

# Taxonomic and distributional notes on *Bolla tepeca* (Bell, 1942), new combination (Lepidoptera: Hesperiiidae: Pyrginae)

José Ricardo Assmann Lemes<sup>1</sup>, Ricardo Russo Siewert<sup>2</sup>, Olaf Hermann Hendrik Mielke<sup>1</sup>, Mirna Martins Casagrande<sup>1</sup> and Andrew David Warren<sup>3</sup>

1. Laboratório de Estudos de Lepidoptera Neotropical, Departamento de Zoologia, Universidade Federal do Paraná, P.O. Box 19.020, 81.531-980 Curitiba, Paraná, Brazil. 2. Departamento de Biologia Animal e Museu de Diversidade Biológica, Instituto de Biologia, Universidade Estadual de Campinas, Monteiro Lobato 255, 13083-862, Campinas, São Paulo, Brazil. 3. McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, 3215 Hull Rd., UF Cultural Plaza, PO Box 112710, Gainesville, FL, 32611-2710, USA. Corresponding author: jrlemes@gmail.com.

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**Abstract:** We propose a new generic combination for the Mexican skipper *Pholisora tepeca* Bell, 1942, transferred into the genus *Bolla* Mabille, 1903, based on morphological and molecular data. In addition, taxonomic notes on this species, including a redescription of the male and the first illustrations of the female genitalia, a taxonomic catalogue, and a distributional map, are provided. Finally, we show that *Bolla tepeca* **new comb.** is closely related to *Bolla saletas* (Godman & Salvin, 1896).

**Key words:** Carcharodini; Mexico; Neotropical; skipper; *Staphylus*.

**Resumen:** Nosotros proponemos una nueva combinación genérica para la mariposa mexicana *Pholisora tepeca* Bell 1942, transferida para el género *Bolla* Mabille, 1903, basados en datos morfológicos y moleculares. Adicionalmente, notas taxonómicas para esta especie, incluyendo la re-descripción del macho y las primeras ilustraciones de la genitálica femenina, un catálogo taxonómico, e un mapa de distribución son presentados. Finalmente, es demostrado que *Bolla tepeca* **new comb.** es relacionada con *Bolla saletas* (Godman & Salvin, 1896).

**Palabras claves:** Carcharodini; mariposa; Mexico; Neotropical; *Staphylus*.

**Resumo:** É proposto uma nova combinação genérica para a borboleta mexicana *Pholisora tepeca* Bell, 1942, transferida para o gênero *Bolla* Mabille, 1903, baseado em dados morfológicos e moleculares. Além disso, notas taxonômicas para essa espécie, incluindo a redescrição do macho e as primeiras ilustrações da genitálica feminina, um catálogo taxonômico, e um mapa de distribuição são apresentados. Finalmente, é demonstrado que *Bolla tepeca* **new comb.** é fortemente relacionada à *Bolla saletas* (Godman & Salvin, 1896).

**Palavras chaves:** borboleta; Carcharodini; México; Neotropical; *Staphylus*.

## INTRODUCTION

*Staphylus* Godman & Salvin, 1896 and *Bolla* Mabille, 1903 are two genera of small to medium-sized brown skippers that are notoriously difficult to identify. With very few markings on their wings, the specific identification of most of the species depends on the analysis of the male genitalia (Evans, 1953; Steinhauser, 1989). For females, identification is even more difficult, as only a few species have had their female genitalia illustrated (Mielke, 1975, 1980; Steinhauser, 1989, 1991; Steinhauser & Austin, 1993; Austin, 1997; Austin & Warren, 2002). Moreover, the morphological characters defining both genera are poorly circumscribed (Steinhauser, 1989).

According to Evans (1953), *Bolla* species are larger, the nudum of the antennal club has 13 segments, and the forewing and hindwing outer margins are more even. As for *Staphylus*, the antennal club is shorter, more or less flattened and hollowed,

with a nudum of only 10 to 11 segments, and the outer wing margins are usually more undulated. Taxonomical studies are in progress to better establish the diagnostic characters of the two above-cited genera (Lemes *et al.*, in prep.).

Recent systematic studies on Hesperiiidae using genomic scale approaches have demonstrated that several genera of Carcharodini are not monophyletic (Cong *et al.*, 2019; Zhang *et al.*, 2022). Accordingly, some species previously classified under *Staphylus* and *Bolla* were transferred to the genera *Clytius* Grishin, 2019, *Incisus* Grishin, 2019, *Perus* Grishin, 2019 and *Pholisora* Scudder, 1872.

Although there have been advances towards a more robust classification of skippers in order to maintain the monophyly of genera, these studies have only accessed a limited number of species to date. The inclusion of more species in such studies are likely to result in new taxonomical arrangements. This is the case for *Staphylus tepeca* (Bell, 1942), popularly known as

the Grizzled Sootywing (Warren *et al.*, 2017) or the Checkered Scallopwing (iNaturalist).

Bell (1942) described *Pholisora tepeca*, currently in the genus *Staphylus*, from a single male specimen collected by Roberto Müller in Lomas de Chapultepec, now a part of greater Mexico City. This species, endemic to Mexico, is poorly represented in most museum collections, and has a highly restricted geographic distribution. It has most often been encountered in and near the Valley of México, Mexico, although it has been found at several sites in Oaxaca in recent decades and once in Puebla (first record for the state, see results section).

In this study, an integrative approach using morphological and molecular data demonstrated that *Staphylus tepeca* actually belongs in the genus *Bolla*. Therefore, a new combination is proposed as *Bolla tepeca* **new comb.** Moreover, a morphological redescription of the male is provided, including detailed images of the genitalia, as well as the first illustrations of the female genitalia. In addition, a taxonomical catalogue and a distributional map with all known records for *Bolla tepeca* **new comb.** are also provided.

