

Nine new emerald species for the fauna of Yemen, with description of two new taxa in the genus *Prasinocyma*

(Lepidoptera, Geometridae, Geometrinae)

Axel Hausmann & Julia Wildfeuer

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In this paper we present a checklist and integrative revision for the genus *Prasinocyma* (Geometridae, Geometrinae, Hemistolini), combining morphological and molecular data, for the Republic of Yemen. Whilst, previously, only one species was recorded, we can now add eight new *Prasinocyma* species to the fauna of Yemen. One species and one subspecies are described as new for the science: *Prasinocyma angolica yemenicola* subspec. nov. and *Prasinocyma saba* spec. nov. Furthermore, *Androzeugma tenuis* (Warren, 1898) was recorded for the first time in Yemen. With this, the number of geometrid species recorded from Yemen is raised from 168 to 177 species.

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Introduction

The geometrid Fauna of Yemen was subject of several previous papers (Hausmann 1999, 2006, Hausmann et al. 2016a) but not all members of the taxonomically difficult genus *Prasinocyma* Warren, 1897 could be identified properly. Three species had earlier been described from Saudi Arabia, two of them (*P. arabica* Wiltshire, 1982, *P. eremica* Wiltshire, 1980) could be recorded for Yemen in the above cited papers. After the revision of the genus *Prasinocyma* in Ethiopia (Hausmann et al. 2016b) and careful study of almost all congeneric type specimens we can present here a revision of the genus *Prasinocyma* in Yemen.

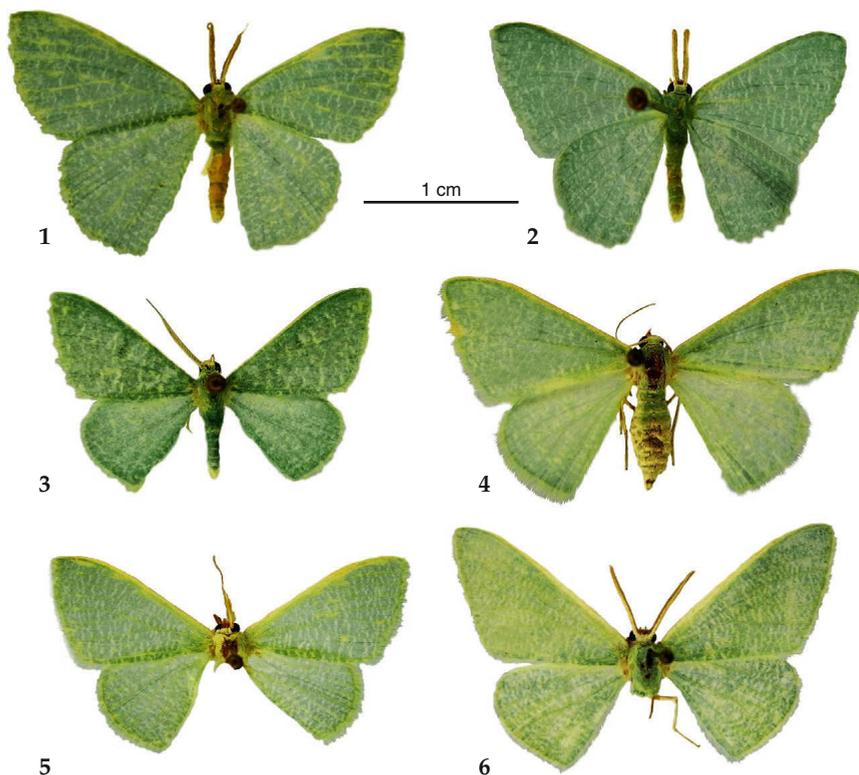
The 117 so far described species for the Afrotropical fauna (19 of them in Hausmann et al. 2016b) are very similar to each other in their green coloration and the almost entirely lacking wing pattern. Often, males can hardly be attributed to conspecific females and almost no genitalia illustrations are published. This is why even the grand-master of geometridology, Claude Herbulot, just gave a very few identifications in his collection.

With the technique of DNA Barcoding (including old type specimens cf. Hausmann et al. 2016c) and with numerous dissections we were able to overcome these problems and to come closer to a thorough revision of the African/Arabian species of *Prasinocyma*. So far we have gathered more than 550 DNA barcodes for African members of the genus *Prasinocyma* belonging to 170 BINs (barcode index numbers, being a good proxy for species numbers) with 20 additional lineages clearly referring to further *Prasinocyma* species but without BIN assignment (fragment lengths < 500 bp). The accumulation curve of African *Prasinocyma* species suggests saturation far beyond 250 species.

