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New *Cyphanthidium* (Hymenoptera: Megachilidae): Highly modified female hind tibial spurs and convergence in East African drylands

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Abstract. A new species, ***Cyphanthidium eardleyi*** Griswold & Copeland, and the previously unknown female of *C. sheppardi* (Mavromoustakis), are described. New distributional records for a third species, *C. intermedium* Pasteels, are provided. Similarities in the distinctive spatulate inner hind tibial spurs of female *C. eardleyi* and *C. sheppardi* with *Samba turkana* Packer, a cohabiting Melittidae, are noted, and the broader importance of the type locality, Ukasi Hill, Kenya as a center of dryland biodiversity, is discussed.

INTRODUCTION

The Afrotropics are the center of diversity for the tribe Anthidiini (Megachilidae, Hymenoptera) at the generic/subgeneric level (Michener, 2007). A total of 19 genera and 28 subgenera currently recognized from the region (Eardley & Urban, 2010; modified by Kasparek & Kuhlmann, 2024), including the Malagasy endemic *Benanthis* Pasteels and one genus and three subgenera described late in the last century in a revision of Eastern Hemisphere Anthidiini (Michener & Griswold, 1994). It is therefore not surprising that yet another distinctive anthidiine is present, one with an exceedingly rare modification of the hind tibial spurs in the female.

The genus *Cyphanthidium* Pasteels is little known. Pasteels (1969) described two new monotypic genera *Cyphanthidium* and *Trianthidiellum* Pasteels, both known only in the male. The subsequent revision of African Anthidiini (Pasteels, 1984) did not add taxa to these genera. Michener & Griswold (1994) synonymized *Trianthidiellum* with *Cyphanthidium*. The subsequent revision of *Cyphanthidium* (Eardley & Griswold, 2018) recognized four species, two of them new and two known only from the male. Of the two known females, *C. intermedium* Pasteels had the typical pair of similar slender hind tibial spurs common in female bees, but in *C. gessorum* Eardley & Griswold, the inner hind tibial spur was greatly enlarged, spatulate, and strongly curved, a rare state in bees. Here we describe an additional species and the previously unknown female of *C. sheppardi* (Mavromoustakis) both with similar disparate pairs of hind tibial spurs, provide additional records for *C. intermedium*, and comment on similarities of rare structures in female hind tibial spurs across two bee families.

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MATERIAL AND METHODS

Morphological terminology follows that of Michener (2007). The abbreviations F, S, and T, are used for antennal flagellomeres, metasomal sterna and metasomal terga, respectively. Photomicrographs were taken using a Keyence® VHX-500F Digital Imaging System and used to record measurements. Total body length was estimated to nearest half millimeter by measuring the combined length of head and mesosoma (from the clypeus to the propodeum, in profile) and adding the length of the metasoma. Forewing length was measured from the posterior border of the tegula to the tip of the forewing. In the description, characters that are generally conserved between sexes are presented first, followed by characters that are typically, or exclusively, female. Habitus images of *Cyphanthidium eardleyi* and *Samba* species were produced using a macro imaging system (Macroscopic solutions, Tolland, Ohio) and Zerene focus-stacking software, http://www.zerenesystems.com › cms › stacker.

Material was provided by the following institutions referenced in the text by their acronyms: American Museum of Natural History, New York, NY, USA (AMNH); USDA-ARS Pollinating Insects Research Unit (formerly Bee Biology and Systematics Laboratory) Logan, Utah, USA (BBSL); International Centre of Insect Physiology and Ecology, Nairobi, Kenya (ICIPE); Maximillian Schwarz personal collection, Ansfelden, Austria (MSchwarz); Max Kasparek personal collection, Heidelberg, Germany (MKasparek); National Museums of Kenya, Nairobi, Kenya; M. Gikungu, W. Kinuthia (NMKE); San Diego Natural History Museum, San Diego, California, USA, P. Horsley (SDNHM); Zoologische Staatssammlung, München, Germany, S. Schmidt (ZSM).