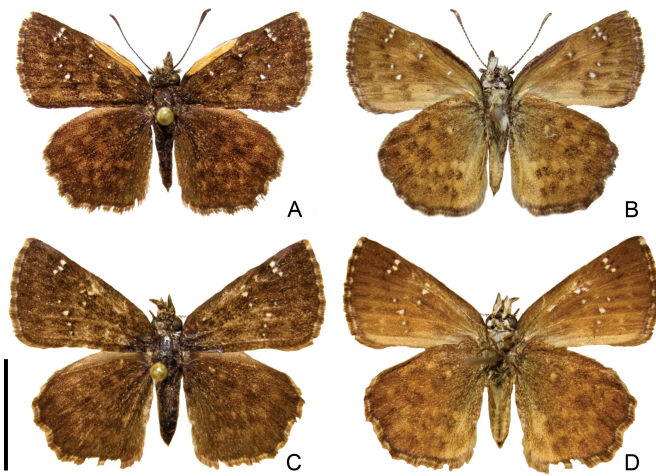
## MATERIALS AND METHODS

Specimens deposited in the following collections were used for the molecular and comparative morphological studies: **DZUP** - Coleção Entomológica Padre Jesus de Santiago Moure, Universidade Federal do Paraná, Curitiba, Paraná, Brazil; **JJGD** - Private collection of José de Jesús García-Díaz, Tehuacán, Puebla, Mexico; **MGCL** - McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, University of Florida, Gainesville, Florida, USA; and **OM** - Olaf Hermann Hendrik Mielke Collection, Curitiba, Paraná, Brazil.

For the molecular analysis, legs from two specimens of *Bolla tepeca* **new comb.** were detached and sent to the Canadian Center for DNA Barcoding (CCDB) for DNA extraction, amplification, and sequencing of the mitochondrial cytochrome oxidase subunit 1 (COI) using standardized methods (Hebert *et al.*, 2003). These sequences were included in GenBank with the accession numbers OQ789933-OQ789934 (NCBI, 2020). Sequences of 39 additional closely related Carcharodini species available in GenBank were also used (Table 1). The molecular alignment of COI sequences was performed using the software Muscle in MEGA7 (Kumar *et al.*, 2016). Optimal models of

**Table 1.** Sequences of mitochondrial cytochrome oxidase subunit 1 (COI) used in this study. Sequences of *Bolla tepeca* **new comb.** in bold. The depository collections of the specimens used in this study and their respective vouchers are also cited.

GenBank accession numbers	Specimen identification	Locality	Reference	Collection - Voucher
MW807713	<i>Bolla cupreiceps</i>	Bolivia, La Paz	Earl <i>et al.</i> (2021)	
MW807689	<i>Bolla eusebius</i>	Guatemala, Sacatepequez	Earl <i>et al.</i> (2021)	
JF751716	<i>Bolla evippe</i>	Costa Rica, Guanacaste	Janzen <i>et al.</i> (2011)	
MW807749	<i>Bolla imbras</i>	Mexico, Veracruz	Earl <i>et al.</i> (2021)	
OQ789929	<i>Bolla mancoi</i>	Brazil, Acre	Lemes <i>et al.</i> in press.	
MW807738	<i>Bolla orsines</i>	Guatemala, Sacatepequez	Earl <i>et al.</i> (2021)	
JF752485	<i>Bolla zorilla</i>	Costa Rica, Alajuela	Janzen <i>et al.</i> (2011)	
MW807712	<i>Bolla saletas</i>	Guatemala, Sololá	Earl <i>et al.</i> (2021)	
<b>OQ789933</b>	<b><i>Bolla tepeca</i> <b>new comb.</b></b>	<b>Mexico, Oaxaca</b>	<b>This study</b>	<b>MGCL - MGCL 1106807</b>
<b>OQ789934</b>	<b><i>Bolla tepeca</i> <b>new comb.</b></b>	<b>Mexico, Oaxaca</b>	<b>This study</b>	<b>MGCL - MGCL/FLMNH 37251</b>
MW807751	<i>Clytius clytius</i>	Mexico, Veracruz	Earl <i>et al.</i> (2021)	
MW982428	<i>Gorgopas c. chlorocephala</i>	Peru, Cusco	Santos <i>et al.</i> (2022)	
MZ335173	<i>Gorgopas trochilus</i>	Argentina, Jujuy	Attinà <i>et al.</i> (2021)	
KP895747	<i>Hesperopsis alpheus</i>	United States, California	Pratt <i>et al.</i> (2015)	
KP895759	<i>Hesperopsis graciellae</i>	United States, Nevada	Pratt <i>et al.</i> (2015)	
KP895739	<i>Hesperopsis libya</i>	United States, California	Pratt <i>et al.</i> (2015)	
OQ789917	<i>Incisus fasciatus</i>	Brazil, Paraná	Lemes <i>et al.</i> in press.	
OQ789918	<i>Incisus incisus</i>	Brazil, Paraná	Lemes <i>et al.</i> in press.	
MZ335256	<i>Perus minor</i>	Argentina, Salta	Attinà <i>et al.</i> (2021)	
MH310833	<i>Pholisora catullus</i>	Mexico, Sonora	Pfeiler (2018)	
OQ793590	<i>Staphylus ascalaphus</i>	Panama, Colón	Lemes <i>et al.</i> in press.	
OQ789924	<i>Staphylus ascalon</i>	Brazil, Minas Gerais	Lemes <i>et al.</i> in press.	
OQ792217	<i>Staphylus azteca</i>	Panama, Panama	Lemes <i>et al.</i> in press.	
OQ793589	<i>Staphylus caribbea</i>	Costa Rica, Limón	Lemes <i>et al.</i> in press.	
OQ789911	<i>Staphylus hayhurstii</i>	United States, Oklahoma	Lemes <i>et al.</i> in press.	
OQ789923	<i>Staphylus kayei</i>	Colombia, Meta	Lemes <i>et al.</i> in press.	
OQ789915	<i>Staphylus lenis</i>	Guatemala, Petén	Lemes <i>et al.</i> in press.	
OQ789921	<i>Staphylus lizeri lizeri</i>	Colombia, Meta	Lemes <i>et al.</i> in press.	
OQ793588	<i>Staphylus mazans</i>	Mexico, Tampa	Lemes <i>et al.</i> in press.	
OQ789925	<i>Staphylus melaina</i>	Bolivia, Santa Cruz	Lemes <i>et al.</i> in press.	
OQ789919	<i>Staphylus m. melangon</i>	Brazil, Minas Gerais	Lemes <i>et al.</i> in press.	
OQ789913	<i>Staphylus melius</i>	Argentina, Salta	Lemes <i>et al.</i> in press.	
MF546431	<i>Staphylus musculus</i>	Argentina, Entre Rios	Lavinia <i>et al.</i> (2017)	
OQ789912	<i>Staphylus oeta</i>	Argentina, Jujuy	Lemes <i>et al.</i> in press.	
OQ789914	<i>Staphylus perforata</i>	Bolivia, La Paz	Lemes <i>et al.</i> in press.	
OQ801568	<i>Staphylus perna</i>	Brazil, Pernambuco	Lemes <i>et al.</i> in press.	
OQ789916	<i>Staphylus tierra</i>	Mexico, Jalisco	Lemes <i>et al.</i> in press.	
OQ789920	<i>Staphylus tingo</i>	Peru, San Martin	Lemes <i>et al.</i> in press.	
OQ789922	<i>Staphylus tucumanus</i>	Paraguay, Presidente Hayes	Lemes <i>et al.</i> in press.	
JQ578308	<i>Staphylus vulgata</i>	Costa Rica, Guanacaste	Janzen <i>et al.</i> (2011)	
MF547398	<i>Viola minor</i>	Argentina: Buenos Ayres	Lavinia <i>et al.</i> (2017)	



