



A new species of the genus *Bertholdia* Schaus, 1896 (Lepidoptera: Erebidae: Arctiinae) from the Neotropical region: *Bertholdia zoenia* sp. n.

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Abstract

A new species of *Bertholdia* Schaus is described: *Bertholdia zoenia* sp. n., based on males and females from Argentina and Paraguay. This new species is closer to *Bertholdia myosticta* Hampson, 1901 from Costa Rica, Irazú. *Bertholdia zoenia* sp. n. can be recognized externally because its hyaline spot on forewing is the widest among all species of genus. Also, the shape of this hyaline spot is like a right triangle with smooth outer margin, different from other species of genus, which have an irregular spot. Habitus, male and female genitalia, and particular structures of *B. zoenia* sp. n. are illustrated. Habitus and male genitalia of *B. myosticta* are also illustrated. A distribution map and commentaries of habitat of *B. zoenia* sp. n. and *B. myosticta* are given. Remarks on nomenclature of the genus are provided.

Key words: Arctiini, Phaegopterina, *Bertholdia*, Argentina, Misiones, Brazil, Travassos, arctiid moth, tiger moth, subtropical forest, Paraná forest

Resumen

Se describe una nueva especie de *Bertholdia* Schaus: *Bertholdia zoenia* sp. n., basada en machos y hembras de Argentina y Paraguay. Esta nueva especie es cercana a *Bertholdia myosticta* Hampson descrita de Costa Rica, Irazú. *Bertholdia zoenia* sp. n. puede ser reconocida externamente debido a que la mancha hialina del ala anterior es la más grande entre todas las especies del género. Además, la forma de esta mancha es semejante a un triángulo rectángulo con el margen externo suave, diferente a las otras especies del género que tienen una mancha hialina irregular. Se ilustran el habitus y genitales de ambos sexos y estructuras particulares de *B. zoenia* sp. n. Por otro lado, se ilustra el genital del macho de *B. myosticta*. Se provee el mapa de distribución y comentarios del habitat de *B. zoenia* sp. n. y *B. myosticta*. Se proporciona comentarios acerca de la nomenclatura del género.

Palabras clave: Arctiini, Phaegopterina, *Bertholdia*, Argentina, Brazil, Misiones, Travassos, ártido, polilla tigre, bosque subtropical, Selva Paranaense

Introduction

Bertholdia Schaus, 1896 currently includes 26 species and 4 subspecies (Vincent & Laguerre 2014; Gibeaux 2016a; 2016b) with a distribution from Southern United States of America to Uruguay (Biezanko *et al.* 1957). Species of this genus are easily recognizable due to a hyaline spot located on distal area of forewings, and also for their coloration pattern (Schaus 1896). On the other hand, the species are known for their particular behavior: they defend against attacking bats using ultrasonic clicks that jam (or interfere) bat sonar (Corcoran *et al.* 2009). Recent phylogenetics analysis placed *Bertholdia* in the ‘jamming clade’ together with *Melese* Walker and *Cissura* Walker (Zaspel *et al.* 2014; Zenker *et al.* 2016).

The genus *Bertholdia* has been very stable and did not present important changes in its taxonomy. Most of the nomenclatural treatments are descriptions of new species. Schaus (1896) described the genus *Bertholdia* based on

Phaegoptera specularis Herrich-Schäffer from Venezuela. Later, Druce (1897) reviewed some species including *Bertholdia albipuncta* Schaus, but the specimens used were misidentified. Hampson (1901) reviewed *Bertholdia* again, based on external morphology and color pattern. In his contribution Hampson also included the description of *B. myosticta* based on specimens misidentified by Druce as *B. albipuncta*. Subsequently, Travassos (1948; 1950) used genital morphology to review some species of the genus and described new species. In this paper, Travassos did not study the type material of *B. myosticta* Hampson and only used specimens from localities of Brazil. Unfortunately, this resulted in a misidentification. In fact, these specimens did not belong to another species previously described. Later, *Bertholdia* was studied by Rawlins (1982) with several new supposed species described but none of them were ever published according to the International Code of Zoological Nomenclature (ICZN). Recently, Gibaux (2016a; 2016b) described 6 species from north of South America.