Material and methods

Abbreviations

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)



Figs 1–6. Adults of *Prasinocyma* and *Androzeugma* species from Yemen. In parentheses the ID-numbers of genitalia slides (“gen.prp.”) and/or DNA barcoding are given (“BC ZSM Lep” = DNA barcode from ZSM, section Lepidoptera). **1.** *Prasinocyma angolica yemenicola* Hausmann & Wildfeuer, subspec. nov. ♂ (BC ZSM Lep 89844; Holotype). **2.** *Prasinocyma angolica yemenicola* Hausmann & Wildfeuer, subspec. nov. ♂ (prp. ZSM G 89857; Paratype). **3.** *Prasinocyma eremica* Wiltshire, 1980 ♂ (BC ZSM Lep 69707, Saudi Arabia). **4.** *Prasinocyma eremica* Wiltshire, 1980 ♀ (BC ZSM Lep 89846). **5.** *Prasinocyma saba* Hausmann & Wildfeuer, spec. nov. ♂ (gen.prp. ZSM G 20181; Paratype). **6.** *Prasinocyma acutipennis* Wiltshire, 1994 ♂ (BC ZSM Lep 58930; gen.prp. ZSM G 19862).

ZSM Bavarian State Collection of Zoology, Munich, Germany
 NHMUK Natural History Museum, London, United Kingdom

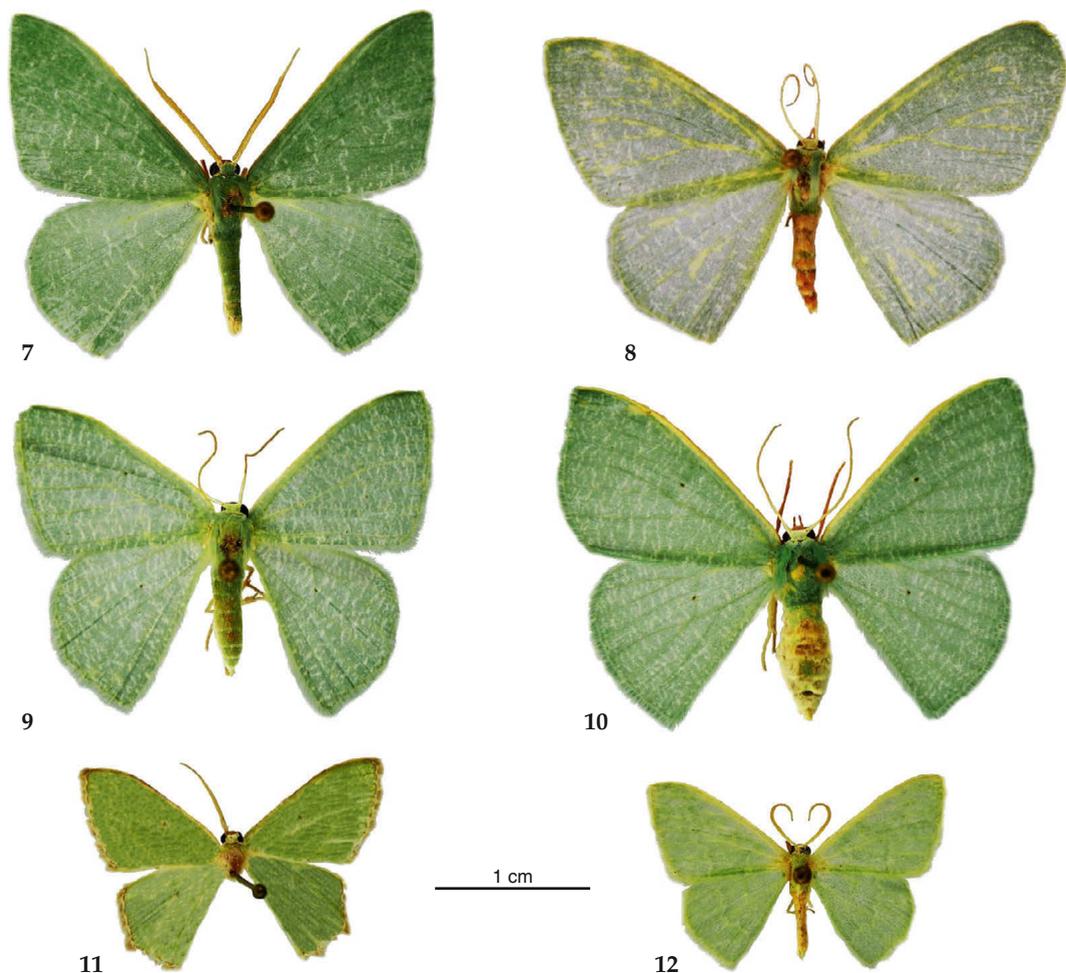
Sampling and morphological analysis

Sampling in various localities of Yemen is described in Hausmann (1999, 2006). For the codification of the sampling localities see Hausmann (2006). 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).

DNA analysis

DNA sequences were generated for 33 Yemenite *Prasinocyma* specimens at the Canadian Centre for DNA Barcoding (CCDB, Guelph) following standard high-throughput protocols (Ivanova et al. 2006, deWaard et al. 2008), 30 of them with fragment lengths over 500 bp. 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. All sequence data 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) in the public data set DS-PRASIYE (<http://dx.doi.org/10.5883/DS-PRASIYE>). For comparison, DNA barcodes have been generated from 72



Figs 7–12. Adults of *Prasinocyma* and *Androzeugma* species from Yemen. In parentheses the ID-numbers of genitalia slides and/or DNA barcoding are given. 7. *Prasinocyma arabica* Wiltshire, 1982 ♂ (BC ZSM Lep 89831). 8. *Prasinocyma arabica* Wiltshire, 1982 ♀ (BC ZSM Lep 89835). 9. *Prasinocyma magica* Hausmann et al., 2016 ♂ (BC ZSM Lep 89845). 10. *Prasinocyma sanguinicosta* Prout, 1912 ♀ (BC ZSM Lep 89842). 11. *Prasinocyma bilobata* Fletcher, 1978 ♂ (BC ZSM Lep 85812-83226). 12. *Androzeugma tenuis* (Warren, 1898) ♂ (BC ZSM Lep 88058).

type specimens from the NHMUK with a special NGS-based protocol (Prosser et al. 2016, Hausmann et al. 2016c).

