

Journal of Insect Biodiversity



ISSN: 2147-7612

RESEARCH ARTICLE

Descriptions of a new species and subspecies of *Halysidota* Hübner, [1819] from Mexico (Lepidoptera: Erebiidae: Arctiinae)

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Abstract: A new species and subspecies of the genus *Halysidota* are described from Mexico and Guadeloupe respectively: *Halysidota witti* **sp. nov.** and *Halysidota leda guadulpensis* **ssp. nov.** Details of the new species and subspecies descriptions are based upon morphological and molecular characters as well as distributional data.

Key words: Arctiini, Phaegopterina, Neotropical fauna, molecular phylogeny.

Introduction

The genus *Halysidota* Hübner, [1819] comprises 39 species and 3 subspecies within the neotropics (Vincent & Laguerre 2014) and an additional species, *Halysidota harrisii* (Walsh, 1864), is found in USA. Watson (1980) published a revision of the *Halysidota tessellaris* species-group (*Halysidota* sensu stricto) where 29 species and 2 subspecies are characterized and discussed.

The geographical distribution of this group ranges from the northern United States to Argentina including the Great and the Lesser Antilles. During the consultation of the neotropical Arctiini specimens from the Thomas Witt collection, housed at the ZSM, the authors studied unidentified specimens from Mexico that could be attributed to the genus *Halysidota*. A comparison of the genitalia and the sequence of the mitochondrial gene COI demonstrate that this taxon is new. It is described and illustrated below with related species.

Moreover, *Halysidota leda leda* was originally described by Druce (1890) from Dominica in the Windward Islands. In 1978, Hervé de Toulgoët described *H. leda enricoi* from Martinique on account of a very distinct habitus. In this paper he stated that the subspecies *H. leda leda* is present in Guadeloupe. A detailed study of specimens collected on Guadeloupe Island shows that the situation is a little bit more complex than previously thought and a new subspecies of *Halysidota leda* (Druce, 1890) is highlighted and described here.

Material and methods

Adult genitalia were prepared by boiling abdomens during 15 minutes with 2 pellets of potash in 5 ml of water. After being washed with water and then alcohol, genitalia were photographed in natural position suspended in 95% alcohol, then types and museum specimens were mounted in Euparal, and remaining specimens were simply stored in glycerol. Photos were taken with a CoolPix 4500 Nikon camera attached to a trinocular Nikon stereomicroscope SMZ-10A.

We had the opportunity to use analysis of short sequences of DNA corresponding to the COI mitochondrial gene of 14 specimens belonging to the genus *Halysidota* and *Pseudamastus* (Table 1). This gene is now routinely used for specific discrimination and identification (Hebert *et al.* 2003). The use of these sequences is currently known as "DNA barcoding". A project concerning Neotropical Arctiidae has been initiated within the framework of "ALL-LEPS BARCODE OF LIFE" (see website www.lepbarcoding.org) which objective is to archive the DNA barcodes of all known Lepidoptera. DNA was extracted, amplified and sequenced at the "Canadian Centre for DNA Barcoding" (CCDB) in Guelph, Ontario, starting from dry legs removed from specimens coming from author's collection. Details of various protocols have been described in Vaglia *et al.* (2008).

Table 1. Data for *Halysidota* and *Pseudamastus* specimens used in the phylogenetic analysis.

Code	GenBank accession number	Identification	Country, Province
BC ZSM Lep 92099	MG030745	<i>Halysidota witti</i> sp. nov.	Mexico, Oaxaca
BC ZSM Lep 92100	MG030739	<i>Halysidota witti</i> sp. nov.	Mexico, Oaxaca
MILA1840	MG030748	<i>Halysidota underwoodi</i>	Costa Rica, Puntarenas
MILA1838	MG030738	<i>Halysidota fumosa</i>	Costa Rica, San José
MILA1841	MG030747	<i>Halysidota pearsoni</i>	Paraguay, Caazapa
BEVI0754	MG030739	<i>Halysidota masoni</i>	Mexico, Michoacan
BEVI0272	KF930930	<i>Halysidota elota</i>	Jamaica
BEVI1688	MG030749	<i>Halysidota leda enricoi</i>	Martinique
BEVI1911	MG030739	<i>Halysidota leda guadulpensis</i> ssp. nov.	Guadeloupe
BEVI0267	MG030743	<i>Halysidota ata</i>	Dominican Republic, Monsenor Nouel
BEVI0269	MG030750	<i>Halysidota ata</i>	Dominican Republic, Independencia
BEVI1925	MG030743	<i>Pseudamastus alsa lalannei</i>	Martinique

