**Bagous hydrillae**

*Hydrilla stem weevil*

*Bagous hydrillae* is a biological control agent approved for release in the USA against *hydrilla*.

### CLASSIFICATION

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<th>SCIENTIFIC NAME</th>
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<td>Species</td>
<td><em>Bagous hydrillae</em> O’Brien</td>
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### DESCRIPTION

Eggs are white and oval. Larvae are C-shaped, whitish-yellow with brown head capsules, and up to 3 mm long (Fig. 1a). Pupae (Fig. 1b) are creamy-white with fused appendages. Adults are elongate with long snouts (Fig. 1c), up to 3 mm long, mottled, and tan to dark brown. In many individuals, 2–4 light-colored spots can be seen on the far ends of the body (Fig. 1d).

### LIFE CYCLE

Overwintering adults emerge in spring, fly from the shore to *hydrilla* mats, and feed on stems and leaves. Females lay eggs (an average of 300 per lifetime) singly in *hydrilla* stems near plant nodes. Larvae bore through stems (Fig. 1a) and feed/develop through three instars. Adult and larval feeding causes stems to break apart (Fig. 2), and fragments float to shore where they become stranded and die. Some mature larvae exit stems to pupate in the soil (Fig. 1b). Others may pupate within stranded stems, though pupation does not occur in submersed *hydrilla*. Adults emerge, fly to new *hydrilla* patches, and continue the cycle. There are multiple generations per year in the native range (possibly 4–5). Adults overwinter in soil or among *hydrilla* stems that were stranded on shorelines.

### DAMAGE

*Hydrilla* stems turn brown where larvae bore inside. Adults feeding externally on leaves and stem tissue and larvae boring internally in stems causes *hydrilla* stems to collapse or break apart (Fig. 2), and fragments float to shore where they become stranded and die.

### FIELD IDENTIFICATION

Two other approved biocontrol agents (*Hydrellia*...).
flies) and two species not approved for redistribution (Cricotopus lebetis and Parapoynx diminutalis) are known to feed on hydrilla in the USA. The most reliable means to confirm the weevil’s presence is to observe larvae or adults actively feeding on hydrilla. Because Bagous hydrillae is the only weevil known to feed on hydrilla in the USA, its adults (Fig. 1c,d) can be readily differentiated by having hardened bodies and long snouts, and it’s larvae are whitish-yellow with a distinct brown head capsule. It will likely be necessary to dissect hydrilla stems in order to observe larvae. Head capsules are lacking on the larvae of the Hydrellia flies (Fig. 4b) and are indistinct on C. lebetis larvae (Fig. 8b). The larvae of P. diminutalis (Fig. 9b) have long, branched gills.

PREFERRED HABITAT
The hydrilla stem weevil does best along margins of non-flowing rivers and in lakes and reservoirs.

HISTORY AND CURRENT STATUS
Bagous hydrillae is native to Australia. Weevils were released in Alabama, Florida, Georgia, and Texas, USA from 1991 to 1996. This weevil was temporarily recovered in Florida and Texas following the original releases; however, it was believed this species had failed to permanently establish in the field. Small numbers were recovered in Louisiana in 2009 (over 360 miles or 580 km from the nearest release), indicating populations persisted throughout the southeastern USA (Fig. 3). There have been no observed reductions to hydrilla mats, and the impacts of any existing weevil populations are believed to be negligible. New inventories are warranted to determine the overall distribution of this species in the USA.

NONTARGET EFFECTS
None reported

Hydrellia balciunasi & H. pakistanae
Australian & Asian hydrilla leaf-mining flies

Hydrellia balciunasi and H. pakistanae are closely related biological control agents approved in North America for release against hydrilla.

