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Source: Journal of the Kansas Entomological Society, 87(4):350-357.

Published By: Kansas Entomological Society

DOI: <http://dx.doi.org/10.2317/JKES131031.1>

URL: <http://www.bioone.org/doi/full/10.2317/JKES131031.1>

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## The Pupal Case of a Nearctic Robber Fly, *Efferia snowi* (Hine, 1919) (Diptera: Asilidae)

D. STEVE DENNIS<sup>1</sup> AND JEFFREY K. BARNES<sup>2</sup>

ABSTRACT: The pupal case of the Nearctic robber fly, *Efferia snowi* (Hine, 1919), is described, illustrated, and compared with the pupal cases of five other Nearctic species. A key is provided to the known pupal cases of Nearctic *Efferia* species.

KEY WORDS: Asilinae, Asiloidea, Brachycera, immature Diptera, Insecta

*Efferia* is a large genus of robber flies that occurs only in the Nearctic and Neotropical zoogeographic regions. Presently, there are 110 described Nearctic species (E. M. Fisher, unpubl. data), and some 140 described and many undescribed Neotropical species (Fisher, 2009; Papavero, 2009). Pupal cases of only 5 species have been described in detail: *E. aestuans* (Linnaeus, 1763), *E. benedicti* (Bromley, 1940), *E. frewingi* Wilcox, 1966, *E. helenae* (Bromley, 1951), and *E. triton* (Osten Sacken, 1887) (Dennis and Lavigne, 1976; Dennis *et al.*, 2008a).

The purpose of this paper is to describe the pupal case of *Efferia snowi* (Hine, 1919). This species occurs in Colorado, Kansas, New Mexico, Oklahoma, South Dakota, and Texas in the United States of America (U.S.A.), and possibly Mexico (Geller-Grimm, 2013, <<http://www.geller-grimmde/catalog/species.htm>>, Last Accessed 20 April 2013).

Artigas and Papavero (1997) defined an “*Efferia*-group” comprised of 8 genera (*Albibarbefferia*, *Aridefferia*, *Carinefferia*, *Efferia*, *Erax*, *Nerax*, *Pogoniefferia*, and *Tuberculefferia*), and they also included the genera *Cratolestes*, *Diplosynaspis*, *Porasilus*, and *Triorla*. However, because of the small number of described pupal cases and for simplicity, we have retained the use of the name *Efferia*. This practice is in agreement with Fisher (2009), who considered many of these genus names to be best treated as synonyms of *Efferia*.

### Materials and Methods

The following description is based on a single pupal case in the collection of the National Museum of Natural History (NMNH), Washington, D.C., with an associated pinned adult female labeled, “Manh’t’n, Ks Apr., R.H. Painter Collector, A.C. 5912, *Efferia snowii* Hine ’19 der. J. Wilcox, USNMMENT00876522.” The authors confirmed the identification of the adult using the keys and descriptions of Wilcox (1966).

Our description follows the format of Dennis *et al.* (2008a, b) and Dennis and Barnes (2012). The majority of robber fly pupal cases have a distinct pattern of dorsal abdominal spines and spurs. Abdominal segment 1 typically has a transverse row of spurs, and abdominal segments 2–7 have transverse rows of spines alternating with spurs, sometimes with 2–3 spines between each pair of spurs. On some pupal