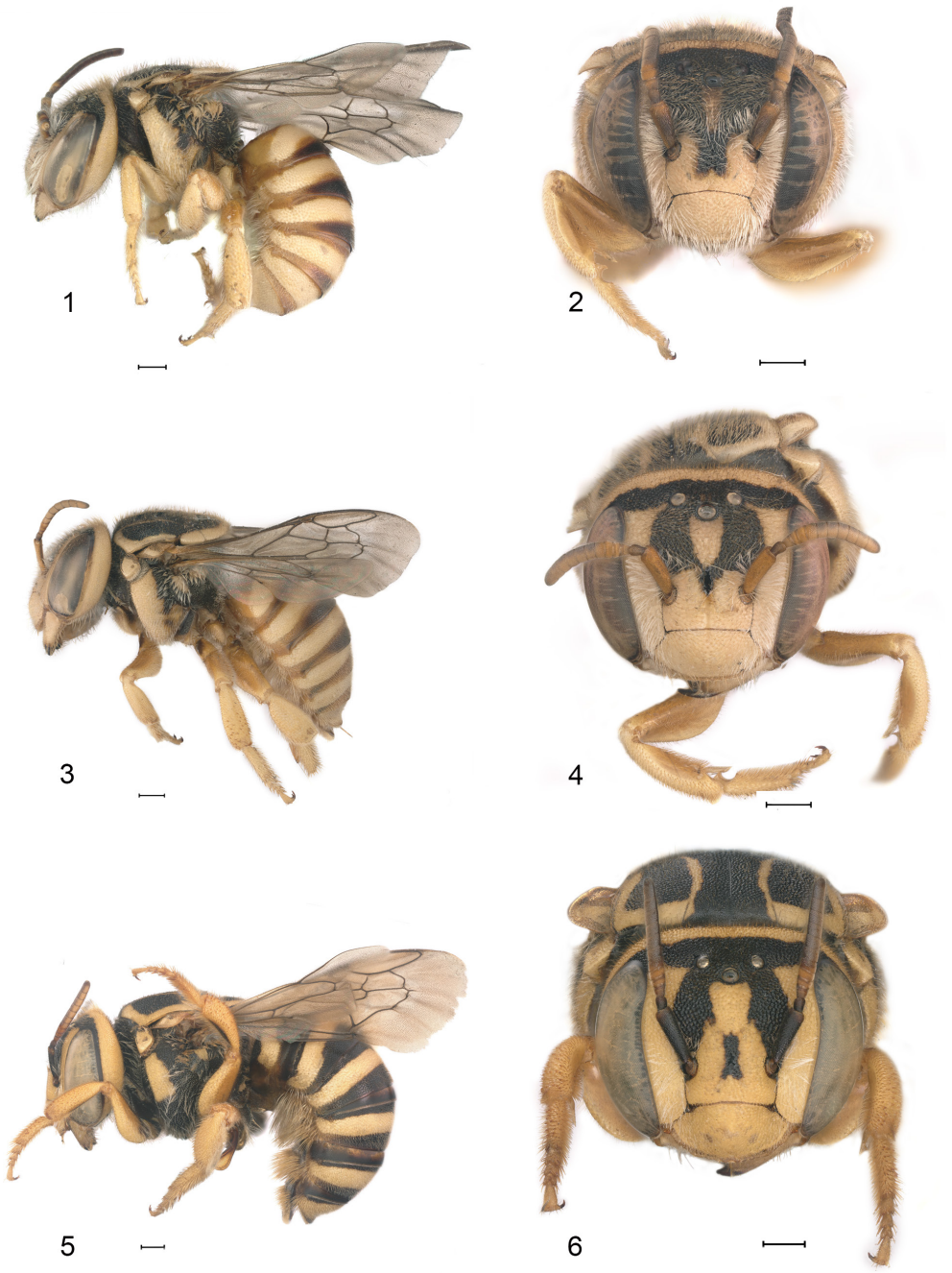
SYSTEMATICS

Cyphanthidium eardleyi Griswold & Copeland, new species
ZooBank: urn:lsid:zoobank.org:act:0A365101-EE2F-40F6-852F-FF32AE01B640
(Figs. 1–4, 7, 9, 11, 13–17)

