Five new dry-area South American *Strymon* species (Lycaenidae: Theclinae) and their biogeographic significance

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Abstract: Five hairstreak species (Eumaeini) are described that occur in dry areas of South America. They are *Strymon ahrenholzi* Nicolay & Robbins, *Strymon jacqueline* Nicolay & Robbins, *Strymon giffordi* Nicolay & Robbins, *Strymon michelle* Nicolay & Robbins, and *Strymon lamasi* Nicolay & Robbins. Three inhabit the Atacama/Tumbesian/Río Marañón areas of southwestern Ecuador and northwestern Peru, one the upper Río Apurímac in south-central Peru, and one the central plateau of Brazil. Evidence is presented concerning the closest relatives of each new taxon. The taxonomy of *Strymon*, which now contains 54 described species, is reviewed. To assess the biogeographic significance of the new taxa, the *Strymon* species with restricted distributions in various South American xeric regions are listed. The Atacama/Tumbesian/Río Marañón area is currently the richest for *Strymon* endemics. The closest relatives of the *Strymon* species in the Atacama/Tumbesian/Río Marañón region occur in variety of other biogeographic areas, suggesting a lack of diversification within this region. This pattern is similar to that of bird distributions, but not to those of lizards and amphibians.

Key words: Atacama, biogeography, Eumaeini, hairstreaks, .

Introduction

The New World genus *Strymon* Hübner (Lycaenidae: Theclinae: Eumaeini) contains 48 species (183 specific names) tentatively partitioned into nine species groups (Robbins & Nicolay 2002). It is characterized by a complex and conspicuous modification of the male genitalia in which setae on the dorsal surface of the valva have the flagellum reduced in size and the socket modified into an anteriorly pointing tooth (Figs. 1-8 in Robbins & Nicolay 2002). Although found in a great variety of habitats, most *Strymon* species inhabit xeric areas.

A variety of biogeographic zones have been proposed for the Andean dry areas (e.g., Lamas 1982, Morrone 2001), but the distributions of species endemic to these areas, as well as their phylogenetic relationships, are still being documented (Morrone 2001 and included references). As part of a project to inventory the hairstreak butterfly fauna of the dry areas of Peru and Ecuador in collaboration with D. Ahrenholz, R. Busby, and G. Lamas, we discovered four new *Strymon* species. Additionally, we found another new species that inhabits the cerrado of Brazil (cf. Brown & Mielke 1967a,b for an overview of this habitat and its butterfly fauna). The purposes of this paper are (1) to describe the five new *Strymon* species, (2) to discuss the significance of these new taxa for the previously proposed "species group" taxonomy (Robbins & Nicolay 2002), and (3) to note the biogeography of the new *Strymon* species and the species that appear to be closely related to them.

Materials and Methods

The results in this paper are based upon a comparison of adult morphology using 6,000+ *Strymon*

specimens in the National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC, USA, plus numerous specimens in other museums. We borrowed specimens of the newly described taxa from Historia Natural, Universidad Nacional Mayor de San Marcos (MUSM), Lima, Peru; the Universidade Federal do Paraná (UFPR), Curitiba, Brazil; and the private collection of Robert Busby (RCB), Andover, MA, USA. Despite extensive searching, we found no other material of these taxa in other museum collections. One type is being deposited in Museo Ecuatoriano de Ciencias Naturales (MECN), Quito, Ecuador.

We used standard entomological techniques (Robbins 1991) and state for each observation below the number of specimens and dissections on which it is based. Genitalic terms follow those in Klots (1970), as illustrated in Robbins and Nicolay (2002), and wing vein terminology follows Nicolay (1971, 1977). Forewing lengths were measured with a vernier caliper and reported statistically as a mean and standard deviation (SD) with sample size.

All *Strymon* species discussed below have anteriorly pointing teeth on the dorsal surface of the valvae (as illustrated with SEM photomicrographs in Robbins & Nicolay 2002), but these teeth are omitted from the figures in this paper because they are too small to show clearly at the magnification used. All have brush organs (sensu Eliot 1973, morphologically characterized in Robbins 1991) on the dorsal vinculum, but are omitted from the figures for clarity. Finally, all these species possess the diagnostic characters of the Eumaeini: 10 forewing veins, "greyhound shaped" male genitalia lacking a juxta, and a male foretarsus that is fused, used for walking, and stubby tipped (Eliot 1973).

STRYMON SERAPIO GROUP

This group of 13 described species is characterized by paired cornuti, larval food plants restricted to Bromeliaceae, and male perching on tree-trunks (Robbins & Nicolay 2002). Wing pattern and shape of the external penis and its cornuti are the primary sources of distinguishing characters; we have not found good distinguishing characters in the morphology of the female genitalia, antennae, androconia and legs. Three species belonging to the *S. serapio* group are newly described.

Strymon ahrenholzi Nicolay & Robbins, New Species

Diagnosis: Strymon ahrenholzi is the only member of the *S. serapio* species group with a penis tip that is straight or upturned and with terminal cornuti (Fig. 21). All others have a conspicuously down-turned penis tip (Figs. 22, 23, Fig. 16 in Robbins & Nicolay 2002) and cornuti that are subterminal or well within the shaft of the external penis (unless the vesica has been everted).

Description of male (N=4): Mean forewing length 13.5mm, SD=1.91.

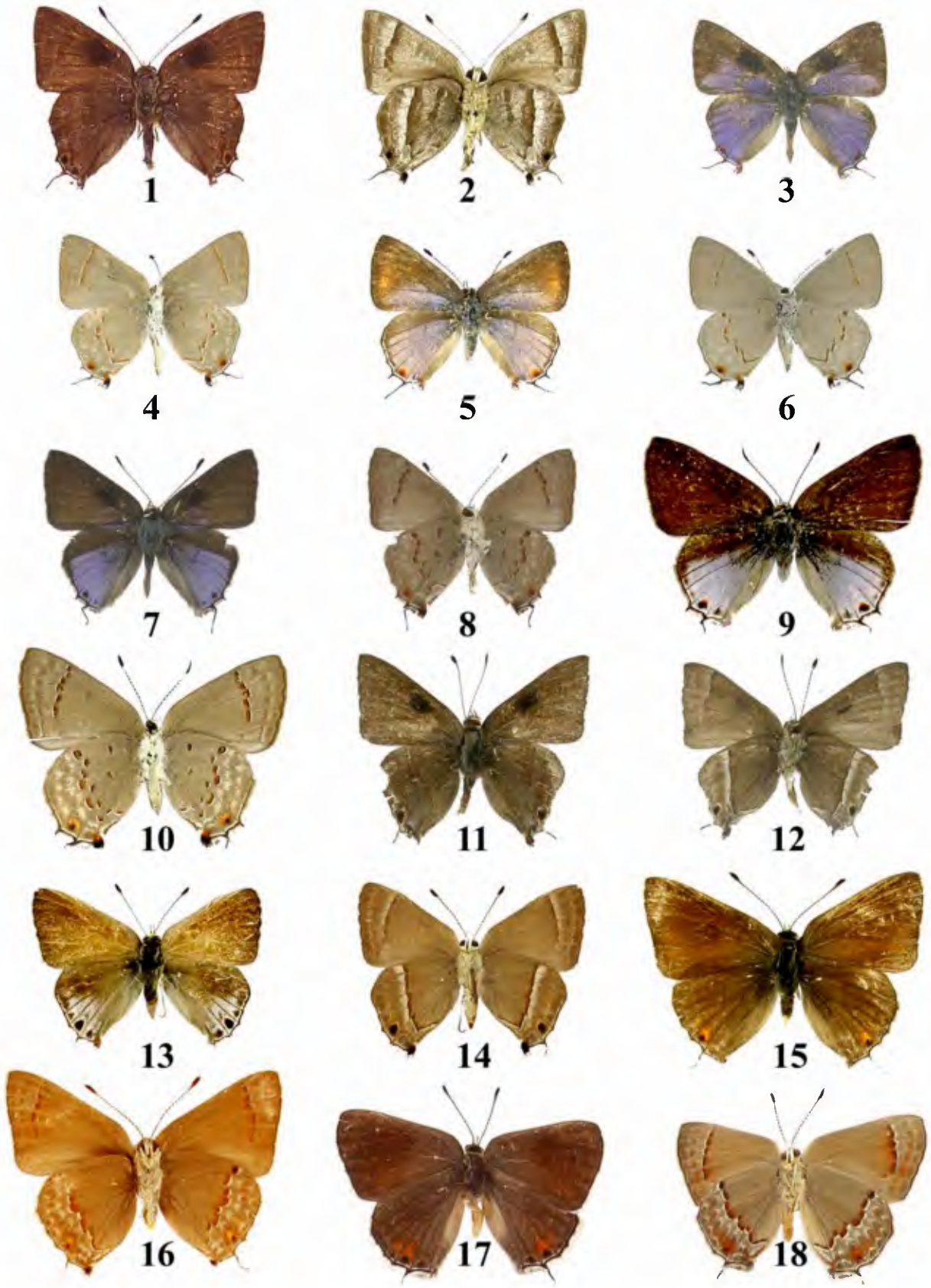
Dorsal wing pattern (Fig. 1): Forewing dark gray-brown with rectangular black scent patch filling distal half of discal cell. Fore and hindwings slightly translucent, veins standing out rather sharply, and underside wing pattern showing faintly. On hindwing, a black cubital spot surrounded by orange scaling, with another black spot between Cu2 and 2A. Submarginal white line between Cu1 and anal lobe spot. Rudimentary black tail at Cu1. Long slender white-tipped black tail at Cu2. Fringes of both wings pale, almost white.

