Nota Lepi. **42**(2) 2019: 151–156 | DOI 10.3897/nl.42.37662

Two new native larval host plants of *Hyles annei* (Guérin-Méneville, 1839) (Lepidoptera, Sphingidae) in the Atacama Desert of northern Chile following exceptional summer rainfall

Héctor A. Vargas[1], Anna K. Hundsdoerfer[2]

1 *Departamento de Recursos Ambientales, Facultad de Ciencias Agronómicas, Universidad de Tarapacá, Casilla 6-D, Arica, Chile, havargas@uta.cl; lepvargas@gmail.com*

2 *Zoological Museum, Senckenberg Natural History Collections Dresden, Königsbrücker Landstr. 159, 01109 Dresden, Germany*

http://zoobank.org/26D14CCA-E628-45ED-9343-3B1E7B53F4E5

Received 25 June 2019; accepted 20 September 2019; published: 17 October 2019
Subject Editor: Maria Heikkilä.

Abstract. Adults of the little-known Neotropical hawkmoth, *Hyles annei* (Guérin-Méneville, 1839) (Lepidoptera: Sphingidae: Macroglossinae: Macroglossini), were reared from larvae collected on *Allionia incarnata* L. (Nyctaginaceae) and *Fagonia chilensis* Hook. & Arn. (Zygophyllaceae) at about 1900 m elevation in the Atacama Desert of northern Chile. The two plants were growing after exceptionally high summer rainfall as part of a blooming desert event. These findings provide a clear example of the ability of this hawkmoth to use ephemeral and unpredictable resources in a hyperarid environment.

Introduction

The Atacama is the most arid desert in the world (Clarke 2006). As a result, many ephemeral herbaceous plants and some shrubs living there can display unusual and explosive development and flowering in years when there is exceptionally high accumulated rainfall, a biological phenomenon known as a "blooming desert" (Chávez et al. 2019). In the Atacama, this amazing event mostly occurs in the southern regions following the autumn-winter rainfall. In contrast, only one blooming desert has been reported from the northern Atacama, which started with the summer rainfall in February 2012 (Chávez et al. 2019). Consequently, blooming desert is currently poorly characterized and understood in the northern Atacama. However, some phytophagous insects would be expected to be able to use the abundant plant resources that suddenly become available in these events.

The Neotropical hawkmoth, *Hyles annei* (Guérin-Méneville, 1839) (Lepidoptera: Sphingidae: Macroglossinae: Macroglossini), is known from Argentina, Bolivia, Chile and Peru (Ureta and Donoso 1956; Haxaire and Herbin 1999; Cock and Boos 2006; Moré et al. 2014), where it has been found in a wide range of habitats from sea level to more than 2000 m elevation (Hundsdoerfer et al. 2009; Juárez and González 2016). It is a polyphagous species (Hundsdoerfer et al. 2017); however, its native host plant range has not been studied in detail in most of its geographic distribution. In Chile, Butler (1882) recorded "*Oxybaptrus parviflorus*", probably involving one of the eight species of *Mirabilis* Riv. ex L. (Nyctaginaceae) of the central part of this country (see Rodríguez et al. 2018), and González et al. (1973) recorded the exotic cultivated grape (*Vitis vinifera* L., Vitaceae), upon which the larvae may be voracious herbivores, and because of which *H. annei* is locally

known as the "monroy de la vid" (grape hawkmoth) (Artigas 1994). Chilean agricultural literature frequently refers to *H. annei* as a minor pest of some other exotic crops, and a few other sources (mainly internet pages) suggest the use of some native plants. However, all these records require confirmation, because they are based on recording only the presence of larvae on plants without subsequent rearing to obtain adults for identification. Detailed and accurate knowledge of the native host plant range of *H. annei* is necessary to understand its biology in natural habitats. This is an especially interesting issue in the hyperarid environments that this hawkmoth inhabits in northern Chile, where food availability can be remarkably unpredictable. The aim of this contribution is to provide the first confirmed records of native host plants of *H. annei* in northern Chile based on fieldwork undertaken in a blooming desert in northern Atacama.