DIAGNOSIS: Female distinguished from all known Megachilidae except *C. gessorum* and *C. sheppardi* by the highly modified posterior hind tibial spur (Figs. 9, 11). From those two species female *C. eardleyi* differs in scutellum with posterior margin slightly indented medially, overall shape slightly straightened on each side of the indention (Fig. 17), not evenly rounded as found in both *C. gessorum* and *C. sheppardi* (Fig. 18). Both sexes differ from all other *Cyphanthidium* except *C. sheppardi* (Eardley & Griswold, 2018) in the fine, contiguous punctation on scutum and scutellum, and propodeal triangle shagreened rather than shiny. *Cyphanthidium eardleyi* females differ from *C. sheppardi* in that the modified hind tibial spur arises distally on the tibia (Fig. 9) compared to near midpoint on the hind tibia in *C. sheppardi* (Fig. 10); males differ in the presence of a weak spike apicomedially on T6; in both sexes the posterior margin of the scutellum is subtruncate medially (Fig. 17), not the even arc of *C. sheppardi* (Fig. 18).

DESCRIPTION: Length, 8 mm; forewing length, 4.5 mm; intertegular distance, 2.2 mm. Integument black with cream to reddish-brown markings abundant throughout (Figs. 1–4) including reddish on anterior face of T1. Subantennal suture slightly curved (Figs. 2, 4). Juxtantennal carina absent. Interantennal area with narrow, slightly depressed impunctate stripe. Ocelloccipital distance three times greater than ocellar diameter. Preoccipital margin narrowly rounded, not carinate. Pronotal lobe carinate. Scutum with narrow lateral impunctate flange, similar impunctate flange along axillar suture. Omaulus sharply angled on dorsal half but not carinate. Scutellum and axillae with posterior margin carinate, not forming an even crescent, slightly straightened medially with slight indentation. Scutoscutellar suture narrow, not foveate. Propodeum vertical, without dorsal shelf, enclosure shagreened, densely punctate throughout, fovea behind

spiracle absent. Tegula rather evenly rounded laterally. Forewing with 2nd recurrent vein exceeding 2nd transverse cubital vein. Hindwing with cu-v one fourth as long as second abscissa of M+Cu. Terga lacking posterior impunctate stripe.

