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A NEW SPECIES OF *OPIUS* (*BELLOPIUS*) (HYMENOPTERA: BRACONIDAE) REARED FROM *HEXACHAETA* (DIPTERA: TEPHRITIDAE) FLIES IN COLOMBIA, WITH A KEY TO NEW WORLD SPECIES OF *OPIUS* PARASITIC ON FRUIT-INFESTING TEPHRITIDAE

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Abstract.—A **new species** of fruit fly parasitoid, ***Opius* (*Bellopius*) *hexachaeta* Kula and Aguirre** (Hymenoptera: Braconidae), is described. The parasitoid was reared from larvae of the genus *Hexachaeta* (Diptera: Tephritidae) feeding on seeds in entireleaf spiritweed, *Aegiphila integrifolia* (Jacq.) B.D. Jacks (Lamiales: Lamiaceae). The morphology and taxonomic placement of the new species is discussed.

Key Words: Opiinae, taxonomy

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Bellopius Wharton (Braconidae: Opiinae) is a subgenus of *Opius* Wesmael that consists of 11 species (Yu et al. 2016) known only from the Neotropical Region (Wharton and Yoder 2021). One species, *Opius* (*Bellopius*) *bellus* Gahan, has been reported from Thailand (Chinajariyawong et al. 2000); however, this is the only report of a *Bellopius* species outside the Neotropical Region and thus requires confirmation (Wharton and Yoder 2021). The species currently in *Bellopius* were placed in *Desmiostoma* Förster in Fischer (1977) and included in a key to the New World species of that genus. Wharton (1983) recognized a group of species in *Desmiostoma* (i.e., *bellus* group) with the following combination of features and transferred them to *Opius*: notauli and mesonotal midpit absent and precoxal sulcus absent or nearly so (Wharton and Marsh 1978), wings heavily infumate, forewing 2cu-a reduced, and pronope present. Wharton (1997) proposed the subgenus *Bellopius* within *Opius* for species of the *bellus* group.

As far as is known, species of *Bellopius* are koinobiont endoparasitoids of fruit flies (Diptera: Tephritidae) (Wharton 1997), although host use is known only for two species: *O.* (*B.*) *bellus* and *Opius* (*B.*) *hirtus* Fischer. Host records for both species have been complied in Yu et al. (2016) and collectively span six genera; the vast majority of hosts are species of *Anastrepha* Schiner. Notably, *O.* (*B.*) *bellus* has been reported from at least 22 host species (all but three of them *Anastrepha* spp.) collectively from at least 27 host plants, including pests such as *Anastrepha fraterculus* (Wiedemann),

Anastrepha obliqua (Macquart), *Anastrepha serpentina* (Wiedemann), *Anastrepha striata* Schiner, and *Ceratitis capitata* (Wiedemann). However, *O.* (*B.*) *bellus* may be a species complex considering its host range, patterns of host use, geographic distribution, and variation with respect to color (Ovruski et al. 2000). Further, Wharton (1997) noted at least two undescribed species of *Bellopius*, but additional species have not been described or assigned to *Bellopius* since that time. Species richness and patterns of host use are unclear for *Bellopius* and will involve disentangling species complexes, as well describing new species and documenting new hosts.

The Instituto Colombiano Agropecuario (ICA) is currently monitoring the geographic distribution of tephritid fruit flies in Colombia via the Programa Nacional Moscas de la Fruta (ICA-PNMF), which employs the following three sampling techniques: (1) McPhail traps baited with hydrolyzed protein for collecting *Anastrepha* spp., (2) Jackson traps baited with trimedlure for attracting *C. capitata* and also with both methyl eugenol and cuelure for attracting species of *Bactrocera* Macquart and *Dacus* Fabricius, and (3) sampling of exotic and native fruit for establishing plant-insect associations. Larvae of *Hexachaeta* Loew were found, using the latter approach, feeding on seeds in fruit of *Aegiphila integrifolia* (Jacq.) B.D. Jacks. (Lamiales: Lamiaceae), entireleaf spiritweed (Figs. 1, 2). The larvae were parasitized by braconids (Fig. 3), which were identified as a new species of *Bellopius*. We describe the new species herein and provide a key for identifying the New World species of *Opius* reported as parasitoids of tephritids that infest fruit (Yu et al. 2016).

