheal gills. The general body color is creamy white grading into brownish anteriorly (toward the segments that protrude from the case). The epidermal surface is textured with minute papillae, which create a distinctive satiny appearance. The head is yellowish or brownish with patches of slightly darker coloration. Before it pupates, the larva attaches its case to leaf blades or petioles of aquatic plants either above or below the water surface. It then spins a cocoon within the case in which it pupates.

Effects on Host
Synclita obliteralis is frequently a pest in aquatic nurseries, especially on waterlilies. Despite this, we know of no investigations of its effects on host plants.

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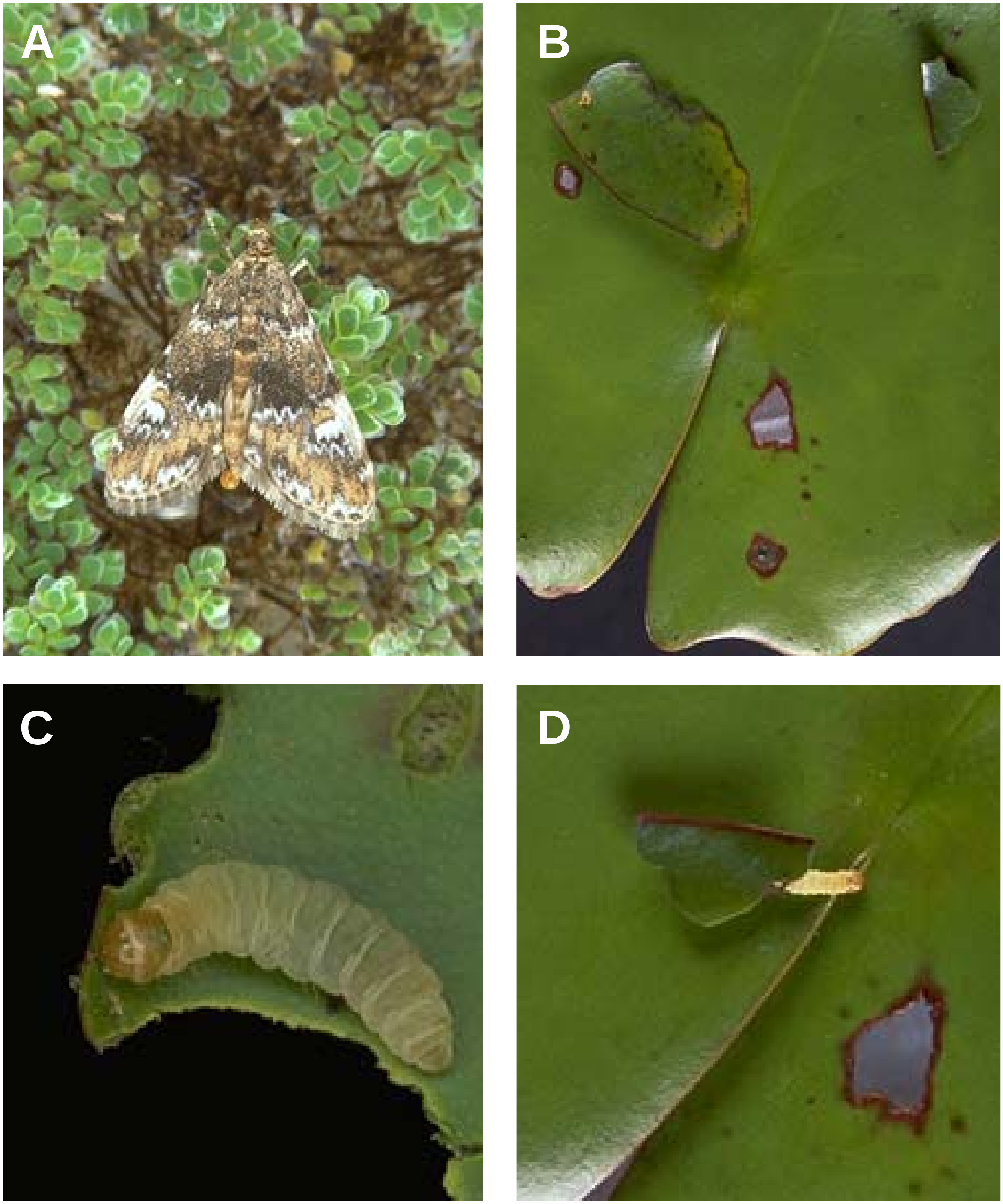
Figure 45. Waterlily leafcutter