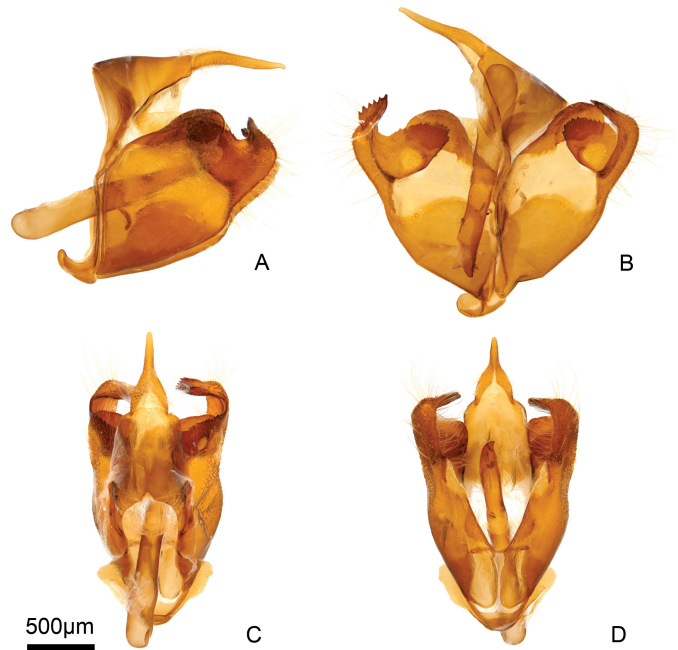
**Figure 1.** *Bolla tepeca* (Bell, 1942) **new comb.** in dorsal and ventral views: (A-B) male (Mexico, Oaxaca, La Cumbre, El Punto, 22.IV.1989, MGCL 1092164), (C-D) female (Mexico, Oaxaca, Sierra Madre del Sur, El Guajolote, 14.VI.1989, MGCL/FLMNH 37251). Scale bar = 1 cm.



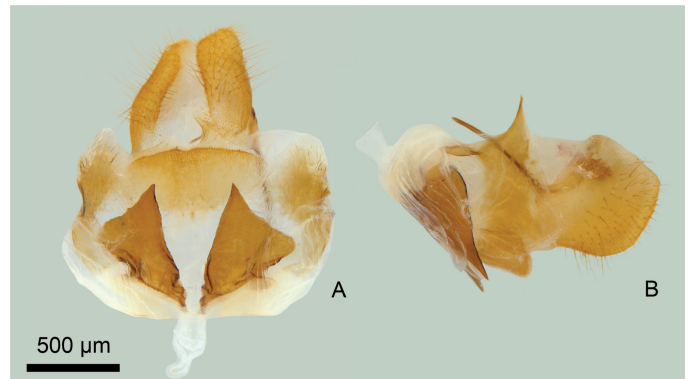
**Figure 2.** Male head of *Bolla tepeca* (Bell, 1942) **new comb.** in dorsal (A) and ventral (B) views (Panama, Chiriquí, Alto Lino, 6.IV.1989, MGCL 1106966).

nucleotide evolution were selected through a partition model by ModelFinder (Kalyaanamoorthy *et al.*, 2017) using the AICc criterion, resulting in TIM3+F+I+G4 for the subsets 1 and 2 and GTR+F+G4 for the subset 3. Maximum likelihood analysis was conducted using the software IQ-Tree v. 2.2.0 (Minh *et al.*, 2020). For the maximum likelihood analysis, the ultra-fast bootstrap approximation method - UFBoot (5,000 bootstrap repetitions) was used (Minh *et al.*, 2013), together with the SH-aLRT test (1,000 repetitions) (Guindon *et al.*, 2010), and with the Bayesian-like transformation of aLRT (aBayes) (Anisimova *et al.*, 2011). The tree obtained was visualized and initially edited in the software FigTree v.1.4.3 (Rambaut, 2006-2009), and later in the software Inkscape 1.0.1 (Harrington *et al.*, 2004-2005). The tree was rooted with *Viola minor* (Hayward, 1933). Branches were considered supported when SH-aLRT  $\geq$  80, aBayes  $\geq$  0.5 and UFBoot  $\geq$  95.

