European Journal of Taxonomy 845: 1–29
https://doi.org/10.5852/ejt.2022.845.1951
ISSN 2118-9773
www.europeanjournaloftaxonomy.eu
2022 · Pérez-Flores Ó. & Toledo-Hernández V.H.

Research article
urn:lsid:zoobank.org:pub:27631402-ECCF-4C70-A199-D995167F6196

Species delimitation in the genus *Ochraethes* Chevrolat, 1860 (Coleoptera: Cerambycidae), with description of two new species

Óscar PÉREZ-FLORES [1,*] & Víctor H. TOLEDO-HERNÁNDEZ [2]

[1] Laboratorio Nacional de Análisis y Síntesis Ecológica, Escuela Nacional de Estudios Superiores, Universidad Nacional Autónoma de México (UNAM), Morelia, Mexico.
[1] Colección Nacional de Insectos, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM). Av. Universidad 3000, 04510 Mexico City, Mexico.
[2] Centro de Investigación en Biodiversidad y Conservación, Universidad Autónoma del Estado de Morelos (UAEM), Av. Universidad 1001, Col. Chamilpa, 62209 Cuernavaca, Mexico.

[*] Corresponding author: oscar_skopt@ciencias.unam.mx
[2] Email: victor.toledo@uaem.mx

[1] urn:lsid:zoobank.org:author:804AA7A8-B0F4-4CF3-8C28-53ABDC9D364B
[2] urn:lsid:zoobank.org:author:DD52F154-A504-459F-A3A1-3ADFC0662207

Abstract. Based on morphological and molecular data we investigated the species boundaries in the genus *Ochraethes* Chevrolat, 1860. The species delimitation with cytochrome *c* oxidase subunit 1 (COI) data supports some synonymies and highlights the existence of a high phenotypic plasticity in some species. The following species are considered as new junior synonyms: *O. virescens* (Chevrolat, 1860) syn. nov. of *O. brevicornis* (Chevrolat, 1860), *O. octomaculata* Chemsak & Noguera 2001 syn. nov. of *Ochraethes cinereolus* (Bates, 1892) comb. nov., *O. zebratus* Bates, 1885 syn. nov. of *O. obliquus* (Chevrolat, 1860), *Trichoxys giesberti* Botero, Santos-Silva & Wappes, 2019 syn. nov. of *O. sommeri* (Chevrolat, 1835), *O. clerinus* (Bates, 1892) of *O. viridiventris* (Chevrolat, 1860), *O. cristoforii* (Chevrolat, 1860) syn. nov. and *O. litura* Bates, 1885 syn. nov. of *O. z-littera* (Chevrolat, 1860). Two new species are described from Mexico: *Ochraethes confusus* sp. nov., and *Ochraethes nigroapicalis* sp. nov.

Keywords. Cerambycid, Clytini, morphology, phenotypic plasticity, COI.

Pérez-Flores Óscar & Toledo-Hernández V.H. 2022. Species delimitation in the genus *Ochraethes* Chevrolat, 1860 (Coleoptera: Cerambycidae), with description of two new species. *European Journal of Taxonomy* 845: 1–29. https://doi.org/10.5852/ejt.2022.845.1951

Introduction

The genus *Ochraethes* was described by Chevrolat (1860) as a "division" of *Clytus* Laicharting, 1784. Thomson (1861) treated *Ochraethes* as a genus and designated *O. circuliferus* (Chevrolat, 1860) as its type species. Currently, it includes 24 described species (Bezark 2021; Tavakilian & Chevillotte 2021), and is one of the biggest and least studied genera within Clytini Mulsant, 1839. The temporality of these insects is governed by the flowering period of the adult feeding plants, that usually belong to the family Asteraceae Bercht. & J. Presl (Hopping 1932, 1937; Linsley 1959). The general pattern of pubescence in several Clytini species resembles the coloration of their feeding flowers.

Ochraethes is distinguished from other genera of Clytini by the short antennae, the elytra with transverse undulant bands, and the mesosternum with an intercoxal process abruptly, subvertically declivous (Linsley 1964; Chemsak & Linsley 1965; Turnbow & Thomas 2002). Species of *Ochraethes* are morphologically similar to those of *Tanyochraethes* Chemsak & Linsley, 1965 and *Trichoxys* Chevrolat, 1860. For example, the shape of the frons and vertex in several species of *Trichoxys* is nearly congruent with *Ochraethes*. Also, the intercoxal process of mesosternum, sutural depression or the pubescent pattern on elytra in these three genera are quite related.

Biogeographically, most of the species of *Ochraethes* are distributed in Mexico, with some species restricted to the United States and Guatemala. *Ochraethes pollinosus* (Chevrolat, 1835) has the widest distribution range, occurring from the southern United States of America to western Panama (no records from Belize or El Salvador) (Bezark 2021; Monné 2021; Tavakilian & Chevillotte 2021).

The taxonomy of the genus *Ochraethes* has been poorly studied and its phylogenetic relationships are unknown. Also, morphological similarity of some species of *Ochraethes* with other genera has hindered the establishment of the boundaries of this genus. In this work we investigate the taxonomic limits of species of *Ochraethes* using morphological and molecular-based methods to describe two new species and propose some synonymies in this genus.

Material and methods

Institutional abbreviations

The following entomological collections are used herein:

ACMT = American Coleoptera Museum, Texas, USA. Currently at FSCA
BMNH = Natural History Museum, (formerly British Museum, Natural History), London, England
CIUM = Colección de Insectos de la Universidad de Morelos, UAEM, Mexico
CNIN = Colección Nacional de Insectos, IBUNAM, Mexico
COLPOS = Colección de Insectos, Colegio de Postgraduados, Mexico
EBCC = Estación de Biología Chamela, IBUNAM, Mexico
EMEC = Essig Museum of Entomology, University of California, Berkeley, California, USA
FMNH = Field Museum of Natural History, Chicago, USA
FSCA = Florida State Collection of Arthropods, Florida, USA
FWSC = Fred W. Skillman Collection, Arizona, USA
IEXA = Colección Entomológica, Instituto de Ecología, Xalapa, Mexico
LACM = Natural History Museum of Los Angeles County, California, USA
MNHN = Muséum national d'histoire naturelle, Paris, France
MZFC = Museo de Zoología "Alfonso L. Herrera", Facultad de Ciencias, UNAM, Mexico
UAEH = Colección de Insectos, Universidad de Hidalgo, Mexico
UCDC = Bohart Museum of Entomology, University of California, California, USA
USAC = Colección de Insectos, Universidad de San Carlos, Guatemala
UVGC = Colección de Insectos, Universidad del Valle de Guatemala, Guatemala

Taxonomic treatment

Several years ago, the prominent cerambycid specialist E.F. Giesbert recognized two new species of the genus *Ochraethes* but passed away prior to completion of the manuscript. The new species described in this work are based on the type material from the Giesbert collection (currently, FSCA collection) and specimens found in the EMEC. Paratypes were labelled following the requirements of the institutions. All label data is given verbatim.

The morphological characters of *Ochraethes* used in this study are based on type specimens (additional specimens were compared), and original descriptions (Table 1); specimens of *Trichoxys* were identified with the key of Lingafelter & Wappes (2012). Morphological terminology follows Linsley (1961, 1964), Chemsak & Linsley (1965), Lawrence *et al.* (2010), Lingafelter & Wappes (2012), Svacha & Lawrence (2014) and Wappes *et al.* (2018). We use the phylogenetic species concept of Wheeler & Platnick (2000): "A species is the smallest aggregation of (sexual) populations or (asexual) lineages diagnosable by a unique combination of character states". Photographs were taken in the Laboratory of Microscopy and Photography of Biodiversity, Biology Institute, UNAM, with ZEN program (Zeiss Efficient Navigation) of the microphotographic equipment Zeiss® AxioZoom V16 (microscope) and Zeiss® AxioCam MRc5.5 megapixels (camera).

Taxon sampling and laboratory procedures

A total of 20 species of *Ochraethes* were included in the DNA species delimitation analyses. Additionally, we included some specimens of *Tanyochraethes* (two species) and *Trichoxys* (four species). Specimens were collected by us between 2014 and 2020, some of them were obtained from different collections (UAEH, CIUM, UVGC, IEXA, ACMT, FSCA, MZFC).

Genomic DNA was isolated using the DNeasy® Blood and Tissue kit (QIAGEN® Inc., Valencia, CA, USA) following the protocol for tissue. The tissue used was obtained from the thorax muscle. The mitochondrial gene cytochrome c oxidase subunit I (COI) was amplified in 15 µL of total PCR volume: 10.40 µl of H_2O, 3.0 µl of 5× PCR buffer, 0.24 µl of each primer (LCO and HCO) (Folmer *et al.* 1994), 0.12 µl of Taq polymerase and 1 µl of DNA. The PCR conditions were: 3 min denaturation at 94°C, followed by 30 cycles of denaturation at 94°C for 40 sec, annealing at 50°C for 40 sec and extension at 72°C for 1 min, with a final extra extension step at 72°C for 7 min. DNA extraction and amplification were performed at the Laboratorio Nacional de Biodiversidad (LANABIO), Institute de Biología, Universidad Nacional Autónoma de Mexico (UNAM). The PCR products were purified and sequenced at the Laboratory of Genomic Sequencing for Biodiversity and Health, IBUNAM (UNAM). Sequencing was performed on an ABI 3730xl DNA Analyzer (Applied Biosystems/Hitachi, Foster City, CA, USA). All sequences were aligned in MAFFT ver. 7.130b (Katoh & Standley 2013) and checked and edited manually with GENEIOUS prime (Biomatters Inc., Auckland, New Zealand). The specimen information and Genbank accession numbers are given in Table 2.

Species delimitation analyses

Species delimitation analyses were carried out under the Automatic Barcode Gap Discovery (ABGD) (Puillandre *et al.* 2012), the bayesian Poisson Tree Process (bPTP) (Zhang *et al.* 2013; Kapli *et al.* 2017), and General Mixed Yule-Coalescence model (GMYC) (Pons *et al.* 2006; Fontaneto *et al.* 2007).

ABGD. This analysis was conducted in the ABGD online version using both uncorrected and Kimura two-Parameter (K2P) (Kimura 1981) distance matrices with default options: Pmin = 0.001, Pmax = 0.1, Steps = 10, Relative gap width (X) = 1, Nb bins = 20.

bPTP. The input tree file for this analysis was obtained in IQ-TREE ver. 1.5.5 (Nguyen *et al.* 2015), we used ModelFinder (-m MF) to select the best substitution model by codon position under the Akaike Information Criterion (AIC). To assess branch support, we performed 1000 replicates of the ultrafast bootstrap approximation (UFB) (Minh *et al.* 2013; Hoang *et al.* 2018), 1000 replicates of the branchbased, Shimodaira-Hasegawa approximate likelihood ratio test (Guindon *et al.* 2010). The IQ-

Table 1 (continued on next page). Morphological characters used to identify the species of *Ochraethes* Chevrolat, 1860.

Species \ Character	Frons (times wider than long)	Upper interocular space (times the width of upper lobe)	Anteclypeus (times as wide as long)	Labrum (sides)	Scape (length of antenommere III)	Pronotum (times as wide as long)	Prosternal process	Mesoventral process (width of mesocoxal cavities)
O. brevicornis	3.3××	4.7×	5.3×	rounded	1.6×	1.2×	narrow, apex slightly widened	0.6×
O. virescens	3.2×	4.5×	5.4×	rounded	1.5×	1.2×	narrow, apex slightly widened	0.6×
O. dimidiaticornis	2.3×	4.0×	3.3×	rounded	1.4×	1.2×	very narrow, apex abruptly widened	0.7×
O. confusus sp. nov.	2.2×	4.5×	3.5×	straight	1.2×	1.2×	narrow, apex slightly widened	0.7×
O. nigrescens	2.1×	3.8×	4.2×	oblique	1.3×	1.3×	narrow, apex slightly widened	0.5×
O. nigropunctatus	2.0×	4.5×	3.4×	rounded	1.8×	1.1×	very narrow, apex abruptly widened	0.5×
O. nigroapicalis sp. nov.	2.3×	5.0×	4.5×	straight	1.2×	1.5×	narrow, apex slightly widened	0.6×
T. cinereolus	2.2×	4.0×	4.2×	rounded	1.3×	1.2×	narrow, apex not widened	0.6×
O. octomaculata	2.2×	4.0×	4.1×	rounded	1.3×	1.1×	narrow, apex not widened	0.6×
O. obliquus	1.8×	4.0×	4.4×	straight	1.4×	1.2×	narrow, apex lobulated	0.7×
O. zebratus	1.8×	4.0×	4.5×	straight	1.5×	1.2×	narrow, apex lobulated	0.7×
O. pollinosus	2.1×	5.5×	4.2×	rounded	1.2×	1.2×	narrow, apex widened	0.5×
O. sommeri	2.0×	4.0×	4.2×	rounded	1.3×	1.2×	narrow, apex widened	0.6×
T. giesberti	2.0×	4.1×	4.1×	rounded	1.4×	1.2×	narrow, apex widened	0.7×
O. tomentosus	2.5×	4.3×	5.2×	straight	1.4×	1.2×	narrow, apex lobulated	0.5×
O. tulensis	2.6×	4.2×	4.0×	rounded	1.3×	1.3×	narrow, apex widened	0.5×
O. umbratilis	2.3×	4.5×	3.8×	straight	1.5×	1.2×	narrow, apex lobulated	0.7×
O. viridiventris	2.9×	4.0×	5.5×	straight	1.5×	1.3×	very narrow, apex not widened	0.4×
O. clerinus	3.0×	4.2×	5.3×	straight	1.6×	1.3×	very narrow, apex not widened	0.5×
O. nigritus	2.9×	3.9×	5.5×	straight	1.5×	1.3×	very narrow, apex not widened	0.4×
O. z-littera	2.1×	5.0×	4.5×	straight	1.4×	1.2×	very narrow, apex widened	0.5×
O. cristoforii	2.1×	4.9×	4.4×	straight	1.4×	1.2×	very narrow, apex widened	0.5×
O. litura	2.2×	5.0×	4.5×	straight	1.5×	1.3×	very narrow, apex widened	0.6×

Table 1 (continued). Morphological characters used to identify the species of *Ochraethes* Chrevrolat, 1860.

