A New Parasitization Record of *Haliaspis spartinae* (Diaspididae) and *Encarsia ellisvillensis* sp. nov. (Chalcidoidea: Aphelinidae) From the United States

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ABSTRACT *Spartina alterniflora* Loisel. and *Haliaspis spartinae* (Comstock) (Hemiptera: Diaspididae), with its parasitoid, were surveyed in Ellisville Marsh, Massachusetts. Average scale density on the damaged leaves was equal to 265 individuals per 10 cm^2. Parasitization of *H. spartinae* was recorded for the first time; however, the percentage was very low at 2.67%. The parasitoid is a new species for science and is described as *Encarsia ellisvillensis* Japoshvili & Russell sp. nov.

KEY WORDS *Encarsia*; *Spartina*; *Haliaspis*; Ellisville Marsh, MA

The armored scale *Haliaspis spartinae* (Comstock) (Hemiptera: Diaspididae) was first detected on *Spartina alterniflora* Loisel. in Woods Hole, MA in 1883 (Tippins and Beshear 1971). Its host, *Spartina alterniflora* Loisel., is a principal primary producer in New England salt marsh habitats. Documented reports of *H. spartinae* in the United States include detections in California (at infestation levels), Delaware, Florida, Georgia, Massachusetts, New Jersey, New York, South Carolina, Texas, and Virginia (Ben-Dov et al. 2010). Several species of salt marsh vegetation, including, *Spartina foliosa* Trin., *Spartina stricta* (Aiton) Roth, *Muhlenbergia capillaris* (Lam.) Trin., and *Distichlis* sp. also serve as hosts (Boyer 1994, Boyer and Zelder 1996, Ben-Dov et al. 2008).

The scale is ≈1.5–2.5 mm in length and has a white (Fig. 1A), fibrous, and waxy armoring (test). The armoring provides protection from the extremes of salinity and submergence by daily tidal cycles. Tippins and Beshear (1971) report that the scale is able to survive submergence for at least 1 h on each high tide. Other investigators (Boyer and Zelder 1996, Boyer 1994) have described salt marsh infestation levels of *H. spartinae*. The immobile female occurs along the adaxial surface of the leaf. The scale's life cycle includes overwintering of eggs beneath the armor or "test" on dead *Spartina* sp., followed by emergence of juvenile crawlers in April–May; winged adult emergence; and eventual settlement of immobile female adults on blades of vegetation. One to two emergences occur throughout the growing season, although it is not clear whether these crawlers are from first or second generation adults (Boyer and Zelder 1996). It feeds on parenchyma cells but does not produce honeydew as do many phytophagous insects (Rosen 1990). Coccinellidae are known predators of the scale (Boyer and Zelder 1996).

The superfamily Chalcidoidea (Hymenoptera) is a hyperdiverse group of insects currently including some 22,000 described species worldwide, and almost all species are parasitoids of insects, with many attacking economically significant pests such as whiteflies, aphids, and scales (Noyes 2011). The family Aphelinidae is the most successful group of Chalcidoidea used in the biological control of pest armored scales (Guerrieri and Noyes 2000, VanDriesche et al. 2008); however, to the best of our knowledge, no description of specific wasp parasites of *H. spartinae* has been reported. Here, we describe this new parasitic species and its association with its host.

Materials and Methods

This investigation was conducted from August to October 2010 at Ellisville Marsh in Plymouth, MA. Leaves of *S. alterniflora*, with intact *H. spartinae*, were haphazardly collected. In this marsh, *H. spartinae* did not become obvious until mid-August.

At each sampling, four or five leaves infested with *H. spartinae* were collected, enclosed in plastic containers, and transferred to the laboratory. Some 150–200 scales were examined from each sample collected, and the developmental stage of the scale was recorded. Our estimate of the density of scale was based on the mean number of adult coccids per 10 cm^2 of leaf area. The numbers of parasitized scales were determined by the presence of exit holes in adult scales (Fig. 1B). Holes were enumerated from 10-cm^2 areas of leaf, and the total number of adult scales was counted to determine a parasitism percentage.

