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The geometrid moths of Ethiopia I: tribes Pseudoterpnini and Comibaenini (Lepidoptera: Geometridae, Geometrinae)

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Abstract

In this paper we present a checklist for Ethiopian Geometridae, subfamily Geometrinae, tribes Pseudoterpnini and Comibaenini. Six species were found to belong to the tribe Pseudoterpnini, two species to the tribe Comibaenini. One species is described as new, *Comibaena theodori* **sp. nov.** Adults of all species are illustrated, genitalia are figured for the new species.

Key words: Lepidoptera, Geometridae, Geometrinae, Pseudoterpnini, Comibaenini, Africa, Ethiopia, DNA Barcoding, integrative taxonomy, new species

Introduction

Though the first descriptions of Ethiopian geometrids date back to the year 1858, the country still has to be regarded as poorly investigated. So far, 90 taxa have been described from Ethiopia of which 79 are currently accepted as valid at species rank (Scoble 1999; Scoble & Hausmann 2007). Most descriptions were done by Herbulot (22 taxa, various papers), Guenée (1858; 18 taxa), Prout (16 taxa; various papers), Fletcher (10 taxa; various papers) and Debauche (1937; 8 taxa). Only 16 descriptions have been contributed by other authors. Most type specimens are deposited in the Natural History Museum in London (51 taxa) and in the State Collection of Zoology in Munich (23 taxa) which facilitates work on Ethiopian Geometridae. A rough estimate based on the study of collection material involving both morphology and DNA barcoding leads to a projected number of geometrids for Ethiopia of at least 500 species. No comprehensive study on this country's fauna has been published. Since the authors have access to thousands of Ethiopian geometrid moths in their collections, this material offers a good basis for reviewing the historical descriptions and for offering additional data. In order to realize this review we are planning about 15 contributions, the first of which presents a checklist for the tribes Pseudoterpnini and Comibaenini (subfamily Geometrinae).

Material and methods

Specimens were collected by netting during daytime or at dusk, by attraction to 125W mercury vapour or miscellaneous light bulbs (in front of white sheets) powered by portable generators, by actinic light traps powered by lead batteries, and by attraction to bait. Specimens were pinned, mounted and identified by comparison with collections, type specimens and literature or, if necessary, by genitalia dissection. Dissection and preparation of genitalia slides were performed applying standard protocols (cf. Robinson 1976); the genitalia were embedded in Euparal and mounted on slides. Measurements were done with a reticule in a Wild M3Z microscope. Specimens are deposited in the entomological collections of the Zoologische Staatssammlung München (Germany), and of the Department of Agriculture, Environment and Food Science at the University of Molise, Campobasso (Italy). Systematic order and attribution to tribes was taken from Hausmann (1996; 1999; 2006); nomenclature follows Scoble (1999) and Scoble & Hausmann (2007).

DNA sequencing was performed at the CCDB following standard high-throughput protocols (Ivanova *et al.* 2006; deWaard *et al.* 2008). PCR amplification with a single pair of primers consistently recovered a 658 bp region near the 5' end of the mitochondrial cytochrome *c* oxidase I (COI) gene that included the standard 648 bp barcode region for the animal kingdom (Hebert *et al.* 2003). DNA extracts are stored at the CCDB, with aliquots being deposited in the DNA-Bank facility of the ZSM (see <http://www.zsm.mwn.de/dnabank/>). All sequences are deposited also in GenBank according to the iBOL data release policy. Complete specimen data including images, voucher deposition, GenBank accession numbers, GPS coordinates, sequence and trace files can easily be accessed in the Barcode of Life Data System (Ratnasingham & Hebert 2007; Ratnasingham 2010) in the public data set DS-PSCOETYE (doi: [dx.doi.org/10.5883/DS-PSCOETYE](https://doi.org/10.5883/DS-PSCOETYE)). Sequence divergences for the barcode region were calculated using the Kimura 2 Parameter model, employing the analytical tools on BOLD. Genetic distances between species are reported as minimum pairwise distances, while intraspecific variation is reported as maximum pairwise distances. A neighbour joining tree with all barcoded species of this article is shown in Fig. 12.

Institutional acronyms and abbreviations are as follows: BOLD—Barcode of Life Data System; CCDB—Canadian Centre for DNA Barcoding; COI—mitochondrial cytochrome *c* oxidase I (COI) gene, region near the 5' terminus (barcode fragment, 658 bp); DAEF—Department of Agriculture, Environment and Food Sciences at the University of Molise, Campobasso (Italy); ZSM—Bavarian State Collection of Zoology, Munich, Germany; MNHN—Muséum National d'Histoire Naturelle, Paris, France; NHM—Nature History Museum, London, United Kingdom.