Materials and Methods

Hexachaeta larvae were collected using fruit sampling techniques carried out in locations of Cundinamarca department. The host plant was photographed in situ using a Samsung A50 cell phone. Subsequently, fruits were placed in plastic containers (15 cm height, 15 cm diameter) under laboratory conditions in a Memmert IN55 Incubator with 24 hours dark, 14–19°C temperature, and 60–75% relative humidity. Adult flies were fed once a day for 2–3 days with a mixture of water, sugar, and hydrolyzed protein. Fly larvae fed upon the same fruit on which they were collected. A host fly puparium was dissected and yielded an opiine braconid pupa (Fig. 3). All opiines emerged from host puparia within 12–47 days of being placed in laboratory conditions. Nine female and seven male parasitoids emerged and were placed in vials with 96% alcohol. Six female and three male specimens were placed in a bath of 99% ethanol for 24 hours and then a bath of formaldehyde for five minutes; those specimens were then air dried for 10 minutes, point-mounted, and used to describe the new species. The remaining three females and four males were not used to write the description due to their poor physical condition and are not part of the type series. We have retained those specimens in 96% alcohol as genetic vouchers that are deposited in Museo Javeriano de Historia Natural "Lorezo Uribe, S.J.", Bogota, Colombia (MPUJ).

Host plant identifications were made by Ms. Guadalupe Caicedo at the herbarium of the Jardín Botánico de Bogotá José Celestino Mutis (JBB). Insect specimens were examined using a Nikon SMZ-1000 stereomicroscope. The specimens of Braconidae were identified as *Opius* (*Bellopius*) using Wharton (1997); they were determined as a new species using diagnostic information and illustrations in Fischer (1977), Wharton and Marsh (1978), and Wharton and Yoder (2021), as well as through comparison with specimens of

Figs. 1–3. *Opius* (*Bellopius*) *hexachaeta* ex *Hexachaeta* sp. in fruit of *Aegiphila integrifolia*. 1, Fruit on host plant, *A. integrifolia*. 2, *Hexachaeta* sp. larva feeding on *A. integrifolia* seed. 3, *Opius* (*B.*) *hexachaeta* pupa and *Hexachaeta* sp. puparium.

described species. The first author (RRK) evaluated multiple images of all described species of *Bellopius*, as well as *Opius* (*Nosopaeopius*) *downesi* Gahan, taken of specimens identified by braconid specialist Dr. Robert A. Wharton (retired, Texas A&M University). Holotypes were examined for *O.* (*B.*) *bellus*, *Opius* (*B.*) *chromaticus* Fischer, *Opius* (*Nosopaeopius*) *baldufi* Muesebeck, and *O.* (*N.*) *downesi*. All type specimens of the new species are deposited in MPUJ.

Measurements were taken as described in Wharton (1977) with additions and modifications as in Kula and Zolnerowich (2005, 2008) using the software incorporated in a monitor Nikon DS-L3 camera system. The following abbreviations are used in the descriptions: head length (HL), head width (HW), temple width (TW), face width (FW), face height (FH), eye length (EL), eye height (EH), flagellomere 1 length (F1L), flagellomere 2 length (F2L), mesosoma length (ML), mesoscutum width (MW), mesosoma height (MH), scutellar sulcus length (SSL), scutellar sulcus width (SSW), tergum 1 length (T1L), tergum 1 width (T1W), and terga one through eight (t1…t8).

Terminology for anatomical features, surface sculpture, and setation follows Sharkey and Wharton (1997). The material examined section is formatted as in Kula and Zolnerowich (2008). The key

to species of *Opius* known to parasitize fruit-infesting Tephritidae is based, in part, on the key in Wharton and Marsh (1978).