Specimens of parasitoids were dried with using hexamethyldisilazene to preserve morphological features

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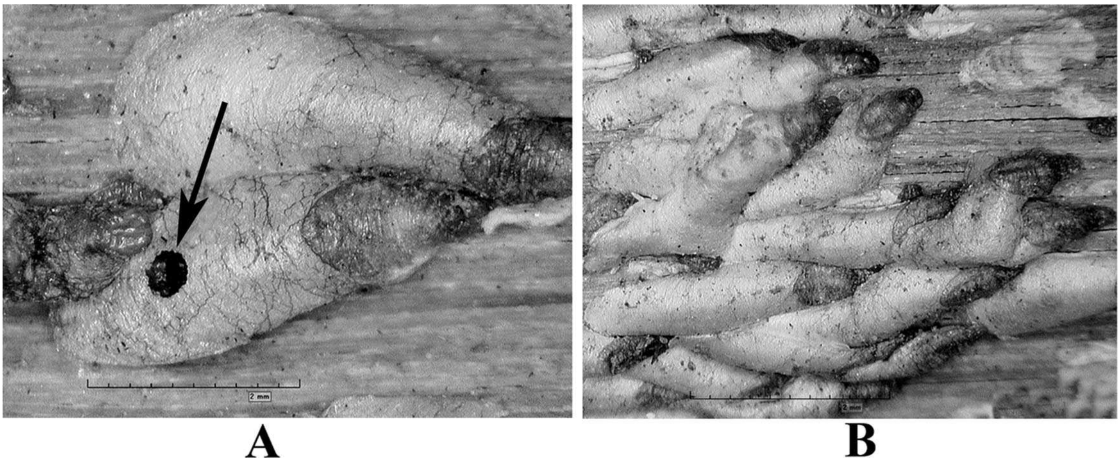


Fig. 1. (A) Armored scale *Haliaspis spartinae* as white coating on adaxial leaf surfaces of host plant *S. alterniflora*. (B) Female of *H. spartinae* with exit hole.

and then card and slide mounted according to Noyes (2011). Identification was done by G.J. using various identification keys (Viggiani 1987; Hayat 1989, 1998; Gibson et al. 1997; Huang and Polaszek 1998; Schmidt and Polaszek 2007).

Descriptions of the new species of parasitoid were done according to Schmidt and Polaszek (2007). The following abbreviations are used in the text: F_1, F_2, etc., first funicle segments, second funicle segment, etc.; FV, width of front vertex; and T_1, T_2, etc., first tergite (gaster), second tergite, etc. Illustrations of parasitoid species were made by using a Hirox KH-7700 digital microscope (Suleyman Demirel University, Isparta, Turkey).

Results

The survey of *H. spartinae* within Ellisville Marsh showed the number of *H. spartinae* on 10 cm^2 of infested leaves was 263 (all females). The highest number observed on 10 cm^2 was 365 (all females). The overall parasitization rate was very low at 2.67%. The parasitoid is a new species of genus *Encarsia* described as *Encarsia ellisvillensis* Japoshvili & Russell sp. nov.

Holotype Female. Morphological characteristics are described below and summarized in Table 1.

Table 1. Morphology of *E. ellisvillensis* compared with *E. tristis*

E. tristis	*E. ellisvillensis*
Pedicel subequal in length to F_1	Pedicel longer than F_1
F_2 subequal in length to F_3	F_2 shorter than F_3
Midlobe of mesoscutum with eight setae	Midlobe of mesoscutum with at least 12 setae
Fore wing ≈2.7 times as long as width of disc; marginal fringe 0.32 as long as width of disc	Forewing ≈3.14 times as long as width of disc; marginal fringe 0.42 as long as width of disc
Ovipositor 0.56 times as long as midtibia. Third valvula ≈0.33 times as long as second valvifer	Ovipositor 0.715 times as long as midtibia; third valvula ≈0.67 times as long as second valvifer

Color. Body all brown, only following parts with different coloration: antennae dirty yellow; mesoscutal sidelobe yellow with one dark spot on the middle of anterior part and one spot on anterior side corner; mesoscutum with yellow band on sides and posterior margin; tibia dirty yellow and tarsal segments yellow.