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DESCRIPTION
Both species are virtually indistinguishable; experts must use genitalia features to differentiate adults. Eggs of both species are yellow-white and elongate with longitudinal ridges (Fig. 4a). Larvae are yellow-green to white, have two anal spines, and are up to 3½ mm long at maturity (Fig. 4b). Pupae are enclosed in cocoons that turn dark brown with age (Fig. 4c). Adults are dark gray with grayish-orange legs and typically bronze faces and are 1½–2 mm long (Fig. 4d).
**LIFE CYCLE**

At warm locations, both *Hydrellia* spp. and hydrilla develop throughout the year; larvae and pupae are the stages most often observed over winter. Adults emerge in spring and lay eggs singly or in small groups (average of 35 eggs per female) on hydrilla leaves and stems at or just above the water surface. Larvae mine within leaves (4–12 per lifetime) and develop through three instars. Leaves are mined completely before larvae exit to find another. Mature larvae attach themselves to leaf axils and pierce the stems with their anal spines while their outer layer hardens into cocoons. Pupae obtain air from the stems via the anal spines. Adults emerge and float to the surface in a bubble of air to repeat the cycle. There are up to seven generations per year depending on site conditions.

**DAMAGE**

Leaves mined by *Hydrellia* larvae decay and sink. The subsequent reduction in photosynthesis reduces plant biomass as well tuber biomass and density.

**FIELD IDENTIFICATION**

One other approved biocontrol agent (*Bagous hydrillae*) and two species unapproved for redistribution (*Cricotopus lebetis* and *Parapoynx diminutalis*) are known to feed on hydrilla in the USA. The surest means to confirm the presence of *Hydrellia* spp. is to observe larvae or adults on hydrilla. *Hydrellia* larvae (Fig. 4b) are smaller and lack the head capsules of *B. hydrillae* larvae, and they mine hydrilla leaves whereas *B. hydrillae* larvae (Fig. 1a) mine hydrilla stems. The larvae of *C. lebetis* (Fig. 8b) feed on the tips of hydrilla stems while *P. diminutalis* larvae (Fig. 9b) feed externally on hydrilla leaves. Adult *Hydrellia* resemble small house flies (Fig. 4d) and are easily differentiated from adults of the other species, which are beetles (*B. hydrillae*, Fig. 1c,d), midges (*C. lebetis*, Fig. 8a), and moths (*P. diminutalis*, Fig. 9a).

**PREFERRED HABITAT**

Both species are restricted to warm climates but perform well in all warm water bodies where hydrilla mats are present. Adult *Hydrellia* can commonly be found resting or mating on emergent hydrilla leaves or other vegetation such as water lilies.

**HISTORY AND CURRENT STATUS**

*Hydrellia balciunasi* sourced from Australia was released in Florida beginning in 1989 and Texas beginning in 1991. It has been confirmed established only in Texas (Fig. 5a) where it was replaced by *H. pakistanae* at most release sites. *Hydrellia pakistanae* is native to Asia. Flies sourced from India were released in the southeastern USA beginning in 1987. *Hydrellia pakistanae* from Pakistan and northern China were subsequently released in 1990 and 1992, respectively, in an attempt to increase survival at cold locations. It is believed the India and Pakistan releases were successful, though due to the fly’s widespread distribution, it is unclear if the China releases were also successful. The different populations were subsequently not differentiated in distribution records. A population collected from flies established in Florida was later redistributed to California (1994) and Baja California, Mexico (1995). Though these have been recorded as coming from the India population, they could have contained flies derived from all three countries.

No major impact has been observed for *H. balciunasi* as populations have remained low and spread has been limited. *Hydrellia pakistanae* is much more widespread and abundant (Fig. 5b); larval mining decreases photosynthesis and reduces tuber production. High fly densities are locally correlated with decreases in hydrilla populations. Some populations of both species are limited by parasitism and cold weather so the overall

![Figure 5. Reported distribution of (a) H. balciunasi and (b) H. pakistanae in North America (Winston et al. 2021)](image-url)
impact in the USA is variable. Studies since 2004 indicate the
monoecious biotype is not as suitable a host for introduced
*Hydrellia* spp. as is dioecious hydrilla. Establishment of *H.*
*pakistanae* in Mexico has not been confirmed.