Observations

In March 2019, hawkmoth larvae were found feeding on *Allionia incarnata* L. (Nyctaginaceae) and *Fagonia chilensis* Hook. & Arn. (Zygophyllaceae) at about 1900 m elevation in the lowest part of the Cardones Ravine, km 63 of 11-CH highway, Arica Province, northern Chile (Figs 1–5). The site is near the western limit of the narrow area in which desert blooming occurs in the northern Atacama, where the local rainfall is complemented by abundant ephemeral surface watercourses whose flow is derived from rainfall on the western slopes of the Andes. A few larvae were collected from each plant and brought into the laboratory in plastic vials to rear to adult to identify the species. Additional leaves of the respective plants were provided daily to the larvae until they finished feeding and pupated. The plastic vials were observed daily until adult emergence. Voucher specimens are deposited in the "Colección Entomológica de la Universidad de Tarapacá" (IDEA), Arica, Chile.

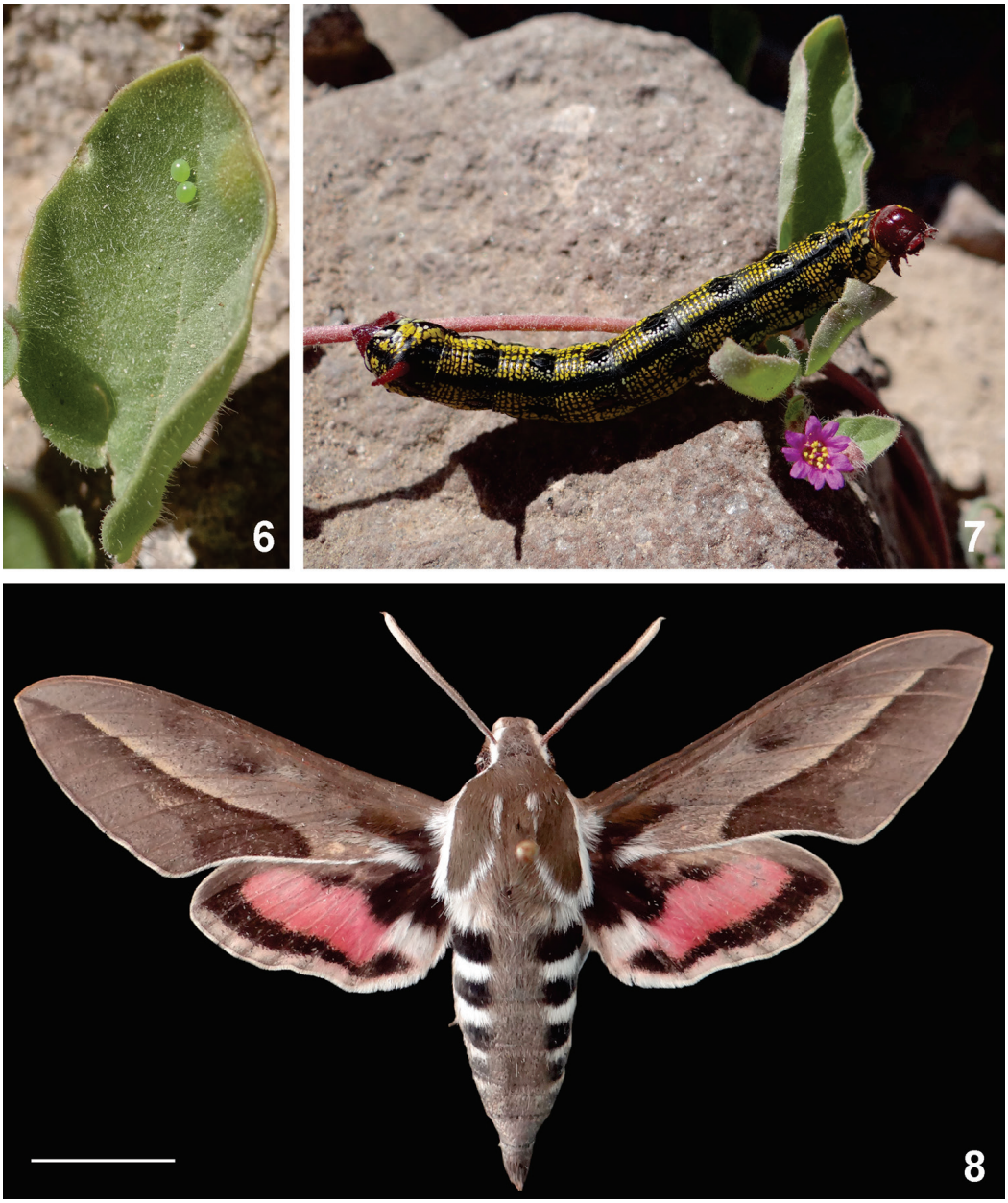
Seven adults were obtained, two females and two males from larvae on *A. incarnata* and three males on *F. chilensis*, all of which were identified as *H. annei* (Figs 6–8) based on comparison with figures provided by Kitching (2019). These results provide a clear example of the ability of this hawkmoth to use ephemeral and unpredictable resources, which is a great advantage for inhabiting the hyperarid environments of the Atacama Desert.

