Full Issue

Source: The Journal of the Lepidopterists' Society, 66(2)

Published By: The Lepidopterists' Society

URL: https://doi.org/10.18473/lepi.v66i2.a9

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Volume 66 Number 2
2012
ISSN 0024-0966

Journal of the Lepidopterists' Society

Published quarterly by The Lepidopterists' Society

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Journal of The Lepidopterists' Society (ISSN 0024-0966) is published quarterly by The Lepidopterists' Society, ℅ Los Angeles County Museum of Natural History, 900 Exposition Blvd., Los Angeles, CA 90007-4057. Periodicals postage paid at Los Angeles, CA and at additional mailing offices. POSTMASTER: Send address changes to The Lepidopterists' Society, ℅ Natural History Museum, 900 Exposition Blvd., Los Angeles, CA 90007-4057.

Cover Illustration:
Hadena ectypa (Morrison, 1875), larva and adult. Larva collected 3 August 2009, photographed in the lab 15 August 2009. Adult collected (as larva) 28 July 2009, emerged from pupa 4 September 2009, photographed in the lab 6 September 2009. Both individuals collected at the Knightville State Wildlife Management Area in the town of Huntington, Hampshire County, Massachusetts, USA. Photos by Michael W. Nelson, Massachusetts Natural Heritage & Endangered Species Program. See article on page 1.

Journal of the Lepidopterists' Society
66(2), 2012, 61–75

THE NICARAGUAN HAIRSTREAK BUTTERFLY FAUNA (THECLINAE: EUMAEINI), ITS BIOGEOGRAPHY, AND THE HISTORY OF NICARAGUAN COLLECTORS

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ABSTRACT. The hairstreak butterfly fauna of Nicaragua has not been comprehensively updated since Godman and Salvin listed 71 species in the Biologia Centrali-Americana over a century ago. Based primarily on Eumaeini in the Anderson and Sullivan Collections (Smithsonian Institution), we treat 149 thecline species recorded from Nicaragua with their localities and months of capture. None are endemic to Nicaragua, but 15 species have the northern or southern limit of their known distribution in Nicaragua. We relate the distributions of these 15 species, many of which are figured, to the life zones and physical features of Nicaragua and adjoining countries. Those eumaeine names for which Nicaragua is a type locality are noted, and a few unresolved taxonomic problems among the Nicaraguan fauna are pointed out. We list another 73 hairstreak species that are recorded both to the northwest and southeast of Nicaragua, but not in Nicaragua. Finally, we present brief historical comments on the collectors of Nicaraguan hairstreaks.

Additional key words: Belt, Biogeography, Biologia Centrali Americana, Godman, Salvin.

Belt (1874) detailed the natural history of Nicaragua in his book 'The Naturalist in Nicaragua' and made extensive natural history collections, including butterflies. Using Belt's collection as the foundation for Nicaragua, Godman and Salvin (1887-1901) treated the Central American butterfly fauna. More recently, Maes et al. (1999) listed the butterflies recorded from Nicaragua as part of an impressive catalog of all Nicaraguan insects. Finally, Anderson (2007) detailed the Hesperiidae species that he collected during a three year residency in Nicaragua.

Godman and Salvin (1887-1901) published the only list of Nicaraguan Theclinae (Lycaenidae: Eumaeini) that was based on museum vouchers. They recorded 73 hairstreak species from Nicaragua, but in two instances, sexually dimorphic males and females were treated as different species (*Thecla coelicolor* [Butler & H. Druce]/*T. myrsina* Hewitson and *Thecla xeneta* Hewitson/*T. amplia* Hewitson, see Robbins 2004). Maes et al. (1999) added ten more species names from subsequent literature citations, but unfortunately the taxonomy was confused.

The purpose of this paper is to present an updated list of the hairstreak fauna of Nicaragua with the localities where each species has been found, including historical notes on the more significant collectors of Nicaraguan Theclinae. We discuss the biogeographical significance of the distributions and habitats of these species. Finally, we add a list of those species recorded both northwest and southeast of Nicaragua, which are likely to be found in Nicaragua in the future.

MATERIALS AND METHODS

The species list of Nicaraguan Theclinae follows the order and taxonomy in Robbins (2004) except for a few updates (Faynel 2007, 2008, Faynel & Moser 2008, Duarte & Robbins 2010, Robbins 2010b). Specific and generic synonymies are detailed in Robbins (2004). Voucher specimens for the Nicaraguan records from Belt, Janson, Richardson, and Hewitson, which were cited in Godman and Salvin (1887-1901), are deposited in the Natural History Museum (BMNH), London. The localities for these specimens are listed after "GS". More information on these localities is presented in Selander and Vaurie (1962). Some names used by Godman and Salvin are listed in this paper under their senior synonyms. For example, *Thecla nepia* and *Thecla volupia* are treated in this paper as *Theritas theocritus* and *Siderus leucophaeus*, respectively (cf. Robbins 2004). In a few cases, Godman and Salvin misidentified a species, such as *Thecla atena* Hewitson (Faynel 2007); we correct these names.

Records of Nicaraguan Theclinae from the Anderson Collection and from the Sullivan Collection are based on specimens deposited in the Smithsonian Institution (USNM), Washington, DC. The Nicaraguan localities where these specimens were collected were briefly described and mapped (Anderson 2007), and in this paper we add the coordinates and Holdrige (1962) life zone for each. These localities with the number of males and females are listed after "RAA/JBS" with the month of capture (first three letters of the month in English). A few additional records from the AMNH (American Museum of Natural History) and USNM are noted with the collector in parenthesis. We omitted Nicaraguan records from the Raymond Jae (= Jablonski) Collection, which is deposited in the Allyn Museum of Entomology, Florida Museum (FSMC), because data reliability is unfortunately an issue (Panamanian locality labels on specimens of *Arawacus sito*, for example, are incorrect because this common Nicaraguan species does not occur in Panama).

Geographical ranges for Central America hairstreak species are based upon published information, the USNM collection, and the collections of other museums from which data was recorded over the past three decades, usually for other purposes. We list and illustrate those species for which Nicaragua represents the northern or southern limit of its known range (in some cases, we refer to published figures). To determine those species that are unrecorded for Nicaragua—but that are likely to occur there—we list those 73 "unrecorded species" for which we have locality records both to the northwest and southeast of Nicaragua. Species names for which Nicaragua is a type locality are noted and were taken from Robbins (2004).

RESULTS

Anderson Collection and Sullivan Collection Localities. The information presented here is complementary to that in Anderson (2007), where collecting localities were mapped. For each locality we note province, coordinates (but in some cases, it is the center of an area), and Holdridge Life Zone. Specimens in the Anderson and Sullivan collections from Bluefields, Corn Island, Nueva Guinea, Rama, Yolaina, and Rio Chontaleña are labeled Department of Zelaya, but this department was subsequently divided. These localities now belong to the Región Autónoma Atlántico Sur.

Bluefields, Zelaya (12º00'41"N, 83º45'50"W), including El Bluff a few kilometers to the east. Very Humid Tropical Forest, with many disturbed areas, at elevations below 100 m.

Corinto, Chinandega (12º30'10"N, 87º10'51"W). Dry Tropical Forest under 50 m elevation.

Corn Island, Zelaya (12º10'30"N, 83º3'12"W). This Atlantic island is wet lowland forest (the highest point is 113 m elevation), but its life zone was not categorized by Holdridge (1962).

Ciudad Dario, Matagalpa (12º43'50"N, 86º07'25"W). Very Dry Tropical Forest at about 450 m elevation.

El Crucero/Las Nubes, Managua (11º55'16"N, 86º16'32"S). Subtropical Humid Forest at 700–900 m elevation from about 18 km SSW to 25 km S of Managua.

Granada, Granada (11º54'32"N, 85º57'30"W). Dry Tropical Forest under 300 m elevation both to the east and west of the city.

Jinotega, Jinotega (13º48'15"N, 85º32'42"W). Subtropical Humid Forest at 1000–1300 m elevation.

Managua, Managua (12º08'51"N, 8º16'24"W). Dry and Very Dry Tropical Forest within about 15 km of the city at elevations up to 550 m. As noted in Anderson (2007), it includes disturbed secondary growth and residential areas.

Matagalpa North, Matagalpa (13º02'29"N, 85º51'58"). An area 10–15 km north of Matagalpa of Subtropical Humid Forest at elevations from 1000–1400 m.

Matagalpa South, Matagalpa (12º56'25"N, 85º55'29"W). An area 4 km south of Matagalpa of Subtropical Humid Forest at 600–700 m.

Nueva Guinea, Zelaya (11º41'01"N, 84º27'01"W). Very Humid Subtropical Forest at about 200 m elevation.

Pochomil, Managua (11º46'31"N, 86º30'19"W). Dry Tropical Forest under 50 m elevation.

Puertas Viejas, Matagalpa (12º36'05"N, 86º02'51"W). Very Dry Tropical Forest at about 525 m elevation.

Puerto Somoza (now called Puerto Sandino), Leon (12º11'30"N, 86º45'41"W). Dry Tropical Forest under 50 m elevation.

Rama, Zelaya (12º09'46"N, 84º13'08"W). Very Humid Subtropical Forest at elevations below 100 m.

Rio Chontaleña, Zelaya. A tributary of the Rio Indio, this is a Scharf collecting locality in Very Humid Subtropical Forest at about 150 m elevation. It is north of San Juan Del Norte and SSE of Nueva Guinea, but we do not have coordinates where Scharf collected.

San Carlos, Rio San Juan (11º07'01"N, 86º46'44"W). Dry and Humid Tropical Forest under 100 m elevation.

San Fernando, Nueva Segovia (13º40'38"N, 86º18'54"W). Subtropical Humid Forest at about 700 to 750 m elevation. These specimens were collected by P. Scharf.

San Juan del Norte, Río San Juan (10º55'17"N, 83º43'17"W). Very Humid Tropical Forest under 50 m elevation.

Santo Tomás, Chontales (12º02'51"N, 84º59'47"W). Humid Tropical and Subtropical Forest at about 300 m elevation.

Yolaina, Zelaya (11º37'06"N, 84º19'55"W). Very Humid Subtropical Forest at 200–225 m elevation. This locality was treated as part of Nueva Guinea in Anderson (2007), but is about 15 km to the south-east.

149 Recorded Nicaraguan Eumaeini

Eumaeus godartii (Boisduval, 1870)

Localities. RAA/JBS: 1 ♂ Nueva Guinea Apr.

Remarks. Not recorded northwest of Nicaragua (illustrated in D'Abrera 1995: 1101).

Theorema eumenia Hewitson, 1865

Localities. GS: Chontales (Belt). RAA/JBS: 1 ♀ Nueva Guinea Aug.

Paiwarria antinous (C. Felder & R. Felder, 1865)

Localities. GS: Chontales (Belt).

Paiwarria umbratus (Geyer, 1837)

Localities. GS: Chontales (Belt).

Type Locality. The type locality of *Thecla parthenia* Hewitson, a synonym of *P. umbratus*, is Nicaragua.

Brangas neora (Hewitson, 1867)

Localities. RAA/JBS: 7 ♂ & 1 ♀ Managua, Feb, Aug, Sep. USNM: 1 ♂ Managua (Todd) Nov.

Brangas coccineifrons (Godman & Salvin, 1887)

Localities. GS: no further data.

Type Locality. The type locality of *Thecla coccineifrons* is Nicaragua and Colombia.

Evenus regalis (Cramer, 1775)

Localities. GS: Chontales (Belt), Matagalpa (Richardson). RAA/JBS: 4 ♂ & 2 ♀ El Crucero/Las Nubes, Jan, Feb, Mar. 2 ♀ Managua, Feb., Aug.

Evenus coronata (Hewitson, 1865)

Localities. GS: Chontales (Belt, Janson).

Evenus batesii (Hewitson, 1865)

Localities. GS: Chontales (Belt).

Lamasina draudti (Lathy, 1926)

Localities. GS: Chontales (Belt).

Nomenclature. The name *Lamasina* Robbins is part of an application to the International Commission on Zoological Nomenclature (Robbins & Lamas 2008b).

Taxonomy. Robbins and Lamas (2008a) showed that the traits used by Bálint (2005) to characterize species in this genus were inaccurate and proposed a provisional taxonomy based on the biological species concept. Unfortunately, the responses by Bálint (2009, 2010) were not based on a scientific species concept (cf. Bálint 2006).

Atlides gaumeri (Godman, 1901)

Localities. RAA/JBS: 1 ♂ & 3 ♀ Managua, Jan, Aug. 2 ♀ El Crucero/Las Nubes, Feb. 1 ♀ Granada, Jul. 1 ♂ no locality (Heller collection).

Atlides rustan (Stoll, 1790)

Localities. RAA/JBS: 10 ♂ & 5 ♀ Managua, Jan, Feb, Apr, Jul, Aug. 2 ♂ & 4 ♀ El Crucero/Las Nubes, Jan, Feb, Mar, Nov, Dec.

Arcas imperialis (Cramer, 1775)

Localities. GS: Chontales (Belt).

Arcas cypria (Geyer, 1837)

Localities. GS: Chontales (Belt).

Pseudolycaena damo (H. Druce, 1875)

Localities. GS: Chontales (Belt, Janson), Matagalpa (Richardson). RAA/JBS: 8 ♂ & 5 ♀ Managua, May, Aug, Nov, Dec. 1 ♀ Bluefields, Dec. 1 ♀ Nueva Guinea, Oct.

Pseudolycaena marsyas (Linnaeus, 1758)

Localities. RAA/JBS: 1 ♀ Bluefields, Dec (Fig. 1).

Taxonomy. Austin et al. (2007) admirably tried to resolve the species taxonomy of *Pseudolycaena*, but phylogenetic analysis of the character states that they presented does not fully support their taxonomic conclusions (Robbins & Nakamura, in prep.). The female from Bluefields (Fig. 1) has the "*marsyas* type of ventral maculation" that was noted in Austin et al. (2007), and if it is indeed *P. marsyas*, it is the northern known limit of this species. *Pseudolycaena marsyas* is listed provisionally, based on the assumption that *P. damo* and *P. marsyas* are distinct species.

Theritas mavors Hübner, 1818

Localities. GS: Chontales (Belt). RAA/JBS: 2 ♀ Rama, Mar. 3 ♂ & 1 ♀ Bluefields, Dec, Jan. 2 ♂ San Fernando, Jul.

Theritas hemon (Cramer, 1775)

Localities. GS: Chontales (Belt). RAA/JBS: 3 ♂ Bluefields, Dec. 1 ♀ Nueva Guinea, Jul.

Theritas augustinula (Goodson, 1945)

Localities. GS: (Hewitson Collection?). RAA/JBS: 1 ♂ Matagalpa North, Aug. 1 ♀ El Crucero/Las Nubes, Feb.

Theritas theocritus (Fabricius, 1793)

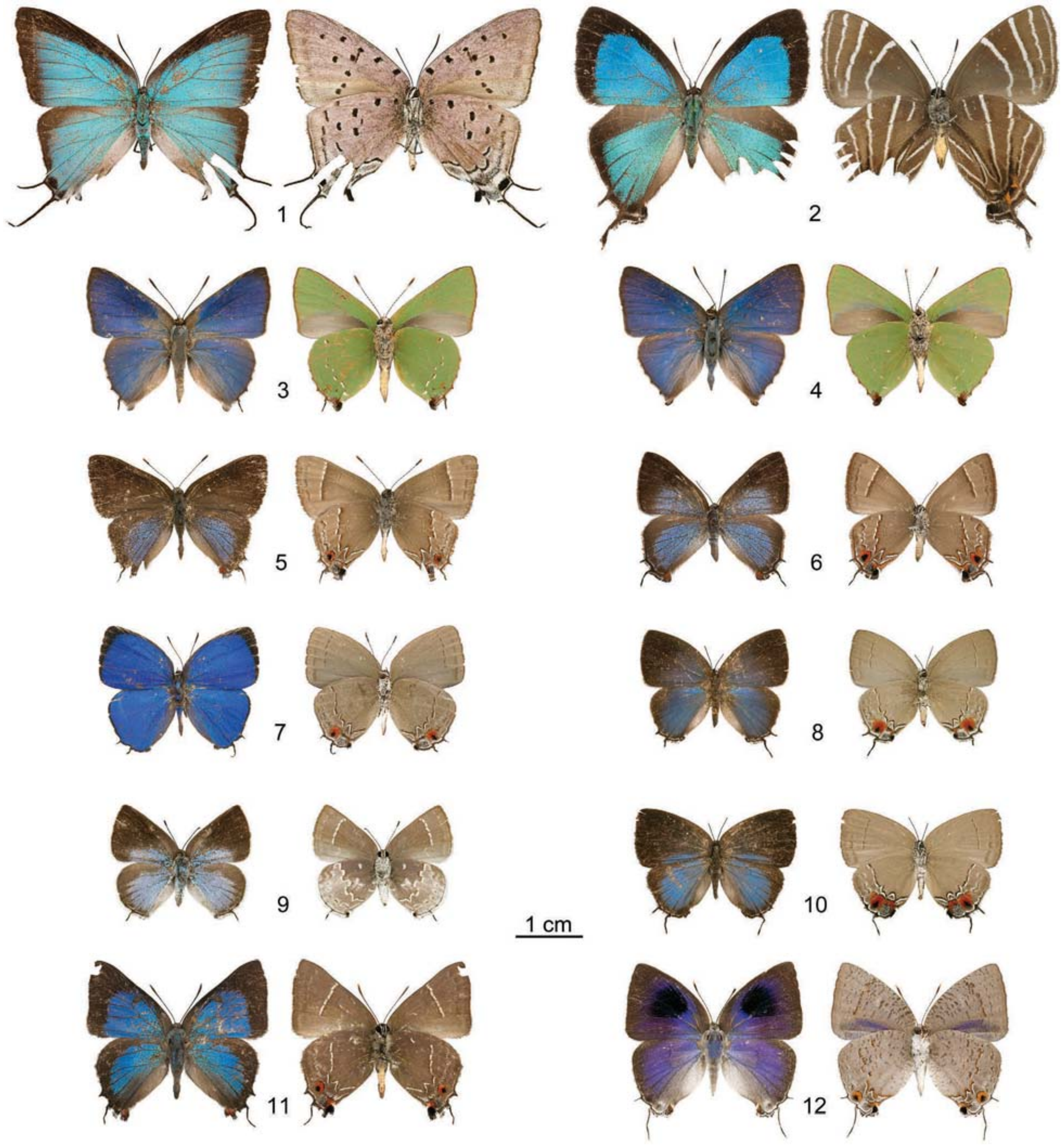
Localities. GS: No further data (Hewitson Collection), Matagalpa (Richardson). RAA/JBS: 1 ♂ Nueva Guinea, Oct.

Type Locality. The type locality of *Thecla nepia* G&S, a synonym of *T. theocritus*, is Guatemala, Nicaragua, and Panama.

Brevianta busa (Godman & Salvin, 1887)

Localities. GS: Chontales (Belt).

Type Locality. The type locality of *Thecla busa* is Guatemala, Nicaragua, and Costa Rica.



Figs. 1–12. Biogeographically or taxonomically significant Nicaraguan hairstreaks. **1.** ♀ *Pseudolycaena marsyas*, Bluefields (northern-most known specimen). **2.** ♂ *Laothus oceia*, Matagalpa North (phenotype intermediate between those from Guatemala and Costa Rica). **3.** ♂ *Cyanophrys herodotus*, Managua (tailed phenotype). **4.** ♂ *Cyanophrys herodotus*, Managua (tailless phenotype). **5.** ♂ *Kisutam micandriana*, Matagalpa North (southern-most known male). **6.** ♀ *Kisutam micandriana*, Matagalpa North (southern-most known female). **7.** ♂ *Theclopsis demea*, Bluefields (northern-most known male). **8.** ♀ *Theclopsis demea*, Bluefields (northern-most known female). **9.** ♀ *Nicolaea viceta*, El Crucero/Las Nubes (northern-most known specimen). **10.** ♀ *Symbiopsis rickmani*, Bluefields (northern-most known specimen). **11.** ♂ *Parrhasius moctezuma*, Matagalpa North (southern-most known specimen). **12.** ♂ *Hypostrymon critola*, Granada (southern-most known specimen).

Brevianta tolmides (C. Felder & R. Felder, 1865)

Localities. RAA/JBS: 2♂ Matagalpa North, Jul, Dec.

Temecla paron (Godman & Salvin, 1887)

Localities. RAA/JBS: 1♀ Matagalpa North, Sep.

Ipidecla schausi (Godman & Salvin, 1887)

Localities. GS: Matagalpa (Richardson).

Thereus cithonius (Godart, 1824)

Localities. RAA/JBS: 7♂ & 3♀ Managua, Aug, Sep. 1♂ El Crucero/Las Nubes, Jan. 1♂ Pochomil, Aug.

Thereus species

Localities. RAA/JBS: 1♀ Managua, Jan. 1♀ Granada, Jul.

Taxonomy. This species is morphologically similar to the Amazonian *T. enenia*, as noted by Robbins and Aiello (1982), but differs in possessing androconia on the dorsal surface of the forewing. Its specific distinctness and its placement in *Thereus* are yet in doubt.

Thereus oppia (Godman & Salvin, 1887)

Localities. RAA/JBS: 3♂ & 1♀ Managua, Jan, Sep, Nov. 1♀ Matagalpa, Dec.

Thereus lausus (Cramer, 1779)

Localities. GS: Chontales (Belt).

Rekoa meton (Cramer, 1779)

Localities. GS: Chontales (Belt). RAA/JBS: 1♀ Rama, Mar.

Rekoa palegon (Cramer, 1780)

Localities. GS: Chontales (Belt). RAA/JBS: 34♂ & 20♀ Managua, Jan, Feb, Mar, Apr, May Jun, Jul, Aug, Nov, Dec. 2♂ & 1♀ Pochomil, Jun, Jul, Aug. USNM: Managua (Todd), Nov.

Rekoa zebina (Hewitson, 1869)

Localities. RAA/JBS: 5♂ & 6♀ Managua, Jan, Feb, Mar, Apr, Jun, Jul, Aug, Nov. 1♂ & 1♀ Pochomil, Jan, Jul. 6♂ & 5♀ El Crucero/Las Nubes, Feb, Mar. 1♀ Ciudad Dario, Jul.

Type Locality. The type locality of *Thecla zebina* Hewitson is Nicaragua.

Rekoa marius (Lucas, 1857)

Localities. GS: Chontales (Hewitson), Matagalpa (Richardson). RAA/JBS: 52♂ & 37♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. 2♂ & 2♀ El Crucero/Las Nubes, Feb, Aug, Dec. 5♂ & 7♀ Pochomil, Jan, Jun, Jul, Aug. 1♀ Granada, Jul. USNM: 1♂ Managua (Todd), Nov.

Remarks. A female from 7 miles SE Managua, July 21, 1976, has a second label "Ex larva on almond blossoms". Other larval food plant records for this polyphagous species are listed in Robbins (1991). Monteiro (1991) showed that the caterpillars turn the same color as the flowers on which they are feeding.

Rekoa stagira (Hewitson, 1867)

Localities. RAA/JBS: 22♂ & 13♀ Managua, Mar, Apr, May, Aug, Sep, Nov, Dec. 1♀ Matagalpa South, Aug. 1♀ El Crucero/Las Nubes, Mar.

Type Locality. The type locality of *Thecla thoana* Hewitson, a synonym of *R. stagira*, is Nicaragua.

Arawacus togarna (Hewitson, 1867)

Localities. GS: Chontales (Belt, Janson), Matagalpa (Richardson). RAA/JBS: 5♂ & 2♀ Managua, Apr, May, Aug. 9♂ Bluefields, Jan, Jun, Oct, Dec. 6♂ & 4♀ Nueva Guinea, Aug, Oct. 1♂ San Carlos, Sep. 2♂ Rama, Mar. 3♂ & 1♀ Yolaina, Aug.

Taxonomy. Wing pattern and genitalic variation was documented in Robbins (2010b), where the nomenclature was corrected

Remarks. Although the areas around Managua are classified as Dry and Very Dry Tropical Forest, the Managua specimens of *A. togarna* were found primarily in an area to the east of the city that is a mosaic of habitats. This species is unknown from dry forest in other parts of its range (Robbins 2010b).

Arawacus sito (Boisduval, 1836)

Localities. GS: Chontales (Belt, Janson), Matagalpa (Richardson). RAA/JBS: 46♂ & 18♀ Managua, Jan, Feb, Apr, May, Jun, Jul, Aug, Nov, Dec. 2♂ Granada, Jul. 2♂ Matagalpa South, Jul. 2♂ Yolaina, Aug. USNM: 1♂ San Marcos (Baker).

Type Locality. The type locality of *Thecla phaenna* G&S, a synonym of *A. sito*, is Nicaragua and Honduras.

Arawacus jada (Hewitson, 1867)

Localities. RAA/JBS: 1♂ Matagalpa North Aug. 1♂ Matagalpa South, Aug. 1♀ San Fernando, Jul.

Contrafacia imma (Prittwitz, 1865)

Localities. GS: Chontales (Belt).

Contrafacia bassania (Hewitson, 1868)

Localities. RAA/JBS: 2♀ Matagalpa North, Aug. 1♂ & 1♀ Jinotega, Jan, Jul.

Kolana ligurina (Hewitson, 1874)

Localities. GS: Chontales (Belt). RAA/JBS: 1♀ Bluefields, Dec.

Type Locality. The type locality of *Thecla ligurina* Hewitson is Nicaragua.

Ocaria petelina (Hewitson, 1877)

Localities. RAA/JBS: 1♀ Matagalpa North, Sep.

Ocaria thales (Fabricius, 1793)

Localities. GS: Chontales (Belt).

Ocaria ocrisia (Hewitson, 1868)

Localities. GS: Chontales (Belt), Matagalpa (Richardson). RAA/JBS: 2♂ & 3♀ Managua, Jan, Aug, Dec. 23♂ & 15♀ El Crucero/Las Nubes, Jan, Feb, Mar, Nov, Dec. 1♂ Granada Jul.

Chlorostrymon simaethis (Drury, 1773)

Localities. RAA/JBS: 3♂ & 6♀ Managua, Feb. 4♂ & 5♀ El Crucero/Las Nubes, Feb, Mar, May. 1♂ & 4♀ Matagalpa, Dec. 1♀ Puertas Viejas, Mar.

Chlorostrymon telea (Hewitson, 1868)

Localities. RAA/JBS: 10♂&13♀ Managua, Jan, Feb, Mar, May, Jul, Aug, Nov. 9♂ & 8♀ El Crucero/Las Nubes, Feb, Mar, Nov. 1♀ 1♂ Bluefields, Jun. 1♂ & 2♀ Pochomil, Jun, Jul. 3♂ Granada, Jul.

Cyanophrys goodsoni (Clench, 1946)

Localities. RAA/JBS: 23♂ & 22♀ Managua, Jan, Feb, Mar, Apr, May, Aug, Sep, Dec. 1♂ & 2♀ El Crucero/Las Nubes, Feb, Mar.

Cyanophrys herodotus (Fabricius, 1793)

Localities. GS: Chontales (Belt), Matagalpa (Richardson). RAA/JBS: 81♂ & 29♀ Managua, Jan, Feb, Mar, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. 2♂ &5♀ El Crucero/Las Nubes, Jan, Feb, Mar, Apr. 1♂ Pochomil, Aug. 2♀ Corinto, Jun.

Type Locality. The type locality of *Cyanophrys sullivani* Johnson & Kruse, a synonym of *C. herodotus*, is Nicaragua.

Taxonomy. Sympatric and synchronic individuals of *C. herodotus* from El Salvador may or may not have tails (Robbins & Duarte 2005), but there are no other evident morphological differences between the tailed and un-tailed forms. The same two forms occur in Nicaragua (Figs. 3, 4) and north-western Costa Rica, where preliminary DNA barcoding results (D. Janzen pers. comm.) also reveal no differences between the wing pattern forms. For these reasons we continue to treat these forms as one species.

Remarks. Without dissecting genitalia, it is very difficult to distinguish females of *C. herodotus* without tails from females of *C. goodsoni*, which never have tails, and some of the females listed under *C. goodsoni* may actually be *C. herodotus*.

Cyanophrys miserabilis (Clench, 1946)

Localities. RAA/JBS: 9♂ &12♀ El Crucero/Las Nubes, Jan, Feb, Mar, Apr. 3♂ & 3♀ Managua, Mar, Jul, Dec.

Cyanophrys agricolor (Butler & H. Druce, 1872)

Localities. RAA/JBS: 1♂ Matagalpa North, Jul

Cyanophrys longula (Hewitson, 1868)

Localities. RAA/JBS: 28♂ &7♀ El Crucero/Las Nubes, Jan, Feb, Mar, Apr, Jul, Oct. 1♂ & 7♀ Matagalpa North, May, Jul, Aug, Oct.

Megathecla cupentus (Stoll, 1781)

Localities. GS: Chontales (Belt). RAA/JBS: 1♂ Nueva Guinea, Aug.

Thestius epopea (Hewitson, 1870)

Localities. GS: Chontales (Belt).

Remarks. Not recorded northwest of Nicaragua (illustrated in D'Abrera 1995: 1208).

Lathecla species

Localities. RAA/JBS: 2♂ Matagalpa North, Sep, Oct.

Taxonomy. This widespread Central American species is being described as part of a generic revision (Robbins & Busby, in prep.).

Allosmaitia strophius (Godart, 1824)

Localities. RAA/JBS: 8♂ & 4♀ Managua, Jun, Jul, Aug, Dec. 2♂ & 4♀ El Crucero/Las Nubes, Jan, Feb, Mar, Jul. 1♀ Pochomil, Jul.

Laothus oceia (Godman & Salvin, 1887)

Localities. RAA/JBS: 1♂ Matagalpa North, Aug.

Taxonomy. Godman and Salvin (1887–1901) described *L. oceia* from Costa Rica and *L. laothoe* from Guatemala, but expressed hesitation at considering them distinct. They distinguished *L. oceia* by a narrower border on the dorsal wings of males and by less black edging along the white lines on the ventral surface of the hindwing near the anal margin. The single known Nicaraguan male (Fig. 2) has the narrow border of *L. oceia* and the black edging of *L. laothoe*, which is consistent with the hypothesis that these names represent geographical variants of one species.

Laothus barajo (Reakirt, 1867)

Localities. GS: Chontales (Belt, Janson). RAA/JBS: 1♂ Rama, Mar. 2♀ Nueva Guinea, Aug, Oct.

Janthecla janthina (Hewitson, 1867)

Localities. GS: Chontales (Belt, Janson). RAA/JBS: 1♂ San Carlos, May.

Lamprospilus collucia (Hewitson, 1877)

Localities. RAA/JBS: 6♂ & 8♀ El Crucero/Las Nubes, Feb, Mar. 1♀ Rama, Mar. 1♀ Matagalpa North, Aug.