The sequences were aligned and downloaded from BOLD and analyzed using MEGA6 (Tamura *et al.* 2013) for a cladistics analysis. Bootstrap values (Felsenstein 1985) were used to estimate branch support: they were calculated in MEGA6 after 1000 random

replications. Distance calculations were performed using the Kimura 2-parameter (K2P) method in MEGA6 (Kimura 1980) including all sites, with the pairwise deletion option and assuming both a homogeneous pattern of divergence among lineages and a uniform rate of substitutions among sites.

Repository abbreviations are as follows:

BMNH: Natural History Museum, London, England, UK.

BV: personal collection of Benoît Vincent, 56 rue des Galaxies, 31130 Quint-Fonsegrives, France.

ML: personal collection of Michel Laguerre, 31 rue de la Haute-Lande, 33850 Léognan, France.

MNHN: Muséum National d'Histoire Naturelle, Paris, France.

MWM: Museum Witt, München, Germany.

ZSM: Zoologischen Staatssammlung, München, Germany.

Results

Halysidota witti sp. nov. (Figs 1A–B)

urn:lsid:zoobank.org:act:4A8A2D28-3DF0-4093-94C1-FCCBFCF1CAD3

Type material: Holotype: 1♂, MEXICO, Est Oaxaca [Oaxaca], 27 km 9 (NE) Huatulco, near Finca Monte-Carlo, 15°59.6' N 96°06.3' W, 26-31.VIII.2011, 890m, *leg.* V. Siniaev & O. Romanov, expedition Dr. R. Brechlin. Museum Witt (white printed label) / HOLOTYPE (red printed label) / BC ZSM Lep 92099 (green printed label) / Gen. ML2512 (white manuscript label), MWM in ZSM. **Paratypes:** 1 ♀, same as holotype except: BC ZSM Lep 92100 (green printed label) / Gen. BV 492 (white manuscript label). 1♂, Mexico, Route Atoyac - El Paraiso, camino Puente El Chico pk 0,8, 30.VI.2008, 900m, 17°19.506' N 100°15.060' W, J. Haxaire *leg.* in BVC.

Diagnosis: *Halysidota witti* sp. nov. can be distinguished externally from the others Arctiinae by the following diagnostic combination of characters: forewings without transverse bands and reniform spot; tegulae with punctuation and costa with rounded spots or punctuation; male genitalia with vincular lobes strongly arcuate.

Description (male holotype)

Head. Antennae pectinate, scape and shaft chrome yellow, pectinations dark brown. Clypeofrons chrome yellow with two black marks. Vertex hairy chrome yellow. Palpi chrome yellow, the two first segments very hairy.

Thorax. Patagia hairy, chrome yellow. Tegulae hairy, chrome yellow with a round black spot near base. Thorax hairy and plain chrome yellow. Legs chrome yellow, very hairy, except claws very dark brown.

Abdomen. Tergites entirely chrome yellow covered at base with long chrome yellow hairs. Below hairy and entirely dull chrome-yellow, a lateral black spot on the last segments.

Forewing. Length: 22-23 mm (n=2). Dorsal surface: plain chrome-yellow slightly translucent externally, the veins dark grey and the background color more intense on costa, base and half anal border but also at end of cell. Almost devoid of pattern except the following black markings: on the costa a basal round spot, then a large oval spot at the first quarter and a reverse U shaped line just after the middle; a thin rounded triangle at the base

and two indistinct thin wavy lines crossing the wing on the disk and corresponding more or less to median and postmedian fasciae.

Hindwing. Unmarked, translucent, very light chrome-yellow, slightly tinted with grey hairs below cell, veins dull chrome-yellow.