The purpose of this paper is to describe a new species of *Bertholdia*: *Bertholdia zoenia* sp. n., and to compare it with closely related species *Bertholdia myosticta*.

Material and methods

Recently, adults with the same habitus and genitalia as specimens illustrated by Travassos (1948; 1950) as *B. myosticta* have been collected in different localities from the northeast of Argentina, Misiones.

Abdomens were removed and genitalia were dissected and prepared using a hot KOH solution (10%), and were examined using standard procedures prior to being photographed (Beccacece & Vincent 2014). Photographs of adults was taken with a Sony DSC-H7. Illustrations images of abdomen and male genitalia were taken with a camera attached to a stereoscopic microscope Zeiss Stemi 2000-C stereomicroscope. Specimens housed at collection of Area de Conservación Guanacaste, Museo Nacional de Costa Rica (AGC/MNCR) were used to make comparison.

Type material of *B. zoenia* sp. n. is housed at collection Grupo de Investigación y Conservación de Lepidópteros de Argentina, Museo de Zoología de la Universidad Nacional de Córdoba (MZUC), Museo Argentino de Ciencias Naturales “Bernardino Rivadavia” (MACN) and Benoit Vincent Collection (BVC). The male holotype of *Bertholdia myosticta* is currently housed at British Museum of Natural History (BMNH). Additional images of males and females housed in Instituto Oswaldo Cruz and illustrated by Travassos were examined (IOC) (Travassos 1948; 1950).

Distribution maps of *B. zoenia* sp. n. and *B. myosticta* were made with the free software Simplemapp (Shorthouse 2010). The localities used were based on type material, information of Global Biodiversity Information Facility (GBIF) and records from literature (Rothschild 1910; Travassos 1948; 1950; Hernández-Baz *et al.* 2003; Süßenbach 2003; Nascimento *et al.* 2016). Genital terminology follows Vincent *et al.* (2014) and Beccacece & Vincent (2014).

Results

Bertholdia zoenia Beccacece, new species

Fig. 1, 2, 8, 9, 10, 14, 16–21

Type material. Holotype male: Argentina, Misiones, Parque Provincial Esmeralda, 505 m, 18–I–2012, S 26°53'39" W 53°52'44", H. Beccacece, A. Zapata, G. San Blas, E. Drewniak & N. Villafañe leg. [MZUC]. Paratypes (7 males and 3 females): 1 male: Argentina, Misiones, Parque Provincial Cruce Caballero, 610 m, 21–X–2010, S 26°31'12" W 53°59'12", H. Beccacece, F. Navarro & A. Chalup leg. [MZUC]. 2 males: Argentina, Misiones, Parque Provincial Esmeralda, 505 m, 17–I–2012, S 26°53'39" W 53°52'44", H. Beccacece, A. Zapata, G. San Blas, E. Drewniak & N. Villafañe leg. [MZUC]. 1 male: Argentina, Misiones, Ruta 27, Km 19 – NE San Pedro, 585 m, 30–X–2012, S 26°37'46.6" W 53°55'21.5", H. Beccacece, A. Zapata, F. Navarro, E. Drewniak, N. Villafañe & A. Chalup leg. [MZUC]. 1 male: Argentina, Misiones, Pozo Azul, Ruta 17, 30–X–2004, U. Drechsel leg. [BVC]. 1 male: Argentina, Misiones, Dos de Mayo, 500m, U. Drechsel leg. [BVC]. 1 male: Argentina, Misiones, D[e]partamento] Candelaria, L. N. Alem, XI–[19]53, Gaitopulo leg. (**dissected**, prep. number:

ARC00009-MACN) [MACN]. 1 female: Argentina, Misiones, San Pedro, 576 m, 27–X–2012, S 26°36' W 54°06', H. Beccacece, A. Zapata A., F. Navarro, E. Drewniak, N. Villafañe & A. Chalup leg [MZUC]. 1 female: Argentina, Misiones, Ruta 27, Km 26.3—NE San Pedro, 585 m, 27–X–2012, S 26°36' W 54°06', H. Beccacece, A. Zapata, F. Navarro, E. Drewniak, N. Villafañe & A. Chalup leg. [MZUC]. 1 male: Argentina, Misiones, Dep. Concepción – Sta. María, I–[1]953, M. J. Viana leg. (**dissected**, prep. number: ARC00010-MACN) [MACN].

