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Review of the world species of *Exoryza* (Hymenoptera, Braconidae, Microgastrinae), with description of five new species

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Abstract

The world species of the genus *Exoryza* (Hymenoptera, Braconidae, Microgastrinae) are revised. Ten species are recognized, including five new, authored by Fernandez-Triana: *mariabustosae*, *richardashleyi*, *ritaashleyae*, *rosamatarritae* and *yeimycedenoae*. The species *Dolichogenidea oryzae* Walker, 1994 is considered as related to *Exoryza* – although is not formally transferred to that genus. A dichotomous key to all species, descriptions and illustrations are provided. The only region where the genus is not yet recorded is Australasia, but this may be a collecting artifact. Host caterpillars (Lepidoptera) include species within Choreutidae, Depressariidae, Gelechiidae, and Pyraloidea – all but Pyraloidea are new host records. The status of *Exoryza* is questioned (it may only represent a species-group within the genus *Dolichogenidea*) but it is retained as a valid genus until a comprehensive phylogenetic study of Microgastrinae is available.

Key Words

Microgastrinae
Exoryza
taxonomic revision
parasitoid wasps
DNA barcoding

Introduction

The braconid subfamily Microgastrinae contains more than 60 genera (Yu et al. 2012), many of them lacking comprehensive revisions and keys to their species. *Exoryza* is a rarely collected genus (Mason 1981, Valerio et al. 2004), and it is poorly represented in collections. It was described by Mason (1981) to include two species of Apantelini (*sensu* Mason 1981) with broad and heavily sculptured metasomal tergites 1–2, and a coarsely rugose and areolate propodeum. Three other species have since been described (Song and Chen 2003, Valerio et al. 2004, Rousse and Gupta 2013), expanding the known distribution of the genus to all continents but Australia.

Here we review *Exoryza*, as it occurs in Area de Conservación Guanacaste (ACG), northwestern Costa Rica (Janzen et al. 2009, Janzen and Hallwachs 2011), as part of comprehensive studies of ACG Microgastrinae (e.g., Fernandez-Triana et al. 2014). Five new species are described, and a key to the known *Exoryza* of the world is provided.

Methods

Most of the specimens studied were Malaise-trapped or reared in ACG, and a few additional specimens were available in the Canadian National Collection of Insects (CNC) in Ottawa, Canada. Five species of *Exoryza* had been described previously; we were able to examine the holotypes of *E. minnesota* and *E. monocavus*, but the original descriptions and illustrations of the rest were sufficiently detailed to allow description of the new species with confidence.

The following institution acronyms are used:

BMNH	The Natural History Museum, London, United Kingdom
FAFU	Fujian Agriculture and Forestry University, Fujian, China
INBio	Instituto Nacional de Biodiversidad, San José, Costa Rica
MNHN	Muséum National d'Histoire Naturelle, Paris, France
NMNH	National Museum of Natural History, Washington DC, United States.

Morphological terms, measurements of structures, and body ratios are mostly as used by Mason (1981), Huber and Sharkey (1993), Whitfield (1997), Karlsson and Ronquist (2012), and Fernández-Triana et al. (2014). Mediotergites 1, 2, etc., are abbreviated as T1, T2, etc; ocular ocellar line as OOL, and posterior ocellar line as POL. The diagnostic descriptions include characters that are commonly used in describing Microgastrinae (e.g., body measurements such as length of body, fore wing and ovipositor sheath, hind wing vannal lobe shape and fringe, and color of particular body areas).

The dichotomous key and descriptions of the new species are based on the study of all available female specimens, to assess intraspecific variation. Body measurements shown are mostly from the holotype specimens. Whenever possible, information on additional female specimens was also included, between parentheses after the holotype data; the voucher codes of those specimens are provided under 'Paratypes' in the corresponding description of each species. Males were not studied morphologically, as most species can only be readily identified by association with females via rearing or molecular data.

Photos were taken with a Keyence VHX-1000 Digital Microscope, using a lens with a range of 13–130×. Multiple images through the focal plane were taken of a structure and these were combined to produce a single in-focus image, using the software associated with the Keyence System.

Together with morphological studies, we also analyzed DNA barcodes (the 5' region of the cytochrome c oxidase I (CO1) gene, Hebert et al. 2003) whenever available. DNA barcodes were obtained using DNA extracts prepared from single legs using a glass fibre protocol (Ivanova et al. 2006). Briefly, total genomic DNA was re-suspended in 30 µl of dH2O, and a 658-bp region near the 5' terminus of the CO1 gene was amplified using standard primers (LepF1–LepR1) following established protocols (Smith et al. 2006, 2007, 2008). If the initial 658 bp amplification was unsuccessful, smaller sequences were generated using internal primers. If each amplification was successful, a composite sequence was generated. However in cases where only one read amplified, this shorter sequence was used. A neighbor-joining (NJ) tree based on Kimura 2-parameter to visually demonstrate the variation present within and between each species in the DNA barcode locus is presented in Figure 40. All information for the sequences (including GenBank accessions) associated with each individual specimen can be retrieved from the Barcode of Life Data System (BOLD) (Ratnasingham and Hebert 2007) using the persistent DOI dx.doi.org/10.5883/DS-ASEXORYZ [requested April 15, 2016 but not yet active].

The new ACG species described below received patronyms honoring the teachers and supporters of a biodiversity conservation event and school child nature awareness competition, conducted by the Programa de Educación Biológica (PEB) of ACG in the last half of 2015 (Kazmier 2015).

Results

Diagnosis and status of *Exoryza*

Diagnosis. Heavily sculptured and broad T1 and T2 (usually with strong longitudinal striation); T2 rectangular or nearly so, as long as or longer than T3 (Figs 5, 12, 18, 24, 31, 38); fore wing without areolet; vannal lobe straight to concave, uniformly fringed by setae (Figs 4, 11, 17, 35); propodeum sculptured and with areola (but sometimes areola obscured by other sculpture) (Figs 4, 11, 17, 18, 23, 24, 30, 37). The uniformly setose vannal lobe separates *Exoryza* from *Apanteles*, while the sculpture of T1 and T2 distinguishes *Exoryza* from *Dolichogenidea* (but see below).

The status of *Exoryza* as a valid genus has been questioned by many authors (e.g., Valerio et al. 2004, Rousse and Gupta 2013, Fernandez-Triana et al. 2014). Mason (1981) characterized *Exoryza* as having T1 and T2 heavily sculptured, and propodeum coarsely rugose (with areola present but obscured by propodeum sculpture). The distinction between it and *Dolichogenidea* is particularly difficult (e.g., Fernandez-Triana et al. 2014), since many species of *Dolichogenidea* have a sculptured propodeum (with or without areola), and T1 is occasionally sculptured (although not as strongly as in *Exoryza*). T2 is also more or less broadly trapezoidal in shape in *Exoryza*, without the more or less sinuate hind margin many *Dolichogenidea* species have. All known sequences (DNA barcodes) of *Exoryza* cluster together in a NJ tree containing more than 50 genera and 17,518 sequences of world species of Microgastrinae (see Appendix S2 in Smith et al. 2013, page 41, sequences 4019–4041); but they are within a larger cluster containing *Dolichogenidea* (and a few specimens of *Parapanteles* and *Apanteles* which were most likely misidentified and are actually *Dolichogenidea*). With no recent, comprehensive phylogenetic study of Microgastrinae available, we consider it best to maintain *Exoryza* as a valid genus for the time being.

Diversity and host data

Five species of *Exoryza* were previously known (Mason 1981, Song and Chen 2003, Valerio et al. 2004, Rousse and Gupta 2013), and five new species are described below for a total of 10 species worldwide. *Dolichogenidea oryzae* Walker, 1994 could probably be included within *Exoryza* as well –based on the examined specimens (including holotype), host data (*Chilo* spp.) and distribution (West Africa), that species fits well within the generic concept used in the present paper. However, we have refrained from transferring *D. oryzae* to *Exoryza* due to the possibility that in the future *Exoryza* becomes a synonym of *Dolichogenidea* –see comments in previous paragraphs. But we include *D. oryzae* in the dichotomous key for *Exoryza* species provided below.