Ventral surface: unmarked dull chrome-yellow, lighter on hindwings.



Figure 1. **A**, *Halysidota witti* **sp. nov.** holotype; **B**, *Halysidota witti* **sp. nov.** paratype female; **C**, *Halysidota leda enricoi*; **D**, *Halysidota leda guadulpensis* **ssp. nov.** male holotype; **E**, *Halysidota elota*, female holotype; **F**, *Pseudamastus alsa lalannei*, holotype. (Scale: 1/1).

Male genitalia. (Figs 2A–C). Apical costal process of valve extending beyond apical process of sacculus. Non setose mid-costal process of valve as a narrow pointed triangle basad and longer than setose process. Lobes of tegumen moderately developed, slightly bulbous. Vincular lobes strongly arcuate, 2 to 2.5 times the smallest diameter. Aedeagus bent at 120°, with ventral protuberance at the vesica insertion.

Female. Forewing length: 24 mm (n= 1). Similar to male but larger, the markings on the costa are larger and shaped as circles and not spots, the reverse U-shaped line is larger almost touching the border and there is a supplementary circle just distally. The basal triangle is completely open distally and there is no wavy lines on the disk. Below the legs display black articulations and one or two black spots on the tibia of two first pairs.

Female genitalia. Papillae anales rectangular. Apophyses anterior and posterior straight and of the same length. Pseudopapillae short and fully fused. Ductus bursae strongly

sclerified, flat, square and widened at the antrum. Corpus bursae very elongate, elliptical with a partially wrinkled wall and densely covered with tiny papillae. It is inserted at an angle of 45° with the ductus bursae. Bulla seminalis slightly smaller than the corpus bursae, bean shaped. Ductus seminalis short and thick, located near the ductus bursae.

Etymology: This species is dedicated in honor of Dr. Thomas J. Witt, who founder of the Thomas Witt Museum, München, has gathered one of the most important collection of Neotropical Arctiinae by facilitating the access and study of these specimens, contributes to the knowledge of this group.

Distribution and Habitat: All specimens collected are from the foothills of the Mexican mountain range of the Sierra Madre del Sur, located on the Pacific coast (Fig. 4). The new species seems to be limited to an altitude close to 1000 m in a dry forest habitat characterized by the presence of Mimosaceae.

Remarks: The male specimen collected in Guerrero state is even less marked than the holotype. On costa, only the second spot is present and very small, the reverse U-shaped line is hardly visible and V-shaped, the basal triangle is completely open distally and there is no wavy line on the disk. The characterization of this new taxon belonging to the *Halysidota* was based on the publication of Watson (1980). He defines two synapomorphic characters carried by male genitalia: "1, presence of a digitate lobe on each side of the vinculum; 2, presence of a flattened process (contorted in some species) at or near the middle of the costal margin of the valve".

The male genitalia of *H. witti* sp. nov. have both these characteristics and a general conformation very close to the species of the genus. On the other hand, the new taxon can be distinguished from the majority of *Halysidota* species by the absence of transverse bands and the reniform spot on the forewings. It is characterized too by the absence of blue-green fringes on the tegulae and patagia, and the absence of a mid-dorsal line on the thorax. These last two characters are only present in *Halysidota elota* (Möschler, 1886) (Fig. 1E) and *Halysidota leda leda* (Druce, 1890). However, these two last species are also characterized by the absence of transverse bands and the contrasted reniform spot on the forewing. These two species are therefore the closest to the new taxon on the criteria of the habitus.

Halysidota elota is endemic to Jamaica. The female holotype has barely marked transverse bands, whereas specimen series studied in several institutions, display well-contrasted transverse bands. The Jamaican species is easily distinguished from *H. witti* sp. nov. by the absence of punctuation on the tegulae and rounded spots or punctuation on the costa. The male genitalia also show a very different conformation with in particular the protuberances of the tegumen barely visible and a very long apical costal process on the valvae.