Ventral wing pattern (Fig. 2): Forewing pale gray with a dark, wide, straight, postmedian band from costa to Cu2. Distally edged with a white band of equal width, sullied with dark scaling. Scattering of white scaling submarginally. Fringes con-colorous. Hindwing pale gray, with a straight narrow, dark basal band from Sc+R1 to 2A. Curved postmedian band from Sc+R1 to inner margin. Double cell-end streak partially connected to postmedian band by brown scaling, giving appearance of being fused with this band. Postmedian band distally bordered with vague band of white scaling. A black cubital spot between Cu1 and Cu2. Dark line at margin fringed with pale gray scales.

Head: Frons with piliform scales, primarily white, with a few dark ones intermixed. Third segment of labial palps slightly longer than basal two and covered with closely appressed scales. Scales between the antennal bases gray. Antennae black with about 16 white-ringed segments and a club with about 14 segments. Nudum confined to club.

Description of female: Female unknown despite extensive collecting in past decade at type locality and other parts of Atacama Desert in northern Peru (often called Tumbesian region, Best & Kessler 1995).

Types: Holotype: Male. Ecuador, Loja, Loja-Catamayo Rd., Km 26, 1800 m, 15 May 1988, leg. S. S. Nicolay. Deposited in USNM.



Figs. 1-18. *Strymon* adults, 1.5x actual size. 1. *S. ahrenholzi*, male, dorsal; 2. same, ventral; 3. *S. jacqueline*, male, dorsal; 4. same, ventral; 5. *S. jacqueline*, female, dorsal; 6. same, ventral; 7. *S. giffordi*, male, dorsal; 8. same, ventral; 9. *S. giffordi*, female, dorsal; 10. same, ventral; 11. *S. michelle*, male, dorsal; 12. same, ventral; 13. *S. michelle*, female, dorsal; 14. same, ventral; 15. *S. lamasi*, male, dorsal; 16. same, ventral; 17. *S. lamasi*, female, dorsal; 18. same, ventral.

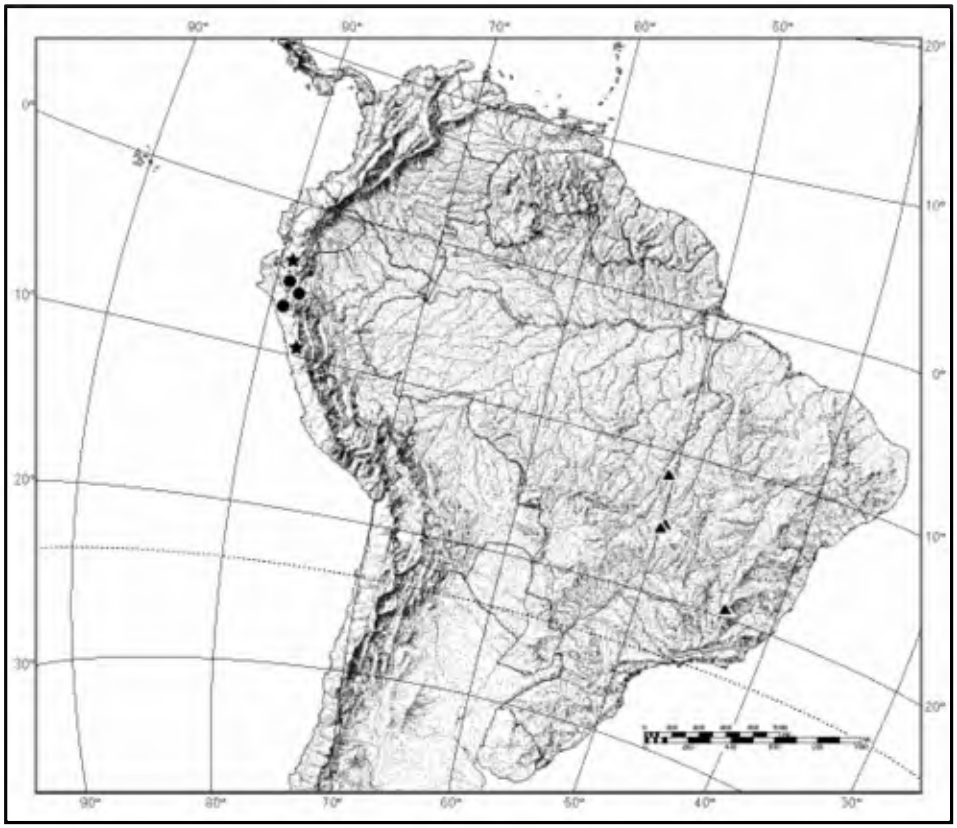


Fig. 19. Distribution of *S. ahrenholzi* (★), *S. jacqueline* (●), and *S. giffordi* (▲).

*Paratypes (2'M'): 1'M' USNM, same data as holotype. 1'M' USNM, same data as holotype, except leg. D. H. Ahrenholz.

Etymology: This species is named for our good friend, Dr. David Ahrenholz, who collected one of the paratypes.

Wing pattern variation: The ventral wing pattern of the holotype (Figs. 1, 2) appears to be representative of fresh specimens. When worn, as are the two paratypes, the markings on the ventral wing surface become indistinct and blurred. A fourth male from Ancash, Peru (deposited in MUSM), has genitalia that are the same as those in the type series, but its ventral wings are markedly rubbed, and its pattern cannot be ascertained. For this reason, it was excluded from the type series. It differs from the type series in having 3 subterminal orange cubital spots on the dorsal surface of the hindwing.

Male genitalic variation (four dissections, Fig. 21): As noted, the cornuti are terminal except when the vesica is partially everted, as in Figure 21. The anterior edge of the vinculum is sinuate with a slight hump in all dissections.

Habitat and distribution (Fig. 19): Currently known from only two localities in the dry mountains (1800-2800 m) of southwestern Ecuador and northwestern Peru (Ancash). It appears to be an exceedingly rare species, having been collected on only two different days.