Data analysis

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 variations are reported as maximum pairwise distances. A neighbour joining tree

with all barcoded species of this article and their nearest neighbours is shown in Figure 21. For species delineation we refer to the BIN-system (Barcode Index Numbers) on BOLD (Ratnasingham & Hebert 2013).

Taxonomy and nomenclature

The systematic order of species and species-groups is based on Hausmann (2016b); the nomenclature follows Scoble (1999), Scoble & Hausmann (2007) and Hausmann et al. (2016b).

Systematic part

Geometrinae

Tribe Hemistolini Inoue, 1961

Genus *Prasinocyma* Warren, 1897

Type species: *Thalassodes vermicularia* Guenée, 1858 (South Africa: Northern Cape, Namaqualand) by original designation.

For systematic position of the genus and differential characters within the “*Thalassodes* group of genera” see extensive discussion in Hausmann (2016b). The aforementioned publication raised the species number of described African and Arabian species from 94 to 117 by the description of 19 new species and the transfer of four other species from genus *Eretmopus* to *Prasinocyma*. With several new samples, recently arrived at the ZSM from various African countries, just six months after the publication of Hausmann et al. (2016b), the estimated species number for African *Prasinocyma* as revealed from DNA barcoding and dissections (restricted to material of the ZSM, so far) has raised from 140 to more than 200 species. Saturation is expected far beyond the mark of 300 species.

The *immaculata* species-group

Prasinocyma angolica Prout, 1930

Prasinocyma angolica Prout, 1930: 22. Locus typicus: Angola, Bihi (Syntypes 5 ♂ NHMUK, examined).

Prasinocyma angolica pseudopedicata Hausmann, Sciarretta & Parisi, 2016: 13. Locus typicus: S. Ethiopia, Oromia, 7 km NW Yabello (Holotype ♂ ZSM, examined, dissected and barcoded). Validated at subspecies rank.

Prasinocyma angolica yemenicola, subsp. nov.

Figs 1, 2, 13

Material (new for the fauna of Yemen). Holotype: ♂, Prov. Ibb, 13°53'N, 43°58'E, Lower Wadi Duur, village Azuhriya, 1350 m, 12.III.2000, leg. F. Aulombard, M. Fibiger, H. Hacker & H.-P. Schreier, BC ZSM Lep 89844. – Paratypes (n=43): Prov. Al Hudaydah, locality no. 36 (7 ♂♀). Prov. Ibb, localities no. 14 (1 ♂, 2 ♀), 40 (3 ♂), 65 (3 ♂), 66 (6 ♂, 1 ♀), 68 (5 ♂♀), 69 (♂♀), 70 (6 ♂♀). Prov. Sana'a, localities no. 55 (1 ♂), 64 (1 ♂).

Description

The new subspecies – like the nominotypical subspecies and subsp. *pseudopedicata* – is medium-sized (wingspan 24–26 mm), frons ochreous to pale brown, male hindtibia with pencil and four spurs, covering first tarsomere, discal spots absent or vague, hind-

wing round. For differential diagnosis from other congeneric species see Hausmann et al. (2016b).

Male genitalia. Without differences from *P. angolica* and subsp. *pseudopedicata*, except for sternum A8: posterior processes in *P. angolica yemenicola* subsp. nov. stouter and much stronger curved outside.

Genetic data. BIN: BOLD:AAF8220. Nearest genetic neighbour: *P. angolica* (examined in subsp. *pseudopedicata* from Ethiopia and subsp. *angolica* from Sao Tomé) at a distance of 2.2 % but BIN-sharing; *P. pedicata aethiopica* Hausmann et al., 2016 from Ethiopia BIN-sharing, too (cf. Hausmann et al. 2016) and even closer, but genitalia clearly assign the Yemenite populations to *P. angolica*. Six DNA barcodes from Yemen (see Fig. 21), two of them dissected: ZSM G 19859, 20172.

Prasinocyma eremica Wiltshire, 1980

Figs 3, 14

Prasinocyma eremica Wiltshire, 1980: in Wittmer & Bütiker (eds) Fauna of Saudi Arabia 2: 191, text-fig. 6a, pl. 1, fig. 6. Locus typicus: Saudi Arabia, Ash Sharayi (Holotype ♂, NHMB Basel), paratype studied, dissected and barcoded in NHMUK: BMNH (E) 1377505.