Halysidota leda leda (Druce, 1890) is described from Dominica. It differs from *H. witti* sp. nov. by its general coloration (brownish-yellow instead of chrome yellow), the forewings pattern composed of scattered black scales and indistinct wavy lines covering the entire disk and in the male genitalia by the wider base of uncus and the larger and wider vincular processes. *Halysidota leda enricoi* Toulgoët, 1978 (Fig. 1C) from Martinique differs by its general coloration (unmarked brownish-yellow instead of chrome yellow), the presence of a large black spot (greater than 1 mm) on the tegulae and the absence of any other pattern on the forewings. About male genitalia (Figs 2G–I), the uncus base is larger, the vincular processes are larger and considerably wider, and the tegumen processes are more prominent.

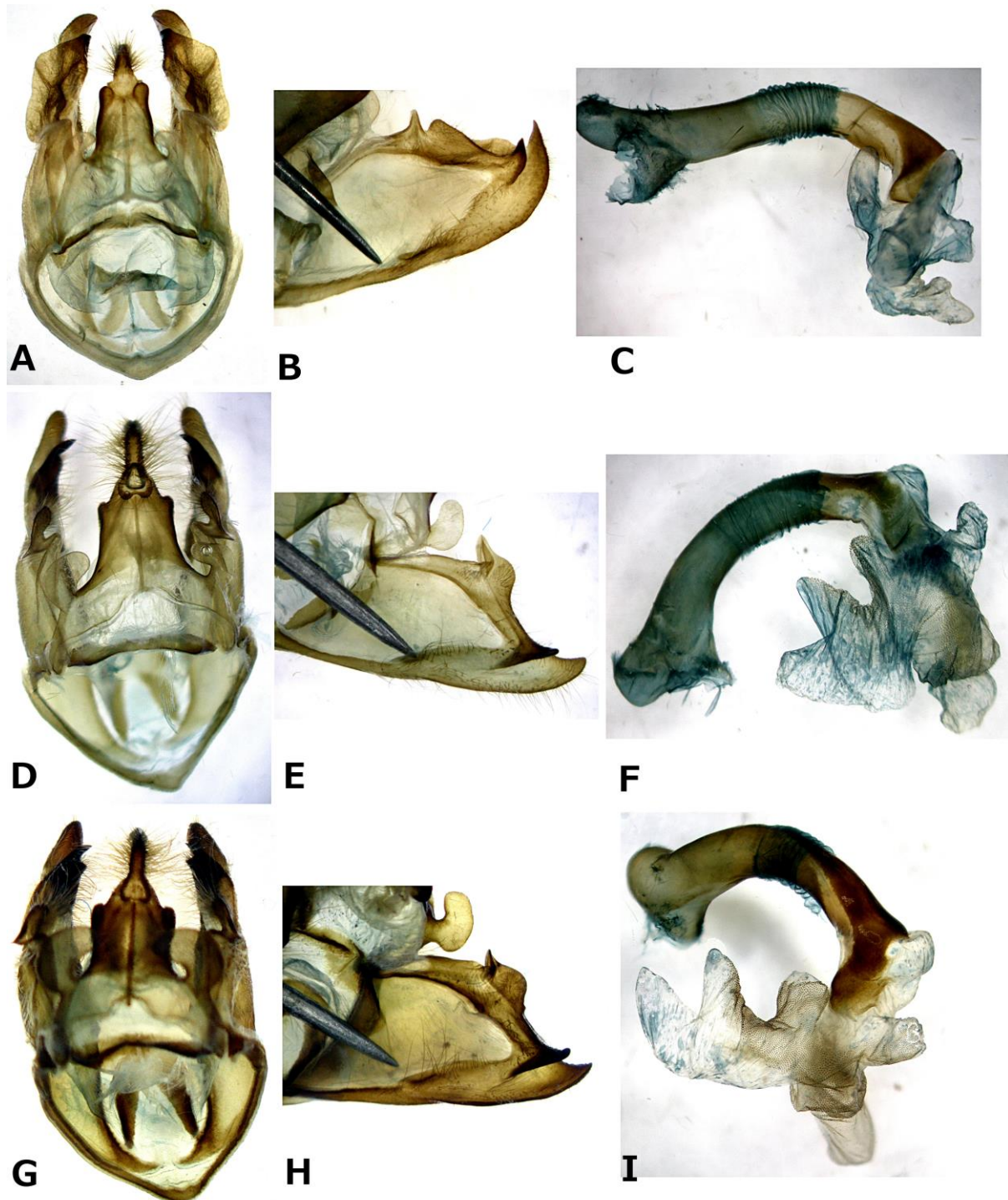


Figure 2. Genitalia A–C, *Halysidota witti* sp. nov.; A, dorsal view; B, valve lateral view; C, aedeagus with devaginated vesica; D–F, genitalia of *Halysidota leda guadulpensis* ssp. nov.; D, dorsal view; E, valve lateral view; F, aedeagus with vesica everted; G–I, genitalia of *Halysidota leda enricoi*; G, dorsal view; H, valve lateral view; I, aedeagus with vesica everted. All views unmounted in natural position.