Relationships: We suggest that *Strymon eremica* (Hayward) and *S. ahrenholzi* are "closest relatives" because they share three wing pattern characters that are otherwise unique in the *S. serapio* group. The males are brown dorsally without any blue. The ventral wings may become markedly indistinct and blurred when worn. The number of orange cubital spots on the dorsal hindwing varies from one to three. *Strymon eremica* is a geographically variable species that occurs in dry habitats from the chaco of Bolivia,

* *NOTE: in whole paper 'M' = male, 'F' = female*

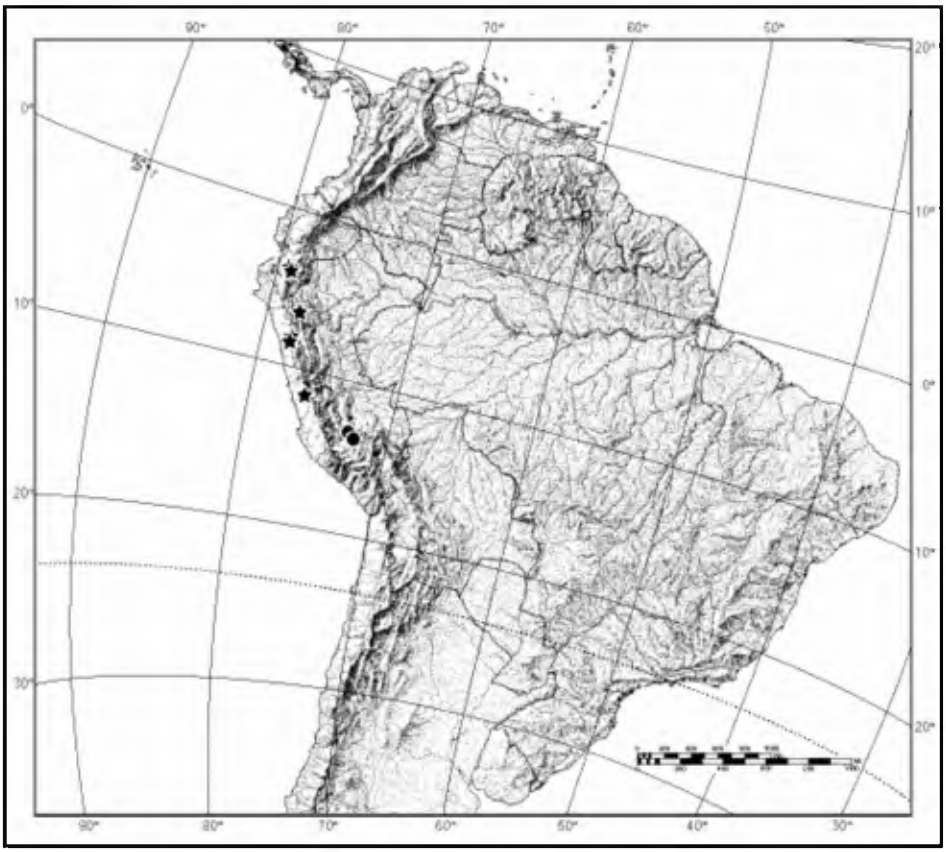


Fig. 20. Distribution of *S. michelle* (★) and *S. lamasi* (●).

Paraguay, and Argentina east to the cerrado of Brazil (MT, SP).

***Strymon jacqueline* Nicolay & Robbins, New Species**

Diagnosis: The male and female dorsal wing patterns (Figs. 3, 5) are similar to those of *S. dindus* (F.), but the blue is a lighter hue and females often have orange spots on the forewing (Fig. 5). Also, *S. jacqueline* lacks the numerous ventral hindwing basal spots of S. *dindus* (Figs. 4, 6). The ventral wing pattern of *S. jacqueline* (Figs. 4, 6) is most similar to that of Central American *S. megarus* (Godart), but males of the latter have a brown "ray" along vein 2A on the dorsal forewing and females are brown dorsally without blue except for a few individuals from Mexico. The genitalia do not provide diagnostic characters, although penis length and shape of the male saccus and vinculum differentiate this species from some members of the *S. serapio* group, such as *S. serapio*.

Description of male (N=7): Mean forewing length 11.9mm, SD=0.87.

Dorsal wing pattern (Fig. 3): Forewing pale, chalky violet-blue with wide brown border along costa and outer margin, becoming narrow at tornus. Large, rectangular black scent patch fills distal three quarters of discal cell. Dark outer marginal line edged by pale fringes. Hindwing pale, chalky violet-blue with narrow brown border at the apex. Orange-red, black pupilled cubital spot between Cu1 and Cu2, trace of black spot between Cu1 and 2A with prominent black anal lobe spot, bordered basally in red. Black outer marginal line dusted basally with white scales, fringes white. Narrow white-tipped black tail at Cu2 and a short projection at Cu1. Abdominal fold pale gray.

Ventral wing pattern (Fig. 4): Forewing pale gray with single postmedian row of macular, orange linear spots faintly dusted distally in black. White scaling from Cu1 to Cu2. Outer marginal line dark brown, fringes paler. Hindwing pale gray with two small orange spots at wing base, the largest located just below the costa. Broken, postmedian line of orange linear spots follows wing contour from apex to inner margin

with breaks toward the base at M1 and M3, then sharply angled to inner margin at 2A. These spots dusted distally by scattered black, then more conspicuous white scaling, not heavily scaled and not very prominent. Orange-red, black pupilled cubital spot and black anal lobe spot edged with orange-red and white scaling. Ill-defined line of white submarginal scaling between vein terminals bordering a short submarginal dark line edged in orange-red beginning at Cu2 and terminating at inner margin. Dark outer marginal line; the fringes pale.

Head: Frons white, with a few dark piliform scales from center. Labial palps white ventrally. Third segment of labial palps slightly shorter than basal two and covered with closely appressed scales. Scales between the antennal bases gray. Antennae black with about 16 white-ringed segments and a club with about 14 segments. Nudum confined to club.

Description of female (N=9): Mean forewing length 15.6mm, SD=1.27.

Dorsal wing pattern (Fig. 5): Forewing pale violet-blue, with very wide brown border along costa, wider at apex and outer margin, tapering to a point on the inner margin near the tornus. Inner margin, widely solid pale violet-blue with no dark margin. A thin black outer marginal line from the apex to tornus. Fringes narrowly pale. Hindwing pale violet-blue with dark brown costal border ending just below apex. A narrow, dark submarginal line from apex to Cu1. An orange-red black-pupilled cubital spot between Cu1 and Cu2, a vague dark spot below Cu2, and a small black anal lobe spot lightly dusted with orange-red scales at inner margin. Prominent outer marginal line black with a prominent white inner margin. Fringes pale with a very short, white-tipped tail at Cu1, and a long, narrow black, white-tipped tail at Cu2. Abdominal fold pale gray.

Ventral wing pattern (Fig. 6): Forewing same as male. Hindwing same as male, but a thin, sharply etched black terminal line from apex to anal lobe. Line of pale scales on inner edge, and pale fringes on outer edge.

Head: Same as male.

Types: Holotype: Male. Peru, Cajamarca, Km 62 Pacasmayo to Cajamarca, 600m, CA., PERU, 4 March 1981, leg. G. Lamas. Deposited in MUSM.

Paratype (8'M', 9'F'): 3'M' MUSM, same data as holotype, but with an additional label on one saying that it was collected on a cactus. 1'M' MUSM, Peru, Cajamarca, Pucará (06°02'S, 79°08'W), 1000-1300m, 9 November 1975, leg. G. Lamas. 1'M' MUSM, Peru, Cajamarca, Km 59, Pacasmayo to Cajamarca, 550m, CA., PERU (07°14'S, 79°03'W), 19 November 1998, leg. J. Grados. 1'F' USNM, Peru, Cajamarca, Km 59, Pacasmayo to Cajamarca (07°14'S, 79°03'W), 550m, 15 September 1999, leg. Robbins, Lamas, Ahrenholz. 2'F' MUSM & 1'M'&3'F' USNM, Peru, Cajamarca, Puente Chetilla (07°13'S, 78°45'W), 1050m, 17 September 1999, leg. Robbins, Lamas, Ahrenholz. 1'F' MUSM & 2'M'&1'F' USNM, Peru, Cajamarca, La Capilla, 10 km W. Chilete (07°12'S, 78°57'W), 700m, 17 September 1999, leg. Robbins, Lamas, Ahrenholz. 1'F' MUSM, Peru, Cajamarca, cerca Tamborapa (05°26'S, 78°48'W), 460m, 19 June 1995, leg. G. Lamas.