Exoryza seems to be almost cosmopolitan, with one species recorded from the Nearctic, six Neotropical, one Afrotropical, one Oriental, and one species found in both the Oriental and Eastern Palaearctic regions (Table 1). So far the only region where the genus has not been recorded is Australasia, but this may be a collecting artifact. We anticipate that additional species will be found as more collecting and study of world collections advances.

Only one of the five previously described species, *E. schoenobii* (Wilkinson), had associated host data. It was reared from five species of Lepidoptera within four genera of Pyraloidea (Yu et al. 2012). That wasp species has been rather extensively studied as a biocontrol agent of stem-boring Lepidoptera in rice fields in Asia (see compilation of references in Yu et al. 2012). Here we report additional hosts species for *Exoryza*, all based on rearing from small leaf-rolling and leaf-silking caterpillars in ACG (Janzen et al. 2009): Choreutidae ('*Brenthia* Janzen05'), several species of Gelechiidae (subfamily Dichomeridinae, with interim names 'gelJanzen01 Janzen16', 'gelJanzen01 Janzen319', 'gelJanzen01 Janzen349'), and Depressariidae ('*Stenoma* Phillips543').

Table 1. World species of *Exoryza*. Geographical distribution and associated host data from Yu et al. (2012) and the present paper. ACG- Area de Conservación Guanacaste; AFR- Afrotropical; NEA- Nearctic; NEO- Neotropical; OTL- Oriental; PAL- Palaearctic. (*)- New country record. The species *Dolichogenidea oryzae* Walker, 1994 is also included (see text for explanation about that species).

***Exoryza* species**	**Geographical distribution**	**Host**	**Host Plant**
D. oryzae Walker, 1994	AFR (Gambia (*), Ivory Coast, Niger, Senegal)	Pyraloidea: *Chilo diffusilineus* (de Joannis), *Chilo zacconius* Bleszynski, 1970	*Oryza sativae* (Poaceae)
E. mariabustosae Fernandez-Triana	NEO (Costa Rica: ACG)	Gelechiidae: 'gelJanzen01 Janzen319'	*Sloanea faginea* (Elaeocarpaceae)
E. minnesota Mason, 1981	NEA (Canada: Ontario; US: Minnesota)	Unknown	Unknown
E. monocavus Valerio & Whitfield, 2004	NEO (Costa Rica: Punta Arenas)	Unknown	Unknown
E. reticarina Song & Chen 2003	OTL (China: Yunan)	Unknown	Unknown
E. richardashleyi Fernandez-Triana	NEO (Costa Rica: ACG)	Gelechiidae: 'gelJanzen01 Janzen349'	Unknown
E. ritaashleyae Fernandez-Triana	NEO (Costa Rica: ACG)	Unknown	Unknown
E. rosamatarritae Fernandez-Triana	NEO (Costa Rica: ACG)	Choreutidae: '*Brenthia* Janzen05'; Depressariidae: '*Stenoma* Phillips543'; Gelechiidae: 'gelJanzen01 Janzen16'	*Desmopsis schippii* (Annonaceae), *Pterocarpus officinalis* (Fabaceae), *Pachira aquatica* (Malvaceae)
E. schoenobii (Wilkinson, 1932)	OTL/PAL (Bangladesh; China: Fujian, Guangdong, Guangxi, Guizhou, Hainan Island, Hubei, Hunan, Jiangsu, Jiangxi, Sichuan, Taiwan, Yunnan, Zhejiang; India; Malaysia, Philippines; Sri Lanka; Vietnam)	Pyraloidea: *Chilo polychrysus* (Meyrick, 1932); *C. supressalis* (Walker, 1863); *Glaucocharis reniell*a Wang & Sung, 1988; *Schoenobius bipunctifer* Strand, 1918, *Scirpophaga incertulas* (Walker, 1863)	Unknown
E. safranum Rousse & Gupta 2013	AFR (Réunion)	Unknown	Unknown
E. yeimycedenoae Fernandez-Triana	NEO (Costa Rica: ACG)	Unknown	Unknown

Key to known species of *Exoryza* and *Dolichogenidea oryzae* (see text for explanation about inclusion of the *Dolichogenidea* species).

1 Basal tergites reddish-yellow, metasoma mostly yellow; ovipositor sheaths 0.7 x as long as metatibia [China] ..... *Exoryza reticarina* Song & Chen, 2003

· Basal tergites black, metasoma mostly dark brown to black (Figs 5, 12, 18, 24, 31, 38); ovipositor sheaths usually as long as or longer than metatibia length 2

2(1) Metacoxa and metafemur entirely black; ovipositor sheaths almost twice as long as metatibia [Réunion island]..... *Exoryza safranum* Rousse & Gupta, 2013

· Metacoxa and metafemur entirely to partially yellow; ovipositor sheaths much shorter (0.7–1.5 x as long as metatibia)..3

3(2) T1 strongly broadening towards posterior margin (Figs 3, 5), its length 0.8–1.0 x its width at posterior margin, and its width at anterior margin 0.5–0.7 x its width at posterior margin; propodeum areola obscured by surrounding heavy sculpture (Figs 4, 5); metapleuron entirely sculptured [Old World tropics]..... 4

· T1 less strongly broadening towards posterior margin (Figs 12, 18, 24, 31, 38), its length at least 1.1 x its width at posterior margin (usually more) and its width at anterior margin 0.8–0.9 x its width at posterior margin; propodeum areola clearly marked by carinae (Figs 11, 17, 18, 23, 24, 30); metapleuron mostly smooth [New World] 5

4(3) Mesopleuron mostly smooth (Fig. 6); metafemur length 2.9 x metatibia length (Fig. 6); malar line 0.9 x mandible width (Fig. 1); ovipositor sheaths 0.7 x metatibia length [Afrotropics: Gambia, Ivory Coast, Niger, Senegal] ..... *Dolichogenidea oryzae* Walker, 1994

· Mesopleuron entirely sculptured; metafemur length 3.1 x metatibia length; malar line 0.5 x mandible width; ovipositor sheaths as long as metatibia length [Oriental: Bangladesh, China, India, Malaysia, Philippines, Sri Lanka, Vietnam].... *Exoryza schoenobii* (Wilkinson, 1932)

5(3) T1 barrel-shaped, with lateral margins convex; metapleuron with medial pit present but not conspicuously deep or evident [Nearctic: USA and Canada] ..... *Exoryza minnesota* Mason, 1981

· T1 parallel-sided to slightly widening towards posterior margin, with lateral margins straight (Figs 12, 18, 24, 31, 38); metapleuron with a conspicuously deep central pit [Neotropics: Costa Rica] 6

6(5) Body length 2.3–2.5 mm; metatibia dark brown to black on posterior 0.5–0.7 (Figs 13, 32)..... 7

· Body length 3.1–3.8 mm; metatibia dark brown to black on posterior 0.1–0.2 (Figs 19, 25, 39)..... 9

7(6) Flagellomere 16 length 2.5 x flagellomere 15 length; ocular ocellar line 1.4 x posterior ocellar line; metafemur length 3.4 x its width; metatibia dark brown to black on posterior 0.5 [Costa Rica: Puntarenas, at 1,000–1,035 m]..... *Exoryza monocavus* Valerio & Whitfield, 2004

· Flagellomere 16 length 1.2 x flagellomere 15 length; ocular ocellar line 1.0–1.1 x posterior ocellar line; metafemur length 3.6–3.8 x its width; metatibia dark brown to black on posterior 0.6–0.7 [Costa Rica, ACG, mostly collected at 500-600m] 8

8(7) T3 entirely smooth (Fig. 12); T1 and T2 mostly with longitudinally striated sculpture (Fig. 12); tarsal claws of hind legs with single spine-like basally ..... *Exoryza mariabustosae* Fernandez-Triana, sp. n.

· T3 sculptured on anterior 0.2–0.5 (but mostly centrally) (Fig. 31); T1 and T2 mostly with reticulate sculpture (Fig. 31); tarsal claws of hind legs simple ..... *Exoryza rosamatarritae* Fernandez-Triana, sp. n.

9(6) Pterostigma with pale yellow spot on proximal 0.5 (Fig. 16); smaller species (body length 3.1 mm and fore wing length 3.4 mm); thinner metafemur (4.1 x as long as maximum width) (Fig. 19)..... *Exoryza richardashleyi* Fernandez-Triana, sp. n.

