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Revision of the West Palaearctic *Idaea nocturna* species group (Lepidoptera, Geometridae, Sterrhinae)

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Abstract

The western Asiatic *Idaea nocturna* species group is revised with an integrative taxonomic approach. Three new species are described: *Idaea millesima* **sp. n.** from southern Greece, *Idaea beata* **sp. n.** from northern Israel, and *Idaea medianocturna* **sp. n.** from eastern Turkey. These three new species are the first known species of the megadiverse genus *Idaea* showing bipectinate male antennae. Adults and genitalia are illustrated. COI barcode data are discussed.

Introduction

The European representatives of the genus *Idaea* have been subject of a major recent revision, including 110 species (HAUSMANN 2004; MÜLLER et al. 2019). In the framework of the preparation of another monograph, the third volume of the "Lepidoptera of Israel" (HAUSMANN et al. 2020), another 46 species were submitted to an integrative taxonomic revision. In the year of 2014, the author collected a geometrid moth near the Lake Kinneret in northern Israel, which revealed to be an *Idaea* species, although it has bipectinate antennae, a character state which was not known for any *Idaea* species, so far. Molecular and morphological analysis showed this specimen to belong to the *Idaea nocturna* species group. In this article, the representatives of this species group are subjected to an integrative taxonomic revision, in the framework of which two other new species were detected from Greece and Turkey. The revision was facilitated by extensive material from Kyrgyzstan, collected by N. KEIL, R. KELLER, B. MAY (Munich), N. PÖLL (Bad Ischl) and some other entomologists in the last few years.

Material and Methods

Abbreviations

BIN	Barcode Index Number
BOLD	Barcode of Life Data System
COI	mitochondrial cytochrome c oxidase I (COI) gene, region near the 5' terminus (barcode fragment, 658 bp)
NHMUK	Natural History Museum, London, U.K.
SMNK	Staatliches Museum für Naturkunde, Karlsruhe, Germany
SMNS	Staatliches Museum für Naturkunde, Stuttgart, Germany
USNM	Smithsonian Institution, United States National Museum, Washington, U.S.A.
ZISP	Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia
ZMH	Zoological Museum, University of Helsinki, Finland
ZSM	SNSB – Bavarian State Collection of Zoology, Munich (Zoologische Staatssammlung München)

Sampling and morphological analysis

Altogether more than 50 specimens of this species group were examined at the ZSM. Dissection and preparation of genitalia slides were performed applying standard protocols (cf. ROBINSON 1976), the genitalia are embedded in Euparal. Measurements were done with a reticule in a Wild M3Z microscope.

DNA Analysis

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' terminus 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 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 be accessed in the Barcode of Life Data System (RATNASINGHAM & HEBERT 2007; RATNASINGHAM 2017) in the public dataset DS-NOCTURNA (doi: https://dx.doi.org/10.5883/DS-NOCTURNA).

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. Species delimitation was investigated using the BIN (barcode index number) system as implemented on BOLD (RATNASINGHAM & HEBERT 2013).

Systematic account

Idaea nocturna species group

Synapomorphies/common characters: Adults with dark ground colour and diffuse wing pattern. Frons flat, brown. Male antennae with dentate or bipectinate flagellum. Proboscis usually well developed, but see description of *Idaea beata* sp. n.. Male hindtibia without pencil, tarsus shortened, tarsomeres appearing as fused. Male genitalia with broad uncus and one stout cornutus in the aedeagus. Female genitalia with long ductus bursae, corpus bursae with spinules ('lamina dentata') and appendix bursae.

Genetic data (Fig. 1): In an analysis of the COI gene of all *Idaea* species worldwide, the core group (*I. nocturna, I. zoferata, I. beata* sp. n., *I. medianocturna* sp. n., *I. millesima* sp. n.) belongs to a common cluster in separate position to other representatives of *Idaea*, but there is no genetic evidence of closer relationship with *I. descitaria* and *I. soldaitisi* from the COI barcode gene fragment (see remarks). Comparatively similar COI sequences are shared by *Idaea distinctaria* (BOISDUVAL, 1840) and *I. nocturna* (6.0%) and by *I. politaria* (HÜBNER, 1799) and *I. descitaria* (5.7%). Therefore, *I. distinctaria* and *I. politaria* are taken as outgroups for the analysis (Fig. 1).