List of Collecting Sites

- 1 Ethiopie [Ethiopia], Arussi, Lac. Langano [7.66°N 38.81° E], 6.III.1981, leg. P.C. Rougeot.
- 2 Ethiopie [Ethiopia], Choa, Debre-Zeit [8.75°N 39.00° E], 1800m, 21.III.1986, leg. F. Thiaucourt.
- 3 Äthiopien [Ethiopia], Arba Minch, Reg. Omo, Prov. Gemu Gofa [5.98° N 37.60° E], 1350–1450m, 27.V.2004, leg. R. Beck & M. Hiermeier. (=‘Gamo Gofa’, lg. S. Naumann & H. Schnitzler, 4.V.2008). *Site description: scrubby escarpment, 150 metres above the Nechisar rain forest.*
- 4 E. Ethiopia, Hararge, Hirna, Kara Jara [9.24° N 41.14° E], 2180m, 20.IV.2006, leg. R. Beck & Tamrat. *Site description: low ground with pond in Podocarpus forest.*
- 5 SE. Ethiopia, Bale, 11 km SW. Goba [6.935° N 39.950° E], 3140m, Bale-Mts. 26.IV.2006, leg. R. Beck & Tamrat. *Site description: see under no. 4.*
- 6 SE. Ethiopia, Bale, 13 km sw Goba [6.924° N 39.940° E], 3100–3300m, Hangaso, 7–12.X.2007, leg. R. Beck, M. Dietl, G. Riedel. *Site description: vegetation dominated by huge shrubs and trees of Hypericum revolutum, Juniperus procera and Hagenia abyssinica. The site is characterized by mean rainfalls of 1200 mm per year and daily temperatures diverging extremely from very cold at night (-7°C measured) to warm at day (26°C).*
- 7 Ethiopia, Kaffa Prov., 5 km e Jim[m]a, 1800m 7°40'N 36°55'E, 28.IV.2008, leg. S. Naumann, H. Schnitzler. *Site description: see under no. 7.*
- 8 Ethiopia, Prov. Kaffa, 10 km n Bonga, 1550m 7°21'N 36°25'E, 29.IV.2008, leg. S. Naumann, H. Schnitzler. *Site description: very small deforested site with agricultural fields, within a larger area of rain forest.*
- 9 W. Ethiopia, Kaffa, 9.V.2008, 30 km nnw Jimma [7.889° N 36.783° E], 1650m, leg. R. Beck, G. Riedel. *Site description: grazed slope, with scattered huge, old, deciduous trees.*
- 10 W. Ethiopia, Kaffa, 11 km nnw Jimma [7.752° N 36.800° E], 10–15.V.2008, 2060m, leg. R. Beck, G. Riedel. *Site description: grazed open land, steep slope, at the fringe of a small deciduous forest with wild coffee shrubs.*
- 11 S. Ethiopia, Sidano, 16 km sw Kibre, Mengist, 1700m, 5.8107° N 38.8880° E, 25–26.III.2009, leg. R. Beck, M. Dietl. *Site description: grazed open land, surrounded by mixed deciduous forest.*
- 12 S. Ethiopia, Sidamo, 13 km, w Yabello, Motel, 1960m, 4.90° N 38.01° E, 28–30.III.2009, leg. R. Beck, M. Dietl. *Site description: open land without low vegetation between Juniperus and deciduous forest.*
- 13 Ethiopia, Oromia Region, sw Shewa Zone, Wenchi Crater Lake [8.781° N 37.891°E], 2900m (lux) 19.IV.2009, leg. A. Sciarretta, G. Spina. *Site description: inner slope of the Wenchi Crater Lake, an extinct volcano arising up to 3380 metres above sea level. Samplings were carried out in a primary mountain forest dominating the vegetation around the lake.*
- 14 Ethiopia, Bale Mountains – Dinsho [7.099° N 39.790° E], 3100m (lux) 25.IX.2009, leg. A. Palladino, F. Parisi.