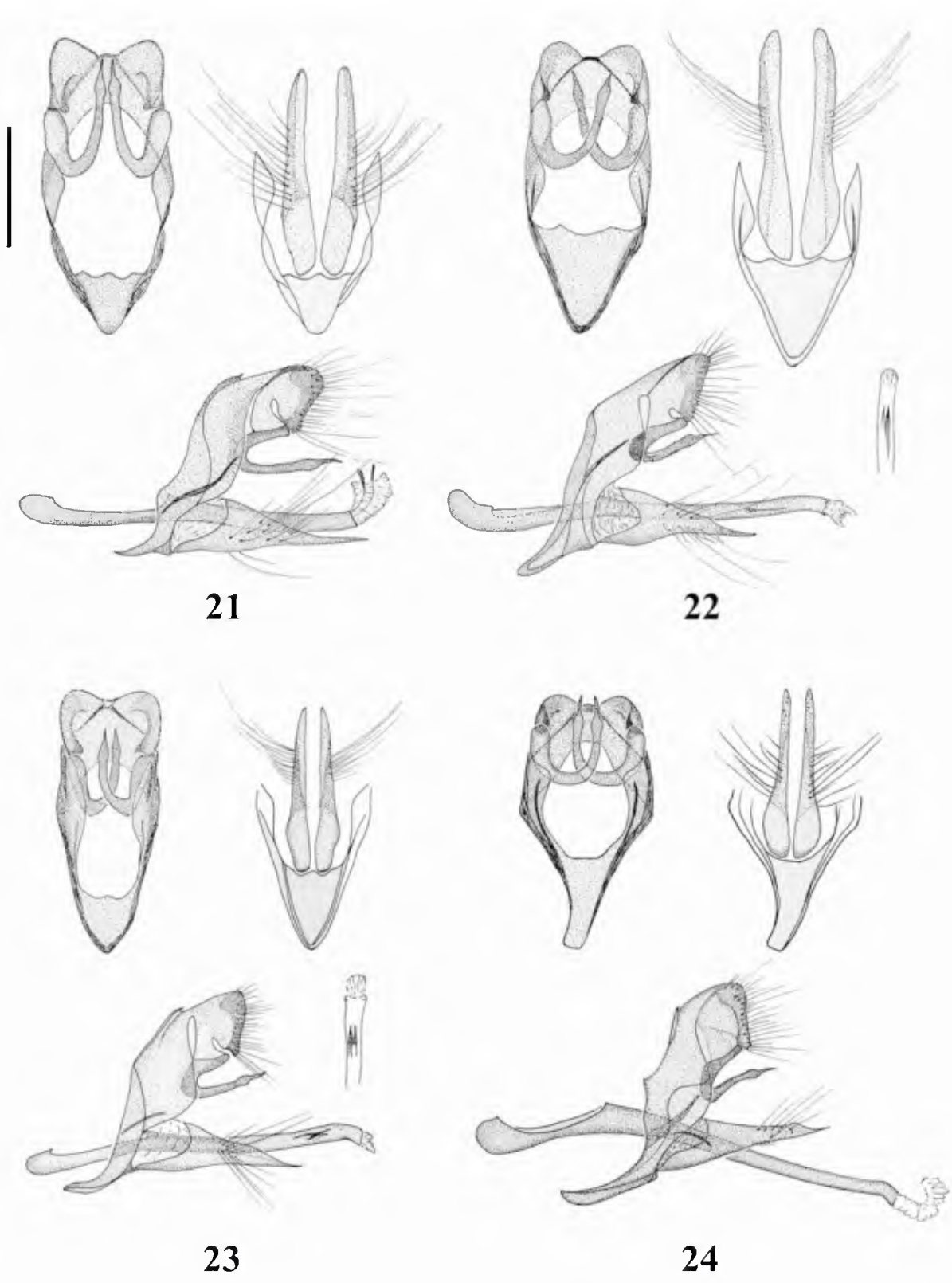
Etymology: This beautiful species is named as a noun in apposition for Jacqueline Nicolay, daughter of Stephen and Linda Nicolay and granddaughter of the senior author.

Wing pattern variation: The amount of orange on the dorsal forewings of females varies from absent to reasonably conspicuous (Fig. 5). The expression of orange scaling is positively correlated with elevation in the type series of nine females, but more specimens would be needed to verify this correlation. The two orange-red ventral hindwing basal spots vary in both sexes from well-developed to absent (Figs. 4, 6), which is highly unusual for the *S. serapio* species group. The ventral hindwing postmedian line varies slightly in width with those illustrated being relatively narrow (Figs. 4, 6).

Male genitalic variation (five dissections, Fig. 22): In some individuals, the dorsal cornutus, which is located to the left of the ventral one, is inconspicuous and may not be visible in lateral aspect (Fig. 22). Otherwise, the genitalia are indistinguishable from many species in the *S. serapio* group (Fig. 16 in Robbins & Nicolay 2002).

Female genitalic variation (four dissections, Fig. 26): The bursa copulatrix is typical of *Strymon* as described in Robbins & Nicolay (2002) with minor variation in the shape of the sclerotized loop of the ductus bursae.

Habitat and distribution: Strymon jacqueline occurs in dry scrub habitats in northwestern Peru (Cajamarca) at 460-1300m elevation in the Tumbesian Regions and the Río Marañón Valley. It has been collected in March, June, September, and November. Adults have been observed on vegetation along streams, on weedy roadside flowers, and on cactus plants in the "middle"



Figs. 21-24. Male genitalia in ventral aspect with valvae removed; saccus, vinculum, and valvae in ventral aspect; and male genitalia in lateral aspect (teeth on valvae and brush organs omitted). 21. *S. ahrenholzi*; 22. *S. jacqueline* with detail of penis tip in ventral aspect—the dorsal cornutus was not visible in lateral aspect; 23. *S. giffordi*; 24. male. Scale line 0.5 mm.

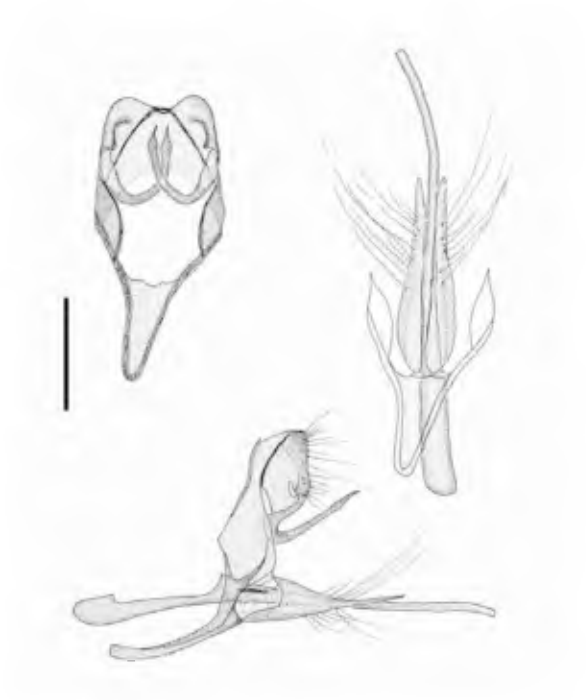


Fig. 25. *Strymon lamasi* male genitalia in ventral aspect with valvae removed; saccus, vinculum, and valvae in ventral aspect (cornutus omitted for clarity); and male genitalia in lateral aspect (teeth on valvae and brush organs omitted). Scale line 0.5 mm.

of the desert. It has not been found to date in similar habitats in southwestern Ecuador. Although this species appears to be exceedingly rare, ten individuals were found in one day at two localities.

Relationships: It is unclear which species within the *S. serapio* species group are the closest relatives of *S. jacqueline*. The dorsal wing pattern of *S. jacqueline* is shared with *S. dindus*, and the ventral wing pattern with *S. megarus*. The genitalia provide little definitive evidence.

***Strymon giffordi* Nicolay & Robbins, New Species**

Diagnosis: Within the *S. serapio* group, the dorsal wing pattern of both sexes *of S. giffordi* is shared only with *S. veterator* (H.H. Druce) while the ventral wing pattern is shared only with *S. megarus*. The genitalia do not provide diagnostic characters, although penis length and shape of the male saccus and vinculum differentiate this species from some members of the *S. serapio* group, such as *S. serapio*.