Morphology. Mandible with three teeth (Fig. 2A). FV 0.66 times as broad as head width. Antennal formula 1,1,3,3 (Fig. 2). Pedicel longer than F_1. (1.76). F_1 longer than wide (1.27), shorter than F_2 (0.76) and F_3 (0.69). Flagellomere with the following numbers of sensilla: F_1, zero; F_2, one; F_3, one; F_4, two; F_5, two; and F_6, two. Midlobe of mesoscutum with 12–14 setae (holotype 12), side lobes with three setae each (Fig. 2C). Scutellar sensilla widely separated (≈5.8 times the maximum width of a sensillum). Distance between anterior pair of scutellar setae equal to distance between posterior pair. Fore wing 3.14 times as long as width of disc (Fig. 2D). Marginal fringe 0.42 times as long as width of disc. Basal cell with seven to eight setae (holotype 7). Submarginal vein with two setae, marginal vein with 10–11 setae. Submarginal joint with marginal with one round sensillum (Fig. 2H). Tarsal formula 5-5-5. Apical spur of midtibia 0.92 as long as corresponding basitarsus. Tergites with the following numbers of setae: T_1, zero; T_2, four; T_3, four; T_4, 4our; T_5, eight; T_6, five; and T_7, seven (Fig. 2E). Ovipositor shorter than midtibia (0.715; Fig. 2F) and longer than clava (1.1). Third valvula ≈0.67 times as long as second valvifer (Fig. 2G).

Male. Coloration as with female, antenna and forewings as in Fig. 3A and B.

Material Examined. Type material. Holotype ♀, USA, MA: Plymouth, Ellisville Marsh, 41° 50′33″ N, 70° 32′24″ W, 29-IX–18-XII-2010, Ex *H. spartinae* on *S. alterniflora;* Paratypes 9 ♀, 4 ♂, same data as holotype; 1 ♀, MA: Plymouth, Ellisville Marsh, 38° 36′285″ N, 043° 34′146″ E, 1,820 m, 03-X–13-X-2010, Ex *H. spartinae* on *S. alterniflora.* 1 ♀, 2 ♂, MA: Plymouth, Ellisville Marsh, 38° 36′285″ N, 043° 34′146″ E, 1,820 m,

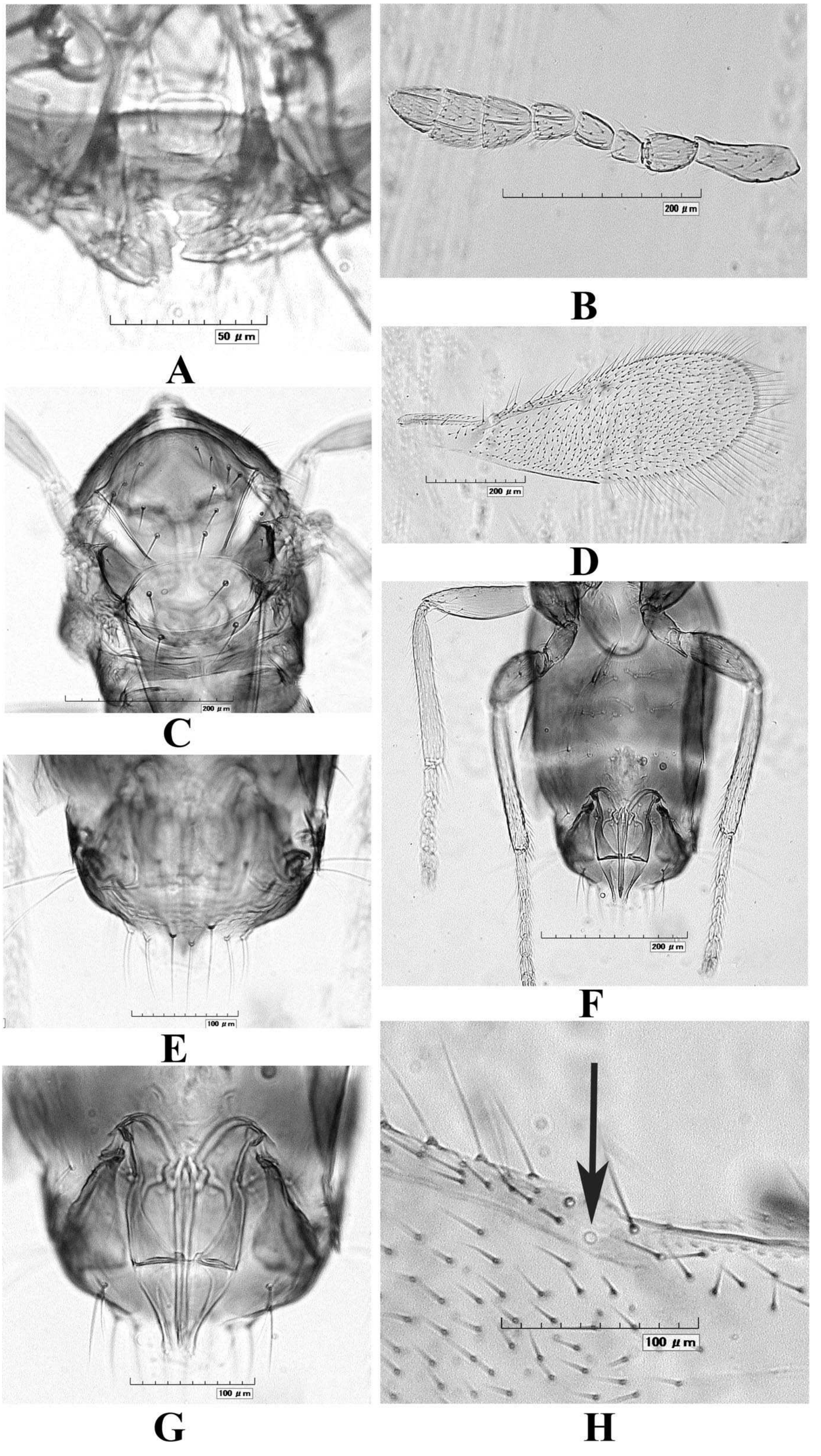
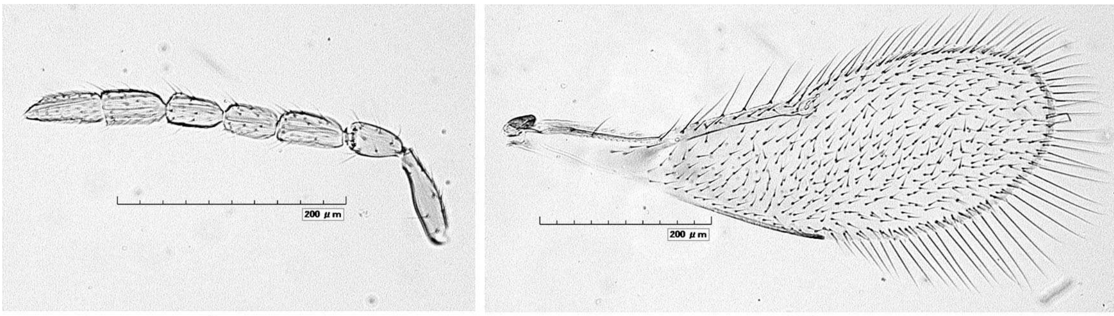