Material. New for the fauna of Yemen, but earlier mentioned without presenting exact data in Hausmann et al. (2016a). New material (n=136): Prov. Abyan, locality no. 22 (1 ♀). Prov. Ibb, localities no. 13 (38 ♂♀), 40 (39 ♂♀), 41 (1 ♂), 48 (1 ♂, 1 ♀), 66 (8 ♂♀), 67 (9 ♂♀), 70 (13 ♂♀). Prov. Sana'a, locality no. 63 (23 ♂♀); N Yemen, Sana'a city, 29.III.2009, leg. A. Saldaitis (2 ♂).

Description and differential diagnosis see Wiltshire (1980).

Genetic data. Two constant BINs (both with 0 % variation) at a distance of 1.5 %: (1) BOLD:ACE4388 with four barcodes from Yemen, provinces Sana'a and Ibb (one dissected: ZSM G 19857); (2) BOLD:AAF0062: two barcodes from Yemen, both from Sana'a city (see Fig. 21). Nearest neighbour: *P. hailei* from Ethiopia (3.8 %).

The *neris* species-group

Prasinocyma saba Hausmann & Wildfeuer,

spec. nov.

Figs 4, 15

Material. Holotype: ♂, N. Yemen, Al Hudaydah Province, Wadi Bura [14.857°N, 43.444°E], 28.3.2009, leg. A. Saldaitis, gen.prp. ZSM G 19860, DNA Barcode BC ZSM Lep 26453. – Paratype: ♂, locality no. 68, gen.prp. ZSM G 20181.

Description

Adult (Fig. 3). Wingspan. Male 23–24 mm. Ground colour comparatively pale green, very densely irrorated with white strigulae. Forewing without spot at the inner termen. On fore- and hindwing, terminal and discal dots absent. Hindwing termen round. Male palpi short, length 0.8–1.0 times diameter of eye, tip and upperside reddish. Frons red-brown. Antennae bipectinate in male. Male frenulum developed but weak. Male hindtibia narrow, with four spurs and white pencil.

Differential diagnosis. Closely related to *Prasinocyma shoa yabellensis* Hausmann et al., 2016, described from southern Ethiopia. Differing in male genitalia in the broader valva, dorsally straight whilst strongly curved in *P. shoa shoa* Herbulot, 1993 and *P. shoa yabellensis*. Ventral part of valva in *P. saba* spec. nov. with spinose sacculus, projection straight rather than inwards curved, basal thorn slightly longer. Aedeagus shorter. No difference from *P. shoa* in the shape of sternum A8. DNA barcode suggesting certain relationships with *P. corrugata* Fletcher, 1958 (see below) but the latter larger, hindwing angled, in male genitalia clearly differing in the shape of the (narrow) harpe, aedeagus with two cornuti, processes of sternum A8 tapered (cf. Hausmann et al. 2016b).

Male genitalia (Fig. 15). Uncus short. Short socii present. Valva broad, with dorsal costa and with a large subapical ventral membranous lobe. Sacculus sclerotized, broad, straight towards tip, terminally round and spinulose. Dorsobasal margin of sacculus with thorny process. Aedeagus with a very narrow proximal stalk, length 1.5 mm, without cornuti, vesica weakly granulated. Sternum A8 with two poorly sclerotized prominent lobes and deep invagination between.

Genetic data. BIN: BOLD:AAL0595. One barcode from Yemen (see Fig. 21). Nearest neighbours: *P. corrugata* (3.1 %) and *P. shoa yabellensis* (3.8 %). Distance to *P. shoa shoa* 6.4 %.

Prasinocyma acutipennis Wiltshire, 1994

Figs 5, 16

Prasinocyma acutipennis Wiltshire, 1994: in Büttiker & Krupp (eds) Fauna of Saudi Arabia 14: 117, pl. 2, fig. 10. Locus typicus: Saudi Arabia, near Taif, al-Shafa (Holotype ♂, NHMUK, examined, dissection W2772, holotype without legs, thus not barcoded).

Material. New for the fauna of Yemen (n=2): Prov. Ibb, locality no. 70 (1 ♂). Prov. Sana'a, locality no. 64 (1 ♂).

Description and differential diagnosis see Wiltshire (1994) and Hausmann et al. (2016b).

Genetic data. BIN: BOLD:ABW1385. One barcode from Saudi Arabia, two barcodes from Yemen (see Fig. 21). The latter genetically somewhat diverging (1.7 %) from populations from Saudi Arabia. Nearest genetic neighbours (three fragmentary barcodes from type specimens): *P. leucopsis exilior* Fletcher, 1958 from Tanzania (4.5 %), *P. edwardsi* Fletcher, 1958 from Kenya (4.5 %) and *P. stictimargo* Warren, 1902 from Kenya (5.3 %). *P. robusta* Hausmann et al., 2016 from Ethiopia diverging by 6.5 %, though morphologically being close to *P. acutipennis*.

Prasinocyma arabica Wiltshire, 1982

Figs 6, 7, 17

Prasinocyma arabica Wiltshire, 1982: in Wittmer & Büttiker (eds) Fauna of Saudi Arabia 4: 282, text-figs 8a–8g, pl. 1, fig. 8. Locus typicus: Saudi Arabia, Asir, An Nimas (Holotype ♀, NHMUK, examined and barcoded: BMNH (E) 1377505, paratype dissected: BMNH Geom. 8745).