Description of male (N=2): Mean forewing length 12.6mm, SD=0.14.

Dorsal wing pattern (Fig. 7): Forewing dark brown with pale fringes. Rectangular black scent patch approximately 2mm in length that fills the distal end of the cell. Dusting of blue scales along the inner margin near wing base. Hindwing purple-blue with broad, brown costal margin tapering near veins M3 and M2 to a thin dark terminal line that continues to anal lobe. Anal lobe spot red with another small black spot between veins 2A and Cu2, and a small black cubital spot with basal red scaling between Cu2 and Cu1. A white-tipped black tail at Cu2 and a short one at Cu1. Abdominal fold gray, fringes pale.

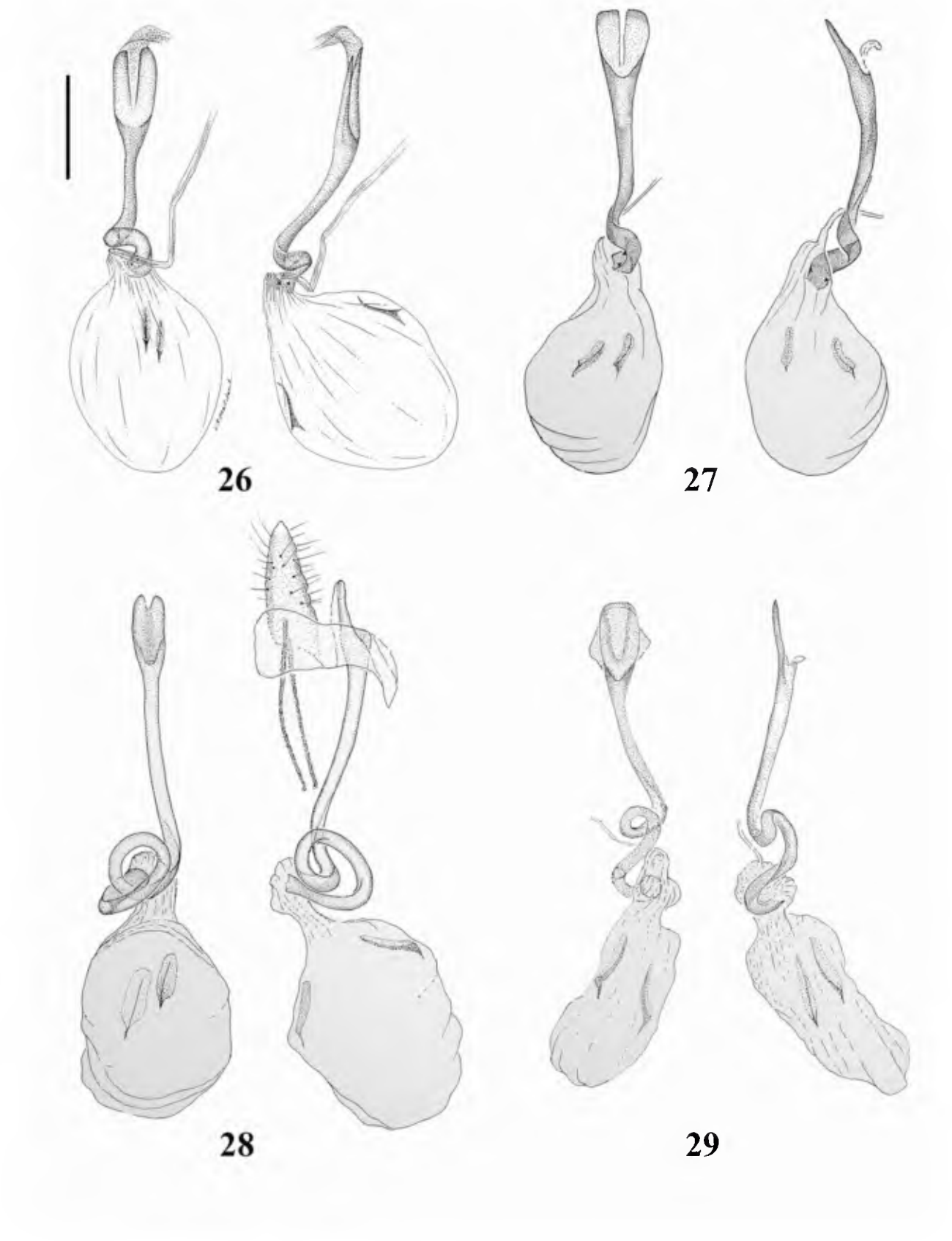
Ventral wing pattern (Fig. 8): Forewing gray, paler along inner margin. Postmedian line of red spots from costa to Cu2, distally edged in black then thinly in white. Narrow, obscure dark gray submarginal line with a dusting of white scales on both sides from costal margin to 2A. Margin a mixture of orange and black scales; fringes gray. Hindwing gray. Four postbasal black-edged red spots. Postmedian line from costa to inner margin consists of red spots distally edged in black, then white scales. Vague submarginal line of white scaling from costal margin to inner margin, distally bordered by thin line of gray crescents. Margin black with inner line of white scaling between Cu1 and anal lobe; fringes gray. Cubital spot red with small black spot below center; the anal lobe black with red inner half and a mixture of scattered red and black scales between veins 2A and Cu2.

Head: Frons white with dark piliform scales from center. Labial palps white ventrally. Third segment of labial palps slightly shorter than basal two and covered with closely appressed scales. Thin line of orange-red scales between antennal bases. Antennae black with about 18 white-ringed segments and a club with about 16 segments. Nudum confined to club.

Description of female (N=3): Mean forewing length 15.6mm, SD=1.27.

Dorsal wing pattern (Fig. 9): Forewing dark brown, fringes pale. Very sparse scattered blue scales along inner margin. Hindwing powder-blue with wide dark costal margin from costa to base of M2, thence distally to the outer margin. Narrow black marginal line. Small black spots between M2 and M3 and between M3 and Cul. Cubital spot black with red inner margin. Black spot between Cu2 and 2A. Anal lobe spot red with a black outer margin. Long black white-tipped tail at Cu2, a short one at Cu1. Abdominal fold gray; fringes pale.

Ventral wing pattern (Fig. 10): Similar to male. Marginal line dark brown and fringes pale. Hindwing postbasal markings very sparse (two small spots



Figs. 26.-29. Female genitalia (bursa copulatrix) in ventral and lateral aspects. 26. *S. jacqueline*; 27. *S. giffordi*; 28. *michelle*; 29. *S. lamasi*. Scale line 1 mm.

instead of four) and the cubital spot more orange than red.

Head: Same as male.

Types: Holopyte: Male. Brazil, Goiás, Serra Dourada (16.3°S, 50.6°W), 7 February 1980, leg. Gifford. Deposited in UFPR.

Paratype (1'M'&4'F'): 1'F' UFPR, same data as holotype. 1'F' USNM, same data as holotype except it was collected on 4 February 1980. 1'F' UFPR, Brazil, Goiás, Ilha do Bananal (this locality is now in the state of Tocantins), 28 June 1979, leg. Gifford. 1'F' USNM, Brazil, Minas Gerais, Serra do Cipó, 1300m, 2 May 1975, leg. C. J. Callaghan. 1'M' USNM, Brazil, Goiás, Pirenópolis (15°53'S, 48°59'W), 1200m, 2 May 1991, leg. Robbins & Becker.

Etymology: This species name is a patronym for the late David Gifford, who collected the holotype during his extensive field work in the cerrado of Brazil.

Wing pattern variation: Although the type series is limited, females are consistently and conspicuously larger than the males. The wing pattern of each sex shows almost no variability except that one female paratype, which is worn, has orange-yellow spots on the ventral wings instead of red-orange spots.

Male genitalic variation (two dissections, Fig. 23): The genitalia of the two known males are similar and are well-represented in the figure.