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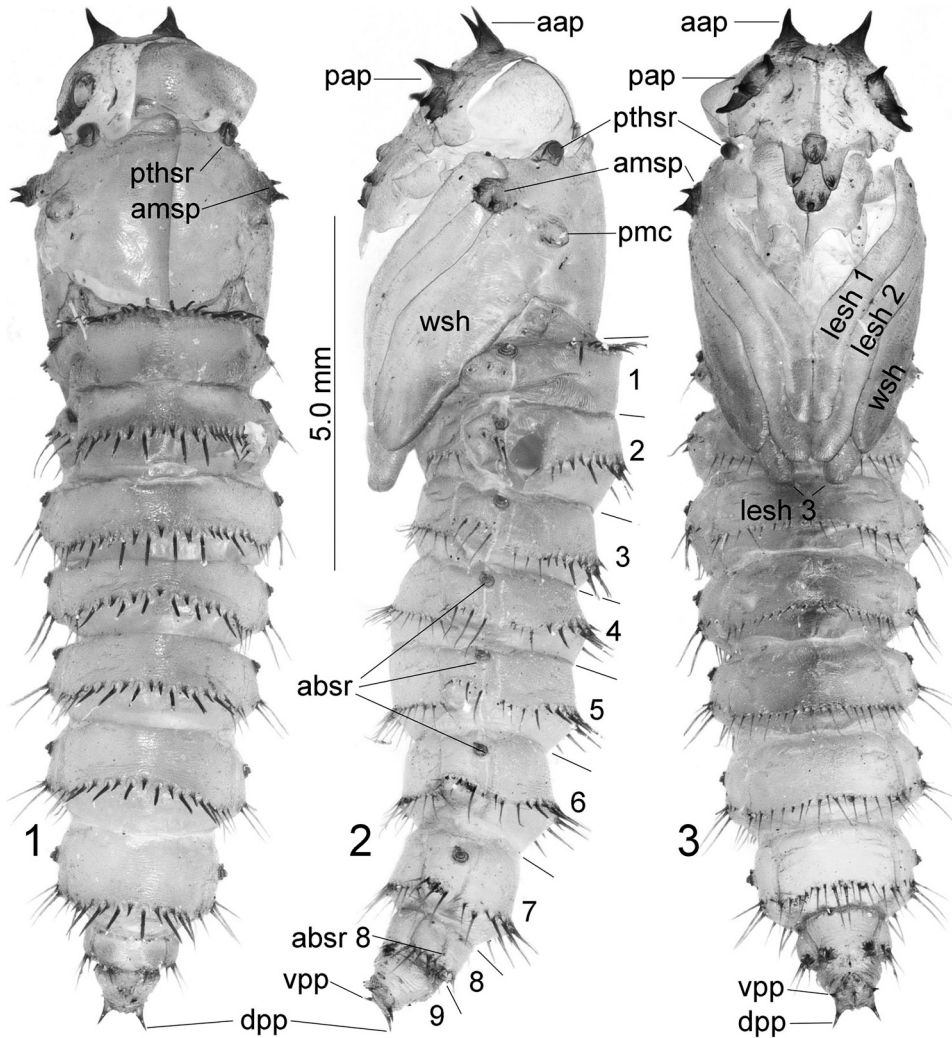
cases the spines are short, stout extensions of the cuticle and the longer thinner spurs emanate from areas of thin cuticle. A spine is a rigid, immovable, thorn-like outgrowth of the cuticle that does not have a socket area of integumental weakness around its base. A spur is a moveable process that has a socket around its base. Some spines also might be bristlelike, but a bristle is defined as an unicellular macrotrichium or seta connected with nerves and surrounded at the base by a membranous ring or socket called an alveolus (Daly *et al.*, 1998; McAlpine *et al.*, 1981).

### Results and Discussion

**Description.** Pupal case straight. Greatest length, including anterior antennal processes 14.5 mm; greatest width of thorax 4.75 mm; greatest width of abdomen 4.0 mm, tapering to 1.5 mm at greatest width of abdominal segment 8. Subshining light golden brown; facial sheath and area extending anteriorly slightly darker; spurs, spines, processes glistening reddish brown; spurs and spines mostly uniformly reddish brown; processes generally darker apically (Figs. 1–3).

Head with pair of basally rugose, recurved, dorsally flattened to slightly rounded, ventrally wedge shaped, apically rounded anterior antennal processes not joined at base with smooth area between processes; with group of 3 subequal, basally rugose posterior antennal processes located ventrolaterally on each side; innermost process dorsally flattened, ventrally wedge shaped, separated from outermost processes by broad U-shaped area of cuticle and slightly curved towards outer processes; 2 outermost processes closer together, apically rounded to more acute than innermost process, separated by small U- to V-shaped area; with middle process dorsally rounded, ventrally wedge shaped to dorsoventrally flattened, apically rounded; with outermost process dorsoventrally flattened, apically broadly rounded, bearing small basal tooth; lacking conspicuous sensory pore (Figs. 2, 3). Labral sheath about 2/3 length of proboscidal (proboscial, formerly, incorrect spelling) sheath, rugulose on each side of midline projecting slightly over proboscidal sheath. Proboscidal sheath rugulose posteriorly on each side of midline; with medium size, posterior callosities with sclerotized ridges; with small, vertical posteromedian tubercle slightly posterior to callosities. Maxillary sheath extending 2/3 length of proboscidal sheath, smooth to rugulose especially in vicinity of large, ridged posterior tubercles. Palpal sheaths small, yellowish callosity outlined by sclerotized ridge, located anterior to area where labral, proboscidal and maxillary sheaths join (Fig. 4).