Taxonomy. Variation and other aspects of the biology of this species were detailed in Robbins et al. (2010).

Lamprospilus coelicolor (Butler & H. Druce, 1872)

Localities. GS: Chontales (Belt).

Type Locality. The type localities of *Thecla myrsina* Hewitson and *Thecla hena* Hewitson, both synonyms of *L. coelicolor*, are Nicaragua.

Taxonomy. Godman and Salvin (1887–1901) treated the dimorphic sexes as distinct species. However, both males and females have identical distributions in the same habitats and were collected *in copula* by K. Brown in Colombia.

Remarks. Not recorded northwest of Nicaragua (D'Abrera 1995:1207, 1209 figured the female as *coelicolor* and the male as *myrsina*).

Arzecla arza (Hewitson, 1874)

Localities. GS: Chontales (Belt). RAA/JBS: 1♂ & 1♀ Managua, Mar. 7♂ & 10♀ El Crucero/Las Nubes, Feb, Mar, Nov, Dec. 1♂ & 2♀ Matagalpa North, Sep.

Type Locality. The type locality of *Thecla arza* is Nicaragua.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Arzecla calatia (Hewitson, 1873)

Localities. GS: Chontales (Belt).

Type Locality. The type locality of *Thecla calatia* is Nicaragua.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Arzecla sethon (Godman & Salvin, 1887)

Localities. RAA/JBS: 1♂ Matagalpa North, Jul. 1♂ Jinotega, Aug.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Arumecla galliena (Hewitson, 1877)

Localities. GS: Chontales (Belt). RAA/JBS: 35♂ & 14♀ El Crucero/Las Nubes, Feb, Mar, Apr. 1♂ Managua, Nov. 1♀ Rio Chontaleña (Scharf), Mar.

Type Locality. The type localities of *Thecla galliena* and *Thecla isopas* G&S, a synonym of *A. galliena*, are Nicaragua.

Camissecla charichlorus (Butler & H. Druce, 1872)

Localities. GS: Chontales (Belt, Janson, Hewitson). RAA/JBS: 3♂ Nueva Guinea, Aug.

Type Locality. The type locality of *Thecla capeta* Hewitson, a synonym of *C. charichlorus*, is Nicaragua.

Ziegleria hesperitis (Butler & H. Druce, 1872)

Localities. GS: Chontales (Belt). RAA/JBS: 1♂ & 1♀ El Crucero/Las Nubes, Jul, Nov. 2♀ Nueva Guinea, Aug.

Ziegleria hoffmani K. Johnson, 1993

Localities. RAA/JBS: 85♂ & 54♀ Managua, Jan, Feb, Mar, Jul, Oct, Nov, Dec. 19♂ & 12♀ El Crucero/Las Nubes, Feb, Mar, Nov, Dec. 2♂ Granada, Jul. 2♀ Matagalpa South, Dec.

Nomenclature. The spelling of this name and its nomenclatural significance were discussed in Duarte and Robbins (2010).

Ziegleria ceromia (Hewitson, 1877)

Localities. RAA/JBS: 1♂ El Crucero/Las Nubes, Feb.

Kisutam micandriana (K. Johnson, 1992)

Localities. RAA/JBS: 1♂ & 1♀ Matagalpa North, Sep.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Remarks. Not recorded southeast of Nicaragua (Figs. 5, 6).

Kisutam syllis (Godman & Salvin, 1887)

Localities. GS: Chontales (Belt). RAA/JBS: 3♂ & 33♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. 1♂ & 3♀ El Crucero/Las Nubes, Feb, Jul, Aug, Oct, Nov, Dec. 1♂ Granada, Jul. 4♀ Pochomil, Jul, Aug. 2♀ Bluefields, Apr. USNM: 1♀ Managua, (Todd), Nov.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Rubroserrata mathewi (Hewitson, 1874)

Localities. RAA/JBS: 28♂ & 33♀ Managua, Feb, Mar, Jul, Aug, Sep, Oct, Nov, Dec. 1♂ & 4♀ El Crucero/Las Nubes, Jan, Feb, Dec. 1♂ & 2♀ Pochomil, Jul, Aug. 1♂ Granada, Jul.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Electrostrymon denarius (Butler & H. Druce, 1872)

Localities. GS: Chontales (Belt). RAA/JBS: 50♂ & 1♀ El Crucero/Las Nubes, Jan, Feb, Mar, Jun, Oct, Nov, Dec. 4♀ Matagalpa North, Jul, Aug, Sep. 5♀ Jinotega, Jul, Aug.

Type Locality. The type locality of *Thecla calena* Hewitson, a synonym of Z. *denarius*, is Nicaragua.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Remarks. This species occurs consistently in lower montane forest and appears to be parapatric with the higher elevation '*E. guzanta* species complex', despite occasional records of both species the same general locality, such as Matagalpa North and Jinotega.

Electrostrymon guzanta (Schaus, 1902)

Localities. RAA/JBS: 4♂ & 6♀ Matagalpa North, Apr, May, Jul, Sep. 1♀ Jinotega, Aug.

Taxonomy. The generic placement of this species was modified in Duarte and Robbins (2010).

Remarks. The phenotypically variable '*E. guzanta* species complex' occurs in montane habitats from Mexico to the Andes, but geographical variation to the southeast of Nicaragua needs to be analyzed. According to current taxonomy, *E. guzanta* is not recorded southeast of Nicaragua.

Electrostrymon hugon (Godart, 1824)

Localities. GS: Chontales (Belt). RAA/JBS: 45♂ Managua, Jan, Feb, Mar, Apr, May, Jun, Jul, Sep, Oct, Nov, Dec. 2♂ El Crucero/Las Nubes, Mar. 1♂ Ciudad Dario, Jul. 2♂ Pochomil, Jul, Aug.

Type Locality. The type locality of *Thecla autoclea* Hewitson, a synonym of *E. hugon*, is Nicaragua.

Nomenclature. The recently discovered type of

Polyommatus hugon shows that this name applies to the species previously called *E. sangala* (Hewitson) (Faynel & Bálint 2004).

Taxonomy. The females of this and the following species cannot be distinguished with certainty. It is possible that some females that were listed in Godman and Salvin as *Thecla autoclea* are the next species. The Anderson and Sullivan Collections contain another 79 females that belong to these two species.

Electrostrymon joya (Dognin, 1895)

Localities. RAA/JBS: 46 ♂ Managua, Jan, Feb, Mar, Arp, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. 1 ♂ Granada, Nov. 1 ♂ El Crucero/Las Nubes, Mar. 3 ♂ Pochomil, Jun, Jul. 4 ♂ Matagalpa South, Dec.

Taxonomy. *Electrostrymon joya* is geographically variable and may consist of more than one species (Duarte & Robbins, in prep.). Female identification of *E. joya* in Nicaragua is discussed under *E. hugon*.

Calycopis clarina (Hewitson, 1874)

Localities. RAA/JBS: 1 ♂ Managua, Feb. 2 ♂ El Crucero/Las Nubes, May. 1 ♀ San Fernando (Scharf), Jul.

Calycopis atnius (Herrich-Schäffer, 1853)

Localities. RAA/JBS: 1 ♀ Bluefields, Dec.

Calycopis demonassa (Hewitson, 1868)

Localities. RAA/JBS: 22 ♂ & 18 ♀ Managua, Feb, Mar, Apr, May, Jun, Jul, Aug, Oct, Nov, Dec. 2 ♂ & 7 ♀ El Crucero/Las Nubes, Feb, Mar, Apr, May. 2 ♂ Pochomil, Jul.

Calycopis calus (Godart, 1824)

Localities. GS: Chontales (Belt).

Calycopis cerata (Hewitson, 1877)

Localities. GS: Chontales (Belt). RAA/JBS: 6 ♂ & 3 ♀ Bluefields, Jan, Jun, Dec. 1 Rama, Mar.

Remarks. Although the wing pattern and some genitalic structures of this species are typical of *Calycopis*, others character states are anomalous (Duarte & Robbins 2010). As noted in Duarte and Robbins (2010), it is possible that this species is congeneric with *Kisutam*. If so, it is a rather remarkable instance of evolutionary wing pattern convergence.

Calycopis isobeon (Butler & H. Druce, 1872)

Localities. RAA/JBS: 1 ♂ San Fernando, Jul. 1 ♂ Matagalpa North, Jul.

Identification. Both males were dissected. The convex posterior edge of the labides of the male genitalia apparently occurs only in *C. isobeon* and *C. cecrops* Fabricius (Field 1967).

Nomenclature. Field (1967) designated a male lectotype of *Tmolus isobeon* Butler & H. Druce, but this specimen unfortunately lacks an abdomen. Because definitive identification based on wing pattern is difficult (Field 1967), the identity of this name could possibly change as geographical variation of wing pattern is better documented.

Remarks: These males are the only specimens of *C. isobeon* that we have seen from Nicaragua. None were noted by Field (1967). *Calycopis isobeon* appears to be an uncommon montane species in the southern half of Central America.

Calycopis xeneta (Hewitson, 1877)

Localities. GS: Chontales (Belt, Janson). RAA/JBS: 17 ♂ Nueva Guinea, Jul, Aug, Oct. 4 ♂ Yolaina, Aug.

Type Locality. The type localities of *Thecla xeneta* Hewitson and *Thecla amplia* Hewitson, a synonym of *C. xeneta*, are Nicaragua.

Taxonomy. Godman and Salvin (1887–1901), Field (1967), and D'Abrera (1995) called males of this species *xeneta* and females *amplia*. The sexes were associated in Robbins (2004) because they have the same distribution from Guatemala to western Ecuador, occur in the same very wet lowland/lower montane forest habitats, and are commonly collected together. Schaus (1920) and Field (1967) treated *Calycopis devia* (Möschler) as a South American synonym or subspecies of *C. xeneta*, but both taxa occur in Panama without evident hybridization, for which reason Robbins (2004) listed them as distinct species. Although *C. xeneta* has been recorded widely in South America (e.g., Godman & Salvin 1887–1901, Weeks 1911, Draudt 1919–1920), we have not seen any authentic South American records from localities to the east of the Andes.

Calycopis origo (Godman & Salvin, 1887)/*Calycopis bactra* (Hewitson, 1877)

Localities. GS: Chontales (Belt), Matagalpa (Richardson). RAA/JBS: 52 ♂ & 44 ♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. 15 ♂ & 10 ♀ El Crucero/Las Nubes, Jan, Feb, Mar, Jun, Jul, Nov. 3 ♂ Matagalpa South, Jul, Aug, Dec. 5 ♂ & 5 ♀ Matagalpa North, Dec. 3 ♂ & 2 ♀ Granada, Mar, Jul, Nov. 4 ♂ & 9 ♀ Bluefields, Dec, Jan, Apr, Oct. 4 ♂ & 1 ♀ Pochomil, Jul. 2 ♂ Nueva Guinea Oct. 1 ♀ Rama, Mar. 1 ♂ San Fernando, Jul. 4 ♂ & 1 ♀ Jinotega, Jan. 1 ♂ Yolaina, Aug. 1 ♀ Corn Island (Scharf), Jun. USNM: 2 ♀ Managua (Todd), Nov.

Type Locality. The type locality of *Thecla bactra* Hewitson is Nicaragua.

Identification. We dissected 15 males. Their genitalia are indistinguishable from those of *C. origo* (Hewitson) and *C. susanna*, which have South American male holotypes.

Nomenclature and Taxonomy. The type of *T. bactra* is a female, which makes identification of this name difficult. For example, Field (1967) could not distinguish females of *C. isobeon* and *C. susanna* Field (a synonym of *C. origo* in Robbins 2004) by wing pattern or genitalia, even though males have distinctively different genitalia. To complicate matters, the type of *T. bactra* lacks an abdomen. As best we can determine, Field's (1967) concept of *C. bactra* included two species, but his characterization was primarily of a species that does not occur in Nicaragua. If the female type of *T. bactra* is really from Nicaragua, it is likely that it is the same species as that now called *C. origo*. If so, *C. bactra* would be the oldest name.

Remarks. This species may occur in more different habitats and localities than any other Nicaraguan hairstreak species. It has been recorded in every month of the year in Managua.

Calycopis drusilla Field, 1967

Localities. RAA/JBS: 16 ♂ & 9 ♀ Bluefields, Jan, Apr, Dec.

Identification and Taxonomy. Field (1967) distinguished *C. drusilla* from *C. origo/C. bactra* (under the name *C. susanna*) by wing pattern and genitalic characters. We distinguish this species by wing pattern alone because we could not distinguish it by the genitalic differences proposed by Field. *Calycopis drusilla* is known only from very wet lowland habitats and is sympatric with *C. origo/bactra* in Bluefields, suggesting that they are distinct species. However, it is possible that the '*drusilla*' wing pattern is a wet lowland phenotype of *C. origo/C. bactra.*

Calycopis trebula (Hewitson, 1868)

Localities. GS: Chontales (Belt). RAA/JBS: 1 ♂ Nueva Guinea, Oct.

Calycopis pisis (Godman & Salvin, 1887)

Localities. GS: Chontales (Belt). RAA/JBS: 4 ♀ Bluefields, Dec.

Calycopis orcillula (Strand, 1916)

Localities. RAA/JBS: 2 ♂ & 6 ♀ Bluefields, Jan, Apr, Jun, Dec. 1 ♂ Nueva Guinea

Remarks. Not recorded northwest of Nicaragua (female figured in D'Abrera 1995: 1236, but the figured 'male' is another female).

Strymon melinus (Hübner, 1818)

Localities. RAA/JBS: 4 ♂ & 2 ♀ Managua, Jan, Aug, Oct, Nov, Dec.

Strymon rufofusca (Hewitson, 1877)

Localities. RAA/JBS: 53 ♂ & 38 ♀ Managua, Feb, Mar, May, Jun, Jul, Sep, Aug, Nov, Dec. 1 ♀ El Crucero/Las Nubes, Aug. 1 ♂ Ciudad Dario, Jan, USNM: 2 ♂ & 1 ♀ Managua (Todd), Nov.

Strymon albata (C. Felder & R. Felder, 1865)

Localities. RAA/JBS: 33 ♂ & 8 ♀ Managua, Jan, Feb, Mar, Apr, Jul, Nov, Dec. 4 ♀ El Crucero/Las Nubes, Feb, Mar, Nov. 2 ♂ & 2 ♀ Pochomil, Jun, Jul. 1 ♀ Matagalpa South, Dec.

Strymon bebrycia (Hewitson, 1868)

Localities. RAA/JBS: 4 ♂ & 5 ♀ Managua, Jan, Feb, May, Jun, Aug, Dec. 2 ♂ & 2 ♀ Pochomil, Jul, Aug. 1 ♂ Granada, Jul. 1 ♀ Puerto Somoza, Aug. 7 ♀ Ciudad Dario, Jan. 1 ♂ El Crucero/Las Nubes, Feb.

Strymon yojoa (Reakirt, 1867)

Localities. GS: Chontales (Belt). RAA/JBS: 28 ♂ & 12 ♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Jul, Nov, Dec. 2 ♀ El Crucero/Las Nubes, Feb, Apr. 1 ♂ Granada, Jul. 1 ♂ Pochomil, Jun.

Strymon mulucha (Hewitson, 1867)

Localities. GS: Chontales (Belt). RAA/JBS: 1 ♂ Managua, May. 1 ♀ Bluefields, Dec.

Strymon cestri (Reakirt, 1867)

Localities. RAA/JBS: 9 ♂ & 12 ♀ Managua, Jan, Feb, Jun, Apr, May, Dec. 2 ♂ & 16 ♀ El Crucero/ Las Nubes, Feb, Mar, Apr, May, Nov.

Strymon bazochii (Godart, 1824)

Localities. RAA/JBS: 32 ♂ & 33 ♀ Managua, Jan, Feb, Mar, Jul, Aug, Sep, Oct, Nov, Dec. 1 ♂ & 1 ♂ Bluefields (El Bluff), Jun, Oct.

Strymon istapa (Reakirt, 1867)

Localities. GS: Matagalpa (Richardson). RAA/JBS: 21 ♂ & 19 ♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Aug, Nov, Dec. 7 ♀ El Crucero/Las Nubes, Feb, Mar, Apr, May, Aug, Nov. 4 ♀ Pochomil, Jan, Jul, Aug. USNM: 2 ♀ Managua (Todd), Nov.

Strymon gabatha (Hewitson, 1870)

Localities. RAA/JBS: 3 ♀ Bluefields, Apr, Dec.

Strymon megarus (Godart, 1824)

Localities. GS: Chontales (Belt). RAA/JBS: 2 ♂ Managua Feb, Dec.

Taxonomy. Robbins (2010a) discussed geographical variation of this species, which is a major pineapple pest, at least in South America.

Strymon ziba (Hewitson, 1868)

Localities. GS: Chontales (Belt). RAA/JBS: 28 ♂ & 5 ♀ Managua, Feb, Mar, Jul, Aug, Sep, Oct, Nov, Dec. Pochomil, Jun. USNM: 1 ♀ no further data

Remarks. The agricultural literature contains dozens of papers on the biology and control of this species and of *S. megarus*, each of which is a pest of cultivated pineapple (Robbins 2010a).

Tmolus echion (Linnaeus, 1767)

Localities. GS: Matagalpa (Richardson). RAA/JBS: 47 ♂ & 34 ♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Nov, Dec. 9 ♂ Pochomil, Jul. 1 ♀ Matagalpa North, Aug. 1 ♂ & 3 ♀ El Crucero/Las Nubes, Jan, Mar, May, Nov.

Tmolus crolinus Butler & H. Druce, 1872

Localities. RAA/JBS: 3♂ & 2♀ San Fernando, Jul. 2♀ Matagalpa North, Jul, Aug.

Tmolus cydrara (Hewitson, 1868)

Localities. RAA/JBS: 1♂ & 2♀ El Crucero/Las Nubes, Feb, Mar, Dec.

Nicolaea viceta (Hewitson, 1868)

Localities. RAA/JBS: 1♀ El Crucero/Las Nubes, Feb.

Remarks. Not recorded northwest of Nicaragua (Fig. 9).

Nicolaea ophia (Hewitson, 1868)

Localities. RAA/JBS: 1♂ & 2♀ Bluefields, Dec.

Remarks. This uncommon, but widespread species occurs in a great diversity of habitats, ranging from very wet lowland forest, such as Bluefields, to very dry scrub at about 1,000 m elevation in Brazil's central plateau (cerrado) to mountain tops over 1,600 m elevation (in at least one case) in Rio de Janeiro state (vouchers in USNM). This diversity of habitats suggest that this name is being applied to a complex of more than one biological species, but so far, morphological evidence for more than one species is lacking.

Nicolaea heraldica (Dyar, 1914)

Localities. RAA/JBS: 1♀ Bluefields, Apr.

Ministrymon clytie (W.H. Edwards, 1877)

Localities. RAA/JBS: 24♂ & 11♀ Managua, Apr, May, Jun, Jul, Aug, Sep, Nov, Dec. 6♂ & 9♀ Granada, Jul. 5♂ & 2♀ Pochomil, Jul, Aug. 1♂ & 2♀ Matagalpa South, Dec. USNM: 1♂ Ducuali, Dept. Esteli (Flint & Ortiz), Jun.

Taxonomy. This species, *M. coronta, M. santans*, and *M. arola* form a complex that is taxonomically unresolved. The type localities for *Thecla arola* and *T. coronta* are "Brazil" and "French Guiana", respectively, but this complex is otherwise only recorded from Central American deciduous forest, where it may be common at times. At least four different wing pattern forms, spanning a wide range of adult sizes, occur sympatrically and synchronically in Guanacaste, Costa Rica (vouchers in USNM). However, there are no other structural differences among these forms. Three of these wing pattern forms occur sympatrically and synchronically in Pochomil. The identifications of *M. coronta* and *M. santans* are provisional.

Ministrymon coronta (Hewitson, 1874)

Localities. RAA/JBS: 8♂ & 2♀ Pochomil, Jun, Jul, Aug.

Taxonomy. As noted, this name is provisional.

Ministrymon santans (Dyar, 1926)

Localities. RAA/JBS: 17♂ & 12♀ Pochomil, Jun, Jul, Aug.

Taxonomy. As noted, this name is provisional.

Ministrymon zilda (Hewitson, 1873)

Localities. RAA/JBS: 1♂ Bluefields, Apr.

Ministrymon phrutus (Geyer, 1832)

Localities. RAA/JBS: 12♂ & 9♀ Managua, Jan, Feb, Apr, May, Jun, Aug, Sep, Dec. 1♂ Granada, Jul.

Ministrymon azia (Hewitson, 1873)

Localities. RAA/JBS: 7♂ & 8♀ Managua, Jan, Feb, May, Jun, Jul, Aug, Sep, Nov. 2♀ Granada, Jul. 1♀ Matagalpa South, Aug. 1♀ Corinto, Jun.

Ministrymon una (Hewitson, 1873)

Localities. GS: Chontales (Janson). RAA/JBS: 1♂ Matagalpa North, Sep. 5♂ & 6♀ Rama, Jan, Mar. 1♀ Jinotega, Jan. 1♀ San Carlos, Sep. 1♀ Bluefields, Dec. 1♂ Granada, Nov. USNM: 12♂ & 15♀ Managua (Todd), Nov.

Type Locality. The type locality of *Thecla scopas* G&S, a synonym of *M. una*, is Nicaragua and Mexico.

Gargina caninius (H.H. Druce, 1907)

Localities. RAA/JBS: 1♂ & 5♀ Managua, Jul, Aug, Dec.

Gargina gnosia (Hewitson, 1868)

Localities. RAA/JBS: 3♂ & 2♀ Managua, May, Sep, Dec.

Gargina emessa (Hewitson, 1867)

Localities. GS: Chontales (Belt). RAA/JBS: 9♂ & 1♀ Managua, Jan, Aug, Nov, Dec. 1♀ Pochomil, Jan.

Type Locality. The type locality of *Thecla legytha* Hewitson, a synonym of *G. emessa*, is Nicaragua.

Remarks. Not recorded northwest of Nicaragua (figured in D'Abrera 1995: 1175).

Gargina thoria (Hewitson, 1869)

Localities. RAA/JBS: 16♂ & 7♀ Managua, Jan, Mar, May, Jun, Aug, Dec.

Siderus leucophaeus (Hübner, 1818)

Localities. GS: Chontales (Belt). RAA/JBS: 1♂ Bluefields, Dec.

Type Locality. The type locality of *Thecla volupia* Hewitson, a synonym of *S. leucophaeus*, is Nicaragua.

Siderus philinna (Hewitson, 1868)

Localities. RAA/JBS: 1♀ Managua, Feb.

Ostrinotes halciones (Butler & H. Druce, 1872)

Localities. GS: Chontales (Belt).

Ostrinotes keila (Hewitson, 1869)

Localities. GS: Chontales (Belt). RAA/JBS: 1♂ & 1♀ Managua, Nov, Dec. 1♀ Matagalpa North, Aug.

Type Locality. The type locality of *Thecla parasia* Hewitson, a synonym of *O. keila*, is Nicaragua.

Theclopsis demea (Hewitson, 1874)

Localities. GS: Chontales (Belt). RAA/JBS: 2♂ & 1♀

Bluefields, Jan, Apr, Dec. 1 ♀ Nueva Guinea, Oct.

Type Locality. The type locality of *T. demea* is Nicaragua.

Remarks. Not recorded northwest of Nicaragua (Figs. 7, 8).

Theclopsis mycon (Godman & Salvin, 1887)

Localities. RAA/JBS: 3 ♂ & 6 ♀ El Crucero/Las Nubes, Jun, Nov, Dec. 1 ♀ Managua, Jan.

Strephonota tephraeus (Geyer, 1837)

Localities. GS: Chontales (Belt, Janson). RAA/JBS: 25 ♂ & 16 ♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep, Oct, Nov, Dec. 4 ♂ & 4 ♀ El Crucero/Las Nubes, Feb, Mar, Apr, Nov. 1 ♂ & 1 ♀ Pochomil, Jul. 1 ♀ Santo Tomás, Mar.

Strephonota species

Localities. RAA/JBS: 1 ♀ Nueva Guinea, Oct.

Taxonomy. A species level taxonomy of the lineage of *Strephonota* to which this species belongs is in preparation by Robbins, Busby, and Faynel.

Strephonota ambrax (Westwood, 1852)

Localities. GS: Chontales (Belt).

Panthiades bitias (Cramer, 1777)

Localities. GS: Chontales (Belt, Janson), Matagalpa (Richardson). RAA/JBS: 26 ♂ & 9 ♀ Managua, Jan, Feb, Mar, Apr, May, Jul, Aug, Sep, Nov, Dec. 1 ♂ & 1 ♀ El Crucero/Las Nubes, Feb. 3 ♂ & 4 ♀ Pochomil, Apr, Jun, Jul. 1 ♂ Granada, Jul. 1 ♂ & 4 ♀ Bluefields, Apr, Jun, Dec. 1 ♂ & 1 ♀ Matagalpa South, Dec.

Panthiades ochus (Godman & Salvin, 1887)

Localities. AMNH: 1 ♂ San Juan del Norte, Aug.

Remarks. Nicolay (1976) noted this specimen, which was part of the F.E. Church collection, but the collector's name on the handwritten locality label appears to be "Field".

Panthiades bathildis (C. Felder & R. Felder, 1865)

Localities. GS: Chontales (Belt, Janson), Matagalpa (Richardson). RAA/JBS: 34 ♂ & 22 ♀ Managua, Jan, Feb, Mar, Apr, May, Jun, Aug, Sep, Nov, Dec. 1 ♀ Pochomil, Aug. 2 ♂ & 3 ♀ El Crucero/Las Nubes Feb, May. 1 ♀ Granada, Jul. 1 ♂ Jinotega, Jan.

Type Locality. The type locality of *Thecla aufidena* Hewitson, a synonym of *P. bathildis*, is Nicaragua.

Panthiades phaleros (Linnaeus, 1767)

Localities. GS: Chontales (Belt). RAA/JBS: 1 ♂ & 1 ♀ Granada, Mar. 1 ♀ San Juan del Norte, Mar.

Thepytus arindela (Hewitson, 1874)

Localities. GS: Chontales (Belt).

Nomenclature. Belt's Chontales specimen is the holotype.

Remarks. Not recorded northwest of Nicaragua (Panamanian specimens figured in Robbins et al. 2010).

Porthecla/Oenomaus melleus (Druce, 1907)

Localities. GS: Chontales (Belt).

Taxonomy. Robbins (2004) placed this species in *Porthecla* and Faynel (2007) transferred it to *Oenomaus*. A phylogenetic analysis of *Porthecla* + *Oenomaus* (Faynel & Robbins, in prep.) should resolve the issue.

Remarks. Godman and Salvin (1887–1901) reported three females of *O. atena* from Nicaragua. According to Faynel (2007), one is a male of this species, one is a male lacking an abdomen (identification is thus tenuous), and one is an unidentifiable female of *Oenomaus. Oenomaus atena* occurs as far north as Costa Rica, but we are unaware of any definitive Nicaraguan records.

Oenomaus ortygnus (Cramer, 1779)

Localities. RAA/JBS: 11 ♂ & 9 ♀ Managua, May, Aug, Nov. 1 ♀ Bluefields, Apr. 1 ♂ & 1 ♀ Granada, Jul.

Oenomaus species

Localities. RAA/JBS: 2 ♀ Bluefields, Dec.

Taxonomy. We do not know if the 'unidentifiable female of *Oenomaus*' that Godman and Salvin misidentified as *Thecla atena* (see above) is the same species as these two females. Additionally, there are two problems with the identification of this species. First, Central American males with a ventral wing pattern very similar to these females represent a species that does not have a name (Faynel et al., in prep.). Second, despite superb work on taxonomic characters in males of *Oenomaus* (Faynel 2008, Faynel & Moser 2008), the identification of female *Oenomaus* using morphology is oftentimes not possible.

Remarks. Not recorded northwest of Nicaragua.

Parrhasius polibetes (Stoll, 1781)

Localities. RAA/JBS: 19 ♂ & 11 ♀ Managua, Jan, Feb, Mar, Jul, Aug, Sep, Nov. 7 ♂ & 9 ♀ El Crucero/Las Nubes, Jan, Feb, Mar, Nov.

Parrhasius moctezuma (Clench, 1971)

Localities. RAA/JBS: 1 ♂ Matagalpa North, Aug.

Remarks. Not recorded southeast of Nicaragua (Fig. 11). Maes et al. (1999) recorded the food plant as *Senecio* (Asteraceae).

Michaelus phoenissa (Hewitson, 1867)

Localities. GS: Chontales (Hewitson).

Michaelus jebus (Godart, 1824)

Localities. RAA/JBS: 3 ♂ & 2 ♀ Managua, Jan, Aug, Nov. 7 ♂ & 3 ♀ El Crucero/Las Nubes, Feb, Mar.

Michaelus hecate (Godman & Salvin, 1887)

Localities. GS: Matagalpa (Richardson). RAA/JBS: 2 ♂ & 3 ♀ Pochomil, Jul. 1 ♀ El Crucero/Las Nubes, Mar.

Michaelus ira (Hewitson, 1867)

Localities. RAA/JBS: 42 ♂ & 4 ♀ Managua, Jan, May, Jun, Jul, Aug, Oct, Nov, Dec. 2♂ Pochomil, Jul, Aug. 1♂& 1♀ El Crucero/Las Nubes, Feb, Nov.

Ignata gadira (Hewitson, 1867)

Localities. RAA/JBS: 3♂& 3♀ El Crucero/Las Nubes, Feb, Mar.

Ignata caldas Robbins, 2010

Localities. RAA/JBS: 1♂ El Crucero/Las Nubes, Mar.

Hypostrymon critola (Hewitson, 1874)

Localities. RAA/JBS: 1♂ Granada, Jul.

Remarks. Not recorded southeast of Nicaragua (Fig. 12).

Nesiostrymon dodava (Hewitson, 1877)

Localities. RAA/JBS: 1♂ Matagalpa North, Jul.

Iaspis andersoni Robbins, 2010

Localities. GS: Chontales (Belt). RAA/JBS: 1♂ Managua, Feb.

Iaspis castimonia (H.H. Druce, 1907)

Localities. RAA/JBS: 1♀ Jinotega, Jan.

Celmia celmus (Cramer, 1775)

Localities. GS: Chontales (Belt).

Celmia conoveria (Schaus, 1902)

Localities. RAA/JBS: 5♂ & 3♀ Managua, Aug, Oct, Nov, Dec. 2♀ El Crucero/ Las Nubes, Feb, Mar.

Erora carla (Schaus, 1902)

Localities. RAA/JBS: 1♂ & 1♀ Managua, May, Oct. 2♂ & 11♀ El Crucero/Las Nubes, Jan, Feb, Mar, Nov.

Taxonomy. Female wing pattern is geographically variable, and it is unclear if more than one species is represented by this name in Central America.