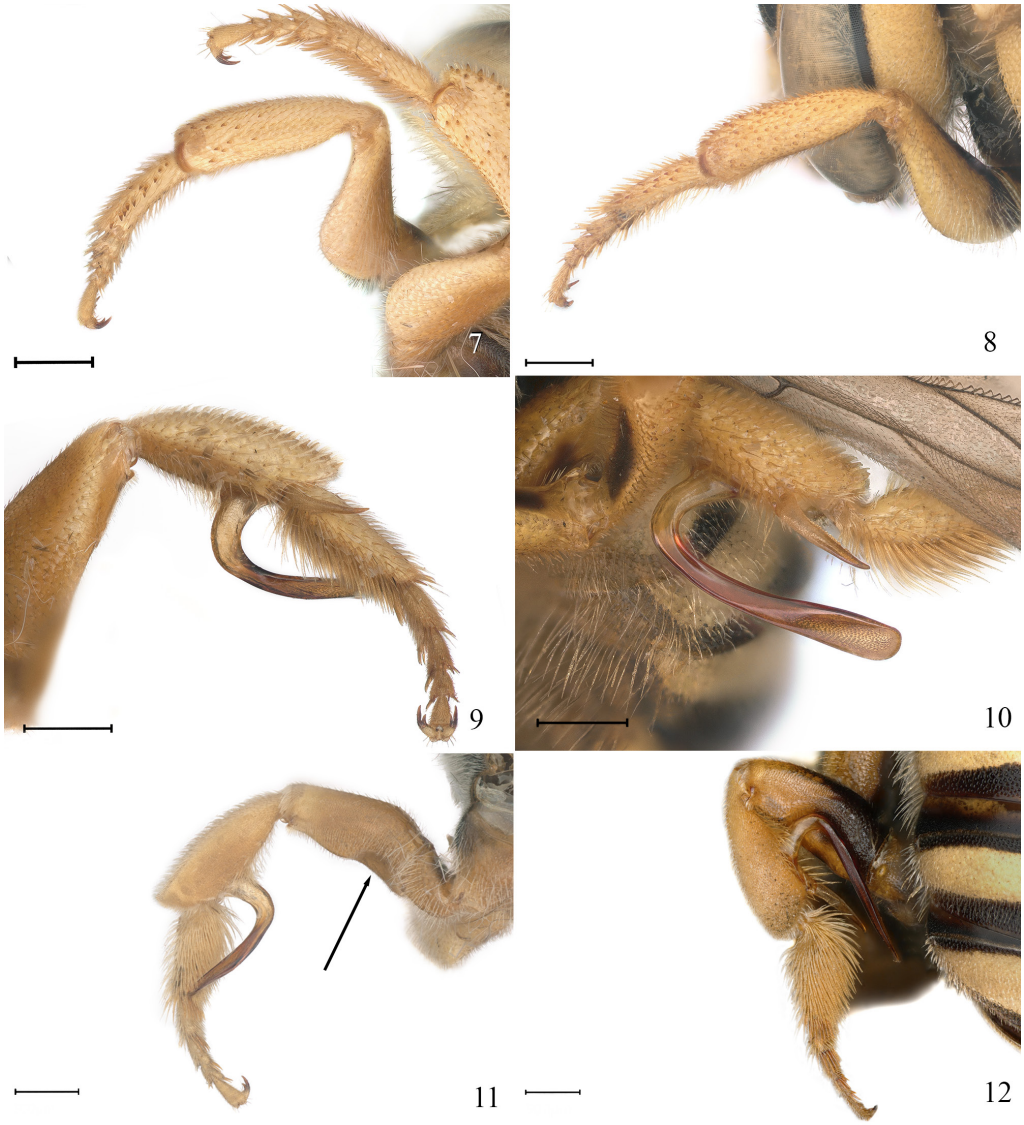


Figures 1–6. *Cyphanthidium* lateral habitus (1, 3, 5); head anterior view (2, 4, 6). **1, 2.** *C. eardleyi* male (ICIPE10273). **3, 4.** *C. eardleyi* female (ICIPE10285). **5, 6.** *C. sheppardi* female (BBSL1056959). Scale bar = 0.5 mm.

Female: Head broader than long (Fig. 4). Mandible stout, tridentate. Labrum slightly longer than broad with subapical fringe of erect setae. Clypeus much broader than long, apical margin slightly convex, finely, irregularly dentate, dorsal margin nearly straight (Fig. 4). Antenna with F1–F3 much broader than long; succeeding flagellomeres increasingly long to F9 as long as broad; F10 nearly twice as long as broad. Foretibia distally, forebasitarsus, midtibia, finely spiculate (Fig. 7). Foretibia apically with rounded flange surmounted by dense fringe of short, fine setae (Fig. 7). Midtibia with rounded flange and minute tooth apically on lateral face. Hindtrochanter without apical denticle. Hindtibia apically lacking denticles on lateral face. Hind tibial spurs very different: anterior spur rather stout, reaching more than midway length of hind basitarsus, margin minutely dentate, apex hooked; posterior spur set in short, apical socket, spur translucent, polished, greatly elongated, initially directed perpendicular to long access of tibia, then abruptly curving posteriorly parallel to hind basitarsus for two-thirds of its length, apically asymmetrically spatulate ending in a rounded acute angle (Fig. 9). Hindfemur depressed posteromedially, accommodating enlarged posterior hind tibial spur (Fig. 12), basoventrally with short longitudinal carina. Tarsal claws with subapical inner tooth. T1 with distinct carina separating anterior, dorsal faces of segment; terga densely, finely punctate lacking even narrow impunctate margins. T6 subapical margin broadly, evenly rounded except small medial invagination, carinate minutely irregular; apical margin narrowly notched medially. S1 triangular in cross section, along midline with ventral translucent, longitudinal lamella almost full length of segment, apical margin narrowly lamellate. Scopa long on S2–S5, S6 with decreasing height toward apex.

Male: As in female except: antenna with F1 and F2 much broader than long; F3–F10 increasing in length to greater than width; F11 nearly twice as long as broad. Legs lacking spicules. Hind tibial spurs similar in shape and size. Hind femur bulging basally, without invagination. T7 tridentate apically, medial projection truncate (Fig. 13). S4 with apical brush of fine, dense setae on middle fourth. S5 apical margin with shallow V-shaped notch across nearly entire width of segment, tiny spike at lateral apex (Fig. 14). S6 with wide trapezoidal apical margin ending lateral in obtuse angle (Fig. 15). Genitalia as in Fig. 16.