Anterior coxal sheath smooth to anteriorly rugulose (minutely wrinkled), with anterior, median, longitudinal split. Posterior coxal sheath folded inward and not visible. Prothoracic spiracle situated midlaterally at anterior margin of thorax, shining, light reddish brown, spherical, raised on slight callosity that has incomplete posterior sclerotized ridge and 2 anterior sclerotized ridges separated by U-shaped area of cuticle. Anterior mesothoracic spines on each side of thorax located above base of mid leg sheath on very rugose callosity with sclerotized ridges; spines subequal in size and length, posteriorly slightly pointed, dorsally rounded, ventrally wedge shaped. Posterior mesothoracic callosity located at base of wing sheath large, oval, rugose to rugulose, with sclerotized ridges and medium sized, apically rounded posterior mesothoracic spine; with small callosity with a rounded, sclerotized edge lateral to spine. Wing sheath rugose to rugulose with posterior, shallow grooves and small, medial, circular to elongate callosity. Apex of hind leg sheath (leg sheath 3)



Figs. 1-3. *Efferia snowi* pupal case. 1, dorsal view (left compound eye sheath missing). 2, lateral view showing abdominal segments 1-9. 3, ventral view (left compound eye sheath and left thoracic sheath missing). aap = anterior antennal process, absr = abdominal spiracles, absr 8 = abdominal spiracle 8, amsp = anterior mesothoracic spines, dpp = dorsal posterolateral process, lesh 1 = fore leg sheath, lesh 2 = mid leg sheath, lesh 3 = hind leg sheath, pap = posterior antennal processes, pmc = posterior mesothoracic callosity, pthsr = prothoracic spiracle, vpp = ventral posterolateral process, wsh = wing sheath.

reaching to middle of abdominal segment 3. Leg sheaths rugulose, apically slightly bilobed. Wing and leg sheaths darker apically (Figs. 2, 3).

Abdominal segment 1 with dorsal transverse row of long, recurved spurs divided by dorsomedian space. Abdominal segments 2-7 with dorsomedian short, straight spine, flanked on each side by transverse rows of alternating short, straight spines and long, straight to slightly apically curved spurs; spines anterior to spurs; some apically forked to bifurcate. Abdominal segment 1 lacking dorsolateral bristlelike spines; abdominal segments 2-7 with dorsolateral bristlelike spines usually separated