Chalybs janias (Cramer, 1779)

Localities. GS: Chontales (Belt). RAA/JBS: 1♂ & 3♀ Bluefields, Dec.

Chalybs hassan (Stoll, 1790)

Localities. RAA/JBS: 5♂ & 3♀ Managua, Mar, Feb, Jun, Jul, Aug, Nov. 9♂& 13♀ El Crucero/Las Nubes, Feb, Mar.

Symbiopsis rickmani (Schaus, 1902)

Localities. RAA/JBS: 3♀ Bluefields, Jan, Dec.

Taxonomy. Previously known as *S. smalli* Nicolay (Robbins 2004).

Remarks. Not recorded northwest of Nicaragua (Fig. 10).

73 Species Recorded both Northwest and Southeast of Nicaragua

Mithras colombiensis (K. Johnson & Constantino, 1997), *Brangas carthaea* (Hewitson, 1868), *Brangas* species, *Brangas getus* (Fabricius, 1787), *Thaeides theia* (Hewitson, 1870), *Enos falerina* (Hewitson, 1867), *Enos thara* (Hewitson, 1867), *Atlides halesus* (Cramer, 1777), *Atlides polybe* (Linnaeus, 1763), *Atlides inachus* (Cramer, 1775), *Atlides carpasia* (Hewitson, 1868), *Theritas lisus* (Stoll, 1790), *Micandra cyda* (Godman & Salvin, 1887), *Temecla heraclides* (Godman & Salvin, 1887), *Thereus orasus* (Godman & Salvin, 1887), *Thereus ortalus* (Godman & Salvin, 1887), *Arawacus hypocrita* (Schaus, 1913), *Contrafacia ahola* (Hewitson, 1867), *Kolana lyde* (Godman & Salvin, 1887), *Ocaria arpoxais* (Godman & Salvin, 1887), *Magnastigma elsa* (Hewitson, 1877), *Cyanophrys amyntor* (Cramer, 1775), *Cyanophrys fusius* (Godman & Salvin, 1887), *Bistonina erema* (Hewitson, 1867), *Lathecla latagus* (Godman & Salvin, 1887), *Janthecla rocena* (Hewitson, 1867), *Arzecla tarpa* (Godman & Salvin, 1887), *Arzecla paralus* (Godman & Salvin, 1887), *Camissecla vespasianus* (Butler & H. Druce, 1872), *Calycopis tamos* (Godman & Salvin, 1887), *Calycopis buphonia* (Hewitson, 1868), *Calycopis caesaries* (H.H. Druce, 1907), *Strymon alea* (Godman & Salvin, 1887), *Strymon astiocha* (Prittwitz, 1865), *Strymon serapio* (Godman & Salvin, 1887), *Tmolus mutina* (Hewitson, 1867), *Nicolaea dolium* (H.H. Druce, 1907), *Nicolaea* species, *Nicolaea velina* (Hewitson, 1868), *Ministrymon arola* (Hewitson, 1868), *Ministrymon inoa* (Godman & Salvin, 1887), *Ministrymon cleon* (Fabricius, 1775), *Gargina gargophia* (Hewitson, 1877), *Theclopsis leos* (Schaus, 1913), *Ostrinotes purpuriticus* (H.H. Druce, 1907), *Ostrinotes* species, *Strephonota syedra* (Hewitson, 1867), *Strephonota ericeta* (Hewitson, 1867), *Porthecla porthura* (H.H. Druce, 1907), *Thepytus echelta* (Hewitson, 1867), *Oenomaus atesa* (Hewitson, 1867), *Oenomaus taua* Faynel & Moser, 2008, *Parrhasius orgia* (Hewitson, 1867), *Michaelus thordesa* (Hewitson, 1867), *Michaelus joseph* Robbins, 2010, *Ignata norax* (Godman & Salvin, 1887), *Hypostrymon asa* (Hewitson, 1868), *Apuecla maeonis* (Godman & Salvin, 1887), *Apuecla upupa* (H.H. Druce, 1907), *Nesiostrymon calchinia* (Hewitson, 1868), *Nesiostrymon celona* (Hewitson, 1874), *Aubergina paetus* (Godman & Salvin, 1887), *Aubergina hicetas* (Godman & Salvin, 1887), *Aubergina* species, *Iaspis temesa* (Hewitson, 1868), *Dicya dicaea* (Hewitson, 1874), *Dicya carnica* (Hewitson, 1873), *Erora subflorens* (Schaus, 1913), *Erora nitetis* (Godman & Salvin, 1887), *Erora aura* (Godman & Salvin, 1887), *Erora gabina* (Godman & Salvin, 1887), *Erora opisena* (H.H. Druce, 1912), *Semonina ares* (Godman & Salvin, 1887).

DISCUSSION

History of Collectors. The Nicaraguan Eumaeini records in the Biologia Centrali Americana are based upon specimens collected by Belt, Janson, and Richardson, and in a few cases, upon specimens in Hewitson's collection for which the collector was usually unstated. Belt (1874) lived in Nicaragua from 1868 to 1872 and worked as a mining engineer. His insect collecting was done during his "spare" time, which also included more general observations on Nicaraguan natural history, with an emphasis on birds and geology. Most insects that Belt collected in Chontales were apparently from the vicinity of Santo Domingo (~600 m elevation wet forest with some hills at slightly higher elevations) (Bates 1872, Belt 1874), but neither Santo Domingo nor the date of capture was noted on the locality labels. According to Belt (1874), Janson visited Nicaragua specifically to collect insects, but we do not otherwise know much about him. Richardson was hired to collect insects specifically for the Biologia project (Selander & Vaurie 1962). All Richardson records were published in the 1901 addendum of Godman and Salvin.

Richard A. Anderson resided in Nicaragua from 1973 to 1976 and collected butterflies as an avocation with special emphasis on Lycaenidae and Hesperiidae (Anderson 2007). J. Bolling Sullivan collected with Anderson for two weeks in 1975 and prepared many of the specimens collected by Anderson.

All other Nicaraguan specimens in museum collections, so far as we are aware, are from short trips, such as those of Todd in the USNM, for which butterfly collecting was not the primary objective. These records mostly represent common and widespread species.

Biogeography. Highlands of rugged ridges up to about 1800 m elevation in central Nicaragua support a mixed forest of oak, pine, and tree ferns that is classified as Dry and Wet Subtropical Forest (Holdrige 1962). To the north, these ridges are continuous with the mountains of Honduras. In southern Nicaragua, the ridges grade into low rolling hills so that there is a lowland gap between the central highlands of Nicaragua and the mountains of Costa Rica. Historically, this area was considered for a Nicaraguan canal before the Isthmus of Panama was chosen.

Most hairstreak species in the Nicaraguan highlands, such as *Laothus oceia* (Fig. 2), *Ocaria petelina*, *Brevianta tolmides*, and *Temecla paron*, occur widely from Mexico to Panama, and sometimes to South America. However, *Kisutam micandriana* (Figs. 5, 6), *Parrhasius moctezuma* (Fig. 11), and possibly *Electrostrymon guzanta* (a species complex in need of taxonomic revision) are recorded only from Mexico to Nicaragua. They reach the southern limit of their distribution in Nicaragua, which is consistent with the break in the mountains in the southern part of the country. Nicaragua is the northern distributional limit for two lower montane species, *Thepytus arindela* (figured in Robbins et al. 2010) and *Thestius epopea* (figured in D'Abrera 1995: 1208). Since *T. arindela* was described in 1874 from a Chontales male, only three other individuals have been documented (Robbins et al. 2010), so this distributional limit is likely to be an artifact of undersampling. *Thestius epopea*, on the other hand, is a reasonably common species in some parts of its range (Godman & Salvin 1887–1901), so this distributional limit may be correct. However, neither Anderson nor Sullivan found this species, which is usually most common in the morning in wet lower-montane forest (Robbins unpubl.).

The coastal Nicaraguan life zones are shared with Costa Rica to the southeast and with Honduras to the northwest. A broad hot, humid coastal plain comprised of Humid and Very Humid Lowland and Lower Montane Forest (Holdrige 1962) dominates the Caribbean coast in all three countries and extends to South America. Similarly, a narrower coastal plain comprised of Tropical Dry and Very Dry Forest (Holdrige 1962) extends along the Pacific coast in all three countries, sometimes interspersed with more humid forest at moderate elevations (El Crucero/Las Nubes is an example).

In Central America *Lamprospilus coelicolor* (D'Abrera 1995 figured the female as *coelicolor* on page 1207 and the male as *myrsina* on page 1209), *Calycopis orcillula* (D'Abrera 1995 figured the female on page 1236), *Theclopsis demea* (Figs. 7, 8), *Oenomaus* species, and *Symbiopsis rickmani* (Fig. 10) are primarily denizens of Caribbean-slope wet lowland forests (*L. coelicolor* may also be found at higher elevations) and occur from Nicaragua, where they reach their northern distributional limit, to South America. They may eventually be found further north. *Pseudolycaena marsyas* (Fig. 1) inhabits many kinds of habitats in South America; the difficulties with its taxonomy are noted in the species accounts.

Hypostrymon critola (Fig. 12) was found on the Pacific slope of Nicaragua. It occurs from southern Arizona (in the mountains) and Baja California (Clench 1975, Brown et al. 1992) to Nicaragua, where it reaches its southern known limit. Clench (1975) noted that this species seems to occur with halophilous shrubs, but this observation has not been investigated further.

Nicolaea viceta (Fig. 9) is a rare species in the Central American part of its range, where there are five records from Panama, Costa Rica, and Nicaragua. It occurs in wet and dry forest, and reaches its known northern limit in Nicaragua.

Gargina emessa (figured in D'Abrera 1995: 1175) is a common species that occurs in a great variety of wet and dry lowland forests under 1,000 m elevation. It reaches the northern limit of its distribution in Nicaragua, but may well occur further north.

Eumaeus godartii (illustrated in D'Abrera 1995: 1101) occurs in a great variety of lowland and montane forest habitats from South America (west of the Andes) to Nicaragua, wherever its Cycadaceae larval food plants occur (DeVries 1977, reared vouchers from Puntarenas, Costa Rica and Valle, Colombia in USNM). This species is not sympatric with *Eumaeus toxea*, which occurs in a similar variety of habitats from Honduras to Mexico and uses the same larval food plants (Ross 1964, Kendall & McGuire 1984). Since the distribution of *E. godartii* does not seem to be limited by its habitat or the distribution of its larval food plants, perhaps food plant competition or mating interference with *E. toxea* prevents its occurrence further northwest.

In sum, no eumaeine species is known to be endemic to Nicaragua. Of the currently known fauna, about 10% has their distributional limit in Nicaragua. Four species (*K. micandriana, E. guzanta, P. moctezuma*, and *H. critola*) are unknown south of Nicaragua and eleven (*Eumaeus godartii, Pseudolycaena marsyas, Thestius epopea, Lamprospilus coelicolor, Calycopis orcillula, Nicolaea viceta, Gargina emessa, Theclopsis demea, Thepytus arindela, Oenomaus* species, and *Symbiopsis rickmani*) are unrecorded north of Nicaragua.

Eumaeine Fauna. The recorded eumaeine fauna of Nicaragua with 149 species is more than double the 71 species listed in Godman and Salvin (1887–1901). Another 73 species, which have not been found in Nicaragua, are recorded both to the northwest and to the southeast. Further, the highlands are likely to contain montane species currently known only to the northwest while the wet Caribbean coastal plain is likely to harbor species currently known only to the southeast. For these reasons, the Nicaraguan eumaeine fauna is likely to be greater than 200 species, perhaps substantially so.

ACKNOWLEDGEMENTS

Dan Janzen and Winnie Hallwachs shared information on reared and DNA barcoded Costa Rican lycaenids. Christophe Faynel and Bob Busby provided information on hairstreak taxonomy, which greatly improved this paper, and made suggestions that improved the accuracy of the manuscript. Paul Scharf accompanied Anderson on many collecting trips and provided him with collected material. John Brown made many helpful suggestions on the discussion of biogeography. John Shuey made available Belize specimens that have improved our taxonomic identifications. For help with recording data, we are grateful to Brian Harris. Karie Darrow made the photographic plate, which amply illustrates her talent. Finally, we thank Lourdes Chamorro for critically reading the manuscript and correcting a number of errors.

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Received for publication 18 February 2011; revised and accepted 5 October 2011

Journal of the Lepidopterists' Society
66(2), 2012, 76–80

A NEW PHYCITINE GENUS AND SPECIES FROM UTAH (PYRALOIDEA: PYRALIDAE: PHYCITINAE)

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ABSTRACT. The new genus *Utah* is described from moths collected in the San Rafael Reef area of eastern Utah and in Juab Co., western Utah near the Nevada border. The type species *Utah sanrafaelensis* is described. Adults and genitalia are illustrated.

Additional key words: Phycitinae, Pyralidae, Pyraloidea, Utah, *Utah sanrafaelensis*

During April and May in 2003–2005, I collected a series of twenty-six specimens of a gray pyralid in UV light traps in the San Rafael Reef area of Emery Co., Utah. The San Rafael Reef is along the eastern portion of the San Rafael Swell, which in turn is part of the Colorado Plateau. Initially, based on habitus, the moths appeared to be an undescribed species of *Interjectio* Heinrich. Subsequent to submitting this paper for initial review, twenty-nine additional specimens were found in the Los Angeles County Museum of Natural History (LACM) and the personal collection of Stephanie Shank (Alburgh, VT), all collected by her in the Fish Springs NWR, Juab Co., Utah during May and June, 1989. Upon examination of the male and female genitalia, I was unable to place the moths to any genus or species treated by Heinrich (1956) or Neunzig (2003). In the possibility that the moth might be a described extralimital species, additional references were consulted yielding no matches in habitus (Ragonot, 1901; Druce [plates], 1891–1900; Herbulot, 1960). In keeping with phycitine genera names derived from place names (*Palatka* Heinrich, *Passadena* Hulst, *Sarasota* Hulst, *Tulsa* Heinrich, etc.), I propose a new genus.

UTAH Ferris, **new genus**

(Figs. 1–13)

Type species: *Utah sanrafaelensis*, Ferris, 2012

Diagnosis. Length of forewing: 12–15 mm males (n = 21), 12–13 mm females (n = 5). Wing venation shown in Fig. 1. Adults are medium-sized phycitines with white dorsal forewing ground color overlaid with black or very dark brownish-black mottling; the dorsal hindwings are essentially unmarked fuscous. The moths could be confused with some of the species in *Interjectio* Heinrich, *Phobus* Heinrich, *Pima* Hulst, *Pyla* Grote, and *Sarata* Ragonot based on size, color, and maculation. The porrect labial palpi in *Interjectio*, *Pima*, and *Sarata* separate these genera from *Utah*, which has strongly upturned labial palpi. Reliable separation from *Phobus* and *Pyla* is by the unique male and female genitalia. In the male, in contrast to related genera, the aedeagus is without a well-defined sclerotized shaft. The membranous vesica is without cornuti (which occur in *Phobus*), but rather the shaft of the aedeagus consists of a sclerotized ventral plate with two parallel rod-like structures that support two robust (easily broken) spines at opposite ends. In the female genitalia, the corpus bursae is without signa and has a well-developed spherical appendix bursae, not seen in the other genera. The sterigma is membranous and nearly unsclerotized. Additional comments and a rudimentary cladistic analysis are included in Appendix 1.

Description. As below for type species.

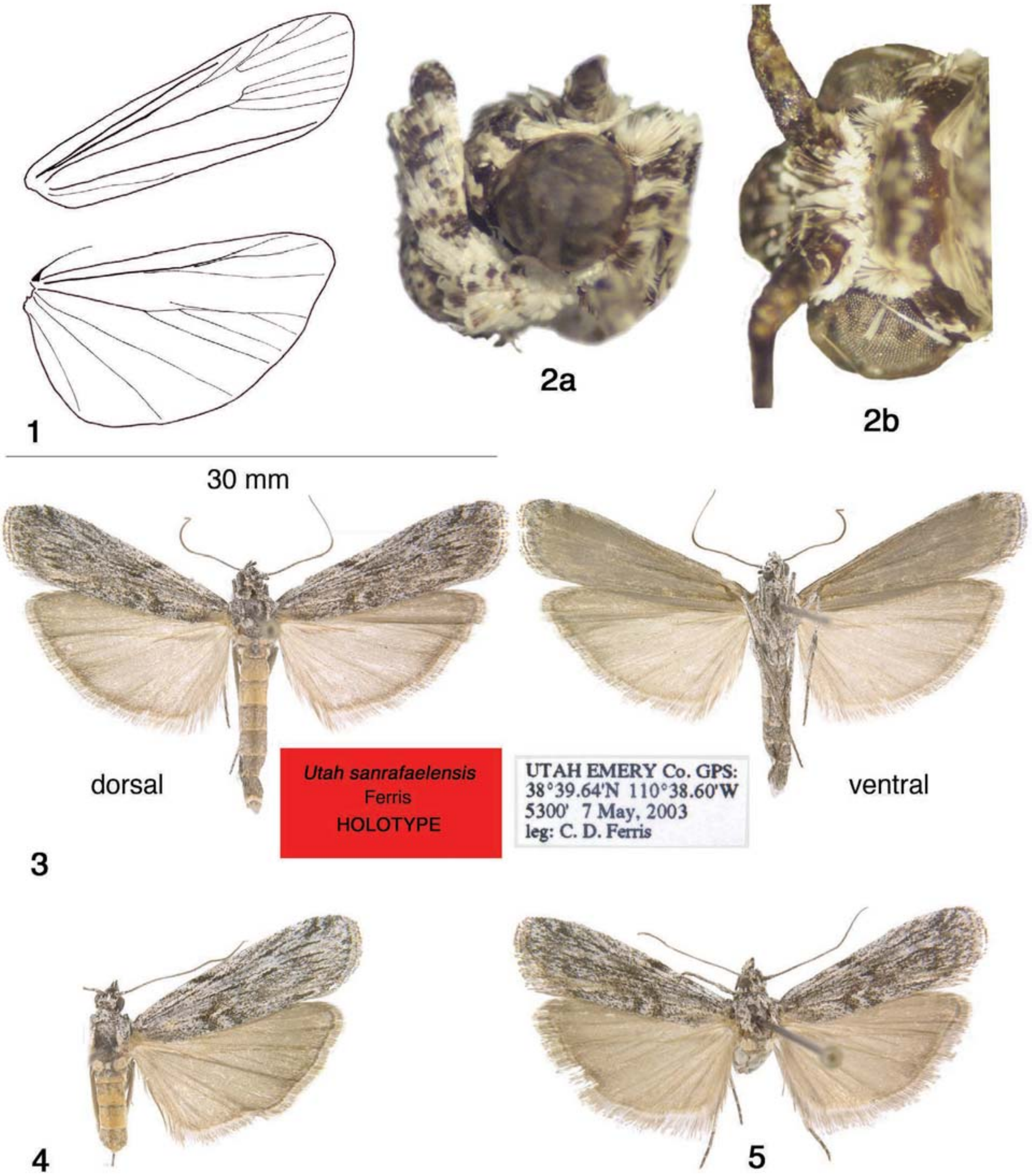
Etymology. *Utah* is masculine. The state name Utah is a noun derived from the name of the Ute Native American tribe, and in their language means "people of the mountains."

Utah sanrafaelensis, Ferris, **new species**

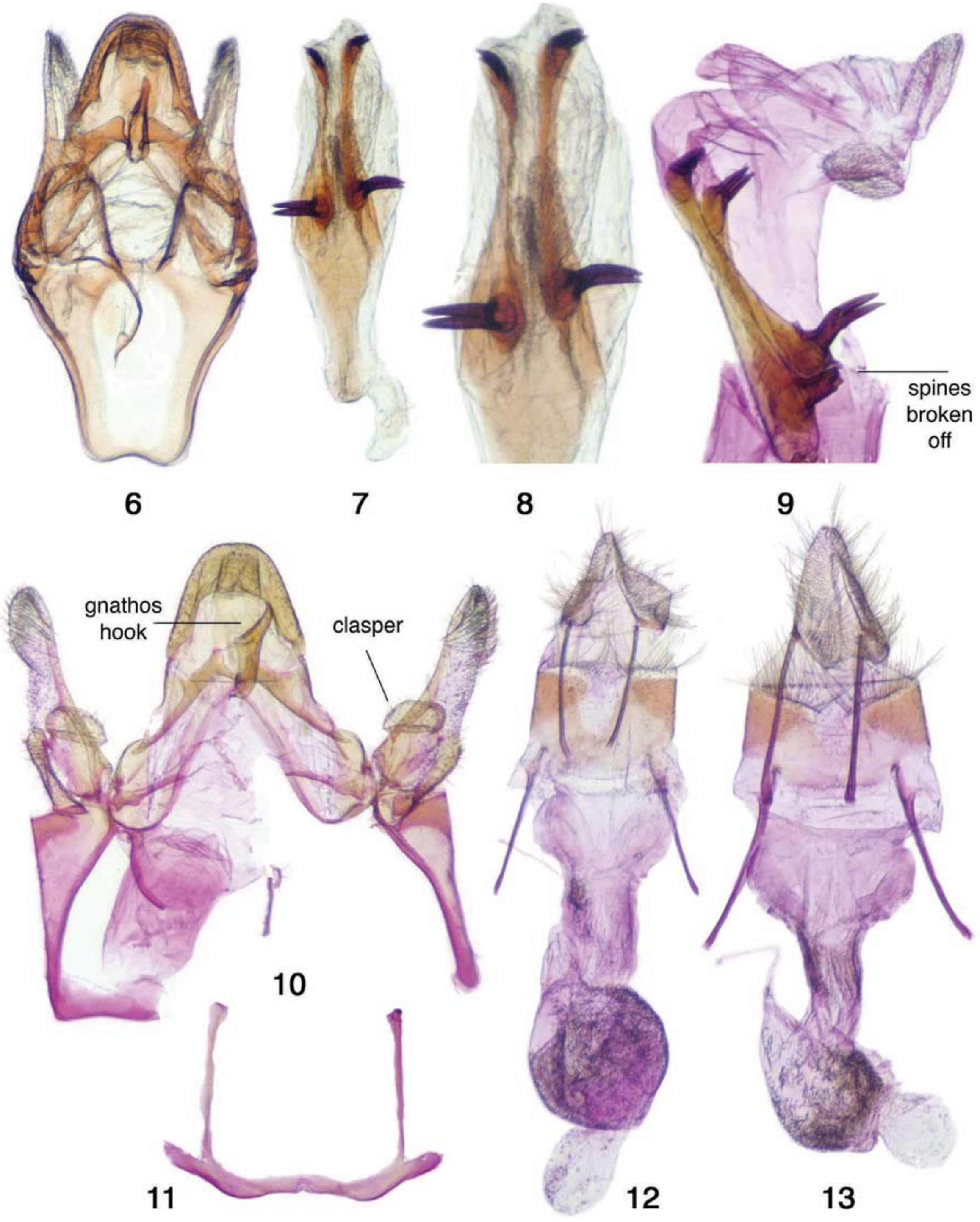
(Figs. 1–13)

Diagnosis. As above for genus.

Description. *Head* (Fig. 2). Male antenna similar to *Castastia* (Neunzig, 2003, p. 41, text fig. 14a). Speckled charcoal gray and white; pubescent. Basal segments of antenna form a very shallow sinus; apices of segments produced into black spine-like processes weakly covered by scale tufts. Female antenna simple. Haustellum well developed and thickly covered with white and brownish scales. Labial palpi robust, oblique, projecting above frons. Ocellus present. Head including frons, palpi, crown speckled with white and dark slightly brownish charcoal gray scales. *Thorax*. Thoracic vestiture similar to head. Legs basically white speckled with dark brownish-black scales, especially on tarsi. *Abdomen*. Dorsally tawny peppered with small brownish scales, prominent dark brown chitinization between segments; laterally and ventrally clothed with white and dark brown scales. *Wings*. Dorsal forewing. Ground color white, overlaid with numerous short horizontal streaks of black or very dark brownish-black scales; two small dark patches along basal third of costal margin and two additional small dark patches immediately before apex. A small horizontal dark basal patch along inner margin. Two horizontal V-shaped dark markings (pointing basad) separated by white scales located along the inner margin in basal half of wing and



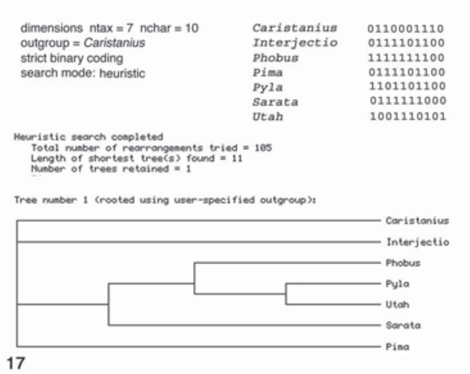
FIGS. 1–5. *Utah sanrafaelensis*. **1,** wing venation. **2,** head, **2a** lateral view less antennae showing labial palpi; **2b** dorsal view showing antenna base. **3,** male holotype with pin labels (not to scale). **4,** male paratype. **5,** female.



FIGS. 6–13. *Utah sanrafaelensis* genitalia. **6–11,** male genitalia. **6,** genital capsule, aedeagus removed. **7,** aedeagus to scale (ventral view). **8,** enlarged view of upper half of aedeagus. **9,** aedeagus with vesica everted. **10,** genital capsule split and flattened. **11,** ventral sclerotization of 8th abdominal segment. **12–13,** female genitalia viewed ventrally.

FIGS. 14–15. Type locality habitat. **14,** looking east. **15,** looking west.

FIG. 16. Utah map showing *Utah sanrafaelensis* colony locations.



```
dimensions  ntax = 7  nchar = 10          Caristanius     0110001110
outgroup = Caristanius                    Interjectio     0111101100
strict binary coding                      Phobus          1111111100
search mode: heuristic                    Pima            0111101100
                                          Pyla            1101101100
                                          Sarata          0111111000
                                          Utah            1001110101

Heuristic search completed
   Total number of rearrangements tried = 105
   Length of shortest tree(s) found = 11
   Number of trees retained = 1

Tree number 1 (rooted using user-specified outgroup):
```

FIG. 17. Data set and associated tree generated by PAUP (original PAUP graphics).

extending vertically to mid-wing. Fringe basally checkered white and dark scales with only white scales along outer edge. No visible transverse scale ridge. Dorsal hindwing. Pale fuscous and slightly hyaline; thin dark fuscous marginal band; fringe basally checkered brownish and white, outer margin white. Ventral forewing. Unmarked fuscous, glossy, slight darkening of costa toward apex; fringe checkered brown and white basally, then white. Ventral hindwing. Similar to dorsal forewing but slightly paler. *Male genitalia* (Figs. 6–10; 8 dissections). Uncus trapezoidal, broad with rounded apex, hoodlike. Gnathos with moderately long robust hook. Transtilla present. Valva short, narrow with heavily sclerotized costa, and pad-like clasper at base. Basal margin of saccus indented. Aedeagus unusual, basically a membranous suggestion of an extended manica; ventrally consisting of a strongly sclerotized plate tapering to base from a swollen midsection; upper half of this structure bifurcated with narrow symmetrical arms. At base of each are a pair of robust spines set perpendicular to the arm axis; the apex of each arm is expanded and supports two robust spines (smaller than basal spines) also set perpendicular to arm axis. Everted vesica is membranous without cornuti; there are two prominent diverticuli, one covered with small spinules, and a spinule-covered spherical pouch. The ventral sclerotization of the eighth abdominal segment is broadly U-shaped without projecting tufts (Fig. 11). *Female genitalia* (Figs. 12–13, ventral aspect; 5 dissections). Ovipositor lobes basally broad tapering to apex, hirsute with long fine hairs. Apophyses robust and of approximately equal length. Sterigma goblet shaped, broad, open, essentially membranous rather than sclerotized. Ductus bursae a membranous tube with length approximately equal to diameter of corpus bursae; two linear diffuse spinule patches along axis. Corpus bursae spherical with diameter about double the diameter of ductus bursae; signa absent, but spinule patches present. Appendix bursae a well-developed unadorned sphere, smaller than corpus bursae, emanating from lower right side of latter. Ductus seminalis originates from a conical projection on the upper left side of the corpus bursae.

Types. Holotype male (Fig. 3): Utah, Emery Co., San Rafael Reef area, 38°39.64'N, 110°38.60'W, 5300' (1617 m), 7 May, 2003. Deposited in Carnegie Museum, Pittsburgh, PA. Paratypes: same collecting locality, 7.v.03 (3m), 22.v.03 (2f); 27.iv.04 (1m); 15.v.05 (17m, 3f), all C. D. Ferris collector. Paratypes in author's collection. Additional paratypes: Utah, Juab Co., Fish Springs NWR, 15.v, 6.vi, 1989 (6m, 15f), all Stephanie Shank (McKown) collector. Five pairs deposited in LACM with the remainder in the S. Shank collection.

Additional material examined. Eight specimens in Shank collection with same data as Juab Co, specimens, but not included as paratypes because of damaged condition.

Biology. Unknown. The type locality (Figs. 14–15) is moderately arid desert with *Artemisia, Ephedra* and *Juniperus* as the principal woody components.

Distribution. Known only from two localities in Utah (Fig. 16).

Etymology. The name *sanrafaelensis* (adjective) denotes the geographic place of occurrence of one colony of the the moths.

ACKNOWLEDGEMENTS

My thanks to Julian Donahue, Los Angeles, CA and Stephanie Shank (McKown), Alburgh, VT for providing loan material for examination. Two anonymous reviewers provided comments and suggestions.

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Appendix 1. Discussion of phylogeny of *Utah*.

The phylogentically appropriate generic placement of *Utah* awaits barcoding of the Phycitinae. The forewing shape of *U. sanrafaelensis* closely matches that of *Sarata incanella* (Hulst) and except for the difference between the labial palpi, it might easily be confused with the pale form of the latter. In general habitus, *U. sanrafaelensis* resembles *Interjectio denticuella* (Rag.) [= *ruderella* (Rag.) *fide* Neunzig, 2003], but again the labial palpi do not agree. Other similarities are to some phenotypes of *Pima granitella* (palpi do not match) and *Phobus brucei* (Hulst), which has somewhat similar palpi, but different male and female genitalia. In habitus, *Utah* does not resemble the several gray species of *Pyla* (Wilterding & Balogh, 2002), which have shorter and broader forewings and dissimilar maculation. There is similarity of the palpi and some superficial similarity of the male genitalia, but the female genitalia are very different in possessing a prominent appendix bursae. One external reviewer requested the inclusion of a cladistic analysis, and a rudimentary analysis is now presented, using PAUP, based upon the genera herein mentioned and in the main body of the paper. The genus *Caristanius* was selected as the outgroup because of some superficial resemblance in habitus of *C. decoloralis* (Walker), but differences in the genitalia from the other *Utah* look-alike genera/species. The character set is based on the characters mentioned in the diagnosis and description sections. In the data matrix shown in Fig. 17, the character columns 1–10 read from left to right. The characters are: 1. labial palpi not porrect = 1, porrect = 0; 2. aedeagus sheath well sclerotized = 1, not so = 0; 3. cornuti present = 1, absent = 0; 4. uncus hoodlike = 1, not so = 0; 5. gnathos with definite hook = 1, no hook = 0; 6. transtilla present but may be incomplete = 1, absent = 0; 7. sclerotized sterigma = 1, not so = 0; 8 ductus seminalis emerges at top of bursae = 1, not so = 0; 9. signum present = 1, absent = 0; 10. appendix bursae present = 1, absent = 0. The single resulting tree is shown in Fig. 17 and suggests that *Utah* is a sister species to *Pyla*. This result must not be construed as definitive because of both the limited character set and the limited number of genera selected. As noted initially, barcoding should eventually resolve the placement of *Utah*.

