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# An enigmatic new species of the genus *Catarhoe* (Lepidoptera: Geometridae: Larentiinae) from Kyrgyzstan and taxonomic notes to the genus

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## Abstract

The paper presents a new species of geometrid moth of the genus *Catarhoe* Herbulot, 1951 from Kyrgyzstan, and offers a concise taxonomic review of the genus based on existing literature and on an analysis of COI barcode mitochondrial DNA fragment in Epirrhoini. A new species and new monotypic subgenus are described: *Catarhoe* (*Hyporhoe* **subgen. nov.**) *narynensis* **sp. nov.** The species is distinguished by a unique set of characters in the male genitalia, which markedly differs from those of other congeneric species, and has significant genetic distances from the rest of the *Catarhoe* spp. but not exceeding genetic distances into the genus at whole. The current species composition of the genus *Catarhoe* has been clarified and includes 13 species. Taxonomic status of *Catarhoe nyctichroa* (Hampson, 1912), *Catarhoe arachne hissarica* Viidalepp, 1988, and "*Catarhoe semnana*" sensu Kemal *et al*. (2020) requires clarification. A high level of morphological and genetic diversity of the genus *Catarhoe* was revealed. The genetic distances between the morphological groups of *Catarhoe* spp. are comparable to those between the genera of Epirrhoini. The generic name *Microcalcarifera* Inoue, 1982, is revived from its synonymy with *Catarhoe*. The genus includes type species *Microcalcarifera obscura* (Butler, 1878: 450) (*Cidaria*), **comb. rev.**, and two subspecies: *Microcalcarifera obscura fecunda* (Swinhoe, 1891), **comb. rev.** and *Microcalcarifera obscura multilinea* (Hampson, 1891), **comb. rev.**

**Key words:** Epirrhoini, new taxa, DNA barcoding, systematics, taxonomy, ecology, Naryn River basin

## Introduction

The Lepidoptera fauna of Central Asia remains insufficiently studied, particularly during the spring and autumn seasons. The research was conducted by the second author in collaboration with S.K. Korb and S.F. Melyakh in April 2023 in central Kyrgyzstan in the lower reaches of the Naryn River basin. It led to the discovery of an unknown and enigmatic species of geometrid moths. Based on an analysis of the morphological features this species was assigned to the genus *Catarhoe* Herbulot (Herbulot 1951a). Nevertheless, an examination of the 5' region of cytochrome oxidase I (DNA barcode) from this species revealed its isolated position within the genus. In the light of these findings, a new subgenus of the genus *Catarhoe* is proposed for the newly described species.

This publication is devoted to the description of this new species, as well as to a brief overview of the current taxonomic composition of the genus *Catarhoe* based on the literature data, morphology and mitochondrial COI genetics.

*Accepted by D. Plotkin: 25 Feb. 2025; published: 3 Apr. 2025*

## Materials and Methods

Specimens belonging to a new species were collected by the second author during the spring (April) expeditions of 2023. They were collected using UV-traps of three different constructions: tent-based and tripod-based traps equipped with high emission UV-sources (160W UV-lamps) and a tripod-based trap equipped with low emission UV-sources (UV-bulbs of 8W).

The photographs of the moths of the new species (Figs 1–8), and majority of the images of the male and the female genitalia (Figs 10, 12, 13, 16–19) were captured using DSLR camera Nikon D7100 with lens AF Micro Nikkor 105 mm 1:2.8D and AF-S Micro Nikkor 60 mm 1:2.8G ED by Pavel Gorbunov. The photograph of the total view of the *Catarhoe arachne hissarica* paratype (Fig. 20) was captured with a Canon 5D Mark IV digital camera equipped with a Canon MP-E 65mm f/2.8 1–5x macro lens and Canon Macro Twin Lite MT-26EX-RT, flash, and Helicon stacking software (Helicon Focus 7.03); this photograph was taken by Ilya Makhov. He also performed part of the photographs of the temporary male and female genitalia preparations of the new species (Figs 11, 14, 15), and the female genitalia of paratype of *Catarhoe arachne hissarica* (Fig. 22), using a Nikon SMZ25 stereoscopic microscope, Nikon DS-Ri2 camera and NIS-Elements BR software.

Wing venation nomenclature is based on Wootton's (1979) system, which was adopted for Lepidoptera by Kristensen (2003). The structures of the copulatory apparatus (genitalia) are named traditionally, according to the dictionary of Klots (1970) with additions according to Kuznetsov & Stekolnikov (2001) and Kristensen (2003), and specifically for Geometridae—according to Beljaev (2008).

Phylogenetic analysis was carried out based on the original COI sequences of *Catarhoe narynensis* **sp. nov.**, and on the selected sequences of other species taken from BOLD, NCBI and EMBL-EBI databases. Two obtained COI barcode sequences of *Catarhoe narynensis* **sp. nov.** were compared with 37 specimens of species from the genus *Catarhoe* (10 species) and 13 specimens of species from the genera *Costaconvexa* Agenjo, 1949 (2 species), *Epirrhoe* Hübner, 1825 (3 species), *Juxtephria* Viidalepp, 1976 (1 species), *Mimoclystia* Warren, 1901 (1 species), and *Protorhoe* Herbulot (Herbulot 1951b) (3 species), including type species of the genera. The genera *Catarhoe*, *Costaconvexa*, *Epirrhoe* and *Mimoclystia* were included in the recently revived tribe Epirrhoini by the molecular-genetic data (Brehm *et al.* 2019; Õunap *et al.* 2024). *Juxtephria* and *Protorhoe* were included based on the close morphological similarity with *Catarhoe*. For the genus *Catarhoe*, all species with available sequences were included in the analysis. Where feasible, multiple samples of each species were selected, with the longest nucleotide sequence, from disparate geographic regions and with different BOLD BINs (where available). For the remaining genera, samples of the type species of the genus and representatives from different morphological groups (if feasible) were selected. As a potential out-group, two species from the genus *Xanthorhoe* Hübner, 1825, and the type species of the genus *Scotopteryx* Hübner, 1825, were also involved (Tab. 1).

For DNA extraction, two dry specimens of *Catarhoe narynensis* **sp. nov.** (three separated legs from each specimen) were used. The legs were placed in lysis solution, and the lysis reaction proceeded overnight. DNA extraction was carried out using the DNeasy Blood & Tissue Kit (QIAGEN, Germany), according to the manufacturer's protocol. DNA elution was performed with 150 µL elution buffer. Amplification of a 658-bp-long *COI* fragment was performed using the standard pair of primers: HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') and LCO1490 (5'-GGTCAACAAATCATAAAGATATTGG-3') (Folmer *et al.* 1994). The polymerase chain reaction (PCR) profile used for this marker was as follows: 95° C for 3 min, 95° C for 30 s, 50° C for 45 s, 72° C for 1 min (steps 2–4 cycled 34 times) and 72° C for 10 min. The samples were sequenced at Evrogen JSC (Moscow).

MEGA 11 software (Tamura *et al.* 2021; http://www.megasoftware. net) was used to determine the nucleotide composition, to calculate the genetic distances, to select the optimal nucleotide substitution model, and to perform phylogenetic reconstructions. The resulting topology was evaluated by bootstrap test with 1000 replicates. The phylogenetic trees were reconstructed by distance method (neighbor-joining, NJ) and likelihood method (maximum likelihood, ML). The optimal nucleotide substitution model with the lowest Bayesian information criterion scores were calculated as TN93+G+I: Tamura-Nei model with a discrete gamma distribution (G) and the assumption that a certain fraction of sites are evolutionarily invariant (I).