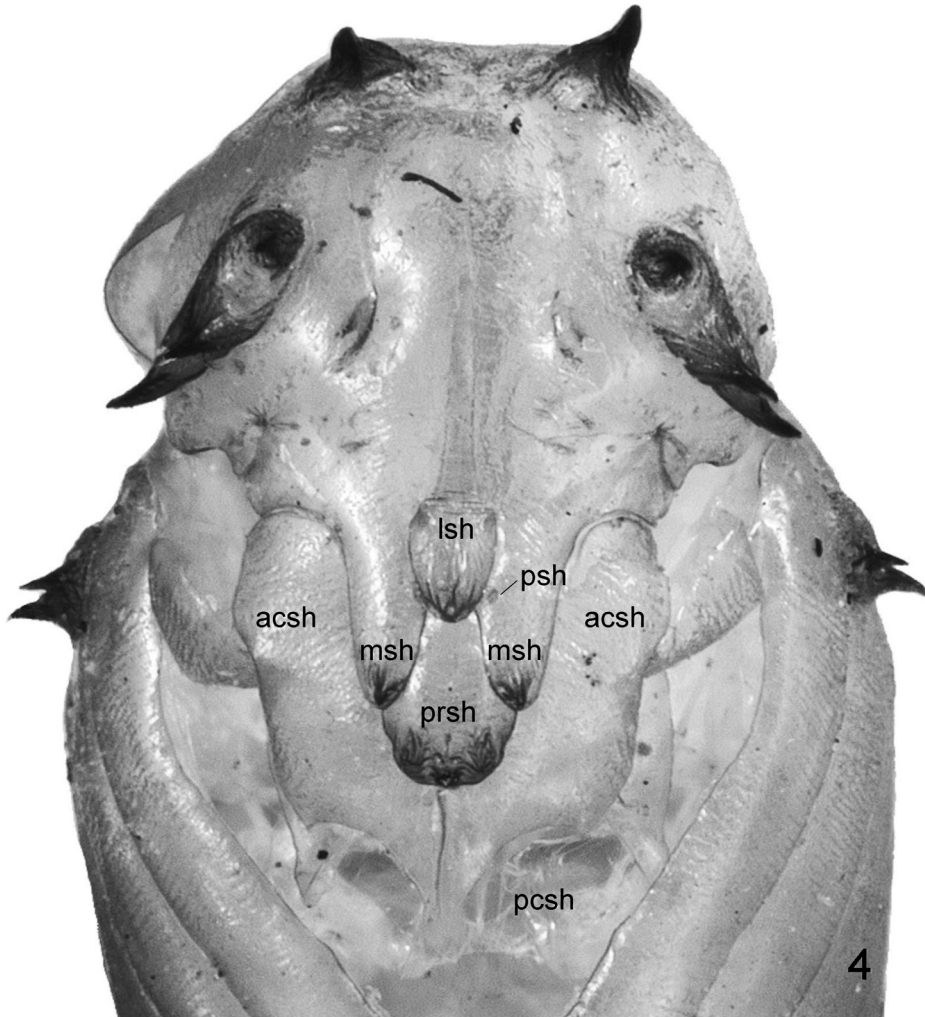


Fig. 4. *Efferia snowi* pupal case, facial sheath and adjacent structures. acsh = anteriorcoxal sheath, lsh = labral sheath, msh = maxillary sheath, pcsh = posterior coxal sheath, prsh = area of proboscidal sheath, psh = palpal sheath.

from dorsal spines or spurs by conspicuous space, becoming shorter from anterior to posterior segments. Postspiracular bristlelike spines subequal from anterior to posterior segments. Ventral bristlelike spines on abdominal segments 3–7 with 7–10 alternating long and short medial spines; some lateral spines also alternating long and short, with short bristles slightly anterior to long bristles, with spines becoming generally longer from anterior to posterior segments (Figs. 1–3).

Abdominal segments 1–7 with spiracles situated along midline laterally, shining light reddish brown, spherical, tilted anteriorly, raised on callosities with circular, sclerotized, basal margins; callosities and spiracles at least slightly smaller from anterior to posterior segments.

Abdominal segment 1 with anterior dorsal transverse row of 18 mostly long, recurved spurs divided by dorsomedian space; with some spurs very close together;



lacking dorsolateral bristlelike spines; with 3 long postspiracular bristlelike spines; with venter obscured by wing and leg sheaths.

Abdominal segment 2 with very short, straight dorsomedian spine flanked on each side by 5 alternating short, straight spines and long, straight to apically recurved spurs, then 1–2 short spines, 1 long spur and 2 short spines; with 3 mostly long bristlelike dorsolateral spines; with 5 long and short postspiracular bristlelike spines, with outermost spines generally shortest; with 6–7 mostly long ventral bristlelike spines on either side of, and extending under, wing sheaths.

Abdominal segment 3 with dorsomedian transverse row of 7 alternating long spurs and short spines, flanked on each side by 2–3 short spines, then 1 long spur and 3 short spines; with 3 long dorsolateral bristlelike spines; with 4–5 mostly long postspiracular bristlelike spines; with ventral transverse row of 21 mostly long bristlelike spines, but some spines very short.

Abdominal segment 4 with dorsomedian transverse row of 7 alternating long spurs and short spines, flanked on each side by 2 short spines, then 1 long spur and 1 short spine; with 3–4 long and short dorsolateral bristlelike spines; with 4–5 postspiracular long and short bristlelike spines; with ventromedian transverse row of 24 mostly long bristlelike spines, some alternating long and short to very short spines.

Abdominal segment 5 with dorsomedian pair of short spines, flanked on each side by 6 alternating long spurs and short spines; one spur apically forked or bifurcate; with 3–4 dorsolateral long bristlelike spines; with 6 alternating long and short postspiracular bristlelike spines; with ventromedian transverse row of 22 mostly long bristlelike spines, some alternating long and short, and one long spine deeply bifurcate.

Abdominal segment 6 with dorsomedian transverse row of 13 alternating short spines and long spurs; with 3–4 long dorsolateral bristlelike spines; with 4–6 alternating long and short postspiracular bristlelike spines; with ventromedian transverse row of 19 mostly long bristlelike spines.

Abdominal segment 7 with dorsomedian transverse row of 13 alternating short spines and long spurs; with 1–2 long dorsolateral bristlelike spines; with 3 long postspiracular bristlelike spines; with ventromedian transverse row of 17 mostly long bristlelike spines, some spines alternating long and short.