For the morphological analysis, specimens had their abdomen detached and soaked in a heated 10% potassium hydroxide solution (KOH) for 5-10 minutes, and subsequently dissected for the study of the genitalia. Dissected genitalia were stored in vials with glycerin, labeled accordingly, and photographed using a photo stacking process (Leica Application Suite X software) associated with a Leica M205C microscope and a Leica DMC 5400 camera. The general terminology follows Evans (1953), and the genitalia morphology follows Carneiro *et al.* (2013). The following abbreviations were used



**Figure 3.** Male genitalia of *Bolla tepeca* (Bell, 1942) **new comb.** in lateral (A), internal (B), dorsal (C) and ventral (D) views (Mexico, Oaxaca, La Cumbre-El Punto, 22.IV.1989, MGCL 1112110).



**Figure 4.** Sterigma (female genitalia) of *Bolla tepeca* (Bell, 1942) **new comb.** in ventral (A) and lateral (B) views (Mexico, Oaxaca, Sierra Madre del Sur, El Guajolote, 14.VI.1989, MGCL/FLMNH 37251).

throughout the paper: DW (dorsal wing), FW (forewing), DFW (dorsal forewing), VFW (ventral forewing), HW (hindwing), DHW (dorsal hindwing), and VHW (ventral hindwing).

A taxonomical catalogue including all publications mentioning the species is provided below, updated from Mielke (2005). The distributional map was produced with SimpleMapp (Shorthouse, 2010) from the label data of the specimens analyzed, iNaturalist (iNaturalist, 2022), and literature records. In the “examined material” section, the symbol “\*” indicates that the specimen had its genitalia dissected and studied.

## RESULTS

### *Bolla tepeca* (Bell, 1942), **new combination**

Figs. 1-5

*Pholisora tepeca* Bell, 1942. **An. Esc. Nac. Cienc. Biol.**, Mexico, 2(4): 458, fig. 2 (male gen.); holotype male, Lomas de Chapultepec, Mexico D.F.,





**Figure 5.** Live male adults of *Bolla tepeca* (Bell, 1942) **new comb.** photographed by John Kemner in Oaxaca, Mexico (approximately 2150 m): (A) 7 km. NE San Miguel Etla, 27.V.2021; (B) Dist. Etla, Mpo. San Juan Bautista Guelache, stream 5 km. NE San Miguel Etla, 1.V.2017; (C) 5 km. NE San Miguel Etla, 12.V.2017; (D) Dist. Miahuatlán, 1 km. N. San Sebastián Río Hondo, 16.III.2017.

Mexico, R. Müller *leg.*, n° 15.192; collection Escuela Nacional Ciencias Biológicas, Mexico.- Beutelspacher, 1980. **Marip. diurn. Valle Mexico**, p. 99, pl. 14, fig. 9 (male d).- Hernández Baz, 1993. **La Cienc. y Hombre** 14: 78.

*Staphylus tepeca*; Evans, 1953. **Cat. Amer. Hesp.** 3, p. 89, pl. 37 (male gen.)- Okano, 1981. **Tokurana** 1: 80.- Bridges, 1983. **Lep. Hesp.** 1, p. 117; 2, p. 34.- Bridges, 1988. **Cat. Hesp.** 1, p. 185; 2, p. 57.- Llorente-Bousquets *et al.*, 1990. **Publ. esp. Mus. Zool.**, Mexico, 1: 30.- J. de la Maza-Elvira, White & R. G. de la Maza-Elvira, 1991. **Rev. Soc. Mex. Lep.** 14(1): 19.- Bridges, 1994. **Cat. Fam.-Group, Gen.-Group, Sp. Group Nam. Hesp. (Lep.) World** 8, p. 222; 9, p. 64.- Llorente-Bousquets *et al.*, 1996. **Dugesiana** 3(2): 5.- Warren *et al.*, 1998. **Jour. Lep. Soc.** 52(1): 46, 51.- Warren, 2000, in Llorente, *et al.* (eds). **Biodiv., Tax., Biogeogr. Art. Mex.** 2, p. 552.- Luis-Martínez *et al.*, 2003. **Proc. Ent. Soc. Wash.** 105(1): 222.- O. Mielke, 2004. Hesperioidea, p. 56, in Lamas (ed.). **Checklist: Part 4A, Hesperioidea-Papilionoidea**, in Heppner (ed.). **Atlas Neotrop. Lep.** 5A.- Luis-Martínez *et al.*, 2004, in García-Mendoza *et al.*, **Biodiv. Oaxaca**, p. 353. - Michán *et al.*, 2004, in Llorente-B *et al.*, **Biod., Tax. y Biog. Artrop. México** 4, p. 41.- O. Mielke, 2005. **Cat. Amer. Hesperioidea** 3, p. 735.- Salinas-Gutiérrez *et al.*, 2005. **Folia Entomol. Mex.** 44(3): 315.- Glassberg, 2007. **Swift Guide Butt. Mexico and C. America**, p. 188, figs (male, female d).- Díaz-Batres & Llorente-Bousquets, 2011. **Mariposas de Chapultepec**, Mexico, p. 126, figs. (male, d, v).- Garwood & Lehman, 2013. **Butt. C. Amer.** 3, **Hesp.**, p. 107, figs (d, v).- Luis-Martínez *et al.*, 2016. **Southw. Ent.** 41(1): 191.- Vargas-Fernández *et al.* 2016, Mariposas Diurnas (Rhopalocera), apéndice 1, p. 186, in Comisión Nacional para el Conocimiento y Uso de la Biodiversidad. (Conabio). **La Biodiversidad en Colima**. Estudio de Estado. Mexico.