Images of the new species and its host were taken with a Nikon DS-L3 camera connected to a Nikon SMZ-1000 stereomicroscope. Images were edited using Adobe Photoshop with the goal of rendering backgrounds of the unedited photographic images more uniform in color and tone. For Fig. 11 two photos were combined to generate one high quality figure, and some setae were painted back in for clarity. The layout of individual figures into plates was accomplished using Adobe Illustrator.

Results and Discussion

Opius (*Bellopius*) *hexachaeta* Kula and Aguirre, new species

http://zoobank.org/3607871A-0ED0-4835-8C27-6B3B36433CC7

(Figs. 4–11)

Diagnosis.—Forewing vein 3RSb not complete to wing margin as tubular vein in *O.* (*B.*) *hexachaeta* (Fig. 9); it is always complete to wing margin as tubular vein in all other species of *Opius* (*Bellopius*). The mesosoma is entirely dark brown (nearly black) in *O.* (*B.*) *hexachaeta* (Figs. 4, 5, 8); it is at least partially or entirely orange in *Opius* (*B.*) *barrosensis* Fischer, *Opius* (*B.*) *bellus* Gahan (Figs. 15, 16), *Opius* (*B.*) *campinaensis* Fischer, *Opius* (*B.*) *chromaticus* Fischer, *Opius* (*B.*) *cingulaticornis* Fischer, *Opius* (*B.*) *fiebrigi* Fischer, *Opius* (*B.*) *hirtus* Fischer (Fig. 17), and *Opius* (*B.*) *marcapatanus* Fischer. All legs (excluding trochantelli and bases of femorae) are entirely dark brown (nearly black) in *O.* (*B.*) *hexachaeta* (Fig. 4); they are entirely yellowish orange with tarsi brown in *Opius* (*B.*) *cuencaensis* Fischer. The propodeum has a median carina in *O.* (*B.*) *hexachaeta* (Fig. 11); propodeal carinae are absent in *Opius* (*B.*) *cuzcoensis* Fischer. The gena, mesonotum, propodeum, and metapleuron are setiferous, but not notably dense (i.e., setose) in *O.* (*B.*) *hexachaeta* (Figs. 4, 5, 8, 11); they are setose in *O.* (*B.*) *cuencaensis* and *Opius* (*B.*) *johannis* Fischer.

Description.—Female (Fig. 4). *Body length:* 3.4–3.9 mm. *Head* (Figs. 5–7): HL 0.5–0.6X HW, HW 4.5–4.7X TW, FW 1.7–1.8X FH, EL 0.5–0.6X EH, F1L 1.3X F2L; antenna with 40 flagellomeres, maxillary palpus with 6 palpomeres, labial palpus with 4 palpomeres; face smooth, setiferous; frons smooth, glabrous; gena and vertex smooth, setiferous; occiput smooth, glabrous; eye glabrous; clypeus flat with ventral margin lobed mesally, setiferous, labrum concealed by clypeus when mandible closed; mandible 2-toothed, smooth and setiferous, setae about as long as width of mandible at its midpoint, upper tooth longer than lower tooth.