Character / Species	Number of transverse black pubescent bands in elytra	Parasutural region	Elytral apex	Apex of abdominal intercoxal process	Total length	Sex
O. brevicornis	1, yellowish about middle	slightly depressed	obliquely truncate, with apicolateral projection reduced	rounded	11mm	Female
O. virescens	1, yellowish about middle	slightly depressed	obliquely truncate, with apicolateral projection reduced	rounded, narrow	10mm	Male
O. dimidiaticornis	5, extremely widened	slightly depressed	obliquely truncate, without apicolateral projection	acute	12mm	Male
O. confusus sp. nov.	5	depressed	obliquely truncate, with apicolateral projection reduced	acute	15mm	Macho
O. nigrescens	2, on posterior half	slightly depressed	truncate, without apicolateral projection	acute	13mm	Female
O. nigropunctatus	3	depressed	truncate, with apicolateral projection reduced	acute	14mm	Female?
O. nigroapicalis sp. nov.	0, only in females	depressed	obliquely truncate, with apicolateral projection reduced	acute	13mm	Male
T. cinereolus	0, four maculae	slightly depressed	truncate, with apicolateral projection reduced	acute	12mm	Female
O. octomaculata	0, four maculae	slightly depressed	truncate, with apicolateral projection reduced	acute	12mm	Male
O. obliquus	6	very depressed	obliquely truncate, with apicolateral projection reduced	rounded	12mm	Male
O. zebratus	6	very depressed	obliquely truncate, with apicolateral projection reduced	rounded	14mm	Female
O. pollinosus	6	very depressed	obliquely emarginate, with apicolateral projection reduced	rounded, narrow	12mm	Male
O. sommeri	4	very depressed	obliquely truncate, with apicolateral projection reduced	acute	12mm	Male
T. giesberti	0	very depressed	obliquely truncate, with apicolateral projection reduced	acute, wide	15mm	Female
O. tomentosus	2, on posterior half	depressed	rounded, with apicolateral projection	acute	9mm	Female
O. tulensis	5	depressed	obliquely truncate, without apicolateral projection	acute	13mm	Male
O. umbratilis	5	very depressed	obliquely truncate, with apicolateral projection reduced	rounded	16mm	Female
O. viridiventris	4	slightly depressed	obliquely truncate, without apicolateral projection	acute	9mm	Male
O. clerinus	4	slightly depressed	obliquely truncate, without apicolateral projection	acute, wide	10mm	Hembra
O. nigritus	4	slightly depressed	obliquely truncate, without apicolateral projection	acute	11mm	Male
O. z-littera	4	very depressed	obliquely emarginate, with internal and apicolateral projection	rounded, narrow	13mm	Male
O. cristoforii	4	very depressed	obliquely emarginate, with internal and apicolateral projection	rounded, narrow	11mm	Male
O. litura	4	very depressed	obliquely emarginate, with internal and apicolateral projection	rounded, narrow	12mm	Female

Table 2 (continued on next two pages). List of specimens, their localities, DNA voucher and GenBank accession numbers for the species delimitation analyses.

CNIN voucher	Species	GenBank number	Locality
2824	*Ochraethes viridiventris*	MT516481	Mexico: San Luis Potosí, Río Verde
2825	*Ochraethes viridiventris*	MT516482	Mexico: San Luis Potosí, Río Verde
2826	*Ochraethes viridiventris*	MT516483	Mexico: San Luis Potosí, Río Verde
2827	*Ochraethes clerinus*	MT516484	Mexico: San Luis Potosí, Río Verde
2829	*Ochraethes sommeri*	MT516485	Mexico: Hidalgo, 10 km NE of Atotonilco
2830	*Ochraethes sommeri*	MT516486	Mexico: Hidalgo, 10 km NE of Atotonilco
2832	*Ochraethes sommeri*	MT516487	Mexico: Hidalgo, 10 km NE of Atotonilco
2834	*Ochraethes zebratus*	MT516488	Mexico: Chiapas, Motozintla
2835	*Ochraethes obliquus*	MT516489	Mexico: Hidalgo, Mineral del Chico, road to Mineral del Chico
2836	*Ochraethes sommeri*	MT516490	Mexico: Morelos, Huaxtla
2837	*Ochraethes pollinosus*	MT516491	Guatemala: Quetzaltenango, Salcajá
2838	*Ochraethes pollinosus*	MT516492	Guatemala: Quetzaltenango, Salcajá
2839	*Ochraethes pollinosus*	MT516493	Guatemala: Quetzaltenango, Salcajá
2840	*Ochraethes pollinosus*	MT516494	Guatemala: Quetzaltenango, Salcajá
2841	*Ochraethes pollinosus*	MT516495	Guatemala: Quetzaltenango, Salcajá
2842	*Trichoxys abbreviatus*	MT516496	Guatemala: Quetzaltenango, Salcajá
2843	*Ochraethes cristoforii*	MT516497	Mexico: Estado de México, Temascaltepec
2847	*Ochraethes z-littera*	MT516498	Mexico: Estado de México, Sierra de Guadalupe
2848	*Ochraethes litura*	MT516499	Mexico: Chiapas, Motozintla
2849	*Ochraethes litura*	MT516500	Guatemala: Quetzaltenango, Salcajá
2874	*Ochraethes zebratus*	MT516501	Mexico: Chiapas, Lagunas de Montebello
2875	*Ochraethes obliquus*	MT516502	Mexico: Veracruz, Banderilla, Reserva Ecológica "La Martinica"
2876	*Ochraethes obliquus*	MT516503	Mexico: Veracruz, Banderilla, Reserva Ecológica "La Martinica"
2877	*Trichoxys sulphurifer*	MT516504	Mexico: Ciudad de México, Coyoacán, Ciudad Universitaria, REPSA
2878	*Trichoxys sulphurifer*	MT516505	Mexico: Ciudad de México, Coyoacán, Ciudad Universitaria, REPSA
2880	*Trichoxys sulphurifer*	MT516506	Mexico: Ciudad de México, Coyoacán, Ciudad Universitaria, REPSA
2881	*Ochraethes sommeri*	MT516507	Mexico: Michoacán, Puruándiro
2882	*Ochraethes sommeri*	MT516508	Mexico: San Luis Potosí, Tierra Quemada
2884	*Ochraethes nigropunctatus*	MT516509	Mexico: Guerrero, 5 km SE of Pilcaya.
2886	*Tanyochraethes* sp.	MT516510	Mexico: Guerrero, Tlapa Km 20.
2887	*Tanyochraethes* sp.	MT516511	Mexico: Hidalgo, Km 30 road Tasquillo–Huichapan.
2888	*Ochraethes nigropunctatus*	MT516512	Mexico: Estado de México, San Diego Alcalá
2889	*Ochraethes nigritus*	MT516513	Mexico: San Luis Potosí, Guadalcazar
2890	*Ochraethes nigritus*	MT516514	Mexico: San Luis Potosí, Guadalcazar

Table 2 (continued). List of specimens, their localities, DNA voucher and GenBank accession numbers for the species delimitation analyses.

CNIN voucher	Species	GenBank number	Locality
2897	*Ochraethes sommeri*	MT516515	Mexico: Guerrero, Km 36 road Arcelia–Teloloapan
2900	*Tanyochraethes* sp.	MT516516	Mexico: Guerrero, Chilpancingo, "El Ocotito"
3151	*Ochraethes sommeri*	MT516517	Mexico: Puebla, San Juan Raboso
3153	*Ochraethes sommeri*	MT516518	Mexico: Puebla, 7 km S of Molcaxac
3155	*Ochraethes sommeri*	MT516519	Mexico: Puebla, 7 km S of Molcaxac
3156	*Ochraethes sommeri*	MT516520	Mexico: Puebla, 7 km S of Molcaxac
3157	*Tanyochraethes cinereolus*	MT516521	Mexico: Puebla, 6 km N of Tepexi de Rodríguez
3158	*Tanyochraethes cinereolus*	MT516522	Mexico: Puebla, 6 Km N of Tepexi de Rodríguez
3159	*Ochraethes sommeri*	MT516523	Mexico: Querétaro, 13 km N of Cadereyta
3160	*Trichoxys giesberti*	MT516524	Mexico: Sinaloa, Concordia, El Palmito
3164	*Ochraethes brevicornis*	MT516525	Mexico: Estado de México, Coatepec Harinas
3165	*Ochraethes brevicornis*	MT516526	Mexico: Estado de México, Coatepec Harinas
3166	*Ochraethes brevicornis*	MT516527	Mexico: Estado de México, Coatepec Harinas
3167	*Ochraethes brevicornis*	MT516528	Mexico: Estado de México, Coatepec Harinas
3168	*Ochraethes brevicornis*	MT516529	Mexico: Estado de México, Coatepec Harinas
3170	*Ochraethes tomentosus*	MT516530	Mexico: Morelos, Yautepec
3171	*Ochraethes tomentosus*	MT516531	Mexico: Morelos, Yautepec
3172	*Ochraethes tomentosus*	MT516532	Mexico: Morelos, Yautepec
3173	*Ochraethes tomentosus*	MT516533	Mexico: Morelos, Yautepec
3174	*Ochraethes z-littera*	MT516534	Mexico: Guerrero, Chilpancingo de Bravo, Omiltemi
3253	*Ochraethes clerinus*	MT516535	Mexico: San Luis Potosí, Río Verde
3155	*Ochraethes viridiventris*	MT516536	Mexico: San Luis Potosí, Río Verde
3258	*Ochraethes tulensis*	MT516537	Mexico: Hidalgo, Tula de Allende, road Tula–Tepeji del Río
3259	*Ochraethes tulensis*	MT516538	Mexico: Hidalgo, Tula de Allende, road Tula–Tepeji del Río
3260	*Ochraethes tulensis*	MT516539	Mexico: Hidalgo, Tula de Allende, road Tula–Tepeji del Río
3261	*Ochraethes virescens*	MT516540	Mexico: Morelos, Tepoztlán
3362	*Ochraethes virescens*	MT516541	Mexico: Morelos, Tepoztlán
3263	*Ochraethes virescens*	MT516542	Mexico: Puebla, Tetela del Volcán
3264	*Ochraethes confusus*	MT516543	Mexico: Oaxaca, Huajuapan de León, Huejonapa
3365	*Ochraethes confusus*	MT516544	Mexico: Oaxaca, Huajuapan de León, Huejonapa
3367	*Ochraethes confusus*	MT516545	Mexico: Oaxaca, Huajuapan de León, Huejonapa
3368	*Ochraethes confusus*	MT516546	Mexico: Oaxaca, Huajuapan de León, Huejonapa
3371	*Ochraethes umbratilis*	MT516547	Guatemala: Quetzaltenango, Cantón Chicuá, Camino a Cerro Quemado
3372	*Ochraethes umbratilis*	MT516548	Guatemala: Quetzaltenango, Cantón Chicuá, Camino a Cerro Quemado

Table 2 (continued). List of specimens, their localities, DNA voucher and GenBank accession numbers for the species delimitation analyses.

CNIN voucher	Species	GenBank number	Locality
3373	*Ochraethes octomaculata*	MT516549	Mexico: Oaxaca, Huajuapan de León, Huejonapa
3375	*Ochraethes octomaculata*	MT516550	Mexico: Oaxaca, Huajuapan de León, Huejonapa
3376	*Ochraethes nigrescens*	MT516551	Mexico: Ciudad de México, Santa Catarina
3377	*Ochraethes nigrescens*	MT516552	Mexico: Ciudad de México, Santa Catarina
3378	*Ochraethes tomentosus*	MT516553	Mexico: Morelos, road [camino in Spanish] Zacualpan de Amilpas–Tetela del Volcán
3379	*Ochraethes tomentosus*	MT516554	Mexico: Morelos, road Zacualpan de Amilpas–Tetela del Volcán
3380	*Ochraethes tomentosus*	MT516555	Mexico: Morelos, road Zacualpan de Amilpas–Tetela del Volcán
3381	*Tanyochraethes* sp.	MT516556	Mexico: Puebla, Tetela del Volcán
3383	*Trichoxys abbreviatus*	MT516557	Guatemala: Chimaltenango, Tecpán, Cerca de ruina Iximché
3406	*Ochraethes dimidiaticornis*	MT516558	Mexico: Ciudad de México, Predregal de San Ángel
3407	*Ochraethes dimidiaticornis*	MT516559	Mexico: Ciudad de México, Predregal de San Ángel
3408	*Ochraethes nigroapicalis*	OM264186	Mexico: Nayarit, San Juan
3409	*Ochraethes nigroapicalis*	OM264187	Mexico: Nayarit, San Juan
3410	*Ochraethes nigroapicalis*	OM264188	Mexico: Nayarit, San Juan
C023	*Tanyochraethes* sp.	MT516565	Mexico: Coahuila, Cuatro Ciénegas
C028	*Trichoxys apelles*	MT516566	Mexico: Hidalgo, Huasca de Ocampo

TREE tree was used in the web server (https://species.h-its.org/ptp/) with default options: rooted tree, MCMC generations = 100 000, Thinning = 100, Burn-in = 0.1, Seed = 123.

GMYC. The ultrametric tree needed for this analysis was obtained in BEAST ver. 2.6.2 (Bouckaert *et al.* 2014). We specified as a speciation tree prior a Coalescence process, with a relaxed molecular clock and GTR+I+Γ model. The analysis ran for 100 million generations, sampling a single tree every 10000 and discarding the first 2500 trees as burnin. The convergence of Markov Chain Monte Carlo (MCMC) and Effective Sample Size (ESS) were evaluated in Tracer ver. 1.7.1 (Rambaut *et al*. 2018). The maximum clade credibility tree (MCC) was generated in TreeAnnotator ver. 1.8.4 (Drummond *et al.* 2012). Subsequently, the ultrametric tree was used to delimit species with the SPLITS package implemented in R (“splits”, “repos=” http://R-Forge.R-project.org), under a single threshold optimization.

