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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 extend 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

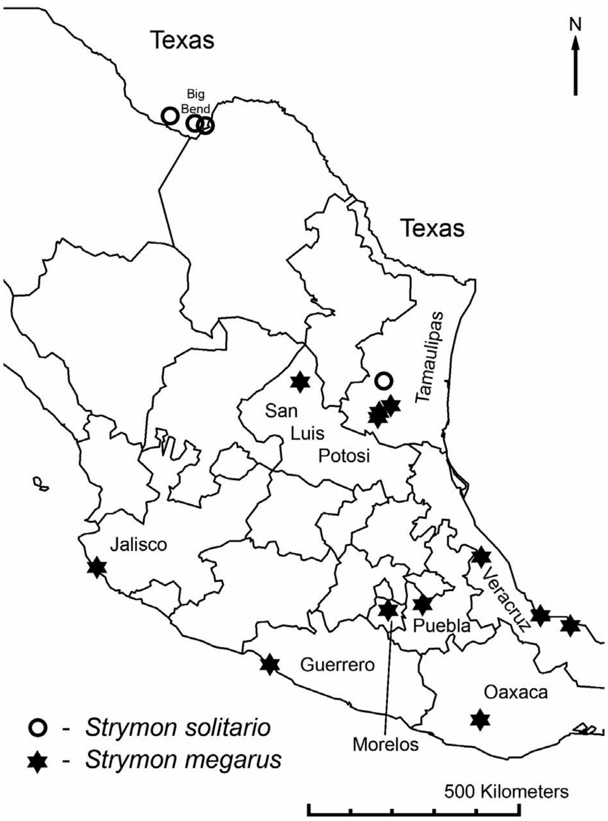


Fig. 1. Records of *Strymon solitario* (circles) and *Strymon megarus* (stars) from the United States (Texas) and Mexico. States with records are labeled.

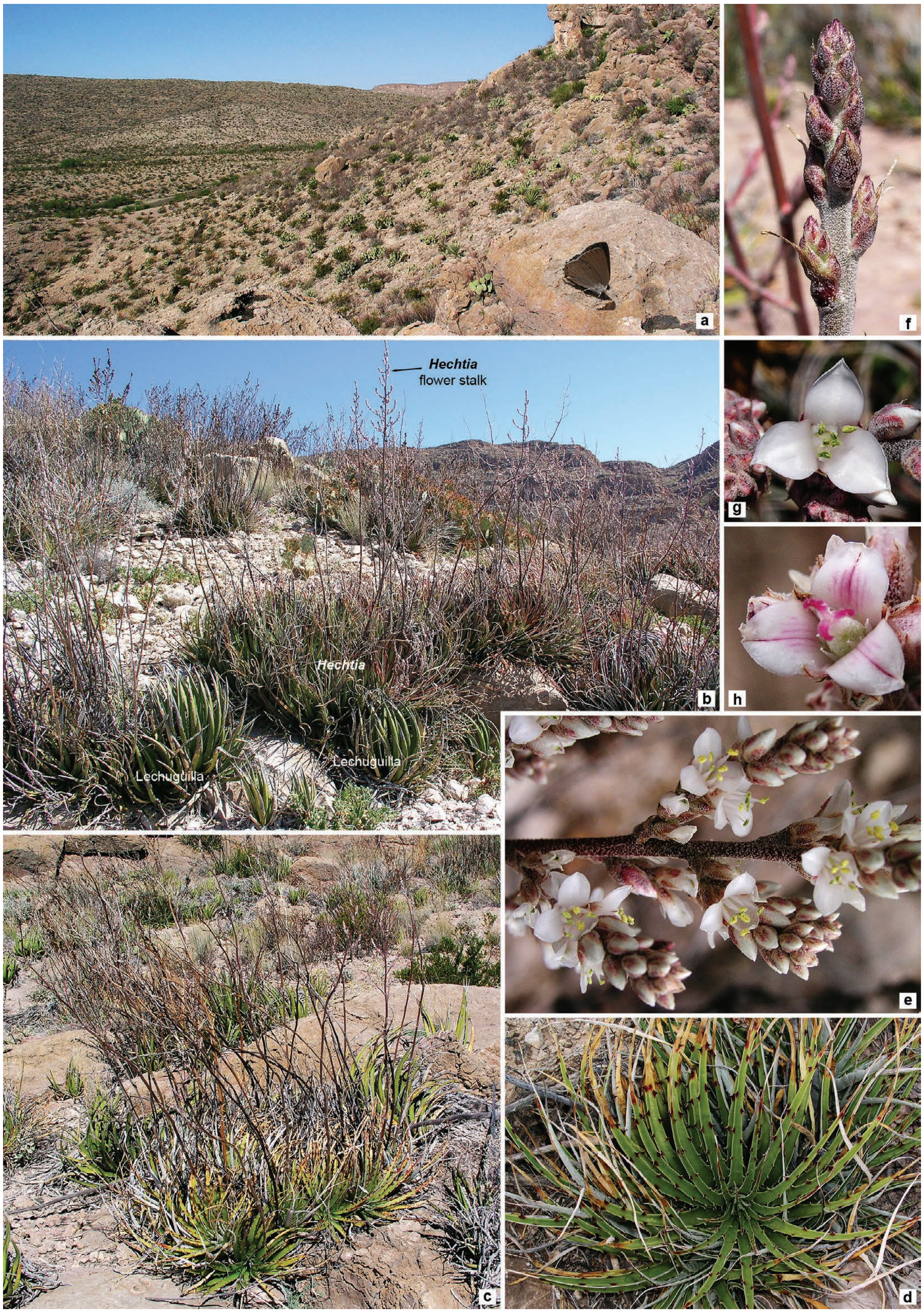


FIG. 2. Typical habitat and larval host plant of *Strymon solitario*. Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ca. 1 mi E of SH118, near Barker House, GPS ca. 29°11'50"N 102°57'06"W, elevation 620m. **a**) overview of the hill slope with *Hechtia texensis* 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.