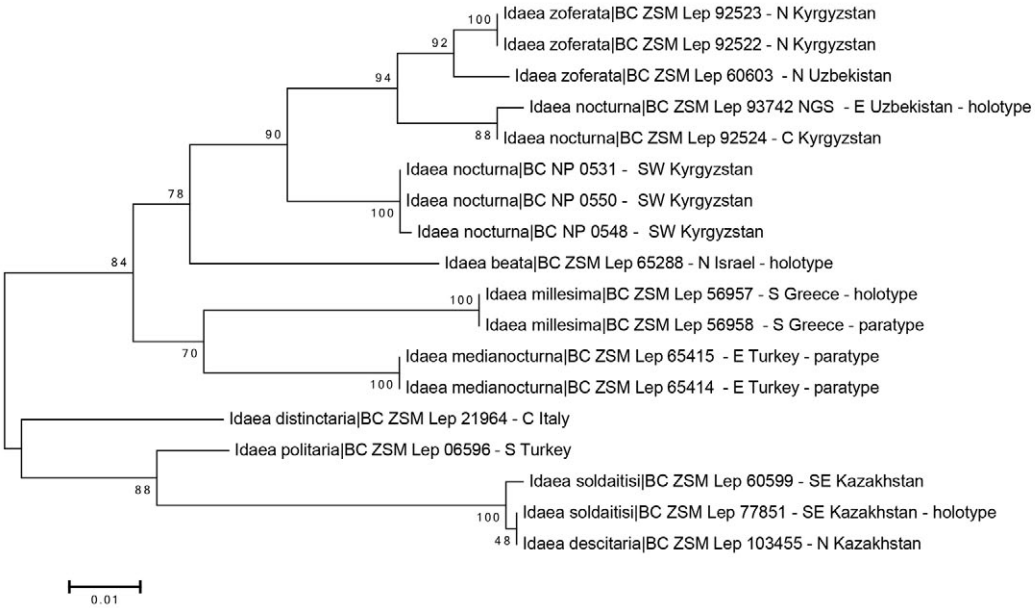
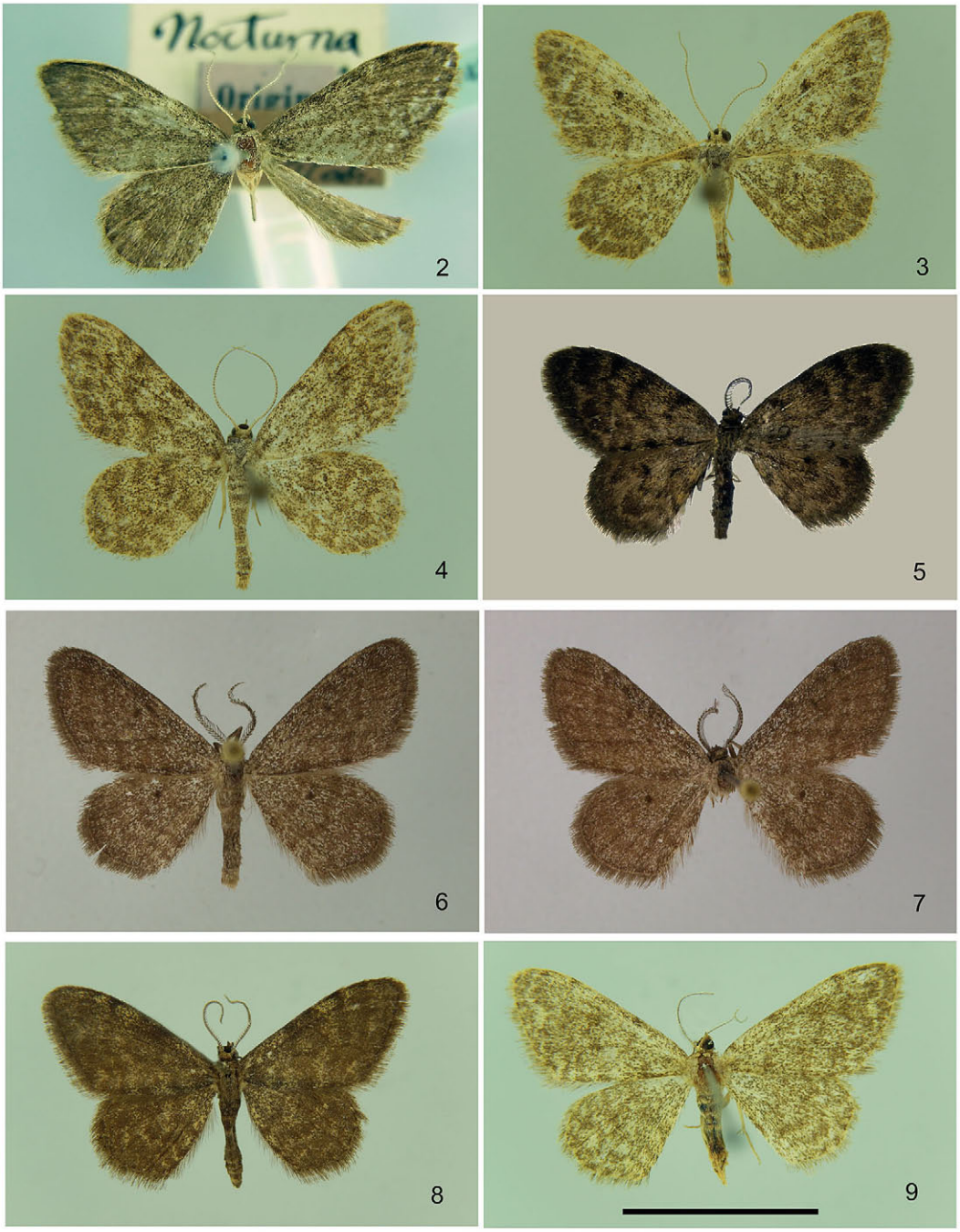


Fig. 1: Maximum Likelihood Tree generated from COI barcode sequences for representatives of the *Idaea nocturna* species group s.l. and two outgroup species (*Idaea distinctaria; I. politaria*); sequence lengths considered from 500bp to 658bp but holotypes of *Idaea nocturna* (277bp) and *I. soldaitisi* (164bp) with shorter sequences; 50 bootstrap replications, Tamura-Nei model, uniform rates, built with Mega 6 software (TAMURA et al. 2013; scale bar = 1 %); original data see https://dx.doi.org/10.5883/DS-NOCTURNA.



Figs 2-9: Adults of the *Idaea nocturna* species group (scale bar = 1 cm): Fig. 2: *Idaea nocturna* (Staudinger, 1892), holotype; **Fig. 3**: *Idaea nocturna* (STAUDINGER, 1892), C Kyrgyzstan; **Fig. 4**: *I. zoferata* KAILA & VIIDALEPP, 1996; **Fig. 5**: *I. beata* HAUSMANN, **sp. n.**, holotype; **Fig. 6**: *I. millesima* HAUSMANN & PROCHAZKA, **sp. n.**, holotype; **Fig. 7**: *I. millesima* HAUSMANN & PROCHAZKA, **sp. n.**, paratype; **Fig. 8**: *I. medianocturna* HAUSMANN, **sp. n.**, holotype, male; **Fig. 9**: *I. medianocturna* HAUSMANN, **sp. n.**, paratype, female.