Additional images examined. 2 males: Brazil, S[ão] Paulo, Jiquiá (Fonte Tapir), 3-XI-[1]940, 2535 L. Travassos & L. Travassos filho leg. (specimens number 2,534 and 2,535) [IOC]. 1 female: Brazil, Paraná, Ponta Grossa, Paraná, 12-IX-[1]938. Camargo de Andrade leg. (specimen number 15,876) [IOC].

Etymology. The species is named after my daughter and wife first names: Zoe and Eugenia = *zoenia*.

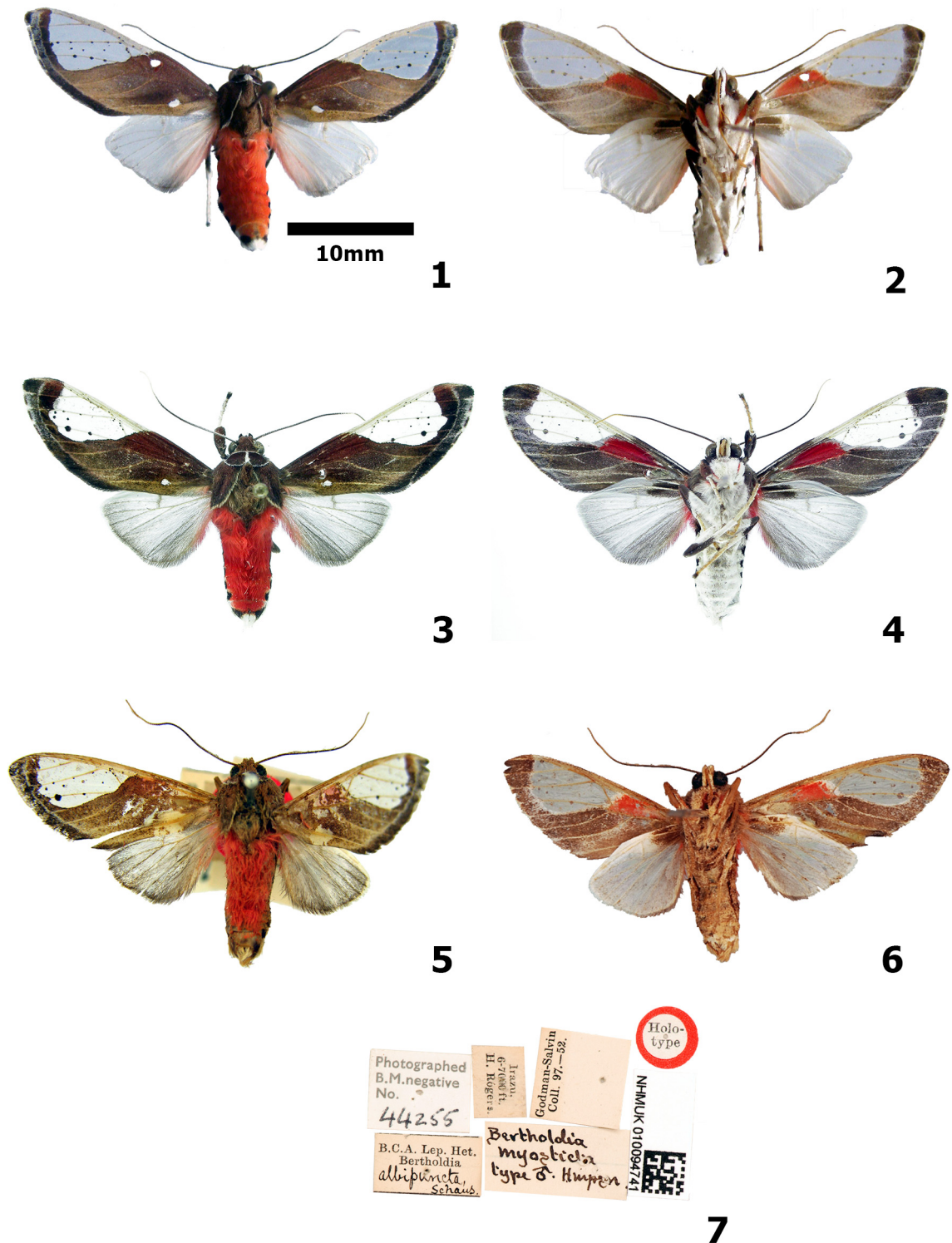
Diagnosis. This new species can be recognized externally because the distal hyaline spot of forewing is the biggest among all species of the genus. Also, the shape of this spot is like a right triangle with outer margin slightly curved and smooth, different to all species with different shape and outer margin irregular and creased. It is similar to *B. myosticta* (Fig. 3–7, 11–13, 15), but can be recognized because the outer margin of hyaline spot is smoother and regular, tip of saccus shorter, valves bigger, apical process narrower and less concave, apical finger-like process longer and uncus longer.