TYPE MATERIAL: Holotype: ♀, KENYA: Eastern Province: base of Ukasi Hill, 613m, 0.82103° S, 38.54443° E, Malaise trap, Acacia/Commiphora woodland, 17–20 Dec 2011 R. Copeland ICIPE10290 (NMKE). Paratypes, all Kenya, Eastern Province. Sosoma area, 489m, 0.86344° S, 38.67907° E, Malaise trap, Acacia/Commiphora woodland, 12–19 May 2018, R. Copeland, 1♂ (ICIPE4844, ICIPE); same except 19-26 May 2018, 1♂ (ICIPE3995, ICIPE); same except 491m, 0.86269° S 38.67851° E, 31 Jan–14 Feb 2024, 1♀ (ICIPE77805, ICIPE); Base of Ukasi Hill, 613m, 0.82103° S, 38.54443° E, Malaise trap, Acacia/Commiphora woodland, 1–6 Jan 2012, R. Copeland, 1♀ (ICIPE10274, ICIPE), 1♂ (ICIPE10273, BBSL); same except 27 Dec 2011–1 Jan 2012, 3♀ (ICIPE10293, ICIPE10295, ICIPE10267, all ICIPE); same except 17–20 Dec 2011, 2♀ (ICIPE10289, ICIPE; ICIPE10288, MK), 1♂ (ICIPE10287, NMKE); same except 10–17 Dec 2011, 1♀ (ICIPE10297, BBSL); same except 1–6 Dec 2011, 1♀ (ICIPE10285, BBSL); same except, 22-27 Dec 2011, 1♂ (ICIPE10280, BBSL); Base of Ukasi Hill, 615 m, 0.82002° S, 38.54378° E, Malaise trap, Acacia/Commiphora savannah, 18 Dec 2019–1 Jan 2020, R. Copeland, 1♀ (ICIPE17923, ICIPE); same except 15–29 Jan 2020, 1♀ (ICIPE17925, ICIPE); same except 29 Jan–12 Feb 2020, 1♀ (ICIPE27045, ICIPE); same except 14–28 Jan 2021, 1♀ (ICIPE41051, ICIPE); Base of Ukasi Hill, north side of hill, 643 m, 0.81529° S, 38.54301° E, Malaise trap, Acacia/Commiphora savannah, 12–26 Feb 2020, R. Copeland, ICIPE17924; same except 26 Feb–11 Mar 2020, 1♀ (ICIPE17927, MK).



Figures 7–12. Female foreleg, lateral view (7, 8) and hindleg, anterior view (9, 10), posterior view (11, 12). **7, 9, 11.** *C. eardleyi* (ICIPE10285). **8, 10, 12.** *C. sheppardi* (BBSL1056959). Scale bar = 0.5 mm.

Etymology: It is a great pleasure to recognize Connal Eardley, colleague and friend, who has contributed so greatly to our knowledge of the bees of sub-Saharan Africa.

Comments: This and the following species run to couplet 24 in the generic level key to Eastern Hemisphere Anthidiini (Michener, 2007) if it is modified in the first half of the couplet to include the larger body size of female *C. sheppardi*, 9.5 mm instead of maximum of 8.5 mm. If the second half of the couplet is chosen, they run to *Rhodanthidium* Isensee but differ in: scutellum strongly overhanging the metanotum, absence of red or reddish-yellow integument present in many *Rhodanthidium*, and complete (not medially divided) maculations on the terga. Additionally, *Rhodanthidium* is not known from tropical Africa.