The trees of all DNA analyses were visualized in Figtree ver. 1.4.4 (Rambaut *et al.* 2018) (http://tree.bio.ed.ac.uk/software/figtree/).

Results

Taxonomy

Class Insecta Linnaeus, 1758
Order Coleoptera Linnaeus, 1758
Suborder Polyphaga Emery, 1886
Superfamily Chrysomeloidea Latreille, 1802
Family Cerambycidae Latreille, 1802
Subfamily Cerambycinae Latreille, 1802
Tribe Clytini Mulsant, 1839

Genus ***Ochraethes*** Chevrolat, 1860

Clytus (*Ochraethes*) Chevrolat, 1860: 454.
Clytopsis Casey, 1912: 350, 373. Type species. *Clytopsis nimbata* Casey, 1912 (= *Clytus dimidiaticornis* Chevrolat, 1860). Original designation.

Ochraesthes – Thomson 1861: 219; 1864: 185; 1865: 424 (error).
Ochrestes – Lacordaire 1869: 65 (error).
Ochresthes – Bates 1880: 50 (error).
Ochraethes – Casey 1912: 348. — Linsley 1935: 86 (list.); 1964: 100. — Hopping 1937: 453. — Arnett 1962: 868. — Monné 1993: 17 (cat.); 2005: 106 (cat.); 2012: 14 (cat.); 2021: 144 (cat.). — Bezark 2021: 73 (checklist). — Heffern *et al.* 2020: 178 (syn.).
Clytopsis – Monné 1993: 24 (cat.); 2005: 77 (cat.); 2012: 13 (cat.). — Heffern *et al.* 2020: 178 (syn.).

Type species

Clytus (*Ochroesthes*) *circuliferus* Chevrolat, 1860 (= *Clytus sommeri* Chevrolat, 1835). Subsequent designation, Thomson 1861: 219).

Diagnosis

Ochraethes is characterized as follows: frons transverse; vertex wider than long; genae short or elongate, broad; upper interocular space slightly wider than lower interocular space; vertex transversely rectangular; subsutural costa (subparallel to suture) beginning from anterior third; elytral apex rounded, truncate or emarginate; prosternal process narrow or broad, arcuate, often with rounded lobes apically; mesoventrite with anterior portion from elevate to strongly elevate; and mesoventral process abruptly depressed. This genus exhibits pubescence patterns on the elytra that are useful for species identification. However, in most species the general coloration of the pubescence on body has a wide range from bright to dark (including the pubescence patterns on the elytra).

Ochraethes confusus sp. nov.
urn:lsid:zoobank.org:act:A9F5815E-5B2E-4092-9482-4B4F69E27A63
Fig. 1

Etymology

The specific name is an adjective derived from Latin '*confusus*' ('confused'); refers to the irregular pattern of black pubescence on the elytra, which is similar to that of other species of the genus.

Material examined

Holotype
MEXICO • ♂; Puebla, 1 km SW of Acatepec; 14 Oct. 1978; E. Giesbert leg.; EMEC.

Paratypes (34)
MEXICO • 2 ♂♂, 2 ♀ ♀; Muséum de Paris 1916 de Tonanzin, Biant 1864; MNHN. – **Chiapas** • 3 ♂♂, 2 ♀♀; 16 km W of Ocozocoautla "El Aguacero"; 30 Sep. 1994; V.H. Toledo leg.; CIUM • 1 ♀; same collection data as for preceding; 16–23 Oct. 1988; E. Giesbert leg.; JEWC. – **Oaxaca** • 2 ♂♂; 4 km S of Miltepec; 13 Oct. 1978; E. Giesbert leg.; FSCA • 2 ♂♂, 2 ♀♀; 15 km NE of Huajuapan de León; 2 Nov. 1991; alt. 1570 m; Felipe A. Noguera and A. Rodríguez leg.; EBCC • 2 ♂♂; Km 26 "carr. fed." [federal road] Huajuapan de León–Oaxaca; 17°42′45.7″ N, 97°39′07.3″ W; alt. 2112 m; 5 Oct. 2009; J. Romero Nápoles leg.; COLPOS • 1 ♂, 1 ♀; Huajuapan de León, Huejonapa; 17°49′58.96″ N, 97°47′19.35″ W; 6 Nov. 2016; O. Pérez Flores leg.; BMNH • 2 ♂♂, 1 ♀; same collection data as for preceding; CNIN • 2 ♂♂, 2 ♀♀; MX125, 38 km NE of Huajuapan de León; 18 Oct. 2001; F. Skillman and J. Davidson; FWSC. – **Puebla** • 1 ♀; same collection data as for holotype; EMEC • 1 ♀; 10 km NE of Chapulco; 15 Oct. 1978; E. Giesbert leg.; FWSC • 1 ♀; Caltepec, 3 km W of Acatepec; 18°13′14.4″ N, 97°36′23.2″ W; alt. 2022 m; 27 Oct. 2014; L. Cervantes and J. Báez leg.; "matorral espinoso"; IEXA • 2 ♂♂, 2 ♀♀; Tehuacan; 19 Oct. 1941; DeLong, Good Culdwell and Plummer leg.; FMNH.

Additional material
MEXICO – **Chiapas** • 1 ♀; 16 km W of Ocozocoautla, "El Aguacero"; 30 Sep. 1994; V.H. Toledo leg.; CIUM • 1 ♀; same collection data as for preceding; 11 Oct. 1994; CIUM • 1 ♂, 1 ♀; same collection data as for preceding; 20 Oct. 1994; CIUM • 1 ♂, 1 ♀; same collection data as for preceding; EBCC • 5 ♂♂; same collection data as for preceding; 2 Nov. 1994; CIUM • 1 ♂; same collection data as for preceding; EBCC • 6 ♂♂; same collection data as for preceding; 4 Nov. 1994; CIUM • 1 ♂, 2 ♀♀; same collection data as for preceding; EBCC • 1 ♂; same collection data as for preceding; 5 Nov. 1994; CIUM • 1 ♀; "El Aguacero", 16 km W of Ocozocoautla; 16–23 Oct. 1988; E. Giesbert leg.; FSCA • 1 ♂, 2 ♀♀; Teotitlán del Valle; 19 Oct. 1978; E. Barrera leg.; CNIN • 1 ♂; Tuxtla Gutiérrez, Cañón del Sumidero, Mirador El Tepehuaje; 16°49′39.5″ N, 93°05′26.3″ W; alt. 1257 m; 28 Oct. 2008; M.M. Álvarez and T. Red leg.; "selva baja caducifolia"; CIUM. – **Oaxaca** • 1 ♀; 22 Sep. 1923; E.G. Smyth leg.; JEWC • 1 ♂; 3 km SSE of Llano Verde, Km 124 "carr." [road] Oax–Huajuapan; 17°16′49″ N, 97°04′26″ W; alt. 2280 m; 8 Oct. 2003; J. Romero Nápoles leg.; COLPOS • 1 ♂; 3 mi. from Miahuatlán on Cuistla rd; 15 Oct. 1948; E.O. Wagner leg.; EMEC •1 ♂; 3 mi. S El Camerón; 2 Oct. 1986; R. Miller and L. Stange leg.; FSCA • 2 ♂♂; 6 km S of Santiago Matatlán, RMO Ocotepec; 16 Oct. 2005; F. Skillman and B. Eya leg.; FWSC • 1 ♂, 2 ♀♀; 8 mi NW of Tutla; alt. 5500 feet; 6 Oct. 975; J. Powell, J. Chemsak, T. Eichlin and T. Friedlander leg.; EMEC • 2 ♂♂, 2 ♀♀; 15 km NE of Huajuapan de León; alt. 1570 m; 2 Nov. 1991; Felipe A. Noguera and A. Rodríguez leg.; EBCC • 1 ♀; 25 km SE of Huajuapan; 13 Oct. 1978; E. Giesbert leg.; FSCA • 8 ♂♂, 7 ♀♀; 25 km SW of Huajuapan de León; 24 Oct. 2005; F. Skillman and B. Eya leg.; flowers; FWSC • 1 ♀; 30 km SE of Cuicatlan; alt. 1281 m; 7 Oct. 2005, E. Elizalde and L. Cervantes leg.; "selva baja"; IEXA • 2 ♂♂, 1 ♀; 35 km N of Huajuapan de León; 15 Oct. 2005; F. Skillman and B. Eya leg.; FWSC • 6 ♂♂, 2 ♀♀; 38 km NE of Huajuapan de León; 18 Oct. 2001; F. Skillman and J. Davidson leg.; FWSC • 1 ♂, 2 ♀♀; 50 km NE of Huajuapan de León; 11 Oct. 1994; E. Giesbert leg.; FSCA • 1 ♂, 2 ♀♀; 63 km NE of Huajuapan; 14 Oct. 1978; E. Giesbert leg.; FSCA • 1 ♀; Chapulapa; 3 May 77; Castillo Cabos leg.; COLPOS • 3 ♂♂, 5 ♀♀; Guelatao; alt. 1800 m; 15 Nov. 1964; EMEC • 1 ♂; Km 68.5 "carr. fed." [federal road] Huajuapan de León–Oaxaca; 18°12′28.7″ N, 97°38´44.6″ W; alt. 1973 m; 6 Oct. 2009; W.J. Romero Nápoles leg.; COLPOS • 1 ♀; Km 75 "carr. fed." [federal road] Huajuapan de León–Oaxaca; 17°42′45.7″ N, 97°39′07.3″ W; alt. 2112 m; 6 Oct. 2009; J. Romero Nápoles leg.; COLPOS • 1 ♂; Km 122 "carr. fed." [federal road] Miahutlan–Puerto Ángel; 16°14′55.1″ N, 96°32′44.2″ W; alt. 2051.3 m; 3 Oct. 2009; J. Romero Nápoles leg.; COLPOS • 1 ♂; Miahuatlán; alt. 1000 m; 9 Oct. 1948; H.O. Wagner leg.; EMEC • 1 ♀; km 15 Miahuatlán–Puerto Ángel; 16°14′55″ N, 96°32′43″ W; alt. 2047 m; 11 Oct. 2005; W.L. Cervantes and E. Elizalde leg.; "encinar"; IEXA • 1 ♀; Monte Albán; 17°03′00″ N, 96°45′56″ W; alt. 1859 m; 7 Oct. 2005; E. Elizalde and L. Cervantes leg.; "bosque pino"; IEXA • 13 ♂♂, 7 ♀♀; vicinity of Matatlan; 19 Oct. 2001; F. Skillman and J. Davidson; microwave tower; FWSC. – **Puebla** • 2 ♀♀; 1 km SW of Acatepec; 14 Oct. 1978; E. Giesbert leg.; FSCA • 3 ♂♂, 3 ♀♀; 2 km SE of Zapotitlán Salinas; alt. 1410 m; 3 Nov. 1991;

F.A. Noguera and A. Rodríguez leg.; EBCC • 1 ♂; 4 mi. SW of Morelos; 20 Sep. 1977; J. Chemsak and A. and M. Michelbacher leg.; "cañada"; EMEC • 1 ♂; 5 mi. S of Chapulco; alt. 7500 feet; 4 Oct. 1975; J. Powell leg.; EMEC • 2 ♂♂; 6 km SW of Teontepec; 2 Oct. 2003; J. Romero Nápoles leg.; COLPOS • 2 ♂♂; 6 mi. S of Zapotitlan; alt. 5500 feet; 6 Oct. 1975; EMEC • 4 ♂♂, 1 ♀; 7 km SE of Morelos; alt. 7700 feet; 4 Oct. 1975; J. Powell, J. Chemsak, T. Eichlin and T. Friedlander leg.; "cañada"; EMEC • 1 ♂; 9 km NE of Chapulco; 15 Oct. 1978; E. Giesbert leg.; FSCA • 1 ♀; 10 km S of Zapotitlán; 14 Oct. 1978; E. Giesbert leg.; FSCA • 2 ♂♂, 1 ♀; 18 km SE of I. de Matamoros; alt. 1270 m; 31 Oct. 1991; F.A. Noguera and A. Rodríguez leg.; EBCC • 3 ♂♂, 5 ♀♀; 23 km SE of Zapotitlán Salinas; alt. 1880 m; 3 Nov. 1991; F.A. Noguera leg.; EBCC • 1 ♀; 25 km N of Tehuacán; 4 Nov. 1991; F.A. Noguera and R. Ayala leg.; EBCC • 1 ♀; Tehuacán; Sep. 1917; C.C. Hoffman leg.; CNIN • 1 ♂; El Tepenene, 10 mi. SE of Izucar de Matamoros; alt. 4500 feet; 8 Oct. 1975; J. Chemsak, T. Eichlin and T. Friedlander leg.; EMEC • 1 ♂, 1 ♀; Km 36 "carr." [road] Zapotitlán–Acatepec; 18.17.30° N, 97.31.737° W; alt. 1633 m; 3 Oct. 2003; J. Romero Nápoles leg.; COLPOS. – **Tabasco** • 1 ♂; Tapijulapa; 28 Jun. 90; Moreno leg.; CNIN.

Description

Male (holotype)

Coloration. Integument black on head, thorax, elytra, and abdominal ventrites I–III, and basal half of IV; from reddish brown to dark orange on antennae, palpi, legs, posterior half of abdominal ventrite IV, and abdominal ventrite V.

Head. Surface finely and densely punctate; with short bright yellow pubescence on frons, genae, gulamentum, and mouthparts, bright orange on vertex (yellow in some specimens), and dense, long, erect, homogeneous bright yellow setae. Frons 2.2× as wide as long; median groove defined; tentorial depression transverse superficial and incomplete. Eyes finely faceted, with interlobular space as long as width lower lobe; distance between upper eyes lobes 4.5× as wide as upper lobe; interantennal space 0.6× length of scape. Antennal tubercles elevated with distinct depression toward median groove. Genae 0.7× as wide as a lower lobe. Anteclypeus 3.5× as wide as long. Labrum narrower than anteclypeus with straight sides. Gulamentum 4× as wide as long. Antennae 1.1× elytral length, reaching posterior third of elytra, with sparse bright yellow (brown on some areas) pubescence on scape, pedicel, and antennomeres III–IV, brown on antennomeres V–XI, and long setae on scape, pedicel, and antennomeres III–XI, especially ventrally and toward apex; antennomere XI with apex rounded; antennal ratio based on length of antennomere III; scape = 1.22; pedicel = 0.51; IV = 0.94; V–VII = 1.00; VIII–IX = 0.91; X = 0.65; XI = 0.92.