Description. Male (Fig. 1, 2). (n=6). *Head.* Brown dorsally. Front with pinkish hair between margins of scapes. Scapes white dorsally and brown ventrally. Antennae brown, except for the lateral of proximal third and all distal third, both white greyish. Pectinations white greyish, short, uniform in length. Palpi brown dorsally and white ventrally, the third segment shorter than the second segment. *Thorax.* Dorsally brown and ventrally white. Patagia and tegulae brown with white margins, white part more pronounced along inner margin of patagia. *Legs.* Proximal and distal thirds white, medial portion brown, except for dorsal surface of forefemora crimson. *Forewings*—length of 14.5–16.5mm (n=6). Dorsally predominantly brown, lighter brown under discal cell and slightly whitish outer margin. Distal hyaline spot right triangle shaped with dark brown spots on wing veins, the three more conspicuous on M2 nerve. Outer margin of the hyaline spot smooth and regular. A tiny white rounded proximal spot, and another, more conspicuous, on subproximal portion of anal vein. A dark brown line surrounding outer margin. Ventral surface with discal cell crimson, and predominantly covered with white scales on corresponding brown-scaled dorsal surface; androconia ovoid, close to the base of wing and under discal cell (Fig. 20). *Hindwings*—length of 9.5–10.5mm (n=6). Semihyaline, white with inner margin reddish and tornus with diffuse greyish. Ventrally white except for costa brownish. *Abdomen.* Dorsally crimson. Ventrally white. Pleura white with a black spot on each pleurite. Sclerotized apodemes of tergite and sternite present on eighth abdominal segment thin and rounded, respectively (Fig. 17, 18). Male genitalia (Fig. 8–10, 19). Uncus completely setose, rounded basally, then thin, slightly curved ventrally and laterally in the middle and rounded at the tip. Tegumen thin. Vinculum rounded ribbon-shaped. Saccus tapering at the tip and slightly curved to the right side. Juxta absent. Anellus sclerotized. Manica membranous. Asymmetrical sclerotized valves, wide at the base and shorter than uncus. Sacculus and costa fused. Apical process width with a concave apex. Apical finger-like process short. Process of right valve longer, twice as long as left. Aedeagus curved, long and thin tapering at the tip; caecum developed and rounded. Vesica membranous with a patch slightly sclerotized distally, with a long tube when vesica is fully everted (Fig. 14, 19).