· Pterostigma mostly brown, at most with small pale spot on proximal 0.1–0.2 (Figs 22, 36); larger species (body length 3.3–3.8 mm and fore wing length 3.5–4.1 mm); thicker metafemur (3.6–3.8 x as long as maximum width) (Figs 25, 39) 10

10(9) Metatibial spurs with brown tips; flagellomere 2 length 2.1 x flagellomere 14 length ..... *Exoryza yeimycedenoae* Fernandez-Triana, sp. n.

· Metatibial spurs entirely yellow; flagellomere 2 length 2.5 x flagellomere 14 length ..... *Exoryza ritaashleyae* Fernandez-Triana, sp. n.

Taxonomic treatment of species

Dolichogenidea oryzae Walker, 1994

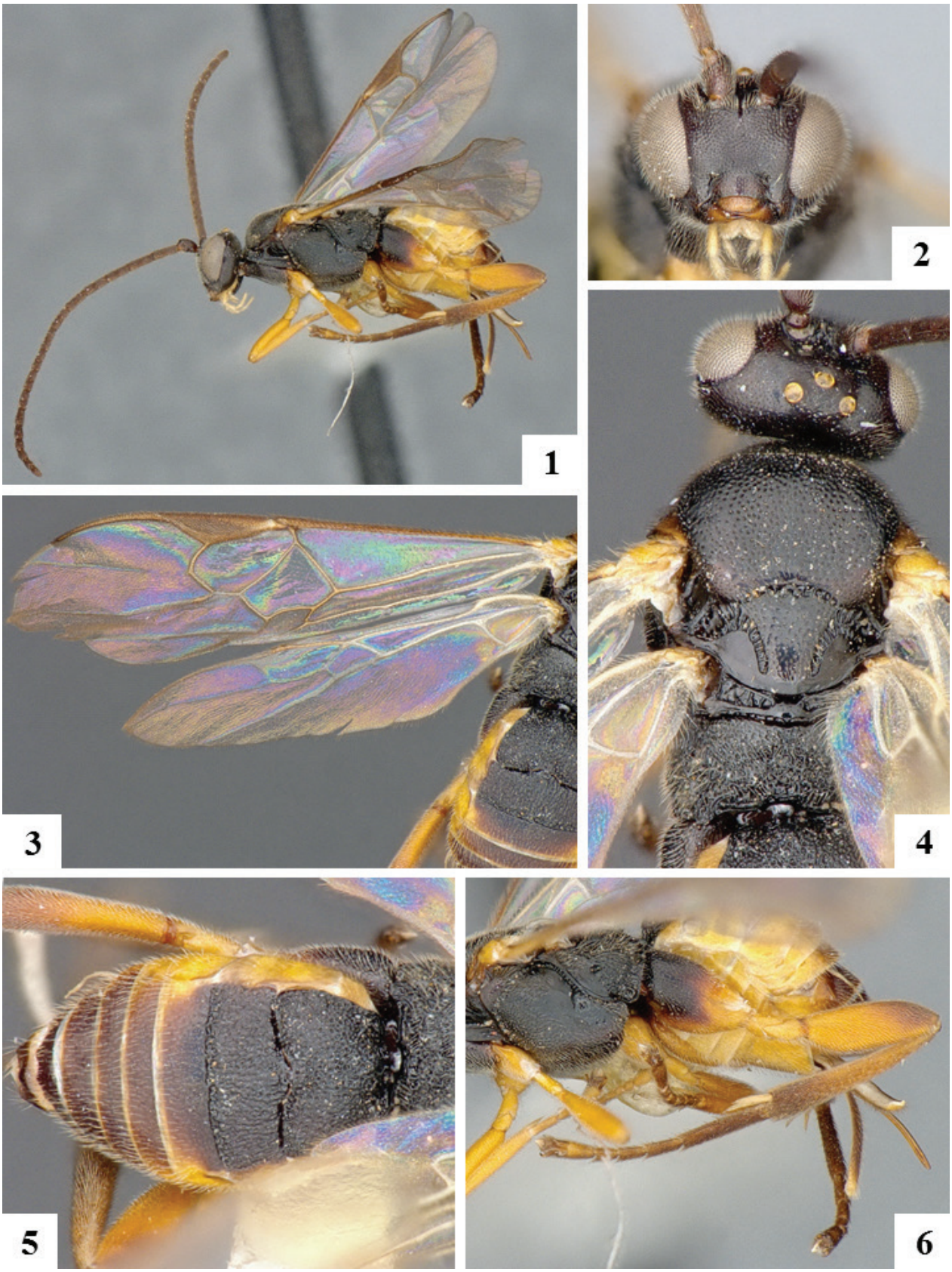
Figs 1–6

Dolichogenidea oryzae Walker, 1994: 426. Original description.

Holotype. Female, BMNH (examined). SENEGAL: Ziguinchor, Djibelor, 5.ix.1981 (J. Etienne leg.), Braconidae ectoparasite de *Chilo* sur Riz, CIE A17916.

Other specimens examined. 1 #F (CNC), Republic of the Gambia, Bakan, 19.i.1978, coll. L. Huggert. DNA voucher code: CNCHYM 01202.

Diagnostic description. Body color. Head (except for clypeus and mandibles), mesosoma and T1–T2 black,



Figures 1–6. *Dolichogenidea oryzae*.

remaining mediotergites brown; laterotergites, sternites and hypopygium yellow; antennal flagellomeres brown; tegula and wing base yellow; pterostigma mostly brown (with small pale spot on proximal 0.1); legs mostly yellow-orange except for metacoxa (black on proximal 0.6, yellow-orange on distal 0.4), metafemur (distal 0.2 dorsally brown), metatibia (distal 0.3 brown), and metatarsus (brown). **Body ratios.** Flagellomere 2 length/width: 3.2 x. Flagellomere 14 length/width: 2.0 x. Malar line/mandible width: 0.9 x. Metafemur length/width: 2.9 x. Metatibial inner/outer spur length: 1.2 x. T1 length/width at posterior margin: 0.7 x. T2 length/width at posterior margin: 0.4 x. Ovipositor sheaths length/metatibia length: 0.7 x. **Body measurements (all in mm).** Body length: 3.2. Fore wing length: 3.4. Flagellomere 2 length/width: 0.26/0.08. Flagellomere 14 length/width: 0.13/0.065. Flagellomeres 1/2/3/14/15/16 length: 0.27/0.26/0.26/0.13/0.12/0.16. OOL: 0.15. POL: 0.13. Diameter of posterior ocellus: 0.07. Malar line/mandible width: 0.09/0.10. Metafemur length/width: 0.75/0.26. Metatibia length: 1.08. First segment of metatarsus length: 0.51. Metatibial inner/outer spur length: 0.28/0.23. T1 length/width at anterior margin/width at posterior margin: 0.46/0.36/0.65. T2 length/width at posterior margin: 0.30/0.71. T3 length: 0.21. Ovipositor sheaths length: 0.75.

Biology. Reared from Pyraloidea (*Chilo diffusilineus* (de Joannis), *Chilo zacconius* Bleszynski, 1970) (Walker 1994).

Distribution. Gambia, Ivory Coast, Niger, Senegal.

Notes. All available evidence (morphology, biology) strongly suggests this species belongs to *Exoryza*. But we have not transferred the species to that genus due to the possibility that *Exoryza* is synonymized under *Dolichogenidea* in the future (see further discussion on the topic above). The diagnostic description provided above, as well as the pictures of the species were based on the female specimen deposited in the CNC. For more details, the original description of the species (Walker 1994) should also be consulted.

Exoryza mariabustosae Fernandez-Triana, sp. n.

http://zoobank.org/8C75D0A4-4EF7-4C82-8589-162345CD0428
Figs 7–13

Holotype. Female, CNC. COSTA RICA: Guanacaste, ACG, Sector Pitilla, Sendero Cuestona, 640m, 10.99455, -85.41461, 5.ix.2011, coll. Manuel Rios. DNA voucher code: DHJPAR0048181.

Paratypes. 4 #M (CNC, NMNH). Costa Rica, Alajuela, ACG. DNA voucher codes: DHJPAR0051074, DHJPAR0051184, DHJPAR0052269, DHJPAR0052281.

