



SOCIEDADE BRASILEIRA  
DE ENTOMOLOGIA  
FUNDADA EM 1937

REVISTA BRASILEIRA DE  
**Entomologia**  
A Journal on Insect Diversity and Evolution

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Short Communication

First host plant record for *Strymon davara* (Hewitson) (Lepidoptera, Lycaenidae) in the highly human-modified coastal valleys of the Atacama Desert



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ARTICLE INFO

Article history:

Received 18 March 2016

Accepted 22 June 2016

Available online 12 July 2016

Associate Editor: Rodrigo Gonçalves

Keywords:

*Alternanthera halimifolia*

Amaranthaceae

Eumaeini

Florivory

Theclinae

ABSTRACT

Some native plants can survive the disturbances associated with agricultural activities, sometimes being considered weeds and objects of control practices. However, these plants can be very important to support populations of native insects in disturbed habitats. *Alternanthera halimifolia* (Lam.) Standl. (Amaranthaceae) is locally considered a weed, and here it is reported as the first host plant known for the Neotropical hairstreak *Strymon davara* (Hewitson, 1868) based on research performed in the coastal valleys of the Atacama Desert of northern Chile. Furthermore, field observations suggest that this is the only host of *S. davara* in this area. This case provides an example of the importance of a weed in the conservation of local populations of a butterfly in a highly human-modified environment.

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The arid environments of northernmost Chile are characterized by a low diversity of butterflies, with about 50 species recorded from the Arica and Parinacota Region, many of which are represented by peripheral populations of widely distributed Neotropical species that reach their southern limit in this area, while a few other species are endemic to the Andes (Peña and Ugarte, 1996; Vargas, 2013a; Vargas et al., 2015).

The coastal valleys of the Arica Province have been widely recognized as among the most important places for the biodiversity of the Atacama Desert (Estades et al., 2007; Vargas and Parra, 2009). However, they are currently submitted to high anthropological pressures, mostly associated with agricultural activities, and consequently the native vegetation is reduced to small, isolated patches (Luebert and Plissock, 2006). In this context of highly disturbed habitats, some native plants are able to breed in these adverse conditions, with the local farmers referring to them as weeds. These plants may become extremely valuable for the conservation of resident populations of butterflies whose larvae feed on them.

*Strymon* Hübner, 1818 (Lepidoptera, Lycaenidae, Theclinae, Eumaeini) is a New World hairstreak genus ranging from Canada to Argentina and Chile, and comprises 56 species, which currently are classified in nine species groups (Robbins and Nicolay, 2002;

Nicolay and Robbins, 2005; Grishin and Durden, 2012). Although the life histories of several species of *Strymon* remain insufficiently studied, host plants have been reported for many of them, and these involve more than 30 plant families (Robbins and Nicolay, 2002). While the larvae of some species are strikingly polyphagous, others have more restricted host ranges (Robbins and Nicolay, 2002; Silva et al., 2011, 2016). The larvae of the *S. serapio* and *S. ziba* species groups feed on Bromeliaceae and may reach pest status on pineapple (Robbins, 2010).

Two species of *Strymon* have been recorded in the coastal valleys of the Atacama Desert in the Arica Province (Peña and Ugarte, 1996): *Strymon bubastus* (Stoll, 1780) and *Strymon davara* (Hewitson, 1868). *S. bubastus* is widely distributed in the Neotropical Region, ranging throughout a greater part of mainland South America and the Caribbean Islands (Robbins and Nicolay, 2002; Nicolay and Robbins, 2005). It is a polyphagous species, with reported larval host plants belonging to six families (Beccaloni et al., 2008; Silva et al., 2014; Vargas et al., 2016). The populations of the Atacama Desert are associated with Malvaceae and Verbenaceae, upon which the larvae eat inflorescences and display host-associated polychromatism (Vargas et al., 2016). *S. davara* is a poorly known hairstreak with a narrower geographic distribution, ranging from southern Peru to northern Chile (Peña and Ugarte, 1996). Robbins and Nicolay (2002) indicated that, as also observed in many other species of the genus, the males of *S. davara* occupy mating territories where they perch. However, no data have been published on its

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immature stages. Accordingly, the objective of this contribution is to provide the first life history notes on *S. davara*, including the first host plant record, based on sampling performed on a native weed in the coastal valleys of the Atacama Desert of northern Chile.