Thorax. Prothorax 1.2× as wide as long, rounded laterally. Pronotum moderately finely punctate, with dense bright yellow pubescence and bright orange pubescence interspersed; on central area more bright orange with transverse black pubescence (sometimes brown), and dense bright yellow (some brown) erect setae; disk with fossula from base to middle, base constricted laterally, and laterobasal area arched. Scutellum longer than wide, apically obtuse, densely covered with bright yellow pubescence. Elytra 2.25× as long as wide, with dense bright yellow pubescence (occasionally bright orange), and long, erect bright yellow (some ochre) setae on base and apex (some along elytral suture); with five transverse black pubescent bands as follows: first on base, undulated, from humerus to suture; second on anterior third, surrounding semicircular yellow pubescent macula; third on middle; fourth on posterior third, wider than the previous ones, subparallel, reaching suture; and fifth near to the apex, as wide as third and fourth, not reaching suture; sub-sutural costa distinguishable, more clearly on posterior third; parasutural region depressed, with its widest zone half width of elytron; apex obliquely truncate, with apicolateral projection reduced. Humeri elevated. Prosternum with dense bright yellow pubescence and moderately erect bright yellow setae; prosternal process narrow and posteriorly arcuate, apex with rounded lobes. Mesoventrite anteriorly strongly elevated, mostly with dense bright yellow pubescence and scarce erect bright yellow setae; mesoventral process broad, 0.7× width of mesocoxal cavities, in lateral view, surpassing dorsal surface of mesocoxae, apex emarginate; mesanepisternum covered with dense pubescence, abundantly punctate; mesepimeron less pubescent than mesanepisternum. Metaventrite with dense bright yellow pubescence, apical projection rounded; metanepisternum more pubescent than metaventrite. Legs with dense bright yellow pubescence, pale yellow on coxae, some brown and ochre on tarsi; metafemora reach apex of ventrite IV, with apical projection reduced, rounded; metatibiae with innermost spine just longer than outermost; metatarsomere I as long as metatarsomeres II–V together.

Abdomen. Intercoxal process moderate, gradually narrowed toward acute apex, with homogeneous bright yellow pubescence, denser laterally and apically, and erect, sparse bright yellow setae; apex of ventrite V truncate and slightly crenulated.

Male genitalia. Parameres moderately sclerotized, subparallel in ventral view, narrower toward apex; with short setae throughout and long apical setae; inter-parameres space rounded; basal projection discontinued, very oblique in ventral view, extending to middle of each paramere (Fig. 1E).

Female

Similar to male. Antennae just surpassing first third of elytra, antennomeres IX–XI shorter and wider than in males. Metafemora slightly shorter than in male. Color of ventrites usually reddish brown-dark orange, occasionally similar to male. Apex of ventrite V rounded.

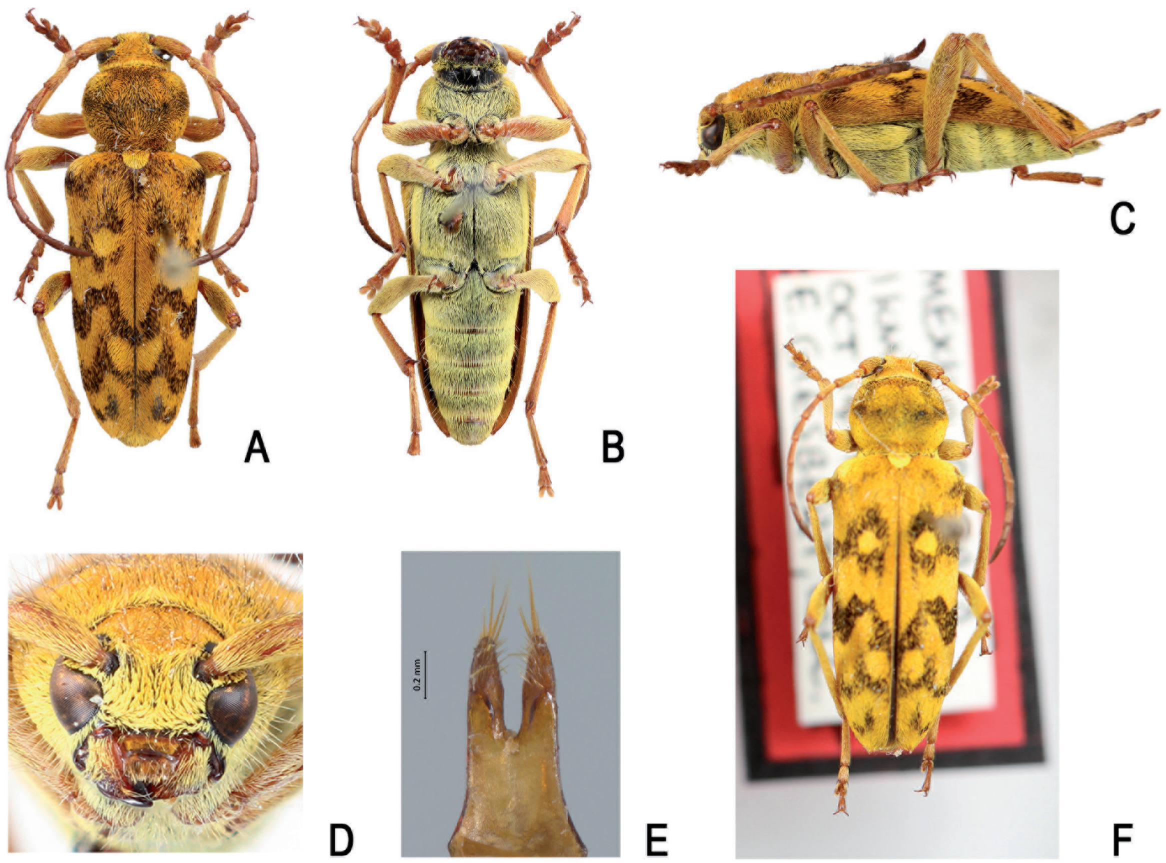

Fig. 1. *Ochraethes confusus* sp. nov. **A**–**D**. Holotype, ♂ (EMEC). **A**. Habitus, dorsal. **B**. Habitus, ventral. **C**. Habitus, lateral. **D**. Frons. **E**. Paratype, ♂ (CNIN), ventral view of male genitalia. **F**. Paratype, ♀ (EMEC), habitus, dorsal.

Dimensions (mm)

Holotype male. Total length, 15.15; prothoracic length, 3.25; anterior prothoracic width, 3.40; posterior prothoracic width, 3.05; widest prothoracic width 3.95; humeral width, 5.20; elytral length, 10.60. Paratypes male/female. Total length, 8.85–15.25/9.85–18.60; prothoracic length, 1.70–3.34/1.95–3.85; anterior prothoracic width, 1.85–3.52/2.10–5.14; posterior prothoracic width, 1.55–3.16/1.75–4.35; greatest prothoracic width 2.15–4.08/2.40–5.70; humeral width, 2.85–5.30/3.05–7.20; elytral length, 6.30–10.73/7.0–13.10.

Distribution

Mexico: Puebla, Oaxaca, Chiapas, Tabasco.

Flower records

Helianthus sp. and *Tithonia tubiformis* (Jacq.) Cass.

Remarks

The specimens from southeastern Oaxaca and Chiapas have the integument colour darker on legs and abdomen. The pubescent pattern of this species is consistent in males and females and allows it to be distinguished it from other species of the genus; only males have darker pubescence on the body. *Ochraethes confusus* sp. nov. is most similar to *O. sommeri* (Chevrolat, 1835) in the pubescence pattern, but differs by the five transverse bands of black pubescence on the elytra (four in *O. sommeri*), which are slender, and more sinuous. Also, it can be distinguished from *O. sommeri* by the anteclypeus and labrum reduced (no reduced in *O. sommeri*); metafemora reaching apex of ventrite IV (reaching V in *O. sommeri*), and the apical projection of the metafemora reduced (not reduced in *O. sommeri*).

Ochraethes nigroapicalis sp. nov.
urn:lsid:zoobank.org:act:6AEDB175-184D-49AB-AD23-AB37386DE4FA
Fig. 2

Etymology

The specific name *nigroapicalis* is composed from the Latin '*niger, nigra, nigrum*', and '*apex, apicis*', referring to pubescence patterns on male elytra, which is mostly black on the posterior half.

Material examined

Holotype

MEXICO • ♂; Nayarit, 5–10 km W of Jala; 8 Dec. 1990; E. Giesbert leg.; EMEC.

Paratypes (32)

MEXICO – **Jalisco** • 8 ♂♂, 2 ♀♀; 3.4 km NW of Tequila; alt. 1295 m; 25 Sep. 1976; C.D. George and R.R. Snelling leg.; LACM • 1 ♀; San Martín de Bolaños; alt. 1400 m; 22–26 Oct. 1996; C. Cabello leg.; "selva baja caducifolia"; EBCC. – **Nayarit** • 1 ♀; same collection data as for holotype; EMEC • 4 ♂♂, 3 ♀♀; same collection data as for holotype; FSCA • 2 ♂♂, 1 ♀; San Juan, Sierra de San Juan; 21.50432º N, 104.92461º W; 14 Oct. 2020; Fernando Amador Martínez leg.; CNIN • 3 ♂♂; Volcán Ceboruco, 8–12 km W of Jala; 4 Oct. 1990; J.E. Wappes leg.; JEWC • 1 ♀; 5–10 km W of Jala; alt. 4000–5000 feet; 27 Sep.–6 Oct. 1991; E. Giesbert leg.; FSCA. – **Zacatecas** • 6 ♂♂, 3 ♀♀; 6 km SSW of Tepetongo; 3 Oct. 1990; J.E. Wappes leg.; JEWC.

Description

Male (holotype)

Coloration. Integument black on head, thorax, coxae, elytra, and abdominal ventrites I–III, and basal half of abdominal ventrites IV and V; reddish brown on antennae, palpi, legs, and posterior half of abdominal ventrites IV and V.

Head. Surface finely and densely punctate; with short bright yellow pubescence on frons, genae, gulamentum, and mouthparts, bright orange on vertex (yellow in some specimens), and dense, long, erect, homogeneous pale yellow (bright yellow in some specimens) setae. Frons 2.1 × as wide as long; median groove defined; tentorial depression transverse superficial and incomplete. Eyes finely faceted, with interlobular space as long as width lower lobe; distance between upper eyes lobes 5.0 × as wide as upper lobe; interantennal space 0.7 × as long as scape. Antennal tubercles slightly elevated with distinct depression toward median groove. Genae small, 0.5 × as wide as of lower lobe. Anteclypeus 4.5 × as wide as long. Labrum distinctly narrower than anteclypeus with straight sides. Gulamentum 3.2 × as wide as long. Antennae 1.2 × elytral length, reaching posterior quarter of elytra, with sparse bright yellowish-white or pale yellow pubescence on scape, pedicel, and antennomeres III–VIII, mostly brown on antennomeres VII–XI, and long setae on scape, pedicel, and antennomeres III–X, mainly ventrally and toward apex; antennomere XI with apex rounded; antennal ratio based on length of antennomere III; scape = 1.20; pedicel = 0.58; IV = 1.00; V–VII = 1.22; VIII–IX = 1.00; X = 0.84; XI = 1.22.

Thorax. Prothorax 1.5 × as wide as long, rounded laterally. Pronotum moderately finely punctate, with dense bright yellow pubescence and bright orange pubescence interspersed; on central area more orange, and with dense bright yellow (some brown) erect setae; base constricted laterally, and laterobasal area arched. Scutellum wider than long, apically rounded, densely covered with bright yellow pubescence. Elytra 2.2 × as long as wide, with dense bright orange pubescence (occasionally bright yellow in some specimens), and long brown (some ochre) setae on base and apex; without transverse bands of black pubescence on basal half; with contrasting maculae of bright yellow (occasionally pale yellow in some specimens) pubescence as follows: first on humeral area, subelliptical; second close to suture on basal third, elongated; third on middle of anterior half, semicircular; fourth before middle, subeliptical, oblique; posterior half mostly covered with black pubescence, except apex with orange and bright yellow pubescence, surrounding dark central pubescence (sometimes, dark pubescence absent in some specimens); sub-sutural costa distinguishable, more clearly on posterior third; parasutural region depressed, with it widest zone 0.4 × as wide as an elytron; apex slightly obliquely truncate, with apicolateral projection reduced. Humeri elevated, with brown (sometimes ochre in some specimens) pubescence. Prosternum with dense pale yellow (bright yellow toward sides) pubescence and moderately erect pale yellow setae; prosternal process narrow and posteriorly arcuate, apex with rounded lobes. Mesoventrite anteriorly moderately elevated, mostly with dense whitish pubescence and scattered erect pale yellow setae; mesoventral intercoxal process broad, 0.6 × as wide as mesocoxal cavities, in lateral view just as elevated as mesocoxae, apex emarginate; mesanepisternum covered with dense bright yellow pubescence, abundantly punctate; mesepimeron with whitish pubescence. Metaventrite with dense pale yellow pubescence, apical projection rounded truncate; metanepisternum with bright yellow pubescence denser than on metaventrite. Legs with dense pale yellow pubescence on coxae, and femora, bright yellow on tibiae, and tarsi, some ochre on tarsi; metafemora reach apex of ventrite V, with apical projection reduced, obtuse; metatibiae with innermost spine just longer than outermost; metatarsomere I 1.15 × length of metatarsomeres II–V together.