- A. Sciarretta. *Site description: scattered forest with presence of Juniperus procera, Olea europaea cuspidata, Celtis africana, Euphorbia ampliphylla, Mimmsops kummel and Ekebergia capensis. Collecting sites near the Bale Mountain National Park Headquarter.*
- 15 Ethiopia, Prov. Oromiya, between Leku and Wendo, 2 km E. Abosto, 6°44,950' N 38°26,612' E, 15–19.V.2010, 1800m, leg. H. Sulak. *Site description: this site is situated 300 km south of Addis Ababa in a long, narrow valley of a small river. Collecting was performed on the upper part of the southern slope with the light reaching both the river and the opposite slope. The vegetation was mountain cloud forest, at beginning of the rain season.*
- 16 Äthiopien [Ethiopia], Äthiopisches Hochland [Ethiopian Highlands], Prov. Sidamo/Oromia, Yabello, 17 km Wildlife Sanctuary OSO, 1580m, (Dornbuschgebiet), 04°51.010' N, 38°14.783' E, 16.V.2012, leg. Dietl M. + S. & R. Beck. *Site description: thorn bush savannah with flowering Acacia trees.*
- 17 Äthiopien [Ethiopia], Ostafrikanischer Graben [East African Rift Valley], Prov. Gamu Goffa, Arba Minch, 12 km NNO 1620m, 06°08.311' N 37°34.953' E, 23.V.2012, leg. Dietl M. + S. & R. Beck. *Site description: pasture with scattered scrub and single trees below the Mount Guge chain.*
- 18 Äthiopien [Ethiopia], Ostafrikanischer Graben [East African Rift Valley], South Nation, Bonga, 16 km E, 2440m, 07°11' N 36°28' E, 04.V.2013, Beck R. & R. Wanninger leg. *Site description: mist forest with Hagenia abyssinica, Juniperus, and wild coffee.*
- 19 Äthiopien [Ethiopia], Ostafrikanischer Graben [East African Rift Valley], South Nation, Bonga, 25 km E, 2720m, 07°19' N 36°00' E, 04.V.2013, Beck R. & R. Wanninger leg. *Site description: mist forest with Hagenia abyssinica, Juniperus, and wild coffee.*
- 20 Äthiopien [Ethiopia], Ostafrikanischer Graben [East African Rift Valley], South Nation, Bonga-Hotel, 1700m, 07°21' N 36°07' E, 06.V.2013, Beck R. & R. Wanninger leg. *Site description: fringe of mist forest*
- 21 Äthiopien [Ethiopia], Ostafrikanischer Graben [East African Rift Valley], South Nation, Wushwush, 7,4 km W, 1910m, [7.31° N 36.04° E], 07.V.2013, Beck R. & R. Wanninger leg. *Site description: gravel pit in the centre of a mixed primary forest.*
- 22 Äthiopien [Ethiopia], Äthiopisches Hochland [Ethiopian Highlands], Prov. Sidamo/Oromia, Yabello, 7 km W Yabello, 1955m, (Bergwald) 04°55' N 38°02' E, 14.V.2013, Beck R. & R. Wanninger leg. *Site description: mixed mountain forest with Juniperus.*
- 23 Äthiopien [Ethiopia], Ostafrikanischer Graben [East African Rift Valley], Prov. Gamu Goffa, Arba Minch, Nachisar Nationalpark 1180–1380m, 06°00' N 37°47' E, 17–19.V.2013, Beck R. & R. Wanninger leg. *Site description: steep, scrubby escarpment, 100 metres above the Nechisar rain forest (NP).*

Systematic part

Geometrinae

Tribe Pseudoterpnini

Pingasa rhadamaria signifrontaria (Mabille, 1893)

(Fig. 1)

Type locality. Comores: Mayotte.

Material. ZSM: 1♀, Arussi ♀ (locality no. 1); Bale 1♀ (14); Keffa 1♂ (20); Gamo Gofa 1♂ (23).

Genetic data. genetically well corresponding with *P. rhadamaria* from nine different countries in Africa.

Pingasa lahayei (Oberthür, 1887)

(Fig. 2)

Type locality. Algeria: Oran, Aïn-Sefra, Lahaye.

Material. ZSM: Gamo Gofa 1♂ (locality no. 3).

Genetic data. genetically well fitting into the cluster of *P. lahayei* as represented by 18 specimens from eight different countries in Africa.

***Pingasa distensaria* (Walker, 1860)**

(Fig. 3)

Type locality. Not stated (BMNH).

Material. ZSM: Keffa 1♂ (locality no. 7); Keffa 1♂ (10); Gamo Gofa 1♀ (18); Gamo Gofa 1♀ (3).