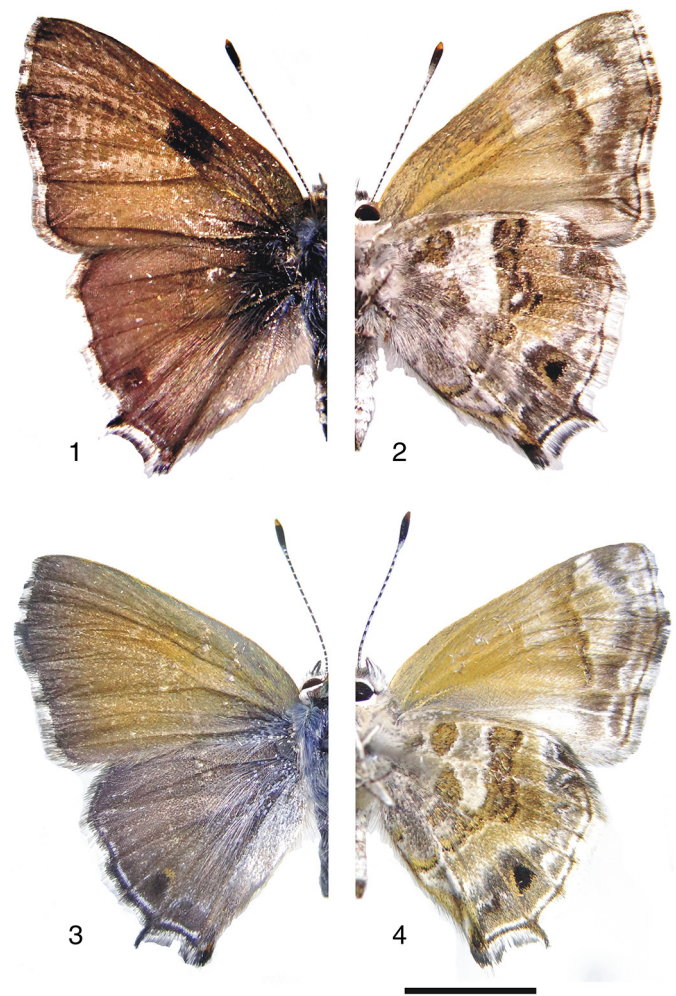
The study was carried out in the Azapa Valley (18°31'S, 70°10'W), Arica Province, northern Chile. This transversal valley extends from the Andes ranges to the Pacific Ocean in the Atacama Desert, an area characterized by a tropical hyper desertic bioclimate with mean annual precipitation about 0 mm (Luebert and Plissock, 2006). The transversal valleys of the Atacama Desert harbor perennial or semi perennial streams as a result of the summer rains that occur in the high plateau and the western slopes of the Andes, which supports native vegetation and agricultural activity (Vargas and Parra, 2009).

Larvae (mostly final instars) of *S. davara* were found on inflorescences of *Alternanthera halimifolia* (Amaranthaceae) between 2002 and 2015. On each occasion the larvae were collected and taken to the laboratory in individual plastic vials. Fresh inflorescences were added daily until the larvae finished feeding and started pupating. Pupae were periodically observed until adult emergence. Adults were pinned and spread following standard procedures. In addition, inflorescences of *A. halimifolia* were randomly collected in July 2015 with the purpose of finding eggs and younger larvae. Rearing procedures followed those mentioned above; a few larvae were successfully reared to adults, while some representatives of each stage were stored in ethanol 70% for subsequent morphological studies. Vouchers are deposited in the Colección Entomológica de la Universidad de Tarapacá (IDEA), Arica, Chile.