Female genitalic variation (three dissections, Fig. 27): The shape of the ductus bursae is variable. In each of the three dissections, the shape of the loop, the lamella postvaginalis, and the middle part is different. However, this intraspecific genitalic variation is typical of *Strymon*.

Habitat and distribution: This species is known only from Brazil's cerrado (cf. Brown & Mielke 1967a,b for an overview). Although recorded elevations are 1200-1300m, Serra Dourada and Ilha do Bananal are at lower elevations. The paratype collected by the junior author was found in a hilly, rocky, desert scrub area that is superficially similar to the desert-like caatinga habitat of eastern Brazil. As with most of the new species described in this paper, *S. giffordi* is rare in museum collections, but it is possible that additional specimens will be found misplaced in series of *S. megarus*.

Relationships: Strymon giffordi appears to be closely related to *S. veterator*, with which it shares a similar dorsal wing pattern, and to *S. megarus*, with which it shares a similar ventral wing pattern. It is sympatric with *S. megarus* and allopatric with *S. veterator*, which occurs from Paraguay to the dry eastern foothills of the Argentinean Andes.

STRYMON MARTIALIS GROUP

This species group contains two Antillean species (*S. martialis* Herrich-Schäffer and *S. christophei* W.P. Comstock & Huntington) that have a single "wide" cornutus (0.05-0.1mm in dorsal aspect), and a lightly sclerotized plate on the dorsal posterior corpus bursae that is anterior of the ductus seminalis (Robbins & Nicolay 2002). The discovery of the following species was surprising because its range is widely disjunct from the Antilles and because it lacks the lightly sclerotized dorsal plate of the corpus bursae.

Strymon michelle Nicolay & Robbins, New Species

Diagnosis. The convoluted shape of the ductus bursae of *S. michelle* (Fig. 28) is shared in the Eumaeini only with *S. martialis* (Fig. 23 in Robbins & Nicolay 2002), and the ventral hindwing postmedian line of both species is similar (Figs. 12, 14, Fig. 40 in Robbins & Nicolay 2002). The lack of a lightly sclerotized dorsal plate of the corpus bursae and brown upperside wing color differentiates *S. michelle* from *S. martialis*.

Description of male (N=6): Forewing length 14.0mm, SD=0.95.

Dorsal wing pattern (Fig. 11): Forewing brown with a black rectangular (almost square), scent patch filling the distal end of the cell. Narrow, dark terminal line from the apex to the inner angle; the fringes pale. Hindwing brown with two submarginal black spots between veins Cu1 and 2A. Bordered basally by bluish-white scaling from M3 to 2A, and distally by white scaling from the apex to the anal lobe. Red anal lobe spot. Black marginal line from apex to anal lobe with a single narrow white-tipped, black tail at Cu2; fringes white.

Ventral wing pattern (Fig. 12): Forewing light brown, paler along the inner margin. A narrow white cell-end streak. Black postmedian line from costa to Cu2 with sparse orange-red scaling basally and white distally. Marginal black line with paler fringes. Hindwing light brown with black postmedian line, basally bordered in orange-red, distally in white. Nearly straight from costa to 2A, then curved rather sharply to inner margin. Faint white submarginal band from apex to prominent black, orange-margined

cubital spot. Faint dusting of pale blue scales between veins Cu2 and 2A. Anal lobe black, edged basally with orange-red and white scaling. Black marginal line basally edged with white from M2 to anal lobe. Fringes white with narrow dusting of orange-red scales along the posterior inner margin.

Head: Frons white with dark piliform scales intermixed. Labial palps white ventrally. Third segment of labial palps shorter than basal two and covered with closely appressed scales. Orange, black, and white scales between antennal bases. Antennae black with about 17 white-ringed segments and a club with about 14 segments. Nudum confined to club.

Description of female (N=4): Forewing length 13.0mm, SD=0.75.

Dorsal wing pattern (Fig. 13): Forewing brown with pale fringes. Hindwing brown except for pale, light blue on distal third of posterior wings. Black submarginal spots from M1 to 2A, largest spot between veins Cu1 and Cu2. Anal lobe spot red and black. Marginal line black; fringes white. Single white-tipped, narrow black tail at Cu2.

Ventral wing pattern (Fig. 14): As in male, but postmedian line more prominent.

Head: Same as male.

Etymology: This beautiful species is named as a noun in apposition for Michelle Dawn Nicolay, the daughter of Joe and Dawn Nicolay and the granddaughter of the senior author.

Types: Holopyte: Male. Ecuador, Loja, Loja-Catamayo Rd., Km 28, 1700 m, 10 Sept. 1975, leg. S. S. Nicolay. Deposited in USNM.

Paratypes (5'M'&5'F'): 3'F' USNM, same data as holotype. 1'M' MECN & 1'M' USNM, Ecuador, Loja, Vilcabamba, 1600m, May 1974, leg. R. de Lafebre. 1'F' RCB, Ecuador, Loja, 4 km E. of Catamayo, 1400m, May 2001, leg. I. Aldas, R. C. Busby. 1'M' MUSM, Peru, Amazonas, 3.5 km S Quebrada Mariposa (06°20'S, 77°56'W), 1700m, 23 August 1998, leg. J. Grados. 1'F' USNM, Peru, La Libertad, Casmiche (07°59'S, 78°39'W), 1950m, 27 September 1999, leg. Robbins, Lamas, Ahrenholz. 1'M' MUSM, Peru, La Libertad, alto Río Chicama, Coina, 8-9 May 1982, 1900-2000m, leg. G. Lamas & E. Pérez. 1'M' MUSM, Peru, Lima, Huinco, 1800 m, 20 September 1965, leg. P. Hocking.

Wing pattern variation: Wing pattern and wing size are remarkably similar among the 11 types. However, rounder wings and light blue color on the posterior half of the dorsal hindwings distinguishes females from males.

Male genitalic variation (four dissections, Fig. 24): In specimens with a non-everted vesica, as illustrated in the figure, the cornutus is at the anterior end of the external penis, but the vesica is often partially everted. The cornutus is not as wide (about 0.04mm in dorsal aspect) as that of *S. martialis* and *S. christophei*. A short process on the anterior vinculum is associated with the anterior base of the brush organs, and its occurrence is consistent in the four dissections. Otherwise, the male genitalia barely differ from those of *S. martialis* and *S. christophei*.

Female genitalic variation (three dissections, Fig. 28): There is slight variation in the exact shape of the loops of the ductus bursae among the three dissections.

Habitat and distribution: *Strymon michelle* is known from the dry mountains of southwestern Ecuador and western Peru in a narrow elevational band from 1400-2000m. Ten specimens are from the western slope of the Andes and one from the inter-Andean Río Marañón Valley (Amazonas). *Strymon michelle* inhabits desert with sparse, scrubby growth, including various species of cacti and small trees. It co-occurs with *S. daraba* (Hewitson) (= *S. tyleri*, Robbins & Lamas 2002) and *S. davara* (Hewitson), which are often abundant in contrast to *S. michelle*. Despite extensive searching during the past decade in suitable habitat in Ecuador and Peru, only three additional individuals of *S. michelle* have been found.

Relationships: *Strymon michelle* is most closely related to the Antillean *S. martialis* and *S. christophei*, but the relationship of these three species is unresolved. The convoluted ductus bursae and ventral hindwing postmedian line suggest that *S. michelle* and *S. martialis* are sisters while the lightly sclerotized posterior dorsal corpus bursae suggests that *S. martialis* and *S. christophei* are sisters. Although the straight post-median line on the ventral hindwing of *S. michelle* superficially resembles those of sympatric *S. daraba* and *S. ahrenholzi*, these species are structurally different and are placed in different species groups (Robbins & Nicolay 2002).

Strymon melinus Group

This species group is not delimited by clear-cut synapomorphies, but all included species lack a scent patch on the dorsal surface of the male forewing and have genitalia that are identical, or nearly so, to those

of *S. melinus* (cf. Figs. 9, 18 in Robbins & Nicolay 2002). Within the group, *S. rufofusca* (Hewitson) and *S. cyanofusca* Johnson, Eisele & MacPherson have more rounded wings, especially female hindwings, than those of the other species, and males set up mating territories on small shrubs rather than on hilltops (Robbins unpubl.). We have discovered a new "rounded wing" species of the *S. melinus* group.