Genetic data. Ethiopian populations genetically diverging from those of South Africa, Mozambique and Zimbabwe (subsp. *respondens*) by 3.3%, suggesting the potential need for raising the taxon *respondens* up to the rank of species. For verifying the identity (and the provenience) of nominotypical *P. distensaria*, the type specimen should be DNA barcoded.

***Pingasa abyssinaria* (Guenée, 1858)**

(Fig. 4)

Type locality. Abyssinie (Ethiopia).

Material. ZSM: Harerge 1♂ (locality no. 4); Keffa 3♂ (19); Keffa 2♂ (21); Keffa 10♂1♀ (18); DAEF: Shewa 2♂ (13); Bale 1♂ (14).

***Pingasa pallidata* de Joannis, 1912**

(Fig. 5)

Type locality. (Ethiopia): Eritrea.

Material. ZSM: Shewa 1♂ (locality no. 2).

Remarks: according to Prout (1932) possibly an individual aberration of *P. abyssinaria*, somewhat smaller and paler, postmedial line slightly less dentate. In the collection Herbulot, a specimen was found under this name, but attributed here as a synonym to *P. distensaria*. The dissection (♂) revealed this specimen as clearly different from both *P. distensaria* and *P. abyssinaria*, e.g. in the asymmetric valvae with a narrow spine at the centre of the left valva, a spinose process from the costa of the left valva, the absence of cornuti in the aedeagus a.s.o. (cf. Fig. 11). Therefore we accept and confirm the species status of this taxon as it was proposed also by Scoble (1999). The type specimen was not traced in the MNHN (Paris; Claude Tautel pers. comm.) and may be deposited in the NHM (London).

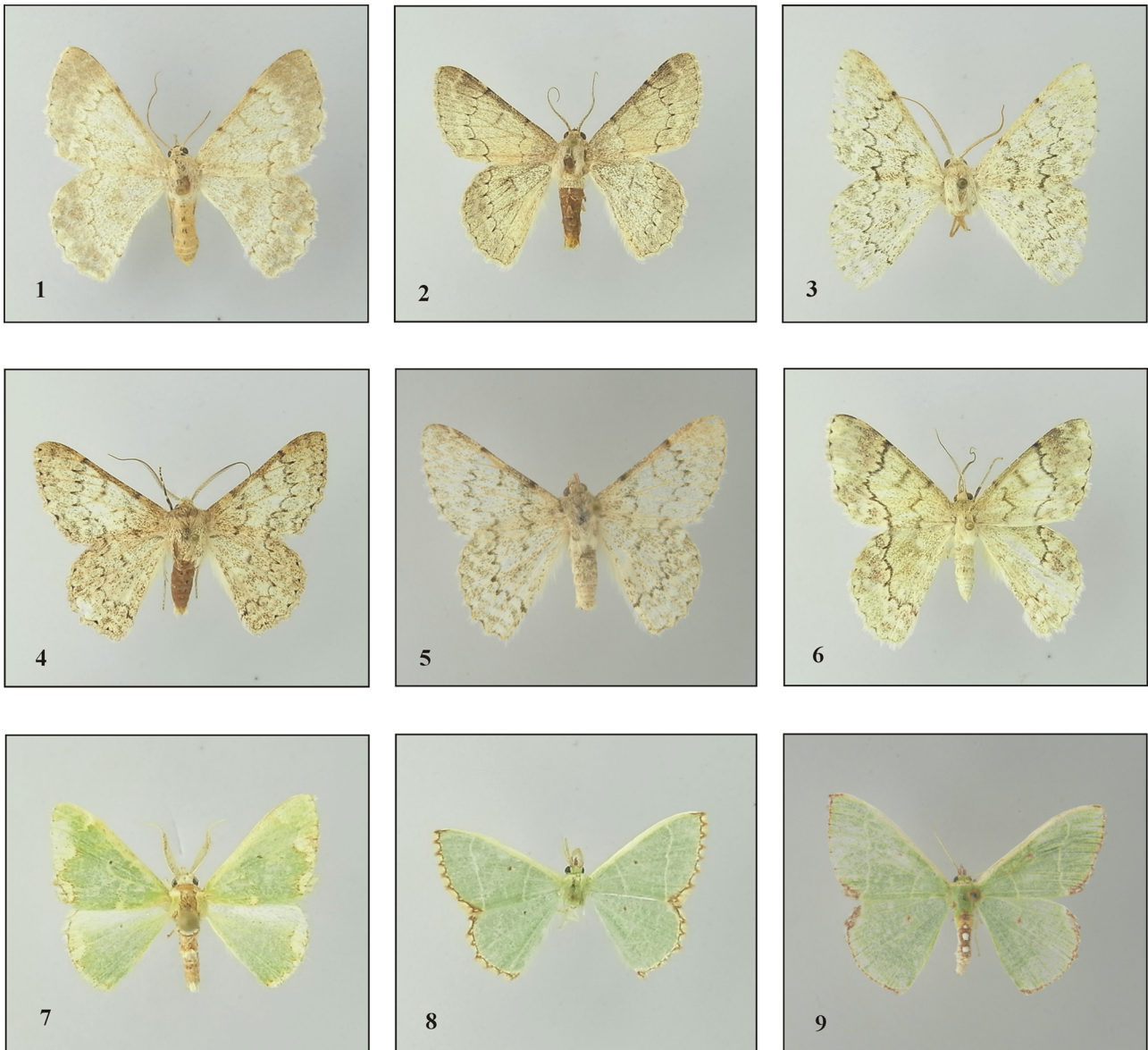
***Pingasa ruginaria interrupta* Warren, 1901**