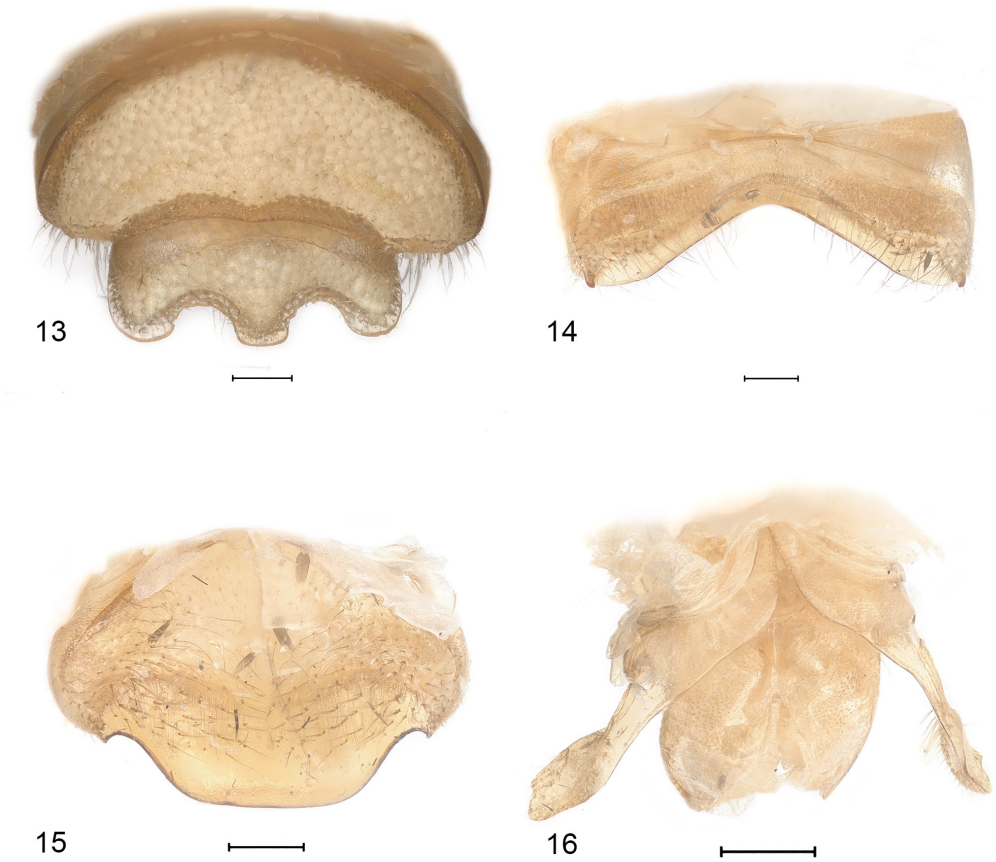


Figure 13–16. Male *C. eardleyi* (ICIPE10273). **13.** T6, T7. **14.** S5. **15.** S6. **16.** Genitalia, dorsal view. Scale bar = 0.25 mm.

Cyphanthidium sheppardi (Mavromoustakis)
(Figs. 5, 6, 8, 10, 12, 18)

Hypanthidium sheppardi Mavromoustakis 1937: 229–230.
Trianthidiellum sheppardi (Mavromoustakis): Pasteels, 1969: 58, 129–132.
Anthidiellum (*Trianthidiellum*) *sheppardi* (Mavromoustakis): Pasteels, 1984: 113–114.
Cyphanthidium sheppardi (Mavromoustakis): Michener & Griswold, 1994: 314.
Cyphanthidium sheppardi (Mavromoustakis): Eardley & Griswold, 2018: 32.

FEMALE DIAGNOSIS: Female distinguished from all known Megachilidae except *C. gessorum* and *C. eardleyi* by the highly modified posterior hind tibial spur (Figs. 10, 12). From those two species female *C. sheppardi* differs in hind femur depressed medially to accommodate the highly modified spur instead of basally; modified hind tibial spur arises near midpoint on the hind tibia compared to distally. *Cyphanthidium sheppardi* further differs from *C. eardleyi* in scutellum evenly rounded without indentation medially compared to posterior margin slightly indented medially, the overall shape slightly flattened on each side of the indentation. From female *C. gessorum* it also differs in scutal punctation fine not coarse, propodeal triangle shagreened rather than shiny, and body size larger.