Material. Previously recorded for Yemen in Hausmann (1999, 2006). New material (n=49): Prov. Hudaydah, locality no. 36 (1 ♂, 1 ♀). Prov. Ibb, localities no. 14 (2 ♀), 40 (3 ♀), 66 (1 ♂, 1 ♀), 67 (1 ♂), 68 (9 ♂ ♀), 70 (1 ♂). Prov. Sana'a, localities no. 5 (2 ♂, 1 ♀), 31 (3 ♂, 3 ♀), 33 (3 ♂), 49 (1 ♀), 51 (1 ♂), 53 (1 ♀), 54 (1 ♂), 63 (1 ♂), 64 (2 ♂, 3 ♀); Yemen, Sana'a, Mujamma Zone near Algier Str., 15°20' 17.21"N 44°11'25.32"E, 2268 m, 8. May 2010, leg. Ingo Brunk (2 ♂). Prov. Ta'izz, locality no. 62 (2 ♂, 3 ♀).

Description and differential diagnosis see Wiltshire (1982).

Genetic data. BIN: BOLD:AAF0061: five barcodes at high but continuous genetic variation (maximum pairwise distance 1.4 %; see Fig. 21). Nearest neighbours: an unidentified species from Zambia (6.0 %) and *P. edwardsi* Fletcher, 1958 from Kenya (6.3 %).

Prasinocyma magica Hausmann, Sciarretta & Parisi, 2016

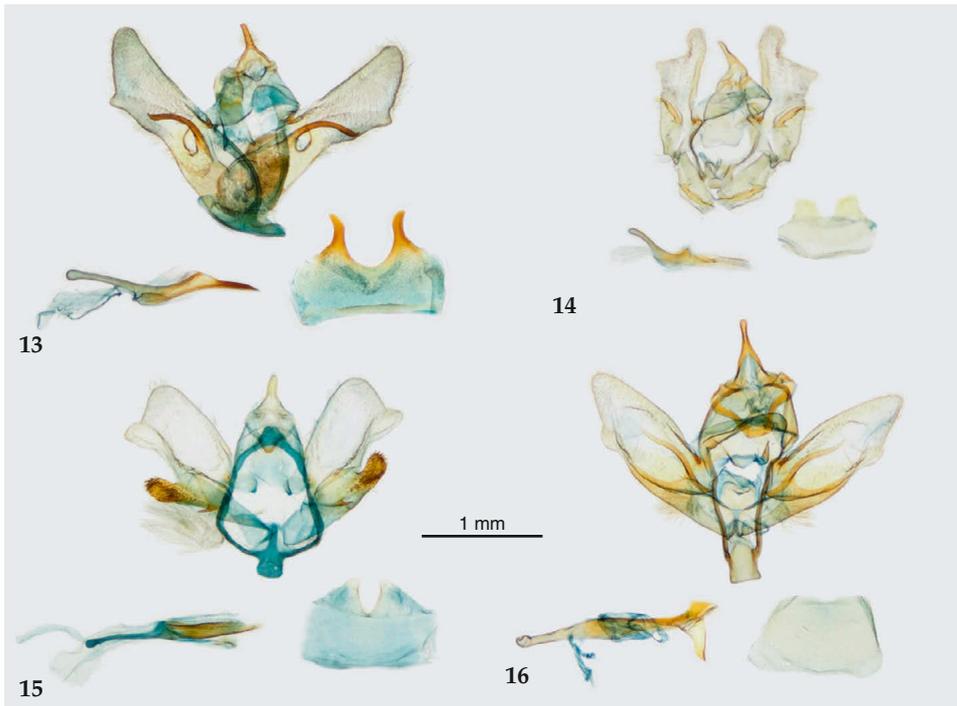
Figs 8, 18

Prasinocyma magica Hausmann, Sciarretta & Parisi, 2016: 24. Locus typicus: S. Ethiopia, Southern Nations, Mago National Park (Holotype ♂ ZSM, examined, dissected and barcoded).

Material. New for the fauna of Yemen (n=2): Prov. Ibb, localities no. 66 (1 ♀), 67 (1 ♂).

Description and differential diagnosis see Hausmann et al. (2016b).

Genetic data. BIN: BOLD:ABA7613. Two barcodes from Yemen (see Fig. 21). Genetically well matching the nominotypical populations from Ethiopia.



Figs 13–16. Male genitalia of Yemenite *Prasinocyma* species. 13. *Prasinocyma angolica yemenicola* Hausmann & Wildfeuer, subsp. nov. (prp. ZSM G 20172). 14. *Prasinocyma eremica* Wiltshire, 1980 (gen.prp. ZSM G 19857). 15. *Prasinocyma saba* Hausmann & Wildfeuer, spec. nov. (gen.prp. ZSM G 20181; Paratype). 16. *Prasinocyma acutipennis* Wiltshire, 1994 (gen.prp. ZSM G 19862).

Nearest neighbours: *P. batesi distans* Hausmann et al., 2016 (3.8 %) and *P. germinaria* (Guenée, 1858) (4.9 %), both described from Ethiopia.