Submitted for publicaton 2 April 2011; revised and accepted 10 October 2011.

Journal of the Lepidopterists' Society
66(2), 2012, 81–110

NEW BROMELIAD-FEEDING *STRYMON* SPECIES FROM BIG BEND NATIONAL PARK, TEXAS, USA AND ITS VICINITY (LYCAENIDAE: THECLINAE)

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ABSTRACT. *Strymon solitario* Grishin & Durden, **new species** is described from southwest Texas, USA. This *serapio* group species of *Strymon* is distinguished from its closest relatives by a combination of: (1) restricted areas of light scales basally from submarginal darker lunules on the ventral hindwing—with these light macules not reaching 1/3 of the distance between the lunules and postmedian orange band; (2) small oval well-separated orange macules in the postmedian ventral hindwing band; (3) the presence of postbasal orange macules on the ventral hindwing in some specimens; (4) limited to almost absent violet blue dorsal wing overscaling; (5) occasional orange overscaling on the dorsal forewing in females; (6) rounder wings, particularly in males; (7) not prominently developed areas of dark scales on leg tibiae in most specimens, and (8) arid, desert and rocky slopes habitat. Relationships with other *Strymon* species are discussed and life history data are presented and illustrated. *Hechtia texensis* (Bromeliaceae) is established as the larval foodplant in the Big Bend National Park area. Over 40 specimens and live individuals of the new species are illustrated to show the extent of wing pattern variation.

Additional key words: *jacqueline*, *megarus*, scrub-hairstreak, Tamaulipas, Boquillas, The Solitario, species concept

The word "hairstreak" for many people is almost synonymous with *Strymon* Hübner, 1818 (Lycaenidae: Theclinae), as *Strymon melinus* Hübner, 1818 is abundant, widespread from Canada to Argentina, and flies during most of the warm part of the year. It will not be an exaggeration to say that *Strymon* is the best-known genus of American hairstreaks. Interestingly, while only very few butterflies are considered to be crop pests of any significance, at least two *Strymon* species are serious commercial pineapple pests, i.e. *S. megarus* (Godart, [1824]) and *S. ziba* (Hewitson, 1868) (Harris 1927, Carter 1934, Silva et al. 1968, Beutelspacher 1972, Otero & Marigo 1990, Robbins 2010). Usage of pineapple family (Bromeliaceae) plants by butterfly caterpillars is not common. The only Eumaeini (Lycaenidae: Theclinae) recorded to feed on these plants belong to *Strymon* (*serapio* and *ziba* species groups, Robbins & Nicolay 2002), and it is likely that the *serapio* group uses Bromeliaceae as the only foodplant (Robbins 2010).

Following Clench (1961), Robbins and Nicolay (2002) characterize *Strymon* by the anteriorly directed teeth on the posterior dorsal surface of male genitalic valvae (Fig. 7c). This character might represent an evidence for monophyly of the genus and nicely unifies most species that have been historically placed in *Strymon*. Only *S. ziba* species group lacks well-developed teeth (Fig. 7#6c). However, it was kept in *Strymon* because it is likely that *S. ziba* has lost the valval teeth and thus truly belongs to *Strymon*, as it exhibits very strong wing pattern similarities with *Strymon megarus* from the *S. serapio* group. Some specimens of *S. ziba* and *S. megarus* might not be reliably separable by wing patterns (Rickard & Grishin 2010).

Robbins and Nicolay (2002) define *S. serapio* and *S. ziba* groups by two cornuti in the penis tip (Fig. 7d), paired in *serapio* group (Figs. 7#1d, #3d, #5d) and unpaired in *ziba* group (Fig. 7#6d). Larvae of both groups feed on Bromeliaceae, *serapio* group exclusively. Most *S. serapio* group species possess down-turned penis tip (Figs. 7#3–#5) and a simple sclerotized loop of the ductus bursae (Fig. 8#5). In contrast, genitalia of *S. ziba* are very distinctive. Males have an up-turned penis tip with 2 very large cornuti (Fig. 7#6), and females lack the sclerotized loop on the ductus bursae, but the posterior end of the corpus bursae is expanded and prominently sclerotized, forming a very characteristic structure termed "hood" by Johnson and colleagues (Johnson et al. 1990, Austin & Johnson 1997) (Fig. 8#7).

Until recently (Rickard & Grishin 2010), Bromeliad-feeding *Strymon* species were not known from the US, maybe somewhat surprisingly, because Spanish moss

(*Tillandsia usneoides* (L.) L.) is a common plant over the eastern part of the country and other species of *Tillandsia* occur in Arizona, Texas and Florida. In the southwestern desert of Texas, *Hechtia texensis* S. Watson, and *H. glomerata* Zucc. occur (all plants mentioned above are in the family Bromeliaceae). The discovery of a resident *Hechtia*-feeding *Strymon* species in Texas was made independently by several collectors, and the data were put together only recently. This synthesis resulted in new research and collecting efforts that culminated in this publication.

MATERIALS AND METHODS

This study is based on comparison of over 1450 specimens from the *serapio* and *ziba* groups of *Strymon* in the National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC; American Museum of Natural History (AMNH), New York, NY; National History Museum, London (BMNH), Great Britain; Burke Museum (UWBM), Seattle, WA; Texas Memorial Museum (TMMC), Austin, TX; Texas A&M University Insect Collection (TAMU), College Station, TX; several private collections; specimens field-caught by the authors under permits (Big Bend National Park and The Solitario region); photographs of live individuals made by several observers; and images in Janzen & Hallwachs on-line database (2011). In addition, the primary type specimens of *S. serapio* and *S. megarus* were inspected using the photographs (and *S. serapio* specimen by NVG) obtained from BMNH and MHNM, respectively, and illustrated herein. The late George T Austin kindly shared some *Strymon* distribution records in Mexico for specimens from Florida Museum of Natural History McGuire Center for Lepidoptera and Biodiversity (MGCL), Gainesville, FL. Unpublished notes, letters and lab notebooks by Roy O. Kendall and Connie A. Kendall relevant to the *S. serapio* group were studied at the TAMU Kendall & Kendall collection and discussed here. Standard entomological techniques were used for specimen preparation and dissection (Robbins 1991). Genitalia and wing venation terminology follow Klots (1970) and Comstock (1918), respectively. Plant names follow the PLANS on-line database (USDA, NRCS 2011). Length measurements are in metric units and were made from photographs of specimens magnified on a computer screen. Most photographs were made using Nikon D200 camera, for specimens through a 105mm f/2.8G AF-S VR Micro-Nikkor lens; for "dry" genitalia of the holotype with an additional 2× teleconverter TC-20E; and "wet" genitalia through a "light-through" microscope.

RESULTS

Historical Records

A brief history of records for this apparently undescribed species follows. The earliest record known to us is from September 25, 1944, "Ameries Boquillas", Rio Grande River, Big Bend National Park (Texas: Brewster Co.) and is a series of 16 specimens at the Burke Museum (WA:Seattle) collected by George Schenk. The Boquillas area is the region of Texas/Mexico west of Boquillas Canyon to Hot Springs (or Tornillo Creek), a distance of approximately 20 miles around the Mexican village of Boquillas, and north of the Rio Grande for 2–3 miles. The area is mostly limestone with *Hechtia texensis* plants abundant on rocky slopes. *Hechtia texensis* (False Agave, Aguapié) is restricted to the limestone soils in the vicinity of the Rio Grande and Solitario in Texas, but grows on limestone soils some distance to the south along the base of the Sierra del Carmen (CJD & Ro Wauer, pers. comm.) and is reported from both Chihiahua and Coahuila in Mexico.

This 1944 record surfaced only recently. Likely independently of this record, R.O. Kendall collected a female specimen on Mar 27, 1968 along the Rio Grande Village Nature Trail (Big Bend National Park), which is in the Boquillas area. Continued efforts by the Kendalls resulted in another specimen, male, collected by Connie A. Kendall on September 14? (per label, but Sep 20 per Kendall notes from TAMU archive) 1971, Old San Vicente [crossing on Rio Grande] (Big Bend National Park, also in Boquillas area). These specimens bear the following determination labels by Clench and by Miller, respectively: ["Thecla" // sp. ♀ // may be new // det. H. Clench 1969] and [*Strymon* sp. // possibly new ♂ // det. Lee D. Miller // 1980].

CJD conduced faunal surveys for the Texas General Land Office (1973) and for The Natural Areas Survey (1975) on The Big Bend Ranch, in Presidio and Brewster Counties (some 50 air miles west from the Boquillas), which supported the setting aside of The Big Bend Ranch State Natural Area. He photographed (May 17, 1973) and collected (May 20, 1973; June 8, 1975) a series of specimens from The Solitario in Presidio & Brewster Counties and reported (Durden 1976) these as a new species of *Strymon* which looked superficially like *Tmolus azia*, which he had taken previously December 26, 1970 at Gomez Farias, Tamaulipas, Mexico. The Solitario is the ring-shaped mountain range of which Fresno Peak is the high point. The Solitario, a circular feature visible from space is an un-roofed lopolith—a bulge over an igneous intrusion now largely removed by erosion. CJD did not associate the specimens with Bromeliads, although *Hechtia* is a frequent component of the slope vegetation in The Solitario and along Fresno Creek. James A. Scott (1986) cites these records but, without examining specimens or pictures reports them as *Strymon bebrycia* (Hewitson, 1868) occurring in the Big Bend Area.

All further information about the insect (until 2005) comes from the notes in the Kendall & Kendall collection archive, Texas A&M University (TAMU), College Station, Texas. Notably, in a letter to Richard S. Peigler, Department of Entomology, TAMU, dated 17 October 1978 Harry K. Clench called Kendall specimens from 1968 and 1971 *Strymon serapio* (Godman & Salvin, 1887). This determination brought Bromeliaceae (i.e. *Hechtia*) as possible larval host plants to attention.

Edward C. Knudson collected a single male on 29-Nov-1985 near Hot Springs (Big Bend National Park, Boquillas area), that he referred to as "unfamiliar Lycaenid resembling a somewhat large *Tmolus azia*, but it was not *Tmolus echion*, but the size thereof." This specimen was loaned to Robert K. Robbins, who in a letter dated January 31, 1986 called it *Strymon serapio*.

Ann B. Swengel observed about a dozen specimens along the Rio Grande Village Nature Trail (Big Bend National Park, Boquillas area) on April 16 1989, hilltopping and perching on lechuguilla (*Agave lechuguilla* Torr., (Agavaceae)), creosote bush (*Larrea tridentata* (DC.) Coville, (Zygophyllaceae)) and *Jatropha* [*dioica* Cerv.] (Euphorbiaceae). Some specimens were photographed and this record was reported in 1989 Lepidopterists' Society Season Summary (News. Lepid. Soc. 2: 22 1990) as *Strymon bebrycia*, which is quite similar below.

Roy O. and Connie A. Kendall did more work in the Boquillas area in 1987, and collected 1 female on March 26, 2 females on March 27 (between the Barker House that is used as lodging facility for researchers in the park, and Boquillas Canyon) and 1 female on March 28 (by the Barker House). On March 31 1987 another female was seen, but escaped capture. All these females were kept alive with flower buds of *Hechtia texensis*, but no eggs were laid.

On April 5, 1992 R.O. Kendall found one last instar larva feeding on *Hechtia texensis* flower buds, road to Boquillas Canyon overlook across road from the Barker House (BBNP). About 1000 flower stalks were examined during two days, but no additional larvae were found. The larva spun-up on April 10 and pupated on April 13, 1992. Parasitoid *Metadontia amoena* (Say, 1836) (Hymenoptera: Chalcididae) hatched from that pupa on May 9 1992. This parasitoid is known to use a wide range of Theclinae as hosts, including *Strymon melinus* (per Kendall collection notes).

Stephen M. Spomer collected a male on March 25, 1994 along TX Ranch Rd 2627, 25mi SE of US Hwy 385 (ca. 3mi NW of Rio Grande). This location is 20mi north from the Boquillas area.

Then, after a 10-year hiatus, the Big Bend Hairstreak project came to life again with the efforts of several photographers (Rich Kostecke, Andrew Spencer, Martin Reid, Ro Wauer) exploring Big Bend who obtained good quality digital photographs of this *Strymon*. Under a Big Bend National Park research permit, NVG collected a series of specimens in 2005, 2007 and 2009 and reared the insect on *Hechtia texensis* flower buds from ova obtained from captive females.

Additionally, analysis of photographs (by Kim Davis & Mike Stangeland and Dan Hardy) from near Ciudad Victoria (Mexico: Tamaulipas, ca. 500 miles southeast from Boquillas) revealed phenotype quite similar to that from the Big Bend Area, and *Hechtia* sp. plants were also photographed in the immediate vicinity of the hairstreak sighting (Warren et al. 2011).

It became apparent due to difficulties with placing these specimens among known taxa (*bebrycia*, *serapio*, possible new species), that a careful analysis of the situation is warranted. The analysis resulted in the conclusion that these specimens represent a biologically distinct species, which is described here as

Strymon solitario Grishin & Durden, **new species**

Diagnosis:

The presence of anteriorly directed teeth on the posterior dorsal surface of male genitalic valvae (Fig. 7#1c) places this species in *Strymon*. Down-turned penis tip with paired cornuti in males (Fig. 7#1d), looped ductus bursae in females (Figs. 8#1–#4) and larval foodplant from the Bromeliaceae (*Hechtia* spp.) position it in the *S. serapio* species group.

Dorsal wing surface is similar to *S. serapio* (Figs. 10#1d–#6d, #20d), except that in males violet-blue overscaling is less developed than in the majority of *S. serapio* males, especially just basally from the orange submarginal spot in Cu_1–Cu_2 cell (Figs. 3#1d, 4#1d–#12d, 9#15, 10#22–#23, #26). This shortage of blue scales resembles *S. ziba* (Fig. 10#7d), not a closely related (as revealed by its genitalia structures, Figs. 7#6, 8#7), but a superficially similar species. Some females possess orange scales in the postmedian area of forewings (Figs. 3#2d, 5#4d, #8d, #11d, 9#11, 10#27d), absent in all examined *S. serapio* specimens, and most females have more pronounced slate overscaling in the postbasal area (e.g. Figs. 10#24d–#25d) than a typical *S. serapio* female (Fig. 10#20d), in which macules formed by slate scales are confined to the marginal area of a hindwing.

Ventral wing surface and genitalia are similar to *S. jacqueline* Nicolay & Robbins, 2005 (Figs. 10#18v, #19v, #21v, 7#5) and *S. megarus* (Figs. 10#9v–#12v, #14v–#17v). The most notable ventral pattern difference from the latter two species is the small amount of light scaling between the postmedian orange band of spots on ventral hindwing and marginal darker lunules (Figs. 3#1v–#2v, 4#1v–#12v, 5#1v–#12v, 9#1–#10, #12–#14, #16–#19, 10#8, #22v–#27v). Light scales are confined to the vicinity of darker marginal lunules framing them, and do not reach 1/3 of the distance from the lunules to orange submarginal band. This pattern gives the ventral surface a grayer, more uniformly flat and less contrasting appearance.

Genitalia are not obviously distinctive (Figs. 4#1–#2), although the terminally narrower, pointed and more asymmetric saccus (as in *S. megarus*, Fig. 4#3), seems to separate the new species from *S. jacqueline* (Fig. 4#5). Not enough material exists to examine the extent of *S. jacqueline* genitalia variation.

Dorsal wing surface is not similar to *S. jacqueline* (Figs. 10#18d–#19d, #21d), due to the lack of extensive blue areas. Occasional presence of orange scales in the postbasal area of the *S. solitario* females is a character shared only with *S. jacqueline* (Figs. 10#19d, #21d). Dorsal wing surface is less similar to *S. megarus* than to *S. serapio*, because in *S. megarus* males, extensive violet-blue areas usually cover the posterior half of the hindwing and pronounced basally elongated submarginal brown macules are present within these areas (Figs. 10#9d–#12d). In the new species, violet-blue scaling is less developed, and rather violet-blue macules are apparent on the brown background of the hindwing submarginal area (Figs. 3#1d, 4#1d–#12d, 9#15, 10#22, #23, #26).

Ventral wing surface and male genitalia are not similar to *S. serapio* (Figs. 10#1v–#6v, #20v, 7#4), as in the latter (from Texas south to Panama) orange postmedian spots form a more continuous band on the hindwing, i.e. the three spots in cells Rs–M_1, M_1–M_2 and M_2–M_3, are elongated and are almost in line (Figs. 10#1v–#6v, #20v), while in the new species spots appear to be more separate and rounder, with the Rs–M_1 and M_1–M_2 spots being offset basad, and distad, respectively (e. g. Fig. 3#1v–#2v). Additionally, *S. serapio* does not have the postbasal orange spots on the hindwings that are frequently developed in the new species (Figs 3#1v, 4#1v–#6v, 5#1v–#6v, 9#6, #9, #12, #13, #14, #16, #17, 10#22v, #27v). Male genitalia of *S. serapio* (Fig. 7#4b) are characterized by a short rounded and mostly symmetric saccus (longer, asymmetric and terminally pointed in the new species: Fig. 7#1b–#2b) and a large tegumen occupying the dorsal half of the genitalic capsule (smaller, similar to *S. megarus* (Fig. 7#3a) tegumen in the new species: Fig. 7#1a–#2a).

Wild-caught specimens of the new species we examined from the Big Bend area exhibit unique leg pattern in which black scaling on the tibia is less developed (Figs. 6a–c, l) than in all similar species (Figs. 6g–k) and if present, forms spots of a few grayish scales rather than clear patches of black scales present in other closely related species.

Desert habitat of the new species (Figs. 2a–c) is similar to that of *S. jacqueline* and not similar to brush and forest habitats of *S. serapio* and *S. megarus*.

In summary, this species continues the trend recently established for other newly described *Strymon*: its characters reveal a new combination of features known in other species. E.g. *S. jacqueline* is a "chimera" of *S. dindus* (Fabricius, 1793) dorso and *S. megarus* venter, and *S. giffordi* Nicolay & Robbins, 2005 combines *S. veterator* (H.H. Druce, 1907) dorso with *S. megarus* venter. Likewise, in the new species, occasional presence of orange scales on the dorsal forewing, ventral wing pattern, and desert habitat preference are shared with *S. jacqueline*, dorsal wing pattern is shared with *S. serapio*, and ventral wing pattern is similar to *S. megarus*. Male genitalia combine features of *S. jacqueline* and *S. megarus*. The most pronounced unique traits are conspicuously underdeveloped lighter scales in the hindwing postmedian area, much weaker dark bands on the leg tibiae (in Big Bend population), and less pronounced violet blue scaling, especially in the posterior postmedial area of the hindwing. These characters give the new species a more neutral, lower contrast appearance with less white, less dark and less blue than the described *serapio* group species.

Description. Male (N=30): FW length (base R to apex) = 13.8 mm (holotype), mean 12.6 mm, standard deviation 0.8 mm, range 11.0–13.9 mm (n=12).

Dorsal wing pattern (Figs. 3#1d, 4): The **ground color** brownish gray, the scales with a copper reflectance. Ground color faded in some paratypes, but the androconial patch still dark. **Forewing**: an **androconial patch** 2.7mm long by 2.0mm wide in the holotype, with enlarged dark apically 3- to 5-denticulate overscales. Enlarged light yellowish-gray glandular underscales with a puckered rounded apex. Basal fifth of androconial patch almost as light in tone as the discal ground color. The blue overscaling of scattered light violet-blue scales. In the holotype this overscaling in forewing cell Cu_2–2A around and basad from the origin of Cu_2 vein occupying half of the wing length, even more extensive around 2A, reaching the postmedian area distad and almost half of the Cu_2–2A cell cephalad. In cell 2A overscaling in the basal half. In many paratypes blue overscaling reduced to two streaks along veins Cu$_2$ and 2A, or almost absent. Prominent orange overscaling along the forewing costa, wider distad but not expressed or lost in some paratypes. In the holotype, **hindwing** overscaling of the same scattered light violet-blue scales in the posterior part of the cell, base of cell M$_3$–Cu$_1$, basal 3/5 of cell Cu$_1$–Cu$_2$, and almost entire cell Cu$_2$–2A with a few scales in the basal half immediately posterior to 2A. Macules of violet-blue scales in the submarginal area of hindwing in cells M$_1$–M$_2$, M$_2$–M$_3$ and M$_3$–Cu$_1$. In some paratypes the blue overscaling reduced, and in Cu$_2$–2A it may be reduced to the basal area and a small submarginal blue macule. Bands of darker small scales immediately over the veins through the areas with overscaling. The reddish-orange submarginal cubital macule on the hindwing distally pupilled with dark shade. Size of the orange macule variable. Anal lobe with prominent reddish-orange scales. The submarginal line of blue scales on hindwing posterior to M$_2$ in holotype, posterior to M$_1$, or M$_3$ in some paratypes. Dark outer margin line darker than the ground color posterior to M$_3$ vein. A white-tipped and white-margined ground color long tail at Cu$_2$ and a short one at Cu$_1$. Abdominal fold pale brownish-gray, posteriorly lighter in color. Fringe white from apex to tornus in forewing, from outer costal angle to tornus in hindwing and dark, almost black on the anal lobe of the hindwing. Inner margin fringe of ground tone, lighter on the hindwing. Costal edge scaling very narrow in forewing and of a contrasting orange color. Costal edge in hindwing is a fringe of the ventral ground tone.

Ventral wing pattern (Figs. 3#1v, 4): The **ground color** light pinkish gray, with **fringe** as on upperside. **Forewing** without basal macules and end of cell macule. In many specimens, Cu1–Cu2 (except submarginal area) and 2A cells lighter ground color than the rest of the wing. Forewing postmedian band of 5–6 macules in cells from R$_2$–R$_3$ (missing in some paratypes) to Cu$_1$–Cu$_2$. No macule in Cu$_2$–2A. Each macule framed distally with black and then with white scales and distally convex. The postmedian band cut at veins by scales of ground color, removal of these scales due to wear in some paratypes reveals prominent darker veins. The postmedian band smoothly bent, distally convex, the macules mostly aligned with their neighbors. In some paratypes M$_1$–M$_2$ and/or M$_3$–Cu$_1$ macules are offset distad and proximad, respectively. Submarginal band of dark macules (lunules) in R$_3$–M$_1$ to Cu$_2$–2A cells, fades anteriorly in some specimens. The most prominent gray macule in Cu$_1$–Cu$_2$. Some gray macules, mostly in cells M$_3$–Cu$_1$ to Cu$_2$–2A distally framed by lighter scales. A dark marginal band of diffuse large gray macules present in holotype and some paratypes from R$_3$–M$_1$ to Cu$_2$–2A cells. These macules lighter than submarginal gray macules and almost blend into a band showing as a darker marginal area of forewing. Thin light submarginal line and dark outer marginal line from apex to tornus in forewing. Orange scaling along the costa and outer margin. The basal band of orange macules on the **hindwing** much reduced or obsolete. Its strongest expression is the presence of 3 macules, the largest one in Sc+R$_1$–Rs cell, the second largest in the posterior of the discal cell, about 3/5 from the base of the cell and a small macule of a few scales in the anterior part of the discal cell, proximally from the posterior side of cell macule, at 1/2 from the base. The largest macules with dark scales around the edges, mostly along the basal side. Just 2, 1 (in Sc+R$_1$–Rs) or no such macules may be present. End-of-cell hindwing macule in most specimens, composed of a narrow assemblage of darker scales, sometimes intermixed with orange scales. The hindwing postmedian band of red-orange macules strongly developed in cells from Rs–M$_1$ to 2A and much more irregular than on the forewing. The macules are well separated from each other, rounded near veins. Macules of varying expression and width distally framed with dark and then with light scales. Sc+R$_1$–Rs macule, and to a lesser extent some other macules with dark scales on the proximal edge in several specimens. Exact location and relative positioning of the macules variable, but as a trend, the Rs–M$_1$, M$_3$–Cu$_1$, and anterior segment of Cu$_2$–2A macules are shifted proximally; M$_2$–M$_3$, Cu$_1$–Cu$_2$, posterior segment of Cu$_2$–2A and anterior segment of 2A are offset distally. The band has an appearance of doublets of closer associated macules: Sc+R$_1$–Rs with Rs–M$_1$, M$_1$–M$_2$ with M$_2$–M$_3$, and M$_3$–Cu$_1$ with Cu$_1$–Cu$_2$. Macules in Cu$_2$–2A and 2A cells in a broad external apex V-shaped arrangement with slightly convex sides. Submarginal band of dark macules (lunules) in Sc+R$_1$–Rs to 2A cells, fading in M$_1$–M$_2$ and M$_2$–M$_3$ in some specimens. The largest macule in Rs–M$_1$ cell. Macules are framed with white scales. White scales between the dark macules and the postmedian band of orange macules not extensive, do not reach 1/3 of the distance proximad of gray macules, and largely present as framing of these gray macules. Orange-red cubital submarginal macule distally pupilled with black and proximally framed with dark gray and then lighter scales. Black anal lobe edged with orange-red segment and white scaling. The marginal orange-red segment by the tornus L-shaped on the left wing and consists of a macule in the distal 1/3 of Cu$_2$–2A cell and a long triangular macule in 2A along the inner margin of hindwing with the smoothly curved proximal margin falling several scale rows distal to postmedian orange band. This 2A macule abruptly cut by a marginal triangle of white at the inner corner of the anal lobe with its acute apex on the submarginal band of dark macules. Dark marginal band of diffuse large gray macules lighter in color than the submarginal band. These macules not well separated from each other along veins and create an impression of a submarginal area being darker than the ground color of hindwing. This feature very prominent in most specimens, however, the male reared in the lab shows an unusually dark ground color not contrasting with the marginal area. The white submarginal line cut by darker scaling on all veins and widens from vein Sc+R to tornus, most prominent in cells Cu$_1$–Cu$_2$ and Cu$_2$–2A, less in M$_3$–Cu$_1$. Dark outer marginal line widens from the apex towards tornus.

Head with the collar of long gray scales, fringed anteriorly with a few orange scales. This orange fringe absent in some specimens. A tuft of long white scales surrounded by gray prominent between the antennae, but elsewhere on the crown the scales gray, very short and appressed. The frons copiously clothed with white scales intruded by sparse black hairs. The basal joint of the palp heavily scaled with white. Apex of palp basally white with short scales grading distally into gray scales both above and below. The eyes brown-hairy. Face behind eye copiously white scaled. Antennal segments apically black, basally white, white areas larger ventrally, the boundary irregular in mid-segment, sharp between segments. Club ventrally scaled from base beyond its widest part to within 3 segments of apex. Club latero-dorsally scaled to within 6 segments of apex, the mesiodorsally nude and microhirsute area extends for at least 10 segments from the apex. The 5 apical segments of the club orange. The next proximal 7 segments black with the first white band appearing in the next proximal segment at the base of the club.

Body vestiture ventrally white, dorsally gray. Abdomen dorsally gray, ventrally white. Legs (Figs. 6a–c, l, m) basally thickly clothed with white scales and hairs. Tibial and tarsal spines are a contrasting shiny black. Each tarsomere white, dorsally black at the base, Tibiae mostly white, with few dark scales. Dark scales on tibiae in 3 dorsal macules: at the base, the darkest small macule, in the middle, more diffuse, frequently obsolete macule and the distal macule at about 1/4 from the tarsus. The middle and distal macules usually reduced to a few dark scales, but in a male reared in the lab more developed and more similar to those visible on the photographs of specimens from near Ciudad Victoria (MEXICO: Tamaulipas, Figs. 6d–f).

Genitalia: (Fig. 7) Typical for *Strymon*. Valvae with anteriorly directed teeth on the posterior dorsal surface, taper regularly to the distally torted acute apex. Saccus asymmetric to the right, terminally pointed, slightly longer than wide. Tegumen less than half of the genital capsule height, brush organs developed. Vinculum at the level of valvae broader than in *S. serapio*, but narrower than in *S. megarus*. Gnathos arms slender, the terminal tapered portion after the bulbous subterminal widening short, 1/3 or less of the arm length. Penis slender, its tip down-turned with 2 paired cornuti in the shaft.

Female (N=36): FW length (base R to apex) = 12.9 mm (allotype), mean 13.1 mm, standard deviation 0.8 mm, range 11.6–14.3 mm (n=12).

Dorsal wing pattern (Figs. 3#2d, 5): **Ground color** similar to male, more brown, warmer and slightly lighter on average. Blue overscaling very light violet-blue, basically slate in color, on **forewing** largely confined to the area around 2A vein, in the posterior basal position of the Cu$_2$–2A cell, rarely in the anterior part basally from and around Cu$_1$ vein origin, and maximally 2/3 basal part of the 2A cell. In one paratype the entire 3/4 of Cu$_2$–2A cell covered in slate overscaling. The ground color still brown-gray, not slate. Most significantly some females with orange-red overscaling in the postmedian and mostly in the submarginal forewing area. These scales present maximally from M$_1$–M$_2$ to Cu$_2$–2A cells, most developed in Cu$_1$–Cu$_2$, or minimally completely lacking. On the **hindwing**, the slate overscaling usually minimal, reduced to basal area of the discal cell and Cu$_2$–2A. Submarginal macules of slate scales may be clearly developed in some specimens (cells M$_1$–M$_2$, M$_2$–M$_3$ and M$_3$–Cu$_1$), sometimes pupilled with ground color scales. In one paratype, hindwing slate overscaling more extensive with traces of slate scales present in most cells. The submarginal line of slate scales on hindwing and posterior of M$_1$ in allotype, posterior of M$_2$, or M$_3$ in some paratypes, usually wider than in males. Vaguely defined orange-red submarginal macule may be present (e.g. in allotype) in Cu$_1$–Cu$_2$. Orange-red scaling proximally of anal lobe well-developed, usually stronger expressed than in males, sometimes overflowing to the distal part of Cu$_2$–2A, mirroring the hindwing pattern. Other features similar to male.