Fig. 2. *E. ellisvillensis* Japoshvili sp. nov. female. (A) Mandible. (B) Antenna. (C) Thorax. (D) Forewing. (E) Seventh tergite. (F) Gaster. (G) Ovipositor. (H) Sensillum on forewing.



A B

Fig. 3. *E. ellisvillensis* Japoshvili sp. nov. male. (A) Antenna. (B) Forewing.

9-X–19-X-2010, Ex *H. spartinae* on *S. alterniflora.* Holotype and paratypes in the collection of the Entomology and Biocontrol Research Centre, Agrarian University of Georgia, Tbilisi, GA. Paratypes deposited to the Museum of Natural History of Washington, DC, and Museum of Natural History, London, United Kingdom.

Discussion

E. ellisvillensis resembles *Encarsia tristis* (Zehntner), but it differs with respect to the characteristics given in Table 1 and its host preference. The new species also differs from *E. escama* Myartseva (Myartseva et al. 2008) by having more setae on the mesoscutum. The forewing is longer (3.14) than that of *E. escama* (2.5). The ovipositor of the new species is also shorter than midtibia (0.715) than it is in *E. escama* (0.8).

The scale exists in this marine habitat and has been reported previously to survive submergence for at least 1 h on each high tide (Tippins and Beshear 1971). However, in Ellisville Marsh, where the scale was observed at infestation levels, it and by association *E. ellisvillensis* may be subjected to sustained submergence for ≥3 h or more (E.R., personal observation).

The crawler stage may require high humidity to avoid desiccation as observed in other scales (Rosen 1990). Other investigators (Boyer 1994, Boyer and Zelder 1996) have examined less than optimum hydraulic conditions within a constructed salt marsh in association with infestation levels of *H. spartinae.* Because inadequate tidal flushing is known to exist in Ellisville Marsh (Ramsey et al. 2007), it may be that this insect's association with salt marsh vegetation is somehow indicative of compromised hydrology or water logging.

Although its rate of parasitization was very low (2.67%), *E. ellisvillensis* may have a role in regulation of *H. spartinae* numbers, and indirectly, in the productivity of *S. alterniflora.* We plan to further investigate the role of *E. ellisvillensis* in *H. spartinae* population dynamics.

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