(Fig. 6)

Type locality. Uganda: Nandi Country, Rau.

Material. ZSM: Bale 1♂ (locality no. 5).

Genetic data. the single specimen of *P. ruginaria* from Ethiopia and populations from South-East Asia (examined from Thailand) diverge by 0.46% only, with very similar haplotypes occurring in most populations from western and eastern Africa. In West Africa, however, there is another cluster of haplotypes at a minimum distance of 4.1%, requiring further study.



FIGURES 1–9. The Geometrid moths of Ethiopia I: tribes Pseudoterpnini and Comibaenini (photos F. Parisi; all figured specimens from Ethiopia). 1. *Pingasa rhadamaria signifrontaria* (Mabille, 1893), female, wingspan: 35mm; 2. *Pingasa lahayei* (Oberthür, 1887), male, wingspan: 31mm; 3. *Pingasa distensaria* (Walker, 1860), male, wingspan: 31mm; 4. *Pingasa abyssinaria* (Guenée, 1858), male, wingspan: 38mm; 5. *Pingasa pallidata* de Joannis, 1912, male, wingspan: 31mm; 6. *Pingasa ruginaria interrupta* Warren, 1901, male, wingspan: 35mm; 7. *Microbaena pulchra minor* Hausmann, 1996, male, wingspan: 15mm; 8. *Comibaena theodori* **sp. nov.**, male, holotype, wingspan: 25mm; 9. *Comibaena theodori* **sp. nov.**, female, paratype, wingspan: 26mm.

Tribe Comibaenini

Microbaena pulchra minor Hausmann, 1996

(Fig. 7)

Type locality. Sudan: Kassala Province, Ercowit, 1000–1300m.

Material. ZSM: Keffa 1♂ (locality no. 8); Keffa 1♂ (1); Sidamo 1♂ (11); Sidamo 1♀ (22); Sidamo 1♀ (16); Sidamo 1♀ (17).

Genetic data. populations of *M. pulchra* split up into six different genetic lineages, awaiting further study.

***Comibaena theodori* Hausmann & Parisi sp. nov.**

(Figs 8, 9)

Type material. Holotype: ♂, Ethiopia, Prov. Kaffa, 10 km n Bonga, 1550m 7°21'N 36°25'E, 29.IV.2008, leg. S. Naumann, H. Schnitzler, coll. ZSM (locality no. 10); gen.prp 19376. DNA Barcode specimen ID BC ZSM Lep 14842. Paratypes: 1♀, Ethiopie, Choa, Debre-Zeit, 1800m, 21.III.1986, leg. F. Thiaucourt (locality no. 2), coll. Herbulot/ZSM; 1♀, Äthiopien, Äthiopisches Hochland, Prov. Sidamo/Oromia, Yabello, 17 km Wildlife Sanctuary OSO, 1580m, (Dornbuschgebiet), 04°51.010''N, 38°14.783'E, 16.V.2012, leg. Dietl M. + S. & R. Beck, coll. ZSM (locality no. 17); 1♀, Äthiopien, Ostafrikanischer Graben, Prov. Gamu Goffa, Arba Minch, 12 km NNO 1620m, 06°08.311'N, 37°34.953'O, 23.V.2012, leg. Dietl M. + S. & R. Beck, coll. ZSM (locality no. 18); 1♀, E. Ethiopia, Hararge, Kara Jara [9.24° N 41.14° E], 2180m, 20.IV.2006, leg. R. Beck & Tamrat (locality no. 4). Other material: DAEF: 1♀, Ethiopia, near Abelti, Ghibe river, 1096m, 30.I.2012, coord. UTM 37P 338350E, 913109N, Sciarretta A., Parisi F. leg, gen.prp. R; 1♂, Ethiopia, Wellega zone, Didessa river, 1280 m, 24.I.2012, coord. UTM 37P 215814E, 961832N, Sciarretta A., Parisi F. leg, gen.prp. N, not included in the type series because of the poor condition of these specimens (worn, almost without scales) and because of the unusually long process of sternum A8 in the male (see below under 'male genitalia').