***Prasinocyma sanguinicosta* Prout, 1912**
Figs 9, 19

Prasinocyma sanguinicosta Prout, 1912: in Wytzman, *Genera Insectorum* 129: 156. Locus typicus: Sudan, Kartum (Holotype ♂, NHMUK, examined, dissected and barcoded: BMNH (E) 1377543).

Material. New for the fauna of Yemen (n=10): Prov. Hadramaut, locality no. 18 (1 ♂). Prov. Ta'izz, locality no. 39 (1 ♂). Prov. Ibb, localities no. 40 (4 ♂), 67 (1 ♂). South Yemen, Lahej Governorate, Al Dhala, 1500 m, June 7 1987, leg. Dr. Bernd Müller (1 ♀).

Description see Prout (1912).

Differential diagnosis. Forewing costa bicolorous, pale creamy-white with reddish margin. All wings with a fine, black discal dot. Frons pale brown. Male palpi comparatively long (1.4 times diameter of eye). Frenulum very weak. Male hindtibia with four spurs, without pencil.

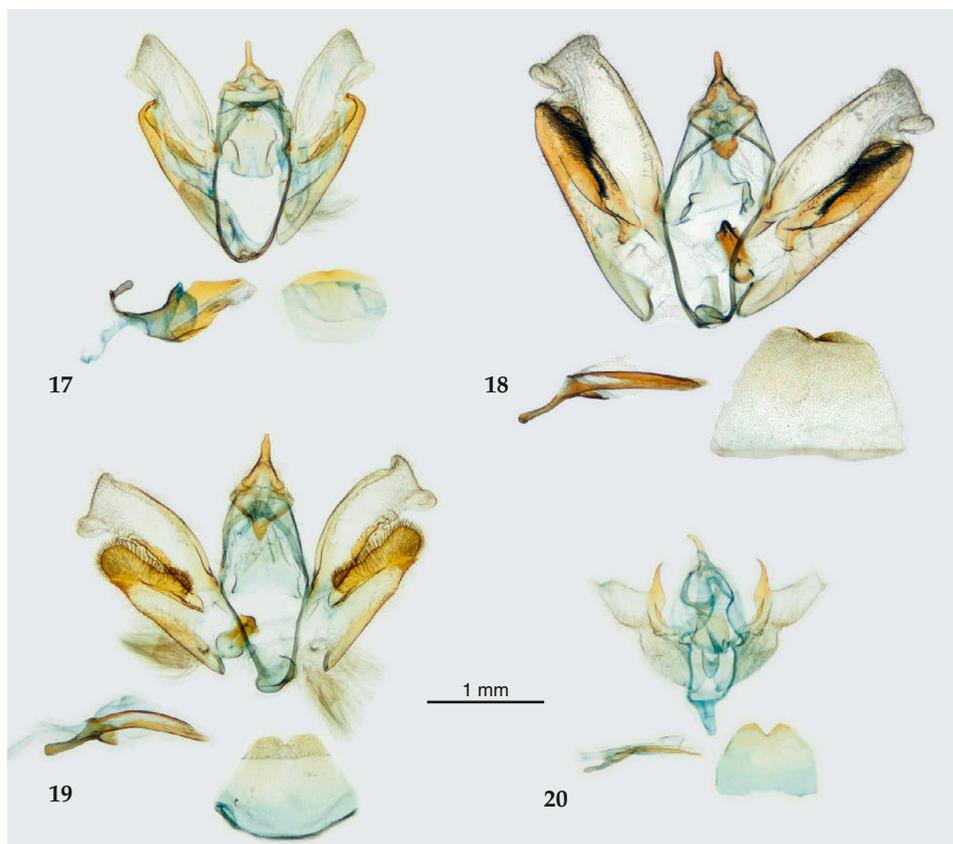
Male genitalia. Uncus comparatively short. Sacculus broad, sub-rectangular, strongly spinose. Aedeagus with two lateral sclerotized crests. Sternum A8 with paired, truncate lobes. In genitalia somewhat reminiscent of *P. magica* but spinose part of sacculus broader, lobes of sternum A8 truncate.

Genetic data. BIN: BOLD:ACV2622. Five barcodes from Yemen (see Fig. 21), three of them dissected. Intraspecific variation low (maximum pairwise distance 0.3 %). Nearest neighbour: *P. germinaria* (Guenée, 1858) from Ethiopia (5.6 %).

The bifimbriata species-group

***Prasinocyma bilobata* Fletcher, 1978**
Figs 10, 20

Prasinocyma bilobata Fletcher, 1978: *Acta Zool. Hung.* 24(1/2): 46, pl. 4, figs 36–39. Locus typicus: Malawi ('Nyasaland'), Mlanje, Luchenyia (Holotype ♂, NHMUK, examined, dissected and barcoded: BMNH (E) 1377496).



Figs 17–20. Male genitalia of Yemenite *Prasinocyma* species. **17.** *Prasinocyma arabica* Wiltshire, 1982 (gen.prp. ZSM G 19858). **18.** *Prasinocyma magica* Hausmann et al., 2016 (gen.prp. ZSM G 16003, Ethiopia). **19.** *Prasinocyma sanguinica* Prout, 1912 (gen.prp. ZSM G 20176). **20.** *Prasinocyma bilobata* Fletcher, 1978 (gen.prp. ZSM G 20173).