For the construction of the NJ tree, we used all nucleotide substitution models available in MEGA 11 software (p-distance, Jukes-Cantor model, Kimura 2-parameter model, Tajima-Nei model, Tamura 3-parameter model, Tamura-Nei model, Maximum Composite Likelihood and LogDet) added with the G and I models, and with pairwise deletion of missing data. All the resulting trees had the same branching pattern and differed only in the bootstrap

**TABLE 1.** List of samples of *Catarhoe* and related Epirrhoini with DNA barcodes. Species names in bold are type species of their genus.

| Species name (as in the database) / correct name | Database and ID of the specimen | Region of the specimen origin | Nucleotides | BOLD BIN |
|---|---|---|---|---|
| *Catarhoe arachne* / = *Catarhoe* sp. *cf. arachne*?1) | NCBI: PP441677.1 | No locality | 1513 bp, reduced to 658 bp | – |
| ***Catarhoe basochesiata*** | BOLD: GWOSK909-11 | Italy, Isola d`Elba | 658 bp | BIN: AAE9526 |
| ***Catarhoe basochesiata*** | BOLD: GWOSB311-10 | Portugal | 658 bp | BIN: AAE9526 |
| ***Catarhoe basochesiata*** | BOLD: GWOSB312-10 | Italy, Sardinia | 658 bp | BIN: AAE9526 |
| ***Catarhoe basochesiata*** | BOLD: GWORB1650-08 | Italy, Sicily | 645 bp | BIN: AAE9526 |
| *Catarhoe cuculata* | BOLD: ABOLD106-16 | Austria | 658 bp | BIN: AAC2047 |
| *Catarhoe cuculata* | BOLD: GWORB1982-08 | Turkey, Erzurum | 609 bp | BIN: AAC2047 |
| *Catarhoe cuculata* | BOLD: GWORE1223-08 (via GBIF) | Iran | 609 bp | BIN: AAC2047 |
| *Catarhoe cuculata* | BOLD: GWORB2699-08 | China, Hebei | 647 bp | BIN: AAC2047 |
| *Catarhoe cuculata* | BOLD: LEFIA312-10 | Finland | 625 bp | BIN: AAC2047 |
| *Catarhoe cuculata* | BOLD: DTNHM7144-23 | United Kingdom | 658 bp | BIN: not indicated |
| *Catarhoe hortulanaria* | BOLD: GWOR289-07 | Israel, Jerusalem | 658 bp | BIN: AAC1540 |
| *Catarhoe hortulanaria* | BOLD: GWORC1112-08 | Turkey, Adana | 579 bp | BIN: ABX6033 |
| *Catarhoe hortulanaria* | BOLD: GWOSI813-10 | Greece | 587 bp | BIN: ABX6033 |
| *Catarhoe hortulanaria palaestinensis* | BOLD: GWOR408-07 | Israel, Haifa | 658 bp | BIN: AAC1541 |
| *Catarhoe hortulanaria palaestinensis* | BOLD: GWORL813-09 | Israel, Northern | 622 bp | BIN: AAC1541 |
| *Catarhoe mazeli* | BOLD: GWOSB315-10 | Spain | 658 bp | BIN: AAN9632 |
| *Catarhoe mazeli* | EMBL-EBI: voucher ZSM BC Lep 34375 | Spain | 658 bp | – |
| *Catarhoe narynensis*, **sp. nov.** | NCBI: PQ276049.1 | Kyrgyzstan | 658 bp | – |
| *Catarhoe narynensis*, **sp. nov.** | NCBI: PQ276050.1 | Kyrgyzstan | 658 bp | – |
| *Catarhoe obscura* | NCBI: MW479702 | Korea | 628 bp | – |
| *Catarhoe permixtaria* | BOLD: GWOSB316-10 | Greece | 658 bp | BIN: AAC2045 |
| *Catarhoe permixtaria* | BOLD: GWOR3619-08 | Turkey, Ankara | 609 bp | BIN: AAC2045 |
| *Catarhoe permixtaria* | BOLD: GWOR321-07 | Israel, Jerusalem | 658 bp | BIN: AAC2045 |
| *Catarhoe permixtaria* / = *Catarhoe* sp., *cf. arachne*?1) | BOLD: GWORE1165-08 | Greece | 658 bp | BIN: AAC2046 |
| *Catarhoe permixtaria* | BOLD: GWORE1167-08 | Iran, Khorasan | 658 bp | BIN: ACE3401 |
| *Catarhoe permixtaria* / = *Catarhoe rubidata*2) | BOLD: GWOTF280-12 (via GBIF) | Turkmenistan | 658 bp | BIN: ACE3401 |
| *Catarhoe renodata* | BOLD: GWORB1978-08 | Turkey, Nevsehir | 582 bp | BIN: AAF1596 |
| *Catarhoe renodata* | BOLD: GWORB1979-08 | Turkey, Nevsehir | 587 bp | BIN: AAF1596 |
| *Catarhoe rubidata* | BOLD: GWORM067-09 | Germany, Bavaria | 658 bp | BIN: AAC4757 |
| *Catarhoe rubidata* | BOLD: LEFIA348-10 | Finland | 658 bp | BIN: AAC4757 |
| *Catarhoe rubidata* | BOLD: GWOR2535-08 | Russia, Chelyabinskaya Obl. | 659 bp, reduced to 658 bp | BIN: AAC4757 |
| *Catarhoe rubidata* | BOLD: GWOSB317-10 | Greece | 658 bp | BIN: AAC4757 |

*......continued on the next page*

**TABLE 1.** (Continued)

| Species name (as in the database) / correct name | Database and ID of the specimen | Region of the specimen origin | Nucleotides | BOLD BIN |
|---|---|---|---|---|
| *Catarhoe rubidata* | BOLD: GWORB1980-08 | Turkey | 587 bp | BIN: AAC4757 |
| *Catarhoe rubidata* | BOLD: GWOSI946-10 (via GBIF) | Uzbekistan | 658 bp | BIN: AAC4757 |
| *Catarhoe rubidata* | BOLD: GWOTF278-12 (via GBIF) | Uzbekistan | 658 bp | BIN: AAC4757 |
| *Epirrhoe galiata* | BOLD: ABOLD109-16 | Austria | 658 bp | BIN: AAB2097 |
| *Epirrhoe mosulensis* / = *Catarhoe mosulensis* | BOLD: GWOR121-07 | Israel, Northern | 597 bp | BIN: AAI6583 |
| *Epirrhoe mosulensis* / = *Catarhoe mosulensis* | BOLD: GWOR566-07 | Israel, Northern | 595 bp | BIN: AAI6583 |
| *Costaconvexa centrostrigaria* (Wollaston, 1858) | BOLD:BBLPA659-10 | Canada, Ontario | 658 bp | BIN:AAA4271 |
| ***Costaconvexa polygrammata*** (Borkhausen, 1794) | BOLD:ABOLC155-16 | Austria | 658 bp | BIN: AAD1079 |
| ***Epirrhoe rivata*** (Hübner, 1813) | BOLD: FBLMZ137-12 | Germany, Bavaria | 658 bp | BIN: AAD7207 |
| *Epirrhoe tristata* (Linnaeus, 1758) | BOLD: GBLAC292-13 | Germany, Bavaria | 658 bp | BIN: AAD7202 |
| ***Juxtephria consentaria*** (Freyer, 1846) | BOLD: GBMNF21902-22 | Russia, Baikal region | 657 bp | BIN: AAD5522 |
| ***Juxtephria consentaria*** | BOLD: GWORD958-08 | China, Hebei | 658 bp | BIN: AAD5522 |
| ***Mimoclystia undulosata*** Warren, 1901 | BOLD: LSAFR1484-12 | South Africa | 658 bp | BIN: AAM3741 |
| *Protorhoe corollaria* (Herrich-Schäffer, 1848) | BOLD: GWORA2594-09 | Greece | 658 bp | BIN: AAK9894 |
| *Protorhoe crebrolineata* (V. Kuznetsov, 1960) | BOLD: GWOR663-07 | Turkmenistan | 602 bp | BIN: AAX8624 |
| ***Protorhoe unicata*** (Guenée, 1858) | BOLD: BSNTN205-23 | Greece, Crete | 658 bp | BIN: AAN3353 |
| ***Protorhoe unicata*** | BOLD: GWORD1154-08 | Iran, Hormozgan | 658 bp | BIN: ADG3655 |
| ***Protorhoe unicata*** | BOLD: GWOSO555-11 | Greece, Makedonia | 658 bp | BIN: AAN3353 |
| ***Scotopteryx coarctaria*** (Denis & Schiffermüller, 1775) | BOLD:GWOTD1004-12 | Germany, Brandenburg | 658 bp | BIN:AAJ5744 |
| ***Scotopteryx coarctaria*** | BOLD:GWORA2124-09 | Turkey, Malatya | 658 bp | BIN:AAJ5744 |
| *Xanthorhoe incursata* (Hübner, 1813) | BOLD: LEATD310-13 | Austria, Tyrol | 658 bp | BIN: AAB5059 |
| ***Xanthorhoe montanata*** (Denis & Schiffermuller, 1775) | BOLD: ABOLB838-15 | Austria, Carinthia | 658 bp | BIN: AAB2524 |