Abdomen. Intercoxal process wide, gradually narrowed toward acute apex, with homogeneous pale yellow pubescence on middle and bright yellow toward sides, denser laterally and apically, and erect, sparse pale yellow setae; apex of ventrite V truncate and slightly crenulated.

Male genitalia. Parameres moderately sclerotized, subparallel in ventral view, narrower toward apex; with short setae throughout and long apical setae; inter-parameres space acute; basal projection discontinued, very oblique in ventral view, extended to middle of each paramere (Fig. 2E).

Female

Similar to male. Antennae just surpassing half length of elytra, antennomeres IX–XI shorter and wider than in males. Elytra with two transverse, wide, subparallel black pubescent bands reaching suture on posterior half, first on middle and second on posterior third, wide, sub-parallel, reaching elytral suture. Metafemora slightly shorter than in male. Apex of ventrite V rounded.

Dimensions (mm)

Holotype male. Total length, 13.35; prothoracic length, 3.20; anterior prothoracic width, 3.0; posterior prothoracic width, 2.80; widest prothoracic width 3.65; humeral width, 4.40; elytral length, 9.20. Paratypes male/female. Total length, 11.45–15.10/13.06–16.10; prothoracic length, 2.40–3.70/3.10–3.90; anterior prothoracic width, 2.25–3.40/2.88–3.72; posterior prothoracic width, 1.95–3.20/2.70–3.50; greatest prothoracic width 2.82–4.48/3.50–4.90; humeral width, 3.70–5.60/5.0–6.35; elytral length, 8.20–10.35/9.10–11.0.

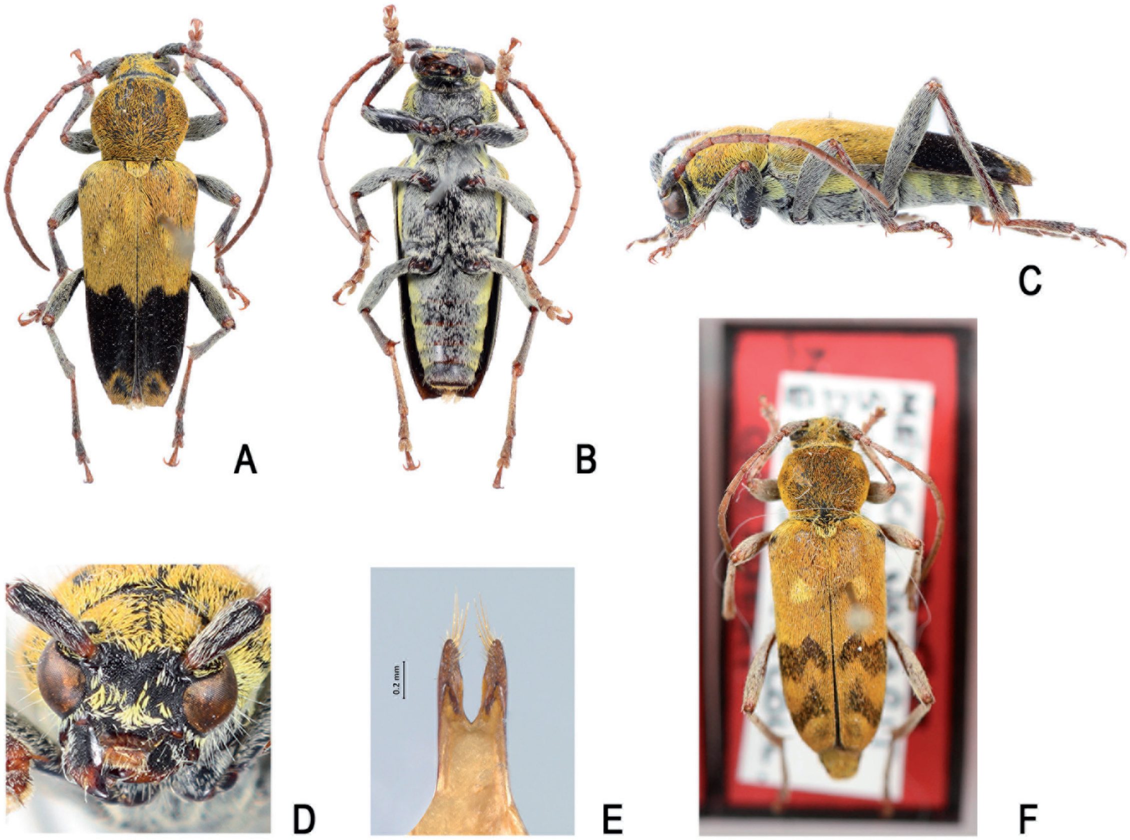

Fig. 2. *Ochraethes nigroapicalis* sp. nov. **A**–**D**. Holotype, ♂ (EMEC). **A**. Habitus, dorsal. **B**. Habitus, ventral. **C**. Habitus, lateral. **D**. Frons. **E**. Paratype, ♂ (CNIN), ventral view of male genitalia. **F**. Paratype, ♀ (EMEC), habitus, dorsal.

Distribution

Mexico: Jalisco, Nayarit and Zacatecas.

Flower records

Tithonia tubiformis (Jacq.) Cass.

Remarks

The females of this species are very similar to *O. sommeri*, but the geographical distribution (only in southern of the Sierra Madre Occidental) and pubescent pattern on the elytra are useful to separate them. Also, this species can be distinguished from other known species by the labrum reduced with straight sides (rounded in *O. sommeri*); elytra with wide dark area covering nearly all of the posterior half (males); and metatarsomere I longer than II–V together. *Ochraethes nigroapicalis* sp. nov. is the species of genus *Ochraethes* with the most evident sexual dimorphism.

Species delimitation analyses

The final matrix of COI includes 84 terminals (including two species of *Tanyochraethes* and four of *Trichoxys*), 660 aligned characters and data of all morphotypes were obtained for each species (Figs 3–4). The multiple delimitation methods (ABGD, bPTP and GMYC) consistently separate the new species and support some synonymies within *Ochraethes*. Most of the species currently recognized species were recovered as single MOTU (Molecular Operational Taxonomic Unit).

The ABGD method with initial and recursive partitions recovered different results (initial = 18 MOTUs, recursive = 19 and 18 MOTUs), however, the last recursive partition showed 18 MOTUs (Fig. 5). In bPTP method, Maximum Likelihood and Bayesian methods were congruent with 18 MOTUs. Finally, the coalescence analysis performed under GMYC method obtained the same MOTUs under coalescent models with a confidence interval of 11–22; likelihood of null model = 519.4138; likelihood of GMYC model = 525.3721.

Nevertheless, *Ochraethes brevicornis* (Chevrolat, 1860) with *O. virescens* (Chevrolat, 1860), *O. octomaculata* Chemsak & Noguera, 2001 with *Tanyochraethes cinereolus* Chemsak & Linsley, 1965, *O. obliquus* (Chevrolat, 1860) with *O. zebratus* Bates, 1885, *O. sommeri* (Chevrolat, 1835) with *Trichoxys giesberti*, *O. viridiventris* (Chevrolat, 1860) with *O. nigritus* Bates, 1892, and *O. z-littera* (Chevrolat, 1860) with *O. cristoforii* (Chevrolat, 1860) and *O. litura* Bates, 1885 were recovered as one MOTU respectively. On the other hand, *O. sommeri* comprises a major morphological variation of the genus, with different populations across Mexico. The coalescence analysis suggest that all populations belong to a single MOTU, except the populations from southwestern Puebla, Oaxaca, Chiapas and Tabasco (*Ochraethes confusus* sp. nov.) and populations from northwestern Jalisco, southwestern Nayarit and Zacatecas (*Ochraethes nigroapicalis* sp. nov.).

The maximum likelihood tree from IQ-TREE represents a first approximation about the phylogenetic relationships of *Ochraethes*, which recovered the genus as polyphyletic; however, a more comprehensive study (additional markers and taxa) about the evolutionary relationships of this group is needed.

Discussion

Taxonomic changes in *Ochraethes* Chevrolat, 1860

The results of the molecular analyses and taxonomic characters (type and additional material) support some nomenclatural changes within the *Ochraethes* (including *Tanyochraethes* and *Trichoxys*).

Fig. 3. Pubescence variation on the elytra in *Ochraethes* Chevrolat, 1860. **A–B**. *Ochraethes brevicornis* (Chevrolat, 1860) (♀, ♂). **C–E**. *O. cinereolus* (Bates, 1892) comb. nov. (♂, ♂, ♀). **F–I**. *O. obliquus* (Chevrolat, 1860) (♂, ♂, ♀, ♀). **J–N**. *O. sommeri* (Chevrolat, 1835) (♂, ♂, ♂, ♀, ♀). **O–S**. *O. viridiventris* (Chevrolat, 1860) (♂, ♀, ♂, ♂, ♀). **T–X**. *O. z-littera* (Chevrolat, 1860) (♂, ♂, ♂, ♀, ♀).

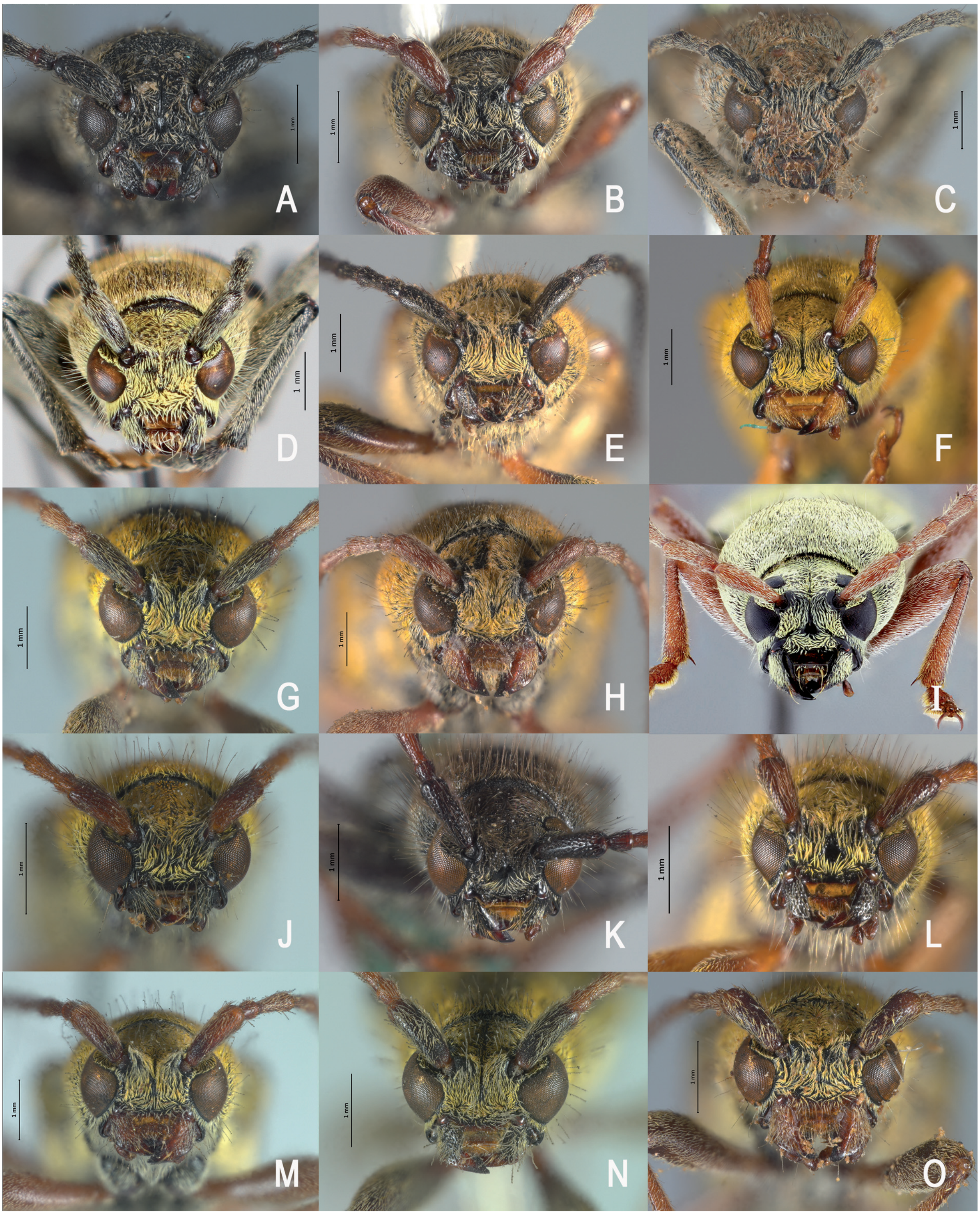

Fig. 4. Head, frontal view of type species of *Ochraethes*. **A**. *Ochraethes brevicornis* (Chevrolat, 1860), ♀. **B**. *O. virescens* (Chevrolat, 1860), ♂. **C**. *O. cinereolus* (Bates, 1892) comb. nov., ♀. **D**. *O. octomaculata* Chemsak & Noguera, 2001, ♂. **E**. *O. obliquus* (Chevrolat, 1860), ♂. **F**. *O. zebratus* Bates, 1885, ♀. **G**. *O. sommeri* (Chevrolat, 1835), ♂. **H**. *O. circuliferus* (Chevrolat, 1860) (= *Ochraethes sommeri*), ♀. **I**. *Trichoxys giesberti* Botero *et al.*, 2019, ♀. **J**. *O. viridiventris* (Chevrolat, 1860), ♂. **K**. *O. nigritus* Bates, 1892 (= *Ochraethes viridiventris*), ♂. **L**. *O. clerinus* Bates, 1892, ♀. **M**. *O. z-littera* (Chevrolat, 1860), ♂. **N**. *O. cristoforii* (Chevrolat, 1860), ♂. **O**. *O. litura* Bates, 1885, ♀.