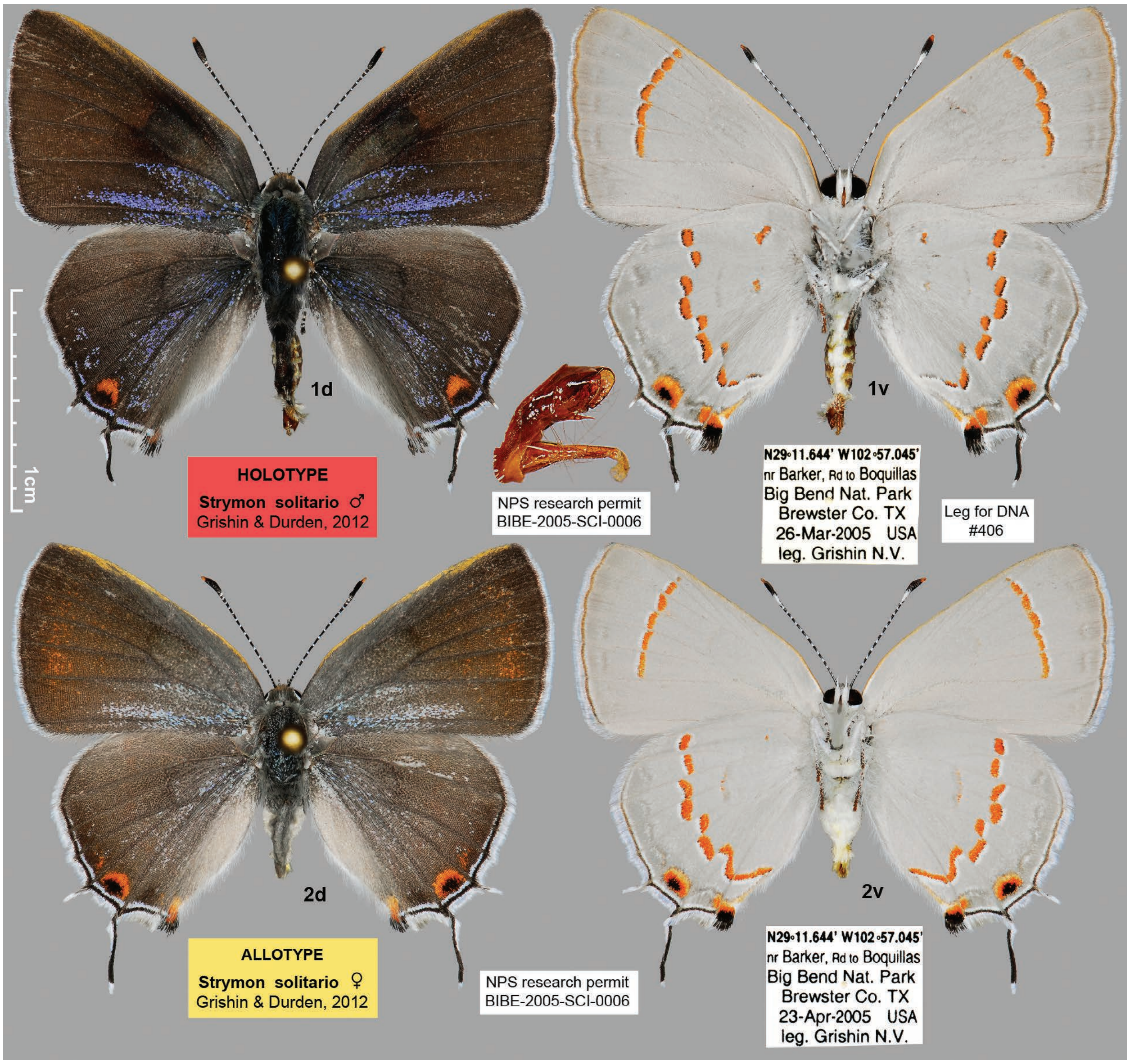


Fig. 3. The type specimens of *Strymon solitario*. Texas: Brewster Co., Big Bend National Park, north of the park road to Boquillas Canyon, ca. 1 mi E of SH118, nr. Barker House. **d** and **v** denote dorsal and ventral views, respectively; labels are shown below each specimen **1**. Holotype ♂, 26-March-2005, 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**.