***Strymon lamasi* Nicolay & Robbins, New Species**

Diagnosis: *Strymon lamasi* is distinguished from other *Strymon* species by (1) faint submarginal orange spots on the ventral surface of the forewing, especially in cell Cu1-Cu2 (Figs. 15, 17, the spots are very faint in the illustrated male), (2) a cornutus at the anterior end of the external penis (Fig. 25, this character is shared only with *S. michelle*, as discussed below), and (3) a long (~0.8mm) sclerotized segment of the ductus bursae between the corpus bursae and the most posterior loop (Fig. 29).

Description of male (N=41): Mean forewing length 13.5mm, SD=1.43.

Dorsal wing pattern (Fig. 15): Forewing light reddish brown with a narrow marginal black line and paler fringes. No scent patch. Hindwing ground color same as the forewing with one or two submarginal cubital spots distally black pupilled. Faint dusting of orange scales between veins M3 and Cu1. Anal lobe spot, small, black and faintly outlined distally in white and pale orange scaling. A single narrow, black tail at Cu2.

Ventral wing pattern (Fig. 16): Forewing reddish-brown, paler along the inner margin. Narrow marginal black line, with paler fringes. Postmedian brown line curves unevenly from R3 to Cu2. Bordered basally with dull red scales and distally with white. Faint, pale submarginal crescents. Hindwing reddish-brown. Postmedian line from costa to inner margin. Same three colors as forewing. Two submarginal bands of pale crescents, separated by brown ground color. A small cubital black spot is basally pale orange with a faint dusting of pale orange scales in space Cu1 - M3. Black anal spot tiny, faintly outlined in white and orange scales. Narrow marginal black line with white fringes.

Head: Frons white with dark piliform scales intermixed. Labial palps white ventrally. Third segment of labial palps shorter than basal two and covered with closely appressed scales. Orange, black, and white between antennal bases. Antennae black with about 18 white-ringed segments and a club with about 15 segments. Nudum confined to club.

Description of female (N=16): Mean forewing length 12.7mm, SD=1.87.

Dorsal wing pattern (Fig. 17): Pale reddish-brown as in male with a scattering of orange overscaling within and beyond the cell. Black marginal line and white fringes. Hindwing same reddish brown. Black cubital spot at base of large orange spot with an additional small patch of orange scaling above the cubital spot between veins Cu1 and M3. Faint dusting of orange scales near black anal spot. Fringes white, with a black marginal line.

Ventral wing pattern (Fig. 18): Forewing similar to male, but with a paler inner margin. Postmedian line more boldly colored, the red scales less dense basally. Diffuse submarginal pale crescents dusted with red scaling. Black marginal line outlined sharply by the white fringes. Hindwing color and pattern the same as in the male, but postmedian line more heavily marked with somewhat brighter and more extensive colors.

Head: Same as male.

Types: Holotype: Male. Peru, Cuzco, 15 km SW Limatambo, 2000m, 10 October 1981, leg. G. Lamas. Deposited MUSM.

Paratypes (40'M'&16'F', MUSM & USNM): 3'M'&1'F' Peru, Apurímac , E. of Curahuasi (13°33.04'S, 72°36.85'W), 2200m, 21 June 2003, leg. R. Robbins. 21'M'&11'F' Peru, Apurímac , Río Pachachaca, 2km S. Matará (13°46.57'S, 72°56.35'W), 2050m, 22 June 2003, leg. R. Robbins. 15'M'&2'F' Peru, Cuzco, Quebrada Uraca, SW of Limatambo (13°30.04'S, 72°26.26'W), 2800m, leg. R. Robbins. 1'M' Peru, Cuzco, Limatambo, 29 October 1964 (MUSM). 1'F' same data as holotype. 1'F' Peru, Ayacucho, Ninabamba, 2300m, 5 April 1978, leg. P. Hocking. All 2003 specimens of *S. lamasi* were accidentally labeled "leg. R. Robbins", but some (we do not know which ones) were collected by G. Lamas and C. Peña.

Etymology: This species is named for Gerardo Lamas in recognition of his prodigious contribution to knowledge of the Peruvian butterfly fauna. In addition, he collected the holotype and part of the type series.

Wing pattern variation: Forewing length varies from 10.7-16.4mm in males and from 10.0-16.2mm in females, which means that the largest individuals have about twice the wing area of the smallest. Since larger

individuals tend to have more orange scaling on average than smaller ones, a small series of specimens could easily appear to be two species.

The dorsal forewing of both sexes varies from all brown to brown with orange patches over half the wing. The illustrated specimens (Figs. 15, 17) have some orange scales at the distal end of the discal cell. All specimens in the type series have a subterminal, black-pupilled orange spot in dorsal hindwing cell Cu1-Cu2. About half also have an orange spot in an adjoining wing cell (Figs. 15, 17). The illustrated ventral wing patterns (Figs. 16, 18) are fairly typical, but most specimens have less orange on the subterminal part of the hindwing than the illustrated female, sometimes reduced to a single cubital spot in wing cell Cu1-Cu2.

It is sometimes difficult to distinguish the sexes in the *S. melinus* species group because sexual dimorphism in wing pattern is minimal and because males lack androconia. However, females of *S. lamasi* can be routinely distinguished by their consistently more rounded wings, especially hindwings.

Male genitalic variation (four dissections, Fig. 25): There is substantial variation in the shape of the saccus, anterior vinculum, and length and curve of the penis, but this variation is equivalent to that in other eumaeine species (e.g., Robbins 1990).

Female genitalic variation (four dissections, Fig. 29): As with many *Strymon* species, the most variable part of the bursa copulatrix is the shape of the sclerotized loop in the ductus bursae. The anterior segment of the ductus bursae is "S"-shaped in three dissections (Fig. 29) and concave in the other.

Habitat, distribution, and behavior: All known specimens were collected in the dry upper Río Apurímac drainage at 2000-2300 m, mostly on weedy flowers, especially Milkweed (*Asclepias*). Additionally, seven males were observed occupying mating territories on low shrubs along paths between 1425 and 1525 hours. The behavior of the males was indistinguishable from that of male *S. rufofusca* (sometimes perching on the same shrubs at the same time), but individuals of *S. lamasi* were immediately recognizable in the field because they had a more robust body than *S. rufofusca*. *Strymon lamasi* is the only member of the *S. melinus* group that is restricted to habitats above 2000 m elevation.

Relationships: We place *S. lamasi* in the *S. melinus* species group because it lacks a scent patch and because it shares its underside wing pattern and "rounded" wings with *S. rufofusca* and *S. cyanofusca*. It differs from these two species by its male genitalia, female genitalia, and wing pattern, as noted in the diagnosis above, and by its larger average size.

Although some individuals of *S. rufofusca* from the southern part of its distribution have a wingspan as wide as *S. lamasi*, they have a less robust thorax and abdomen. The phylogenetic relationships among *S. lamasi*, *S. rufofusca*, and *S. cyanofusca* are unresolved. The widespread *S. rufofusca* is sympatric with the other two, whose distributions are allopatric.

The only *Strymon* species in which the cornutus occurs at the very anterior end of the exterior penis are *S. lamasi* and *S. michelle*. However, other evidence does not support a close relationship between these two. *Strymon lamasi* lacks androconia and has relatively rounded wings, in contrast to *S. michelle*. The loop of the ductus bursae is quite complex in both—which may be correlated with a long vesica and a relatively anterior cornutus—but the shape is considerably different (Figs. 28, 29).

Discussion

Strymon Systematics

Strymon now contains 54 described species. Robbins and Nicolay (2002) listed 48, but on the basis of new information, Robbins (2004) removed four names from synonymy, synonymized two others, and transferred one to another genus. We describe *S. ahrenholzi, S. giffordi, S. jacqueline, S. lamasi*, and *S. michelle* in this paper. There appear to be another 2-3 undescribed *Strymon* species, but sufficient material to assess variation is not yet available.