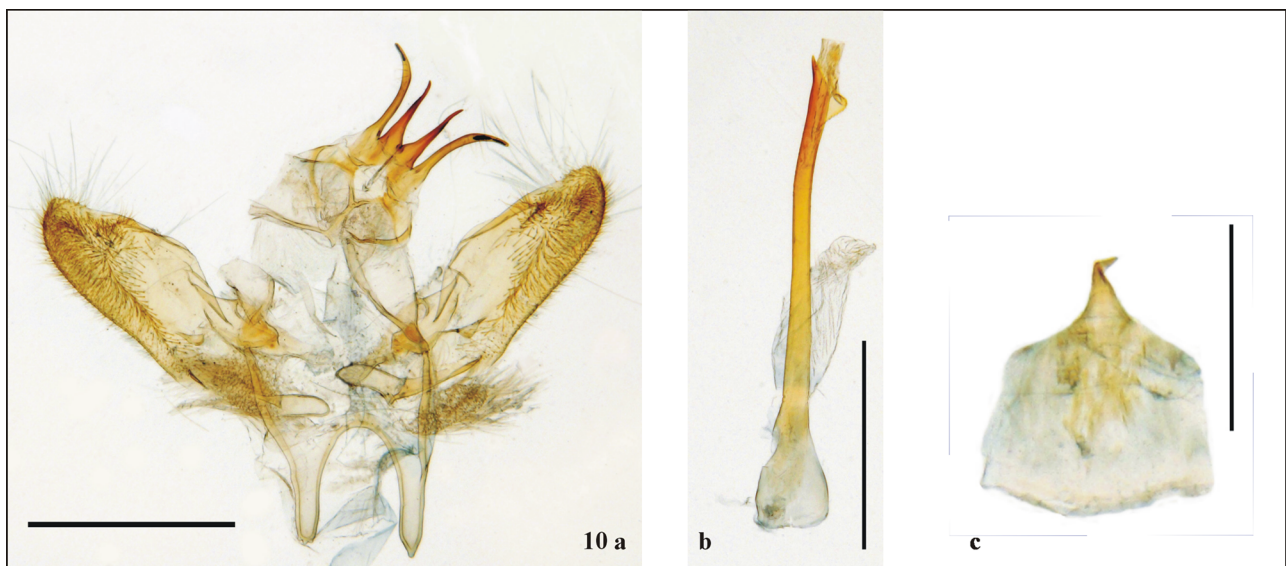


FIGURE 10. *Comibaena theodori* sp. nov., holotype, (a) male genitalia, gen. prp. ZSM G 19376, (b) aedeagus, (c) sternum A8 (scale bars = 1 mm).