Ventral wing pattern (Figs. 3#2d, 5): Similar to male, except that on **forewing** Cu$_2$–2A cell may express an orange-red postmedian macule in its anterior part, this macule strongly offset proximally compared to the Cu$_1$–Cu$_2$ macule position, and frequently visible as a trace of darker scales only. On the **hindwing**, postbasal orange macules developed even less than in males and mostly obsolete.

Head: Collar with few to many orange scales in the anterior fringe and these extend forward into the edge of the interantennal tuft. This tuft centrally white with prominent black hairscales. Elsewhere on the short-scaled gray crown prominent black hairscales, not present in the male. Antennae colored as in the male. Mesial naked microhirsute area more extensive, reaching 12 segments behind the apex, almost to the base of the club. Club externally scaled to within 6 segments of the apex.

Body vestiture as on the male except being lighter above and the last 2/3 of the abdomen mostly brownish gray. Patterns on legs the same as in males.

Genitalia: (Fig. 8) Typical for the *serapio* group *Strymon*, bursa copulatrix large containing two pronounced "boat"-shaped signa with anterior pointing spines, not sclerotized around ductus seminalis, which arises from the posterior tip of bursa copulatrix. Ductus bursae about the length of bursa copulatrix, relatively wide, basally with a narrowly twisted single-turn loop, with two small teeth inside the anterior portion. Ductus bursae gradually broader towards lamella. Ductus bursae mostly sclerotized, but some portions in the median part of ductus bursae poorly sclerotized and appear as transparent areas.

Dimorphism of wing shape: the male more female-shaped in wing outline than other similar species. Shape differs principally in the straight to slightly convex rather than slightly concave at Cu$_2$ posterior 2/3 of the outer margin of the forewing (Figs. 4, 10), and more convex rather than straight (e.g. *S. jacqueline*) median (from vein M$_1$ to Cu$_2$) section, except one possibly wing-shape aberrant due to pupation problems male with the straight margin, Fig. 4#5. Most other species of *Strymon* much more dimorphic in wing shape.

Type specimens:

Holotype male bearing the following labels: 3 printed white labels: [N29°11.644' W102°57.045' // nr Barker, Rd to Boquillas // Big Bend Nat. Park // Brewster Co. TX // 26-Mar-2005 USA // leg. Grishin N.V.], [Leg for DNA // #406], [NPS research permit // BIBE-2005-SCI-0006], printed red label [HOLOTYPE // *Strymon solitario* ♂ // Grishin & Durden, 2011]. **Allotype** female is from the same locality and collector as the holotype male, 23-Apr-2005. Additionally, there are **29 male and 35 female paratypes**: 3 ♂♂, 10 ♀♀ the same locality, date and collector as holotype, these females are in very poor condition as they were used for oviposition in captivity; 6♂♂, 3♀♀ Ibid., 23-Apr-2005, 1 ♂ Ibid., 24-Apr-2005, 2 ♂♂, 6 ♀♀ Ibid, 15-Apr-2007, 1 ♂, ex ovum, ex ♀, Ibid, hatched 20-May-2005, 1 ♀ Ibid., 15-Sep-2007, 1 ♂, 1 ♀ Ibid., 8-Mar-2009; 1 ♂ 1 ♀, TEXAS: Brewster Co.: "Ameries Boquillas", Rio Grande River, Big Bend National Park, 25-Sep-1944, leg. George Schenk; 2 ♀♀ Ibid. 26-Sep-1944; 2 ♂♂, 2 ♀♀ Ibid., 27-Sep-1944; 1 ♂, 2 ♀♀ Ibid., 28-Sep-1944; 1 ♀ Ibid., 29-Sep-1944; 1 ♂, 1 ♀ Ibid., 8-Oct-1944; 1 ♂, 1 ♀ Ibid., 9-Oct-1944; 1 ♀, TEXAS: Brewster Co. Big Bend Nat. Park, Rio Grande Village Nature Trail, 27-Mar-1968, leg. Roy O. Kendall & Connie A. Kendall; 1 ♂, TEXAS: Brewster Co. Big Bend Nat. Park, Old San Vicente crossing on Rio Grande, 14-Sep-1971, leg. Roy O. Kendall & Connie A. Kendall; 1 ♂, TEXAS: Brewster Co. Big Bend Nat. Park, between Barker House and Boquillas Canyon 26-Mar-1987, leg. Roy O. Kendall & Connie A. Kendall; 2 ♀♀ Ibid., 27-Mar-1987; 1 ♀ Ibid., 28-Mar-1987; 2 ♂♂, TEXAS: Presidio Co., The Solitario, Gray's Ridge 29.43°N 103.80°W, 20-May-1973, leg. Christopher J Durden; 5 ♂♂, TEXAS: Brewster Co. The Solitario, ridge south of Tres Papalotes 29.44°N 103.77°W, 8-Jun-1975, leg. Christopher J Durden.

In addition to these specimens, photographs of a dozen live individuals from the Big Bend Area of Texas and near Ciudad Victoria, Mexico: Tamaulipas, were examined (see Fig. 9 for images and locations). However, since these were not collected and their taxonomic placement remains uncertain, they are **excluded** from the type series.

The **holotype** and **allotype** are deposited in the **USNM** collection. Paratypes are deposited in the TAMU, MGCL, BMNH, UWBM, TMMC, and other collections (see Materials and Methods for abbreviations).

Variation:

When wing patterns are similar among many frequently not very close species (e.g. *S. ziba* and *S. megarus*) and genitalia do not offer clear-cut characters, as in many *Strymon* taxa, it becomes essential to study the extent of variation in order to define the hiatus between species. We assembled a large series (ca. 70 specimens) of this rarely encountered insect that offers good material for variation studies.

Wing pattern variation (Figs. 4, 5): The most notable variation is the extent of postbasal orange spots on ventral hindwing. These spots carry taxonomic importance, as some *serapio* group species (e.g. *S. serapio*) consistently lack the spots, while others (e.g. *S. megarus*) consistently have them present. The question might arise whether individuals lacking the spots might be a species different from that with the spots. In several specimens (e.g. holotype) the spots are developed differently on left and right wings, and some have spots present on one wing, but lack them on the other. It is more likely that in this species (as in *S. jacqueline*), development of spots (to complete lack of them) is variable. On some wings 2 spots are present, on others only one to none. Spot development is more pronounced in males, and most females completely lack any trace of orange scaling in the hindwing postbasal area.

Color of orange spots, macules and bands was found to be variable as well, with hue ranging from orange-red to orange-yellow. It is suspected that this color might be at least in part environmentally induced, as the male specimen reared in the lab (Fig. 4#12v) possesses much yellower, unusual bands than wild-caught specimens. Development of orange macules in postmedian band is also variable, and some specimens have those bands much reduced (e.g. Figs. 4#11v, 5#11v). Some specimens exhibit orange scaling at the distal edge of the darker cell bar on ventral hindwing, while the majority of specimens possess only dark and light end-of-cell scales. Postmedian orange macule in Cu_2–2A cell on ventral forewing is lacking in males, but may be present in females. If present, this macule is basally offset compared to the row of macules.

In males, extent of violet blue dorsal overscaling and its hue varies from being very underdeveloped and present along Cu_2 and 2A veins and the basal area of the wing (e.g. Fig. 4#8d), to more extensive, with a significant portion of forewing cell Cu_2–2A covered in blue scales (e.g. Fig. 4#7d). The hue varies from purplish to violet-blue, typically redder than that in *S. serapio*, but about the same color as in *S. megarus*. Variation in hue of blue-violet structural color and copper tones may be influenced by humidity but is rather stable. Variation in pigmented ground color fades naturally, day by day with exposure to the sun during the life of the individual and later when illuminated in the collection.

In females, interesting variation is the extent of orange overscaling in the postmedian area of dorsal forewings. These orange scales, absent in *S. megarus*, but usually present in *S. jacqueline*, are rather weakly expressed in about a quarter of females, but absent in the majority of them. Slate-blue dorsal overscaling is also variable, but is not extensive in all females seen.

It is noteworthy, that photographs of Mexican specimens (Fig. 9#12–#16) show quite similar wing patterns, but differ in leg patterns in that tibiae possess darker and more contrasty bands of scales (Figs. 6a–f), more similar to those of *S. megarus*, *S. jacqueline* and *S. serapio* (Figs. 6g–k) than specimens from the Big Bend area (Figs. 6a–c, l, m).

Male genitalic variation (5 dissections, Fig. 7): Most variation is confined to the saccus, which differs in shape and the degree to which its tip is pointed (Figs. 7#1, #2). However, the saccus is always asymmetric and is never that short and rounded at the tip as in *S. serapio* (Fig. 7#4).

Female genitalic variation (6 dissections, Fig. 8): Minor variation was observed in the shape of the sclerotized loop of the ductus bursae and in the bend in the ductus bursae, as illustrated in Figs. 8#1–#4.

Habitat, distribution and behavior:

Type Locality (Figs. 2a, b) ***and habitat***: The type locality is USA: TEXAS: Brewster Co., Big Bend National Park, ca. 2 miles west of Boquillas Canyon. It is a limestone hill immediately to the north of the paved park road leading to Boquillas Canyon, ca. 1 mile east of SH118, near Barker House, GPS around 29°11'50"N 102°57'06"W, elevation 620m. A roadside offers a small parking site with GPS N29°11.644' W102°57.045'. These GPS coordinates are listed on the holotype label. GPS data for the Barker House, which is referenced several times throughout this paper is 29°11'31.26"N 102°56'34.11"W. This historic house is currently being used as lodging station for researchers in the park, but is closed to the public. *Hechtia texensis* plants cover most of the hill, but are particularly dense along small canyons and gulches. It is in these small gulches on the eastern side of the hill that the majority of *Strymon* specimens were captured. Males were also found hilltopping at the highest point of this hill. Along with *Hechtia*, dry limestone slopes and bedrock harbor lechuguilla, Pricklypear cactus, Ocotillo (*Fouquieria splendens* Engelm., Fouquieriaceae), Creosote Bush, *Jatropha dioica* and also *Leucophyllum minus* (Scrophulariaceae) along the top. This location can be

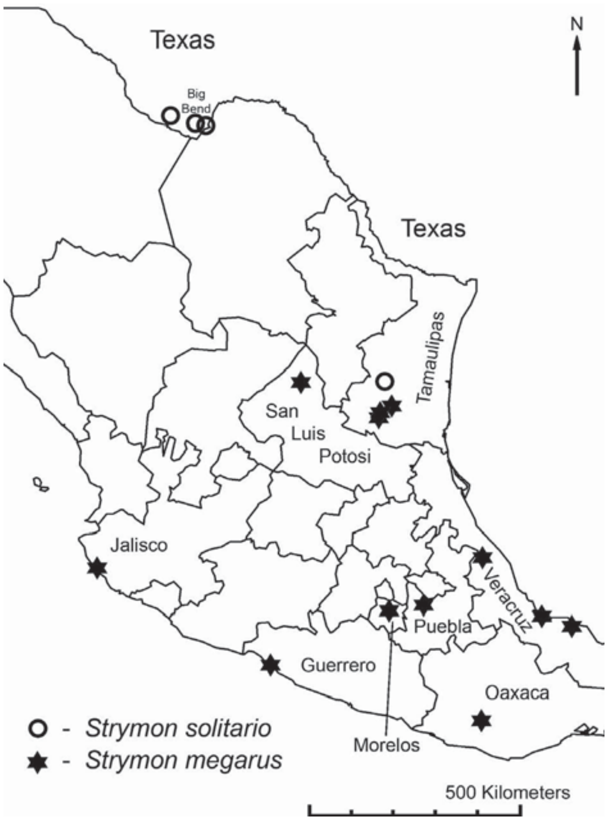


FIG. 1. Records of *Strymon solitario* (circles) and *Strymon megarus* (stars) from the United States (Texas) and Mexico. States with records are labeled.

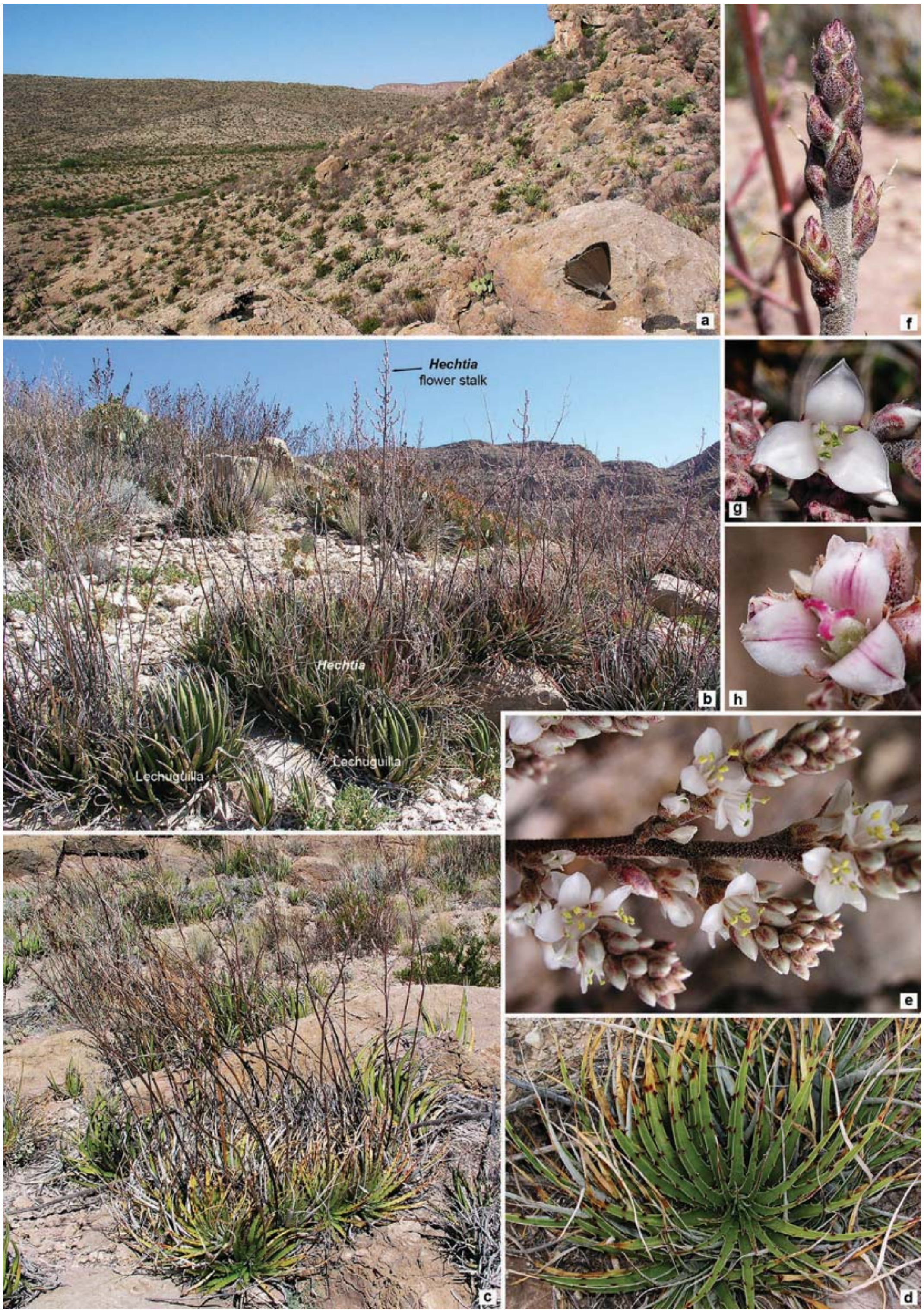


FIG. 2. Typical habitat and larval host plant of *Strymon solitario*. Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ca. 1 mi E of SH118, near Barker House, GPS ca. 29°11'50"N 102°57'06"W, elevation 620m. **a**) overview of the hill slope with *Hechtia texensis* plants, view towards north-west. *Hechtia* flower stalks are visible as gray-brown blotches. A hairstreak image taken at this location is pasted in to signify the event. **b**) a close-up of the habitat showing *Hechtia* mixed with lechuguilla and Opuntia (behind). *Hechtia texensis*: **c**) a cluster of plants, **d**) a leaf rosette, **e**) part of a male flower stalk, **f**) a tip of a flower stalk with flower buds, **g**) male and **h**) female flowers. The images are taken on 26-March-2005, except the hairstreak (27-March-2005) and d), e) and h) photographed on 23-April-2005.

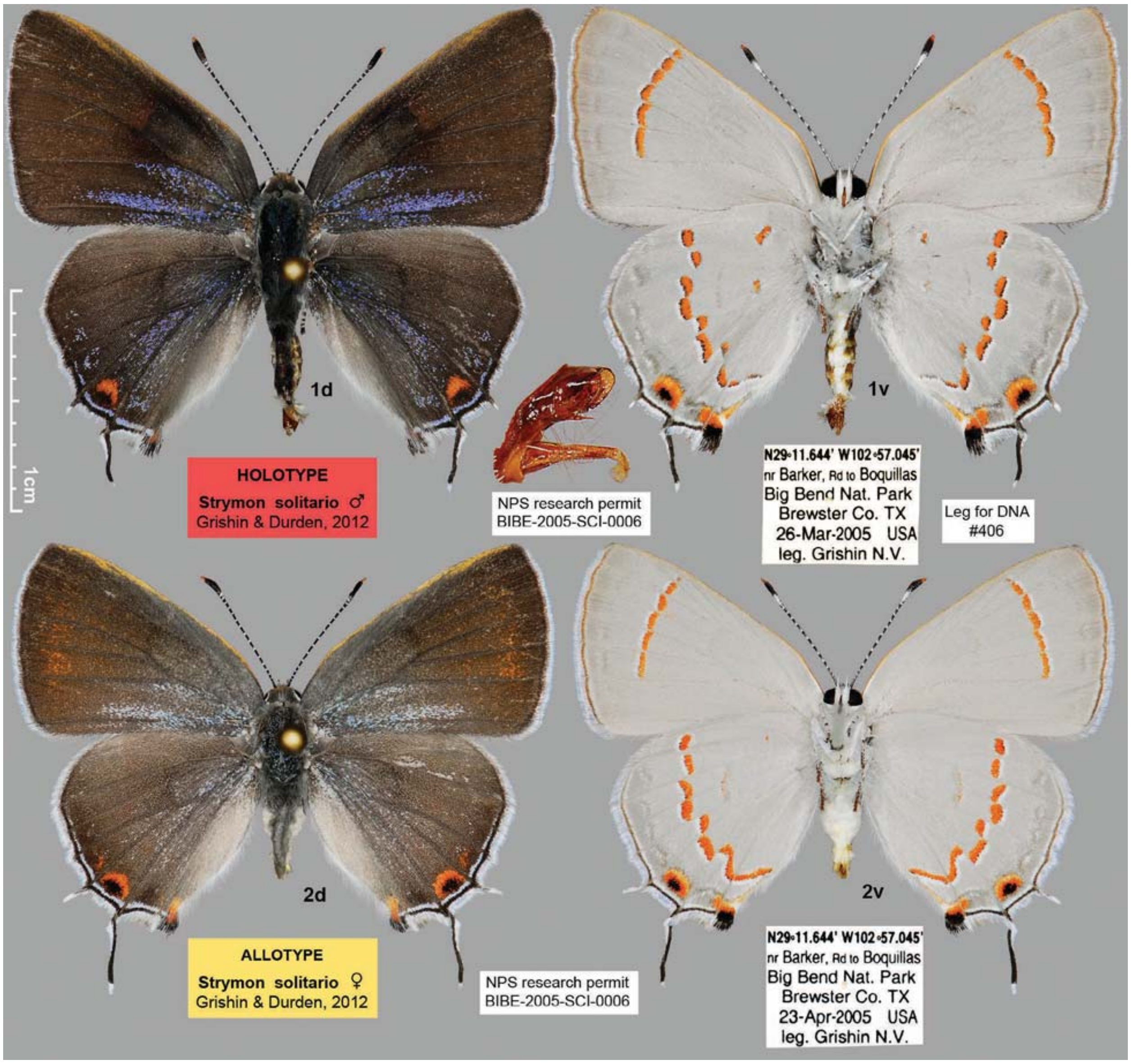


Fig. 3. The type specimens of *Strymon solitario*. Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ca. 1 mi E of SH118, nr. Barker House. **d** and **v** denote dorsal and ventral views, respectively; labels are shown below each specimen **1**. Holotype ♂, 26-March-2005, enlarged lateral view from the left on the in situ genitalia, saccus is not visible. **2**. Allotype ♀, 23-April-2005. Live image on Fig. **9#3**. Leg pattern Figs. **6c**, **l**

rich in Malvaceae plants during wet season, and *Celotes limpia* Burns, 1974 with *Systasea zampa* (W. H. Edwards, 1876) can be quite abundant. As for other *Strymon* species, *Strymon melinus* occasionally occurs here.

In addition to this hill, which simply offered a good parking site and convenient collecting access, *Strymon* specimens were found at several locations in the general Boquillas area—from Boquillas Canyon in the east to Hot Springs and Old San Vicente, either on flowers, e.g. along the roadside, or in gulches among the larval foodplants.

In the Solitario range (on the line between Presidio and Brewster Counties, ca. 50 miles west from the type locality), open desert rocky slopes with lecheguilla and *Hechtia texensis* are broken by gulches harboring relict woodland scrub of *Quercus pungens* Liebm., *Q. vaseyana* Buckley (Fagaceae) and hilltop scrub with *Prunus havardii* (W. Wight) S.C. Mason (Rosaceae). Hilltopping males were collected at flowers of *Acacia greggii* A. Gray (Fabaceae).

Distribution (Fig. 1): While it is likely that many limestone slopes and bedrock with *Hechtia* across west Texas and north-central Mexico support population of this butterfly, the insect is currently known from only a handful of sites. In addition to the Boquillas area in Big Bend National Park, Brewster Co. TEXAS, it has been recorded in similar habitat 1) ca. 20 air miles north, about 3 miles from the Rio Grande river; 2) ca. 17 air miles west, from the grassy brushlands, near the mouth of Pine Canyon, Chisos Mountains (photograph, Fig. 9#1, *Hechtia* is recorded from the nearby mountains, e.g. Nugent Mountain); 3) ca. 50 miles west in the Solitario range, at the boundary of Presidio and Brewster Counties (recorded from both counties).

Most surprisingly, photographs of several hairstreak specimens from MEXICO: Tamaulipas, northwest of Ciudad Victoria, along Los Troncones Canyon, taken 18- and 27-Nov-2004, by Kim Davis and Mike Stangeland (Figs. 9#12–#14, 10#8); and 8 miles south-southwest of Ciudad Victoria, along Balcón de Moctezuma Road (23°35'52.84"N 99°12'31.32"W), taken 6-Nov-2007 by Dan Hardy revealed a very close match to *Strymon* specimens from the Big Bend area. Hardy also photographed *Hechtia sp*. in the immediate proximity of his hairstreak sighting.

We tentatively place these photographed individuals with this new species, however, since no specimens were collected for more detailed analysis, and leg pattern of photographed insects differs somewhat from the unique pattern of the Big Bend *Strymon* (Figs. 6a–c vs. 6d–f), this placement awaits confirmation. Nevertheless, compared to *S. megarus* (Figs. 10#9–#12, #14–#17), Ciudad Victoria *Strymon* appear much closer to the Big Bend populations by the wing pattern.

Phenology: Over the years, specimens in the Big Bend area have been recorded from February to June and from September to November with majority of records being in late March–April and then September, with early and late dates being 18-Feb-2005 and 9-Oct-1944. No records are available for July, August, December and January. Tamaulipas (MEXICO) photographic records are only from November, but this is largely because most butterfliers visit these locations late in the fall. Since in the lab development of immatures was direct, it is possible that in warmer areas of Big Bend adults could be encountered throughout the year. However, during very dry years, as in 2006, extensive searches for adults in spring were not successful. Therefore it is likely that the insect stays quiescent (diapause, aestivation) at one or more its life stages to withstand hardship of unsuitable weather and the lack of blooming *Hechtia* to be used as larval host plants.

Adult behavior: Adults were observed feeding on flowers of the following plants: *Hechtia texensis* (15-Apr-2005, Boquillas area, NVG), *Chromolaena odorata* (L.) King & H. Rob. (Asteraceae) (18,27-Nov-2004, MX:TAM, Kim Davis & Mike Stangeland), *Acacia greggii* (20-May-1973, 8-Jun-1975, the Solitario, CJD), *Larrea tridentata* (Figs. 9#7–#10, 7-Mar-2009, Boquillas area, Martin Reid), *Giliastrum rigidulum* (Benth.) Rydb. (Polemoniaceae) (26-Mar-1987, Boquillas area, Kendall), *Sphaeralcea angustifolia* (Cav.) G. Don (Malvaceae) (28-Mar-1987, Boquillas area, Kendall). In addition to flowers, adults collect moisture from stones (Fig. 9#3), leaves, and cacti (Fig. 9#1, probably extrafloral nectar), in a manner similar to that described (Vila & Eastwood 2006) for *S. jacqueline*. Males hilltop and exhibit territorial behavior, i.e. engage in attacks on each other, returning to the prior perch afterwards. Females, unless they move around to feed on flowers, stay closer to the ground in the proximity of larval foodplants.

Larval food plants: As established below (life history section), flowerbuds, flowers and fruits of *Hechtia texensis* (Bromeliaceae) serve a viable larval food source (Figs. 2b–h). Two *Hechtia* species are recognized in Texas (USDA, NRCS 2011): *H. texensis* – False Agave (including *H. scariosa* L. B. Smith – Rough False-Agave) in Presidio, Brewster Cos (and also in Mexico: Chihuahua, Coahuila), has sepals acute, white or scarious, to 6mm; flowers 8–10mm long, leaf margins scarcely repand, all their spines remote. *H. glomerata* - Guapilla, in Starr and Zapata Cos. (and also in Mexico: Tamaulipas, Hidalgo, Queretaro), has sepals obtuse or apiculate, brown, 4mm; leaves repand-serrate toward base with spines relatively close. An additional more robust species *Hechtia stenopetala* Klotzch – Papalomé or Guapila is frequent on dry limestone cliffs and karst in the Sierra Madre Oriental from Tamaulipas southward. *Hechtia* plants look somewhat like small agave plants, for which it got its English name false agave. *Hechtia* mostly reproduces by offshoots within the clump of plants. The clump starts from a seed and single leaf rosettes without clumps are readily observed. Flowering is mostly confined to April, but following fall rains some flower stalks appear as well. According to Green (1973), in Big Bend National Park *Hechtia texensis* grows primarily on the Dead Horse Mountains, Mariscal Mountain and in Mariscal, Boquillas and Santa Elena Canyons. Secondarily, the plants exist in the Hannold Hill area, east and south Nugent Mountain, south Chilicotal Mountain, up the Juniper Canyon road and near Glenn Springs. On the west side of the Chisos mountains, plants were found on Goat Mountain, Trap Mountain, Mule Ears Peak and Borth Castolon Peak. *Hechtia* also grows in the Limestone Hills along the Rio Grande from Mariscal Mountain to Boquillas and upstream to Fresno Creek and into The Solitario.

Rearing studies and life history:

The hint that *Hechtia* might be a larval host plant was given in 1978, when Harry K. Clench called specimens collected by Kendall in the Boquillas area of Big Bend National Park *Strymon serapio*. Since *serapio* uses Bromeliaceae, and *Hechtia texensis* is an abundant member of this family around Boquillas, the foodplant hypothesis was formed. Kendall's 1987 experiments with 3 females confined with flower buds of *Hechtia* failed to induce oviposition (Kendall & Kendall collection archive, TAMU). However, in 1992 Kendall succeeded in finding a single caterpillar feeding on *Hechtia texensis* flower buds, road to Boquillas Canyon overlook across road from the Barker House (BBNP). That larva pupated on April 13, 1992 and a parasitoid *Metadontia amoena* (Say, 1836) (Hymenoptera: Chalcididae) hatched from the pupa on May 9 1992. This parasitoid is known to use a wide range of Theclinae as hosts, including *Strymon melinus* (per Kendall collection archive).

To follow up the *Hechtia* hypothesis, and being prepared for the difficulties experienced by Kendall, 10 females caught on March 28, 2005 near the Barker House (TEXAS: Brewster Co. Big Bend Nat. Park), were confined with fresh flower stalks, flower buds and flowers of *Hechtia*. 500ml tightly closed glass jars were used. The first jar contained 5 females, the second - 2 females and three jars one female each. Jars were exposed to natural light at all times and were placed under 60W regular light-bulb for 5 hours every evening. One of the females in its own jar expired the next day (possibly overheated), at least 2 females in a 5-female jar and 2 females in their own jars laid several eggs each on March 29th upon being exposed to the light and heat from the light bulb, and after being fed with diluted honey solution the night before (Fig. 11a). Ova were placed on stalks, below flower buds, at branching points, on clusters of just forming flower buds, and 3 ova on the glass of the jar. As in many hairstreaks (e.g. *Satyrium* Scudder, 1876), position for each ovum was carefully searched for with the ovipositor, this search was taking at times up to 1–2 minutes before the proper site was selected and an ovum ejected and glued to the site. While this oviposition behavior is typical for hairstreaks with overwintering ova, which makes sense as the egg needs to stay put for several months under all weather condition, *Strymon* ova developed without delay.

Oviposition continued for three days (March 29, 30, 31, 2005) and then stopped (15 ova total), while females survived for about 2 weeks. It is possible that for normal maturation of ova inside females different conditions/food source are needed, or maybe laboratory conditions were not sufficient to induce oviposition, and only excess eggs were laid during the first few days. Females were fed every other day and jars ventilated and cleaned during this time. New plant segments were used to replace deteriorated ones and ova were taken out and stored in 100ml glass jars (Gerber baby-food jar).

All ova hatched on April 5, 6, and 7. 1st instar larvae were very active and, possibly because the eggs were large, containing enough nutrients, could spend up to 12 hours crawling around before starting to feed. Some larvae had to be put inside opening flowers and their way out blocked by the petals before they showed any attempt at feeding. Nevertheless all hatched larvae started feeding and none perished before April 10. Three larvae expired due to mold accumulating on the flowers on April 10th.

Caterpillars fed on buds and flowers, both white and green parts of the flower. Small caterpillars can bury themselves completely inside the green stem of the flower, when they are feeding on the bottom part of the flower. This behavior is interesting, as according to Janzen & Hallwachs database (2011), *Strymon megarus* larvae are leaf miners in Costa Rica, even in the last instar (see Fig. 10#15).

Caterpillars produced yellow-brownish semi-liquid frass when fed on petals, and green grainy frass when fed on green parts, Grainy frass particles do not separate from each other and form interesting chains of frass grains (Fig. 11f), somewhat like *Polygonia* Hübner, [1819] (Nymphalidae) eggs deposited on top of each other. Some larvae can be surrounded by plant juices and appear to be completely immersed in liquid. This, lasting for about a day before the liquid dries out or is absorbed, does not seem to harm the larvae. This is also consistent with the observation that larvae of a close relative *S. megarus* are leaf miners.