Female description: Length, 9.5 mm; forewing length, 5.5 mm; intertegular distance, 2.7 mm. Integument black with extensive yellow markings abundant throughout, including black on T1 anterior face, T1–T5 with apical black bands (Figs. 5, 6). Head broader than long. Mandible stout, not tridentate (only hint of subapical tooth). Labrum slightly longer than broad with subapical fringe of erect setae. Clypeus much broader than long, apical margin finely, irregularly dentate, dorsal margin broadly convex (Fig. 6). Subantennal suture straight (Fig. 6). Juxtantennal carina absent. Interantennal area not medially depressed, without distinct impunctate stripe. Ocelloccipital distance nearly four times greater than ocellar diameter. Preoccipital margin rounded, not carinate. Pronotal lobe carinate. Scutum with narrow lateral impunctate flange, similar impunctate flange along axillar suture. Omaulus sharply angled on dorsal half but not carinate. Scutellum and axillae posteriorly forming carinate, even crescent. Scutoscutellar suture narrow, not foveate. Propodeum vertical, without dorsal shelf, enclosure shagreened, densely punctate throughout, fovea behind spiracle absent. Tegula roundly angled laterally. Forewing with 2nd recurrent vein exceeding 2nd transverse cubital vein. Hind wing with cu-v one fourth as long as second abscissa of M+Cu. Foretibia, forebasitarsus, midtibia coarsely spiculate (Fig. 8). Foretibia apically with rounded flange surmounted by dense fringe of short, fine setae (Fig. 8). Mid tibia with rounded flange and minute tooth apically on lateral face. Hind trochanter with subapical denticle. Hind femur depressed anteromedially accommodating enlarged posterior hind tibial spur (Fig. 12). Hind tibia apically with several denticles on lateral face. Hind tibial spurs very different: anterior spur rather stout, reaching more than midway length of hind basitarsus, margin minutely dentate, apex not hooked (Figs. 10, 12); posterior spur with longitudinal basal platform set in elongate invagination of tibial cuticle that extends for more than half ventral length of segment, spur translucent, polished, greatly elongated, initially directed basally at approximately 60° angle from midway on hind tibia, then abruptly curved posteriorly parallel to hind basitarsus for half or less its length (Fig. 12), apically asymmetrically spatulate, ending in rounded blunt angle. Tarsal claws with subapical inner tooth. Terga with narrow posterior impunctate stripes. T1 with indistinct carina separating anterior, dorsal faces of segment; terga densely, finely punctate with very narrow impunctate margins; T6 subapical margin broadly, evenly rounded, carinate and denticulate; apical margin narrowly notched medially. S1 triangular in cross section along midline with ventral translucent, longitudinal lamella almost full length of segment, apical margin narrowly lamellate. S6 flat, apical margin evenly rounded. Scopa long on S2–S5, S6 with decreasing height toward apex.

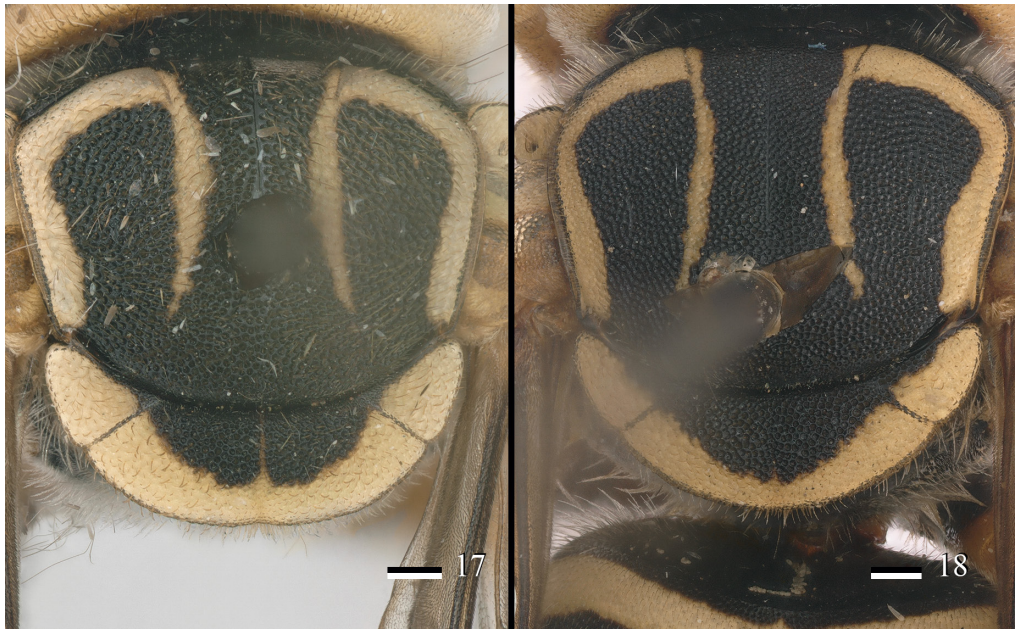
New material: 1♀, Afrika NE-Zimbabwe, 5km E Kotwa (16°58′S 32°44′E), vi–ix. 1986; leg.: S. Potel & M. Lilling S23.8 (ZSM).