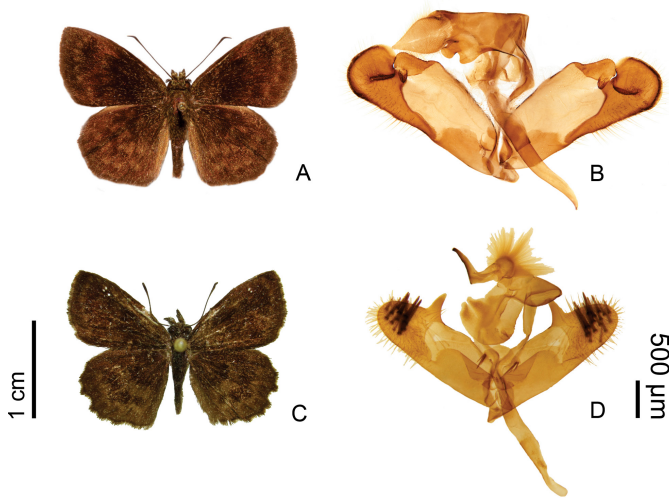
(no genus) *tepeca*; Beattie, 1976. **Rhop. Direct.**, p. 271.

**Taxonomic history.** Bell (1942) described *Pholisora tepeca*. Evans (1953) placed the species in the genus *Staphylus*; this combination has been followed by almost all subsequent authors that have mentioned this species in taxonomic comments, faunistic studies, and catalogs.

**Type.** *Pholisora tepeca* Bell, 1942 was described from a male holotype from Lomas de Chapultepec, [DF] (now Mexico City), Mexico, collected by Roberto Müller, said to be deposited in the collection of the Escuela Nacional de Ciencias Biológicas, Mexico. The holotype of *Pholisora tepeca* is currently deposited in the AMNH with the following labels: / HOLOTYPE [red label]/ Lomas de Chapultepec S. F. V./ R. Müller Coll. 15192/ slide 15192./ G1991/ Holotype ♂ *Pholisora tepeca* Bell/ (Warren *et al.*, 2023).

**Diagnosis** (Figs. 1-5). *Bolla tepeca* can be distinguished from other species of *Bolla* by its single or double hyaline spot in the forewing discal cell, reddish-brown dorsal and yellow reddish-brown ventral ground color of the wings and the darker brown rounded patches on the discal and postdiscal area of VHW. The male genitalia are similar to those of *Bolla saletas* (Godman & Salvin, 1896) (Fig. 9), with valva longer than wide and somewhat rectangle-shaped, sacculus broad, rounded, and harpe exceeding ampulla and bearing a serrated dorsal margin. However, the harpe on *B. tepeca new comb.* possesses a strongly curved process that transposes the ampulla, while *B. saletas* lacks such a process. Moreover, the aedeagus of *B. saletas* is distally bifid, while *B. tepeca new comb.* has a cylindrical aedeagus. The female genitalia of *B. tepeca new comb.* possesses a lamella antivaginalis developed as two large, separate triangular, sclerotized plates, distinct from other known species of *Bolla*.

**Male redescription** (Figs. 1A-B, 2, 3, 5). **Head:** Brown, with some yellow scales dorsally; pure white with some black and yellow hair-like scales ventrally,



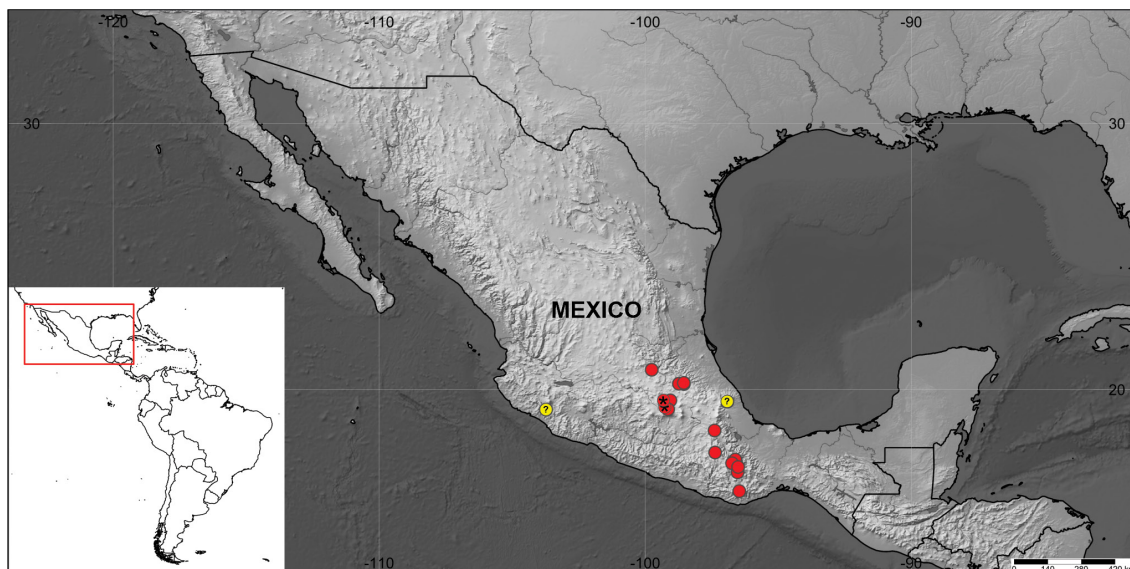
**Figure 6.** Type species of *Bolla* and *Staphylus* in dorsal views and male genitalia in internal view. **(A-B)** *Bolla imbras* (Godman & Salvin, 1896), **(A)** El Salvador, Santa Tecla, 19.VIII.1972 (MGCL); **(B)** Guatemala, Retalhuleu Province, NN Nuevo San Carlos, 22.XII.2002, Ulrich Reber leg., MGCL 1112131 (MGCL). **(C-D)** *Staphylus ascalaphus* (Staudinger, 1876), **(C)** Guatemala, Zacapa, La Unión, 3.X.1981, Welling leg., DZ 45.176 (DZUP); **(D)** Mexico, Chiapas, San Jerónimo, 17.VII.1978, Welling leg., OM 44.713 (OM).