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1) The specimen "*Catarhoe arachne*" (NCBI ID: PP441677.1, with no data on the collection locality) and the specimen "*Catarhoe permixtaria*" (BOLD ID: GWORE1165-08, from Greece) are clustered together with high level of bootstrap support (99%) separate from other specimens of *Catarhoe permixtaria*. The photo of the "*Catarhoe permixtaria*" is almost identical with photo of the moths of "*Catarhoe semnana*" in Kemal *et al*. (2020: figs 2, 3), which possibly is a separate undescribed species (see text).

2) The specimen "*Catarhoe permixtaria*" (BOLD ID: GWOTF280-12) from Turkmenistan is clustered into the *Catarhoe rubidata* clade and has to be this species in spite of the deviated wing pattern.

value of some nodes, which varied from one to three units. For the illustration and discussion, a tree constructed with the Kimura 2-parameter model (in accordance with standard BOLD protocol: Hebert *et al.* 2003) was chosen (Fig. 23).

For the construction of ML tree, we used the nucleotide substitution model TN93+G+I, using all sites (Fig. 24). The genetic pairwise distance (p-distance) was computed using the Kimura 2-parameter model protocol + G + pairwise deletion of missing data.

## Descriptions

### *Catarhoe* Herbulot, 1951a

### (*Hyporhoe* Beljaev & Gorbunov, subgen. nov.)

http://zoobank.org/urn:lsid:zoobank.org:act:20231F4B-DE6B-4F18-9E8E-D8B4E107C8FF

**Diagnosis.** The new subgenus *Hyporhoe* differs from the nominative subgenus *Catarhoe* in the appearance by the cylindric male flagellum, by the weakly sinuous and somewhat blurred transverse lines on the wings; in the wing venation by the short proximal areole on the forewing and lacking the vein A2 on the hindwing; in the male genitalia by the obtuse distal process of the costa of valva, by presence of numerous small spines on the costa of valva, and by lacking cornuti on the vesica of phallus; in the female genitalia by the presence of a relatively narrow and strictly transverse ring of sclerotisation of the ductus bursae at the base of the corpus bursae.

**Description.** See description of the species.

**Etymology.** The name *Hyporhoe* is formed by the combination of Ancient Greek prefix ὑπο- (hupó—under, sub-, hypo-) and noun ῥοή (feminine gender) (rhoḗ—a river, a stream).

### *Catarhoe* (*Hyporhoe*) *narynensis* Beljaev & Gorbunov, sp. nov.

http://zoobank.org/urn:lsid:zoobank.org:act:8F96972A-6DD8-4252-942A-1C5C336B8359
(Figs 1–19)

**Material.** Holotype: ♂, **Kyrgyzstan,** Moldo-Too Range, 15 km NW of Kazarman village, Naryn River valley, 1220 m a.s.l., 41°30’46” N, 73°55’38” E, 22–23.04.2023, leg. P. Gorbunov, S. Melyakh, S. Korb.

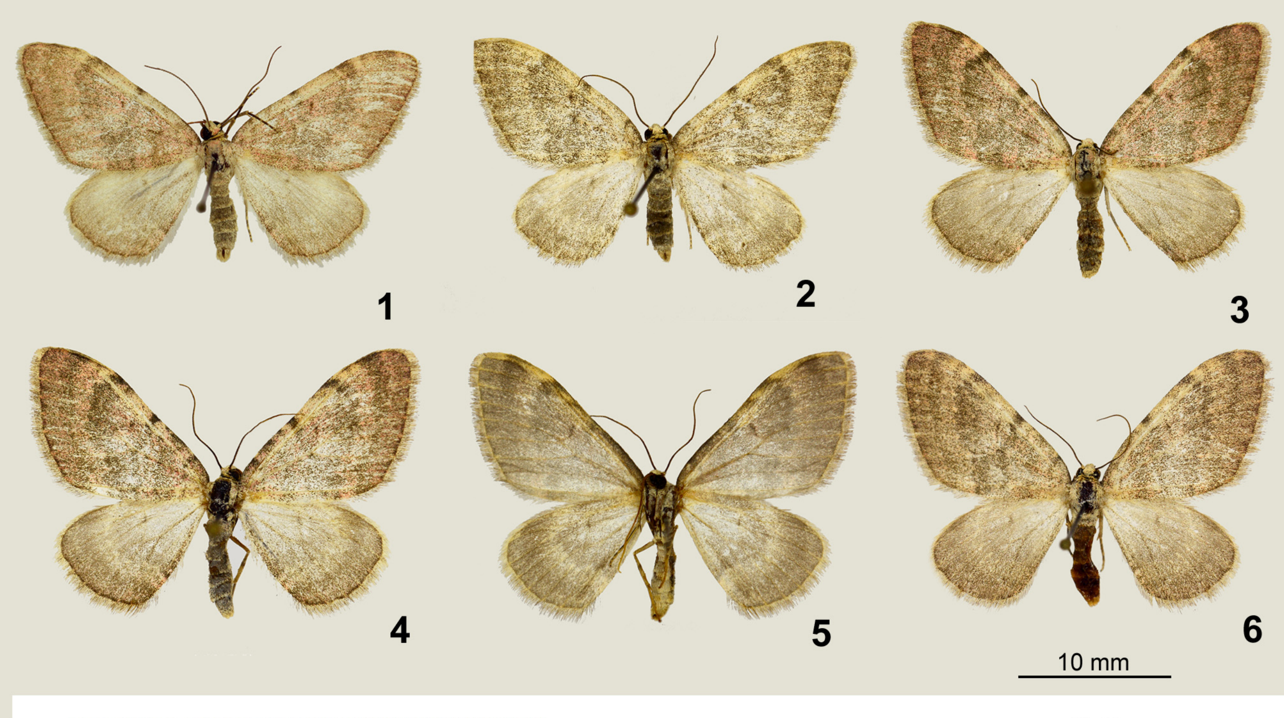
Paratypes: **Kyrgyzstan:** 2 ♂♂, 6 ♀♀, same locality and date; 1♂ (GenBank ID: PQ276049.1), 1♀ (GenBank ID: PQ276050.1), same locality, 21–22.04.2023, leg. P. Gorbunov; 2 ♂♂, Moldo-Too Range, 7 km E of Kyzyl-Korgon, Dyungereme River valley, 41°43’43.08”N, 74°16’38.54”E, 1491 m, 24.04.2023, leg. P. Gorbunov, S. Melyakh, S. Korb.