Material. New for the fauna of Yemen. Prov. Ibb, locality no. 70 (3 ♂).

Description

Adult (Fig. 6). Wingspan. Male 18–20 mm. Ground colour bluish green, not irrorated with white strigulae. Forewings sometimes with minute spot at the inner termen. On fore- and hindwings, a minute black discal dot present but variable in intensity. Terminal line fine, black, slightly undulate, at vein endings marked by whitish dots distally from terminal line. Hindwing termen angled at M3. Male palpi long, length 1.4–1.6 times diameter of eye, last segment elongate and narrow, ochreous. Frons brown with slight greenish tinge. Antennae bipectinate in male. Male frenulum very weak, almost absent. Male hindtibia narrow, with four spurs, without pencil.

Differential diagnosis. The closest related species, *P. albisticta* (Warren, 1901), shares with *P. bilobata* the

following features: gnathos well developed, socii developed though remaining short, saccus elongate digitiform, valva with dorsal projection, aedeagus with a long lateral appendage. *P. albisticta* differs from *P. bilobata* in the larger wingspan (22–26 mm), longer male palpi (1.7 times diameter of eye), in male genitalia in the shorter dorsal process of valva, ventral margin of valva less concave, transtilla with long dorsal projection, aedeagus longer (1.4 mm) and curved at tip, paired lobes of sternum A8 rounded.

Male genitalia (Fig. 20). Uncus of medium length. Socii short. Gnathos well developed. Transtilla developed as a large, sub-oval sclerite. Saccus projecting, digitiform. Valva with a long, sclerotized, tapering dorsal projection, ventral margin deeply concave at centre. Aedeagus straight, comparatively short (1.05–1.15 mm), with very thin lateral appendage, as long as the rest of the aedeagus. Sternum A8 sclerotized, with two triangular projections.

Genetic data. BIN: BOLD:ADB1216. One barcode from Yemen (BC ZSM Lep 89840, see Fig. 21). Nearest neighbour: *P. albisticta* (Warren, 1901) from Ethiopia (3.8 %).

Remarks. *P. bilobata* was described from Malawi, but so far, no DNA barcode could be generated for a south-eastern African specimen. Currently, the species identification is based on the very high similarity with the genitalia of the type specimen. The holotype, however, is differing from populations from Yemen by the lacking discal dots, by its yellow fringe, separated from the uniform green ground colour of wings and by the straight, fine black terminal line. The minute white dots distally from the terminal line at the vein endings are almost invisible. Further study is needed to investigate if these differences are constant and if they are, potentially, correlated with divergences in the DNA barcode.

The lateral projection of aedeagus, the missing subapical lobe on the ventral margin of valva, the dorsal projection of valva and the sclerotization of juxta are reminiscent of genus *Thalassodes*, but the very short socii and the genetic similarity with the *bifimbriata* species-group support a position in *Prasinocyma* as proposed by Prout (1930) and Scoble (1999).

Genus *Androzeugma* Prout, 1913

Type species: *Androzeugma hapala* Prout, 1913 (junior synonym of *A. tenuis* Warren, 1898) (northern Nigeria: Zungeru); by original designation.

Androzeugma tenuis (Warren, 1898)

Fig. 11

Syndromodes tenuis Warren, 1898: Novit. Zool. 5: 16. Locus typicus: Nigeria: Warri (Lectotype ♀, NHMUK, examined).

Material. New for the fauna of Yemen (n=4): Prov. Ibb, localities no. 65 (1 ♂), 69 (1 ♂). Prov. Sana'a, locality no. 55 (2 ♂).

Genetic data. BIN: BOLD:AAD6950 (n=24 from Ethiopia, Cameroon, Gabon, Gambia, Ghana, Guinea, Liberia, Mali). One submitted specimen from Yemen (BC ZSM Lep 91637) not successful in DNA barcoding.

Remarks. Secure discrimination from similar species of *Prasinocyma* is possible when based on the lamellate male antennae (bipectinate in *Prasinocyma*). One dissected male from Yemen confirms the species identification as *Androzeugma tenuis*.

Checklist of the Hemistolini of Yemen

Subfamily Geometrinae

Tribe Hemistolini Inoue, 1961

Genus *Prasinocyma* Warren, 1897

The *immaculata* species-group

Prasinocyma angolica yemenicola Hausmann & Wildfeuer, subspec. nov.

Prasinocyma eremica Wiltshire, 1980

The *neris* species-group

Prasinocyma saba Hausmann & Wildfeuer, spec. nov.