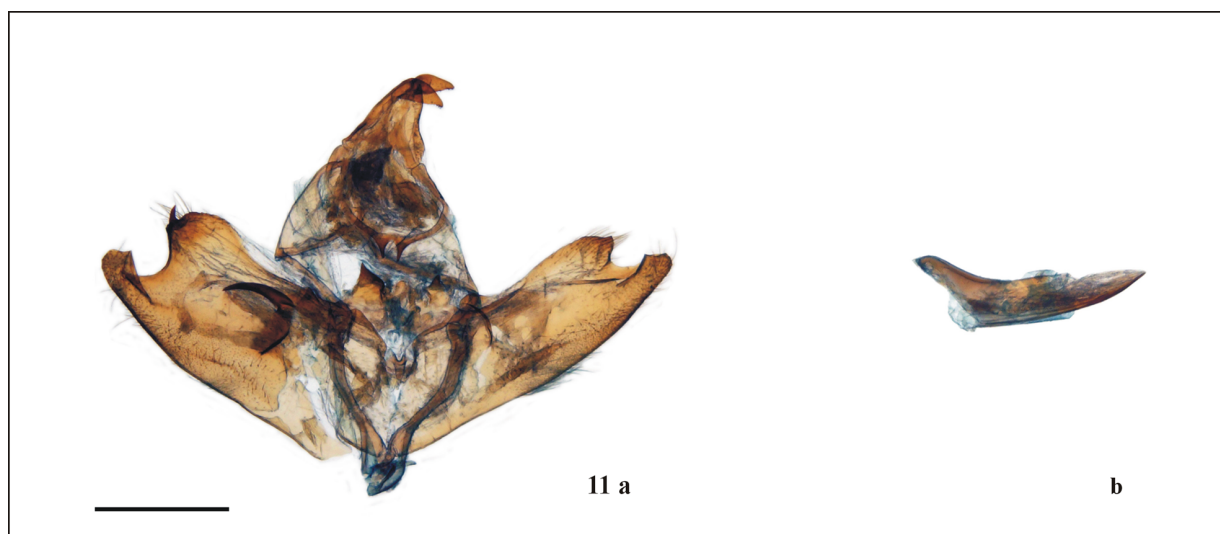


FIGURE 11. *Pingasa pallidata* de Joannis, 1912, Ethiopia, (a) male genitalia, gen. prp. ZSM G 19461, (b) aedeagus (scale bars = 1 mm).