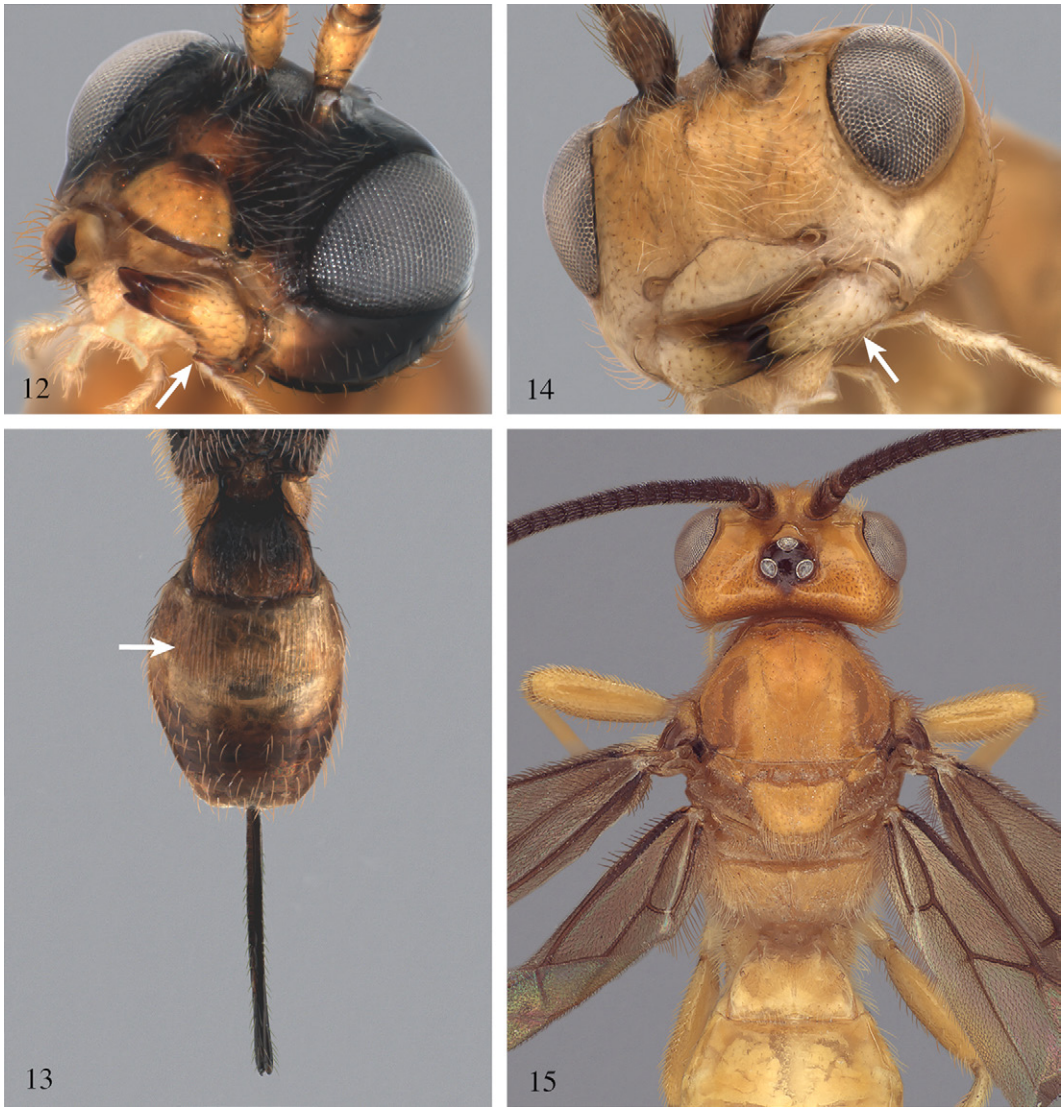
Mesosoma (Figs. 5, 8, 11): ML 1.2–1.3X MW, ML 0.9–1.0X MH, MW 0.7–0.8X MH, SSL 0.2X SSW; pronotal collar smooth and shiny, setiferous, setae oriented anteriorly; pronope large, lateral portion of pronotum smooth, mostly glabrous but setiferous along margins, setae oriented anteriorly, anterolateral furrow shallow but present in dorsal one-fourth and crenulate from pronotal collar; notauli absent; mesoscutal midpit absent; mesoscutum smooth and shiny, uniformly setiferous except two glabrous areas posterolaterally; scutellar sulcus crenulate, with three to four longitudinal carinae; scutellar disc smooth, setiferous, setae oriented posteriorly; propodeum smooth except complete median carina, setiferous; epicnemial carina absent; precoxal sulcus present, smooth; posterior mesopleural furrow entirely smooth; mesopleuron smooth, setiferous except glabrous areas dorsad precoxal sulcus and posterodorsally dorsad episternal scrobe;

Figs. 4–10. *Opius* (*Bellopius*) *hexachaeta*, female. 4, Lateral habitus. 5, Head and mesosoma, lateral. 6, Head, anterior. 7, Head, dorsal. 8, Mesonotum, dorsal. 9, Forewing (arrow = 3RSb incomplete). 10, Hind wing.

metapleuron smooth, setiferous, setae oriented posteroventrally.