Discussion

Moré et al. (2014) mentioned Polygonaceae and Vitaceae as host plants of *H. annei*, although they indicated that each of these records was based on a single observation. Hundsdoerfer et al. (2019) reared *H. annei* larvae on *Chamerion angustifolium* (L.) Holub (Onagraceae) and on European natural hybrids of the genus *Epilobium* L. in captivity, and experimentally found the species retained a limited capacity to metabolise spurge (*Euphorbia* L., Euphorbiaceae) toxins. Representatives of Nyctaginaceae are consumed by larvae of several hawkmoth species (Robinson et al. 2010), including *H. livornicoides* (Lucas, 1892) in Australia (*Boerhavia diffusa*; Moulds 1981). Furthermore, *A. incarnata* is a host plant of *H. lineata* (Fabricius, 1775) (Felger et al. 2003) and *H. euphorbiarum* (Guérin-Méneville & Percheron, 1835) (Cates 1981). Although feeding on Nyctaginaceae by larvae of *H. annei* was already recorded (Butler 1882; Moss 1912), this is the first confirmed record of *A. incarnata* as a host of this hawkmoth. Species of Zygophyllaceae have been recorded as host plants of three species of *Hyles* Hübner, (1819) (Robinson et al. 2010; Hundsdoerfer et al. 2017); however, this is the first confirmed record of a representative of the Zygophyllaceae as a host plant of *H. annei*. As *A. incarnata* is distributed from the United States to Argentina and Chile

Figures 1–5. The study site following summer rainfall in 2019 and newly recorded host plants of *Hyles annei*. **1.** The lowest part of Cardones Ravine, Arica Province, northern Atacama Desert of Chile. **2.** *Fagonia chilensis*. **3.** Flowers of *F. chilensis*. **4.** *Allionia incarnata*. **5.** Flower of *A. incarnata*.

(Turner 1994), it could be used by *H. annei* throughout its range. In contrast, the geographic range of *F. chilensis* is restricted to northern Chile and southern Peru (Beier 2005), which covers only a small part of the range of *H. annei*. Interestingly, *H. livornicoides* from Australia has a very similar food plant family spectrum, feeding naturally on Nyctaginaceae and Zygophyllaceae, as well as the wine grape crop family Vitaceae (*Vitis vinifera*; all in Moulds 1981). Both these *Hyles* species belong to the first five species to branch off in the phylogeny of *Hyles* (Hundsdoerfer et al. 2017).



Figures 6–8. *Hyles annei* on *Allionia incarnata* in the lowest part of Cardones Ravine, Arica Province, northern Atacama Desert of Chile. **6.** Two eggs of *H. annei* on a leaf of *A. incarnata*. **7.** Last instar larva on *A. incarnata*. **8.** Male adult reared in the laboratory from a larva collected on *A. incarnata*. Scale bar: 10 mm.

In the present study, eggs and larvae of *H. annei* were found on all plants of *A. incarnata* (n = 15) and *F. chilensis* (n = 7) examined in the field. In contrast, at least three plants of native species of Amaranthaceae, Asteraceae, Brassicaceae, Fabaceae, Portulacaceae and Solanaceae were carefully examined at the study site but no eggs or larvae of *H. annei* were found. Thus, despite

the ability of *H. annei* to feed on plants of different families (Moré et al. 2014; Hundsdoerfer et al. 2019), the pattern found in northern Atacama suggests a preference for some plant species, an aspect of the species' biology that deserves further attention.