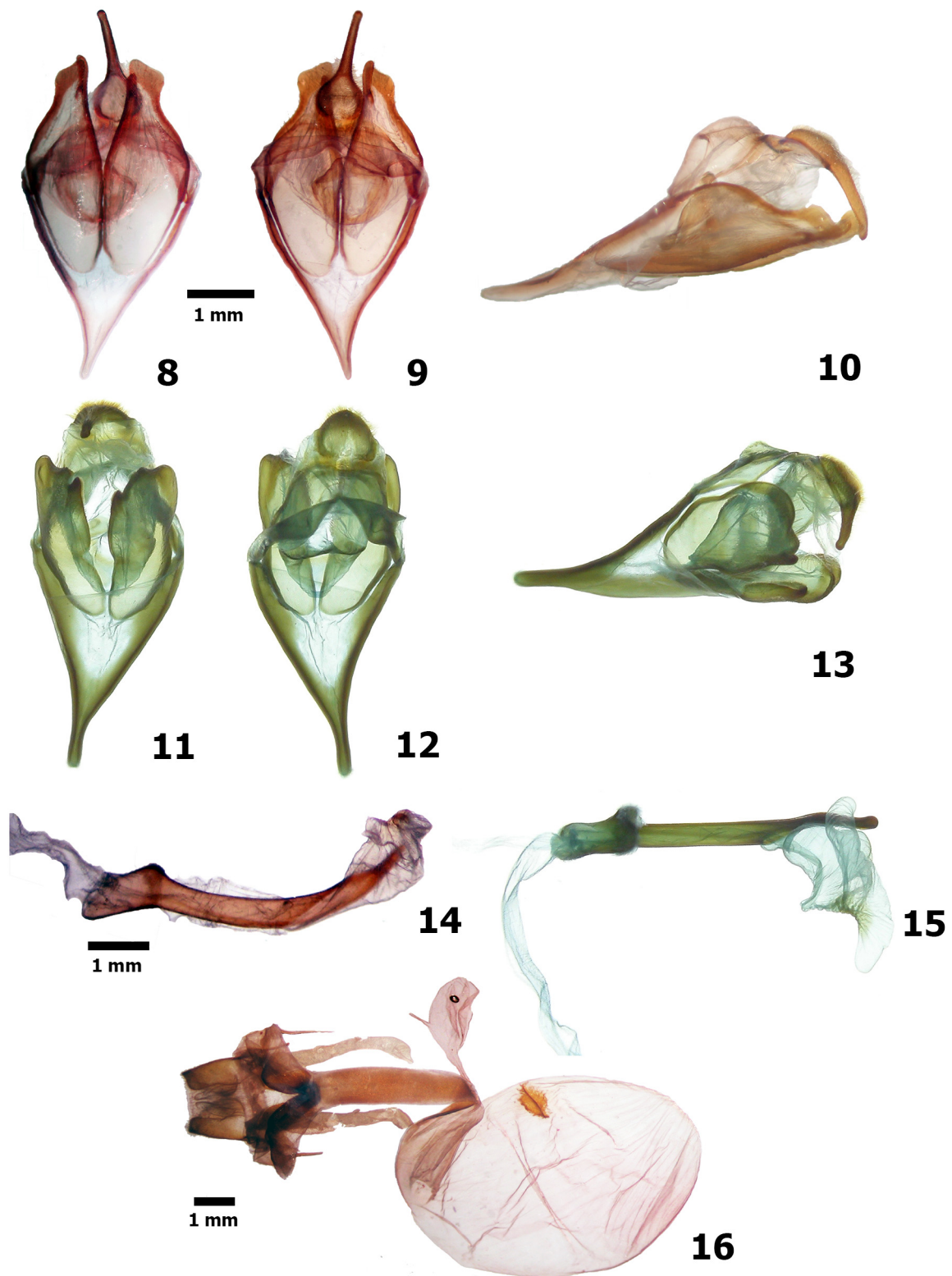
Female. Externally as male except for the following characters: *Forewings*—length 16–20mm. *Hindwings*—length of 10–11.5mm (n=3). Tornus with greyish more pronounced. Female genitalia (Fig. 16, 21). Papillae anales trapezoid and setose. Pseudopapillae anales conspicuous. Anterior and posterior apophyses with same length. Pheromone glands longer than wide, unbranched, reaching anterior margin of seventh abdominal segment. Eighth sternite partially divided mid–ventrally. Ductus bursae sclerotized and longer than wide, distal part creased. Corpus bursae oval, membranous, proximal area creased. Signum ovoid, present on middle-left surface (Fig. 21). Bulla seminalis with a single chamber, oval, smaller than corpus bursae.

Distribution and biology. *Bertholdia zoenia* sp. n. has a restricted distribution in South America from eastern Brazil (Travassos 1948; 1950) to northeastern Argentina and center Paraguay (Fig. 22). Adults have been collected from 3 to 610m above the sea level. The habitat is rain forest lowlands of Atlantic forest. On the other hand, *B. myosticta* has a restricted distribution principally in Mesoamerica from south of Mexico to Costa Rica (Fig. 22). This species occurs from 300 to 1,800m. The habitat is rain and cloud forest. Moreover, there are records of *B. myosticta* in South America from Colombia to Bolivia, reaching more than 2,000m elevation in Ecuador (Rothschild 1910; Süßenbach 2003), where the habitat is principally cloud forest from Los Andes mountains.