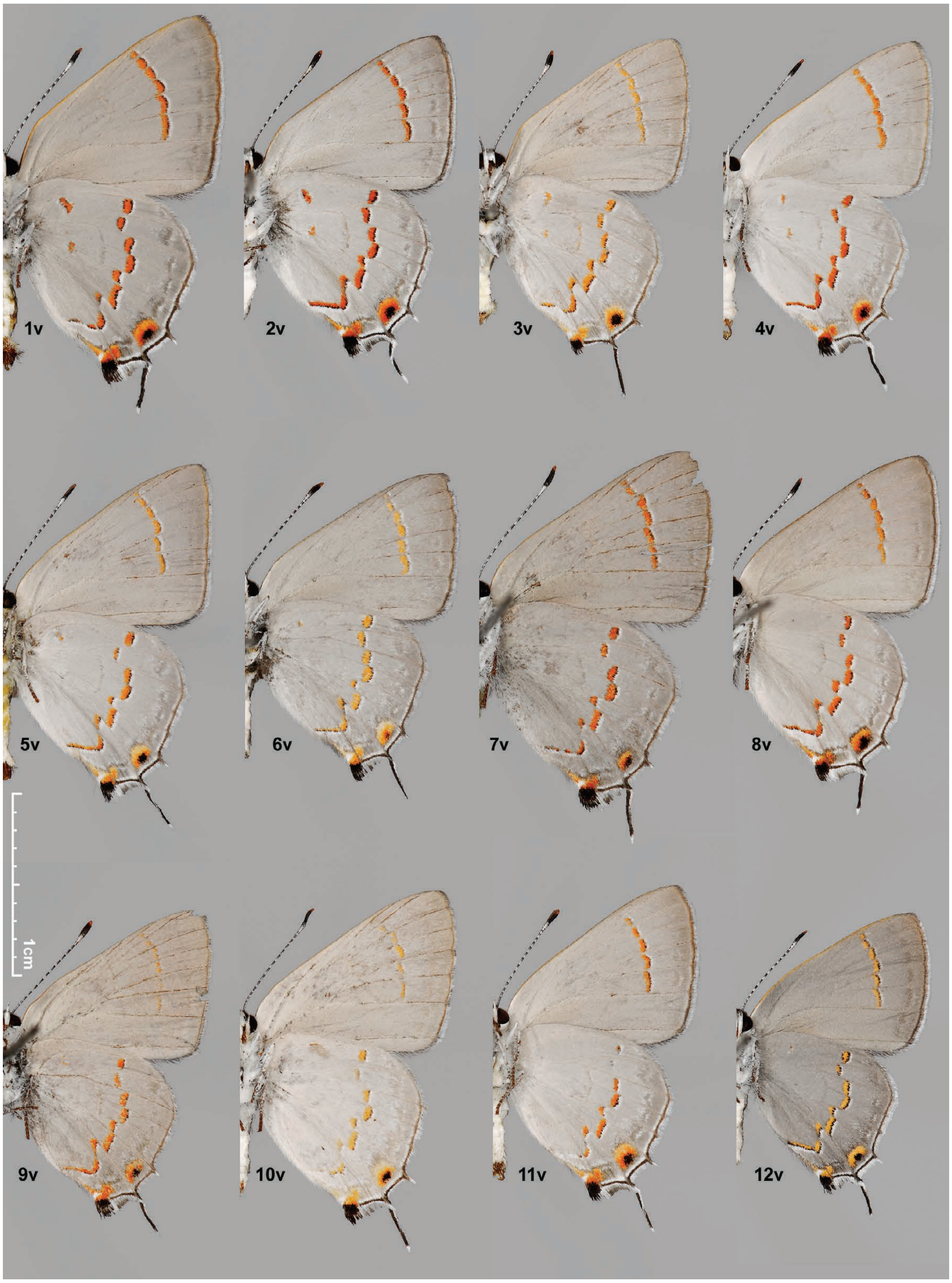


FIG. 4. (cont.) Wing pattern variation in *Strymon solitario* males