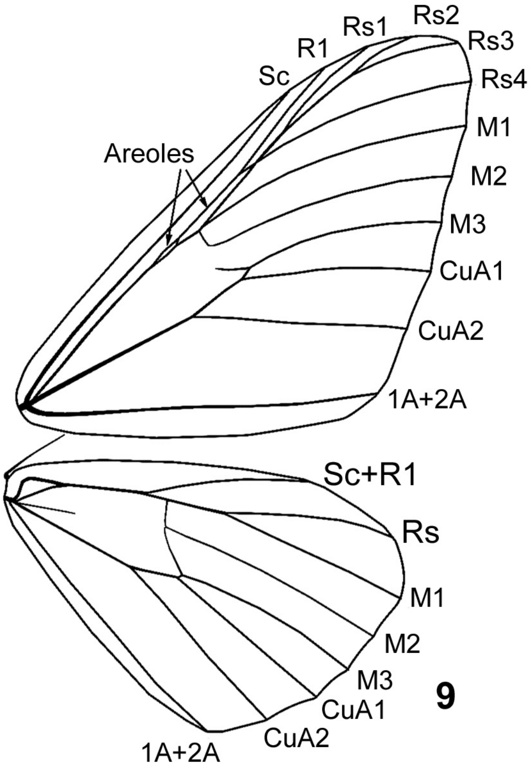
The holotype and one paratype are deposed in the collection of the Zoological Institute of the Russian Academy of Sciences (St. Petersburg). The remaining paratypes are in the private collections of P.Yu. Gorbunov and S.F. Melyakh (Ekaterinburg).

**Diagnosis.** See the diagnosis of the subgenus.

**Description.** Moth (Figs 1–9). Wingspan of males and females 25–30 mm, notable difference between sexes in size, shape and pattern of the wings not traced. Palpi short (1 mm), three-segmented. Proboscis normally developed, about 7 mm long. Frons convex, two times narrower than the diameter of the eye, covered with light scales. Light protruding scales present between the bases of antennae. Antennae of males cylindrical, flagellum on underside covered with thin light cilia, length of which slightly exceeding half of the thickness of the flagellum.

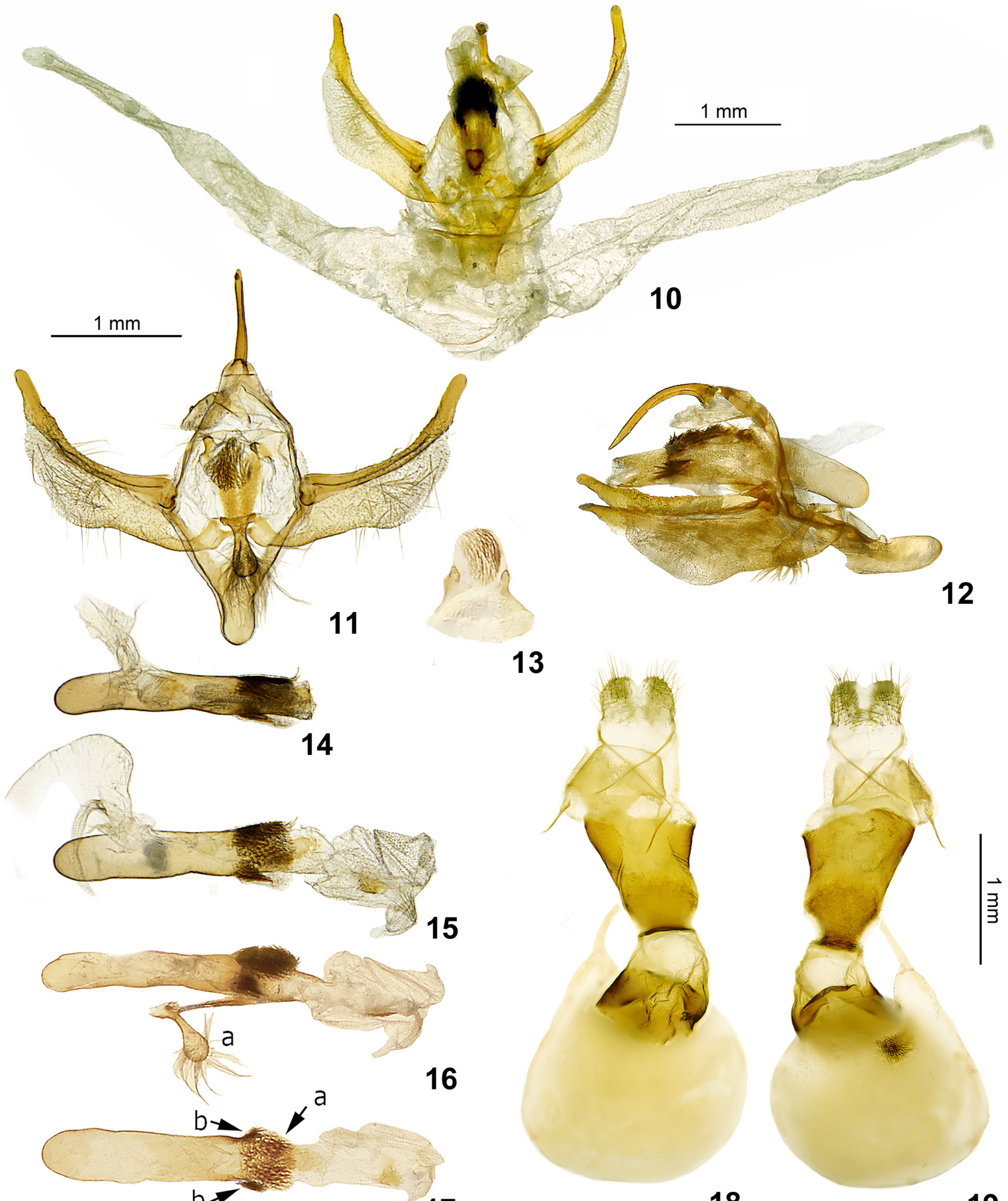
Wings wide, forewing length 12.5–14.5 mm, width 6.5–8.0 mm. Forewing broadly triangular with termen slightly longer than inner margin, apex rounded. Hindwing with costal margin noticeably longer than anal margin, termen rounded. Termen of both pairs of wings barely wavy. Wings above brownish-grey with pink tint in some specimens. Wing pattern soft, not contrasting, dark-grey median field most prominent. Medial field on costal margin of the forewing 2–3 times wider than on inner margin, in anterior half with median triangular brightening centered with weak stroke-like discal spot. Antemedial and postmedial lines grey, wavy or moderately serrated, indistinct. Underside of wings gray with wide, light, indistinct postmedial band and yellowish-grey spots at costal margin of the forewing, and with dark stroke-like discal spot on each wing.