Diagnostic description. Body color. Head (except for clypeus and mandibles), mesosoma and metasoma (dorsally) dark brown to black; laterotergites, sternites and hypopygium partially yellow, partially dark brown; antennal flagellomeres dark brown; tegula and wing base white-yellow; pterostigma mostly brown (with small pale spot on proximal 0.1); legs mostly white-yellow except for metacoxa (black on proximal 0.7, white-yellow on distal 0.3), metafemur (distal 0.1 dorsally brown), metatibia (distal 0.7 dark brown), and metatarsus (dark brown). **Body ratios.** Flagellomere 2 length/width: 3.1 x. Flagellomere 14 length/width: 1.3 x. Malar line/mandible width: 1.1 x. Metafemur length/width: 3.6 x. Metatibial inner/outer spur length: 1.2 x. T1 length/width at posterior margin: 1.2 x. T2 length/width at posterior margin: 0.4 x. Ovipositor sheaths length/metatibia length: 0.9 x. **Body measurements (all in mm).** Body length: 2.5. Fore wing length: 2.7. Flagellomere 2 length/width: 0.23/0.075. Flagellomere 14 length/width: 0.09/0.07. Flagellomeres 1/2/3/14/15/16 length: 0.22/0.23/0.21/0.09/0.09/0.11. OOL: 0.12. POL: 0.11. Diameter of posterior ocellus: 0.065. Malar line/mandible width: 0.08/0.07. Metafemur length/width: 0.72/0.20. Metatibia length: 0.82. First segment of metatarsus length: 0.41. Metatibial inner/outer spur length: 0.19/0.16. T1 length/width at anterior margin/width at posterior margin: 0.40/0.29/0.33. T2 length/width at posterior margin: 0.18/0.46. T3 length: 0.14. Ovipositor sheaths length: 0.70.

Male. As female but metacoxa and metatibia entirely dark brown to black, and T1–T2 narrower and smaller.
Biology. Reared from Gelechiidae (an undetermined species with interim name ‘gelJanzen01 Janzen319’).

Distribution. Costa Rica, Alajuela and Guanacaste provinces, ACG (Sectors Pitilla, San Cristobal and Rincon Rain Forest), between 527–980m.

Etymology. Named in honor of María Margarita Bustos González for her enthusiasm in teaching her La Garita Vieja students to understand and protect the wild nature that occurs in her homeland.

Exoryza minnesota Mason, 1981

Exoryza minnesota Mason, 1981: 40. Original description.

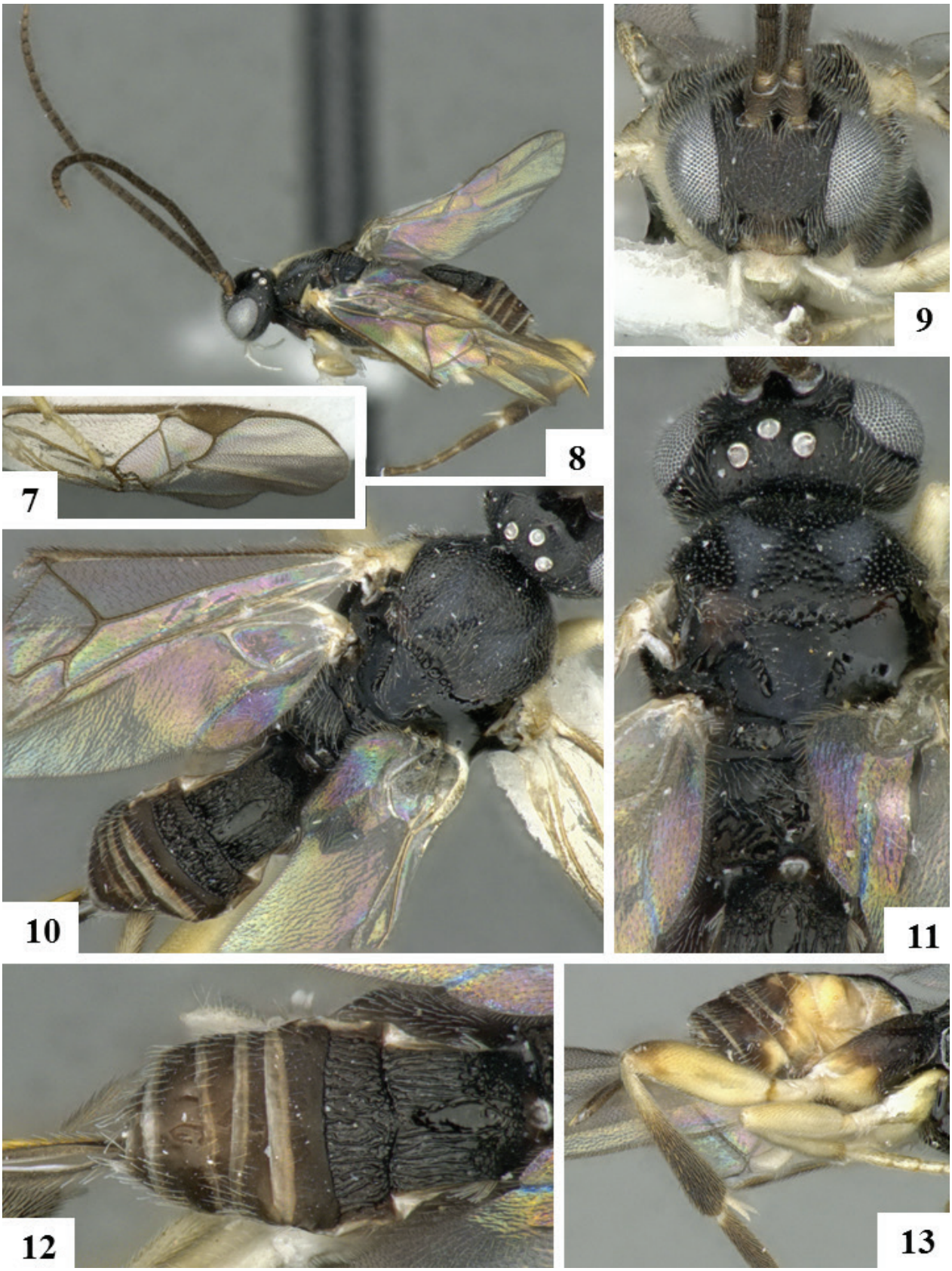
Holotype. Female, NMNH (examined). UNITED STATES: Minnesota, Lake Itasca, Westside across from Biological Station, 28.vii.1963, coll. D. L. Deonier.

Description. Detailed descriptions and images of the species available in Mason (1981) and Valerio et al. (2004).

Biology. Unknown.

Distribution. Canada (Ontario) and United States (Michigan) (Mason 1981, Valerio et al. 2004, Fernandez-Triana 2010).

Comments. Valerio et al. (2004) mentioned that the holotype of this species was in the CNC. However, the NMNH is the institution actually storing the type – see the original description for details (Mason 1981: 41).



Figures 7–13. *Exoryza mariabustosae*, holotype.

Exoryza monocavus Valerio & Whitfield, 2004

Exoryza monocavus Valerio & Whitfield, 2004: 3. Original description.

Holotype. Female, INBio (examined). COSTA RICA: Puntarenas, San Luis, Monte Verde, Buen Amigo, 1,000–1,350m, xi-1994, coll. Z. Fuentes de Luz, LN 250850–449250.

Description. A detailed description and images of the species are available in Valerio et al. (2004).

Biology. Unknown.

Distribution. Known only from the holotype locality in Costa Rica.

Exoryza reticarina Song & Chen, 2003

Exoryza reticarina Song & Chen, 2003: 287. Original description.

Holotype. Female, FAFU (not examined). CHINA: Xishuangbanna, Yunnan, 19-ix-1988, coll. Zhang Liqin.

Description. A detailed description of the species and images are available in Song and Chen (2003).

Biology. Unknown.

Distribution. Known only from the holotype locality in China.

Exoryza richardashleyi **Fernandez-Triana, sp. n.**

http://zoobank.org/EA513E18-11FE-4118-B5E7-1EB1A312C20B
Figs 14–19

Holotype. Female, CNC. COSTA RICA: Guanacaste, ACG, Sector Cacao, Sendero Cima, 1,460m, 10.93328, -85.45729, 18.xii.2008, coll. D. Janzen & W. Hallwachs. DNA voucher code: DHJPAR0031507.