Prasinocyma acutipennis Wiltshire, 1994

Prasinocyma arabica Wiltshire, 1982

Prasinocyma magica Hausmann, Sciarretta & Parisi, 2016

Prasinocyma sanguinicosta Prout, 1912

The *bifimbriata* species-group

Prasinocyma bilobata Fletcher, 1978

Genus *Androzeugma* Prout, 1913

Androzeugma tenuis (Warren, 1898)

Genus *Thalassodes* Guenée, 1858

Thalassodes quadraria Guenée, 1858 (cf. Hausmann 2006, confirmed by DNA barcodes)

Genus *Celidomphax* Prout, 1912

Celidomphax analiplaga (Warren, 1905) (cf. Hausmann 2006, confirmed by DNA barcodes)

Genus *Victoria* Warren, 1897

Victoria fifensis Wiltshire, 1994 (cf. Hausmann 2006, confirmed by DNA barcodes)

Acknowledgements

We thank Hermann H. Hacker, Hans-Peter Schreiber (Staffelstein), and Bernd Müller (Berlin) who collected numerous geometrids from Yemen Republic and provided information on the collecting localities. For mounting of moths, dissections, tissue sampling and databasing (DNA Barcoding) we are grateful to Eckhard Wierig and Mei-Yu Chen (Munich). We thank John Chainey (London) for access to NHMUK collections and kind help in digitizing the genitalia slides. The genetic analyses have received considerable support from Paul D. N. Hebert and the Biodiversity Institute of Ontario (BIO) and the Canadian Centre for DNA Barcoding (CCDB University of Guelph). For supporting the DNA barcoding of type specimens we thank John Chainey and Geoff Martin (NHMUK, London), Sean Prosser and Jeremy deWaard (BIO, Guelph). The data management and analysis system BOLD was provided by Sujeevan Ratnasingham (BIO, Guelph). The work was financially supported by Genome Canada (Ontario Genomics Institute) in the framework of the iBOL program, WG 1.9.

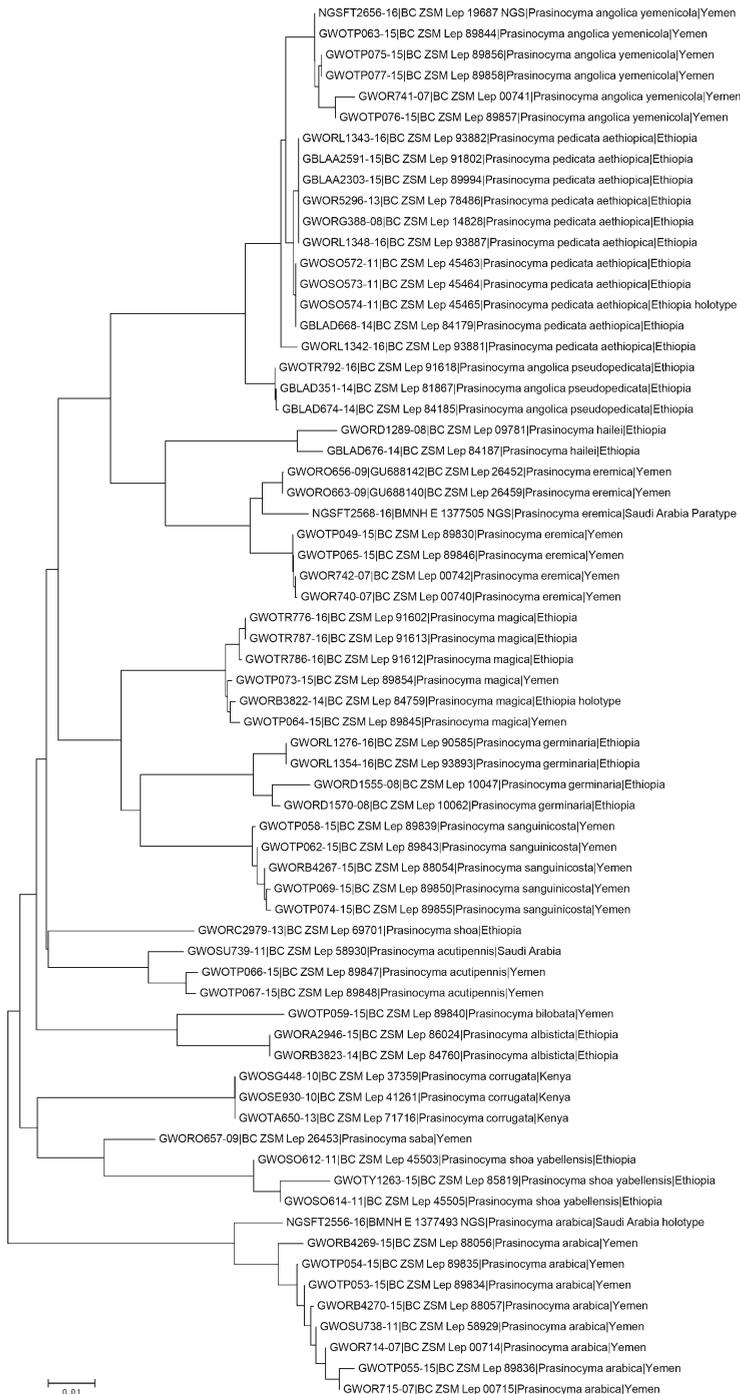


Fig. 21. Neighbour Joining Tree of 67 specimens of the genus *Prasinocyma* with representatives of their genetically nearest species and with conspecific specimens from Ethiopia and Saudi Arabia, if available (> 500 bp, BOLD alignment, Kimura 2 parameter, pairwise deletion, constructed with MEGA 6, Tamura et al. 2013). All sequence records, trace files and images are available and accessible on BOLD as a single citable dataset (<http://dx.doi.org/10.5883/DS-PRASIYE>).

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