Forewing (Fig. 9): Length 4.0–4.3 mm; stigma ellipitcal, distal margin tapering into vein R1; vein r arising slightly basad middle of stigma; vein length ratios: 2RS 0.6–0.7X 3RSa, 2RS 0.5X 2M, 3RSa 0.7X 2M; veins C+Sc+R, 1RS, 1M, (RS+M) a, r, 2RS, 3RSa, 2M, 1m-cu, 1CUa, 1CUb, 2CUa, 1cu-a, 1-1A, and 2-1A complete

Fig. 11. *Opius* (*Bellopius*) *hexachaeta*, female, propodeum and metasoma in dorsal view (arrows: a = median propodeal carina, b = smooth tergum 2).



Figs. 12–15. *Opius* (*Bellopius*) spp. 12, 13, *Opius* (*B.*) *downesi*. 12, Head, anterior (arrow = basal tooth present). 13, Metasoma, dorsal (arrow = striate tergum 2). 14, 15, *Opius* (*B.*) *bellus*. 14, Head, anterior (arrow = basal tooth absent). 15, Head and mesosoma, dorsal.

and tubular; veins (RS+M)b and r-m complete but not tubular; vein 3RSb not complete to wing margin as tubular vein, proximal portion tubular ~1/3 distance to apical wing margin with remainder spectral to wing margin; vein 3M incomplete, tubular proximally transitioning to spectral distally to wing margin; vein 2CUb incomplete, nebulous; vein 2cu-a incomplete, nebulous, 1st subdiscal cell open.

Hindwing (Fig. 10): Veins C+Sc+R, Sc+R, R, R1, r-m, 1M, M+CU, cu-a, and 1A complete and tubular, basal and subbasal cells closed; RS minutely tubular proximally and 2M tubular proximally along half its length, transitioning distally to nebulous and then spectral.

Fig. 16. *Opius* (*Bellopius*) *bellus*, female, lateral habitus.

Fig. 17. *Opius* (*Bellopius*) *hirtus*, head and mesosoma in dorsal view.

Metasoma (Fig. 11): T1L 0.8–0.9X T1W, T2L 0.2X T2W, T3L 0.2–0.3X T3W, T4L 0.3X T4W, T5L 0.1–0.4X T5W, T6L 0.2–0.4X T6W, T7L 0.1X T7W; ovipositor longer than gaster; t1 smooth with dorsal carinae extending slightly posteriad spiracles, dorsope present, setiferous laterally and posteriorly but otherwise glabrous; t2 smooth, setiferous posterolaterally; t3–t7 smooth, setiferous posteriorly with setae in single transverse line; t8 smooth, setiferous.

Color: Head (including antenna) entirely dark brown (nearly black), mandible dark brown with yellowish orange tips, palpi yellow; mesosoma entirely dark brown (nearly black); wings infumate, stigma and veins brown; legs dark brown (nearly

black) except trochantellus and narrow band at base of femora yellowish orange; metasoma entirely orangish yellow.

Male: As in female except: *Body length:* 2.5–3.0 mm. *Head:* HW 4.8–4.9X TW, FW 1.6–1.8X FH, EL 0.6–0.7X EH; antenna with 38–42 flagellomeres. *Mesosoma:* ML 1.1X MH; propodeum entirely dark brown (almost black) to mostly dark brown but with small testaceous area dorsomesally.