A NJ tree (Fig. 3) of 16 specimens reveals that despite very similar habitus, *H. witti* sp. nov. is not close to *H. elota* and *H. leda*. It is part of a clade consisting of several species typical of the genus *Halysidota*, among them *H. underwoodi* (Rothschild, 1909) with a

distance of 3.3%, *H. pearsoni* Watson, 1980 with a distance of 3.2%, *H. fumosa* (Schaus, 1912) and *H. pectenella* Watson, 1980 with a distance of 2.4%. Considering the BOLD general tree containing more than seven millions sequences, these two last species, both from Central America, are the closest species but genitalia and habitus are largely different.

For *Halysidota elota*, in the same conditions, the closest species are *H. masoni* and *H. fumosa* at a distance of 2.8 and 3% respectively.

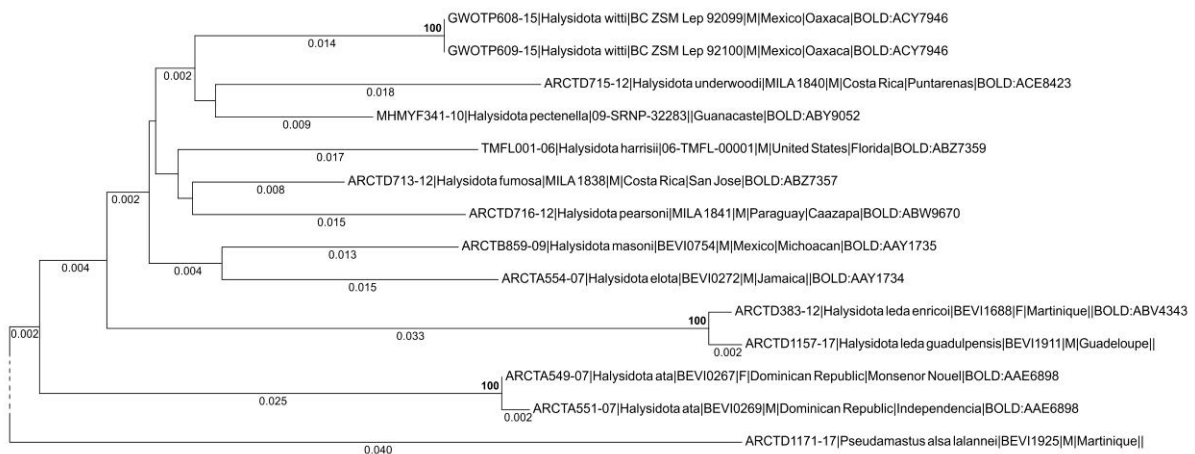


Figure 3. Neighbor-Joining Tree for the 14 specimens of *Halysidota* species group and *Pseudamastus alsa lalannei*. Distances in % are given below each branch and bootstrap supports are given above each branch (in bold case) (obtained with MEGA6, see Tamura *et al.* 2013).