In order to assess the host range of *S. davara*, at least 20 plants representing the other species of Amaranthaceae of the study area (i.e. *Amaranthus* sp., *Atriplex* spp., *Chenopodium* sp.) were carefully searched for immature stages of this hairstreak. A similar survey was performed on species belonging to other families: Anacardiaceae (*Schinus molle*), Asteraceae (*Baccharis alnifolia*, *Grindelia tarapacana*, *Pluchea chingoyo*, *Tessaria absinthioides*), Bignoniaceae (*Tecoma fulva*), Boraginaceae (*Heliotropium curassavicum*), Euphorbiaceae (*Euphorbia* spp.), Fabaceae (*Acacia macracantha*, *Geoffroea decorticans*, *Prosopis alba*), Malvaceae (*Waltheria ovata*), Myricaceae (*Morella pavnis*), Salicaceae (*Salix humboldtiana*), Solanaceae (*Solanum peruvianum*) and Verbenaceae (*Phyla nodiflora*, *Pitraea cuneato-ovata*).

Twenty-four adults were obtained by rearing (13 males, 11 females), all of which were identified as *S. davara* based on wing pattern (Figs. 1–4). No parasitoids were detected in the laboratory rearing. All the larvae were feeding on inflorescences of *A. halimifolia* when they were collected, and continued to feed on it in laboratory conditions, mostly on the reproductive tissues of the plant. Molting was observed several times, and the subsequent instars continued to feed normally until pupation. Thus, *A. halimifolia* is effectively used as a host plant by larvae of *S. davara*. In contrast, immature stages of *S. davara* were not found on the other plants surveyed.

Adults fly throughout the year in the study site. Females deposited the eggs only on open flowers, close to the pistil, remaining concealed by the external tepals and bracts after anthesis (Fig. 5). The larvae feed only on the inflorescences, mostly on the pistil and young fruits. Four instars were observed. The first instar partially consumes the chorion to exit the egg; it starts consuming the plant tissue while concealed with the head toward the base of the pistil and the anal apex directed to the distal apex of the bracts (Fig. 6). Fecal pellets can be observed intermixed with the anthers and the tips of the bracts (Fig. 7). Subsequent instars become progressively more exposed. Third and fourth instars are cryptic (Figs. 8–10) and eat with the thorax and abdomen fully exposed and the head inserted into the inflorescences. These later two instars can be found on the shoots of the host when



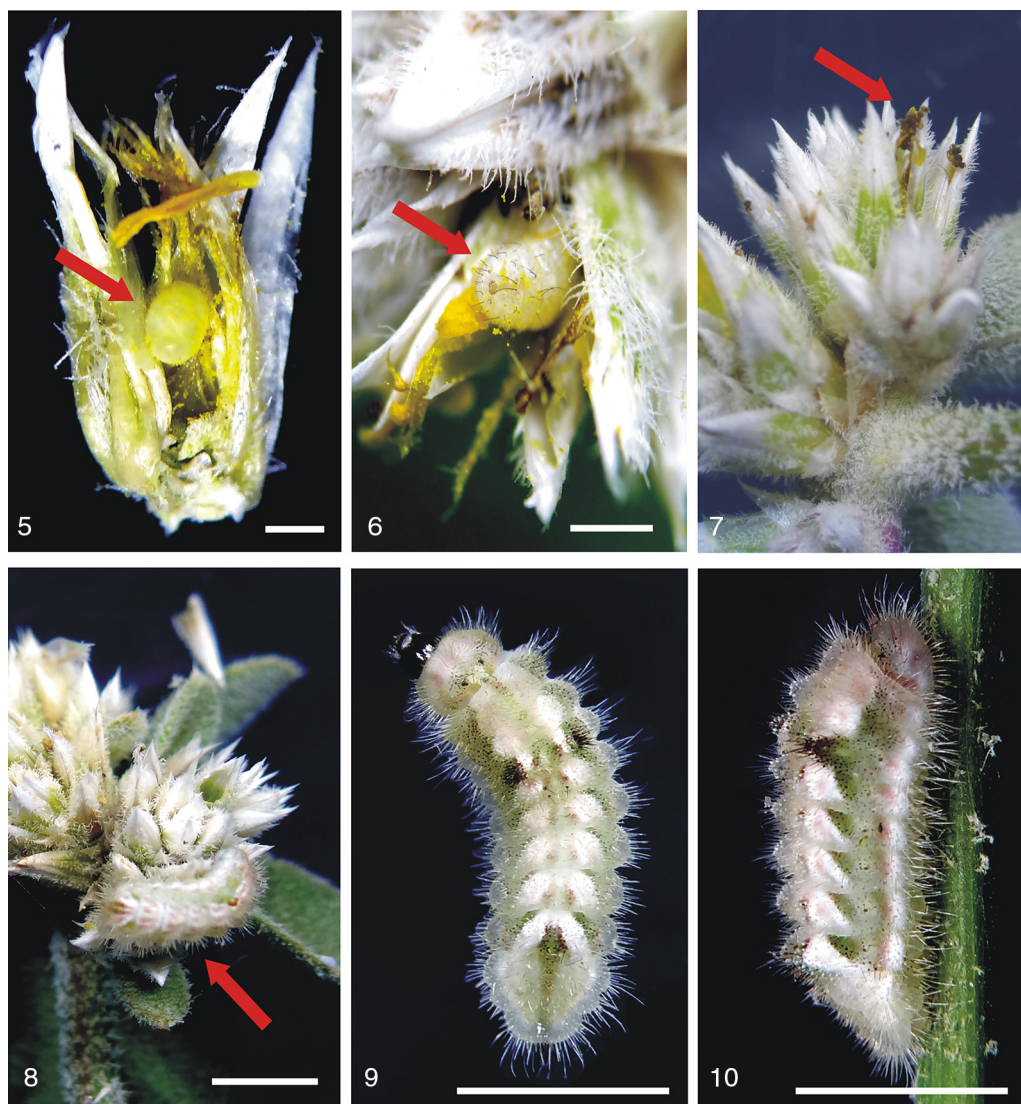
**Figs. 1–4.** Adults of *Strymon davara* reared from larvae collected on *Alternanthera halimifolia*. 1–2, Male, dorsal and ventral view, respectively. 3–4, Female, dorsal and ventral view, respectively. Bar = 5 mm.