except the third segment of the palpus which is brown. Antenna brown dorsally, ventrally with small yellow dots at the joints on the side. Nudum with 13 segments ( $n = 5$ ). **Thorax:** Brown with yellow hair-like scales dorsally, brown with white hair-like scales ventrally. Legs brown with yellow scales and white hair-like scales. **FW length:** 1.3 cm ( $n = 2$ ). **FW shape:** Outer margin rounded. **DFW:** Reddish brown. Two distinct transverse bands with paler pattern in the discal and postdiscal areas, which gives the wings a maculated aspect; few sparse paler scales present across wing. Costal fold present. Three small white dots in the subapical area. One white dot in the upper distal end of the discal cell (some specimens with an additional white dot in the lower distal end of the discal cell), and the other two between  $M_3$ - $CuA_1$  and  $CuA_1$ - $CuA_2$ . Fringe bicolored, paler and darker brown. **VFW:** Yellow reddish-brown, much paler than DFW. Spots as on DFW but surrounded by darker brown scales.

Fringe as on DFW, but darker. **HW shape:** Outer margin slightly undulated. **DHW:** Reddish brown. Two distinct transverse bands with paler pattern in the postdiscal and central area, which gives the wings a maculated aspect. Some pale scales and long, thin, brown hair-like scales present in basal area. Fringe as on FW. **VHW:** Yellow reddish-brown, much paler than DHW. Three transverse lines of small darker brown rounded patches present on the sub-basal, discal and postdiscal areas. Paler scales sparsely distributed, predominantly on the internal margin. **Abdomen:** Brown dorsally and ventrally with scattered paler scales. **Genitalia:** Tegumen slightly longer than wide, except the proximal margin that connects with the ventral arms of the tegumen, which is convex. Ventral arms of the tegumen narrow and fused with dorsal projection of saccus, assuming that the boundaries between these structures are at the angle between them. Saccus triangular, short, rounded proximally. Uncus longer than wide, enlarged at the base, ventrally with a large concavity that becomes a longitudinal opening towards the narrower apex, bearing some short setae dorsally. Gnathos slightly sclerotized, as two lateral plates connected ventrally. Valva longer than wide in lateral view; sacculus broad, rounded; harpe bifid, the ventrodistal lobe strongly serrated distally and the dorsal subterminal lobe rounded, weakly serrated at the distal margin and reaching the center of ampulla; ampulla longer than wide, rounded at the dorsal-distal margin, fitting in with the harpe's process; costa not well defined. Aedeagus cylindrical, about the same length as valva, insertion of manica in the middle of aedeagus; vesica without cornuti. Fultura inferior developed, thin, moon-shaped in anterior view.

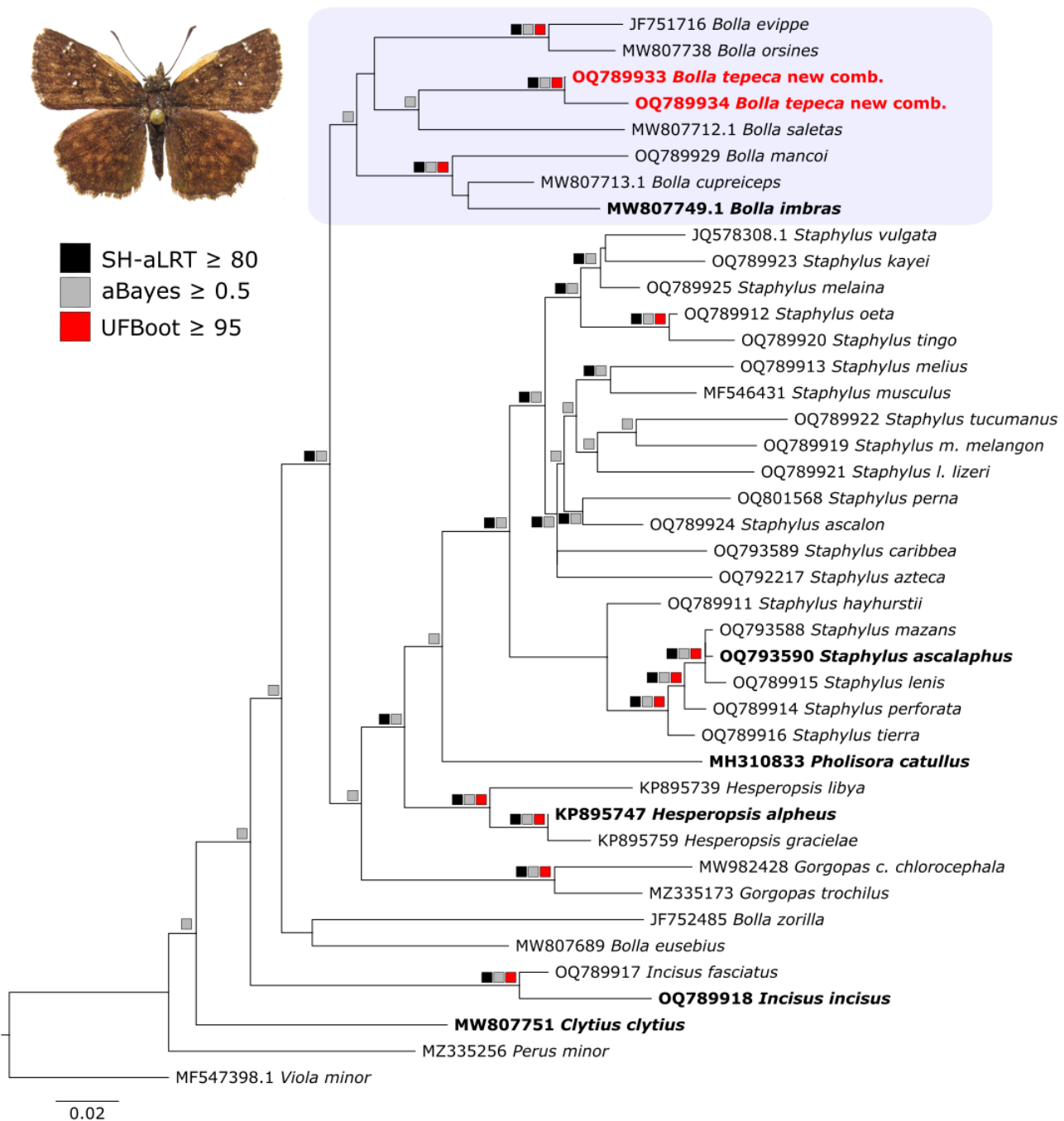
**Female description** (Figs. 1C-D, 4). The female differs from the male as follows: **FW length:** 1.4 cm ( $n = 1$ ). The FW has five white dots: two (one above the other) in the discal cell, one at the base of  $R_2$ - $R_3$ , just below the lower discal cell spot, and two in  $CuA_2$  and 2A. **Genitalia.** Corpus bursae membranous, globular, about 1/3 the length of the ductus bursae; ductus bursae membranous. Lamella antevaginalis forming two large, triangular, sclerotized plates, which project below the lamella postvaginalis. Lamella postvaginalis as a sclerotized plate with fine microtrichia, rounded at the proximal margin and with the distal margin nearly straight, with a subtle central concavity on the ventral margin that is produced into a subtle center carina; laterally expanded as a triangular projection. Papilla analis semi-rounded, covered by setae; posterior apophysis slightly curved, about the same length as papilla analis.