Remarks: *I. descitaria* and *I. soldaitisi* were attributed to the *consolidata* species group in HAUSMANN (2004). They share with the *Idaea nocturna* species group the dark ground colour of wings, the stout cornutus in the male aedeagus and the long ductus bursae and the spinulose corpus bursae in female genitalia. Because of some other diverging morphological characters (male antennal flagellum filiform, not dentate, male uncus and saccus narrow) and the large genetic distance, these two species are tentatively maintained in the *consolidata* species group as proposed in HAUSMANN (2004), but are nevertheless briefly discussed in this article. Morphology of *Idaea curtopedata*, which is only known in the holotype from Afghanistan, indicates a closer relationship to *I. descitaria* and *I. soldaitisi* than to the *Idaea nocturna* species group (see below).

***Idaea nocturna* (STAUDINGER, 1892)**

Acidalia nocturna STAUDINGER, 1892: 148 (easternmost Uzbekistan: Namangan) (Holotype male, MNHU, examined, dissected, with DNA barcode BC ZSM Lep 93742_NGS). The locus typicus, belongs to the westernmost Tian Shan mountain chain, the attribution of the locus typicus to the southern mountain systems in Tadzhikistan (KAILA & VIIDALEPP 1996: "Ferghana range, Tadzhikistan") is erroneous.

Distribution: Adjacent territories to the "Ferghana basin": easternmost Uzbekistan (locus typicus), central and south-western Kyrgyzstan, possibly also Tadzhikistan (VIIDALEPP 1988: male genitalia and hindtibia figured: pl. 4, figs 8-10; KAILA & VIIDALEPP 1996: male genitalia of holotype figured).

Material examined: [holotype, see above]; 3 males, Kyrgyzstan, prov. Batken, Distr. Batken, Turkestan Mts, valley of Kalay-Makhmud river, N 39.69522, E 70.88864, 1830m, 10.06.2010, LUX, leg. et coll. N. PÖLL, gen.prp. 16799, barcode specimenIDs BC NP 0531, 0548, 0550; 1 male, Kirghizstan, Narin, Inner Tianshan, Moldo Too Mts., near Moldo, Ashoo-pass, 2020m, N 41°34'26.09", E 75°1'13.82", 17.VII.2015, leg. N. KEIL (MAY, KELLER, PLÖSSL), gen.prp. ZSM G 16800, barcode specimenID BC ZSM Lep 92524, coll. KEIL in ZSM.

(Re-)Description (Figs 2, 3): Adult, male: Wingspan 19–20 mm, male holotype 21 mm (STAUDINGER 1892). Ground colour brown, pattern very diffuse, just the pale and undulate wavy line in the terminal area better visible. Discal spots absent from holotype (Fig. 2) and the specimens from western Kyrgyzstan, but forewing discal spot conspicuous in one specimen from central Kyrgyzstan (Fig. 3). Terminal line very fine, almost uninterrupted. Fringe dots absent. Antennae with sub-dentate flagellum, shortly ciliate-fasciculate, longest cilia 0.15–0.2 mm (1.5–2 times width of flagellum). Palpi narrow, beige, 0.7–0.8 mm (1.2–1.4 times diameter of eye). Hindleg slender, length of tarsus 0.7–0.85 mm (0.4–0.45 times length of tibia, i.e. longer than figured in Viidalepp 1988 for a specimen from Tadzhikistan).

Male genitalia (Fig. 10) (n=3): Uncus short and sub-truncate, sometimes finely notched posteriorly, but not in the specimens from western Kyrgyzstan. Saccus long and broad. Valva parallel-bordered, not dilated at centre, costa at tip dorsally oblique. Length of aedeagus 1.1–1.2 mm, of cornutus 0.9–1.0 mm (0.8 times length of aedeagus), cornutus stout, dilated at centre.

Female unknown.

Genetic data (Fig. 1): BINs: BOLD:ADA5921 (n=2; holotype, central Kyrgyzstan) and BOLD:AAU 3298 (n=3; western Kyrgyzstan, prov. Batken), both BINs diverging by 1.9%, requiring further study with more material. Genetic distances from the other representatives of the species group: *Idaea zoferata* (3.0%), *I. beata* sp. n. (4.2%), *I. medianocturna* sp. n. (5.7%), *I. millesima* sp. n. (6.9%).

***Idaea zoferata* KAILA & VIIDALEPP, 1996**

Idaea zoferata KAILA & VIIDALEPP, 1996: 59 (Kazakhstan, Dzhambulskaja obl., 70 km NNE Frunze) (Holotype male, ZMH).

Distribution: Northern edge of the Tian Shan mountain chain: northernmost Uzbekistan, northernmost Kirghizstan, south-eastern Kazakhstan (locus typicus; KAILA & VIIDALEPP 1996: male genitalia of holotype figured).

Material examined: 1 female, [northernmost] Uzbekistan, Tienshan, Ugamski Chrebet, Tepar, ca 5-10km SW Pskem, valley of Tepar river, ca 1200m NN, 41°50' n.Br., 70°16' ö.L., 4.-5.VII.1998, LF, 125W HQL, leg. T. KARISCH, coll. ZSM/HERBULOT, gen.prp. ZSM G 16794, barcode specimenID BC ZSM Lep 60603; 1 male, 1 female, Kyrgyzstan, Chuy, N Tianshan, Alexander mts., S Bishkek, Alamedin gorge, 1740m, N 42°36'41", E 74°39'48", 10.VII.2015, leg. B. MAY (KEIL, KELLER, PLÖSSL), barcode specimenID BC ZSM Lep 92522, coll. MAY in ZSM; 1 male, id., leg. KEIL, coll. KEIL in ZSM, gen.prp. ZSM G 16795, barcode specimenID BC ZSM Lep 92523.

(Re-)Description (Fig. 4): Adult, male: Wingspan 17–19.5 mm. Ground colour pale brown. Antemedial, medial, postmedial lines and discal spots darker, with little contrast but well visible. Terminal line very fine,

in some specimens broken into streaks. Fringe dots absent. Antennae with sub-dentate flagellum, shortly ciliate-fasciculate, longest cilia circa 0.15 mm (1.5–1.8 times width of flagellum). Palpi narrow, beige, 0.65 mm (1.1 times diameter of eye). Hindleg slender, length of tarsus 0.9 mm (0.4 times length of tibia).