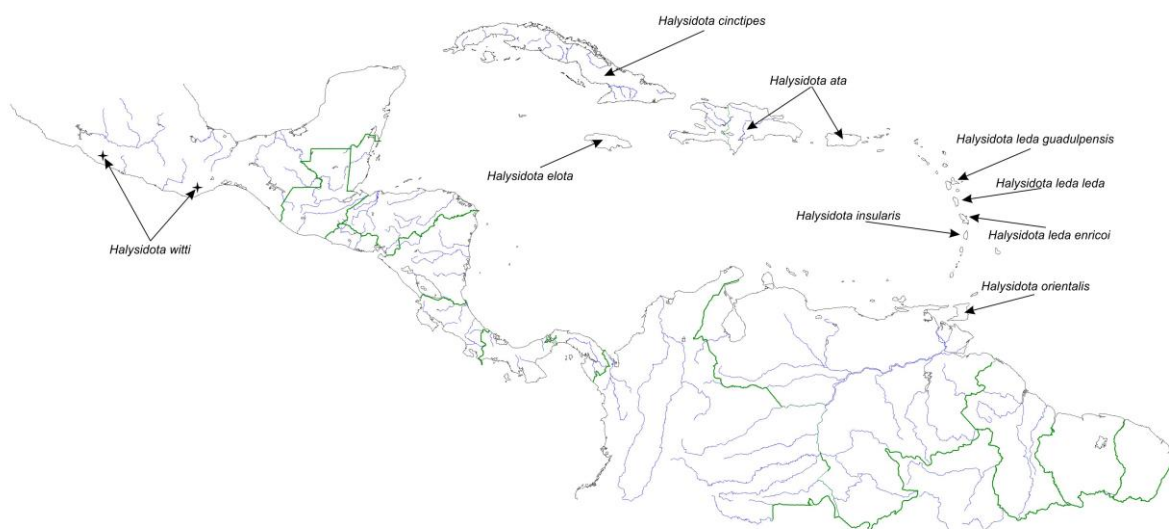


Figure 4. Distribution of examined specimens of the *Halysidota* group.

Notes on *Halysidota leda leda* (Druce, 1890)

Specimens of *Halysidota leda leda* from Guadeloupe and *H. leda enricoi* from Martinique, despite very divergent habitus, display very similar COI gene with a difference of only 0.2 %. This difference is the consequence of a single mutation which is in fact a silent mutation,

CAC or CAU, both genes coding for the same histidine. Unfortunately, recently collected material of *H. leda leda* was not available for sequencing. Nevertheless their genitalia display enough differences to be considered at least as subspecies which moreover exhibit genitalia clearly different from those of a specimen coming from Dominica and dissected by Alan Watson (slide n° 2475 housed in BMNH). Namely the two apical processes are more pointed, the lobes of tegumen are less developed and not protruding. The vincular lobes are less arcuate and narrower, especially when compared to *H. leda enricoi*. So we described below the Guadeloupe entity as a new subspecies *Halysidota leda guadulpensis* **ssp. nov.**

Description of *Halysidota leda guadulpensis* ssp. nov. (Fig. 1D)

[urn:lsid:zoobank.org:act:664552A5-A7C8-4D21-8195-3D4D2379B139](https://zoobank.org/act:664552A5-A7C8-4D21-8195-3D4D2379B139)

Type material: Holotype: 1 ♂, GUADELOUPE, Bouillante, Crête de Village, 07-VIII-2013, 530 m, 16°06.96' N 61°44.43' W, J. Barbut *leg.* / Gen. ML2532 (white manuscript label) / deposited in MNHN. **Paratypes:** 2 ♀, same as holotype ; 1 ♂, Guadeloupe, Sainte-Rose, Piton de Sainte-Rose, 06-VIII-2013, 350m, 16°19'54" N 61°45'44" W, J. Barbut *leg.*, Gen. ML2808, BEVI 1911, 1 ♀, *idem* ; 2 ♀, Guadeloupe, Trois-Rivière, Monts Caraïbes, 04-VIII-2013, 170m, 15°58'05" N 61°40'39" W, J. Barbut *leg.* ; *all* in BV ; 2 ♀, Guadeloupe, Sainte-Rose, Piton de Sainte-Rose, 02-VIII-2013, 350m, 16°19'54" N 61°45'44" W, J. Barbut *leg.*, in ML.