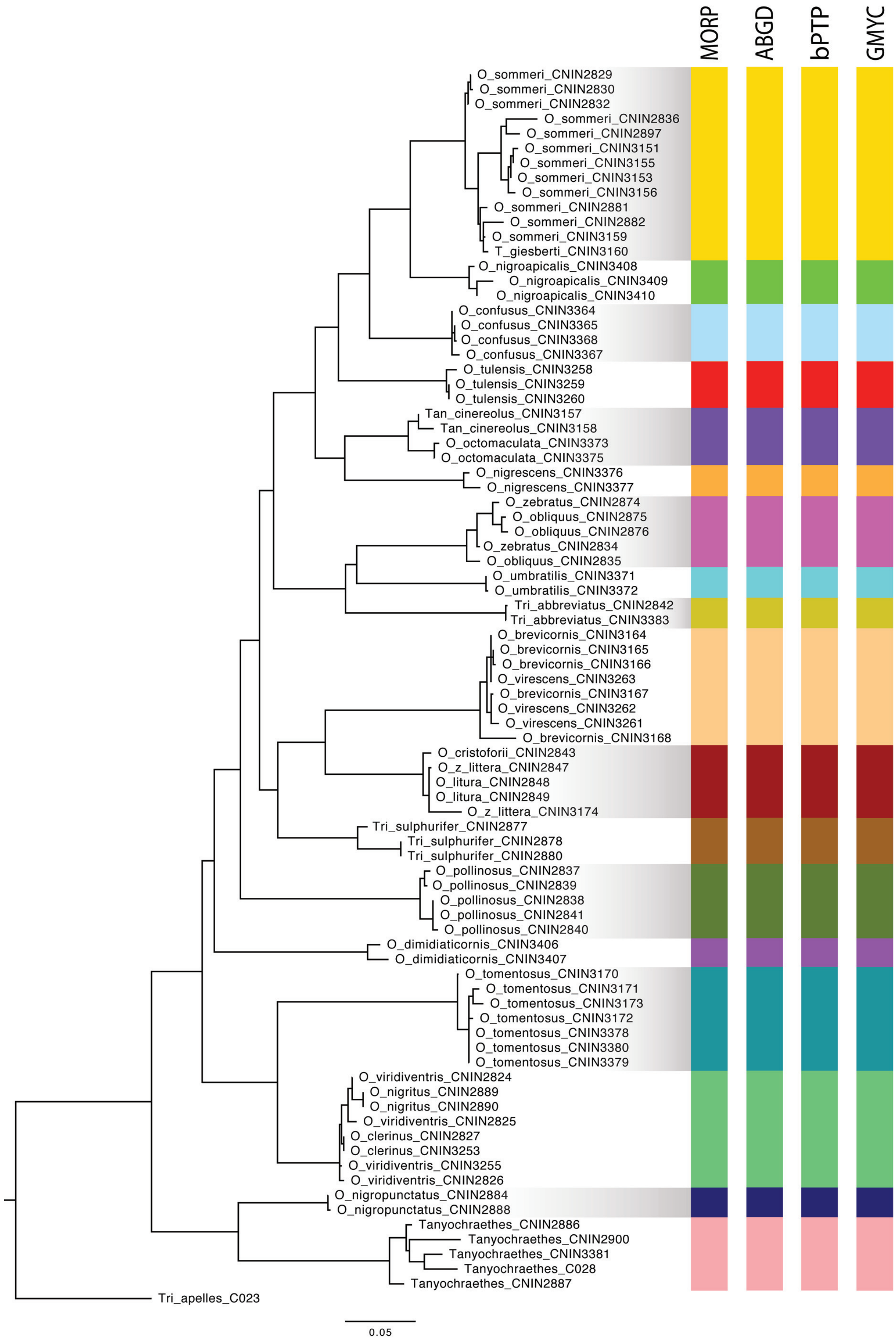

Fig. 5. Species delimitation in *Ochraethes* Chevrolat, 1860. Maximum likelihood tree inferred from COI in IQ TREE. The molecular operational taxonomic units (MOTU) are separated by colour bars. Abbreviations: ABGD = ast recursive analyses; bPTP = both Maximum likelihood and Bayesian analyses; GMYC = coalescence and yule analyses; MORP = morphology.

Ochraethes brevicornis (Chevrolat, 1860)

Clytus (*Ochroesthes*) *brevicornis* Chevrolat, 1860: 480.
Clytus (*Ochroesthes*) *virescens* Chevrolat, 1860: 481, **syn. nov.**

Ochrestes brevicornis – Lacordaire 1869: 66.
Ochrestes virescens – Lacordaire 1869: 66.
Ochresthes brevicornis – Bates 1880: 52 (distr.).
Ochresthes virescens – Bates 1880: 52 (distr.).
Ochraethes brevicornis – Aurivillius 1912: 386 (cat.). — Chemsak & Linsley 1974: 183. — Chemsak *et al.* 1992: 69 (cat.). — Monné 1993: 18 (cat.); 2005: 106 (cat.); 2021: 144 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Noguera & Chemsak 1996: 401 (cat.). — Monné & Hovore 2006: 46 (cat.). — Wappes *et al.* 2018: 3. — Pérez-Flores *et al.* 2021: 465 (checklist). — Bezark 2019: 405 (distr.); 2021: 74 (checklist);
Ochraethes virescens – Aurivillius 1912: 386 (cat.). — Chemsak & Linsley 1974: 183. — Chemsak *et al.* 1992: 70 (cat.). — Monné 1993: 20 (cat.); 2005: 109 (cat.); Monné 2021: 148 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Noguera & Chemsak 1996: 401 (cat.). — Monné & Hovore 2006: 46 (cat.). — MacRae *et al.* 2012: 176. — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 74 (checklist);.
Triodoclytus brevicornis – Linsley 1935: 86 (distr.). — Blackwelder 1946: 581 (cat.).
Triodoclytus virescens – Linsley 1935: 87 (distr.). — Blackwelder 1946: 581 (cat.).

When Chevrolat (1860) described the genus as a subgenus of *Clytus*, he included two very similar species, *O. brevicornis* and *O. virescens*. According to Chevrolat (1860), *O. brevicornis* and *O. virescens* are similar ("Cet insecte [*O. brevicornis*] est très voisin du Cl. virescens"), but the latter differs in the antennomeres VI–XI longer, antennal coloration, and prothorax longer than width. In this case, sexual dimorphism is evident (similar to *O. viridiventris*). In females, the antennae are always shorter with the last antennomeres wider, the pubescence is sligtly darker (bright in some specimens), and the longitudinal line of light-yellow pubescence that extends from the scutellum to elytral apex is more visible. On the other hand, the males have the brightest pubescence on the body, and the longitudinal band on the elytra is evident, and with the transverse pubescent band near half of the elytra less obvious, but always present. The prothorax and apex of the elytra are features nearly identical in the type material of both species. The frons and the shape of the anteclypeus and labrum (Fig. 4A–B) are other diagnostic characters to propose *O. virescens* as a junior synonym of *O. brevicornis*.

Ochraethes cinereolus (Bates, 1892) comb. nov.

Trichoxys cinereolus Bates, 1892: 162.
Ochraethes octomaculata Chemsak & Noguera, 2001: 51, **syn. nov.**

Trichoxys cinereolus – Aurivillius 1912: 382 (cat.). — Chemsak 1967: 80 (lect.).
Trichoxys cinereola – Blackwelder 1946: 580 (cat.).
Tanyochraethes cinereola – Chemsak & Linsley 1965: 148. — Chemsak *et al.* 1992: 70 (cat.). — Chemsak & Noguera 1993: 62 (distr.). — Noguera & Chemsak 1996: 401 (cat.).
Tanyochraethes cinereolus – Monné 1993: 25 (cat.); 2005: 112 (cat.); 2021: 157 (cat.). — Monné & Giesbert 1994: 117 (cat.). — Monné & Hovore 2006: 47 (cat.). — Noguera & Gutiérrez 2016: 658 (distr.). — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 75 (checklist).
Ochraethes octomaculata – Monné 2005: 108 (cat.); 2021: 146 (cat.). — Monné & Hovore 2006:46 (cat.). — Noguera & Gutiérrez 2016: 658 (distr.). — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 74 (checklist).

Trichoxys cinereolus was originally described by Bates (1892) in the genus *Trichoxys*, and subsequently transferred to *Tanyochraethes* by Chemsak & Linsley (1965). On the other hand, *O. octomaculata* was originally described by Chemsak & Noguera (2001). The characters that support this synonymy are the frons transverse (Fig. 4C–D), the elytral apex oblique-truncate, the mesoventral process moderate elevated; even the pattern of the pubescence on the elytra is the same. This pattern of pubescence on the elytra is similar in *Tanyochraethes anthophilus* (Chevrolat, 1860), *T. clathratus* (Chevrolat, 1860), and *T. tildeni* Chemsak & Linsley, 1965. However, the shape of the frons and vertex is totally different. Accordingly, we consider *O. octomaculata* as a junior synonym of *T. cinereolus*. We used characters of the type specimens of both species to stablish the new combination for *Ochraethes cinereolus*.

Ochraethes obliquus (Chevrolat, 1860)

Clytus (*Ochroesthes*) *obliquus* Chevrolat, 1860: 473.
Ochresthes zebratus Bates, 1885: 298, **syn. nov.**

Ochraestes obliquus – Thomson 1861: 219.
Ochrestes obliquus – Lacordaire 1869: 66.
Ochresthes obliquus – Bates 1880: 51; 1885: 296 (distr.).
Ochraethes obliquus – Aurivillius 1912: 386 (cat.). — Linsley 1935: 86 (distr.). — Monné 1993: 19 (cat.); 2005: 107 (cat.); 2021: 146 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Turnbow *et al.* 2003: 15 (distr.). — Monné & Hovore 2006: 46 (cat.). — García-Morales *et al.* 2014: 100 (distr.). — Noguera & Gutiérrez 2016: 657 (distr.). — Bezark 2019: 405 (distr.); 2021: 73 (checklist). — Pérez-Flores *et al.* 2021: 466 (checklist).
Ochraethes zebratus – Aurivillius 1912: 386 (cat.). — Monné 1993: 20 (cat.); 2005: 109 (cat.); 2021: 148 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Monné & Hovore 2006: 46 (cat.). — Hovore 2006: 373 (distr.). — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 74 (checklist);.
Ochraethes obliqua – Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 69 (cat.). — Noguera & Chemsak 1996: 401 (cat.).
Ochraethes zebrata – Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 70 (cat.).

In the original description, Chevrolat (1860) described *Ochraethes obliquus* as the large species with one of the most important characters that differentiated it from related species ("... Corselet un peu plus long que large, arrondi, assez largement étranglé à la base, droit aux extrémités [the prothorax extremely constricted at base] …") and five black pubescent bands. The type specimen has the pubescence paler than other specimens and the last black pubescent band (sixth) is poorly evident (drawing by Bates). Bates (1885) described *O. zebratus* from Cobán, Guatemala, from only one female specimen. He mentioned seven narrow, slightly diagonal (oblique) bandages (brown or black transversal pubescent bands) on elytra and described the elytral apex as obliquely truncate. However, all speciemens revised and type material only have six evident pubescent bands in the same arrangement as *O. obliquus*, but narrower. The pubescence in these specimens conforms to the brighter variation of *O. obliquus* with the southernmost distribution. The frons is another character that is equal in both (sub-quadrate) (Fig. 4E–F). Accordingly, we consider *O. zebratus* as a junior synonym of *O. obliquus*.

Ochraethes sommeri (Chevrolat, 1835)

Clytus sommeri Chevrolat, 1835: 4 (53).
Clytus tibialis Laporte & Gory, 1836: 71.
Clytus (*Ochroesthes*) *circuliferus* Chevrolat, 1860: 472.
Trichoxys giesberti Botero *et al.* 2019: 2, **syn. nov.**

Clytus sommeri – Laporte & Gory 1836: 72. — White 1855: 273.
Clytus (*Ochroesthes*) *sommeri* – Chevrolat 1860: 474.

Ochraesthes sommeri – Thomson 1861: 219.
Ochraesthes circuliferus – Thomson 1861: 219; 1864: 185.
Ochrestes sommeri – Lacordaire 1869: 66.
Ochresthes sommeri – Bates 1880: 51; 1885: 296 (syn.).
Ochresthes circuliferus – Bates 1880: 51 (distr.).
Ochraethes sommeri – Aurivillius 1912: 386 (cat.). — Linsley 1935: 86 (distr.). — Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 69 (cat.). — Monné 1993: 19 (cat.); 2005: 108 (cat.); 2021: 147 (cat.). — Chemsak & Noguera 1993: 62 (distr.). — Monné & Giesbert 1994: 116 (cat.). — Noguera & Chemsak 1996: 401 (cat.). — Monné & Hovore 2006: 46 (cat.). — MacRae *et al.* 2012: 175 (host). — Ordóñez-Reséndiz & Martínez-Ramos 2017: 828 (distr.). — Heffern *et al.* 2020: 178. — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 73 (checklist).
Ochraethes circulifer Aurivillius 1912: 386 (cat.).
Trichoxys giesberti – Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 75 (checklist). — Monné 2021: 159 (cat.).

Chevrolat (1835) described *Ochraethes pollinosus* and *O. sommeri* in the genus *Clytus*, and subsequently Chevrolat (1860) included both within the *Ochraethes* division. *Ochraethes sommeri* is one of the species that exhibits pubescence varying from dark to bright, some of them have been described as different species (*O. circuliferus* and *Clytus tibialis*). Botero *et al.* (2019) described *Trichoxys giesberti* based on two females from Sinaloa, Mexico, which are very similar to some specimens of *O. sommeri* reviewed by us with the same location (including a female lacking the evident transverse bands of black pubescence on the elytra used in delimitation analyses). The blurred transverse bands of black pubescence is a character present in other species within *Ochraethes*. The type material of *T. giesberti* has the frons and scape nearly identical to those in the type specimens of *O. sommeri* (= *O. circuliferus*), even the shape of anteclypeus and labrum is similar (Fig. 4G–I). The proportion of metatarsomere I (1.65 × as long as II–III together) is other character to propose *T. giesberti* as junior synonym of *O. sommeri*.