Abdominal segment 8 with pair of long, dorsal posterior spurs on each side of midline on rugose swelling; outer spurs medially curved towards midline; lacking dorsolateral bristlelike spines; with 5–6 lateral bristlelike spines in irregular pattern; with small, spherical, reddish brown, spiracle flush with cuticle; with 3 approximate ventrolateral bristlelike spines on each side apically curved towards midline (Fig. 5).

Abdominal segment 9 slightly rugose; with pair of long, rounded, dorsal posterolateral processes pointed and slightly curved apically away from each other; with pair of shorter, straight ventral posterolateral processes pointing away from each other; with dorsomedian pair of short, separated tubercles between dorsal posterolateral processes; with pair of long, separated posteroventral tubercles slightly anterior to ventrolateral processes (Fig. 5).

**Comparative Morphology of *Efferia* Pupal Cases.** Dennis *et al.* (2008a) provided a key to the pupal cases in the Asilinae-group for which there are detailed descriptions. The morphological characteristics for the *Efferia snowi* pupal case agree well with all of the characteristics used to separate *Efferia* pupal cases from the cases of other genera. These include presence of anterior and posterior mesothoracic spines; abdominal spiracles distinctly elevated above cuticle (at least on segments 1–7);

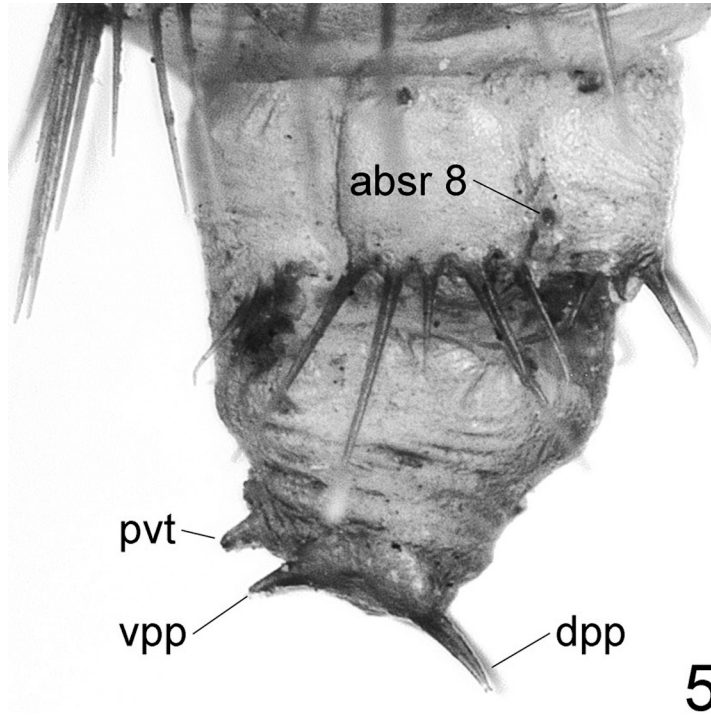


Fig. 5. *Efferia snowi* pupal case, abdominal segments 8 and 9, lateral view. absr 8 = spiracle of abdominal segment 8, dpp = dorsal posterolateral process, pvt = posteroventral tubercle, vpp = ventral posterolateral process.

proboscidal sheath lacking median tubercles, with posterior tubercle or tubercles; and abdominal segment 9 with ventral posterolateral processes and ventromedian tubercles or callosities (previously called processes), outer or third posterior antennal process lacking apical points, not appearing attached to side of middle process; and segment 9 with ventral posterolateral processes long and narrow, resembling dorsal posterolateral processes, but not as long.

Melin (1923) and Dennis *et al.* (2008a) found that male pupal cases could be distinguished from female cases by the presence of midventral callosities on the ninth abdominal segment. These anteroventral callosities are present on the male pupal cases of *E. aestuans*, *E. helenae*, and *E. triton* on the ninth abdominal segment near the juncture of the eight and ninth segments. On both the male and female pupal cases of these species and the female cases of *E. benedicti*, *E. frewingi*, and *E. snowi*, the posterior part of segment 8 has a pair of midventral tubercles and posteroventral callosities or tubercles on segment 9 just slightly anterior to the ventral posterolateral processes (Figs. 4, 5). We believe that the anteroventral callosities or tubercles on segment 9 sheath the male genitalia (Dennis *et al.*, 2008a).