The larvae were transferred on fresh flower branches at least every other day to avoid mold on their food source. Some flower buds were nicked by scissors to stimulate larval feeding, and larvae most frequently started feeding at the places of the nick. However, some larvae started to bore near the base of a flower, forming cavities similar to the one shown on Fig. 11e. This is likely to be their natural behavior.

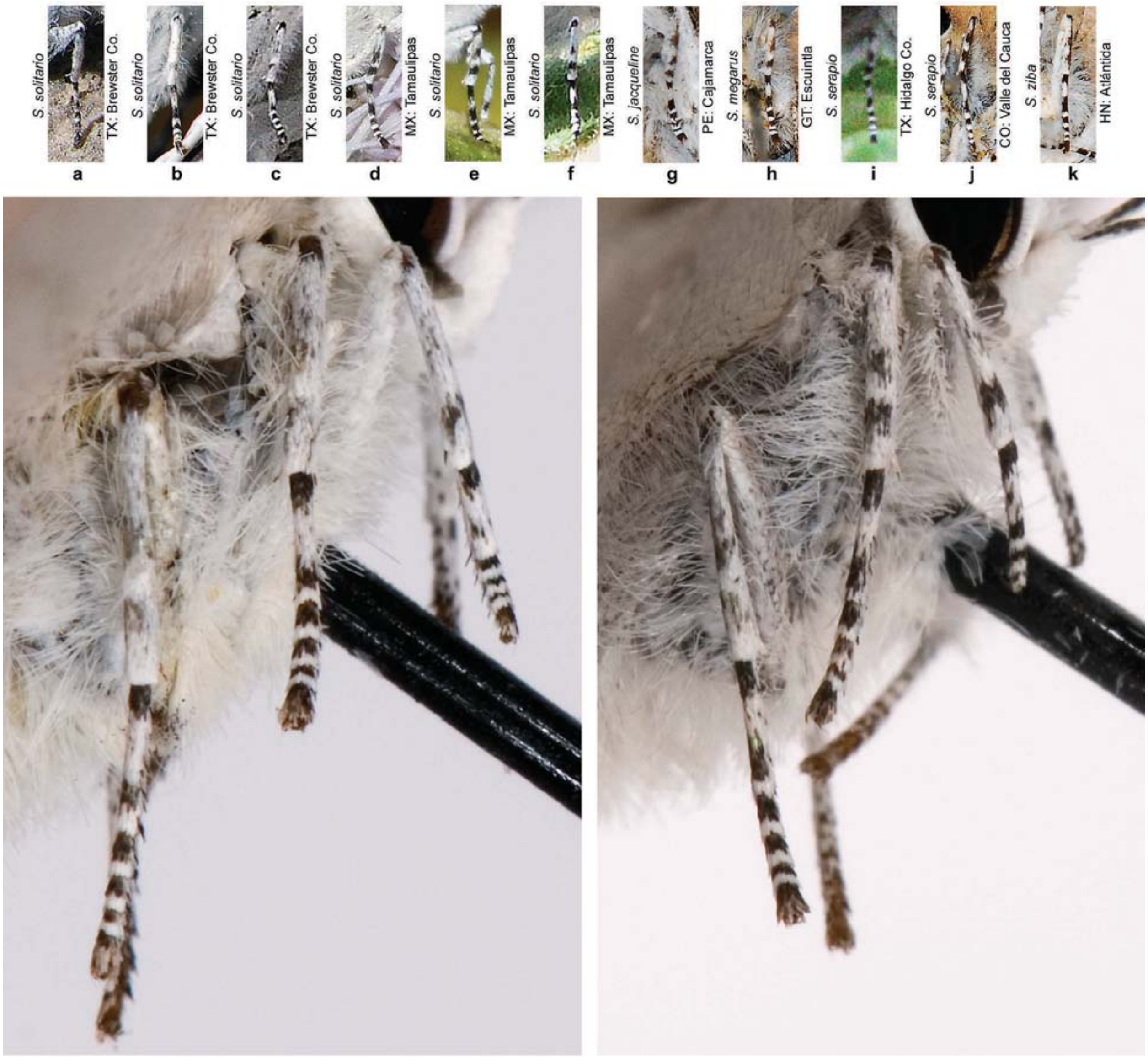
Due to insufficient numbers of larvae all attempts have been made to preserve them rather than to experiment with food conditions and feeding behavior. All of this may have affected the larval behavior making it unnatural. Despite these attempts, the majority of hatched larvae died early on, not reaching the 3rd instar. Higher than native levels of humidity are suspected as the cause, as 1) relative humidity is

FIG. 4. Wing pattern variation in *Strymon solitario* males. All specimens are from Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ca. 1 mi E of SH118, near Barker House, leg. N.V. Grishin. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. 1–11 are field-caught specimens, dates are as follows: **1**, **7**, **8**, **9**. 26-March-2005; **2, 6.** 15-April-2007; **3**, **4**, **10**, **11**. 23-April-2005; **5.** 24-April-2005; **12**. Reared ex ovum in the lab, hatched 20-May-2005. **1**. is the holotype, also shown on Fig. **3#1**.

FIG. 4. (cont.) Wing pattern variation in *Strymon solitario* males

FIG. 5. Wing pattern variation in *Strymon solitario* females. All specimens are from Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ca. 1 mi E of SH118, near Barker House, leg. N.V. Grishin. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. The dates of capture are as follows: **1**, **2**, **4**, **6**, **10**, **11**. 15-April-2007; **3**, **7**, **8**, **9**. 23-April-2005; **5**. 15-September-2007; **12**. 8-March-2009. **8**. is the allotype, also shown on Figs. **3#2**, **6c**, **l** and **9#3**.

FIG. 5. (cont.) Wing pattern variation in *Strymon solitario* females.



l *S. solitario* allotype TX: Brewster Co.

m *S. solitario* reared TX: Brewster Co.

FIG. 6. Leg patterns of Bromeliad-feeding *Strymon*. Midleg in lateral view is shown on all images. **a**), **b**), and **c**) *S. solitario*, Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ca. 1 mi E of SH118, near Barker House, ♂ 27-March-2005, ♀ 15-April-2007 and ♀ 23-April-2005, close-up of live specimens shown on Figs. **9#2**, **#11** and **#3**, respectively. **d**), **e)** *S. solitario* ♀, ♂, Mexico: Tamaulipas, NW Ciudad Victoria, Los Troncones Canyon, 18-November-2004, photographs by Kim Davis and Mike Stangeland, close-up of live specimens shown on Figs. **9#17** and **#16** respectively. **f**) *S. solitario* ♀, Mexico: Tamaulipas, 8mi SSW of Ciudad Victoria, Balcón de Moctezuma Road, 23°35'52.84"N 99°12'31.32"W, 6-November-2007, photo by Dan Hardy, close-up of a live specimen shown on Fig. **9#19**. **g**) *S. jacqueline* ♂ paratype, Peru: Cajamarca, Puente Chetilla 07°12'S 78°45'W elevation 1050m, 17-September-1999, leg. Robbins, Lamas & Ahrenholz. In USNM collection. Close-up of specimens shown on Fig. 10#18. **h)** *S. megarus* ♂, Guatemala: Escuintla, October. Schaus & Barnes collection. In USNM collection. **i**) *S. serapio* ♂, Texas, Hidalgo Co. Estero Llano Grande State Park, 19-December-2009, photo by Michael A. Rickard, close-up of the live specimen shown on Fig. **9#1**. **j**) *S. serapio* ♂, Colombia: Valle del Cauca, Rio Anchicaya, elevation 100m, 13-February-1982, leg. C.J. Callaghan. In USNM collection. **k**) *S. ziba* ♂, Honduras: Atlántida, La Ceiba, 28-December-1982, reared on pineapple, leg J. Miranda. In USNM collection. **l**) lateral view of *S. solitario* ♀ allotype, see Fig. 3#2 for data. **m**) lateral view of an ex ovum *S. solitario* ♂ reared specimen, shown on Fig. 4#12, see Fig. 4 legend for data.

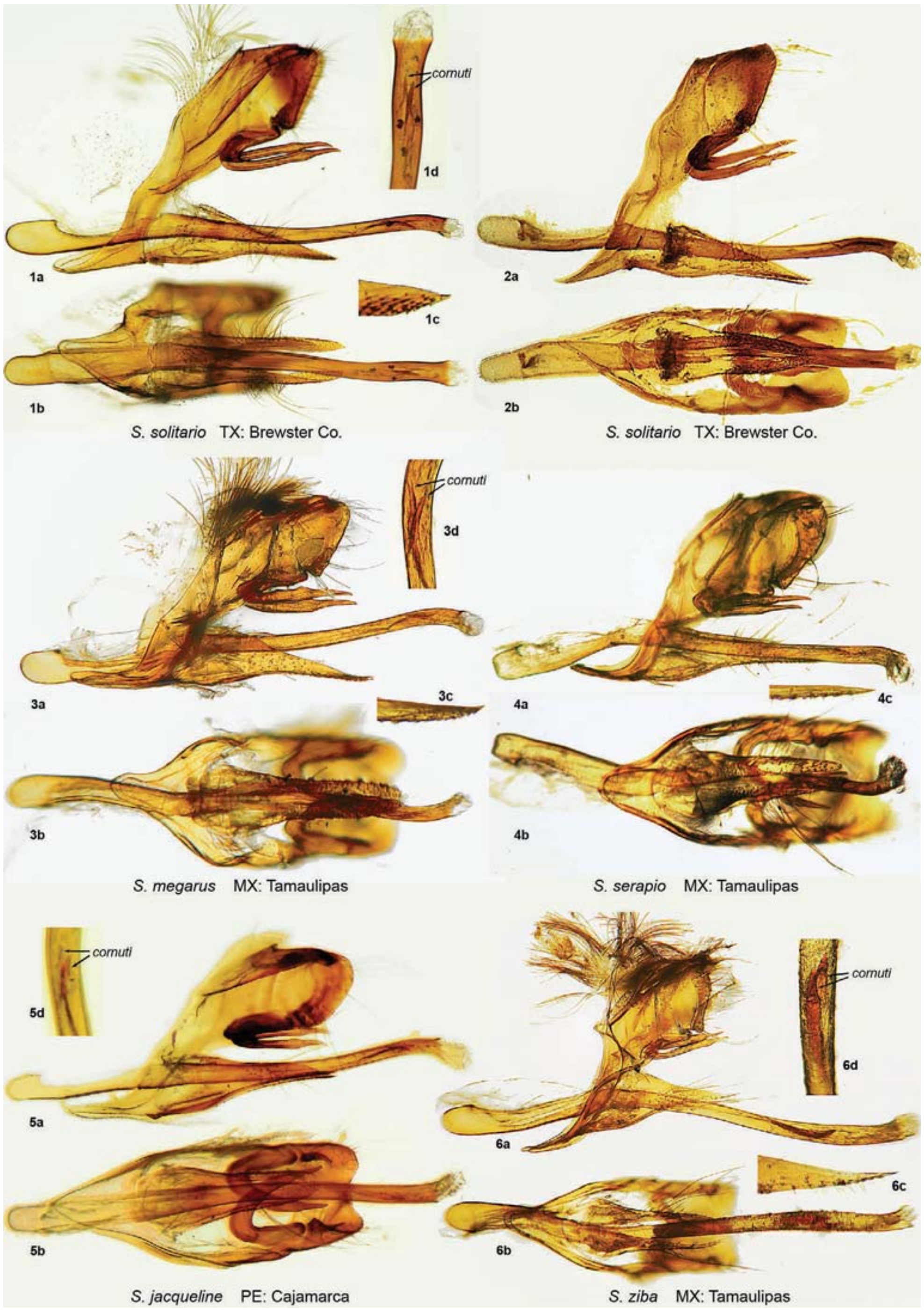


FIG. 7. Male genitalia of the *serapio* group *Strymon* species. **a** and **b** denote left lateral and ventral views, **c** is a magnified left lateral view of the left valva tip (in orientation similar to **a**) showing teeth on the ventral surface pointing down (teeth reduced in *S. ziba*), **d** is a magnified ventral view of the penis tip. **1**, **2**. *S. solitario*, Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ~1 mi E of SH118, near Barker House, leg. N.V. Grishin **1**. 26-March-2005, Genitalia No. NVG #516. The specimen is shown on Fig. 4#9; **2**. 8-March-2009, Genitalia No. NVG #529. **3**. *S. megarus*, Mexico: Tamaulipas, Road to Ocampo (Hwy A70) ca 16km W of Hwy 85, 5-January-1974, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. Genitalia No. NVG #518. The specimen is shown on Fig. **10#11**. **4**. *S. serapio*, Mexico: [Tamaulipas], ex larva 1977, Sue Gardner, larval food plant *Tillandsia utriculata*, from R.O. Kendall & C.A. Kendall collection. In TAMU collection. Genitalia No. NVG #517. **5**. *S. jacqueline*, paratype, Peru: Cajamarca, La Capilla, 10 km W Chilete 07°12'S 78°57'W elevation 700m, 17-September-1999, leg. Robbins, Lamas & Ahrenholz. In USNM collection. Genitalia No. 2002:13♂ R.K. Robbins. **6**. *S. ziba*, Mexico: Tamaulipas, Taylor Ranch ca. 32 km NNW of Ciudad Mante, 5-January-1974, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. Genitalia No. NVG #521.

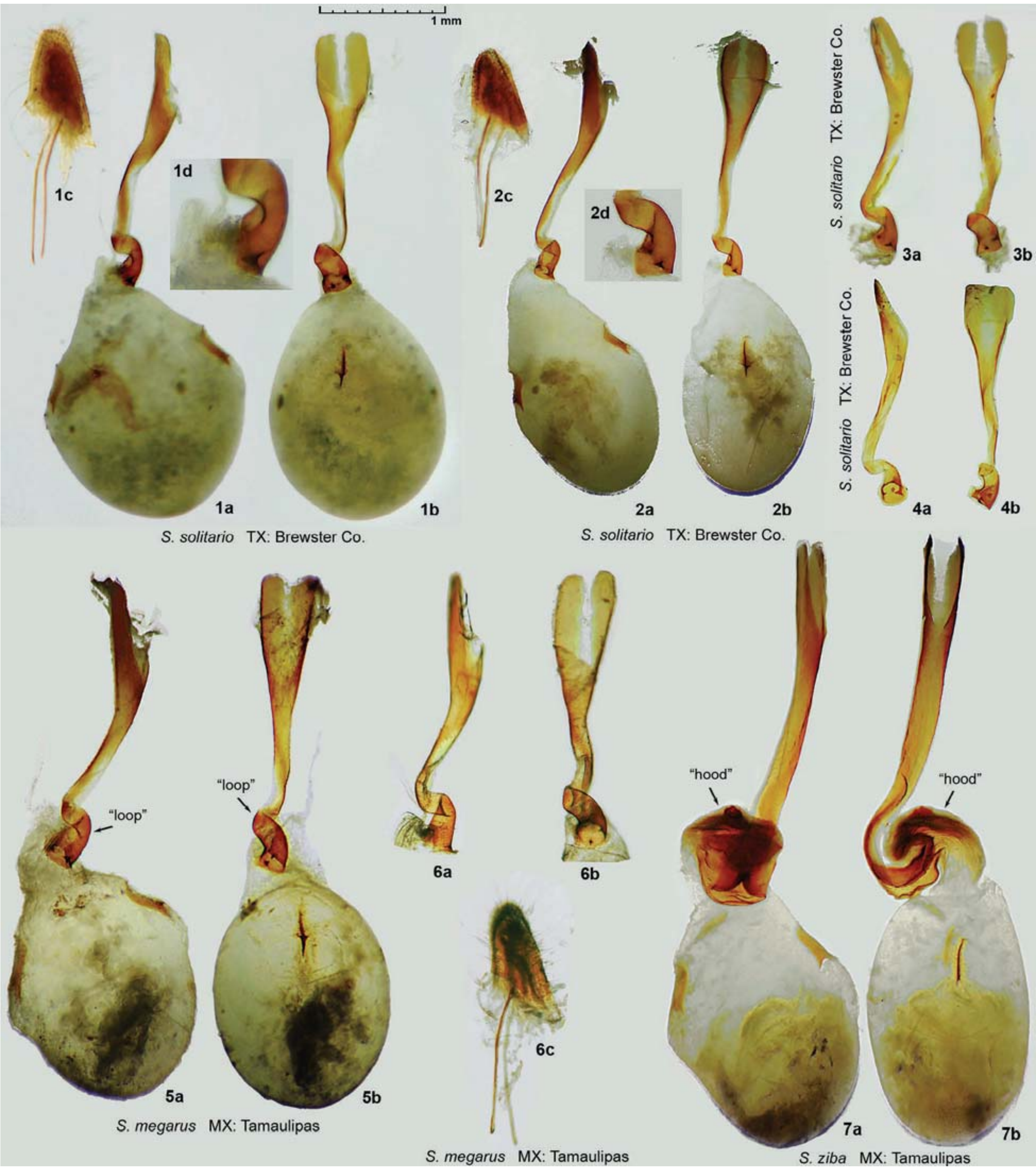


FIG. 8. Female genitalia of the *serapio* group *Strymon* species. **a** and **b** denote left lateral and ventral views, **c** is a left lateral view of papillae and apophysis, **d** is a magnified view of ductus bursae base. Only lamella and ductus bursae are shown in **3**, **4**, and **6**. **1-4**. *Strymon solitario*, Texas: Brewster Co., Big Bend National Park, along the road to Boquillas Canyon, near Barker House, **1**. 26-March-2005, leg. N.V. Grishin, NVG #515 specimen shown on Fig. **5#11**; **2**. 27-March-1987, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. Genitalia No. NVG #523. The specimen is shown on Fig. 10#25; **3**. 26-March-2005 leg. N.V. Grishin. Genitalia No. NVG #514; **4**. 28-March-1987, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. Genitalia No. NVG #524. **5**. *S. megarus*, Mexico: Tamaulipas, Paso del Abra near El Abra, 18-December-1973, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. NVG #522 specimen shown on Fig. **10#17**. **6**. *S. megarus*, Mexico: Tamaulipas, Gomez Farias, 25-August-2003. Genitalia No. NVG #527. **7**. *S. ziba*, Mexico: Tamaulipas, Rancho Pico de Oro vic. of Los Kikos, 9-January-1974, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. Genitalia No. NVG #521.


1. ♀ TX: Brewster Co. BBNP, Pine Canyon, 18-Feb-05 Rich Kostecke


2. ♂ TX: Brewster Co. BBNP, nr. Barker House, 27-Mar-05 Nick V. Grishin


3. ♀ TX: Brewster Co. BBNP, nr. Barker House, 23-Apr-05 Nick V. Grishin


4. ♂ TX: Brewster Co. BBNP, nr. Barker House, 24-Apr-05 Nick V. Grishin


5. ♂ TX: Brewster Co. BBNP, nr. Barker House, 14-Apr-05 Andrew Spencer

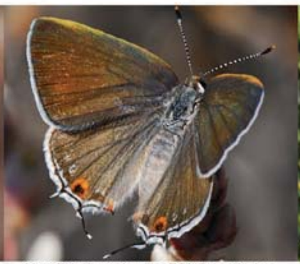

6. ♂ TX: Brewster Co. BBNP, nr. Barker House, 14-Apr-05 Andrew Spencer


7. ♂ TX: Brewster Co. BBNP, nr. tunnel, rd. to Rio Grande Village 7-Mar-09 Martin Reid


8. ♀ TX: Brewster Co. BBNP, nr. tunnel, rd. to Rio Grande Village 7-Mar-09 Martin Reid


9. ♂ TX: Brewster Co. BBNP, nr. tunnel, rd. to Rio Grande Village 7-Mar-09 Martin Reid


10. ♀ TX: Brewster Co. BBNP, nr. Barker House, 15-Apr-07 Nick V. Grishin


11. ♀ TX: Brewster Co. BBNP, nr. Barker House, 15-Apr-07 Nick V. Grishin


12. ♂ TX: Brewster Co. Black Gap WMA, La Linda, 19-Nov-07 R. Craig Hensley


13. ♂ MX: Tamaulipas, Los Troncones Cyn. 27-Nov-04 Kim Davis & Mike Stangeland


14. ♂ MX: Tamaulipas, Los Troncones Cyn. 18-Nov-04 Kim Davis & Mike Stangeland


15. ♂ MX: Tamaulipas, Los Troncones Cyn. 18-Nov-04 Kim Davis & Mike Stangeland


16. ♂ MX: Tamaulipas, Los Troncones Cyn. 18-Nov-04 Kim Davis & Mike Stangeland


17. ♀ MX: Tamaulipas, Los Troncones Cyn. 18-Nov-04 Kim Davis & Mike Stangeland


18. ♀ MX: Tamaulipas, 8mi SSW. of Ciudad Victoria 6-Nov-07 Dan Hardy


19. ♀ MX: Tamaulipas, 8mi SSW. of Ciudad Victoria 6-Nov-07 Dan Hardy


20. ♀ MX: Tamaulipas, 8mi SSW. of Ciudad Victoria 6-Nov-07 Dan Hardy

FIG. 9. Live adults of *Strymon solitario*. Location, date and photographer are indicated below each image. Specimens from Texas: Brewster Co., Big Bend National Park (BBNP) and Black Gap Wildlife Management area (WMA, Texas Parks and Wildlife Department) are shown above the red line (images **1–12**), specimens from Mexico (from Tamaulipas, in the vicinity of Ciudad Victoria) are below the red line (images **13–20**). Some specimens are illustrated by two (**10–11** and **15–16**) or three (**18–20**) photographs. **3**, **4**, **10–11**. These three specimens are shown on Figs. **5#8**, **4#5**, and **5#11**, respectively. **3**. is the allotype, also illustrated on Figs. **3#2** and **6c**, **l.**

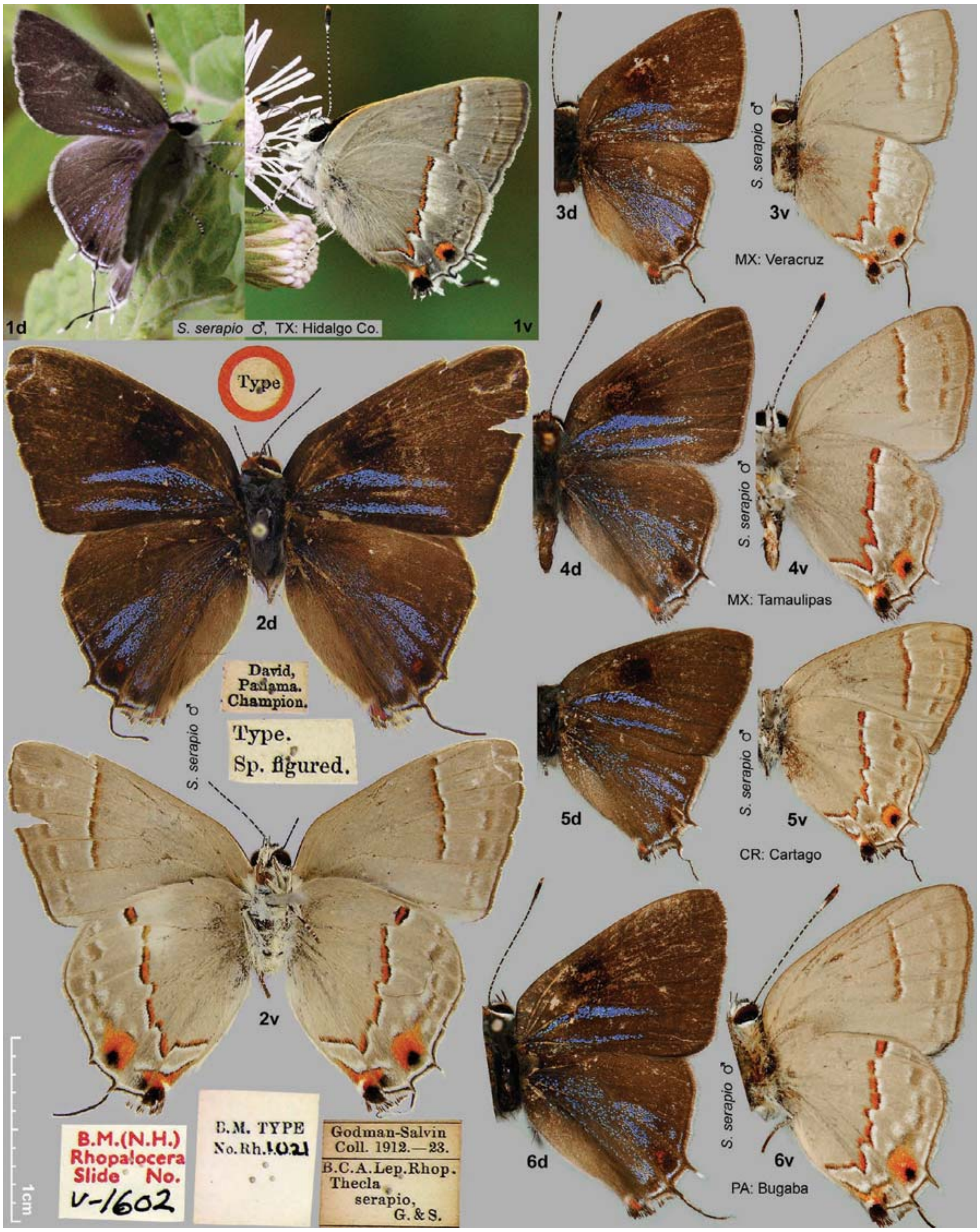


FIG. 10. Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Primary types are displayed in full expanse, with all the labels shown. Only a half for other specimens is illustrated. Species names and general location are indicated on the plate and detailed here. All pinned specimens are to scale. Live individuals are scaled approximately to match corresponding species. **1**. *S. serapio* ♂, Texas: Hidalgo Co. Estero Llano Grande State Park, 19-December-2008, first US record, photographed in natural conditions, photographs by Michael A. Rickard. **2**. *S. serapio* ♂, syntype. Panama: Chiriquí, David, leg. Champion, Godman & Salvin collection 1912–1923. In BMNH collection, photograph courtesy of BMNH. **3**. *S. serapio* ♂, Mexico: Veracruz, Orizaba. Possibly Wm. Schaus collection. In USNM collection. **4**. *S. serapio* ♂, Mexico: Tamaulipas, Villa Gomez Farias, elevation 500m, 28-December-1972, leg. W.W. McGuire. In USNM collection. **5**. *S. serapio* ♂, Costa Rica: Cartago, Juan Vinas, November, Possibly Wm. Schaus collection. In USNM collection. **6**. *S. serapio* ♂, Panama: Chiriquí, Bugaba, July, Wm. Schaus collection. In USNM collection.

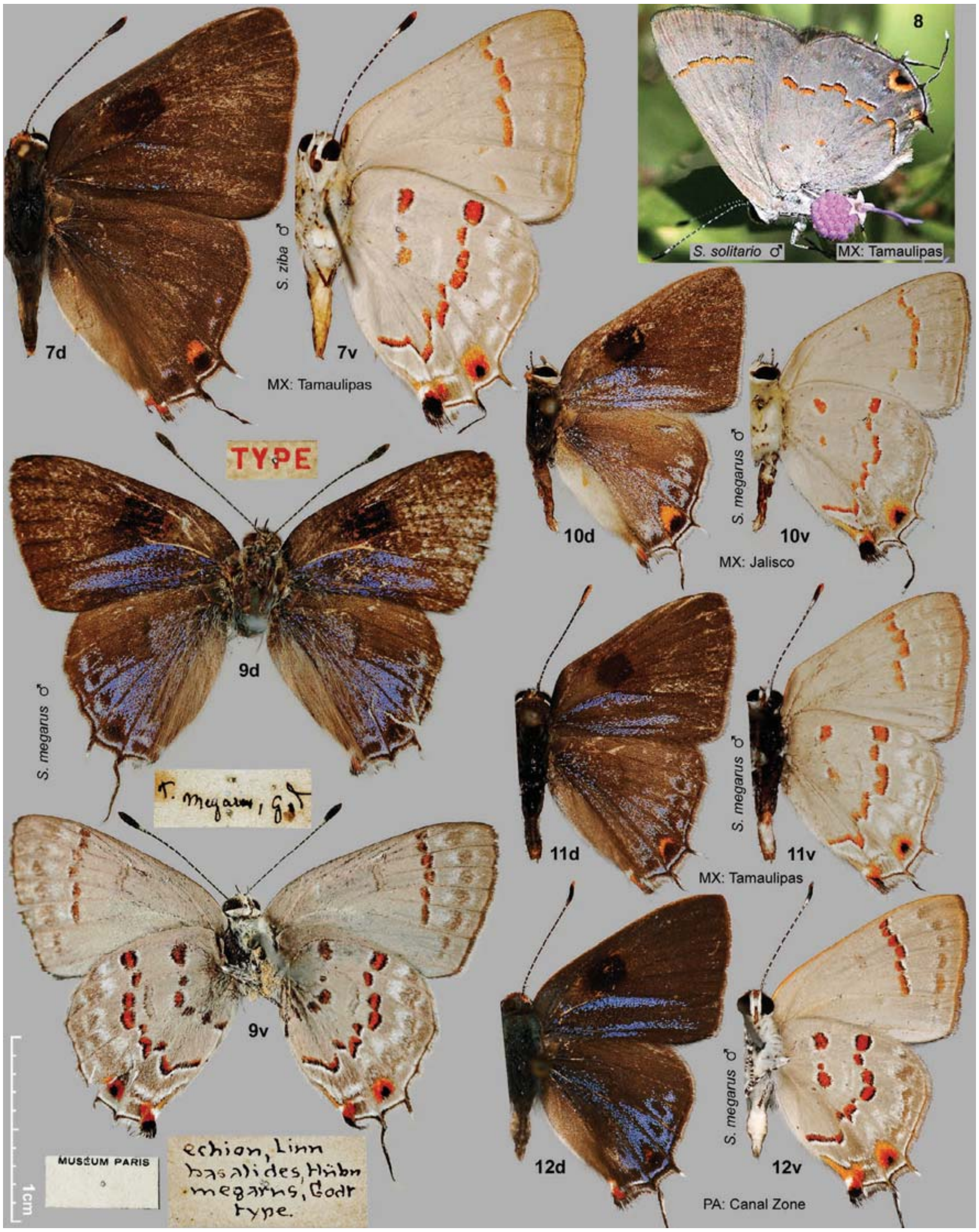


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Primary types are displayed in full expanse, with all the labels shown. Only a half for other specimens is illustrated. Species names and general location are indicated on the plate and detailed here. All pinned specimens are to scale. Live individuals are scaled approximately to match corresponding species.**7**. *S. ziba* ♂, Mexico: Tamaulipas, Villa Gomez Farias, 14-July-1973, leg. W.W. McGuire. In USNM collection. **8**. *S. solitario* ♂, live individual, Mexico: Tamaulipas, NW Ciudad Victoria, Los Troncones Canyon, 27-November-2004, photograph by Kim Davis and Mike Stangeland, the same individual shown on Fig. **9#12**, **9**. *S. megarus* ♂, possible holotype. Possibly Brazil. Label "P. megarus, God" matches Godart's handwriting. In MNHN collection, photograph by Rene Lahousse. **10**. *S. megarus* ♂, Mexico: Jalisco, Chamela, 29-March-1939. Fred. H. Rindge collection. In USNM collection. **11**. *S. megarus* ♂, Mexico: Tamaulipas, Road to Ocampo (Hwy A70) ca 16km W of Hwy 85, 5-January-1974, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. **12**. *S. megarus* ♂, Panama: Canal Zone, Paraíso, 5-August-1977, leg. G.B. Small. In USNM collection.