Female: No significant sexual dimorphism, i.e. no difference from male in coloration and pattern, just fore- and hindwings broader and moreover showing the (genus-) characteristic differences for females, i.e. antennae filiform, hindtibia with two spurs, hindtarsus not shortened, frenulum a brush of bristles.

Male genitalia (Fig. 11) (n=2): Uncus short, terminally rounded. Saccus long and broad. Valva parallel-bordered, in the terminal fourth narrowing. Length of aedeagus 1.1 mm, of cornutus 0.8 mm (0.7 times length of aedeagus), cornutus stout, often narrower than in the preceding species, but without constant and significant differences. Measurement of cornutus in the original description erroneous ("0.285 mm").

Female genitalia (Fig. 16) (n=1): Length of apophyses posteriores 0.8 mm, of apophyses anteriores 0.45 mm. Ductus bursae comparatively short (0.75 mm) and broad. A scattered patch of spinules (length of spinules 0.05 mm) at the posterior part of corpus bursae. Appendix bursae without spinules.

Genetic data: BINs: BOLD:ABU6268 (n=1 from Uzbekistan), BOLD:ADA8023 (n=2 from Kyrgyzstan), both BINs diverging from each other by 1.4%. Genetic distances from the other representatives of the species group: *Idaea nocturna* (3.0%), *I. beata* sp. n. (7.2%), *I. medianocturna* sp. n. (7.8%), *I. millesima* sp. n. (8.1%).

***Idaea beata* HAUSMANN, sp. n.**

Type material: Holotype: Male, northern Israel, lake Kinneret north, Domus Galilaeae near Korazim, 120 m, 32.9012° N, 35.5514° E, 28.III.2014, leg. A. HAUSMANN, coll. ZSM, DNA barcode BC ZSM Lep 65288, gen.prp. ZSM G 15839.

Description (Fig. 6): Adult, male: Wingspan 17.5 mm. Forewings with rounded apex. Wing coloration brown with dark black brown pattern. Antemedial, medial and postmedial lines conspicuous, undulating. Terminal area dark black brown, with an uninterrupted pale wavy line. Discal spots poorly visible. Terminal line and fringe dots absent. Frons black, vertex dark grey brown. Proboscis vestigial, very short. Palpi dark grey brown, bushy, length 0.7 mm (1.4 times diameter of eye). Antennae bipectinate, branches very long and narrow, 0.25–0.3 mm (5 times width of flagellum). Hindtibia slender, of medium length (1.2 mm), tarsomeres appearing as fused, total length of tarsus 0.5 mm, 0.4 times length of tibia.

Male genitalia (Fig. 13) (n=1): Uncus short, sub-truncate with rounded edges. Saccus very short, rounded. Valva narrow at centre, dilated at 3/4, rounded at tip. Length of aedeagus 0.8 mm, of cornutus 0.5 mm (0.62 times length of aedeagus), cornutus narrow.

Female unknown.

Differential diagnosis: In wing coloration most reminiscent of *I. medianocturna* sp. n. but differing by the much better contrasted transverse lines, longer palpi, longer antennal branches and reduced proboscis. A similar dark ground colour and long antennal pectination is shared by *I. millesima* sp. n. which, however, shows straighter and much less contrasted transverse lines and has a much less rounded forewing apex. The other species of this group are characterized by paler coloration of males and dentate flagellum of male antennae.

Genetic data (Fig. 1): BIN: BOLD:ACM8700. Genetic distances from the other representatives of the species group: *Idaea nocturna* (4.2%), *I. millesima* sp. n. (7.1%), *I. zoferata* (7.2%), *I. medianocturna* sp. n. (7.3%).

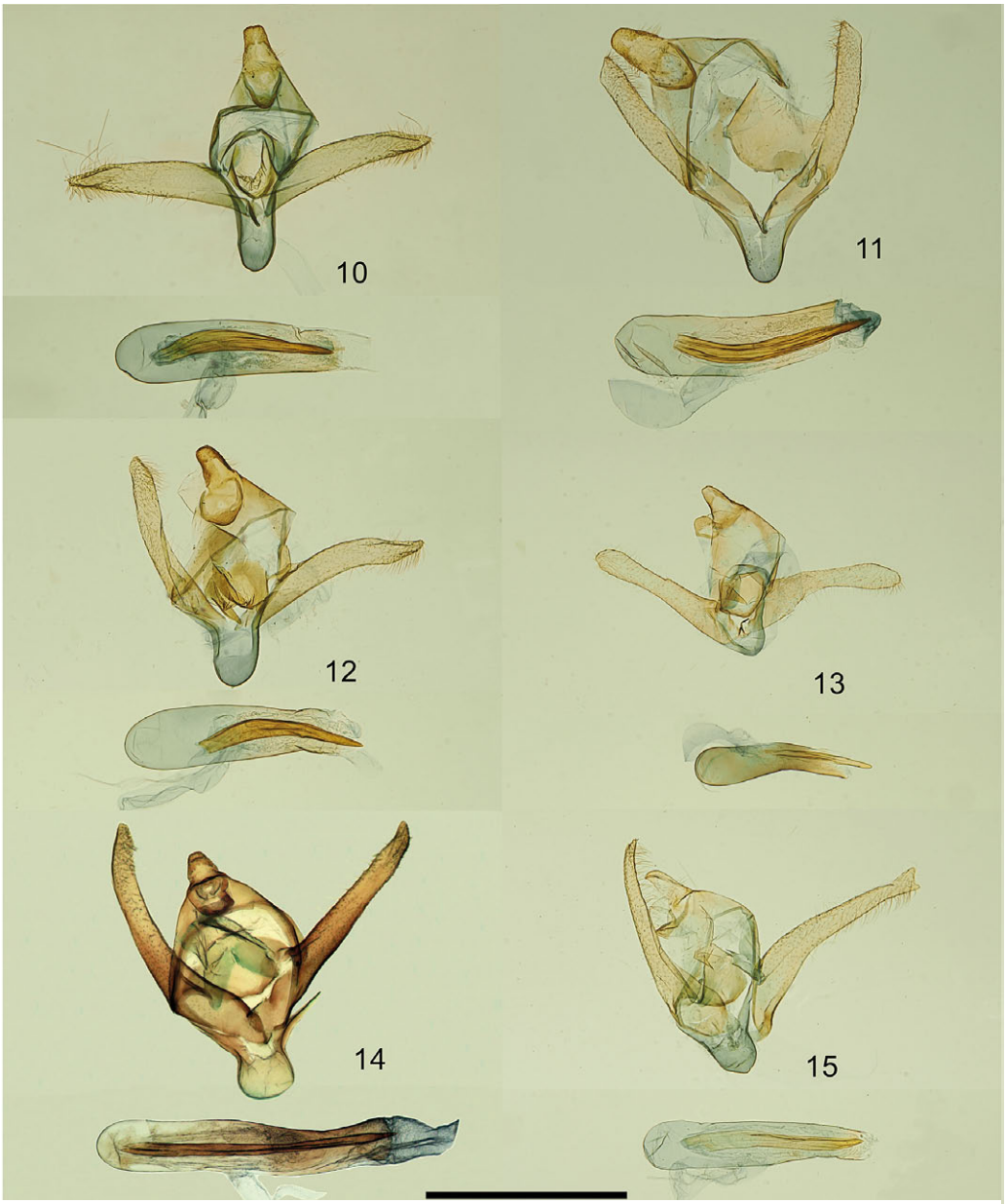
Etymology: The species name refers to the type locality on the Mount of Beatitudes (lat. beatus, -a, -um = blessed).