**Nontarget Effects**
None reported

**Notes**
Both introduced *Hydrellia* spp. closely resemble native
*Hydrellia* spp. Introduced males can be differentiated by their
abdomen being approximately the same size as their thorax,
while the abdomen of a native male is 1½–2 times as long as
the thorax (Fig. 6). Females of introduced and native species
are usually indistinguishable and must be differentiated by
their genitalia.

**Non-Established Species**

*Bagous affinis*
(Coleoptera: Curculionidae)

**Description and Life Cycle**
Adults are elongated, 3–4 mm long, a mottled brown, and
have long snouts (Fig. 7a). Adults emerge in spring and feed
on hydrilla stems and leaves exposed by receding waters.
Females lay up to 230 eggs singly on emerged or drying
hydrilla stems, tubers, moist wood, or soil. Eggs are white and
oval. Larvae are C-shaped, white with brown head capsules,
and up to 5 mm long (Fig. 7b). Larvae crawl through
sediment searching for hydrilla tubers, then feed on or within
hubs and develop through three instars. Pupation typically
occurs within tubers. There are possibly 2–3 generations per
year in the native range. Adults overwinter in soil or among
stranded hydrilla stems.

**Cricotopus lebetis**
(Diptera: Chironomidae)

**Description and Life Cycle**
Adults are 3–4 mm long and a very pale olive green with
multiple dark bands. Females have short antennae and thick
abdomens while males have long feathered antennae and
narrow abdomens (Fig. 8a). Females lay 50–250 whitish eggs
in long strings on the water. Larvae feed and develop through
four instars on the growing tips of hydrilla. Larvae are up
to 4 mm long and translucent green with a dark band on
the thorax (Fig. 8b). Pupation occurs within hydrilla stems.
There are up to 11 overlapping generations per year.

**History and Current Status**
Bagous affinis is native to Asia. Individuals from India were
released in Florida beginning in 1987 and Texas beginning in
1994. Though this weevil was initially recovered in Florida,
permanent establishment has not been reported. It is possible
that establishment has been limited by this species requiring
extensive drawdown conditions which expose the sediment
surface and allow immature weevils access to buried hydrilla
tubers.

Two accidentally introduced species are established on
hydrilla in the USA. They are not approved for use, and it is
illegal to intentionally move these species to new areas in
the USA. Care should be taken when transferring approved
agents to ensure that these unapproved species are not also
included in transferred material.

**Unapproved Biocontrol Agents**

**History and Current Status**
This midge was first recorded in Louisiana, USA in 1957
and is now is established in both Louisiana and Florida.
Parapoynx diminutalis
(Lepidoptera: Crambidae)

DESCRIPTION AND LIFE CYCLE
Adults are 8 mm long and are white with brown and tan markings and bands (Fig. 9a). Females lay ~200 yellow eggs in ~30-egg masses on hydrilla stems and leaves. Larvae are up to 10 mm long and are white to yellow with spotted heads and long branched gills (Fig. 9b). Larvae feed on hydrilla leaves and develop through seven instars. Late instars construct silk cases within bound leaves. Pupation occurs in cocoons within these cases. There are multiple generations per year.

HISTORY AND CURRENT STATUS
Parapoynx diminutalis was studied for its potential as a hydrilla biological control agent in the USA but was rejected because it feeds on numerous native plant species. It was accidentally introduced and first recorded in Florida, USA in 1975. The moth has since spread and is now established throughout the southeastern USA. Larval feeding can heavily damage hydrilla populations locally. However, this moth only occurs sporadically, so its overall impact is typically low. Populations are limited by cold weather. This species is not approved for redistribution in the USA.

REFERENCES


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NAISMA is a network of professionals challenged by invasive species: land managers, water resource managers, state, regional, and federal agency directors and staff, researchers, and nonprofit organizations. NAISMA’s members are a diverse group of individuals and organizations who are involved in implementing invasive species management programs at all scales. Our mission is to support, promote, and empower invasive species prevention and management in North America. Our vision is to have North America’s lands and waters protected from invasive species. NAISMA’s programs aim to provide the support, training, and standards needed by the professional invasive species management community.
SUGGESTED CITATION