Ochraethes viridiventris (Chevrolat, 1860)

Clytus (*Ochroesthes*) *viridiventris* Chevrolat, 1860: 479.
Ochresthes nigritus Bates, 1892: 162.
Ochresthes clerinus Bates, 1892: 162, **syn. nov.**

Ochrestes viridiventris – Lacordaire 1869: 66.
Ochresthes viridiventris – Bates 1880: 52 (distr.); 1885: 297.
Ochresthes nigritus – Chemsak 1967: 77 (lect.).
Ochraethes viridiventris – Aurivillius 1912: 386 (cat.). — Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 70 (cat.). — Monné 1993: 20 (cat.); 2005: 109 (cat.); 2021: 148 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Noguera & Chemsak 1996: 401 (distr.). — Monné & Hovore 2006: 46 (cat.). — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark, 2021: 74 (checklist).
Ochraethes nigritus – Aurivillius 1912: 386 (cat.). — Monné 1993: 18 (cat.); 2005: 107 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Noguera & Chemsak 1996: 401 (distr.). — Monné & Hovore 2006: 46 (cat.). — Heffern *et al.* 2020: 178 (syn.).
Ochraethes clerinus – Aurivillius 1912: 386 (cat.); Monné 1993: 18 (cat.); 2005: 107 (cat.); 2021: 144 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Monné & Hovore 2006: 46 (cat.). — Ordóñez-Reséndiz & Martínez-Ramos 2017: 828 (distr.). — Pérez-Flores *et al.* 2021: 465 (checklist). — Bezark 2021: 74 (checklist).
Ochraethes nigrita – Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 69 (cat.).
Ochraethes clerina – Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 69 (cat.). — Noguera & Chemsak 1996: 401 (dist.).

Heffern *et al.* (2020) recently synonymized *Ochraethes nigritus* and discussed the pubescence colour of the body in both species, which is not informative to separate them. The similar form of their frons, anteclypeus and labrum are other characters which support this proposed synonymy. The pubescence coloration in this species ranges from bright to dark tones, even totally dark.

Also, in this work, we propose *O. clerinus* as a junior synonym of *O. viridiventris* based on the same situation as *O. nigritus*. Bates (1892) described *O. clerinus* and *O. nigritus* from the same locality in Guerrero; these specimens are very similar and differ only in the coloration of pubescence on body. The holotype of *O. clerinus* is female, which is very important because females are commonly longer than males, and the holotype of *O. viridiventris* is a male (the specimen was described as female). The pattern of the black pubescence on the elytra is almost identical, the elytral apex obliquely truncate, anteclypeus and labrum have the same shape in the type material of the two species described by Bates (Fig. 4J–L).

Ochraethes z-littera (Chevrolat, 1860)

Clytus (*Ochroesthes*) *z-littera* Chevrolat, 1860: 476.
Clytus (*Ochroesthes*) *cristoforii* Chevrolat, 1860: 477, **syn. nov.**
Ochresthes litura Bates, 1885: 298.

Ochraestes z-littera – Thomson 1861: 219.
Ochraesthes cristoforii – Thomson 1861: 219.
Ochrestes z-littera – Lacordaire 1869: 66.
Ochrestes cristoforii – Lacordaire 1869: 66.
Ochresthes z-littera – Bates 1880: 51 (distr.); 1885: 297 (distr.).
Ochresthes cristoforii – Bates 1880: 51; 1885: 297 (distr.).
Ochresthes citrinus – Bates 1885: 297 (error).
Ochraethes z-littera – Aurivillius 1912: 386 (cat.). — Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 70 (cat.). — Monné 1993: 21 (cat.); 2005: 109 (cat.); 2021: 148 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Noguera & Chemsak 1996: 401 (distr.). — Monné & Hovore 2006; 46 (cat). — Pérez-Flores *et al.* 2021: 466 (checklist) — Bezark 2021: 74 (checklist).
Ochraethes christofori – Aurivillius 1912: 386 (cat.). — Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 69 (cat.).
Ochraethes litura – Aurivillius 1912: 386 (cat.). — Blackwelder 1946: 581 (cat.). — Chemsak *et al.* 1992: 69 (cat.). — Monné 1993: 18 (cat.); 2005: 107 (cat.); 2021: 145 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Monné & Hovore 2006: 46 (cat.). — Hovore 2006: 373 (distr.). — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 73 (checklist).
Ochraethes z-litterata – Linsley 1935: 86 (error).
Ochresthes litura – Chemsak 1967: 77 (lect.).
Ochraethes cristoforii – Monné 1993: 18 (cat.); 2005: 107 (cat.); 2021: 145 (cat.). — Monné & Giesbert 1994: 116 (cat.). — Noguera & Chemsak 1996: 401 (distr.). — Monné & Hovore 2006: 46 (cat.). — Pérez-Flores *et al.* 2021: 466 (checklist). — Bezark 2021: 73 (checklist).
Ochraethes cristofori – Noguera & Chemsak 1996: 401 (cat.).

Chevrolat (1860) described two similar species *Ochraethes z-littera* and *O. cristoforii*. According to Chevrolat´s description of *O. z-littera*: "…sa couleur et les taches du corselet le rapprochent encore du *Cl. Cristoforii*." (the colour and pattern approaches that of *O. cristoforii*). Although the coloration in these specimens differ, the transverse Z-shaped band of black pubescence on elytra are almost identical. Bates (1885) described *O. litura* from Guatemala, based on female specimens. In the original description, Bates mentioned that this species resembles *O. tomentosus*, but larger and with elytral apex "oblique sinuate-truncatis". Here we propose *O. cristoforii* and *O. litura* as junior synonyms of *O. z-littera* based on the following characters: frons strongly transverse (Fig. 4M–O), pronotum with a centrobasal sulcus (pubescence pattern on pronotum is the same in all specimens), patch of yellowish pubescence on first third of elytra, transverse Z-shaped bands of black pubescence on anterior third, and elytral apex with apicolateral spine.

Species delimitation of *Ochraethes* Chevrolat, 1860

The pubescence pattern on the elytra is the most important character for discriminating the species of *Ochraethes* (Linsley 1964). However, in most species of the genus *Ochraethes* there is a certain degree of polymorphism, especially in the pubescence (showing tonalities from dark to pale or bright yellow) and integument colour variation (Fig. 3). The delimitation analyses performed in this study allowed the inference of a slight variation in genetic structure within populations of *Ochraethes* and the high phenotypic plasticity of their species (Fig. 3). However, the specimens with extreme range of variation (dark or bright yellow tonalities) are less common, and this fact may be caused by environmental conditions (Hartl & Clark 1997; Freeland *et al.* 2011).

The revised material distribution allowed to explore the influence of other extrinsic factor: exposure to heat or humidity. The specimens that inhabit dry environments showed a light coloration on the body, and the specimens in temperate and cold environments showed a darker coloration. This fact has already been studied in other insect groups (e.g. ants, damselflies), and it is linked to heat regulation mechanisms or different behaviors depending on the temperature (Bishop *et al.* 2016; Law *et al.* 2020; Blow *et al.* 2021). Also, there may be evolutionary factors related to mimicry strategies, as well as camouflage, i.e., the pubescence matching in colour with the flowers on which the adults feed.

Although populations of species of *Ochraethes* showed a variable coloration of pubescence and integument, they exhibited diagnostic characters throughout their distribution (Table 1). For most of the species analyzed, we included specimens from different localities, and they were delimited as MOTUs with a high degree of variation. Particularly, *O. sommeri* shows the largest phenotypic plasticity, and two populations commonly considered as *O. sommeri* were discriminated as independent lineages (representing the two new species). Moreover, the delimitation analyses support synonymies in some species showing morphological similarities and the same distribution.

On the other hand, sexual dimorphism is common in *Ochraethes*, for example in *O. sommeri*, females do not show dark tones in the pubescence. Some other species (*O. nigrescens*, *O. viridiventris*) show a full range of variation in males and females (even in one locality). This is relevant since several species of *Ochraethes* described in the past were based on single specimens, or used only one sex, and some of them represent only variations of other species. In the descriptions of new species in this group, the type material should at least include specimens of both sexes for a better taxonomic treatment.

A complete morphological revision of the genus *Ochraethes* will allow the differentiation and boundaries of the genus from other genera of the tribe Clytini, and subsequent nomenclatural changes and keys for species placed in the related genera.

Acknowledgements

We thank the curators of the collections who provided specimens for this study. We also thank Alejandro Zaldívar-Riverón for funding and support granted at the CNIN, IBUNAM; Santiago Zaragoza-Caballero, Cristina Mayorga, and Guillermina Ortega for their help in the CNIN IBUNAM; Andrea Jiménez, and Laura Márquez for their help in the IBUNAM laboratory; Kipling Will (EMEC) for photographing type specimens that we described in this work; Susana Guzmán for help with the use of the Zeiss equipment in the IBUNAM; to Gustavo F. Pérez for his help in processing the figure plates; Posgrado en Ciencias Biológicas, UNAM, and the Consejo Nacional de Ciencia y Tecnología (CONACyT) for fellowship support (no. 585070), and the Programa de Apoyo para Estudios de Posgrado (PAEP) for funding travel to entomology collections and field work.

References

Arnett R.H. 1962. *The Beetles of the United States*. The Catholic University of America Press, Washington, D.C.

Aurivillius C. 1912. *Coleopterorum Catalogus, Pars 39, Cerambycidae: Cerambycinae*. W. Junk, Berlin. https://www.biodiversitylibrary.org/page/10357128

Bates H.W. 1880. Insecta, Coleoptera, Longicornes. *In*: Godman F.D & Salvin O. (eds) *Biologia Centrali-Americana. Insecta, Coleoptera Vol. 5*: 17–152. Dulau and Co., London. https://doi.org/10.5962/bhl.title.730

Bates H.W. 1885 Insecta, Coleoptera, suppl. to Longicornia. *In*: Godman F.D. & Salvin O. (eds) *Biologia Centrali-Americana. Vol. 5*: 249–436. Dulau and Co., London.

Bates H.W. 1892. Additions to the Longicornia of Mexico and Central America, with remarks on some of the previously recorded species. *Transactions of the Entomological Society of London* 1892: 143–183. https://doi.org/10.1111/j.1365-2311.1892.tb02044.x

Bezark L.G. 2019. New species and distribution records for Mexican and Central American Cerambycidae (Coleoptera). *Zootaxa* 4551 (4): 401–414. https://doi.org/10.11646/zootaxa.4551.4.1

Bezark L.G. 2021. *Checklist of the Oxypeltidae, Vesperidae, Disteniidae and Cerambycidae, (Coleoptera) of the Western Hemisphere*. Edition 2021. Available from http://bezbycids.com/byciddb/checklists/WestHemiCerambycidae2020.pdf [accessed Dec. 2021].

Bishop T.R., Robertson M.P., Gibb H., Van Rensburg B.J., Braschler B., Chown S.L., Foord S.H., Munyai T.C., Okey I., Tshivhandekano P.G., Werenkraut V. & Parr C.L. 2016. Ant assemblages have darker and larger members in cold environments. *Global Ecology and Biogeography* 25 (12): 1489–1499. https://doi.org/10.1111/geb.12516

Blackwelder R.E. 1946. Checklist of the coleopterous insects of Mexico, Central America, the West Indies and South America. Part 4. *Bulletin of the United States National Museum* 185: 551–763. https://doi.org/10.5479/si.03629236.185.4

Blow R., Willink B. & Svensson E.I. 2021. A molecular phylogeny of forktail damselflies (genus Ischnura) reveals a dynamic macroevolutionary history of female colour polymorphisms. *Molecular Phylogenetics and Evolution* 160: 107134. https://doi.org/10.1016/j.ympev.2021.107134

Botero J.P., Santos-Silva A. & Wappes J.E. 2019. New species, a new combination, and a new country record in American Clytini (Coleoptera: Cerambycidae: Cerambycinae). *Insecta Mundi* 697: 1–19.

Bouckaert R., Heled J., Kühnert D., Vaughan T., Wu C.H., Xie D., Suchard M.A., Rambaut A. & Drummond A.J. 2014. BEAST 2: a software platform for Bayesian evolutionary analysis. *PLoS Computational Biology* 10 (4): e1003537. https://doi.org/10.1371/journal.pcbi.1003537

Casey T.L. 1912. Studies in the Longicornia of North America. *Memoirs on the Coleoptera* 3: 215–376. Available from https://www.biodiversitylibrary.org/page/962383 [accessed Dec. 2021].

Chemsak J.A. 1967. Lectotype designations of Cerambycidae in the British Museum (Natural History). *Journal of the Kansas Entomological Society* 40 (1): 73–81.

Chemsak J.A. & Linsley E.G. 1965. New genera and species of North American Cerambycidae. *The Pan-Pacific Entomologist* 41 (3): 141–153.

Chemsak J.A. & Linsley E.G. 1974. Reclassification, synonymy, and descriptions of some North and Central American Cerambycidae (Coleoptera). *The Coleopterists Bulletin* 28 (4): 181–184.

Chemsak J.A. & Noguera F.A. 1993. Annotated checklist of the Cerambycidae of the Estación de Biología Chamela, Jalisco, Mexico (Coleoptera), with descriptions of new genera and species. *Folia Entomológica Mexicana* 77: 123–140.

Chemsak J.A. & Noguera F.A. 2001. New Mexican and Central American Cerambycidae. *Occasional Papers of the Consortium Coleopterorum* 4 (1): 50–55. https://doi.org/10.1649/0010-065X(2001)055[0369:ANSOEA]2.0.CO;2

Chemsak J.A., Linsley E.G. & Noguera F.A. 1992. *Listados Faunísticos de México II. Los Cerambycidae y Disteniidae de Norteamérica, Centroamérica y las Indias Occidentales*. Instituto de Biología, Universidad Nacional Autónoma de México, Mexico.

Chevrolat L.A.A. 1835. *Coléoptères de Mexique* 4: 54–70. Impr. de G. Silbermann. Strasbourg.

Chevrolat L.A.A. 1860. Description d'espèces de *Clytus* propres au Mexique. *Annales de la Société entomologique de France* 8 (3): 451–504.