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**.

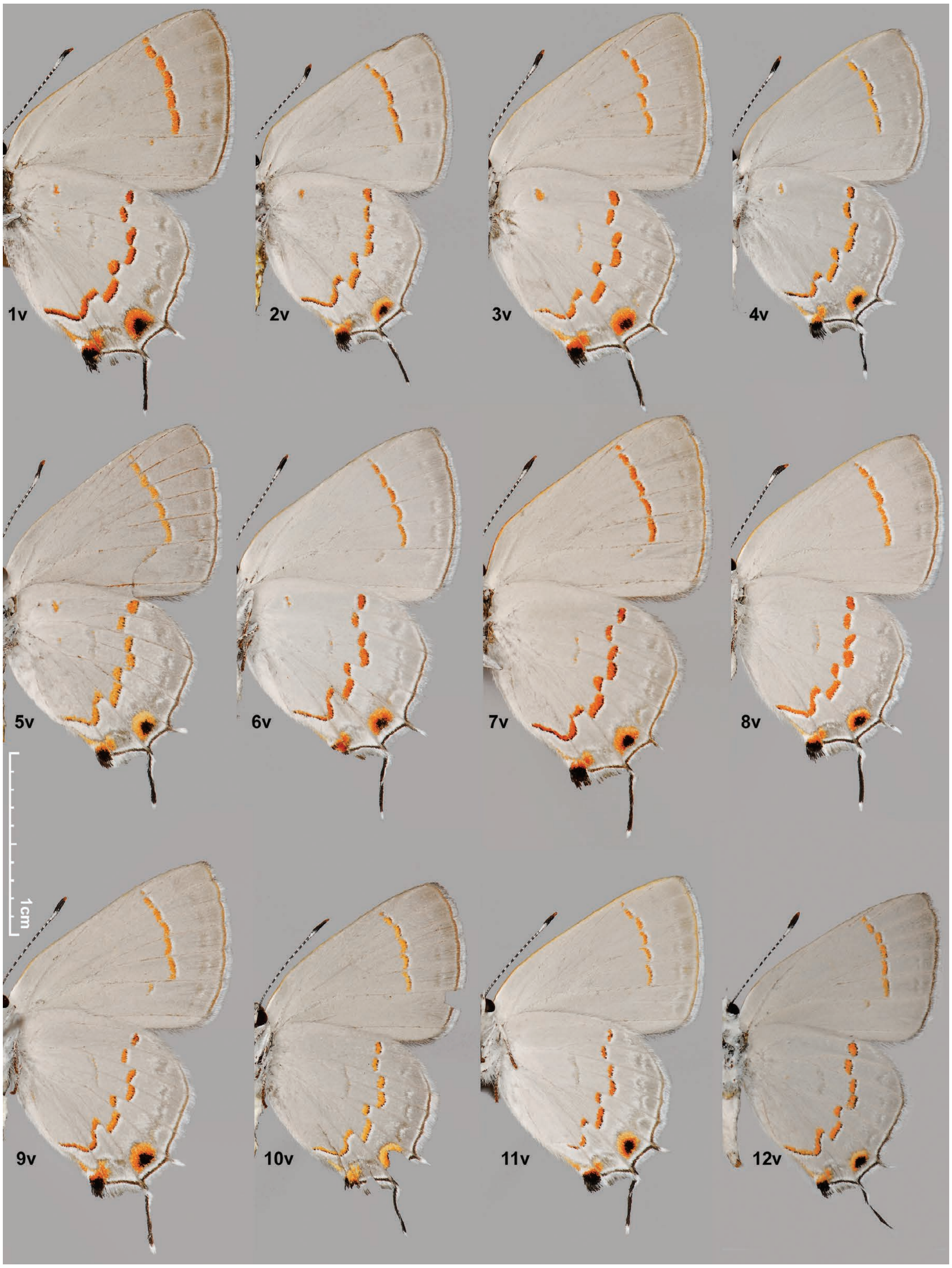
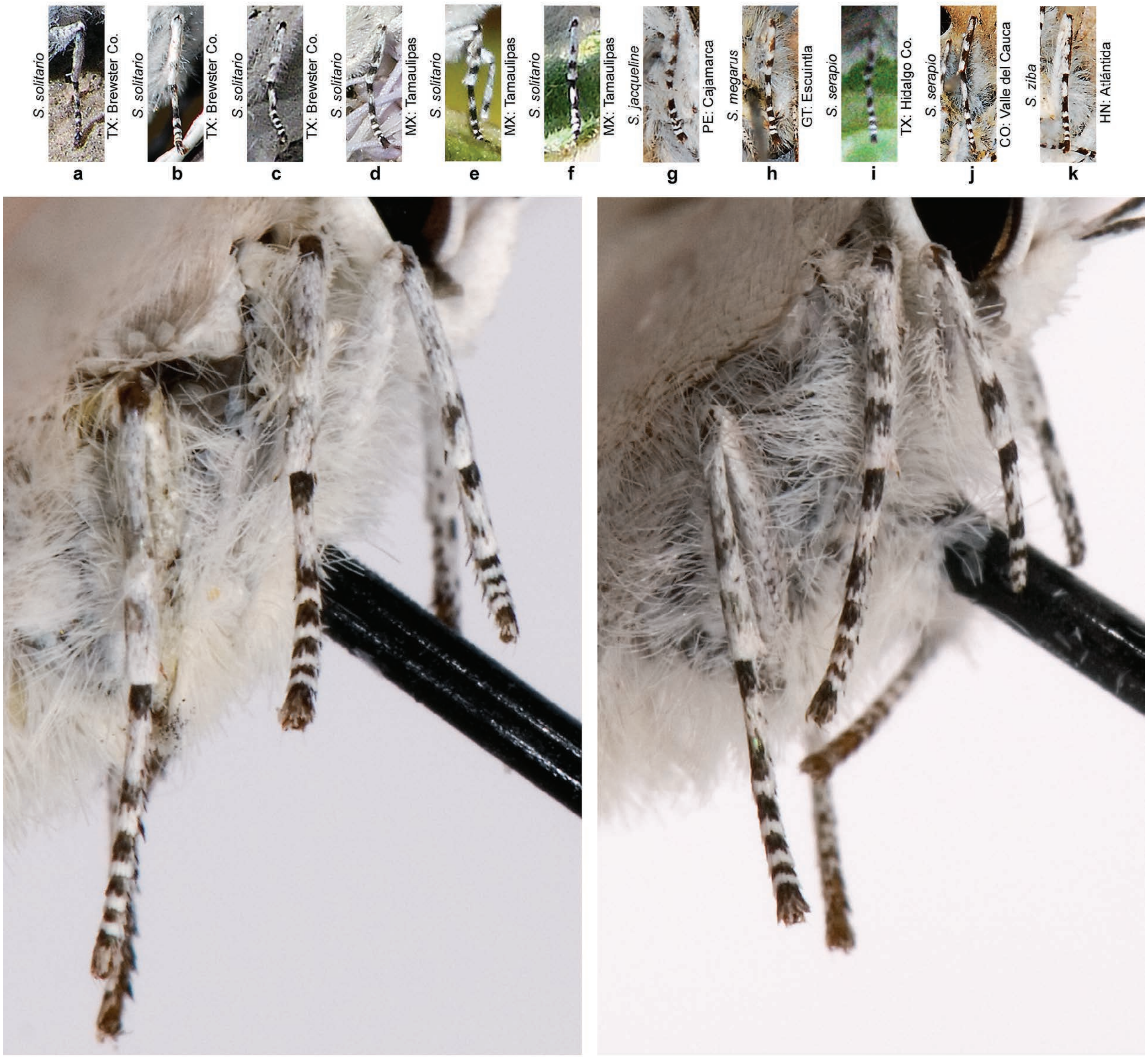