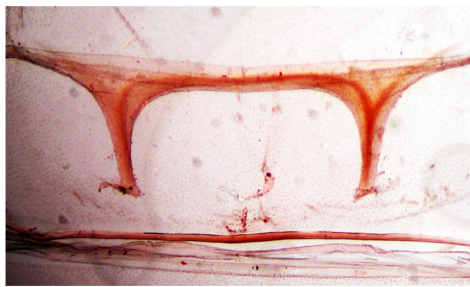
However, these records in South America are most likely misidentified specimens. The life cycle and host plants of *B. zoenia* **sp. n.** and *B. myosticta* are unknown. It is necessary further studies of life cycle not only with species of *Bertholdia* but also with most of the Arctiinae species.



FIGURES 1–7. Adult dorsal and ventral view. 1–2. *Bertholdia zoenia* **sp. n.** 3–4. *Bertholdia myosticta* Hampson, male from Costa Rica (specimen labeled INB0004312781). 5–6. *Bertholdia myosticta* Hampson male holotype. 7. *Bertholdia myosticta* holotype labels.

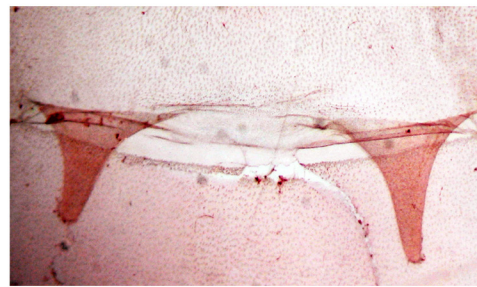


FIGURES 8–15. Male genitalia of *Bertholdia zoenia* sp. n. (paratype) and *Bertholdia myosticta* (specimen labeled INBIOCRI002234884). 8–10. Ventral, dorsal and lateral view of *B. zoenia* sp. n. 11–13. Ventral, dorsal and lateral view of *B. myosticta*. 14. Lateral view of *B. zoenia* sp. n. aedeagus. 15. Lateral view of *B. myosticta* aedeagus. **FIGURE 16.** Female genitalia ventral view of *B. zoenia* sp. n. (paratype).



1 mm

17

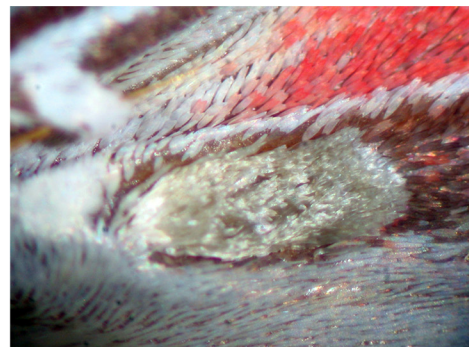


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18

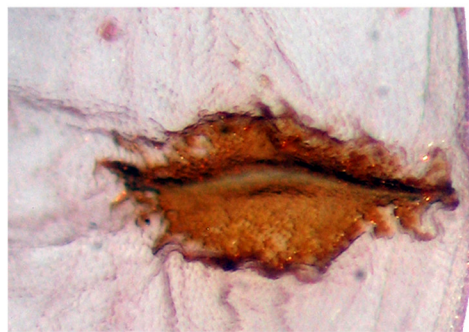


19



1 mm

20



0.5 mm

21

FIGURES 17–21. Special details of *Bertholdia zoenia* sp. n. 17. View of eight tergite with apodemes. 18. View of eight sternite with apodemes. 19. Aedeagus with everted vesica. 20. Androconia present on forewings. 21. Detail of signum present in corpus bursae.

Discussion

Bertholdia zoenia sp. n. was misidentified with *B. myosticta* before due to its similar habitus (Travassos 1948; 1950). However, this new species can be recognized from *B. myosticta* and other species of the genus because the

outer margin of hyaline spot is smoother and regular. The distribution is restricted to forest lowlands of Atlantic forest Atlantic forest.

On the other hand, *Bertholdia* was studied by John Rawlins in a PhD presented to the Faculty of the Graduate School of Cornell University in August 1982. Several new species described by Rawlins were then proposed but none of them were ever published according to ICZN. Therefore, the new species proposed in his thesis are considered manuscript names without valid types (Vincent & Laguerre 2014).