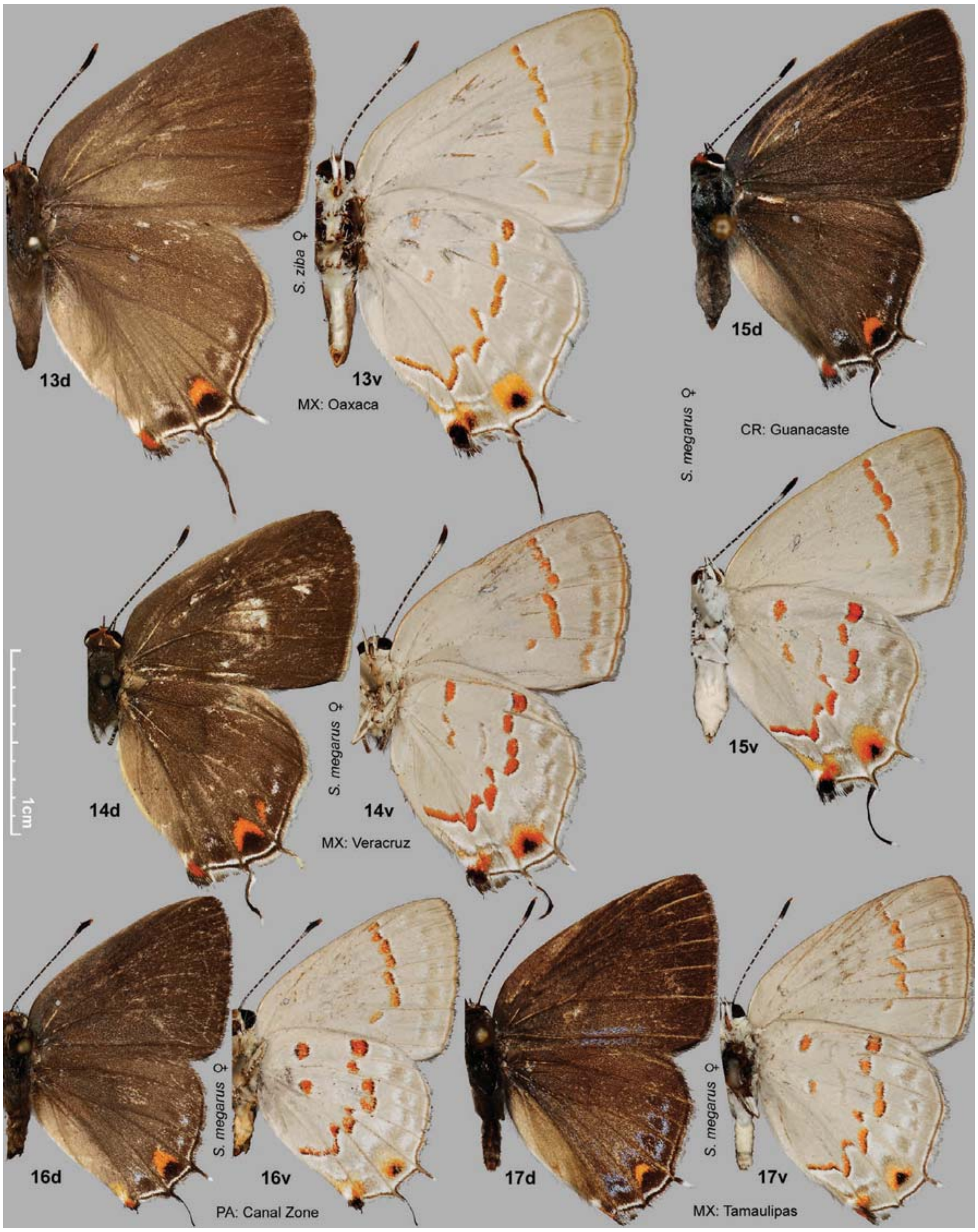


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Species names and general location are indicated on the plate and detailed here. All specimens are to scale. **13**. *S. ziba* ♀, Mexico: Oaxaca, Candelaria Loxicha 15°54'N 96°31'W elevation 500m, 30-June-1972, leg. E. Welling. In USNM collection. **14**. *S. megarus* ♀, Mexico: Veracruz, Tlacotalpan leg. O.W. Barrett. In USNM collection. **15**. *S. megarus* ♀, Costa Rica: northern Guanacaste Province, Guanacaste National Park, Janzen & Hallwachs Voucher Specimen Database 92-SRNP-254, Latitude: 10.83764 Longitude: -85.61871, ex larva, leaf miner found as last instar feeding on *Bromelia pinguin*. Hatched 13-February-1992. In USNM collection. **16**. *S. megarus* ♀, Panama: Canal Zone, Farfan, 17-February-1963 leg. S.S. Nicolay. In USNM collection. **17**. *S. megarus* ♀, Mexico: Tamaulipas, Paso del Abra near El Abra, 18-December-1973, leg. R.O. Kendall & C.A. Kendall. In TAMU collection.

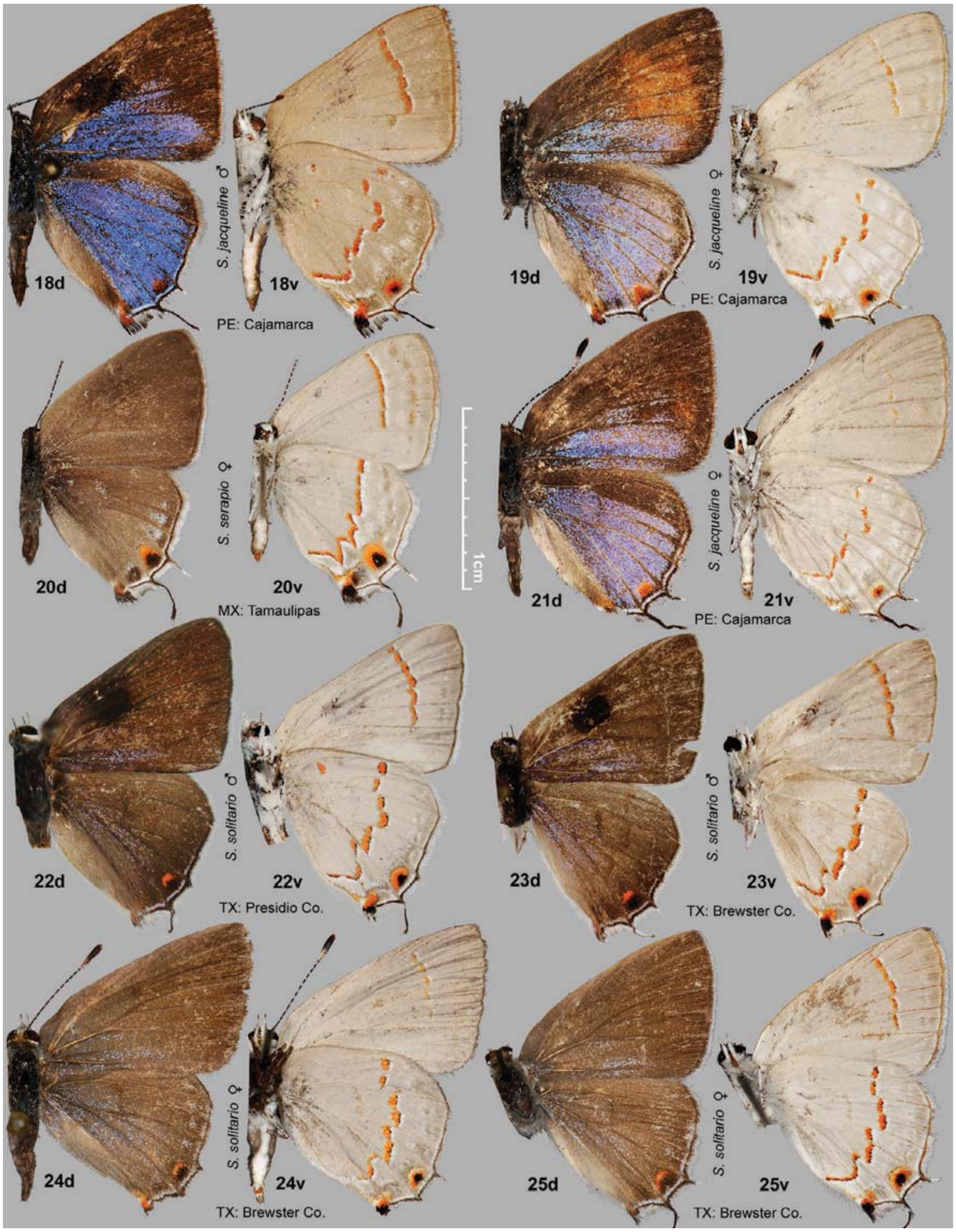


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Species names and general location are indicated on the plate and detailed here. All specimens are to scale. **18**, **19**, **21**. *S. jacqueline* ♂, ♀ and ♀, paratypes, Peru: Cajamarca, Puente Chetilla 07°12'S, 78°45'W elevation 1050m, 17-September-1999, leg. Robbins, Lamas & Ahrenholz. In USNM collection. **20**. *S. serapio* ♀, Mexico: Tamaulipas, El Abra, 22-December-1973, leg. W.W. McGuire. In USNM collection. **22**. *S. solitario* ♂, Texas: Presidio Co. The Solitario, Gray's Ridge 29.43°N 103.80°W, at flowers *Acacia greggii*, 20-May-1973, leg. C.J. Durden, #73140D3. **23**. *S. solitario* ♂, Texas: Brewster Co. The Solitario, ridge south of Tres Papalotes 29.44°N 103.77°W, at flowers *Acacia greggii*, 8-June-1975, leg. C.J. Durden, #75159A15. **24**. *S. solitario* ♀, Texas: Brewster Co. Big Bend National Park, between Barker House and Boquillas Canyon, 27-March-1987, leg. R.O. Kendall & C.A. Kendall. In TAMU collection. **25**. *S. solitario* ♀, Texas: Brewster Co. Big Bend National Park, between Barker House and Boquillas Canyon, 27-March-1987, leg. R.O. & C.A. Kendall. In TAMU collection. Genitalia shown on Fig. 8#2.

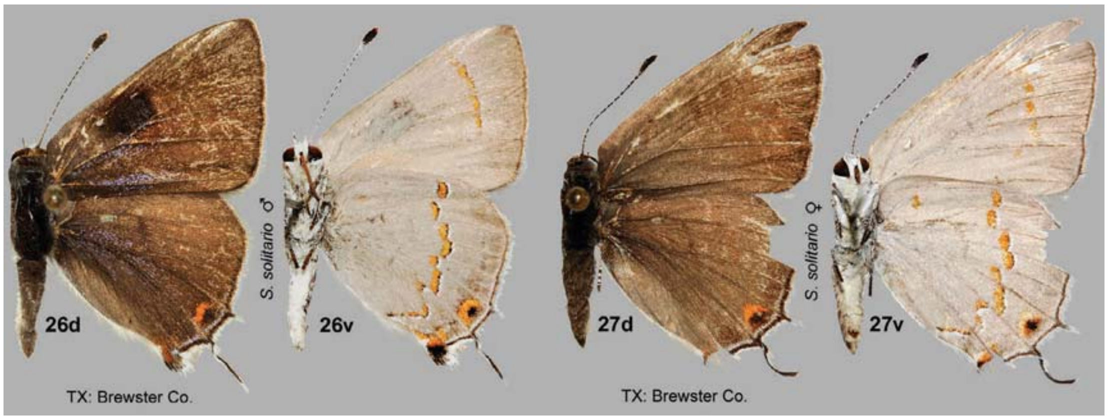


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Species names and general location are indicated on the plate and detailed here. **26**. and **27**. *S. solitario* ♂ and ♀, Texas: Brewster Co. Big Bend National Park, "Ameries Boquillas, Rio Grande River", 29°12'N 102°55'W, 25-September-1944, leg. George Schenk. In UWBM collection.

naturally higher in the Dallas area where the experiments were conducted than in dry Boquillas desert; 2) rearing was done in closed glass jars; 3) *Hechtia* flower buds develop mold easily and larvae did not distinguish between fresh and slightly moldy food source. It is possible that only fresh plant matter is digested properly. While caterpillars fed on flower buds and stalk cuttings readily, they continued to die off with every instar, even when the food source was replaced daily. The foodplant may release alkaloids when injured and these may inhibit larval health.

All caterpillars were unusually active for flower-feeding hairstreaks. They frequently abandoned the feeding position and crawled about the jar, either returning to the same feeding site, or resumed feeding at a different location. This extra mobility might be caused by insufficient food quality, or be a display of a natural behavior, for instance, caterpillars resting at the base of a plant and crawling up the flower stalk to feed. The latter might explain the difficulty of finding caterpillars in the wild. In the wild most feeding may be nocturnal. We conducted several hour searches for caterpillars on April 15 2005 and May 21 2005 (with James P. Brock), exploring several thousand flower stalks without success. However, flower damage consistent with caterpillar feeding in the lab was observed on many occasions, including the cavities like the one shown on Fig. 11e. We were not able to detect mines on *Hechtia* leaves, so it is unclear whether this species can engage in mining behavior as does *S. megarus* (Carter 1949, Sanches et al. 1985, Janzen & Hallwachs 2011).

Life cycle from oviposition to adult took about 50 days at 70F. Larva went through 5 instars. This might be a result of unnatural rearing conditions, as the overwhelming majority of Lycaenidae are known to have 4 instars with just a handful of exceptions (Ballmer & Pratt 1988, Duarte et al. 2005, Duarte & Robbins 2009). Therefore the number of instars in *S. solitario* needs to be investigated further. Brief description of *S. solitario* immatures follows.

Ovum (N=15, Fig. 11b) is 0.9–1.2mm diameter, develops 7 days. Unusually large for the family, it is sculptured inconspicuously, with a prominently depressed micropyle area. Color is light-ivory.

1st instar (N=15, Figs. 11c, d) is ca. 3mm long, takes 5 days, with the last 24 hours prior to molt, quiescent, not feeding. Glossy, covered with prominent setae, especially long caudad, it is up to 0.8mm length. Color is dark khaki, pinkish caudad. Pinkish tint develops on all segments closer to the first molt, especially laterally in proximity of spiracles.

2nd instar (N=10, Fig. 11e) is ca. 6mm long, 6 days, with the last 24 hours prior to molt, quiescent, not feeding. Similar to previous instar, but with setae comparatively shorter, it is of less pronounced pinkish coloration. Ground color is still dark khaki.

3rd instar (N=7, Figs. 11f, g) is ca. 9mm long, 6 days, with the last 24 hours prior to molt, quiescent, not feeding. Upon feeding, color lightens to khaki and even lighter pattern becomes more prominent on each segment. The pattern consists of a median stripe (over heart) and two longitudinal stripes on each side placed at a slight angle to the median stripe. Caterpillar appears semi-transparent, not very strongly pigmented.

4th instar (N=5, Fig. 11h) is ca. 12mm long, 6 days, with the last 24 hours prior to molt, quiescent, not feeding. Tracheae become more visible through semi-

FIG. 11. Life history of *Strymon solitario*. All specimens from Texas: Brewster Co. Big Bend National Park, north of the park road to Boquillas Canyon, ~1 mi E of SH118, nr. Barker House. **a**) Captive females feeding on a paper towel with diluted honey solution. **b**) Ovum on a *Hechtia* flower stalk. Caterpillars: **c**), **d**) 1st instar, on **d**) ready to molt; **e**) 2nd instar, feeding cavity seen at the base of the flower bud to the left of the larva; **f**), **g**) 3rd instar; **h**) 4th instar; **i**) 5th instar. **j**), **k**) pupa ♂ (adult image Fig. **4#12**) on an oak leaf, dorso-lateral and dorsal views, respectively.

transparent cuticule as a web-like lighter lateral pattern in the vicinity of spiracles, otherwise the same as previous instar.

5th instar (N=2, Fig. 11i) is ca. 15mm long, 9 days to pupation, 6 days feeding, 1.5 days searching for pupation site, 1.5 days as prepupa. It is the same color as previous instar, just larger. Tracheae are clearly visible. Setae covering the body are short and thin compared to those in *Strymon melinus*.

Pupa (N=1, Figs. 11j, k) is 8.0mm long, 3.7mm wide at the abdomen, develops 12 days. Probably on the smaller side, as the adult hatched on 20-May-2005 is the smallest specimen in the type series. Pupation occurred on an oak leaf, chosen among other objects (dry and green leaves, twigs, bark pieces) that were placed in a jar after the caterpillar stopped feeding and started to move about in search for pupation site. It is most likely that in natural conditions pupation does not occur on flowers either, and caterpillar finds a pupation site close to the ground. Pupa stout, of a typical shape for the family, is covered in small setae, particularly conspicuous on the abdomen. It is attached to the leaf by a single girdle and hooked by a cremaster to a loose silkpad. Color is wheat (ivory-brown), abdomen lighter, yellowish especially on the sides. Each abdominal segment dorsally has two dark small macules on each side and a darker middle stripe (see-through "heart" line). Median darker macules are present dorsally at the connection between the thorax and abdomen and the head and thorax. Thorax has indistinct grayish mottled pattern on both sides, basally from the wing cases.

Since immatures developed without delay in the lab, it remains unclear what stage may be quiescent (diapause or aestivation). It is most likely that at least one stage enters diapause, as winter conditions, at least in The Solitario and around the Pine canyon are too harsh to support continuous development. Since no adults were observed in 2006, which was a very dry year, and no *Hechtia* was in bloom, there should also be some mechanisms for these *Strymon* to stay in diapause for longer than one year. It seems unlikely that fragile adults and succulent caterpillars are capable of this, so either ova or pupae can enter diapause. Ova were unexpectedly large, about 1.5 times the size of *Strymon melinus* ova, and oviposition behavior with lengthy search for oviposition site (as in the species with overwintering ova, e.g. *Satyrium*) argue for the possibility of ova entering diapause that might be induced by dry and cold conditions. However, we could not rule out the possibility that pupae, as in many spring-flying ephemeral hairstreaks (e.g. *Callophrys* Billberg, 1820) might enter diapause that can last for several years, as in *Anthocharis* Boisduval, Rambur & Graslin, [1833] (Pieridae), for instance. Early emergence of adults (18-Feb as the earliest) date is more consistent with the pupal hypothesis, as it would mean that the ovum would have hatched no later than early January, and probably as early as December, for the adult to appear in mid-February. In addition, no flowering plants are available in January. It is also possible that both mechanisms (ova, pupae) can be used depending on conditions. Future research will address these questions.

Etymology:

The species is named after the geologic feature in the Big Bend Ranch State Natural Area, Texas (The Solitario), where specimens were collected by CJD. Although holotype was ultimately selected from the Big Bend National Park, "*solitario*" rhymes with *serapio*, which is the species group *S. solitario* belongs to. The name is a non-Latinized noun in apposition and is indeclinable.

DISCUSSION

Relationships to and comparisons with other taxa:

It is frequently difficult to know whether an insect represents a new biological species, or is an extreme geographic variant of a known species. Due to the lack of formal, verifiable and quantitative criteria the answer to this question often remains hypothetical. Perhaps, the easiest approach is an attempt to place the unusual phenotype within described taxa. If this attempt is not particularly successful, it is likely that a new species is discovered.

Significant difficulties were encountered with the Big Bend Hairstreak identification. While it is apparent that it belongs to *Strymon* (teeth on the male valvae), and to the *S. serapio* group (down-turned penis tip with paired cornuti, Bromeliaceae as larval foodplants), it is not easy to identify it as any single described species, because it apparently possesses an amalgamation of characters known from several *S. serapio* group taxa. Even historically, there have been problems with the identity of the specimens from the Big Bend National Park collected by Kendall. Independently, researches very experienced with "*Theclinae*", such as Clench and Miller wrote the ID labels on the two of the Kendall specimens: ["Thecla" // sp. ♀ // may be new // det. H. Clench 1969] and [Strymon sp. // possibly new ♂ // det. Lee D. Miller // 1980].

Later, this species was tentatively identified as *S. serapio*. Although it does exhibit certain traits of *S. serapio*, for instance dorsal wing pattern, as we tried to demonstrate here, all other characters are inconsistent with *S. serapio* and many recently described species placed under *"serapio"* by Robbins & Nicolay (2002). Ventral wing pattern, in particular developed postbasal orange spots on hindwing in many specimens, presence of orange scales on the dorsal forewing, tibial leg pattern, shape of saccus, size of tegumen and desert habitat do not agree with *S. serapio*, but agree with several other described *Strymon* species. We think that the evidence presented here is sufficient to support the distinctness of the Big Bend Hairstreak from *S. serapio* and taxa closely related to it (synonyms and subspecies according to Robbins & Nicolay 2002) and characterized by the absence of basal orange spots on the hindwing, very short saccus and a bulky tegumen.

Upon careful comparison of Big Bend specimens with all 46 described taxa placed by Robbins & Nicolay (2002) and Robbins (2004) in the *"serapio"* group and arranged into 15 species, only *S. megarus* with its 5 synonyms and subspecies, and *S. jacqueline* warrant further consideration. Briefly, the following features rule out other taxa: *S. serapio* (11 names, discussed above), *S. glorissima* K. Johnson & Salazar, 1993 (2 names), *S. gabatha* (Hewitson, 1870) (4 names), *S. monopeteinus* Schwartz & J.Y. Miller, 1985, *S. azuba* (Hewitson, 1874) (3 names), *S. eremica* (Hayward, 1949) (4 names), and *S. veterator* (H.H. Druce, 1907) (3 names) lack the postbasal orange spots on the hindwing venter; *S. oreala* (Hewitson, 1868), *S. dindus*, *S. lucena* (Hewitson, 1868) (6 names), *S. cardus* (Hewitson, 1874) and *S. ahrenholzi* Nicolay & Robbins, 2005 have very prominent postbasal spots or bands on the hindwing venter, together with developed end of cell bar; and *S. giffordi* Nicolay & Robbins, 2005 possesses quite different dorsal wing pattern with most of hindwing being solidly violet-blue (males) or slate (females). In addition to those features, many other characters, too numerous to be discussed here and frequently individual to each taxon, help us to rule out the above-mentioned taxa as the determination of the Big Bend hairstreak, and the readers are referred to the original descriptions and examination of specimens.

Many Big Bend Hairstreak specimens possess orange postbasal spots on the hindwing venter, while those spots are never very large, but frequently dot-like and many specimens lack the spots. Some specimens have spots on one hindwing and lack them on the other hindwing. This feature (presence and absence of small spots) is characteristic of *S. jacqueline*. While dorsal hindwings might have violet-blue (males) and slate (females) overscaling, it is never very prominent, in fact is even less prominent than in most *S. serapio* specimens, and *serapio* is being referred to as the species most closely resembling the Big Bend Hairsterak on the dorsal wing surface.

Thus, our analysis of 46 described *serapio* group taxa leaves us with 2 possible names for the Big Bend Hairstreak: *S. megarus* and *S. jacqueline*. The following evidence suggests that the Big Bend Hairstreak might be distinct from *S. megarus*. First, some females display orange scales on dorsal forewing. *S. megarus* (all 5 taxa, Robbins & Nicolay 2002) females always lack orange scaling. Second, postbasal orange spots on the hindwing venter are smaller than those in most *S. megarus*, or lacking altogether. Third, violet-blue overscaling is less developed in the new taxon compared to most *S. megarus*. Forth, blotches of light scales on the hindwing between the orange postmedian band and submarginal dark lunules are not prominent, while being well-developed and conspicuous in *S. megarus*.

Perhaps the strongest evidence for biological distinctness of the new taxon populations from *S. megarus* is that in Tamaulipas (Mexico) *S. megarus* flies in the proximity of the Big Bend hairstreak phenotype with about 35 miles separating the two distinct phenotypes (south of Ciudad Victoria and near El Abra and Gomez Farias). It is possible that the two taxa are even sympatric, but *S. megarus* occurs in brush and forest habitat, not deserts although *Hechtia* is present on dry karst limestone at these localities. These *S. megarus* specimens exhibit larger, blotchy orange spots on the hindwing, especially in the postbasal area, more extensive violet-blue dorsal overscaling, with the difference being especially prominent in females in the hindwing submarginal area (Fig. 10#17), well-pronounced light areas between the submarginal dark lunules and postmedian orange band on the hindwing venter (Figs 10#11, #17). Big Bend Hairstreak phenotype lacks extensive dorsal marginal blue areas and light scales on the hindwing venter are restricted to around the darker submarginal lunules and along the margin of the orange postmedian band.

It is essential to consider variation in each taxon to define the boundaries between them. To address this question, we assembled a type series of close to 70 specimens from the Big Bend and examined photographs of 4 individuals from near Ciudad Victoria (Mexico: Tamaulipas) that in many characters agree with the Big Bend specimens very well. This pool of specimens from an area of 500 miles defines individual and geographic variation in this species. Figs 4, 5, and 9 show the extent of this variation. While it is apparent that the size, shape and color of ventral orange macules and the extent of the dorsal violet-blue overscaling varies quite significantly, it is equally clear that the hiatus between the new species and S. *jacqueline/megarus* remains well-defined. Those diagnostic features listed in the previous paragraph hold true for all examined specimens, including live individuals from central Tamaulipas.

Although the main diagnostic features are sufficient to differentiate between the new species and S. *jacqueline/megarus*, several other more minute differences exist. For instance, the new species is additionally differentiated from *S. jacqueline* by: 1) the wing shape being more rounded with the forewing margin more curved than a relatively straight margin of almost triangular-shaped wings in males *S. jacqueline*; 2) in most specimens, basal margin of the orange macule in ventral hindwing cell M_3–Cu_1 is basally offset compared to the basal margin of the Cu_1–Cu_2 macule, and the margins of the two macules are more in-line in *S. jacqueline*; 3) in most specimens, orange macule in ventral hindwing cell Rs is not prominently offset basally compared to the macule in cell $Sc+R_1$–Rs, as characteristic of *S. jacqueline*.

Biogeographic significance:

Occurrence of a Bromeliad-feeding *Strymon* in the United States perhaps should not come as a surprise, because Bromeliad family plants occur here. However, despite a wide distribution of Spanish moss (*Tillandsia usneoides*) over the entire eastern US (Texas to Maryland) and other *Tillandsia* species in Arizona, Texas and Florida, *S. serapio* has been recorded to use *Tillandsia* as larval host (see Fig. 7#4 legend) is not a resident over most part of its host plant range. Apparently, the *serapio* group *Strymon* are restricted to subtropical biota. Thus, the discovery of the new species in the Big Bend area by George Schenk in 1944, Roy O. Kendall (apparently independently) in 1968, CJD in 1973 and others since then is a significant one. It is clear that this *Strymon* is a well-established resident in the region provided the vast areas densely covered with its foodplant *Hechtia texensis* and records from the following years: 1944 [Schenk, 25-Sep–9-Oct, 16], 1968 [Kendall 27-Mar 1♀], 1971 [Kendall 20-Sep 1♂], 1973 [Durden 17–20-May, photo, 2♂], 1975 [Durden 8-Jun, 5♂], 1985 [Knudson 29-Nov 1♂], 1987 [Kendall, 26–28-Mar, 4♀], 1989 [Swengel, 26-Apr photo], 1992 [Kendall, 5-Apr, last instar larva] 1994 [Spomer 25-Mar, 1♂], 2005 [Kostecke, Grishin, Spencer photos, 18-Feb–24-Apr, 25], 2007 [Grishin, 15-Apr–15-Sep, 9; Hensley, 19-Nov photo 1♂], 2009 [Reid 7-Mar, Grishin 8-Mar, 1♂, 1♀, Wauer 14-Mar, photos]. Recently, the Hairstreak has been found in all searches for it during the bloom of *Hechtia*. However, *Hechtia* does not bloom in some dry years. No specimens were found in the absence of fresh *Hechtia* flower stalks. It is particularly interesting that the apparently most similar relative, *S. jacqueline* also inhabiting arid areas, has been described from a different continent (Peru), and only recently. It seems like inaccessibility and dryness of the habitat that is relatively devoid of other butterfly species and the rarity of these *Strymon* species except in the most favorable and rainy years hinders their discovery and subsequent research. In addition to the Big Bend area (Texas: Brewster and Presidio counties), it might be fruitful to continue searches for the *serapio* group *Strymon* in extreme south Texas (and in Coahuila and Chihuahua, Mexico), since *Hechtia* species are known to occur in Zapata and Starr counties.

CONCLUSIONS

Evidence is presented that the Bromeliad-feeding *Strymon* found in arid, desert and rocky slopes areas of Big Bend National Park and its vicinity is an undescribed biological species, which was named herein. This new taxon combines characters of several described *Strymon* species from the *serapio* group. S. *jacqueline* appears to be most similar in facies and habitat. *S. jacqueline* shares ventral wing patterns, presence of orange scaling on female dorsal forewing, genitalia structures and habitat preferences. However, dorsal pattern of the new species differs drastically from *S. jacqueline* and has very restricted violet blue and slate areas present only as overscaling. This dorsal pattern is most similar to *S. serapio*. Another related species, *S. megarus*, shares ventral and partly dorsal wing patterns, but occurs in brush and forest habitat, not deserts. The new species is most easily distinguished from both *S. jacqueline* and *S. megarus* by the restricted light scale areas just basally from the submarginal dark lunules on the hindwing venter, present only as framing of the lunules. In *S. jacqueline* and *S. megarus* these areas are more extensive and usually reach at least 1/3 of the distance from dark marginal lunules to postmedian band of orange spots. In general, the new species is less contrasted, and is more flat and uniformly colored in appearance: less developed blue scaling, smaller light areas, fewer dark scales on the leg tibiae. While genitalia do not offer profound differences from many congeners, combination of shorter terminal tapered areas of gnathos arms with clearly asymmetric terminally pointed saccus is characteristic of the males of this taxon.