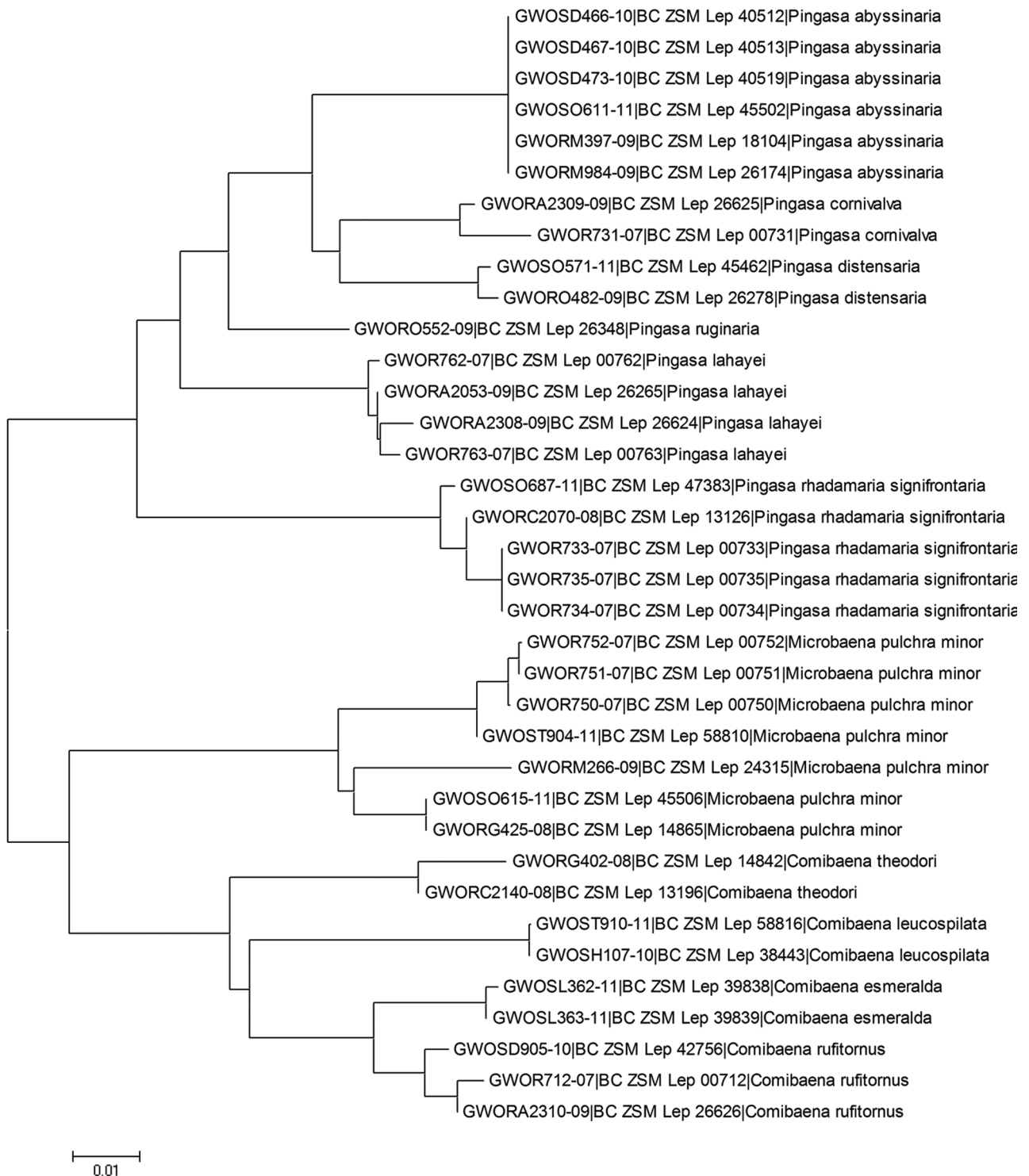


FIGURE 12. Neighbor Joining Tree of Pseudoterpnini and Comibaenini from Ethiopia and Yemen (BOLD alignment, Kimura 2 parameter, constructed with MEGA 6, Tamura *et al.* 2013). All sequence records, trace files and images are available and accessible on BOLD as a single citable dataset (doi: dx.doi.org/10.5883/DS-PSOETYE).

Description. Adult (Figs 8–9). Wingspan: ♂♀ 23–29 mm. Ground colour leaf green, ante- and postmedial lines fine, whitish. Medial area dilated towards forewing costa. Discal dots red brown, fine and sharp on all wings. Terminal line uninterrupted, red brown, slightly dilated at forewing tornus and hindwing apex. Fringe chequered pale yellow and red brown, the latter in triangles. Underside shiny pale green with postmedial fascia darker green, discal dots fine on all wings, fringe chequered as on upper side. Frons pale green, vertex darker green. ♂ palpi with

mixed brown and white scales, length 1.5 mm, last segment smoothly scaled. ♂ antennae long bipectinate, length of branches up to 1.3 mm, approx. 10 times width of flagellum. ♂ hindtibia with four spurs and a terminal process, length of the latter 0.75 mm. **Male genitalia** (Figs 10a–10c): Uncus with lateral projections much longer than central, 0.5–0.6 mm deepest incision. Valva comparatively broad at centre. Saccus projections comparatively short, length 0.5–0.6 mm from central excavation. Aedeagus straight, length 2.25 mm. Sternum A8 with moderately long projection, length 0.3 mm in the holotype (but 0.95 mm in the specimen from Didessa river).

Differential diagnosis. African members of genus *Comibaena* often show interspecific differential features in coloration and wing pattern, though the differences in male genitalia are often small, e.g. in the *rufitornus/leucospilata/esmeralda* species-group. The specific differential traits in the habitus, however, are well correlated with COI-haplotypes at interspecific genetic distances of usually 5 to 8%. Anticipating a comprehensive revision of the African species of the genus *Comibaena* (probably raising the species number from actually 12 to more than 20) we describe a new Ethiopian species here, which is well differentiated from all other African species in male genitalia and DNA barcodes. The new species differs from *C. rufitornus* Prout, 1916 (dissections examined from Kenya, Cape Verde), *C. leucospilata* (Walker, 1863) (South Africa, Natal) and *C. esmeralda* (Warren, 1898) (Nigeria, Guinea) by a shorter projection of sternum A8 (0.3 mm rather than 0.5–0.9 mm) by the long lateral projections of uncus (0.55 mm rather than 0.35–0.50 mm) which are clearly exceeding the length of the central projections and by the comparatively short saccus projections. *C. leucospilata* from South Africa (Natal) very similar in habitus, on average with narrower medial area, length of ♂ antennal branches 1.1–1.2 mm, length of ♂ hindtibial process 0.5 mm. Genetically the nearest neighbour (6.2%) is an undescribed species from Kenya and Tanzania which strongly differs in habitus (transverse lines absent, discal spots weak, triangle pattern of terminal line and fringe absent) and genitalia (aedeagus much longer, with termino-lateral lobe, saccus projections and posterior spine on sternum A8 much longer). *C. rufitornus* (barcoded from Uganda, Yemen and Cape Verde, the last tentatively considered conspecific), *C. leucospilata* (South Africa, Zimbabwe, Zambia, Tanzania) and *C. esmeralda* (Ghana, Cameroon, Sierra Leone) diverge from *C. theodori* sp.nov. by 6.8%, 7.5% and 6.5% respectively.

Etymology. The new species is dedicated to Theodor Beck, the father of the collector of two paratypes.

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