It appears that some male *Efferia* pupal cases have more ventral bristlelike spines on abdominal segment 8 than do female pupal cases. This also has been observed for the pupal cases of *Machimus* spp. (Dennis *et al.*, 2008a).

It is quite common for robber fly pupal cases to have callosities or tubercles posteriorly on the proboscidal sheath (Dennis *et al.*, 2008a). Some also have these

structures (sometimes referred to as keels) on the labral and maxillary sheaths. However, only in the Asilinae-group do the majority of species have pupal cases with callosities or tubercles on the labral, proboscidal, and maxillary sheaths. Although this characteristic was not mentioned in Dennis and Barnes (2011), it may be useful in separating cases at the subfamily level.

**Key to Known *Efferia* Pupal Cases.** Dennis *et al.* (2008a) presented a key to the pupal cases of 5 Nearctic species of *Efferia* (*aestuans*, *benedicti*, *frewingi*, *helenae*, and *triton*). This key is here revised to include *E. snowi*.

- 1. Labral sheath with low apical keel or tubercle on posterior third or more; proboscidal sheath with posteromedian tubercle; abdominal segment 8 with 2 (male and female *E. helenae* pupal cases) or 6–16 (6 in female and 9–16 in male *E. aestuans*, *E. frewingi*, *E. snowi*, and *E. triton* pupal cases) ventral bristlelike spines . . . . . 2
  - Labral sheath with raised tubercle-like apical keel on posterior half; proboscidal sheath with median spinelike posterior tubercle; female abdominal segment 8 with 4 ventral bristlelike spines . . . . . *Efferia benedicti*
- 2. Proboscidal sheath posteriorly with large median tubercle and single smaller tubercle on each side in rugose area; abdominal segment 8 with 2–3 dorsal posterolateral spurs on each side of midline and 5–8 bristles below and behind each spiracle . . . . . 3
  - Proboscidal sheath posteriorly with large median tubercle and 3–8 minute tubercles on each side in rugose area; abdominal segment 8 with 0–1 dorsal spurs on each side of midline and with 2–3 bristles below and behind each spiracle . . . . . 5
- 3. Wing sheath lacking basal or median tubercle or small callosity; abdominal segment 1 with 3 postspiracular bristlelike spines; abdominal segments 2–7 often with bifurcate dorsal spines and some bifurcate or trifurcate dorsolateral bristlelike spines; segment 8 with 2 dorsal or dorsolateral spurs on each side and 6 (female) or 9–14 (male) subequal ventral bristlelike spines. . . . . *Efferia aestuans*
  - Wing sheath with basal and/or median tubercle or callosity; abdominal segment 1 with 3–6 postspiracular bristlelike spines; abdominal segments 5–7 lacking bifurcate dorsal spines and segments 2–7 lacking bifurcate or trifurcate dorsolateral bristlelike spines; abdominal segment 8 with 2–3 dorsal or dorsolateral spurs on each side and 6 subequal to 16 long and short ventral bristlelike spines. . . . . 4
- 4. Wing sheath with small median callosity; abdominal segment 1 with 3 postspiracular bristlelike spines; abdominal segments 2–4 sometimes with apically bifurcate dorsal spines; abdominal segment 8 with 2 dorsal or dorsolateral spurs on each side, 5–6 postspiracular bristlelike spines, and 6 (female) subequal ventral bristlelike spines . . . . . *Efferia snowi*
  - Wing sheath with small basal and median tubercles; abdominal segment 1 with 6 post-spiracular bristlelike spines; abdominal segments 2–7 lacking bifurcate dorsal spines; abdominal segment 8 with 3 dorsal or dorsolateral spurs on each side, 6–8 postspiracular bristlelike spines, and 16 (male) long and short ventral bristlelike spines . . . . . *Efferia triton*



5. Anterior mesothoracic spines apically rounded; wing sheath lacking median tubercle; abdominal segment 1 with 14 dorsal spurs; abdominal segment 8 with 14 ventral bristlelike spines. . . . . *Efferia frewingi*
- Anterior mesothoracic spines distinctly acuminate; wing sheath with median tubercle; abdominal segment 1 with 12 dorsal spurs; abdominal segment 8 with 2 ventral bristlelike spines. . . . . *Efferia helenae*

### Acknowledgments

We thank F. Christian Thompson and Erin Kolski with the National Museum of Natural History, Washington, D.C., for lending us the *Efferia snowi* specimens. We appreciate comments on the manuscript from anonymous reviewers.

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