FIG. 5. (cont.) Wing pattern variation in *Strymon solitario* females.



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.

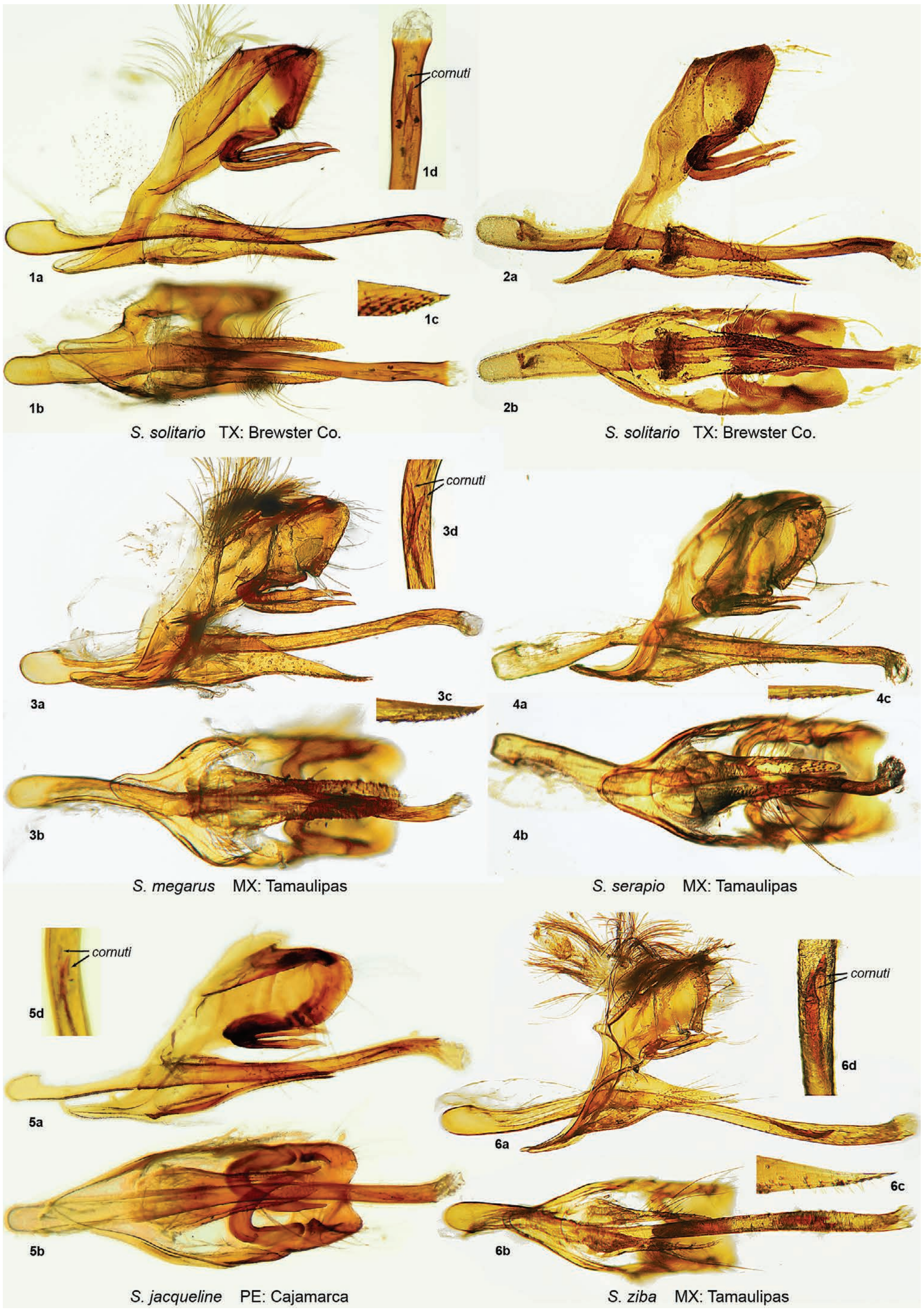


FIG. 7. Male genitalia of the *serapio* group *Strymon* species. **a** and **b** denote left lateral and ventral views, **c** is a magnified left lateral view of the left valva tip (in orientation similar to **a**) showing teeth on the ventral surface pointing down (teeth reduced in *S. ziba*), **d** 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.

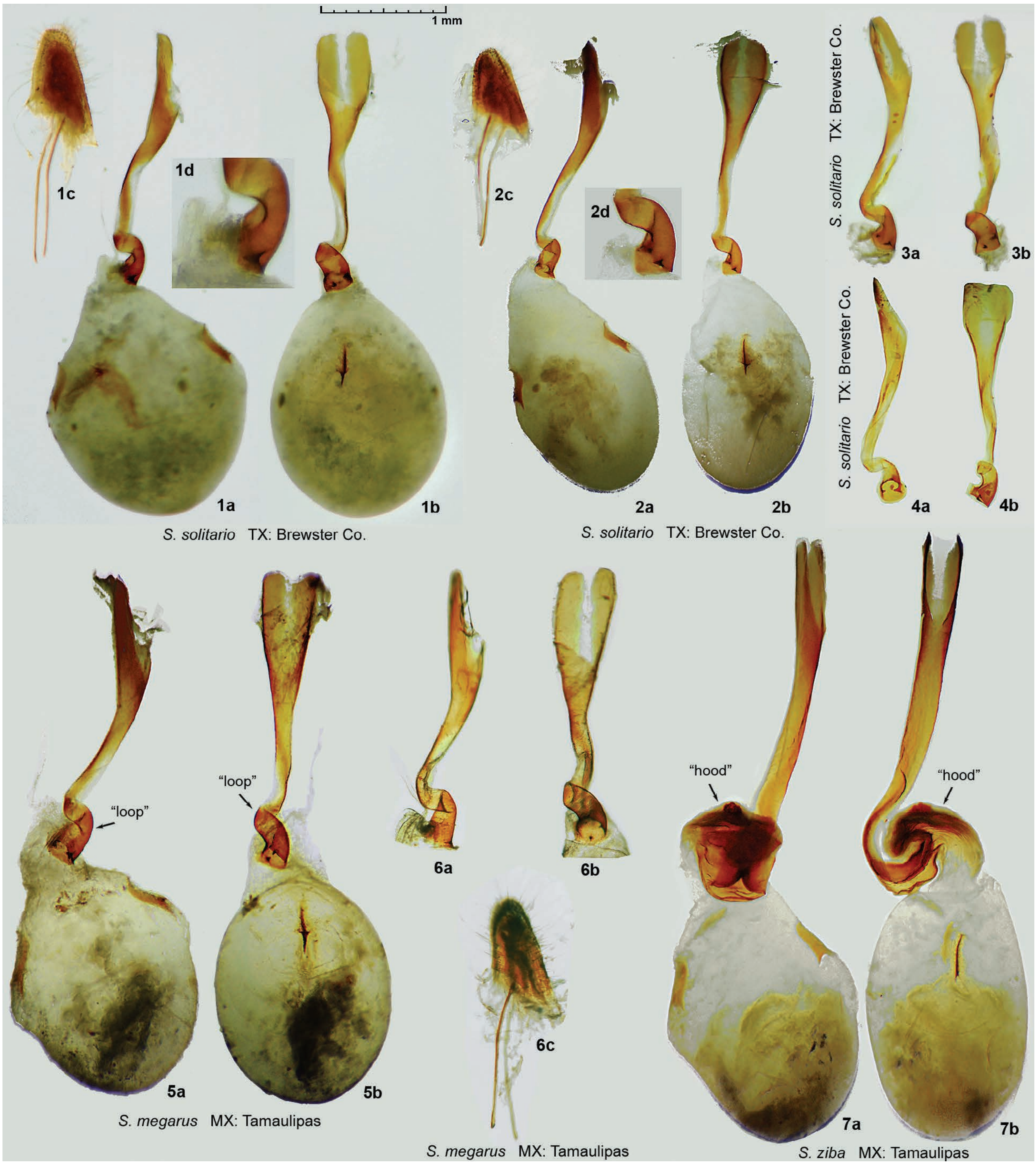


FIG. 8. Female genitalia of the *serapio* group *Strymon* species. **a** and **b** denote left lateral and ventral views, **c** is a left lateral view of papillae and apophysis, **d** is a magnified view of ductus bursae base. Only lamella and ductus bursae are shown in **3**, **4**, and **6**. **1-4**. *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.**