A, Adult female waterlily leafcutter on waterfern

B, Synclita obliteralis larva in its case on a waterlily leaf

C, Waterlily leafcutter larva that has been removed from its case

D, Synclita obliteralis larva feeding on the edge of a waterlily leaf


A
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Yellow Bear Moth, *Spilosoma virginica* (Fabricius)
(Lepidoptera: Arctiidae: Arctiinae)

General Information and History
The Arctiidae, or tiger moths, constitute a rather common moth family. The larvae are generally very well known and are referred to as “woolyworms” or “woolybears” because of their fuzzy look. A common example is the banded woolyworm (or Isabella tiger moth), *Pyrrharctia isabella* (J.E. Sm.), the larva of which is black at both ends and orange red in the middle. According to folklore, the relative width of the red and black bands on the caterpillars forecasts the severity of the coming winter. In reality, this is merely an indication of the age of the larvae.

The fuzzy appearance of tiger moth larvae is the result of a covering of numerous tufts of hairs. These tufts originate on protuberances or bumps called “verrucae.” The presence of these verrucae can be useful for separating the arctiids from other families that contain species with hairy caterpillars.

This species is also known as the yellow woolyworm or the Virginian tiger moth.

Plant Hosts
Many aquatic and terrestrial plant species

Biology and Ecology
Eggs of the yellow bear moth are typically laid on leaves in single-layered masses. Each mass contains from 20 to 100 or more eggs. The young caterpillars tend to be gregarious. As they increase in size they progressively become more solitary.

The larvae of *Spilosima virginica* are commonly found feeding on the emergent portions of waterhyacinth, pickerelweed, frog’s bit, waterlettuce, smartweeds, and other aquatic species. The larvae are not always yellow. They range in color from white to yellow to brown or brownish yellow. The early instars tend to be lighter, and later instars become progressively darker. Fully grown caterpillars measure about 5 cm in length. When feeding on sunflowers, larval development progresses through six instars and requires 20–27 days. Pupation frequently occurs on the larval host plant. Pupae are formed in a flimsy cocoon consisting of mostly larval body hairs that are incorporated into a thin layer of silk. The pupa is typically dark and stout.

Adults are pure white, with a few dark spots on the wings and a row of yellow spots on the abdomen. The wingspread ranges from 3.5 to 5.2 cm.

Another common arctiid often associated with aquatic plants is the salt marsh caterpillar, *Estigmene acrea* (Drury). The forewing of the adult salt marsh moth is white with numerous dark black flecks, and the hind wing is dark yellow orange in males but white in females. The abdomen is mostly yellow orange, in contrast to the nearly all-white abdomen of *S. virginica*.

Effects on Host
We know of no studies describing the impacts of this insect on its host plants.

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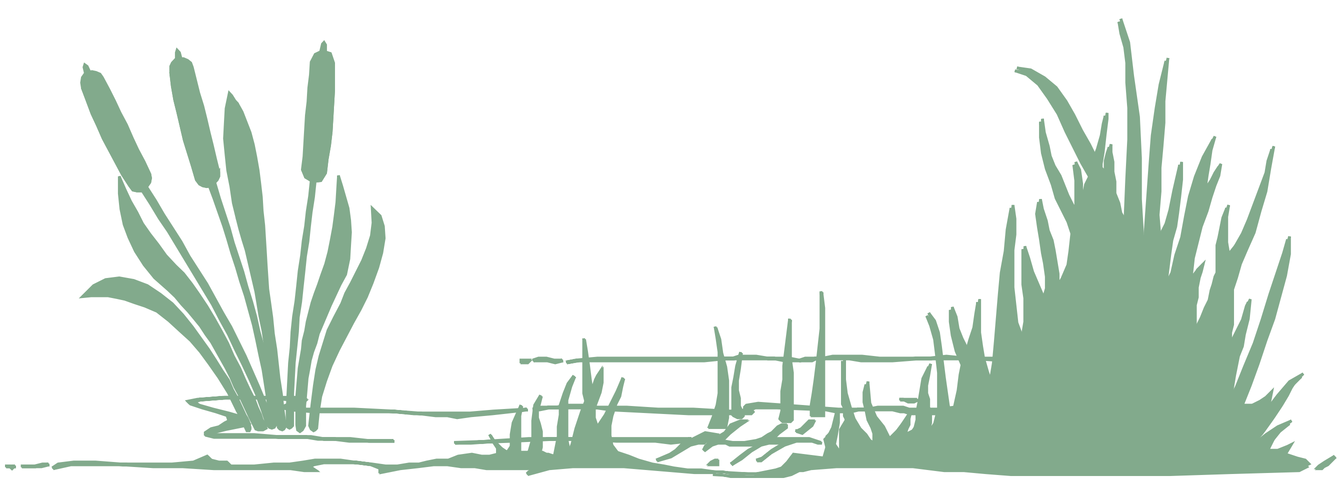