moving from one inflorescence to another. Although the integument of the last instar bears a dorsal nectary organ (DNO) and pore cupola organs (PCOs), no interaction with ants was observed. No pupae were found in the surveys. In a few instances ( $n = 2$ ) pupation occurred on host leaves during the laboratory rearing, but pupation occurred mostly on the paper towel placed at bottom of the vials ( $n = 22$ ), suggesting that pupation takes place off of the plant under field conditions, probably on the dried leaf litter. The pupal stage lasted 11–12 days. Immature stages of *S. davara* can be found throughout the year in association with the continuous activity of the adults and availability of inflorescences of *A. halimifolia* in the study site.

Weeds may be involved in many ecological interactions in agroecosystems, among which competition with cultivars is perhaps the most evident, mostly due to its negative economic consequences (Ma et al., 2015). However, weeds may also provide many other less evident but extremely important services, as when they are used as a food source or refuge for pollinators (Nicholls and Altieri, 2013).

Butterflies may use exotic weeds as host plants or nectar sources (Shapiro, 2002). Accordingly, exotic weeds could underlie expansions of geographic ranges or fly seasons of butterflies (Graves and Shapiro, 2003). Also, they may be the only or the most abundant host plant available to support local populations of native butterflies in highly human-disturbed habitats (Shapiro, 2002; Vargas, 2013b). However, the presence of exotic plants can be negative





**Figs. 5–10.** Egg and larvae of *Strymon davara* on *Alternanthera halimifolia*. 5, Egg (arrow) inside a flower; bar = 0.5 mm. 6, Anal apex (arrow) of the first instar inserted into the flower; bar = 0.3 mm. 7, Feces (arrow) of the first instar on the apex of the flower. 8, Cryptic last instar (arrow) on an inflorescence; bar = 5 mm. 9, Last instar, dorsal view; bar = 5 mm. 10, Last instar, lateral view; bar = 5 mm.

when they are attractive to egg laying females but are toxic for larvae (Graves and Shapiro, 2003). Obviously, this and other eventual negative consequences of using weeds as hosts can be ruled out when the interaction involves a native plant which has become referred to as a weed only due to biased economic criteria.

It has been widely recognized that knowledge of the host plants is key to understand the ecology and evolution of butterflies (Robbins and Aiello, 1982). Some examples have been recently described from the arid environments of the Atacama Desert and the Andes of northern Chile, where host plant records have been useful to explain patterns of abundance and distribution of the butterflies (Despland et al., 2012; Vargas and Benítez, 2013; Despland, 2014; Vargas, 2014).