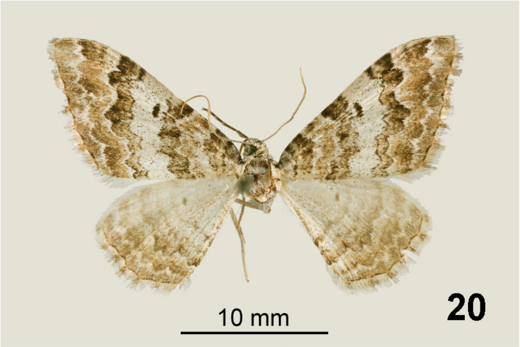


**FIGURES 1–9.** *Catarhoe narynensis* **sp. nov.**, adult. 1–6—moths, spread: 1—holotype, male, 22-23.04.2023, Kyrgyzstan, 15 km NW of Kazarman village, Naryn River valley; 2–6—paratypes, same locality and date (2—male, 3—female, 4—female, 5—same female underside, 6—female); 7, 8—moths in nature, same locality and date, both, probably, females; 9—wing venation, male.

Wing venation (Fig. 9). Forewing with two radial accessory areoles, proximal one three times shorter than distal one, distal one long, reaching the base of Rs4, vein dividing areoles very short. Discal cell open, discal vein widely interrupted posterior to the base of vein M2. Sc distant from C, R1 rising from the distal end of the distal areole, Rs1 from stalked Rs2+Rs3 two times closer to R1 than to the fork of Rs2 and Rs3, Rs3 approximately as long as stalked



**FIGURES 10–19.** *Catarhoe narynensis* **sp. nov.**, male and female genitalia, paratypes. 10—male genitalia, total ventral view with the spread coremata placed between the 8-th abdominal segment and the genitalia; 11—male genitalia, ventral view, phallus removed; 12—male genitalia, lateral view; 13—anellus with manica and labides, dorsal view; 14—phallus with manica, lateral view; 15—phallus with manica and vesica everted, lateral view; 16—phallus with manica, vesica everted, caulis and juxta (a), lateral view; 17—phallus with manica and vesica everted, dorsal view (a—dorsal spines on manica, b—lateral groups of spines on manica); 18—female genitalia, dorsal view; 19—female genitalia, ventral view. FIGURES 11–17 in the same scale.



20

Памир. Пяндж, Ко-
лаи Хумб, 1500 м
29.6.75. Загуляев

Paratypus Catarhoe
arachne ssp.
hissarica Vid.

ZISP
INS_LEP_0001373

21

22

**FIGURES 20–22.** *Catarhoe arachne hissarica* Viidalepp, 1988, paratype (ZISP). 20—moth; 21—labels; 22—female genitalia, ventral view.

Rs2+Rs3 and reaching to the apex of the wing, Rs4 rising from near the distal end of the distal areole. M1 rising from Rs stalk near the discal cell, M2 from anterior portion of the discal vein, M3 from posterior angle of the discal cell. CuA1 rising from discal cell near its posterior angle, CuA2 from posterior vein of discal cell approximately at ¾ of its length. CuP plica not expressed, 1A+2A common. Hindwing with discal cell closed. Sc+R1 rising from 4/5 of the length of the discal cell. Rs and M1 on long stalk (distance between discal vein—Rs significantly greater than distance between Sc+R1—discal vein). Discal vein broken at branching point of M2. M3 and CuA1 rising from posterior angle of discal cell close to each other. CuA2 rising from posterior vein of discal cell approximately at ¾ of its length. CuP plica not expressed, 1A+2A going to tornus, 3A lacking.

Legs. Fore tibia more than two times shorter than middle and hind tibiae, equipped with epiphysis a little bit too short of reach apex of tibia. Middle tibia with pair of unequal spurs (0.3 mm and 0.5 mm long) at the apex. Hind tibia (2.8 mm long) with two pairs of unequal spurs (0.3 mm and 0.5 mm long) on the apical part.

Male genitalia (Figs 10–17). Size of the male genitalia (valva length along dorsal edge without distal process of the costa 1.2 mm.) approximately coinciding with the characteristic size of the genitalia of *Catarhoe* spp. with similar wingspan. Tegumen very narrow, almost same as lateral arms of vinculum, without dorsal sagittal rib. Vinculum narrow, antero-ventrally with long cylindrical saccus rounded on apex. Between vinculum and 8th segment pair of very long conical coremata, swollen in basal half, 2.5 times longer than valva. Uncus 0.8 mm long, thin, curved, slightly flattened laterally, pointed. Gnathos and socii lacking. Subanal plate distinct, long. Valva oblong (4 times longer than its width in middle part), with strongly sclerotised costal sclerite (costa), curved medially and ending in free flattened apical process with rounded apex. Costa mediodorsally with small dilation at the level of apex of valvula, on middle part from about 1/3 of its length to the base of distal process dorsally and medially covered with randomly scattered small spines. Valvula thin, translucent. Sacculus present in the form of narrow, ridge-shaped, weakly sclerotised dilation of the ventro-lateral edge of valva. Anellus in form of dense manica, dorsally covered with short spines, passing onto its internal fold, laterally with two dense groups of 8–10 longer (0.1–0.15 mm) spines located on the internal fold of manica. Two sclerotised papilla-shaped processes with tuft of moderately long bristles at top (labides) on anellar membrane laterad of phallus. Juxta with short plate-like basal portion connecting dorso-medial angles of valvular sacculi, and with dorso-posterior long spatulate process, covered with rigid long hair-like setae in distal half. Two closely spaced elongated elliptical sclerites present dorsal to the juxta. According to the criteria of position and connections—between the juxta plate and the papillary setaceous processes of the anellus—these sclerites are homologous to the “rod-shaped sclerites” of Xanthorhoini and Epirrhoini (the term