***Idaea millesima* HAUSMANN & PROCHAZKA, sp. n.**

Type material: Holotype: Male, Greece, Peloponnese, Taygetos, Tseria, 19.V.1992, leg. T. DOBROVSKY, coll. ZSM (DNA barcode ID: BC ZSM Lep 56957). Paratype(s): 1 male, id., coll. J. PROCHAZKA (DNA barcode ID: BC ZSM Lep 56958; gen.prp. nr. Proch-12001); 2 males, id., coll. T. DOBROVSKY.

Description (Fig. 7): Adult, male: Wingspan 18–19 mm. Wing coloration dark brown, towards wing basis slightly irrorated by paler scales. Transverse lines slightly curved and slightly dentate, slightly darker than ground colour, inconspicuous. Wavy line in terminal area almost invisible. Discal spots blackish, round, small. Terminal line uninterrupted, fine. Fringe concolorous, fringe dots absent. Palpi and hindtibia not examined. Antennae bipectinate, branches very long (0.3 mm = 4 times width of flagellum).

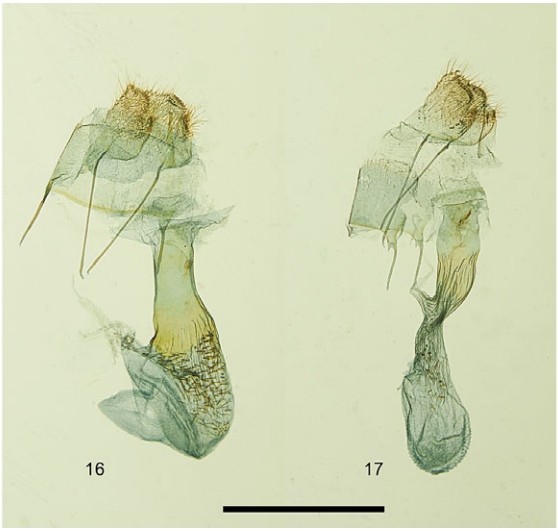
Male genitalia (Fig. 14) (n=1): Comparatively large. Uncus short, sub-trapezoid, posteriorly with rounded edges. Saccus sub-quadratic, broad. Valva slightly curved, parallel-bordered over the whole length, at tip sub-truncate with rounded edges. Length of aedeagus 1.8 mm, of cornutus 1.5 mm, cornutus narrow.



Figs 10-15: Male genitalia of the *Idaea nocturna* species group (scale bar = 1 mm): Fig. 10: *Idaea nocturna* (STAUDINGER, 1892), central Kyrgyzstan; **Fig. 11**: *Idaea nocturna* (STAUDINGER, 1892), western Kyrgyzstan; **Fig. 12**: *I. zoferata* KAILA & VIIDALEPP, 1996; **Fig. 13**: *I. beata* HAUSMANN, **sp. n.**, holotype; **Fig. 14**: *I. millesima* HAUSMANN & PROCHAZKA, **sp. n.**, paratype; **Fig. 15**: *I. medianocturna* HAUSMANN, **sp. n.**, holotype.

Female unknown.

Differential diagnosis: In wing coloration reminiscent of *Idaea beata* sp. n. and *I. medianocturna* sp. n., but differing from the former by less rounded forewings, straighter and much less contrasted transverse lines, from the latter by the long bipectinate male antennae. Males of *I. nocturna* and *I. zoferata* show paler coloration and more diffuse pattern.



Figs 16-17: Female genitalia of the *Idaea nocturna* species group (scale bar = 1 mm): Fig. 16: *Idaea zoferata* KAILA & VIIDALEPP, 1996; **Fig. 17**: *I. medianocturna* HAUSMANN, **sp. n.**, holotype.

Genetic data (Fig. 1): BIN: BOLD:ABW0363 (n=2 from Greece). Genetic distances from the other representatives of the species group: *Idaea medianocturna* sp. n. (6.4%), *I. nocturna* (6.9%), *I. beata* sp. n. (7.1%), *I. zoferata* (8.1%).