Host.—*Opius* (*B.*) *hexachaeta* was reared from two new species of *Hexachaeta* (Rodríguez et al. in prep.) with larvae feeding on seeds in fruit of *Aegiphila integrifolia*. *Opius* (*B.*) *hexachaeta* is the only species of Braconidae reported from a species of *Hexachaeta*.

Material examined.—*Holotype female:* COLOMBIA: Cundinamarca: Anolaima, Vereda Santo Domingo, near to finca Villa Mariana 4.80171°N, 74.47542°W, 1532 m, fruits collected 1 Jan 2018, adults and parasitoids emerged 12–16 Feb P. A. Rodriguez; El Colegio, Predio Boyacá, 4.55000°N, 74.48751°W, 861 m, fruits collected 3 Jan 2018, adults and parasitoids emerged 15–23 Jan 2019, P. A. Rodriguez (Museo Javeriano de Historia Natural "Lorezo Uribe, S.J.", MPUJ). *Paratypes:* Two females and one male, same data as holotype. Three females and two males, El Colegio, Predio Boyacá, 4.55000°N, 74.48751°W, 861 m, fruits collected 3 Jan 2019, adults and parasitoids emerged 15–23 Jan 2019, P. A. Rodriguez (MPUJ).

Etymology.—The stem of the specific epithet refers to the genus name of the host fruit fly, *Hexachaeta*.

Discussion.—*Opius* (*B.*) *hexachaeta* is most similar morphologically to *O.* (*B.*) *cuencaensis*, *O.* (*B.*) *cuzcoensis*, and *O.* (*B.*) *johannis*; these four species have the mesosoma entirely dark brown. In addition to the features listed above in the diagnosis, the ovipositor is longer than the gaster in *O.* (*B.*) *hexachaeta*, while it is shorter than the gaster in *O.* (*B.*) *cuencaensis* and *O.* (*B.*) *cuzcoensis*. Also, setation of the gena, mesonotum, propodeum, and metapleuron is less dense in *O.* (*B.*) *hexachaeta* compared with the other three species, although the difference is less profound in *O.* (*B.*) *cuzcoensis*. Additionally, while the legs of both *O.* (*B.*) *hexachaeta* and *O.* (*B.*) *johannis* are entirely dark brown except the yellowish orange trochantelli and band at base of each femora, the femorae of *O.* (*B.*) *johannis* are yellow apically where they articulate with the tibiae.

Opius (*B.*) *hexachaeta* is the only species of *Bellopius* with 3RSb not complete to the wing margin as a tubular vein. Vein 3RSb extends to the wing margin but is spectral for most of its length.

Key to the New World Species of *Opius* Reared from Fruit-Infesting Tephritids

1. Mandible with basal tooth (Fig. 12); t2 distinctly striate (Fig. 13) 2
   Mandible with ventral surface evenly curved, basal tooth absent (Fig. 14); t2 smooth (Fig. 11) 3
2(1). Ovipositor shorter than gaster, t1 usually rugulose or coriaceous ..... *Opius* (*Nosopaeopius*) *baldufi*..... Muesebeck
   Ovipositor at least as long as gaster, t1 usually striate (Fig. 13).....*Opius* ..... (*Nosopaeopius*) *downesi* Gahan
3(1). Forewing vein 3RSb not complete to wing margin as tubular vein (Fig. 9); mesosoma entirely dark brown (Figs. 4, 5, 8) ..... *Opius* (*Bellopius*) *hexachaeta* ..... Kula and Aguirre, new species
   Forewing vein 3RSb complete to wing margin as tubular vein; mesosoma at least partially yellow (Fig. 15) 4
4(3) Head, excluding ocellar triangle, yellow (Fig. 15); legs yellow except metatibia and metatarsus brown in some specimens (Fig. 16) ..... *Opius* .....(*Bellopius*) *bellus* Gahan

Head entirely dark brown (Fig. 17); legs (excluding trochantelli and bases of femorae) entirely brown (cf. Fig. 4) ....*Opius* (*Bellopius*) *hirtus* Fischer

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