Figure 46. Yellow bear moth

A, Adult yellow bear moth

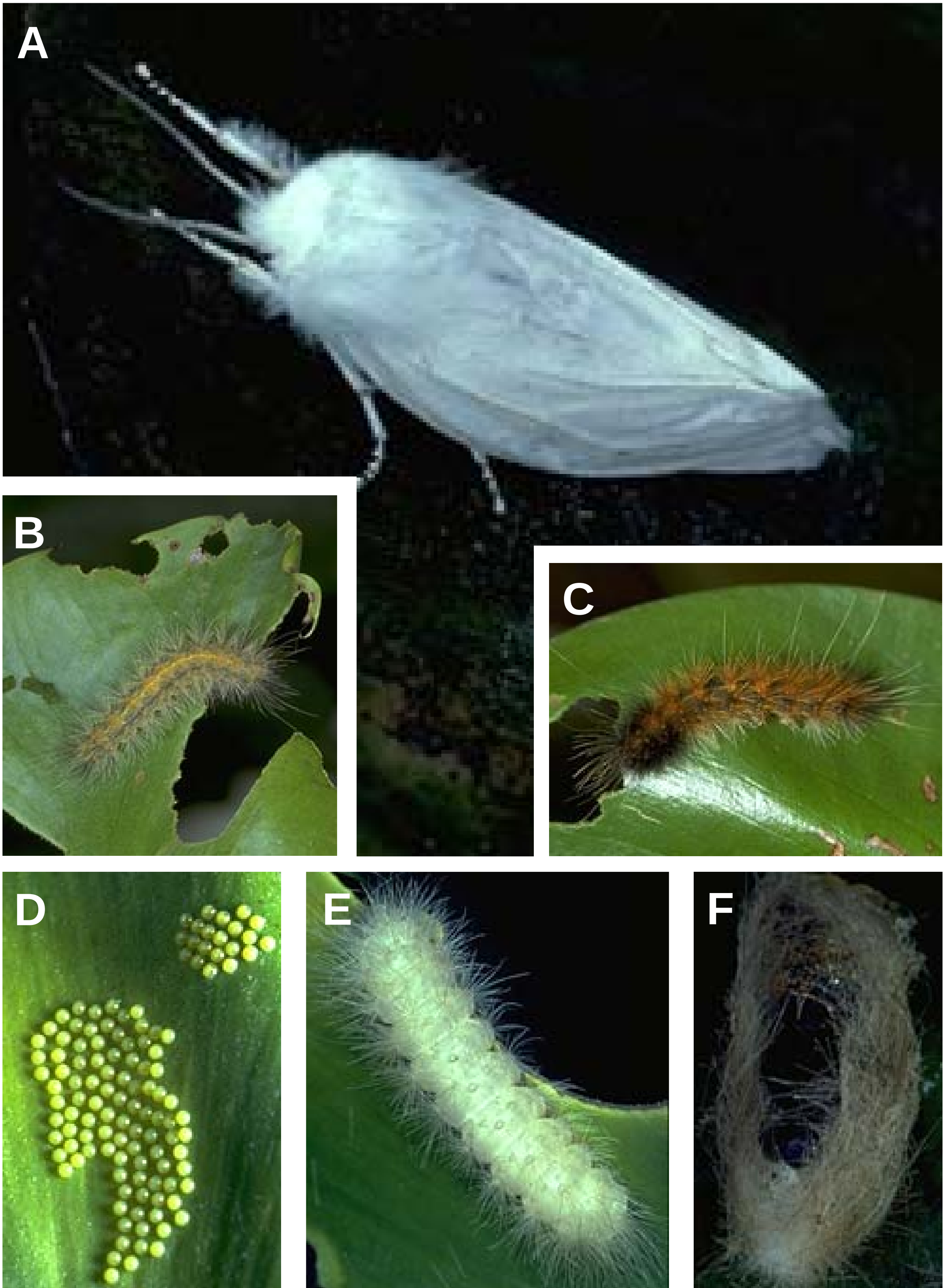
B, Yellowish *Spilosoma virginica* larva

C, Reddish form of *Spilosoma virginica* larva

D, Eggs of *Spilosoma virginica*

E, Early-instar caterpillar of *Spilosoma virginica*

F, Yellow bear moth cocoon partially opened to show the pupa inside


A
B
C
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E
F

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Index of Insects, by Common Name

Index of Insects, by Scientific Name

Index of Host Plants, by Common Name, and Their Insect Pests

Index of Host Plants, by Scientific Name, and Their Insect Pests