The first author (HAV) collected adults of *H. annei* at an elevation of about 200 m in the Azapa Valley, Arica Province, in October 2011. These adults were placed into a cage with tomato *Solanum lycopersicum* L. (Solanaceae) leaves to obtain eggs, because the labels of two adults from the same locality deposited in IDEA indicated they had been reared from this plant. The females deposited eggs. However, the larvae were unable to eat leaves of tomato or other native Solanaceae. They ate leaves of *V. vinifera*. In addition, HAV observed two larvae of Sphingidae, probably of *H. annei*, feeding on *Mirabilis* (Nyctaginaceae) in the Azapa Valley in December 2011. However, he did not collect these larvae to obtain adults to identify the species.

Many hawkmoths are powerful fliers, and some are migratory (Cary 1951). Angulo and Antezana (2001) reported a large number of female and male adults of *H. annei* flying at night over the Pacific Ocean about 10 km SW of "Lengua de Vaca", Tongoy, Coquimbo Region, and suggested that these were part of a pre-reproductive migration. Although further studies to confirm migratory behaviour in *H. annei* have been not undertaken, its ability to feed on ephemeral plants would be a great advantage to colonize new areas after migration, especially in extremely arid environments, such as those found in northern Chile.

Further field and laboratory studies are certainly needed to characterize the host range of *H. annei* in detail. These studies should be complemented with phylogeographic analyses using molecular markers (e.g., Mende et al. 2016; Cardoso et al. 2018), with samples from throughout the geographic distribution of *H. annei*, to understand better the ecology and evolution of this still little-known Neotropical hawkmoth.

Acknowledgements

We thank Ian J. Kitching for kind comments and suggestions that significantly improved the previous version of the manuscript, Sebastián Espinoza-Donoso for editing the figures and Lafayette Eaton for checking the English.

References

Angulo AO, Antezana T (2001) Vuelo de mariposas nocturnas frente a la costa de Chile (Lepidoptera: Sphingidae). Revista de Biología Tropical 49(3–4): 1265–1266.

Artigas JN (1994) Entomología Económica. Insectos de interés agrícola, forestal, médico y veterinario. Ediciones Universidad de Concepción, Concepción, 943 pp.

Beier BA (2005) A revision of the desert shrub *Fagonia* (Zygophyllaceae). Systematics and Biodiversity 3(3): 221–263. https://doi.org/10.1017/S1477200005001684

Butler AG (1882) Heterocerous Lepidoptera collected in Chili by Thomas Edmonds, esq. Part I. Sphinges and Bombyces. Transactions of the Entomological Society of London 15: 1–30. https://doi.org/10.1111/j.1365-2311.1882.tb01566.x

Cardoso LW, Silva-Brandão KL, Duarte M (2018) *Adhemarius eurysthenes* (Felder, 1874) (Lepidoptera, Sphingidae) in the Atlantic Rain Forest: A phylogeographic perspective. Zoologischer Anzeiger 277: 231–241. https://doi.org/10.1016/j.jcz.2018.10.005

Cary MM (1951) Distribution of Sphingidae (Lepidoptera: Heterocera) in the Antillean-Caribbean Region. Transactions of the American Entomological Society 77(2): 63–129.

Cates RG (1981) Host plant predictability and the feeding patterns of monophagous, oligophagous, and polyphagous insect herbivores. Oecologia 48(3): 319–326. https://doi.org/10.1007/BF00346488

Chávez RO, Moreira-Muñoz A, Galleguillos M, Olea M, Aguayo J, Latín A, Aguilera-Betti I, Muñoz AA, Manríquez H (2019) GIMMS NDVI time series reveal the extent, duration, and intensity of "blooming desert" events in the hyper-arid Atacama Desert, Northern Chile. International Journal of Applied Earth Observation and Geoinformation 76: 193–203. https://doi.org/10.1016/j.jag.2018.11.013

Clarke JDA (2006) Antiquity of aridity in the Chilean Atacama Desert. Geomorphology 73(1–2): 101–114. https://doi.org/10.1016/j.geomorph.2005.06.008

Cock MJW, Boos JO (2006) Observations on Sphingidae (Lepidoptera) from Talara, North coastal Peru. Revista Peruana de Entomología 45: 75–78.