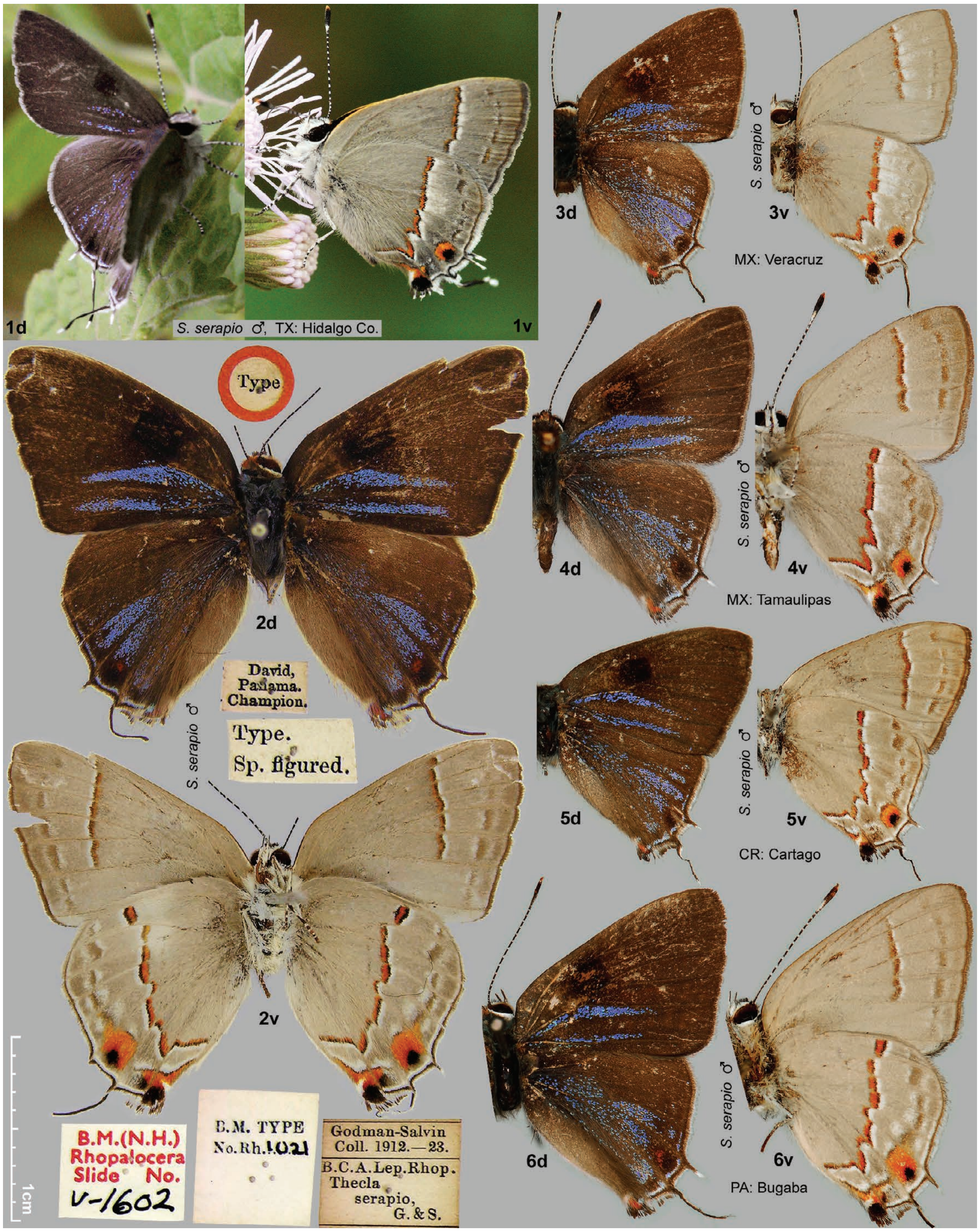


FIG. 10. Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Primary types are displayed in full expanse, with all the labels shown. Only a half for other specimens is illustrated. Species names and general location are indicated on 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.