Paratype. 1 #M (CNC). Costa Rica, Alajuela, ACG, same locality than holotype. DNA voucher code: DHJPAR0031469.

Diagnostic description. Head (except for clypeus and mandibles), mesosoma and metasoma (dorsally) dark brown to black; laterotergites, sternites and hypopygium partially yellow, partially dark brown; antennal flagellomeres dark brown; tegula and wing base yellow-brown; pterostigma pale yellow on proximal 0.5, brown on distal 0.5; legs mostly white-yellow except for metacoxa (black on proximal 0.7, white-yellow on distal 0.3), metafemur (distal 0.1 dorsally brown), metatibia (distal 0.2 dark brown, but also with narrow brown band dorsally on distal 0.5), and metatarsus (dark brown). **Body ratios.** Flagellomere 2 length/width: 3.2 x. Flagellomere 14 length/width: 1.5 x. Malar line/mandible width: 0.9 x. Metafemur length/width: 4.1 x. Metatibial inner/outer spur length: 1.1 x. T1 length/width at posterior margin: 1.1 x. T2 length/width at posterior margin: 0.4 x. Ovipositor sheaths length/metatibia length: 1.3 x (approximate value). **Body measurements (all in mm).** Body length: 3.1. Fore wing length: 3.4. Flagellomere 2 length/width: 0.26/0.08. Flagellomere 14 length/width: 0.105/0.07. Flagellomeres 1/2/3/14/15/16 length: 0.27/0.26/0.25/0.105/0.105/0.14. OOL: 0.14. POL: 0.13. Diameter of posterior ocellus: 0.08. Malar line/mandible width: 0.09/0.10. Metafemur length/width: 0.95/0.23. Metatibia length: 1.10. First segment of metatarsus length: 0.51. Metatibial inner/outer spur length: 0.21/0.19. T1 length/width at anterior margin/width at posterior margin: 0.46/034/0.42. T2 length/width at posterior margin: 0.19/0.52. T3 length: 0.19. Ovipositor sheaths length: 1.50 (approximate value).

Male. As female, with slightly smoother sculpture.

Biology. Reared from Gelechiidae (an undetermined species with interim name ‘gelJanzen01 Janzen349’).

Distribution. Costa Rica, Alajuela and Guanacaste provinces, ACG (Sectors Cacao and Rincon Rain Forest), between 980–1,460m.

Etymology. Named in honor of Richard Ashley from Huacas, Nicoya, for his serious enthusiasm for understanding and protecting the wild nature that occurs all around him, and specifically for causing 20 Guanacaste school children and their teachers to begin to share that enthusiasm.

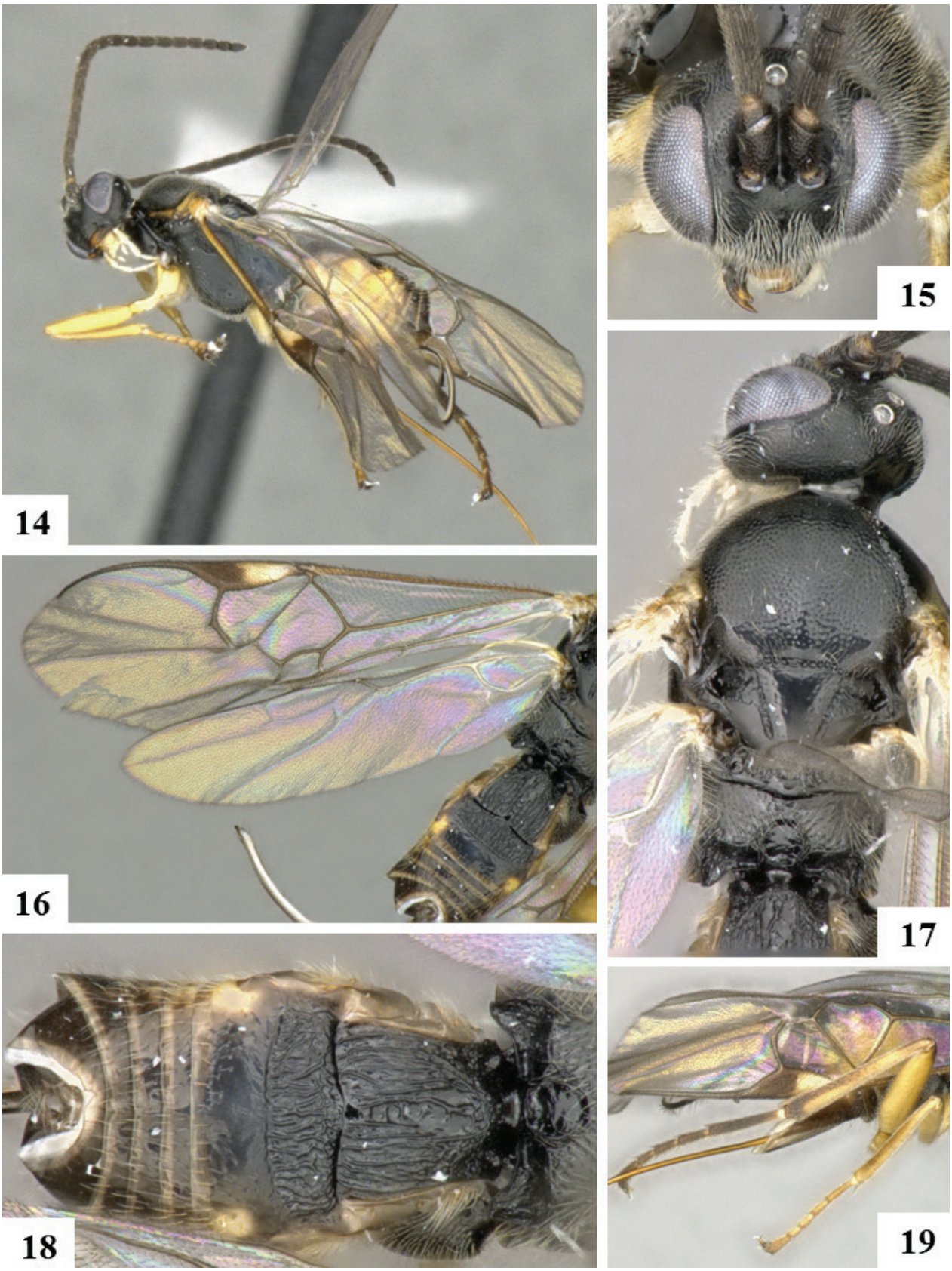
Exoryza ritaashleyae **Fernandez-Triana, sp. n.**

http://zoobank.org/1B47AE69-4F7E-439B-A886-346A0DD305E7
Figs 20–25

Holotype. Female, CNC. COSTA RICA: Guanacaste, ACG, Sector Cacao, Sendero Cima, 1,460m, 10.93328, -85.45729, 18.xii.2008, coll. D. Janzen & W. Hallwachs. DNA voucher code: DHJPAR0031500.