Felger RS, Turner DS, Wilson MF (2003) Flora and vegetation of the Mohawk Dunes, Arizona. Sida 20(3): 1155–1187.

González RH, Arretz VP, Campos LE (1973) Catálogo de las plagas agrícolas de Chile. Publicación de Ciencias Agrícolas, Universidad de Chile, 68 pp.

Haxaire J, Herbin D (1999) Les Lépidoptères Sphingidae de Bolivie. 1 ère Partie: sous-famille des Sphinginae Latreille. Revue de l'Association Roussillonnaise d'Entomologie 8(3): 69–79.

Hundsdoerfer AK, Rubinoff D, Attié M, Wink M, Kitching IJ (2009) A revised molecular phylogeny of the globally distributed hawkmoth genus *Hyles* (Lepidoptera: Sphingidae), based on mitochondrial and nuclear DNA sequences. Molecular Phylogenetics and Evolution 52(3): 852–865. https://doi.org/10.1016/j.ympev.2009.05.023

Hundsdoerfer AK, Päckert M, Kehlmaier C, Strutzenberger P, Kitching IJ (2017) Museum archives revisited: central Asiatic hawkmoths reveal exceptionally high late Pliocene species diversification (Lepidoptera, Sphingidae). Zoologica Scripta 46(5): 552–570. https://doi.org/10.1111/zsc.12235

Hundsdoerfer AK, Buchwalder K, O'Neill MA, Dobler S (2019) Chemical ecology traits in an adaptive radiation: TPA-sensitivity and detoxification in *Hyles* and *Hippotion* (Sphingidae, Lepidoptera) larvae. Chemoecology 29(1): 35–47. https://doi.org/10.1007/s00049-018-0274-4

Juárez G, González U (2016) Los Sphingidae Latreille, 1802 (Lepidoptera: Bombycoidea) de la Región Piura (Perú). Arquivos Entomolóxicos 16: 61–66.

Kitching IJ (2019) Sphingidae Taxonomic Inventory. http://sphingidae.myspecies.info/ [accessed 22 May 2019]

Mende MB, Bartel M, Hundsdoerfer AK (2016) A comprehensive phylogeography of the *Hyles euphorbiae* complex (Lepidoptera: Sphingidae) indicates a 'glacial refuge belt'. Scientific Reports 6: 29527. https://doi.org/10.1038/srep29527

Moré M, Kitching IJ, Cocucci AA (2014) Sphingidae. In: Roig-Juñent S, Claps LE, Morrone JJ (Eds) Biodiversidad de Artrópodos Argentinos volumen 4. INSUE-UNT Ediciones, San Miguel de Tucumán, 281–295.

Moss AM (1912) On the Sphingidae of Peru. Transactions of the Zoological Society of London 20: 73–134. https://doi.org/10.1111/j.1469-7998.1912.tb07830.x

Moulds MS (1981) Larval food plants of hawk moths (Lepidoptera: Sphingidae) affecting commercial crops in Australia. General and Applied Entomology 13: 69–80.

Robinson GS, Ackery PR, Kitching IJ, Beccaloni GW, Hernández LM (2010) HOSTS – A Database of the World's Lepidopteran Hostplants. Natural History Museum, London. http://www.nhm.ac.uk/hosts [Accessed: 27 May 2019]

Rodríguez R, Marticorena C, Alarcón D, Baeza C, Cavieres L, Finot VL, Fuentes N, Kiessling A, Mihoc M, Pauchard A, Ruiz E, Sanchez P, Marticorena A (2018) Catálogo de las plantas vasculares de Chile. Gayana Botánica 75(1): 1–430. https://doi.org/10.4067/S0717-66432018000100001

Turner BL (1994) Revisionary study of the genus *Allionia* (Nyctaginaceae). Phytologia 77(1): 45–55. https://doi.org/10.5962/bhl.part.4444

Ureta E, Donoso R (1956) Revisión de la familia Sphingidae (Lep. Het.), en Chile. Boletín del Museo Nacional de Historia Natural 26: 237–256.