**Comments** (Fig. 6). *Bolla tepeca* **new comb.** shows some similarities in the male genitalia when compared with *B. imbras* (Godman & Salvin, 1896) (the type species of the genus). The uncus, in ventral view, has a proximal rounded opening that turns into a slit towards the distal portion. In *Staphylus ascalaphus*, the type species of *Staphylus*, the slit opening is



**Figure 7.** Distributional map of *Bolla tepeca* (Bell, 1942) **new comb.** The symbol “\*” indicates literature records, and the yellow circles with “?” indicate questionable literature records.

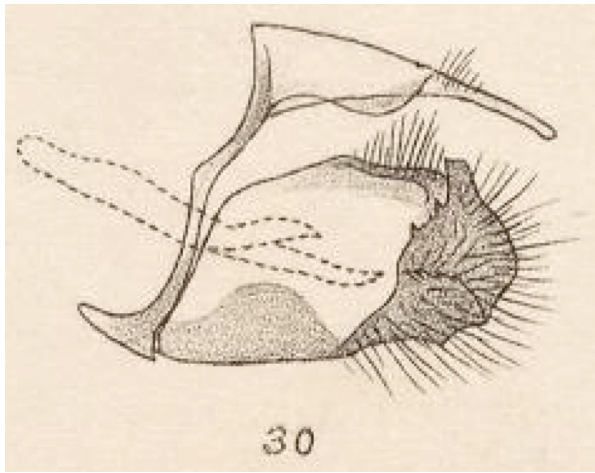




**Figure 8.** Relationships among *Bolla tepeca* (Bell, 1942) **new comb.** and other species of Carcharodini based on DNA COI sequences obtained by Maximum likelihood inferred with IQTREE. The blue rectangle represents the genus *Bolla*. The type species of different genera used in the analysis are bold highlighted. Support values were considered sufficient when SH-aLRT  $\geq$  80, aBayes  $\geq$  0.5 and UFBoot  $\geq$  95.

absent. Besides that, the uncus in lateral view of *S. ascalaphus* bends in a somewhat right-angle at the center and bears dorsally a prominent tuft of long-sized hairs proximally, which are absent in *B. tepeca new comb.* and *B. imbras*. Another difference is the presence in *S. ascalaphus* of a set of prominent socketed spines directed posteriorly at lateral margins of the fulcrum superior, absent in *B. tepeca new comb.* and *B. imbras*. The valva of *S. ascalaphus* presents the ampulla fused with harpe, which externally bears a set of stout socketed spines, while in *B. tepeca new comb.* and *B. imbras* the ampulla is clearly separated from harpe, and the harpe externally lacks the spines.

**Distribution** (Fig. 7). *Bolla tepeca new comb.* is endemic to Mexico, with confirmed records from Distrito Federal (now Ciudad de México) (Beutelspacher, 1980), in the northern region of the Tehuacán-Cuicatlán Valley in Puebla (herein), Oaxaca (Luis-Martínez et al. (2016); Warren et al., 2017; iNaturalist), Hidalgo and Querétaro (iNaturalist), and with questionable records from Veracruz (Hernández-Baz, 1993) and Colima (Llorente-Bousquets et al., 1996). Sites where *B. tepeca new comb.* has been found range from 2011-2500m elevation. Hernández-Baz (1993) reported *Pholisora tepeca* from Xalapa, Veracruz, from the month of May. We have not



**Figure 9.** Illustration of the male genitalia of *Bolla saletas* (Godman & Salvin, 1896) from Godman & Salvin (1896, volume 3, plate 89, fig. 30).

examined material upon which this record is based, but feel the possibility of a misidentification exists, given the low elevation (~1190-1520m) and tropical climate of the Xalapa area. As noted by Warren *et al.* (1998), the record of *B. tepeca* **new comb.** from Colima is based on material in the AMNH simply labeled “Colima”, without specific locality data. Given that no additional specimens of *B. tepeca* **new comb.** have been found in Colima or other western Mexican states, we suspect that the AMNH material is likely to be mislabeled, and probably from the Valley of México.