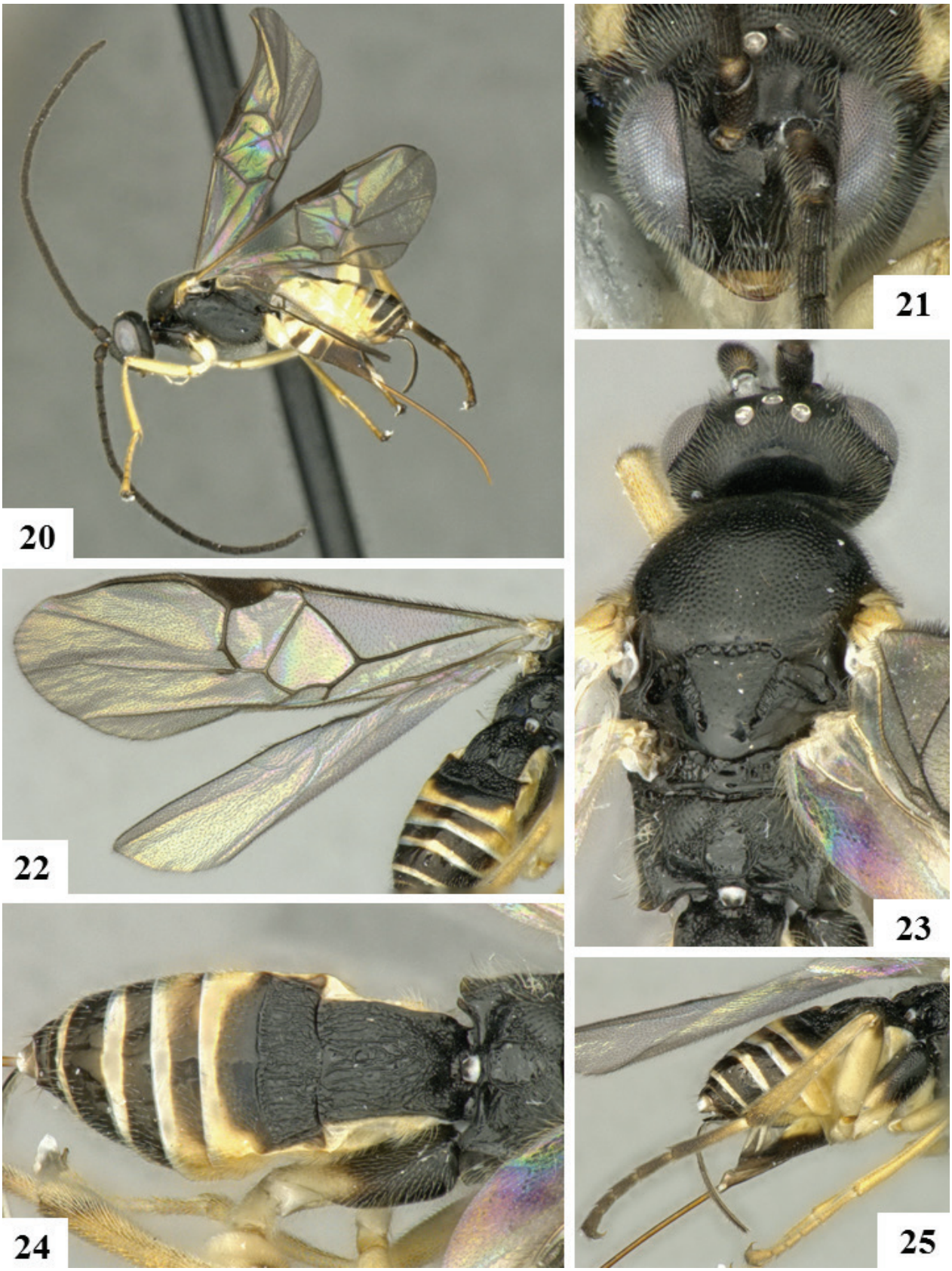
Paratypes. 3 #F (CNC, NMNH). Costa Rica, Guanacaste, ACG, same locality than holotype. DNA voucher codes: DHJPAR0034091, DHJPAR0034103, DHJPAR0034150.

Diagnostic description. Body color. Head (except for clypeus and mandibles), mesosoma and metasoma (dorsally) dark brown to black; laterotergites, sternites and hypopygium partially yellow, partially dark brown; antennal flagellomeres dark brown to black; tegula and wing base yellow-white; pterostigma mostly brown (with small pale spot on proximal 0.1); legs mostly yellow-white except for metacoxa (black on proximal 0.6–0.7, white-yellow on distal 0.4–0.3), metafemur (distal 0.1 dorsally brown), metatibia (distal 0.1 dark brown), and metatarsus (dark brown). **Body ratios.** Flagellomere 2 length/width: 3.5 x. Flagellomere 14 length/width: 1.6 x. Malar line/mandible width: 1.1 x. Metafemur length/width: 3.6 x. Metatibial inner/outer spur length: 1.0 x. T1 length/width at posterior margin: 1.2 x. T2 length/width at posterior margin: 0.4 x. Ovipositor sheaths length/metatibia length: 1.3 x. **Body measurements (all in mm).** Body length: 3.5–3.8. Fore wing length: 3.6–4.1. Flag-



Figures 14–19. *Exoryza richardashleyi*, holotype.

ellomere 2 length/width: 0.30/0.085. Flagellomere 14 length/width: 0.12/0.075. Flagellomeres 1/2/3/14/15/16 length: 0.29/0.30/0.30/0.12/0.11/0.15. OOL: 0.14. POL: 0.12. Diameter of posterior ocellus: 0.08. Malar line/mandible width: 0.11/0.10. Metafemur length/width: 0.98/0.27. Metatibia length: 1.25. First segment of meta-



Figures 20–25. *Exoryza ritaashleyae*, holotype.

tarsus length: 0.57. Metatibial inner/outer spur length: 0.26/0.25. T1 length/width at anterior margin/width at posterior margin: 0.52/0.35/0.42. T2 length/width at posterior margin: 0.22/0.58. T3 length: 0.21. Ovipositor sheaths length: 1.6–1.9.

Male. Unknown.

Biology. Unknown.

Distribution. Costa Rica, Guanacaste, ACG (Sector Cacao), 1,460m.

Etymology. Named in honor of Rita Ashley from Huacas, Nicoya, for her serious enthusiasm for understanding and protecting the wild nature that occurs all around her, and specifically for causing 20 Guanacaste school children and their teachers to begin to share that enthusiasm.

Exoryza rosamatarritae Fernandez-Triana, sp. n.

http://zoobank.org/423F126F-DCBB-4F09-81AE-4C3A81C7CEAB
Figs 26–32

Holotype. Female, CNC. COSTA RICA: Alajuela, ACG, Sector San Cristobal, Finca San Gabriel, 645m, 10.878, -85.393, 18.vi.2013, coll. C. Cano. DNA voucher code: DHJPAR0053053.

Paratypes. 4 #F (CNC, NMNH). Costa Rica, Alajuela, ACG. DNA voucher codes: DHJPAR0033751, DHJPAR0049364, DHJPAR0052979, DHJPAR0053807.

Diagnostic description. Body color. Head (except for clypeus and mandibles), mesosoma and metasoma (dorsally) dark brown to black; laterotergites, sternites and hypopygium partially yellow, partially dark brown; antennal flagellomeres dark brown; tegula and wing base white-yellow; pterostigma mostly brown (with small pale spot on proximal 0.1); legs mostly white-yellow except for metacoxa (black on proximal 0.8, white-yellow on distal 0.2), metafemur (distal 0.2 dorsally brown), metatibia (distal 0.6 dark brown), and metatarsus (dark brown). **Body ratios.** Flagellomere 2 length/width: 3.1 x. Flagellomere 14 length/width: 1.3 x. Malar line/mandible width: 1.0 x. Metafemur length/width: 3.7 x. Metatibial inner/outer spur length: 1.1 x. T1 length/width at posterior margin: 1.1 x. T2 length/width at posterior margin: 0.5 x. Ovipositor sheaths length/metatibia length: 0.8 x. **Body measurements (all in mm).** Body length: 2.5 (2.3–2.8). Fore wing length: 2.7 (2.4–2.8). Flagellomere 2 length/width: 0.22/0.07. Flagellomere 14 length/width: 0.09/0.07. Flagellomeres 1/2/3/14/15/16 length: 0.21/0.21/0.21/0.09/0.09/0.11. OOL: 0.11. POL: 0.10. Diameter of posterior ocellus: 0.06. Malar line/mandible width: 0.09/0.09. Metafemur length/width: 0.66/0.18 (0.65/0.17; 0.74/0.20). Metatibia length: 0.82 (0.82; 0.94). First segment of metatarsus length: 0.41 (0.41; 0.42). Metatibial inner/outer spur length: 0.18/0.16 (0.20/0.18). T1 length/width at anterior margin/width at posterior margin: 0.38/0.28/0.35. T2 length/width at posterior margin: 0.21/0.42. T3 length: 0.18. Ovipositor sheaths length: 0.6–0.8.

Male. Unknown.

Biology. Reared from Choreutidae (‘*Brenthia* Janzen05’), Depressariidae (‘*Stenoma* Phillips543’), and Gelechiidae (an undetermined species with interim name ‘gelJanzen01 Janzen16’).