Drummond A.J., Suchard M.A., Xie D. & Rambaut A. 2012. Bayesian phylogenetics with BEAUti and the BEAST 1.7. *Molecular Biology and Evolution* 29 (8): 1969–1973. https://doi.org/10.1093/molbev/mss075

Folmer O., Black M., Hoeh W., Lutz R. & Vrijenhoek R. 1994. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology* 3 (5): 294–299.

Fontaneto D., Herniou E.A., Boschetti C., Caprioli M., Melone G., Ricci C. & Barraclough T.G. 2007. Independently evolving species in asexual bdelloid rotifers. *PLoS Biology* 5 (4): 914–921. https://doi.org/10.1371/journal.pbio.0050087

Freeland J.R., Kirk H. & Petersen S. 2011. *Molecular Ecology*. Second edition. Wiley-Blackwell, Hoboken, New Jersey. https://doi.org/10.1002/9780470979365

García-Morales L.J., García-Jiménez J., Toledo-Hernández V.H. & Cantú-Ayala C.M. 2014. Lista anotada preliminar de los Cerambycidae (Coleoptera) de Tamaulipas, México. *In*: Correa S.A., Horta J.V., García-Jiménez J. & Berrientos-Lozano L. (eds) *Biodiversidad Tamaulipeca*: 97–120. Tecnológico Nacional de México, Instituto Tecnológico de Ciudad Victoria, Tamaulipas.

Guindon S., Dufayard J.F., Lefort V., Anisimova M., Hordijk W. & Gascuel O. 2010. New algorithms and methods to estimate maximum-likelihood phylogenies: assessing the performance of PhyML 3.0. *Systematic Biology* 59 (3): 307–321. https://doi.org/10.1093/sysbio/syq010

Hartl D.L. & Clark A.G. 1997. *Principles of Population Genetics*. Fourth edition. Sinauer Associates, Inc. Sunderland, Massachusetts.

Heffern D., Botero J.P. & Santos-Silva A. 2020. Synonymies, new records, and new species in Cerambycinae (Coleoptera, Cerambycidae). *Zootaxa* 4747 (1): 177–190. https://doi.org/10.11646/zootaxa.4747.1.8

Hoang D.T., Chernomor O., Von Haeseler A., Minh B.Q. & Vinh L.S. 2018. UFBoot2: improving the ultrafast bootstrap approximation. *Molecular Biology and Evolution* 35 (2): 518–522. https://doi.org/10.1093/molbev/msx281

Hopping G.R. 1932. A revision of the Clytini of boreal America, (Cerambycidae, Coleoptera). *Annals of the Entomological Society of America* 25 (3): 529–577. https://doi.org/10.1093/aesa/25.3.529

Hopping G.R. 1937. A revision of the Clytini of boreal America, (Cerambycidae, Coleoptera) Part II. *Annals of the Entomological Society of America* 30 (3): 438–457. https://doi.org/10.1093/aesa/30.3.438

Hovore F.T. 2006. The Cerambycidae (Coleoptera) of Guatemala. *In*: Cano E. (ed.) *Biodiversidad de Guatemala, Vol. 1*: 363–378. Universidad del Valle de Guatemala, Guatemala.

Kapli P., Lutteropp S., Zhang J., Kobert K., Pavlidis P., Stamatakis A. & Flouri T. 2017. Multi-rate Poisson tree processes for single-locus species delimitation under maximum likelihood and Markov chain Monte Carlo. Bioinformatics 33 (11): 1630–1638. https://doi.org/10.1093/bioinformatics/btx025

Katoh K. & Standley D.M. 2013. MAFFT multiple sequence alignment software version 7: improvements in performance and usability. *Molecular Biology and Evolution* 30 (4): 772–780. https://doi.org/10.1093/molbev/mst010

Kimura M. 1981. Estimation of evolutionary distances between homologous nucleotide sequences. *Proceedings of the National Academy of Sciences of the USA* 78: 454–458. https://doi.org/10.1073/pnas.78.1.454

Lacordaire J.T. 1869. *Histoire naturelle des Insectes. Genera des Coléoptères, ou exposé méthodique et critique de tous les genres proposés jusqu'ici dans cet ordre d'insectes*. Vols 8 and 9. Paris. Librairie Encyclopédique de Roret. https://doi.org/10.5962/bhl.title.8864

Laporte F.L.N. & Gory H.L. 1836. Monographie du genre *Clytus*. *In*: Castelnau F. & Gory H.L. (eds) *Histoire Naturelle et iconographie des insectes coléoptères, publié par monographies séparées* 3: 1–124. Duménil, Paris. Available from https://www.biodiversitylibrary.org/item/193087#page/9/mode/1up [accessed Dec. 2021].

Law S.J., Bishop T.R., Eggleton P., Griffiths H., Ashton L. & Parr C. 2020. Darker ants dominate the canopy: testing macroecological hypotheses for patterns in colour along a microclimatic gradient. *Journal of Animal Ecology* 89 (2): 347–359. https://doi.org/10.1111/1365-2656.13110

Lawrence J.F, Beutel R.G, Leschen R.A.B. & Ślipiński A. 2010. Glossary of morphological terms. *In*: Leschen R.A.B., Beutel R.G. & Lawrence J.F. (eds) *Handbook of Zoology, Arthropoda Insecta. Coleoptera, Beetles, Morphology and Systematics, Vol. 2*: 9–20. De Gruyter, Berlin and New York. https://doi.org/10.1515/9783110911213.9

Lingafelter S.W. & Wappes J.E. 2012. A new species of *Trichoxys* Chevrolat (Cerambycidae: Cerambycinae: Clytini) from Mexico, with a key to known species. *The Pan-Pacific Entomologist* 88 (2): 154–162. https://doi.org/10.3956/0031-0603-88.2.154

Linsley E.G. 1935. Studies in the Longicornia of Mexico (Coleoptera: Cerambycidae). *Transactions of the American Entomological Society* 61: 67–102.

Linsley E.G. 1959. Ecology of Cerambycidae. *Annual Review of Entomology* 4 (1): 99–138. https://doi.org/10.1146/annurev.en.04.010159.000531

Linsley E.G. 1961. *The Cerambycidae of North America. Part I. Introduction*. University of California Publications in Entomology, University of California Press, Berkeley.

Linsley E.G. 1964. *The Cerambycidae of North America. Part V. Taxonomy and Classification of the Subfamily Cerambycinae, Tribes Callichromini through Ancylocerini*. University of California Press, California.

MacRae T.C., Bezark L.G. & Swift I. 2012. Notes on distribution and host plants of Cerambycidae (Coleoptera) from Southern Mexico. *The Pan-Pacific Entomologist* 88 (2): 173–187. https://doi.org/10.3956/2012-10.1

Minh B.Q., Nguyen M.A.T. & von Haeseler A. 2013. Ultrafast approximation for phylogenetic bootstrap. *Molecular Biology and Evolution* 30 (5): 1188–1195. https://doi.org/10.1093/molbev/mst024

Monné M.A. 1993. *Catalogue of the Cerambycidae (Coleoptera) of the Western Hemisphere. Part IX. Subfamily Cerambycinae: Tribes Clytini, Anaglyptini, Tillomorphini and Cleomenini*. Sociedade Brasileira de Entomologia, São Paulo.

Monné M.A. 2005. Catalogue of the Cerambycidae (Coleoptera) of the Neotropical Region. Part I. Subfamily Cerambycinae. *Zootaxa* 946 (1): 1–765. https://doi.org/10.11646/zootaxa.946.1.1

Monné M.A. 2012. Catalogue of the type-species of the genera of the Cerambycidae, Disteniidae, Oxypeltidae and Vesperidae (Coleoptera) of the Neotropical Region. *Zootaxa* 3213 (1): 1–183. https://doi.org/10.11646/zootaxa.3213.1.1

Monné M.A. 2021. Catalogue of the Cerambycidae (Coleoptera) of the Neotropical region. Part II. Subfamily Cerambycinae. Edition 2021. Available from http://cerambyxcat.com/ [accessed Dec. 2021].

Monné M.A. & Giesbert E.F. 1994. *Checklist of the Cerambycidae and Disteniidae* (*Coleoptera*) *of the Western Hemisphere*. Wolfsgarden Books, Burbank.

Monné M.A. & Hovore F.T. 2006. Electronic checklist of the Cerambycidae and Disteniidae (Coleoptera) of the Western hemisphere. Available from http://www.hovore.com [accessed Dec. 2021].

Nguyen L.T., Schmidt H.A., Von Haeseler A. & Minh B.Q. 2015. IQ-TREE: a fast and effective stochastic algorithm for estimating maximum-likelihood phylogenies. *Molecular Biology and Evolution* 32 (1) 268–274.

Noguera F.A. & Chemsak J.A. 1996. Cerambycidae (Coleoptera). *In*: Llorente-Bousquets J.E., Morrone J.J., Yáñez-Ordóñez O. & Vargas-Fernández I. (eds) *Biodiversidad, Taxonomía, y Biogeografía de Artrópodos de México: Hacia una Síntesis de su Conocimiento*: 381–409. Universidad Nacional Autónoma de México, Mexico.

Noguera F.A. & Gutiérrez N. 2016. New distributional records of Cerambycidae (Coleoptera) from Mexico. *The Coleopterists Bulletin* 70 (3): 656–662. https://doi.org/10.1649/0010-065X-70.3.656

Ordóñez-Reséndiz M.M. & Martínez-Ramos Y. 2017. Diversidad y fenología de Cerambycidae (Insecta: Coleoptera) en bosques de la Sierra de Taxco, México. *Entomología mexicana* 4: 826–831.

Pérez-Flores O., Toledo-Hernández V.H., Bezark L.G. & Monné M.A. 2021. Updated checklist of the Cerambycidae (Coleoptera: Chrysomeloidea) from Mexico. *Zootaxa* 5005 (4): 460–502. https://doi.org/10.11646/zootaxa.5005.4.2

Pons J., Barraclough T.G., Gómez-Zurita J., Cardoso A., Duran D.P., Hazell S., Kamoun S., Sumlin W. & Vogler A.P. 2006. Sequence-based species delimitation for the DNA taxonomy of undescribed insects. *Systematic Biology* 55 (4): 595–609. https://doi.org/10.1080/10635150600852011

Puillandre N., Lambert A., Brouillet S. & Achaz G. 2012. ABGD, Automatic Barcode Gap Discovery for primary species delimitation. *Molecular Ecology* 21 (8): 1864–1877. https://doi.org/10.1111/j.1365-294X.2011.05239.x

Rambaut A. 2018. FigTree version 1.4.4. Computer program and documentation distributed by the author. Available from http://tree.bio.ed.ac.uk/software/figtree/ [accessed Nov. 2021].

Rambaut A., Drummond A.J., Xie D., Baele G. & Suchard M.A. 2018. Posterior summarisation in Bayesian phylogenetics using Tracer 1.7. *Systematic Biology* 67 (5): 901–904. https://doi.org/10.1093/sysbio/syy032

Svacha P. & Lawrence J.F. 2014. Cerambycidae Latreille, 1802. *In*: Leschen R.A.B. & Beutel R.G (eds) *Handbook of Zoology, Arthropoda: Insecta, Coleoptera 3*: 77–177. Walter de Gruyter, Berlin and New York. https://doi.org/10.1515/9783110274462.77

Tavakilian G. & Chevillotte H. 2021. Titan, base de données internationales sur les Cerambycidae ou longicornes. Version 2021. Available from http://titan.gbif.fr/index.html [accessed Dec. 2021]

Thomson J. 1861. *Essai d'une classification de la famille des Cérambycides et matériaux pour servir à une monographie de cette famille*. Chez l'auteur et au Bureau du Trésorier de la Société entomologique de France, Paris. https://doi.org/10.5962/bhl.title.9206

Thomson J. 1864. Systema cerambycidarum ou exposé de tous les genres compris dans la famille des cérambycides et familles limitrophes. *Mémoires de la Société royale des Sciences de Liège* 19: 1–352.

Thomson J. 1865. Diagnoses d'espèces nouvelles qui seront décrites dans l'appendix du systema cerambycidarum. *Mémoires de la Société royale des Sciences de Liège* 19: 353–578.

Turnbow R.H. & Thomas M.C. 2002. Cerambycidae Leach 1815. *In*: Arnett R.H.J., Thomas M.C., Skelley P.E & Frank J.H. (eds) *American Beetles, Polyphaga: Scarabeoidea through Curculionoidae*: 568–601. CRC Press, Boca Raton, Florida. https://doi.org/10.1201/9781420041231.ch8

Turnbow R.H., Cave R.D. & Thomas M.C. 2003. A list of Cerambycidae of Honduras, with additions of previously unrecorded species. *Ceiba* 44 (1): 1–43.

Wappes J.E, Santos-Silva A. & Botero J.P. 2018. Description of a new species of *Ochraethes* Chevrolat, 1860, redescription of *Plocaederus mirim* Martins and Monné, 2002, and new geographical records for *Plocaederus* Dejean, 1835 (Coleoptera, Cerambycidae, Cerambycinae). *Insecta Mundi* 0609 (1): 1–8.

Wheeler Q.D. & Platnick N.I. 2000. The phylogenetic species concept (sensu Wheeler and Platnick). *In*: Wheeler Q.D. & Meier R. (eds) *Species Concepts and Phylogenetic Theory*: 55–69. Columbia University Press, New York.

White A. 1855. Longicornia 2. *In*: Boehman C.H., Smith F. & White A. (eds) *Catalogue of the coleopterous insects in the collection of the British Museum* 8: 175–412. British Museum, London. Available from https://www.biodiversitylibrary.org/item/122645#page/3/mode/1up [accessed Dec. 2021].

Zhang J., Kapli P., Pavlidis P. & Stamatakis A. 2013. A general species delimitation method with applications to phylogenetic placements. *Bioinformatics* 29 (22): 2869–2876. https://doi.org/10.1093/bioinformatics/btt499

Manuscript received: 17 January 2022
Manuscript accepted: 5 September 2022
Published on: 20 October 2022
Topic editor: Tony Robillard
Section editor: Max Barclay
Desk editor: Pepe Fernández