The distribution of *B. zoenia* **n. sp.** seems to correspond to *B. inundulata* Rawlins (1982) *in litteris*. It is necessary to review the Rawlins' manuscript names to confirm if they are valid entities (Table 1).



FIGURE 22. Distribution map of *Bertholdia zoenia* **sp. n.** and *Bertholdia myosticta* Hampson. Yellow triangles = *B. zoenia* **sp. n.** Red circles = *B. myosticta*.

TABLE 1. Actualized checklist of 27 species, 4 subspecies, 1 junior synonym and 21 manuscript names of *Bertholdia* Schaus.

Species names and author	Species status
<i>Bertholdia zoenia</i> Beccacece	new species
<i>Bertholdia albipuncta</i> Schaus	valid species
<i>Bertholdia almeidai</i> Travassos	valid species
<i>Bertholdia aroana</i> Strand	valid species
<i>Bertholdia bolivariana</i> Gibeaux	valid species
<i>Bertholdia detracta</i> Seitz	valid species
<i>Bertholdia flavidorsata</i> Hampson	valid species
<i>Bertholdia flavilucens</i> Schaus	valid species
<i>Bertholdia fumida</i> Schaus	valid species
<i>Bertholdia grisescens</i> Rothschild	valid species
<i>Bertholdia livida</i> Seitz	valid species
<i>Bertholdia moutouchi</i> Gibeaux	valid species
<i>Bertholdia myosticta</i> Hampson	valid species

.....continued on the next page

TABLE 1. (Continued)

Species names and author	Species status
<i>Bertholdia ockendeni</i> Rothschild	valid species
<i>Bertholdia philotera</i> Druce	valid species
<i>Bertholdia pseudofumida</i> Travassos	valid species
<i>Bertholdia rawlinsi</i> Gibeaux	valid species
<i>Bertholdia rubromaculata</i> Rothschild	valid species
<i>Bertholdia schausiana</i> Dyar	valid species
<i>Bertholdia semiumbrata</i> Seitz	valid species
<i>Bertholdia soror</i> Dyar	valid species
<i>Bertholdia steinbachi</i> Rothschild	valid species
<i>Bertholdia tavakiliani</i> Gibeaux	valid species
<i>Bertholdia trigona</i> (Grote)	valid species
<i>Bertholdia. neglecta</i> Gibeaux	valid species
<i>Bertholdia crocea crocea</i> Schaus	valid subspecies
<i>Bertholdia crocea mossi</i> Rothschild	valid subspecies
<i>Bertholdia specularis rufescens</i> Rothschild	valid subspecies
<i>Bertholdia specularis specularis</i> (Herrich-Schäffer)	valid subspecies
<i>Bertholdia antistupris</i> Rawlins	manuscript name
<i>Bertholdia bilineola</i> Rawlins	manuscript name
<i>Bertholdia canissima</i> Rawlins	manuscript name
<i>Bertholdia coronifera</i> Rawlins	manuscript name
<i>Bertholdia eximia</i> Rawlins	manuscript name
<i>Bertholdia flammea</i> Rawlins	manuscript name
<i>Bertholdia gloriosa</i> Rawlins	manuscript name
<i>Bertholdia griseopalpis</i> Rawlins	manuscript name
<i>Bertholdia impuncta</i> Rawlins	manuscript name
<i>Bertholdia inundulata</i> Rawlins	manuscript name
<i>Bertholdia mirifica</i> Rawlins	manuscript name
<i>Bertholdia pararia</i> Rawlins	manuscript name
<i>Bertholdia partita</i> Rawlins	manuscript name
<i>Bertholdia prava</i> Rawlins	manuscript name
<i>Bertholdia rutrigata</i> Rawlins	manuscript name
<i>Bertholdia serrata</i> Rawlins	manuscript name
<i>Bertholdia simplex</i> Rawlins	manuscript name
<i>Bertholdia spatuloides</i> Rawlins	manuscript name
<i>Bertholdia vidualis</i> Rawlins	manuscript name
<i>Bertholdia watsoni</i> Rawlins	manuscript name
<i>Bertholdia yashoquintela</i> Rawlins	manuscript name
<i>Bertholdia braziliensis</i> Hampson	junior synonym of <i>B. soror</i>

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