Distribution. Costa Rica, Alajuela, ACG (Sector San Cristobal), 540–645m.

Etymology. Named in honor of Rosa Iris Matarrita Díaz for her enthusiasm in teaching her Colonia Bolaños students to understand and protect the wild nature that occurs in her homeland.

Exoryza schoenobii (Wilkinson, 1932)

Exoryza schoenobii (Wilkinson, 1932): 142. Original description.

Holotype. Female, BMNH (not examined). INDIA: ‘South India, Hebbal Farm’.

Description. Detailed descriptions of the species and images are available in Mason (1981) and Valerio et al. (2004).

Biology. Reared from Pyraloidea (*Chilo polychrysa*, *C. supressalis*, *Glaucocharis reniella, Schoenobius bipunctifer*, and *Scirpophaga incertulas*) (Yu et al. 2012).

Distribution. Bangladesh, China (Fujian, Guangdong, Guangxi, Guizhou, Hainan Island, Hubei, Hunan, Jiangsu, Jiangxi, Sichuan, Taiwan, Yunnan, Zhejiang), India, Malaysia, Philippines, Sri Lanka, Vietnam (references summarized in Yu et al. 2012).

Comments. Although the holotype was not examined, we studied two CNC specimens that were compared with the holotype by Mason (Mason 1981, Valerio et al. 2004).

Exoryza safranum Rousse & Gupta, 2013

Exoryza safranum Rousse & Gupta, 2013: 530. Original description.

Holotype. Female, MNHN (not examined). REUNION: Plaine des Palmistes/Grand Etang, xi-2010, coll. T. Ramage.

Description. A detailed description of the species and images are available in Rousse and Gupta (2013).

Biology. Unknown.

Distribution. Known only from the holotype locality in Réunion.

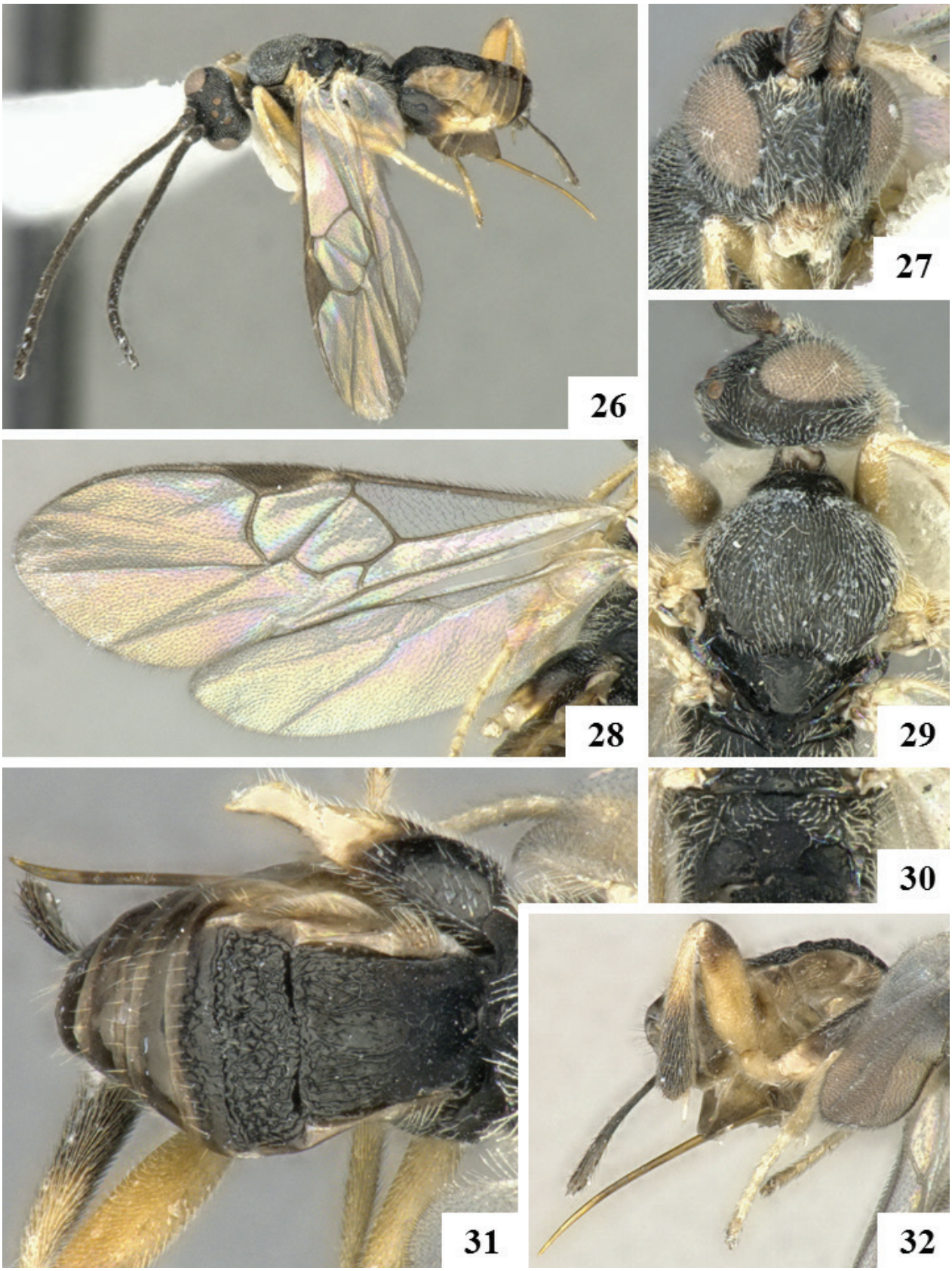
Comments. This species was collected with a light trap.

Exoryza yeimycedenoae Fernandez-Triana, sp. n.

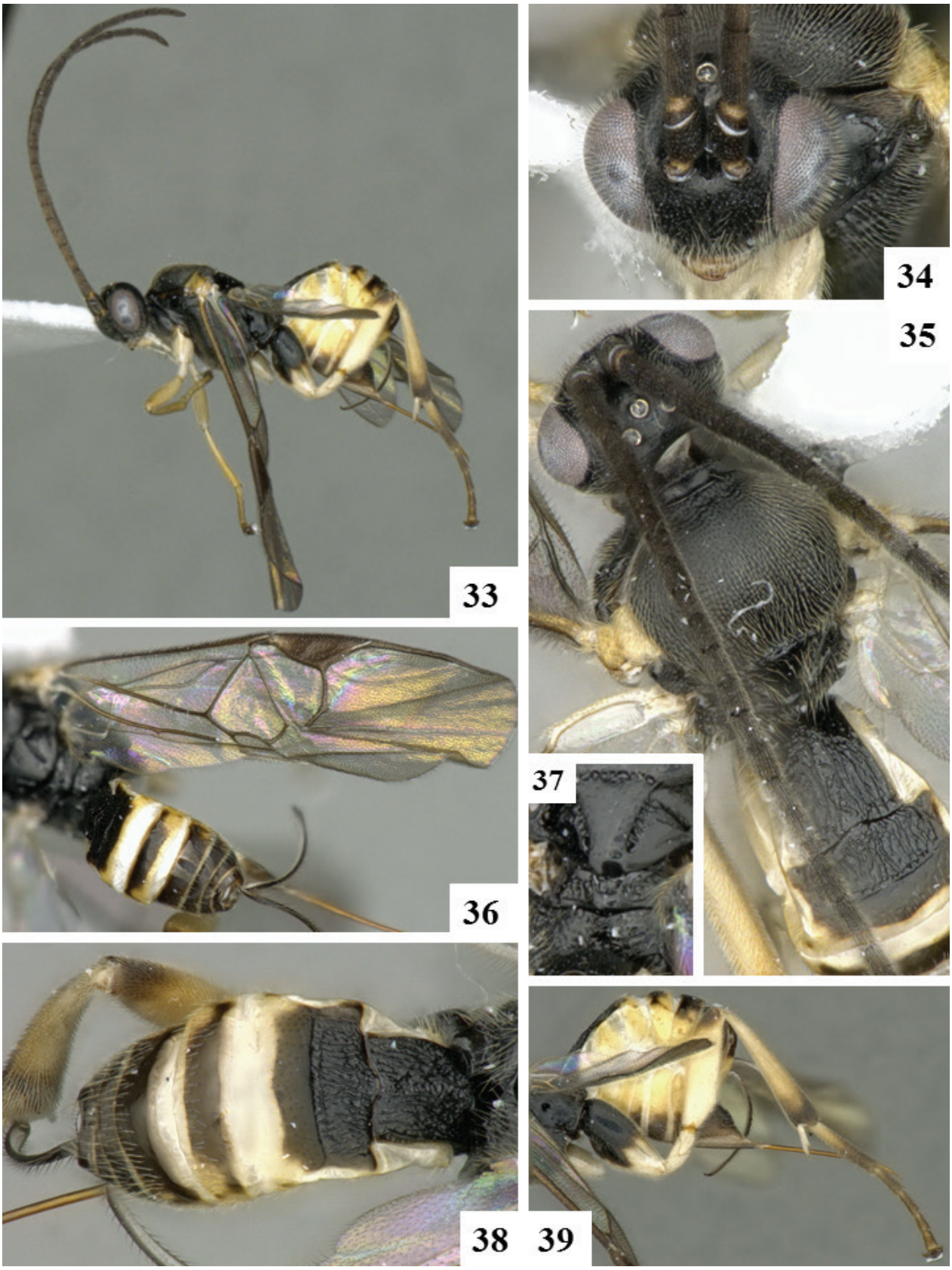
http://zoobank.org/D659373B-3BF5-4E7F-A580-17488460A972
Figs 33–39