Etymology: The species name was given referring to the fact that this is the first European species described after the completion of the book series 'The Geometrid Moths of Europe' which contains 999 European geometrid species. After the new record for Europe of *Athroolopha latimargo* ROTHSCHILD, 1914 in Spain (GUERRERO et al. 2020) and the downgrading of *Rhodostrophia discopunctata* AMSEL, 1935 to subspecies rank of *R. calabra* (PETAGNA, 1786) (HAUSMANN 2020), this new species seems to be the thousandth geometrid species of Europe (latin millesimus, -a, -um = the thousandth).

***Idaea medianocturna* HAUSMANN, sp. n.**

Type material: Holotype: Male, Turkey, Hakkari, Tanin Daglari, Elkek Gecidi, W-side, 2300 m, 6 km ENE Uludere, 26.VI.1984, leg. L. WEIGERT, coll. ZSM (gen.prp. ZSM G 17043). Paratypes: 2 males, 1 female, id.; 2 males, 2 females, Turkey, Hakkari, Altin Daglari, E-side, Süvarihalil Gecidi, 2400 m, 40 km WSW Hakkari, 27.VI.1984, leg. L. WEIGERT, coll. ZSM (male female gen.prp. ZSM G 16994, gen.prp. ZSM G 16845). 3 males, 1 female, Türkei, Hakkari, Kirigdag, 13 km NO Hakkari,1300-1500 m ü.NN, N 37°35`/ O 43°52`, 30.06.2011 LF, leg. R. FIEBIG & S.ROTHE, BC ZSM Lep 65414, BC ZSM Lep 65415, dissected DS 37/2012 (male), DS 36/2012 (female), coll. Ralf FIEBIG; 1 male, Türkei, Hakkari, 6,5 km westl. von Hakkari, 2500-2600 m ü.NN, N 37°33`/ O 43°40`, 29.06.-03.07.2011 LF, leg. R. FIEBIG & S. ROTHE, coll. Ralf FIEBIG; 1 male, Turkey, Siirt province, Şirvan district, Nallıkaya (Dikilitaş), 38°09'20" N, 42°10'30" E, 1950 m, 06.09.2013 (gen.prp. Gp362), leg. et coll. E. SEVEN (TR, Siirt prov.); 4 males, SE Turkey, Siirt Province, Akyamaç, 700m, 19.05.2015, 38°01' 05" N- 41° 55' 58" E, (gen.prp. GP2015-66) leg. et coll. E. SEVEN (TR, Siirt prov.).

Description: Adult, male (Fig. 8): Wingspan 16–19 mm. Ground colour of wings dark chocolate brown, pattern slightly darker, with three undulate transverse lines on all wings, discal dots and fringe dots absent. Frons black brown, vertex paler grey brown. Palpi bushy, length 0.5–0.6 mm, i.e. 1.0–1.1 times diameter of eye. Antennae shortly bipectinate with paired, ciliate, sub-triangular branches on each antennomere, length of branches approx. 1.0 times width of flagellum. Hindtibia slender, length 1.5–1.6 mm, hindtarsus fused, length 0.55–0.65 mm, tarsus 0.4 times length of tibia.

Female (Fig. 9): Wingspan 16–19 mm. Sexual dimorphic, females much paler than males, pale grey brown, transverse lines similar, but pale wavy line close to termen more conspicuous.

Male genitalia (Fig. 15) (n=3): Uncus rounded at tip. Saccus short, broad. Valva long, narrowing to tip, at tip furcate. Length of aedeagus 1.1 mm, of cornutus 0.9 mm (0.8 times length of aedeagus), cornutus narrow.

Female genitalia (Fig. 17) (n=1): Length of apophyses posteriores 0.7 mm, of apophyses anteriores 0.4 mm. Length of antrum and ductus bursae 1.2 mm, longitudinally furrowed, ductus seminalis arising from half length. Very few scattered minute spinules in the anterior part of ductus bursae. Corpus bursae small, oval (0.6 mm).

Differential diagnosis: In wing coloration (of males) reminiscent of *Idaea millesima* sp. n. and *I. beata* sp. n., the former with sharper wing pattern, the latter with much better contrasted transverse lines, longer palpi, vestigial proboscis. *Idaea medianocturna* sp. n. differs from both aforementioned species by the short pectination of male antennae.

Genetic data (Fig. 1): BIN: BOLD:ABX1275. Genetic distances from the other representatives of the species group: *Idaea nocturna* (5.7%), *I. millesima* sp. n. (6.4%), *I. beata* sp. n. (7.3%), *I. zoferata* (7.8%).

Etymology: The species name refers to the latin term 'media nox' = midnight, alluding to the dark coloration of males, and thus alluding also to the species name of *Idaea nocturna*.

Idaea descitaria (CHRISTOPH, 1893)

Acidalia descitaria CHRISTOPH, 1893: 94 (south-eastern European Russia: Sarepta; Urals: Guberli; Tagan-rog; central Asia: Askhabad, Kuldscha). Syntypes (ZISP), lectotype not yet selected.

Description see HAUSMANN (2004). Adults with forewing costa straighter than in the *Idaea nocturna* species group, hindwing slightly edged at M3, and with much more prominent pattern, i.e. postmedial line of all wings conspicuous, dentate, fringe dots conspicuous. Male antennae comparatively shortly ciliate, length of cilia 0.8–1.1 mm (0.9–1.3 times diameter of flagellum). Male hindtibia with pencil, hindtarsus 0.35–0.5 times length of tibia. In male genitalia saccus & cornutus narrower than in the *Idaea nocturna* species group, length of aedeagus 1.5–1.6 mm, length of cornutus 0.8 mm (0.5 times length of aedeagus).

Genetic data (Fig. 1): BIN: BOLD:ADA8023 (n=2). At large distance from the *Idaea nocturna* species group. One specimen of *I. descitaria* from Uralsk (short sequence: 244bp) diverging from *Idaea soldaitisi* (SE Kazakhstan) by 1.1%. Another specimen identified as *I. descitaria* from northern Kazakhstan (sequence length 547bp) diverging from *I. soldaitisi* by only 0.4% and without difference from the 164bp short fragment of the holotype of *I. soldaitisi*.