*Alternanthera halimifolia* is the first host plant recorded for *S. davara*, unveiling extremely important life history information on this poorly known hairstreak. This plant is native to South America; its Chilean range is restricted to the northern area of this country (Serra et al., 2007), covering all the Chilean range of *S. davara*. Although plants of the family Amaranthaceae already have been mentioned as hosts for species of *Strymon* (Robbins and Nicolay, 2002), this is the first record of *A. halimifolia* as a host plant for this genus (Beccaloni et al., 2008).

Host ranges of *Strymon* appear to be variable, ranging from oligophagous to polyphagous (Robbins and Nicolay, 2002; Silva et al., 2011, 2014, 2016). Interestingly, although other Amaranthaceae of the study site (i.e.: unidentified species of *Amaranthus*, *Atriplex* and *Chenopodium*) were examined carefully during the sampling period for eventual presence of larvae of *S. davara*, we were unable to find any. In addition, because polyphagous species of the genus are able to use unrelated plants (Robbins and Nicolay, 2002; Silva et al., 2011, 2014; Vargas et al., 2016), other native and exotic plants belonging to other families (Anacardiaceae, Asteraceae, Bignoniaceae, Boraginaceae, Euphorbiaceae, Fabaceae, Malvaceae, Myricaceae, Salicaceae, Solanaceae and Verbenaceae) were also surveyed, but larvae of *S. davara* were not found. This finding suggests that *A. halimifolia* is the only host plant used by *S. davara* in the coastal valleys of the Atacama Desert of northern Chile. However, as the diversity of Amaranthaceae is greater toward the central and north parts of the range of *S. davara* (León et al., 2006), this hairstreak eventually could be associated with additional host plants in Peru.

Although interaction with ants and presence of ant organs (DNO and PCOs) have been recorded for a few species of *Strymon* (Ballmer and Pratt, 1991; Brown, 1993; Daniels et al., 2005; Silva et al., 2014),

the presence of morphological specializations for myrmecophily without confirmation of the interaction with ants is also known for other species of the genus (Daniels et al., 2005; Silva et al., 2014, 2016; Vargas et al., 2016). The observations performed in this study suggest that *S. davara* is a facultative myrmecophilous species, because the larvae are provided with DNO and PCOs, but interaction with ants was not verified in the study site.

*Strymon davara* is not currently classified in any conservation status in Chile. However, our findings associating the larvae with *A. halimifolia* should alert us to an eventual threat, because the larval host plant of *S. davara* is currently referred to as a weed by local farmers and included in weed control practices. Unfortunately, as almost no pristine habitats are available in some of the coastal valleys of the Atacama Desert of northern Chile, including the Azapa Valley (Luebert and Plissock, 2006; Estades et al., 2007), the presence of *A. halimifolia* in this locality is currently associated mostly with agricultural habitats. As a consequence, several agricultural practices besides weed control (e.g., insect pest control) could have serious effects on the local populations of *S. davara*. The populations of *S. davara* inhabiting the Chilean part of the Atacama Desert are peripheral, since the species reaches the southern limit of its range in this area, like other butterflies of northern Chile (Peña and Ugarte, 1996; Vargas and Lamas, 2011; Vargas, 2013a; Vargas et al., 2015). It is known that peripheral populations of butterflies can be especially valuable in evolution and conservation (Cassel-Lundhagen et al., 2009), because many distinctive ecological features can be displayed by populations inhabiting the margin of a species' range (Vilbas et al., 2015). Accordingly, further studies to assess the conservation status of *S. davara* should be performed. In addition, taking advantage of the discovery of the host plant, it would be useful to assess the value of the different human-modified habitats to support the populations of this hairstreak in the Atacama Desert.

### Conflicts of interest

The authors declare no conflicts of interest.

### Acknowledgments

The authors would like to thank Annette Aiello and an anonymous referee for kind and valuable comments that improved the manuscript; Marcelo Vargas-Ortiz for editing the figures and Lafayette Eaton for checking the English. HAV was supported by project DGI-9710-13, from Universidad de Tarapacá. MD was supported by the Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP grants 2002/13898-0, 2010/14682-8), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq grants 563332/2010-7, 305905/2012-0, 311083/2015-3).

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