ACKNOWLEDGEMENTS

We are indebted to the United States National Park Service and the personnel of Big Bend National Park for assistance (in particular, to Wildlife Biologist Raymond Skiles), and continuing support with research permits (BIBE-2004-SCI-0011, BIBE-2005-SCI-0006, BIBE-2007-SCI-0007, BIBE-2008-SCI-0044) that were absolutely essential for this work. We are grateful to Edward G. Riley (Associate Curator, Texas A & M University insect collection) for the loan of specimens and permission to photograph specimens under his care. We acknowledge Texas Parks and Wildlife Department (Natural Resources Program Director David H. Riskind) for the permit #08-02Rev making the work in Texas State Parks possible. For work done before creation of the Big Bend Ranch State Natural Area (CJD) thanks are due to Red Oliver, Steve Kennedy, Mike McKann and Roseanne Rowlett of The Texas General Land Office (1973) and Don Kennard, Mary Butterwick and Stuart Strong of The Texas Natural Areas Survey, Lyndon B. Johnson School of Public Affairs, The University of Texas at Austin (1975). Thanks are due also to the late Roy O. and Connie A. Kendall and to W. W. McGuire for field discussion and discoveries made at El Abra, Gomez Farias and Rio Sabinas (Tamaulipas, Mexico, 1972 to 1974) as they were introduced to CJD's favorite localities, which were in turn recommended to him by the late Harry Clench. We are indebted to Jonathan P. Pelham (Curatorial Associate of Lepidoptera, Burke Museum of Natural History and Culture, University of Washington Seattle, WA) for discussions of the oldest known *S. solitario* specimens from the Big Bend and critical reading of the manuscript. Special thanks to Kim Davis, Mike Stangeland, Michael A. Rickard, Dan Hardy, Rich Kostecke, Martin Reid, R. Craig Hensley, and Andrew Spencer for sharing images of live adults and permission to use their photographs as illustrations. NVG thanks Andrew D. Warren for bringing the significance of this insect to our attention, numerous discussions, insightful comments and continuous help shaping our opinions about *Strymon*, and for the photographs of the Schenk specimens, the late George Austin for discussions of *Strymon* and records of *S. megarus* from Mexico per MGCL collection; Robert K. Robbins for stimulating discussions, encouragement, and many helpful comments on the manuscript; Charles Bordelon, Jr. for critical reading of the manuscript; Steve Spomer for discussion of the specimen he collected; Rene Lahousse for the *S. megarus* type images; Blanca Huertas for help and *S. serapio* type images; Ro Wauer for images and discussions.

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Received for publication 2 February 2011; revised and accepted 21 September 2011

Journal of the Lepidopterists' Society
66(2), 2012, 111–113

YOUNG LOVE? MATING OF *PARNASSIUS SMINTHEUS* DOUBLEDAY (PAPILIONIDAE)

Additional key words: age, pupal mating, reproduction, Rocky Mountain Apollo, sphragis, teneral mating

Butterflies exhibit a range of mating behaviors (Scott 1972, 1974) and reproductive strategies (Rutowski 1984) that can have consequences for the growth, genetic structure, and persistence of populations (Calabrese & Fagan 2004; Rhainds 2010). In this study we investigate mating in the alpine butterfly, *Parnassius smintheus* (Papillionidae). There have been several previous accounts for this species, detailing its protandry, mating with newly eclosed females, and the production of sphragides—structures affixed to females by males to prevent subsequent mating (e.g., Scott 1972, 1974; Guppy & Shepard 2001). Calabrese et al. (2008) showed that ≈10% of female *P. smintheus* never mate. Mechanistic models fit to mark-recapture data showed that the proportion of unmated females in the population increased with increasing male density and/or male age. Here, we bring together disparate data to determine whether mating success for female *P. smintheus* varies with their age.

In 2007, we conducted an experiment originally intended to examine the effects of male age on female mating success. We paired 29 field-collected virgin females with males. Pairs were housed at ambient conditions in mesh enclosures (0.5 × 0.5 × 0.5 m) at the Biogeosciences Institute which is approximately 13 km from and 700 m lower than the alpine meadow habitat (2100 m) from where the butterflies were removed (Jumpingpound Ridge, 50.957°N, 114.890°W). Enclosures contained nectar flowers (Matter et al. 2009), but did not contain host plants. If a male died before the female, the male was replaced. Trials lasted for the lifespan of the female. Surprisingly, only one mating occurred (3.5%).

Based on these results, and the fact that we rarely see mating unless females are immobile (e.g., in nets or glassine envelopes), we began to question how frequently non-pupal mating occurs. We first examined the frequency of mating of virgin females in our mark-recapture data (see Matter & Roland 2010 for details of mark-recapture methodology and the study site). Mark-recapture data from 1995–1997 and 2001–2009 comprising 3119 captures of 2303 females revealed only 51 instances where a female who was initially marked as a virgin was later recaptured. The majority of these recaptures were within a single marking period (< 2 hrs). Twenty-two recaptures were over an interval of at least 24 hrs and were thus deemed of sufficient time to potentially reveal mating. Less than one-third of these recaptures showed that mating had occurred (7 of 22). The longest time between recaptures that a female remained unmated was 11 days; three of the seven females mated with at most one day between recaptures. The mean number of days between observations did not differ between females that mated (4.7) and those that did not (3.9 days; t = 4.0, separate variance df = 8.8, P = 0.70).

To further test the frequency of adult mating, in 2010, we released 13 virgin females who were captured as larvae, reared in captivity, and released as adults into populations M and J on Jumpingpound Ridge. Releases took place between the 7th and 18th of August. Five of these females were subsequently recaptured. In contrast to the low rate of mating seen in our previous experiment and mark-recapture data, all of these butterflies mated. The mean time between release and recapture when mating was first observed was 5.0 days. In concordance with the analyses of Calabrese et al. (2008), showing an inverse relationship between female mating success and male density, total population size in these meadows was low in 2010. The maximum estimated population size in meadow M in 2010 was 84.6 versus a mean of 233.3 ± 187.1 (SD) from 1995–2009. Population size in meadow K in 2010 was 30.1 versus a mean of 143.3 ± 106.4. Despite this agreement, the results also indicate that other mechanisms may affect female mating success.

Differences in observed female mating success seen for released virgins and from mark-recapture data could relate to accurately determining mating status by the presence of a sphragis. We are certain that the butterflies we reared and released were virgins because larvae were housed individually. In the field we rely on the presence of a sphragis to indicate mating. Females with worn sphragides are difficult to distinguish from virgins and occasionally males fail to properly attach a sphragis (Guppy & Sheppard 2011). Vlasanek and Konvicka (2009) estimated that ≈ 3% of *P. mnemosyne* lose a sphragis. Thus, some females presumed to be virgin in the mark recapture data may have mated. If males avoid mated females (Gilbert 1976), and if some females assumed to be virgins were mated, it could account for the low mating success seen in the mark-recapture data. However, there is no indication that male *P. smintheus* avoid mated females. Additionally, Vlasanek and Konvicka (2009) show evidence for remating in *P. mnenosyne* following the loss of a sphragis, and two sphragides on one female can occur (Guppy & Sheppard 2001, p.54). Thus, it is unlikely that misidentification of mated females accounts for the lack of female mating seen in the mark-recapture data.

A possible explanation for the incongruous results is that males only mate with young females. *P. smintheus* have several traits making this hypothesis plausible. First, males often mate with females who have not expanded their wings (Scott 1972). Second, *P. smintheus* are protandrous; males emerge prior to females and patrol for mates. Finally, there is evidence that females emit a pupal pheromone whose effect diminishes with time (Scott 1974).

From an evolutionary perspective, male selection for females is thought to be rare (Rutowski 1984). Because male sexual function is inexpensive compared to females, males should maximize fitness by increasing their number of copulations. Exceptions occur where there is a cost of reproduction for males. For male butterflies, costs are usually in the form of courtship time or nuptial gifts (Rutowski 1984). Male Parnassians incur a reproductive cost by the production of a sphragis. These costs involve both missed mating opportunities during the time it takes to produce a sphragis (> 2 hrs) and the physiological cost of its production (Eltringham 1925). If males are limited in the number of females with whom they can mate, they should mate with females who will optimize their fitness. Because females only mate once, lay eggs singly from emergence whether they have mated or not, and continue to mature eggs throughout their life, the youngest females have the greatest potential fitness, and should be selected by males (Rutowski 1982).

Although not explicitly designed to test it, data are consistent with this hypothesis. Virgin females released in 2010 had high mating success and were very young. They were kept cool (2 °C) to minimize physiological demand and were all released within 1–3 days of emergence. The ages of the females with low mating success in the enclosure study were known less precisely, but were older. For this experiment, females were field-collected (Matter & Roland 2010). Using a mean collection interval of 2.9 days (range 1–5) in 2007 and a capture probability of $p = 0.30$ seen for females in the populations from which they were removed, the mean age of these females was 4.7 days, assuming no mortality or migration. Thus, females used in the mating experiment were on average 1.8 days older than virgins released in 2010. Females encountered during mark-recapture are also of an imprecise age. From 2001, age has been assessed based on wing wear, using the categories "new," "old," and "tattered." All but one of the 20 virgins recaptured during this time were initially scored as having new wings. These data are consistent with the age hypothesis in that all those that mated were initially new and the butterfly initially captured as an old virgin did not mate. Because wing condition is a function of age and flight, sedentary females often are scored as new, even those up to 5–6 days old.

Our analyses of mating indicate that females do mate after expansion of their wings, but the window of opportunity for a female to mate appears to be short, about 3 days. Most considerations of insect mating assume that females are equally mateable (but see Rhainds 2010). Our results indicate that the mating success of female *P. smintheus* decreases as females age, possibly due to the loss of a pheromone produced during the pupal stage (Scott 1972). Thus, effects previously attributed to male age may also be due to its correlation with female age (Calabrese et al. 2008). We are currently testing this hypothesis by releasing old and young virgins reared in the lab.

ACKNOWLEDGEMENTS

This research was supported by NSF grants DEB-0326957 & 0918929 to SFM and an NSERC Discovery grant to JR. We thank many field assistants for help with the mark-recapture over the years, in particular A. Hanneman, C. Holder, D. LeGendre, S. Ogle, and E. Williams who helped with the rearings, releases, and recaptures in 2010. Justin Calabrese and Larry Gilbert provided helpful comments on an earlier draft of the manuscript.

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Received for publication 8 November 2010; revised and accepted 13 January 2012.

Journal of the Lepidopterists' Society
66(2), 2012, 113–114

CHETOGENA SCUTELLARIS (DIPTERA: TACHINIDAE), AN ENDOPARASITE OF LARVAL *STRYMON ACIS BARTRAMI* (LYCAENIDAE)

Additional key words: parasitoid, population regulation, threatened species

The Bartram's hairstreak, *Strymon acis bartrami* (Comstock & Huntington) (Lycaenidae), occurs locally within the pine rocklands of southern Florida and the lower Florida Keys (Minno & Emmel 1993; Smith et al. 1994), where it is endemic. Due in large part to habitat loss, *S. a. bartrami* populations have declined considerably during the last several decades (Salvato & Salvato 2010). In response to this, *S. a. bartrami* was listed as candidate species for federal protection in 2006. Hennessey and Habeck (1991) and Worth et al. (1996) described many aspects of *S. a. bartrami* natural history. Salvato and Hennessey (2004) and Salvato and Salvato (2008, 2010) also discussed *S. a. bartrami* ecology and provided a review of known parasites and predators for the species. Although larval parasites have been recorded for other lycaenids throughout the New World (Arnaud 1978; Stireman & Singer 2003a, 2003b), little has been reported for *S. a. bartrami*. To our knowledge, the only observation of *S. a. bartrami* larval parasitism was provided by Hennessey and Habeck (1991) who collected a single unspecified braconid wasp from a late instar larva on Big Pine Key, Florida. Tracking the fate of late instar *S. a. bartrami* larvae is difficult due to the fact that this species tends to pupate in ground litter (Worth et al. 1996; Salvato & Hennessey 2004).

On 11 December 2010 MHS and HLS observed eggs (n = 2) of a parasitoid fly (Diptera: Tachinidae) attached to the cuticle of a late instar *S. a. bartrami* larva (Fig. 1) in the Long Pine Key region of the Everglades National Park (Miami-Dade County, Florida). The *S. a. bartrami* larva was encountered on pineland croton, *Croton linearis* Jacq. (Euphorbiaceae), the only known host plant for the species. After photographing the observation in the field, the parasitized larva was subsequently collected. Within approximately 72 h of the initial observation the white egg casings dropped off the larva, exposing dark spots (necrosis) on the cuticle.

The *S. a. bartrami* larva was maintained in a screen mesh cage and provided fresh food plants. MHS and HLS have successfully reared numerous *S. a. bartrami* larvae under these conditions over 15 years of research on this species. However this *S. a. bartrami* larva, which behaved lethargically in the field and laboratory, fed only minimally until 15 December 2010, when it became moribund while attempting to pupate. Five days later on 20 December 2010 a tachinid larva emerged from the *S. a. bartrami* larva. The tachinid larva was placed in a small plastic cup containing a layer of soil in which it quickly pupated. An adult fly emerged on 6 January 2011.

The adult fly (Fig. 2) was pinned and sent to JOS who examined and identified it as a female *Chetogena scutellaris* (Wulp). Often, a male *Chetogena* specimen is required to determine the particular species, as females in this genus can be nearly indistinguishable (Parchami-

FIG. 1. A late-instar *Strymon acis bartrami* larva with eggs of *Chetogena scutellaris* attached to its cuticle on 11 December 2010 in Long Pine Key, Everglades National Park (Miami-Dade County, Florida) (Photo Credit: H. L. Salvato).

FIG. 2. A female *Chetogena scutellaris* reared from a moribund late-instar *Strymon acis bartrami* larva (Photo Credit: H. L. Salvato).

Araghi 2008). However, this individual possessed several characteristics typical of female *C. scutellaris*, including yellow-golden parafrontals, a "trident" pattern of pruinescence on the abdominal tergites, and the apex of tergite 5 reddish (Aldrich & Webber 1924).

Chetogena scutellaris is a generalist endoparasite that preys on a variety of insect groups, including several families of Lepidoptera (Arnaud 1978; Sourakov & Mitchell 2002; Stireman & Singer 2003a, 2003b; Janzen & Hallwachs 2009) in Florida, Arizona and throughout the Americas. However, *Chetogena* has not previously been reported to parasitize lycaenids, despite a wide diversity of host records. *Chetogena scutellaris* has been consistently documented in Long Pine Key as a parasitoid of *Anaea troglodyta floridalis* F. Johnson & Comstock (Nymphalidae) (Salvato et al. 2009). *Strymon acis bartrami* and *A. t. floridalis* both use the host-plant *C. linearis* exclusively, with their larvae occasionally encountered feeding on the same individual plant (Salvato & Salvato 2008). As a result, it is possible that there may be some spillover of *Chetogena* parasitism from *A. t. floridalis* to *S. a. bartrami*. Additional studies may help to better determine the influence of *Chetogena* parasitism on *S. a. bartrami* larval ecology.

ACKNOWLEDGEMENTS

The authors thank the staff of Everglades National Park, particularly Jimi Sadle, P. J. Walker and Nancy Russell, for permitting and technical assistance.

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Received for publication 19 January 2011, revised and accepted 21 December 2011

Journal of the Lepidopterists' Society
66 (2), 2012, p. 115

CORRECTION OF THE SPELLING OF *SYNCOPACMA CROTOLARIELLA* (BUSCK) (LEPIDOPTERA: GELECHIIDAE)

Additional key words: Crotalaria, nomenclature

Busck (1900) described *Aproaerema crotolariella* from specimens reared from *Crotalaria pumila* Ortega, but he misspelled the generic name of the host as "*Crotolaria*." Dyar (1901) changed the spelling to *A. crotalariella*, and this name has been used in other checklists with different generic combinations, *Stomopteryx crotalariella* (McDunnough, 1938) and *Syncopacma crotalariella* (Hodges, 1983; Lee et al., 2009). The International Commission on Zoological Nomenclature, ICZN (1999) states that the original spelling of a name is the "correct original spelling" (Art. 32.2) unless it qualifies as an incorrect original spelling due to an inadvertent error, such as a *lapsus calami* or printer's error (Art. 32.5). The name *crotolariella*, even though based on the misspelled name of the host genus, is the correct original spelling that Busck used in his text (pg. 226) and explanation of plate 1 (pg. 254). Therefore, it is restored here as the valid name. The subsequent misspelling by Dyar (1903) is an unjustified emendation (Art. 33.2).

I thank Charley Eiseman (Ecological Services, Pelham, MA) for calling attention to this unjustified emendation and Richard Brown (Mississippi Entomological Museum, Mississippi State, MS) and Ronald W. Hodges (Eugene, OR) for their advice in resolving this problem.

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Received for publication 10 January 2012; revised and accepted 13 February 2012.

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Journal of the Lepidopterists' Society
66(2), 2012, p.116–118

BUTTERFLY HUNTER: THE LIFE OF HENRY WALTER BATES. By Anthony Crawforth. 272 pp. Hardbound; ISBN 9780956071613. About $54 from online sources. University of Buckingham Press. Buckingham UK. 2009.

The power of today's molecular technology to dissect nature sometimes overwhelms the history of discovery in biology. This new book by Anthony Crawforth helps put the Bates back into Batesian mimicry and will be a welcome resource to better understand the importance of Henry W. Bates' work on mimicry in butterflies and his contributions to evolutionary theory.

Crawforth, an amateur lepidopterist, has an MA in museum management and a PhD in Biography from the University of Buckingham. With this background, he and his son retraced Bates' travels in the Amazon where Crawforth collected materials and impressions for this book. The author believes that Bates, in spite of his friendship and professional association with Wallace and Darwin, is relatively unknown and his contributions to evolutionary theory not fully appreciated outside a small circle of evolutionary biologists. This book is a biography of a scientist whose discovery and elucidation of mimicry in Lepidoptera was historically important. Its strength is in its extensive biographical material and it isn't intended to be either a natural history of the Amazon region nor a popular science treatment of mimicry in Lepidoptera.

The book is divided into three parts: Early Development, The Evolution of the Naturalist, and The Evolution of the Man. Following chapters on Bates' early life, the book details his eleven year exploration, jointly at first with Wallace, of the vast, primitive and at times dangerous Amazon Basin. Eight plates are included of paintings Bates had done based on his memory of collecting specimens, boat travel on the Amazon, social gatherings in villages, etc. Other reproductions are sprinkled in the text, including a whimsical sketch —"Incident with Toucans"— of a befuddled Bates being mobbed by them after capturing one of their number. In addition to a bibliography and literature citations, there are four appendices: Bates' butterflies (including reproductions of his color plates), awards and medals, a chronology of Bates' time with the Royal Geographical Society, and details of his family life post-Amazon.

Butterfly Hunter documents Bates' three main contributions: 1) Bates published numerous professional articles and a best-selling book describing his travels and the extraordinary richness of the Amazon biota (reprinted as Clodd, 1892), 2) He added immensely to the collections of British Museum of Natural History, especially in insects and in particular butterflies, 3) Bates discovered a striking resemblance among certain unrelated butterflies in Amazonia. On return to England he was stimulated by Darwin's newly published *Origin of Species*, and with contributions from Wallace formulated his theory of mimicry, which Darwin in turn embraced as crucial evidence for natural selection in the wild.

I particularly enjoyed reading Crawford's introductory material describing converging life stories of Wallace, Bates, and others who contributed to Darwin's synthesis in *On the Origin of Species*. Bates met Alfred Russel Wallace when both were college students in England. They shared an interest in natural history and were intrigued by the mystery of the origin of species. The two men hatched an idealistic scheme to travel to Brazil, to be funded by collecting specimens to be shipped back to England and sold to museums and private collectors. The catalyst that fueled their enthusiasm and fixed the Amazon basin as their goal was the 1846 book by the American Lepidopterist William Henry Edwards: *A Voyage up the River Amazon: Including a Residence at Para*.

Landing at Belém (then Pará) on 28 May, 1848, they collected and explored together until October. They were aided by letters of introduction, including William Henry Edwards, yet found the traveling and collecting unexpectedly arduous. It was perhaps inevitable that a split between Bates and Wallace occurred early on, probably a rift between two strong-willed intellects, in spite of their shared devotion to natural history. Bates persevered alone, befriending land-owners for lodging and recruiting locals as field assistants. Bates' record of discovery and exploration is indeed impressive. He spent four of the eleven years in the vicinity of Tefé, an inland community along the Upper Amazon, where he collected an incredible 7000 insect specimens, 3000 new to science including 550 new butterfly species! Of the 14,712 animal specimens he brought back to England, 8000 were new to science.

The severe class-consciousness and puritanical social mores that characterized Victorian England are central themes in Crawford's historical narrative. Bates was fascinated by the mix of Portuguese, other Europeans, black slaves and the many tribes of indigenous people he met in the Amazon, and uncritical of their commonplace intermarriage. He was a keen observer of various tribes, employing many as aides in collecting and preparing specimens, and in some cases developing enduring personal friendships. Crawforth offers evidence that Bates may have fathered a daughter from one liaison, who tragically died during his stay in the Amazon. These cross-cultural experiences were in stark contrast to Bates' reception upon returning to England.

Crawforth pointedly describes the hypocrisy of British society in not fully accepting Bates into the social structure of preeminent scientists, probably due to his origins as a tradesman (stocking manufacturing) and lack of "proper" schooling. In spite of his reputation gained from his well-documented collections and his publications, Bates was not given a position as curator of entomology at the British Natural History Museum. He was passed over in favor of an administrator's crony with no entomology background over the protests of Darwin and members of the Royal Entomological Society. Indeed, science as a profession had not yet fully achieved parity with other professions and was looked down upon by the Museum trustees, who funded the yearly budget for insect collecting at only £10! I found Crawforth's sociological discussion fascinating, with his use of Bates' Amazon experience as a foil to that encountered in contemporary England upon his return.

With support from Darwin and others, Bates was eventually elected as Secretary to the Royal Geographical Society where he successfully developed a life-long career. During this period he published his book and many scientific papers, but never again returned to collecting or original research of any kind. In his summary chapter, Crawforth proposes that Bates experienced "distress or great disappointment" upon returning to England and taking up a new career, and that he coped with this "unbearable event" by taking on a new post-Brazil personality, with "workaholic tendencies … reaching the optimum in achievements or self-actualising …". I found little support in *Butterfly Hunter* for any such dramatic change in personality, nor in the concise biography by O'Hara (1995) who describes Bates as both successful in his new career while at the same time actively publishing his Amazon work.

The author's explanation of mimicry, and its basis in behavior, genetics, and physiology is less satisfying than the biographical material. About ten pages are devoted to the topic, including Bates' discovery of mimicry by pierids of model species in the Ithomiinae, and of the formulation by Fritz Müller of shared mimicry among unrelated distasteful species, known as Müllerian mimicry. Crawforth cites his personal experiences with the African *Papilio dardanus* mimicry system, and includes a plate of adults, but Bates' example species are treated in a single plate at the end of the book, separate from the relevant text. The specimen numbers given in the plate legend are not repeated in the plate, making species identification ambiguous at best. Clark and Sheppard studies with *Papilio dardanus* and *P. glaucus* are discussed, but the explanation of hybridization as a means to demonstrate a mimicry "supergene" is superficial. Mimicry in nature would be a useless gesture if memory did not guide predation. The studies of the Browers (1958) demonstrating the learned ability of birds to avoid the model monarch and mimic viceroy should have been cited. A reader of Crawforth's book might gain the mistaken impression that the study of mimicry genetics ended with the *P. dardanus* work. Not mentioned are the many population genetics studies of mimicry systems, using DNA technology, such as by James Mallet (University College London) or Larry Gilbert (University of Texas, Austin) on hybrid zones between mimetic forms in *Heliconius*.

An important theme in Crawforth's book is that Bates has historically not been fully recognized for his contributions to evolutionary biology. An anecdote concerning mimetic butterflies, as an example of natural selection in the wild, supports this view. In the early twentieth century genetics was maturing as a science, and skepticism remained toward Darwinism. The anti-selection camp was headed by the geneticist T. H. Morgan, of Columbia University, who insisted that dramatic change through mutation, not natural selection on innate variation, was the mechanism of evolution. Taken by Julian Huxley to see the impressive collection of mimetic butterflies at Oxford, "Morgan left the exhibit quite shaken. He said: 'This is extraordinary. I just didn't know that things like this existed.' By the end of his life Morgan had become reconciled to the possibility that Darwin might have something after all." (Edey and Johanson 1989, pp. 169-170).

It wasn't until the evolutionary synthesis of genetics, systematics and ecology that the significance of Batesian mimicry was understood. Fisher, in his seminal "Genetical Theory of Natural Selection" (1930) mentions Bates and mimicry, yet Dobzhansky (1951) only devotes a few pages to the subject. The words "Bates" and "mimicry" are not found in the index of Gould's (2002) treatise on evolutionary theory. On the other hand, Mayr (1963) cites Bates' observation on geographic variation and the importance of physical barriers in isolating closely related species, but notes that neither Bates nor Wallace developed their observations into a coherent theory of geographic speciation. The genetic basis and ecological operation of mimicry is routinely discussed in text books, but the influence of Bates is often ignored in favor of Darwin and Wallace.

As discussed by O'Hara (1995), but not by Crawforth, Bates should also be remembered for his contributions to biogeography, in the form of insightful speculation included in his taxonomic papers, often citing the likely role of glaciation in dispersal and speciation.

I have only minor criticisms on the production and organization of *Butterfly Hunter*. Crawforth devotes just a single chapter to his own travels in Amazonia. This is disappointing as his writing is personal, vivid and entertaining. He describes and identifies birds, mammals and butterflies he encountered on rain forest trails, and intersperses his own narrative with quotes from Bates' writings on the same region. Citations are given as numbered footnotes in very small typeset, but not all are included in the selected references which are listed, without spacing or indentation, at the end of the book. Certain proper names are listed by first name in the index. Finding a specific citation can be difficult. Otherwise the production is first-rate, printed on quality paper with a dark, high contrast ink. I recommend *Butterfly Hunter*, not just to Lepidopterists, but to anyone interested in natural history and the history of science.

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Journal of the Lepidopterists' Society
66(2), 2012, 119–120

ERRATUM: COMPLEX MTDNA VARIATION AND SPECIES DELIMITATIONS IN THE *PHYCIODES THAROS* SPECIES GROUP (NYMPHALIDAE: MELITAEINI): A SECOND LOOK IN MICHIGAN AND OHIO

Editor's note: The above article (Proshek and Houghton 2012) was published in issue 66(1) with an unfortunate error. Throughout the manuscript, one species name (*batesii*) was replaced by another (*cocyta*) (excluding the figures, table and appendix). This error rendered the meaning of much the article unintelligible. This short note is meant to give a brief synopsis of the text so that, when combined with the figures, table and appendix in the original article, readers of the article may understand the significance of the research. Readers are also reminded that the corrected original article is available in .pdf format online from the Lepidopterists' Society website or by contacting the author at the email address given at the end of this note.

The Nearctic genus *Phyciodes* is a taxonomically interesting group of butterflies. In particular the North American *P. tharos* species group (*P. tharos*, *P. cocyta*, *P. batesii* and *P. pulchella*) has posed several historical taxonomical challenges due to their phenotypic similarity and variability and apparently incomplete reproductive isolation (Oliver 1980; Porter and Mueller 1998; Scott 1998). The specific status of *Phyciodes tharos* and *cocyta* in particular are controversial, the latter having been relatively recently raised to species status from a subspecies of *tharos* (Scott 1994), but not to a consensus of lepidopterists (e.g., Glassberg 1999).

Wahlberg et al. (2003) conducted the first molecular analysis of the genus *Phyciodes*, sampling 140 specimens from all ten North American *Phyciodes* species and sequencing 1450 base pairs of the mitochondrial gene cytochrome oxidase I (COI). Their findings largely supported previous research based on morphology and ecology, except for the suggestion that *P. cocyta* was not as closely related to *P. tharos* as it was to *P. batesii*. The purpose of Proshek and Houghton (2012) was to re-examine the relationship between *P. tharos*, *P. cocyta* and *P. batesii* in a limited geographic area (the lower peninsula of Michigan and northwest Ohio), where the ranges of those three species coincide (*P. pulchella* is not found in the East) (Fig. 1).

We sequenced 40 novel COI sequences (5 *P. tharos*, 10 *P. batesii*, and 25 *P. cocyta*) and constructed a split network. We also combined those sequences with 78 sequences from Wahlberg et al. (2003) and generated a maximum-likelihood phylogenetic tree.

In the split network, two distinct clusters were formed: one containing all five *P. tharos*, and the other all 10 *P. batesii* (Proshek and Houghton 2012, Fig. 2). Of the 25 *P. cocyta* sequences, 20 were found with the *P. tharos* sequences, and five with the *P. batesii* sequences. Of those five, two were two of the three *P. cocyta* collected from Otsego Co., MI, the only sampling location where *P. batesii* was the most numerous *Phyciodes* present. On the other side of the network, one of two *P. cocyta* sequences that clustered most closely to the *P. tharos* sequences was the lone *P. cocyta* collected from Ionia Co., MI, which was by far the geographically closest site to where all the *P. tharos* were sampled (Lucas Co., OH) (Appendix).

In the combined maximum-likelihood tree, our results closely mirrored the parsimony tree of Wahlberg et al. (2003) in topology and branch support (Fig. 3). The tree of Wahlberg et al. (2003) had a "*tharos*" clade, a "*cocyta/batesii*" clade, and a "*pulchella*" clade. Of our novel sequences, all of the *P. tharos* and 20 of the 25 *P. cocyta* clustered in the "*tharos*" clade, and the remaining five *P. cocyta* along with all of the *P. batesii* clustered in the "*cocyta/batesii*" clade (Table 1).

Our results suggest that: (i) mitochondrial introgression may be occurring between *P. cocyta* and both *P. tharos* and *P. batesii* in our area of study, and (ii) that *P. cocyta* is in fact more closely related to *P. tharos* than *P. batesii*, at least in our area of study, in contrast to the conclusion suggested by Wahlberg et al. (2003). The evidence for assertion is that: (i) in Fig. 1 (Proshek and Houghton 2012), none of the three species form an exclusive split; (ii) two of the three *P. cocyta* from Otsego Co., MI cluster with the *P. batesii* samples from Otsego Co., MI, despite three-quarters of the *P. cocyta* sequences clustering with the *P. tharos* sequences; (iii) in Fig. 3 (Proshek and Houghton 2012) four-fifths of our novel *P. cocyta* sequences, as well as all five of our *P. tharos*, cluster in the "*tharos*" clade of the phylogenetic tree, not the "*cocyta/batesii*" clade.

It is hoped that this study will help to clarify some questions on the relationships among the members of the *Phyciodes tharos* species group, and especially that it may inspire future research. An analysis incorporating nuclear genes in particular may help to clarify matters.

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Received for publication 29 March 2012; revised and accepted 2 April 2012.

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