Holotype. Female, CNC. COSTA RICA: Guanacaste, ACG, Sector Cacao, Sendero Cima, 1,460m, 10.93328, -85.45729, 18.xii.2008, coll. D. Janzen & W. Hallwachs. DNA voucher code: DHJPAR0031496.

Diagnostic description. Body color. Head (except for clypeus and mandibles), mesosoma and metasoma (dorsally) dark brown to black; laterotergites and sternites mostly yellow, hypopygium mostly dark brown; antennal flagellomeres dark brown; tegula and wing base white-yellow; pterostigma mostly brown (with small pale



Figures 26–32. *Exoryza rosamatarritae*, holotype.



Figures 33–39. *Exoryza yeimycedenoae*, holotype.

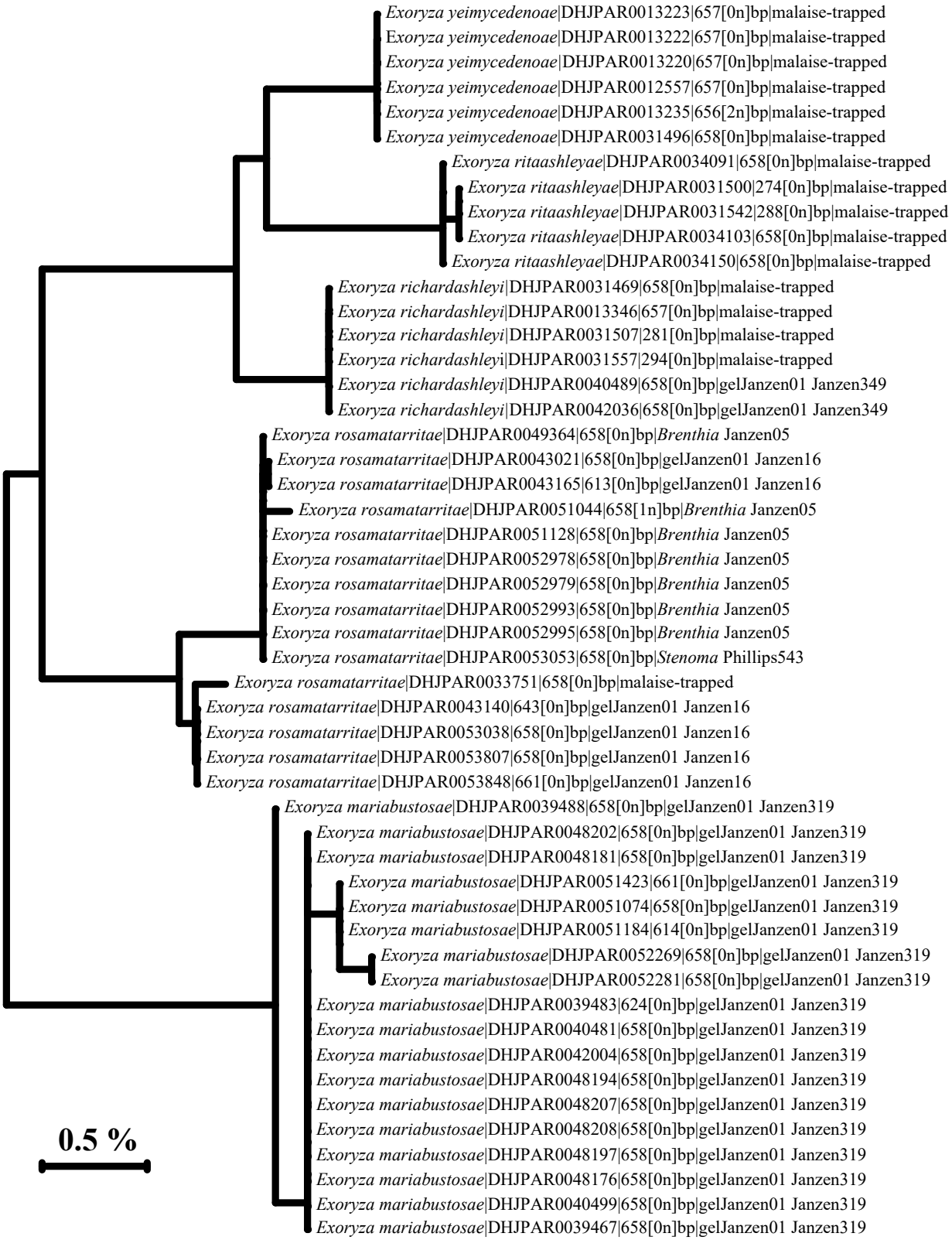


Figure 40. Neighbor-Joining (NJ – Saitou and Nei 1987) tree based on Kimura 2-parameter distances (K2P – Kimura 1980) made using BOLD (Ratnasingham and Hebert 2007) for all barcoded specimens from each of the five species of *Exoryza* in ACG. Tip labels include species name, specimen accession number, sequence length and host species.

spot on proximal 0.1); legs mostly white-yellow except for metacoxa (black on proximal 0.6, white-yellow on distal 0.4), metafemur (distal 0.1 dorsally brown), metatibia (distal 0.2 dark brown), and metatarsus (mostly dark brown). **Body ratios.** Flagellomere 2 length/width: 3.3 x. Flagellomere 14 length/width: 2.1 x. Malar line/mandible width: 0.9 x. Metafemur length/width: 3.8 x. Metatibial inner/outer spur length: 1.1 x. T1 length/width at posterior margin: 1.4 x. T2 length/width at posterior margin: 0.5 x. Ovipositor sheaths length/metatibia length: 1.1 x. **Body measurements (all in mm).** Body length: 3.3. Fore wing length: 3.5. Flagellomere 2 length/width: 0.30/0.09. Flagellomere 14 length/width: 0.14/0.065. Flagellomeres 1/2/3/14/15/16 length: 0.29/0.30/0.30/0.14/0.13/0.165. OOL: 0.13. POL: 0.12. Diameter of posterior ocellus: 0.07. Malar line/mandible width: 0.09/0.10. Metafemur length/width: 0.98/0.26. Metatibia length: 1.17. First segment of metatarsus length: 0.60. Metatibial inner/outer spur length: 0.28/0.25. T1 length/width at anterior margin/width at posterior margin: 0.50/0.33/0.35. T2 length/width at posterior margin: 0.24/0.48. T3 length: 0.19. Ovipositor sheaths length: 1.3.

Biology. Unknown.

Distribution. Costa Rica, Guanacaste, ACG (Sector Cacao), 1,460m.

Etymology. Named in honor of Yeimy Cedeño Solís for her enthusiasm in encouraging her Area de Conservacion Tempisque community to understand and protect the wild nature that occurs in her homeland.

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