Head. Antennae pectinate, scape and base buff yellow, pectinations and shaft dark brown. Clypeofrons and vertex hairy and buff yellow. Palpi dark grey with long ventral beige hairs on the two first segments

Thorax. Patagia hairy, beige. Tegulae hairy, brownish beige with a round black spot near base. Thorax hairy and beige. Legs beige below and yellow above, with black articulations and one black spot on the tibia.

Abdomen. Entirely dull orange covered at base with long concolorous hairs. Below hairy and entirely brownish beige.

Forewing. Length: 31 mm Dorsal surface: plain beige slightly translucent externally, the veins concolorous and the background color more intense on costa, base and anal border. The whole wing slightly irrorated with black scales forming a very indistinct pattern. Some indistinct and irregular patches on the costa.

Hindwing. Unmarked, translucent, very light buff yellow with yellow hairs on the anal border and veins brownish-yellow.

Ventral surface: identical to the upperside but pattern even more indistinct and colors dull and washed out.

Male genitalia. (Figs 2D–F). Apical costal process of valve extending beyond apical process of sacculus which is longer than in *H. leda enricoi*. Non setose mid-costal process of valve well sclerotized but short, pointing backward, basad and almost fused with setose process which is rounded. Lobes of tegumen developed, almost protruding. Vincular lobes very strongly arcuate, not enlarged distally, 2 times the smallest diameter. Aedeagus evenly bent at 120°. Vesica with three ventral and two dorsal lobes. The central part, the first ventral, the second dorsal and half the second ventral lobes very minutely spinose. Compared to the published male genitalia of *H. leda leda* (Watson, 1980 p. 61), the apical costal process of valvae is wider and less pointed than in *H. leda leda*, the vincular processes are strongly arcuate and wider, the mid-costa complex is different: the setose and non-setose processes appear almost fused whereas they are clearly separated in *H. leda leda*.

Female genitalia. Papillae anales rectangular. Apophyses anterior twice as short as the posterior apophyses. Ductus bursae rectangular, flat, sclerified. It is twisted at 45° at the level of its insertion with the corpus bursae. Corpus bursae large, circular, slightly wrinkled. Ductus seminalis formed by a small bulge opposite the insertion with the ductus bursae. Bulla seminalis slightly smaller than the corpus bursae.

Description of male genitalia of *Halysidota leda enricoi* for comparison

Apical costal process of valve almost bifid in dorsal view and extending beyond apical process of sacculus. Non setose mid-costal process of valve short, pointing backward, basad and almost fused with setose process which is rounded. Lobes of tegumen developed, almost protruding and more sclerotized than in *H. leda guadulpensis* ssp. nov. Vincular lobes strongly arcuate, very wide distally (the widest of the whole genus), 2 times the smallest diameter. Aedeagus evenly bent at 140°. Vesica with three ventral and two dorsal lobes. The central part, the first ventral, the second dorsal and half the second ventral lobes minutely spinose. From a general point of view male genitalia are larger and more robust than those of *H. leda guadulpensis* ssp. nov.

Acknowledgements

We would like to acknowledge Paul Hebert (CCDB, Guelph, Canada) for access to the BOLD project and providing very efficient, competent and quick DNA barcoding; Rodolphe Rougerie (MNHN) for his help and his technical and scientific support in editing and compiling the hundreds of various sequences involved in the ARCT project; Tomas Witt who allowed us to study and borrow some Arctiini specimens from his collection and Axel Hausmann for his reception at ZSM and obtaining the COI sequences of the material-types; Jérôme Barbut, Bernard Lalanne-Cassou, Anne-Marie Toussaint and Gérard Chauvet for providing us the specimens originating from the Lesser Antilles; Jean Haxaire for providing us with one of the paratypes and the comparison specimens originating from Jamaica.

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Received: 23.08.2017 **Accepted:** 29.11.2017 **Published:** 06.12.2017

Cite paper: Vincent B. & Laguerre M. 2017. Descriptions of a new species and subspecies of *Halysidota* Hübner, [1819] from Mexico (Lepidoptera: Erebidae: Arctiinae). *Journal of Insect Biodiversity* 5(20): 1–10.

<http://dx.doi.org/10.12976/jib/2017.5.20>

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