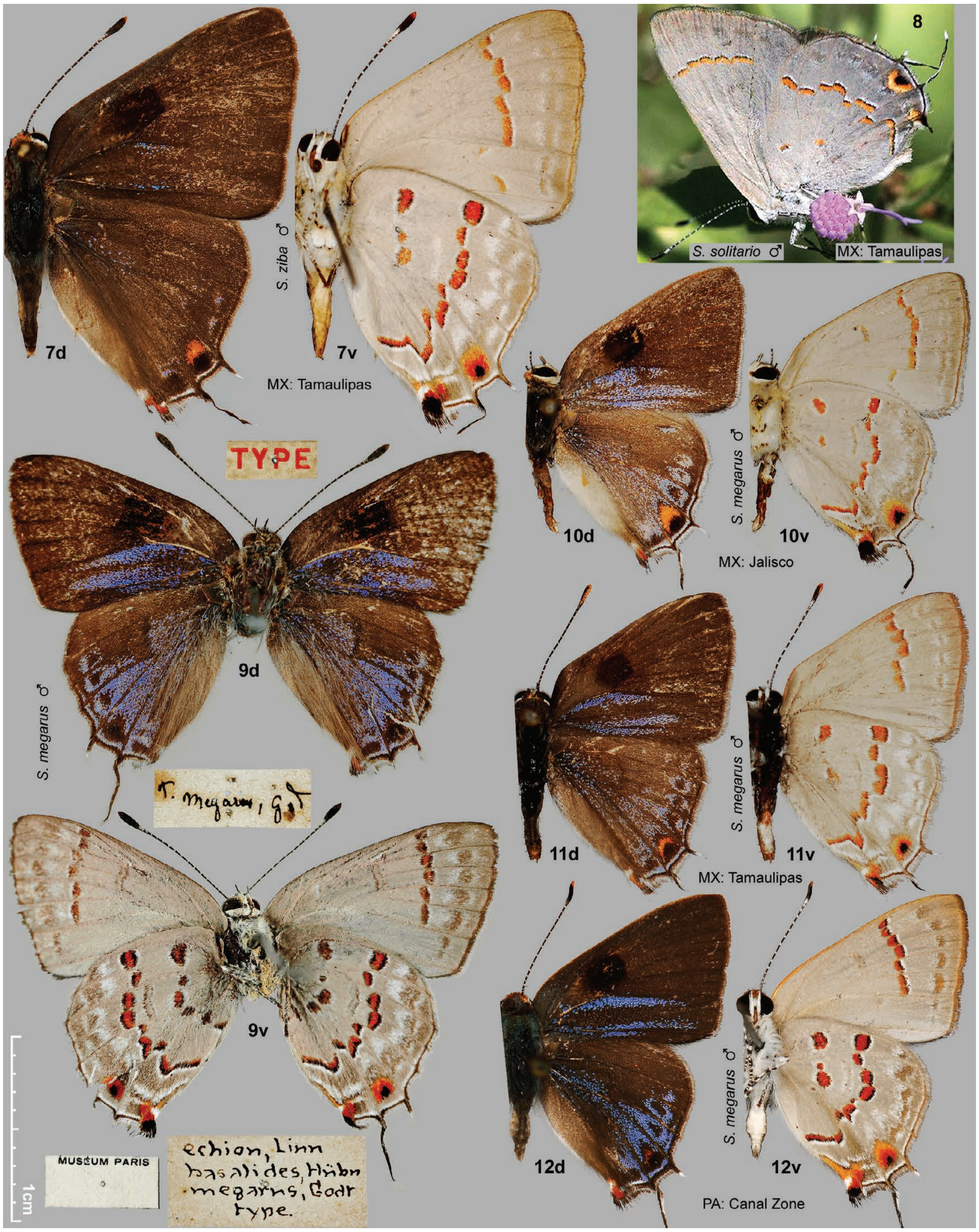


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Primary types are displayed in full expanse, with all the labels shown. Only a half for other specimens is illustrated. Species names and general location are indicated 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.

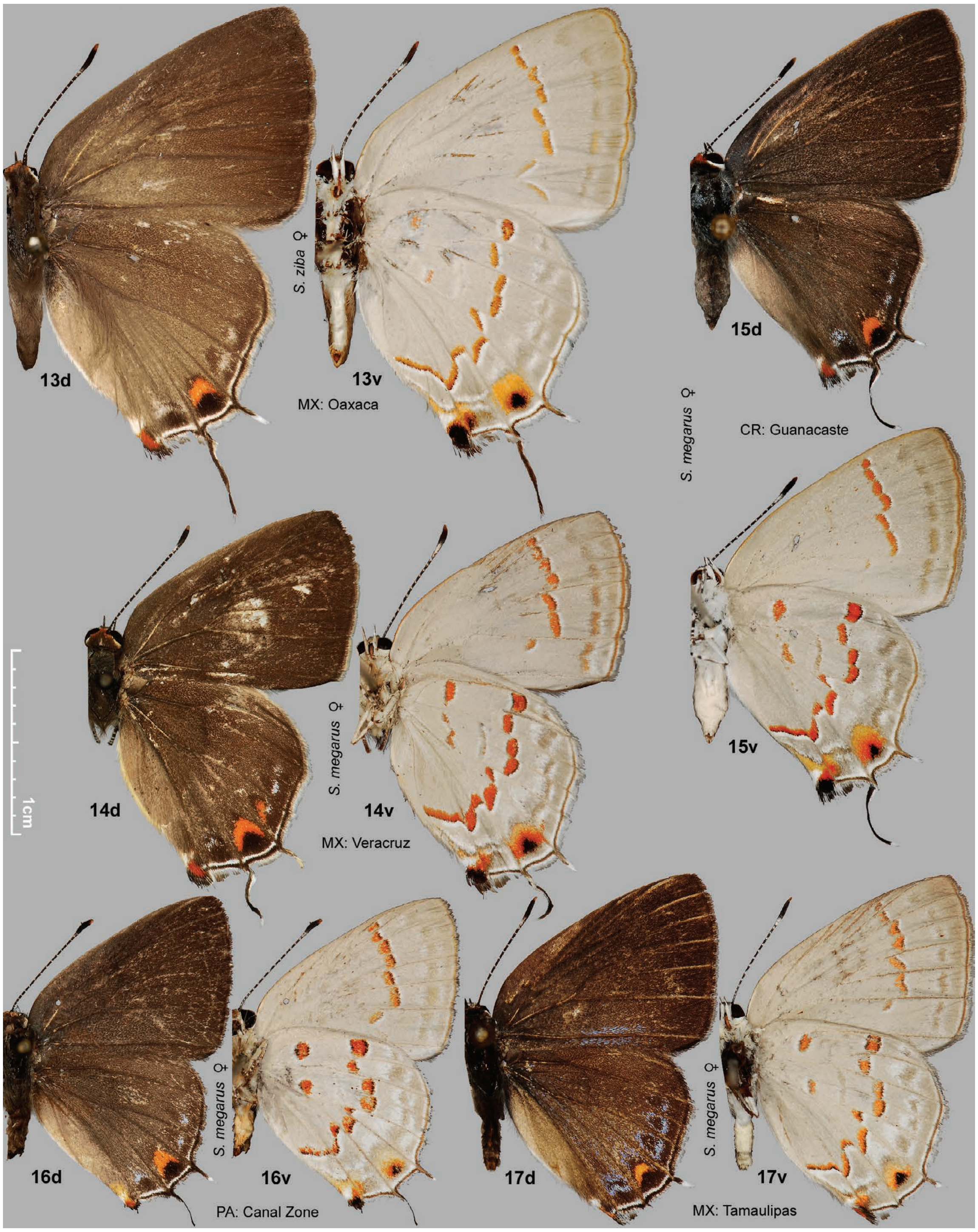


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Species names and general location are indicated on the plate and detailed here. All specimens are to scale. **13**. *S. ziba* ♀, Mexico: Oaxaca, Candelaria Loxicha 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.