Comments: The presence of a partial sclerotized bridge separating the hind tibial spurs is not common in bees other than some Apidae (Cane, 1979). It is present in *C. eardleyi* and even more recessed in *C. sheppardi*. Cane (1979) suggested this surrounding of the spur could function in support of foraging.

Cyphanthidium intermedium Pasteels

Cyphanthidium intermedium Pasteels, 1969: 57, 128–131.
Cyphanthidium intermedium Pasteels: Eardley & Griswold, 2018: 27–31.

New records: NAMIBIA: 1♂, SWA Fish River Cyn., 15 km E. Ai-Ais, 28 Jan 1988 Faulkner (SDNHM); 1♀, Karibib: 65 Km SW Usakos 1.3.1990 leg. Max Schwarz (MSchwarz); SWA, 1♂, Ugab River, 45 km. N. of Uis Mine March 24, 1976 J.G. & B.L. Rozen (AMNH).



Figures 17, 18. *Cyphanthidium* dorsal view of female mesosoma. **17.** *C. eardleyi* (ICIPE10280) 1**8.** *C. sheppardi* (BBSL1056959). Scale bar = 0.25 mm.

DISCUSSION

The distinctive female hind tibial spur described here for this species and *C. sheppardi* is not the first account of such a modification. It was previously noted for congener *C. gessorum* (Eardley & Griswold, 2018). A melittid from Kenya, *Samba turkana* Packer, has a similar appendage associated with foraging on *Crotalaria* (Packer & Martins, 2015) (Figs. 19, 20).



Figures 19, 20. Females of *Cyphanthidium* (Megachilidae) and *Samba* sp. (Melittidae). **19.** Frontolateral habitus of *C. eardleyi*. **20**. Dorsal habitus of *Samba* sp. In both images, an arrow points to the large hind tibial spur (Photo credits: R. S. Copeland). Scale bar = 1.0 mm.

Cyphanthidium eardleyi joins a long list of distinctive species and records from xeric eastern Kenya adding to the importance of Ukasi Hill for dryland biodiversity. Ukasi lies within the south-eastern branch of the Sahel that reaches as far south as northern Tanzania (Coe, 1999). The vegetation around Ukasi Hill is savanna with dry scrub and trees (Greenway, 1973). Patches of *Acacia*/*Commiphora* woodland and *Aloe*, *Boscia*,

Maerua, and *Sansevieria* spp. grow on the sides and base of the hill. Ukasi and nearby Sosoma, the other site at which we collected *C. eardleyi*, endure regular rainfall deficits, with failures of the maize crop common. Recorded mean annual precipitation on the western boundary of the Ndenyini area (which encompasses Ukasi) is about 15 inches (ca 381mm) (Wright, 1964).

Ukasi Hill, the type locality of *C. eardleyi*, best known as the type locality of the terrible hairy fly, *Mormotomyia hirsuta* Austen, a flagship endemic of the Afrotropical region and the only species in the monotypic Mormotomyiidae (Copeland *et al*., 2011; Kirk-Spriggs & Copeland, 2021), is also the site for rare Apoidea. Four species of the rarely seen Meganomiinae (Melittidae) have been collected at Ukasi; *Meganomia rossi* Michener, *Pseusophilanthus taeniatus* Alfken, *Pseudophilanthus tsavoensis* (Strand), and *Uromonia stagei* Michener (Pauly & Copeland, 2019). Two species of the recently described cleptoparasitic bee genus *Schwarzia* Eardley (Apidae) are endemic to Ukasi: *S. gretae* Bossert & Copeland and *S. icipeensis* Bossert & Copeland (Bossert *et al.*, 2020).

Other endemic insects from Ukasi include two species of chalcid genus *Dirhinus* (Delvare & Copeland, 2018), the only known locality of the asilid *Hermannomyia ukasi* (Stenopogoninae) Londt & Copeland (2013), a genus known previously only from southern Africa, one of the locations for the Kenyan endemic genus *Nanoculcita* Londt (Diptera: Asilidae: Stichopogoninae) (Londt & Copeland, 2017) and *Bocchus hyalinus* Olmi (Dryinidae), the only record of the species from the Afrotropical region (Olmi *et al*., 2019). It is expected that future collections will continue to reveal new species at Ukasi and its environs.

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