Idaea soldaitisi HERBULOT, 1994

Idaea soldaitisi [sic!] HERBULOT, 1994: 66 (south-eastern Kazakhstan: Bakanas vill.). Holotype male (ZSM), examined and DNA barcoded. Unfortunately, HERBULOT misspelled the name of the collector in the dedication (Soldaitis instead of Saldaitis), and consequently the species epitheton should have been "*saldaitisi*". However, since there is no evidence for a misspelling in the original desciption itself, the name is a correct original spelling and cannot be emended according to art. 32.5. of the Code (ICZN).

Description see HERBULOT (1994) and HAUSMANN (2004). Wing coloration and pattern reminiscent of that of *I. descitaria*, somewhat more greyish, transverse lines less conspicuous, wings narrower, forewing apex more pointed (cf. HERBULOT 1994). Male antennae slightly longer ciliate than in *I. descitaria*, length of cilia 1.0–1.2 mm (1.2–1.4 times diameter of flagellum). Male hindtibia with pencil, hindtarsus 0.6–0.7 times length of tibia. In male genitalia length of aedeagus 1.6 mm, length of cornutus 0.8 mm (0.5 times length of aedeagus).

Genetic data (Fig. 1): BIN: BOLD:ADA8023 (n=2). Although the great genetic similarity with *I. descitaria* (see preceding species) suggests the need of taxonomic downgrading to subspecies rank and subordination under *I. descitaria*, the morphological differences seem to justify species rank. More research is needed to test if the differential features are subject to clinuous character transitions or not.

Idaea curtopedata (EBERT, 1965)

Sterrha curtopedata EBERT, 1965: 6, figs 1/6, 2/6 (Afghanistan, northern Badakhshan: Khinsch-e-Andarab). Holotype male (not traced in SMNK nor in SMNS, M. FALKENBERG & H. RAJAEI pers. comm.).

Distribution: North-eastern Afghanistan (locus typicus).

Data from original description: Adult, male (cf. pl. 1, fig. 6 in EBERT 1965): Forewing length 12 mm, corresponding to a wingspan of 21-22 mm, thus larger than the two preceding species. Ground colour whitish with yellow tinge, transverse lines darker, fine. Discal dots conspicuous but small. Antennae with rounded flagellomeres, shortly ciliate, length of cilia equal to width of flagellum, thus shorter than in the two preceding species. Frons and palpi blackish brown. Proboscis developed. Hindtibia slightly dilated, tarsus short, one third length of tibia.

Male genitalia (cf. pl. 2, fig. 6 in EBERT 1965): According to the figure in the original description very similar to those of *I. descitaria* and *I. soldaitisi*. Uncus long and narrow. Saccus long and narrow. Valva parallel-bordered. Cornutus aciculate, narrow, length of cornutus half length of aedeagus.

Genetic data: Not yet DNA barcoded.

Remarks: Examination of the holotype and of more material is required to understand the amplitude of variation and to revise its taxonomic status. Morphology of *Idaea curtopedata* clearly indicates a closer relationship to *I. descitaria* and *I. soldaitisi* than to the *Idaea nocturna* species group (e.g. narrow uncus, narrow saccus, narrow cornutus etc.), potential synonymy was suggested in HAUSMANN (2004).

Discussion

So far, filiform and ciliate male antennae were retained as one of the synapomorphies for the genus *Idaea* (PROUT 1913; STERNECK 1940), but very short pectinations have been found in the antennae of two European species, *Idaea serpentata* (HUFNAGEL, 1767) and *I. macilentaria* (HERRICH-SCHÄFFER, 1847) (HAUSMANN 2004). However, since the aforementioned two species show quadripectinate male antennae, the bipectinate character state of *Idaea beata* sp. n. and *I. millesima* sp. n. cannot indicate any closer relationship. The species of the genus *Cleta* share the bipectinate character state of the male antennae, but do not reveal any closer genetic similarity and show striking differences in coloration, wing pattern, and female genitalia. There is clear evidence (from structure of genitalia and COI barcodes) for a close relationship between the two species with long bipectinate antennae (*Idaea beata* sp. n. and *I. millesima* sp. n.) and the species pair *Idaea nocturna* and *I. zoferata*, which means that the evolution of bipectinate antennae occurred independently from that of other bipectinate Sterrhinae genera.

The results of the herewith presented analysis of the *Idaea nocturna* species group moreover show, that such a striking difference (filiform versus bipectinate antennae) can be subject of recent, intrageneric evolution. The age of the divergences of *I. beata* sp. n. and *I. millesima* sp. n. (with long bipectinate antennae) from the supposed *Idaea*-ancestors with shortly bipectinate antennae (as in *I. medianocturna* sp. n.) or filiform, ciliate-setose antennae (as in *I. nocturna* and *I. zoferata*) can roughly be estimated based on a tentative extrapolation from COI-substitution rates in other lineages within the genus *Idaea*: These usually show distances (minimum pairwise distances, Kimura 2 parameter) of 1.9–6.5% in young sibling species pairs which supposedly diverged and speciated during the eleven quartary glaciations in Europe in the last 800,000 years, e.g. in *Idaea circuitaria / I. rainerii / I. mimosaria* (1.9%–4.1%), *Idaea typicata / I. alyssumata* (2.6%), *Idaea mediaria / I. leipnitzi* (3.5%), *Idaea distinctaria / I. predotaria* (6.0%), *Idaea attenuaria / I. incalcarata* (6.5%), and several other species pairs and triplets (cf. HAUSMANN et al. 2013). Under the assumption of constant nucleotide substitution rates the means of the aforementioned examples of 4.1 % (genetic distance) and 400,000 years (divergence time of *Idaea* species pairs inferred from geological events) would suggest an age of 556,000–712,000 years for the character shifts from ciliate to shortly or long bipectinate antennae in the *Idaea nocturna* species group.