The five newly described species slightly alter characterization of the species groups previously proposed (Robbins & Nicolay 2002). *Strymon ahrenholzi* is the first species in the *Strymon serapio* species group with a straight or upturned penis tip, but is otherwise quite similar to *S. eremica*. *Strymon michelle* is the first species in the *S. martialis* group without a sclerotized "plate" on the posterior corpus bursae, but the shape of its ductus bursae is otherwise the same as that of *S. martialis*. The genitalia of the *S. melinus* group are homogenous except for those of *S. lamasi*, which are different from those of all other *Strymon*. We place *S. lamasi* in the *S. melinus* group because it and *S. rufofusca* share a similar wing pattern, wing shape, lack of androconia, and male behavior.

Endemism of *Strymon* Taxa in the Dry Areas of South America

Although some *Strymon* species, such as *S. sylea* (Hewitson) and *S. gabatha* (Hewitson), occur in wet lowland forest, most species are restricted to, or are most common in, xeric areas (Robbins & Nicolay 2002).

Many are widely distributed, but a few have restricted ranges in South America, such as the five species described in this paper. As an overview of the *Strymon* that have restricted ranges in the xeric regions in South America, (1) *S. ahrenholzi*, *S. jacqueline*, *S. michelle*, and *S. daraba* are endemic to the Atacama Desert of western Peru north to the Loja region of southern Ecuador, with the latter three also occurring in the inter-Andean Río Marañón Valley; (2) *Strymon lamasi* is endemic to Peru's Río Apurímac Valley; (3) *S. sabinus* (C. Felder & R. Felder) and a dark phenotype of *S. rufofusca*—probably a distinct species—are endemic to the llanos of Colombia, Venezuela, and the Guianas; (4) *S. ohausi* (Spitz) and *S. giffordi* are endemic to Brazil's cerrado; and (5) *S. veterator* appears to be endemic to the chaco in Argentina. Others, such as *S. tegaea* (Hewitson) and *S. eremica*, occur in more than one of these areas.

The dry inter-Andean valleys of Peru are arguably the most poorly collected of the South American xeric regions and are most likely to contain undiscovered *Strymon* species. For example, we found *S. lamasi* commonly at two localities in the upper Río Apurímac Valley, yet it was previously not represented in any North American or European museum.

Besides the endemic species listed in the previous paragraphs, a number of geographical variants of *Strymon* have restricted ranges in South America. Three distinctive geographical phenotypes of *S. bubastus* (Stoll) occur in Peru; one is endemic to the Atacama Region (to which the name *sapota* Hewitson refers), another to the Río Apurímac Valley, and a third to the Río Mantaro Valley. A slightly differentiated form of *S. yojoa* (Reakirt) inhabits the Atacama Region with another phenotype in the Río Marañón Valley. Finally, a slightly differentiated phenotype—the ground color of the ventral wings is darker on average—of *S. ziba* (Hewitson) occurs in the chaco of Argentina, to which the name *diaguita* Hayward refers.

Strymon Biogeography and the Atacama Desert of Ecuador and Peru

Amphibian and lizard species that are endemic to the Atacama Desert and Río Marañón of northern Peru and southern Ecuador are usually reported to be related to other species in this region (Cadle 1991, Duellman & Wild 1993). In striking contrast, the closest relatives of birds in a variety of other regions (Best & Kessler 1995), as appears to be the case with *Strymon*. The evidence is reasonably strong that *Strymon michelle* is most closely related to two species that inhabit the Greater Antilles. There are no close relatives in suitable habitat in the intervening areas, and extinction is a possible explanation for this disjunct distribution. *Strymon ahrenholzi* appears to be the sister of *S. eremica*, a species that occurs in chaco and cerrado habitats east of the Andes. Although the wing pattern of *S. daraba* superficially resembles that of *S. yojoa*, it is closely related to *S. melinus* (Nicolay & Robbins 2002, unpubl.), a North and Central American species that ranges south to the llanos. Analysis of the entire Tumbesian butterfly fauna should provide a clearer picture of butterfly biogeography in this region.

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Literature Cited

Best, B.J. & M. Kessler. 1995. Biodiversity and conservation in Tumbesian Ecuador and Peru. BirdLife International, Cambridge, UK, 212 pp.

Brown, K. S. & O. H. H. Mielke. 1967a. Lepidoptera of the Central Brazil Plateau. I. Preliminary list of Rhopalocera; Introduction, Nymphalidae, Libytheidae. Journal of the Lepidopterists' Society 21: 77–106.

Brown, K. S. & O. H. H. Mielke. 1967b. Lepidoptera of the Central Brazil Plateau. I. Preliminary list of Rhopalocera (continued): Lycaenidae, Pieridae, Papilionidae, Hesperiidae. Journal of the Lepidopterists' Society 21: 145–168.

Cadle, J. E. 1991. Systematics of lizards of the genus *Stenocercus* (Iguania: Tropiduridae) from northern Perú: new species and comments on relationships and distribution patterns. Proceedings of the Academy of Natural Sciences of Philadelphia 143: 1–96.

Duellman, W. E. & E. R. Wild. 1993. Anuran amphibians from the Cordillera de Huancabamba, northern Peru: systematics, ecology, and biogeography. Occasional Papers of the Museum of Natural History, The university of Kansas, Lawrence, Kansas 157: 1–53.

Eliot, J. N. 1973. The higher classification of the Lycaenidae (Lepidoptera): a tentative arrangement. Bulletin of the British Museum (Natural History) Entomology 28: 371–505.

Lamas, G. 1982. A preliminary zoogeographical division of Peru, based on butterfly distributions (Lepidoptera, Papilionoidea). pp. 336-357 *In*: Prance, G. T. (Ed.), The Biological Model for Diversification in the Tropics. New York, Columbia University Press.

Klots, A. B. 1970. Lepidoptera, pp. 115–130. *In*: S.L. Tuxen (ed.), Taxonomist's glossary of genitalia in insects. Munksgaard, Copenhagen.

Morrone, J. J. 2001. A formal definition of the Paramo-Punan biogeographic subregion and its provinces, based mainly on animal taxa. Revista del Museo Argentino de Ciencias Naturales (new series) 3: 1–12.

Nicolay, S. S. 1971. A new genus of hairstreak from Central and South America (Lycaenidae, Theclinae). Journal of the Lepidopterists' Society 25: Supplement 1, 39 pp.

Nicolay, S. S. 1977. Studies in the genera of American hairstreaks. 4. A new genus of hairstreak from Central and South America (Lycaenidae: Eumaeini). Bulletin of the Allyn Museum 44: 24 pp.

Robbins, R. K. 1990. The *Mitoura spinetorum* complex in New Mexico and the validity of *M. millerorum* (Lycaenidae: Theclinae). Journal of the Lepidopterists' Society 44: 63–76.

Robbins, R. K. 1991. Evolution, comparative morphology, and identification of the eumaeine butterfly genus *Rekoa* Kaye (Lycaenidae: Theclinae). Smithsonian Contributions to Zoology #498, 64 pp.

Robbins, R. K. 2004. Lycaenidae. Theclinae. Tribe Eumaeini, pp. 118-137. *In*: Lamas, G. (ed.), Checklist: Part 4A. Hesperioidea - Papilionoidea. *In*: Heppner, J. B. (ed.), Atlas of Neotropical Lepidoptera. Volume 5A. Gainesville, Association for Tropical Lepidoptera; Scientific Publishers.

Robbins, R. K. & G. Lamas. 2002. Nomenclatural changes in the Neotropical Eumaeini (Lepidoptera: Lycaenidae: Theclinae). Revista Brasileira de Zoologia 19 (supplement 1): 197–214.

Robbins, R. K. & S. S. Nicolay. 1999. Taxonomy of *Strymon toussainti, S. andrewi, S. amonensis,* and *S. rhaptos* (Lycaenidae: Theclinae). Journal of the Lepidopterists' Society 52: 328–334.

Robbins, R. K. & S. S. Nicolay. 2002. An overview of *Strymon* Hübner (Lycaenidae: Theclinae: Eumaeini). Journal of the Lepidopterists' Society 55: 85–100.