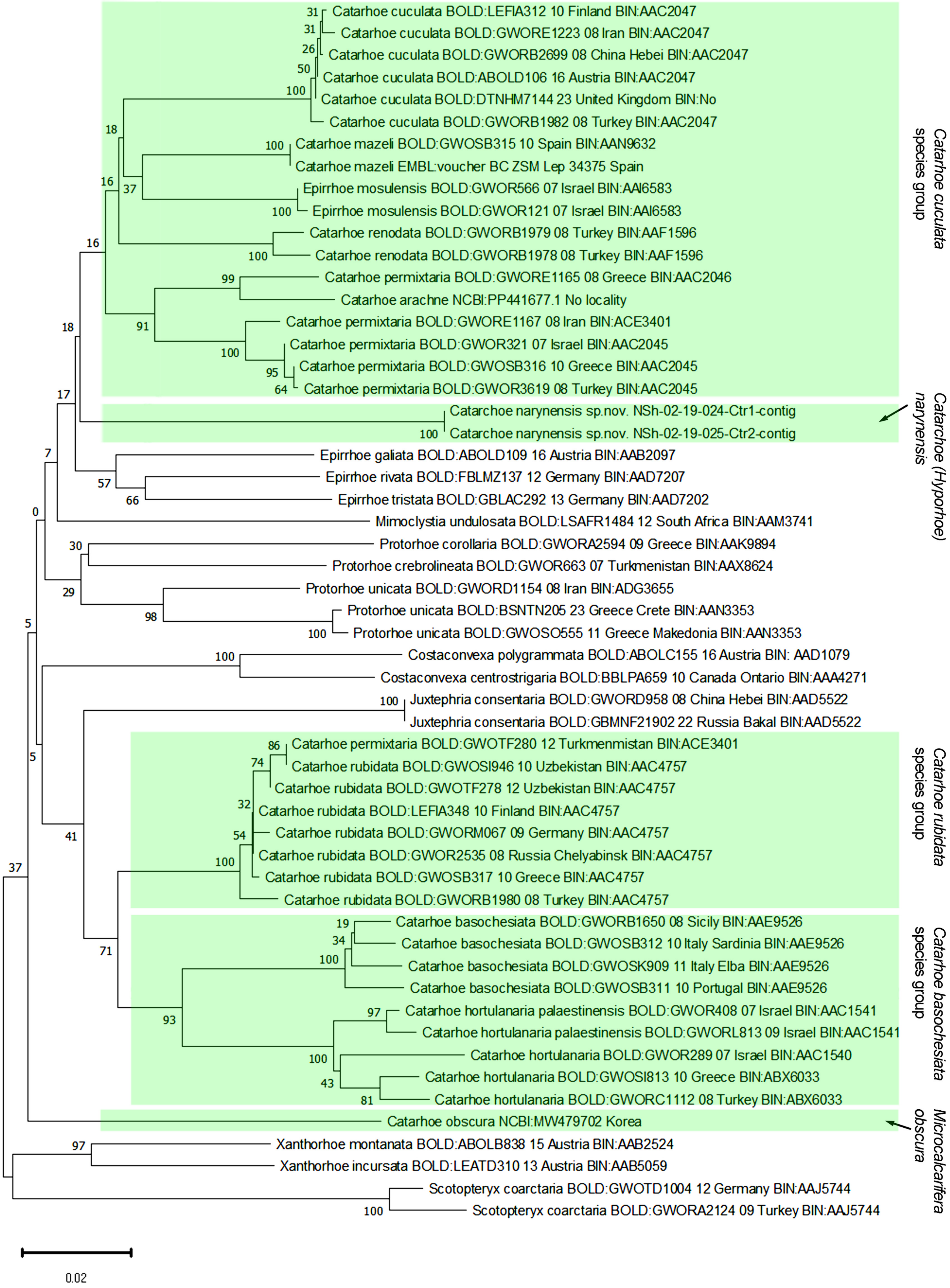


**FIGURE 23.** Neighbor-joining optimal tree of selected *Catarhoe*, *Costaconvexa*, *Epirrhoe*, *Juxtephria*, *Mimoclystia*, *Protorhoe*, *Scotopteryx* and *Xanthorhoe* samples based on *COI* 5' sequences (built with MEGA 11; Kimura 2-parameter model; bootstrap value, 1000 replications).

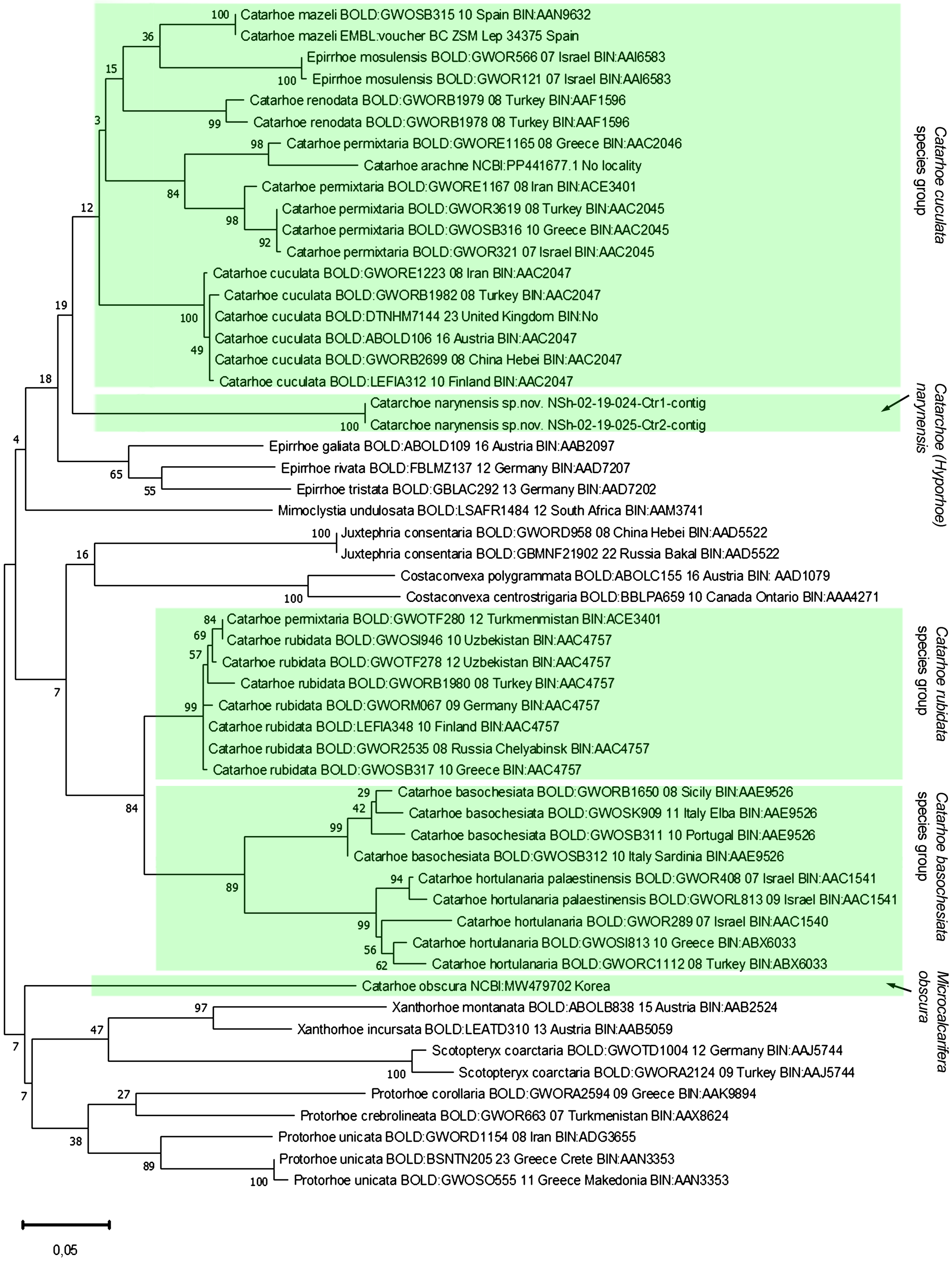


**FIGURE 24**. Maximum likelihood tree of selected *Catarhoe*, *Costaconvexa*, *Epirrhoe*, *Juxtephria*, *Mimoclystia*, *Protorhoe*, *Scotopteryx* and *Xanthorhoe* samples based on *COI* 5' sequences (built with MEGA 11; Tamura-Nei model; bootstrap value, 1000 replications).

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**FIGURES 25–26.** Collecting sites and biotope of *Catarhoe narynensis* **sp. nov.** 24—map of collecting sites in Kyrgyzstan. 25—biotope in one of the collecting sites—lower part of the bushy slope of the eastern exposure in the Naryn River valley, 15 km NW of Kazarman village, 1220 m a.s.l., 22.04.2023.

proposed by Schmidt 2013: 554). Phallus. Aedeagus (sclerotised tube of phallus) about 1.7 mm long and 0.3 mm in diameter, cylindrical, almost straight, anteriorly with large basal process about 1/4 of length of aedeagus, posteriorly closely connected with manica (during the genitalia dissection, phallus is isolated together with internal fold of the manica, bearing dorsal and lateral spines). Everted vesica about 1 mm long and up to 0.5 mm wide, with several asymmetrical swellings on sides and two small appendices in apical portion, with numerous dispersed small spines, and with sclerotised flat cornutus of irregular shape with several small spines in middle.