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Zusammenfassung

Die westasiatische *Idaea-nocturna*-Artengruppe wird mit einem integrativ-taxonomischen Ansatz bearbeitet. Drei neue Arten werden beschrieben: *Idaea millesima* **sp. n.** aus Südgriechenland, *Idaea beata* **sp. n.** aus Nordisrael und *Idaea medianocturna* **sp. n.** aus der Osttürkei. Bei diesen drei neuen Arten handelt es sich um die ersten bekannten Vertreter der megadiversen Gattung *Idaea* mit doppelt gefiederten männlichen Fühlern. Adulte und Genitalien werden illustriert, COI-Barcode-Daten werden diskutiert.

Literature

CHRISTOPH, H. 1893: Lepidoptera Nova Faunae Palaearcticae. – Deutsche entomologische Zeitschrift Iris **6**: 86-96.

deWAARD, J.R., IVANOVA, N.V., HAJIBABAEI, M. & P.D.N. HEBERT 2008: Assembling DNA barcodes: analytical protocols. In: MARTIN C (ed.): Methods in molecular biology: environmental genetics. – Totowa, NJ: Humana Press. pp. 275-293.

EBERT, G. 1965: Afghanische Geometriden (Lep.) I. – Stuttgarter Beiträge zur Naturkunde **142**: 1-32.

GUERRERO, J.J., CUENCA, E.D., BARROS, D. & A.S. ORTIZ 2020: Redescription and DNA barcoding of diurnal moth *Athroolopha latimargo* ROTHSCHILD, 1914 bona sp., stat. rev. from the southern Iberian Peninsula (Lepidoptera: Geometridae: Ennominae). – Zootaxa **4729** (4): 582–588.

HAUSMANN, A. 2004: Sterrhinae. In: A. HAUSMANN (ed.), The Geometrid Moths of Europe **2**: 1-600. – Apollo Books, Stenstrup.

HAUSMANN, A., GODFRAY, H.C.J., HUEMER, P., MUTANEN, M., ROUGERIE, R., VAN NIEUKERKEN, E.J., RATNASINGHAM, S. & P.D.N. HEBERT 2013: Genetic patterns in European geometrid moths revealed by the Barcode Index Number (BIN) system. – PLOS ONE 10.1371/journal.pone.0084518.

HAUSMANN, A., MÜLLER, G.C & V.D. KRAVCHENKO 2020: The Lepidoptera of Israel, Volume 3: Geometridae. – Proceedings of the Museum Witt, Munich, ca. 300 pp (in print).

HEBERT, P.D.N., CYWINSKA, A., BALL, S.L. & J.R. deWAARD 2003: Biological identifications through DNA barcodes. – Proceedings of The Royal Society of London B **270**: 313-321 (doi:10.1098/rspb.2002.2218).

HERBULOT, C. 1994: Un nouvel Idaea d'Asie Centrale. – Bulletin de la Société Entomologique de Mulhouse **1994**: 66.

IVANOVA, N.V., deWAARD, J.R. & P.D.N. HEBERT 2006: An inexpensive, automation-friendly protocol for recovering high-quality DNA. – Molecular Ecology Notes **6**: 998-1002.

KAILA, L. & J. VIIDALEPP 1996: *Idaea zoferata*. In: KAILA, L., VIIDALEPP, J., MIKKOLA, K. & V. MIRONOV 1996: Geometridae (Lepidoptera) from the Tian-Shan Mountains in Kazakhstan and Kyrgyzstan, with descriptions of three new species and one new subspecies. – Acta Zoologica Fennica **200**: 57-82.

MÜLLER, B., ERLACHER, S., HAUSMANN, A., RAJAEI, H., SIHVONEN, P. & P. SKOU 2019: Ennominae II. – In: A. HAUSMANN, P. SIHVONEN & H. RAJAEI (eds): The Geometrid Moths of Europe **6**: 1–906. Brill, Leiden.

PROUT, L.B. 1912-1916: Die spannerartigen Nachtfalter. In: SEITZ, A. (ed.): Die Groß-Schmetterlinge der Erde, vol. **4**. – Verlag A. Kernen, Stuttgart.

RATNASINGHAM, S. & P.D.N. HEBERT 2007: BOLD: The Barcode of Life Data System (http://www.barcodinglife.org). – Mol. Ecol. Notes **7** (3): 355-364.

RATNASINGHAM, S. & P.D.N. HEBERT 2013: A DNA-based registry for all animal species: The Barcode Index Number (BIN) System. PLOS ONE **8**(8): e66213. doi:10.1371/journal.pone.0066213.

RATNASINGHAM, S. 2017: BOLD Barcode of Life Data System. – http://www.boldsystems.org/views/login.php. Accessed 2017 Jun 02.

ROBINSON, G.S. 1976: The preparation of slides of Lepidoptera genitalia with special reference to the Microlepidoptera. – Entomologist´s Gazette **27**: 127-132.

STAUDINGER, O. 1892: Neue Arten und Varietäten von Paläarktischen Geometriden. – Iris **5**: 141-260.

STERNECK, J. 1940: Versuch einer Darstellung der systematischen Beziehungen bei den palaearktischen Sterrhinae (Acidaliinae), Studien über Acidaliinae (Sterrhinae) VII, I. Teil: Die Gattung Sterrha und deren nächste Verwandte. – Zeitschrift des Wiener Entomologen-Vereines **25**: 6–17; 25–36; 56–59; 77–79; 98–107; 126–128; 136–142; 152–159; 161–176, pl. 1–10.

TAMURA, K., STECHER, G., PETERSON, D., FILIPSKI, A. & S. KUMAR 2013: MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0. Molecular Biology and Evolution **30**: 2725-2729.

VIIDALEPP, J. 1988: [Geometrid moths of mountainous Middle Asia]. – Moscow, Nauka. 240 pp. (in Russian).

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