**Biology.** While poorly represented in most collections, *Bolla tepeca* **new comb.** may be locally abundant in the Valley of México (Díaz-Batres & Llorente-Bousquets, 2011). As noted by Beutelspacher (1980) and Díaz-Batres & Llorente-Bousquets (2011), *B. tepeca* **new comb.** flies from April to September in the Valley of México. No information on the larval foodplant of *Bolla tepeca* **new comb.** has been reported.

**Etymology.** Although not mentioned in the original description, the epithet *tepeca* is clearly in reference to the type locality, Lomas de Chapultepec (Mexico City). As noted by Díaz-Batres & Llorente-Bousquets (2011), *Bolla tepeca* **new comb.** remains common within the Bosque de Chapultepec, a protected natural area adjacent to the Lomas de Chapultepec neighborhood, surrounded by urban development of greater Mexico City.

**Material examined.** Mexico – **Puebla: Tehuacán**, 1.VIII.2012, 1♂, J. J. García-Díaz *leg.* (JJGD). **Oaxaca: La Cumbre-El Punto**, 13.IV.1989, 1♂, John Kemner *leg.*, Allyn Museum Photo No. 930921-5,6. Genitalia Vial SRS-4464\* Allyn Museum Acc. 1989-7, DNA Voucher JRAL-COI-07 José R. A. Lemes, MGCL 1106807 (MGCL); 22.IV.1989, 3♂, John Kemner *leg.*, G. T. Austin colln. MGLC Accession #2004-5, MGCL 1092164, Gen. Prep. Lemes 2021-45\*, MGCL 1112110 (MGCL). **Sierra Madre del Sur, El Guajolote**, 14.VI.1989, 1♀, John Kemner *leg.*, G. T. Austin colln. MGCL Acc. 2004-5, DNA Voucher JRAL-COI-08 José R. A. Lemes, MGCL/FLMNH 37251\* (MGCL). **San Miguel**, 10 miles S., 8500 ft., 6.IV.1989, 1♂, John Kemner *leg.*, Allyn Museum Acc. 1989-7. DNA voucher LEP-79278, MGCL 1106966 (MGCL). Additional specimens from the Valley of México (Mexico City) and Oaxaca, examined by ADW without recording details, are deposited at the Colección Entomológica Alfredo Barrera del Museo de Historia Natural

y Cultura Ambiental de la Ciudad de México (MHNCM), and at the Museo de Zoología, Departamento de Biología Evolutiva, Facultad de Ciencias, Universidad Nacional Autónoma de México (MZFC), respectively.

## DISCUSSION

Evans' (1953) classification of new world Pyrginae, while comprehensive, was limited in that he only studied the species that were available in the Natural History Museum (NHMUK), London, United Kingdom. Therefore, while placing species into his generic framework, for many species the only information Evans had available was the original descriptions. This was the case with *Bolla tepeca* **new comb.**, as Evans (1953, p. 89) cites the absence of this species in the NHMUK. According to Evans (1953), the forewings of *Bolla* species never have a hyaline discal cell spot. *Bolla tepeca* **new comb.**, however, has a hyaline spot in the upper (and sometimes lower) part of the discal cell. This was likely one of the reasons that Evans included this species in *Staphylus*. Additionally, in the original description of *Pholisora tepeca*, Bell (1942) compared the new taxon only to *Pholisora* (now *Staphylus*) *mazans* (Reakirt, [1867]), implying a close relationship between the two.

Our COI analysis recovered *Bolla* as a paraphyletic taxon, with a separated clade including *B. eusebius* (Plötz, 1884) and *B. zorilla* (Plötz, 1886). Although a taxonomical revision of *Bolla* is not the purpose of this manuscript, the authors are studying the genus to better elucidate its taxonomical issues (Lemes *et al.* in prep.). Despite that, *Bolla tepeca* **new comb.** was recovered within the clade of the type species of *Bolla*, *B. imbras*. Moreover, our analysis demonstrated that *Bolla tepeca* **new comb.** is the sister-taxon of *Bolla saletas* (Godman & Salvin, 1896) (Fig. 8). In fact, *B. saletas* (adult photos available in Warren *et al.* (2023)) shares many morphological similarities with *B. tepeca* **new comb.**, including checkered wing fringes, patches of reddish-brown scales on the dorsal wings, presence of a costal fold, palpi with yellowish scales dorsally and whitish scales ventrally, male genitalia (Fig. 9) with a tubular uncus, gnathos formed by two lateral plates, valva with sacculus broad and rounded, and harpe strongly developed and ornamented with serrated dorsal margins.

*Bolla tepeca* **new comb.** is one of the few species of *Bolla* that can be identified without examining the genitalia. While most species of *Bolla* and other Carcharodini (*e.g.*, *Staphylus*) have brown wings without many conspicuous markings, *B. tepeca* **new comb.** has a very characteristic wing maculation. The checkered wing fringes, grizzled aspect dorsally, and the single or double spot in the forewing discal cell separate *B. tepeca* **new comb.** from all other species of *Bolla*.

With the removal of *Bolla tepeca* **new comb.**, 47 species are now included in *Staphylus*, while 29 species are in *Bolla* (Mielke, 2004, 2005; Warren *et al.*, 2023; Cong *et al.*, 2019; Zhang *et al.*, 2022a; Zhang *et al.*, 2022b). Additional taxonomic studies on these two genera are in progress by the authors, including descriptions of new species, in an effort to better understand the boundaries between these two similar genera of skippers (Lemes *et al.*, in prep.).

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