Female genitalia (Figs 18, 19). Relatively large, about 5 mm in total length. Papillae anales oval. Posterior apophyses 2.5 times longer than anterior apophyses. Antrum sclerotised, weakly conical, very large relative to corpus bursae, anteriorly passing into short and wide membranous portion of ductus bursae, ending in oblique annular sclerite of irregular shape. Dorsal wall of the membranous part of ductus bursae with longitudinal elongated field of small spines, passing into annular sclerite. Corpus bursae membranous, oval, in posterior half with small spot-like sclerotised signum, composed of small spines and larger short spine in the center of plate. Ductus seminalis departing from mammillary protrusion on right side of base of corpus bursae.

**Distribution. Kyrgyzstan:** west of Jalal-Abad Region. The new species is known so far only from two sites in the lower part of the Naryn River basin (Fig. 25).

It is probably one of the endemics of the Fergana—Naryn mountain-steppe region, which is characterised by significant floristic endemism and has the rank of a subprovince in botanical geography (Rachkovskaya *et al.* 2003). A number of Lepidoptera species are known from here, the modern distribution of which does not extend beyond the Naryn River basin, the Fergana valley and the southern slopes of the Chatkal range, for example *Parnassius davydovi* Churkin from Papilionidae, *Melitaea acreina* Staudinger from Nymphalidae, *Neolycaena olga* Lukhtanov and *Neolycaena zhdankoi* Churkin from Lycaenidae, *Thargelia orbona* (Bang-Haas) and *Sartha mirabilis* (Staudinger) from Noctuidae, *Rhodostrophia lanceolata* Kaila & Viidalepp from Geometridae, *Hyperlais orodruinella* Korb, Gorbunov & Melyakh from Pyralidae, and *Zolotuhia paradoxa* Beljaev, Gorbunov & Korb from Lasiocampidae.

**Ecological notes.** All individuals were caught at night in a light trap in the third ten-day period of April in the Naryn River valley and in the Dyungereme River valley (a tributary of the Kekemeren River), in petrophyte-steppe habitats at altitudes of 1200–1500 m above sea level (Fig. 26). In the Naryn River valley the trap was located in the lower part of a rocky slope with an eastern exposure, quite densely overgrown with shrubs (*Spiraea hypericifolia* L., *Berberis sphaerocarpa* Kar. & Kir., *Berberis nummularia* Bunge, *Prunus prostrata* Labill., *Ephedra intermedia* Schrenk & C.A.Mey., *Zygophyllum atriplicoides* Fisch. & C.A.Mey., *Rhamnus songorica* Gontsch., *Caragana leucophloea* Pojark., *Cotoneaster* sp., *Rosa* sp.) and dwarf shrubs (*Helianthemum songaricum* Schrenk, *Ephedra fedtschenkoae* Paulsen). In spring (during the flight of the imago), the herbaceous plants *Tulipa toktogulica* B.D.Wilson & Lazkov, *Tulipa tetraphylla* Regel, *Allium galanthum* Kar. & Kir., *Artemisia* sp. were observed. In the summer, *Krascheninnikovia ceratoides* (L.), *Krascheninnikovia ewersmanniana* (Stschegl. ex Losinsk.) Grubov, *Glycyrrhiza shiheziensis* X.Y.Li, and *Sophora alopecuroides* L. grew abundantly here.

In 2023, the moths of *Catarhoe narynensis*, **sp. nov.** were observed during the final ten-day period of April and the beginning of May. In 2024, in the Dungereme River valley during the second ten-day period of April this species was not observed, possibly, because it was too early for the moths to emergence.

**Etymology.** The name *narynensis* is derived from the location where a new species was discovered—Naryn River valley.

## Discussion

In appearance, the moths of the new species resemble geometrids of the genus *Xanthorhoe* from the group (or subgenus) *Odontorhoe* Aubert, 1962 by having a pinkish tint to the colour of the wings and relatively weakly sinuous, slightly blurred transverse lines on the wings. However, the males of the new species do not have bipectinate antennae, and both males and females have a different structure of the genitalia. The wings and genitalia of this species combine features of two related genera, *Catarhoe* and *Protorhoe*, without demonstrating obvious similarity with either of them. As a result, the generic affiliation of the new species is challenging to ascertain.

The genus *Protorhoe* has recently been revised (Rajaei *et al*. 2017), and we will not discuss its composition. In contrast, the genus *Catarhoe* has not been revised to date, and thus, its current species composition will be subjected to a review.

According to the portal "An online taxonomic facility of Geometridae" (Rajaei *et al*. 2022), the genus *Catarhoe* comprises 17 species. Among the species listed in the database, "*Catarhoe tadzhikaria* (Shchetkin, 1956)" and "*Catarhoe turkmenaria* (Shchetkin, 1956)" are currently associated with the genus *Protorhoe* (Viidalepp 1996; Hausmann & Viidalepp 2012; Rajaei *et al*. 2017), and "*Catarhoe semnana* Wiltshire, 1970" is synonymised with *Catarhoe arachne* Wiltshire, 1967 (Rajaei *et al*. 2023). The taxonomic status of "*Catarhoe fecunda* (Swinhoe, 1891)" is controversial. Swinhoe (1891) referred to this name in the genus *Cidaria* Treitschke, 1825 as a species.

The first reviser, Prout (1939: 280), considered *fecunda* as subspecies of *Catarhoe obscura* (Butler, 1878), noting that it is “extremely variable, perhaps almost a synonym of *o[bscura]. obscura*”. The consideration of *fecunda* as a subspecies of *obscura* was accepted by subsequent authors (Chang 1989; Inoue 1992; Yazaki 1992; Wang 1997). Moreover, the last of the cited authors published a photograph of the holotype from India in comparison with a moth from Japan. However, in the “Geometrid Moths of the World” (Scoble 1999: 599) the name *fecunda* was listed as a species, which is now widely accepted in various internet sources. As the last decision has never been motivated, we follow Prout (*loc. cit.*) in consideration of the taxonomic status of *fecunda* as a subspecies of *Catarhoe obscura*.

Thus, the genus currently contains 13 valid species.

Descriptions and images of the external structures and genitalia of moths of the genus *Catarhoe*, used in the analysis of the systematic position of the new species, are accessible in the following publications:

*Catarhoe arachne* Wiltshire, 1967, in: Wiltshire (1967: 152, pl. 1: fig. 8, pl. 12: fig. 44—moth and male genitalia; 1970: 378, pl. 2: fig. 10, text fig. 5—as *Catarhoe semnana* Wiltshire, 1970; pl. 3: fig. 1, text fig. 6—moths, male and female genitalia); Viidalepp (1988: 79, pl. 6: fig. 4—moth, as *Catarhoe arachne hissarica* Viidalepp, 1988); ? Viidalepp (2011: fig. 142—male genitalia); ? Kemal *et al*. (2020: 2, figs 2, 3, 5, 7) (moths, male and female genitalia, as *Catarhoe semnana*); present article, Figs 20, 21—moth, female paratype, 22—the female genitalia.

*Catarhoe basochesiata* (Duponchel, 1831), in: Hausmann & Viidalepp (2012: 126, figs 53—moths, male and female genitalia).

*Catarhoe cuculata* (Hufnagel, 1767), in: Xue & Zhu (1999: 602, pl. 17: 2, text figs 716, 717—moth, wing venation, male genitalia, as *Catarhoe cuculata undulosa* (Warnecke, 1934); Hausmann & Viidalepp (2012: 132, figs 57—moths, male and female genitalia).