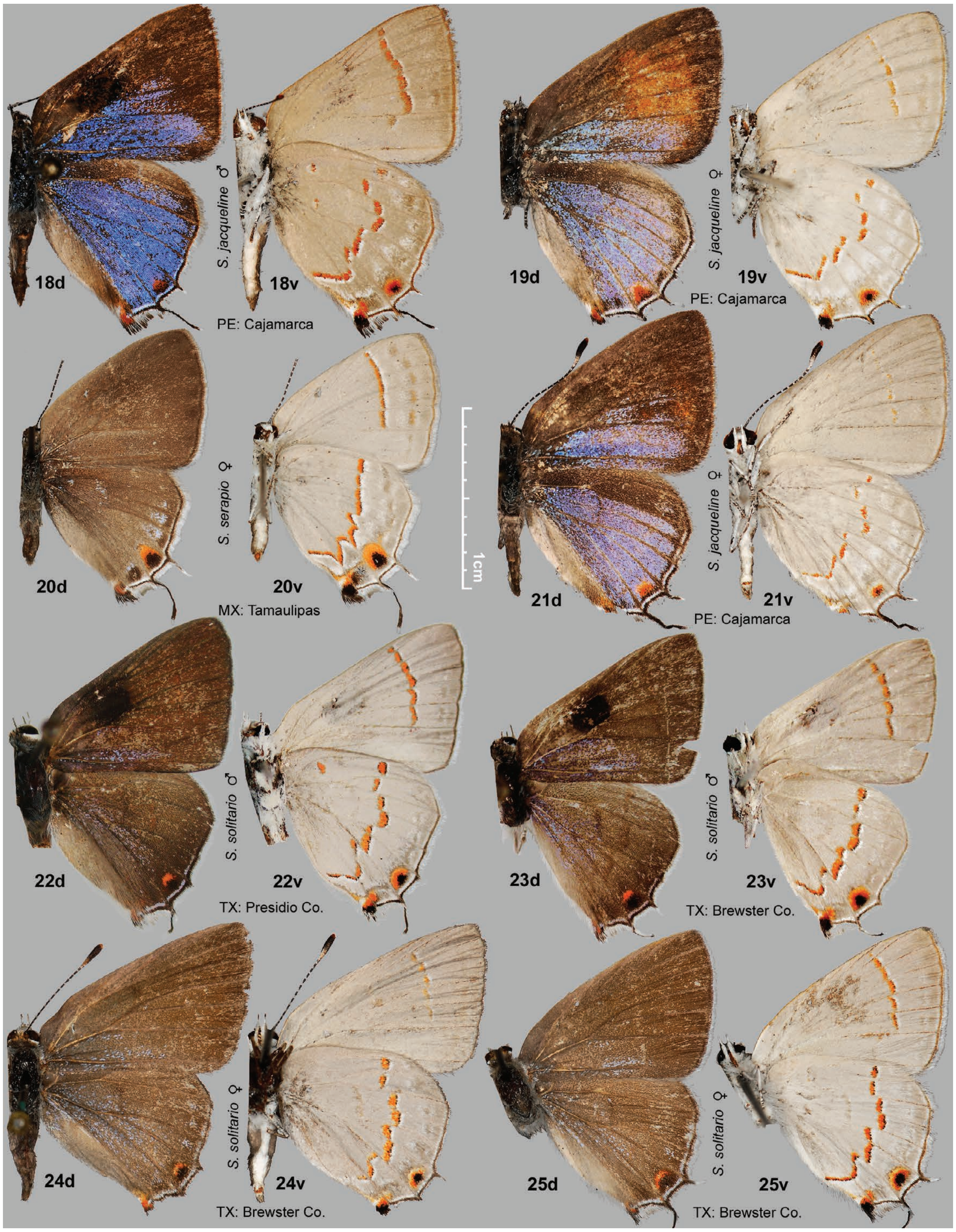


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Species names and general location are indicated on the plate and detailed here. All specimens are to scale. **18**, **19**, **21**. *S. jacqueline* ♂, ♀ and ♀, paratypes, 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.

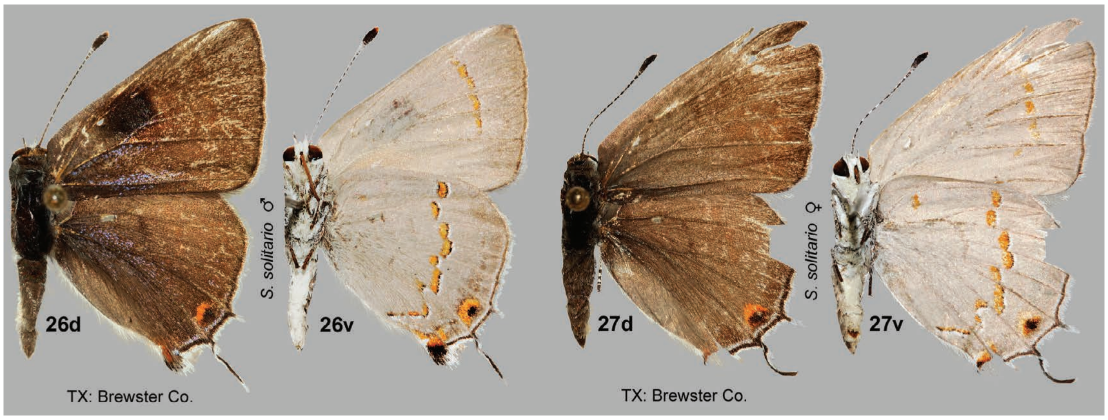


FIG. 10. (cont.) Some Bromeliad-feeding *Strymon* species. Dorsal (**d**) and ventral (**v**) wing surfaces are shown for each specimen. Species names and general location are indicated on the plate and detailed here. **26**. and **27**. *S. solitario* ♂ and ♀, Texas: Brewster Co. Big Bend National Park, "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.

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