*Catarhoe hortulanaria* (Staudinger, 1879), in: Hausmann & Viidalepp (2012: 124, fig. 52—moths, male and female genitalia).

*Catarhoe mazeli* Viidalepp, 2008, in: Viidalepp (2008: 43, figs 1, 3, 5, 7, 8—moths, male and female genitalia); Hausmann & Viidalepp (2012: 129, figs 55—moths, male and female genitalia).

*Catarhoe mosulensis* (Schawerda, 1924), in: Schawerda (1923: 160, pl.: fig. 7—moth, as *Cidaria mosulensis*); Hausmann (1991: 130, pl. 13: fig. 125, pl. 4: figs 34, 35—moth, male and female genitalia); Kemal & Koçak (2017: 5, figs 3, 5—moth, male genitalia).

*Catarhoe nyctichroa* (Hampson, 1912), in: Hampson (1912: 1245, pl. G: fig. 15—moth, as *Cidaria nyctichroa*); Prout (1939: 280, fig. 27k—moth, as *Euphyia nyctichroa*).

*Catarhoe obscura* (Butler, 1878), in: Wang (1997: 257—moths, as *Microcalcarifera obscura*, also a photo of the holotype of *Cidaria fecunda* Swinhoe, 1891); Xue & Zhu (1999: 571, pl. 16: 9, text figs 673, 674, 675—moth, wing venation, male and female genitalia, as *Microcalcarifera obscura obscura*); Choi (2002: 221, figs 30, 44, 49—male and female genitalia; 2012: 17, figs 5, 87, 167, 245—moths, male and female genitalia).

*Catarhoe permixtaria* (Herrich-Schäffer, 1856), in: Hausmann & Viidalepp (2012: 130, figs 56—moths, male and female genitalia); Kemal *et al*. (2020: 3, figs 4, 8—moth, female genitalia).

*Catarhoe putridaria* (Herrich-Schäffer, 1852), in: Viidalepp (2008: 43, figs 2, 6, 9, 10—moth, male and female genitalia); Hausmann & Viidalepp (2012: 127, fig. 54—moths, male and female genitalia).

*Catarhoe renodata* (Püngeler, 1909), in: Püngeler (1909: 300, pl. 4: fig. 25—moth, as *Larentia renodata*); Wiltshire (1970: 377, pl. 2: figs 11, 12, text fig. 4—moths, male and female genitalia).

*Catarhoe rubidata* (Denis & Schiffermüller, 1775), in: Hausmann & Viidalepp (2012: 133, figs 58—moths, male and female genitalia).

*Catarhoe yokohamae* (Butler, 1881), in: Xue & Zhu (1999: 602, pl. 17: 1, text figs 718, 719—moth, male and female genitalia); Choi (2002: 221, figs 3, 29, 43, 48; 2012: 16, figs 4, 86, 166, 244—moth, male and female genitalia).

Thus, the illustrations of the male and female genitalia have been published for all species of the genus, except for the Indian *Catarhoe nyctichroa*, which differs greatly in size and wing pattern from the newly described species. Two comments should be made regarding the species of the genus presented above.

1. The photo of the male genitalia of “*Catarhoe arachne* Wiltshire (Tadjikistan)” (Viidalepp 2011) differs from the images of the male genitalia of *Catarhoe arachne* and *Catarhoe semnana* in Wiltshire (1967, 1970) by the presence of a spine on the costa of valva (similar to that in *Catarhoe putridaria* and *Catarhoe mazeli*). This feature raises the question of whether *Catarhoe arachne* sensu Viidalepp actually belongs to this species. Possibly, *Catarhoe arachne* sensu Viidalepp is a male of *Catarhoe arachne hissarica*, described from Tajikistan based on

two females (Viidalepp 1988). The female genitalia of the paratype of *Catarhoe arachne hissarica* (Figs 20–22) has significantly longer posterior processes on the antrum than those depicted for *Catarhoe arachne* and *Catarhoe semnana* by Wiltshire (1967). It is possible that *Catarhoe arachne hissarica* represents an independent species, but further material, including the examination of the holotype, is needed to resolve this issue.

2. The genitalia and appearance of the moths published by Kemal *et al*. (2020) as "*Catarhoe semnana*" differ greatly from the original descriptions of *Catarhoe arachne* and *Catarhoe semnana*, and may represent an undescribed species.

Compared to the moths from the genera *Protorhoe* and *Catarhoe*, the new species has a specific set of morphological characters, partly unique, partly common with representatives of both genera. The wing venation of the new species is generally consistent with the characteristics observed in geometrids belonging to the tribes Xanthorhoini and Epirrhoini. It is most similar to the wing venation of the genus *Protorhoe* (see Rajaei *et al*. 2017) in that the proximal areole on the forewing is significantly shorter than the distal one. However, vein A2 of the hindwings, which is characteristic for *Protorhoe* and *Catarhoe*, is absent.

In certain characteristics of the male genitalia, the new species also resembles *Protorhoe*, having a long finger-like distal process of the costa of valva with a rounded, non-pointed apex and the absence of needle-like cornuti on the vesica of the phallus. However, in contrast to the species of the genus *Protorhoe*, the male of the new species has a thin uncus, which is not expanded distally, narrow base of the valvular sacculi, a non-tongue-shaped but spoon-shaped calcar on a thin long stalk, articulated with the valvular sacculi by means of a short transverse bar-like juxta. Furthermore, the new species lacks a "transverse connection of the tegumen" (vestigial gnathos: Schmidt 2015), which is well-defined in *Protorhoe* (Rajaei *et al*. 2017). The fold of the anellus, which is situated in a comparable position, is not sclerotised. These genital features are shared by the new species and the majority of representatives of the genus *Catarhoe*.

The female genitalia of the new species have a structure typical of most *Catarhoe*, possessing a wide and extended antrum (sclerotised posterior part of the ductus bursae), which in most *Catarhoe* is probably formed by the fusion of the antrum proper and colliculum (terms follow Scoble 1995, and Hausmann 2001) and a nearly flat signum with a weakly expressed central spine. These features are not characteristic to *Protorhoe*, in which the antrum and colliculum are clearly separated by a narrow membranous constriction, and the signum is in the form of a long, sharp spine. However, in the presence of cylindrical antennae in males, numerous spines on the costa of the valva, and the absence of cornuti on the vesica, the new species differs from both *Protorhoe* and *Catarhoe*. The latter two genera have a dorsoventrally flattened flagellum (Hausmann, Viidalepp 2012) and a costa with a single spine or the absence of spines altogether. Thus, the new species displays a combination of characteristics from both *Protorhoe* and *Catarhoe*, but it can be assigned to the latter genus on the basis of most of their similarities, particularly in the female genitalia morphology. However, within this genus it has no clear morphological relationships with any other species.

Within the genus *Catarhoe*, several morphological groups of species can be identified (the analysis does not include *Catarhoe nyctichroa*, whose genitalia morphology has not been described in the literature and is unknown to the authors).

1. *Catarhoe basochesiata* species group includes the type species of the genus, *Catarhoe basochesiata*, and *Catarhoe hortulanaria*. Males have a sharp spine-like process in the middle part of the costa, numerous large cornuti on the vesica, and females have fused sclerotised elements of the almost straight tubular ductus bursae, broad sclerotisation of the base of the corpus bursae, and minute spine-shaped signum.

2. *Catarhoe rubidata* species group includes only one species. It differs greatly from other members of the genus in the details of the structure of the male and female genitalia. Males of this species have a well-developed "transverse connection of the tegumen" (sensu Rajaei *et al*. 2017), a short calcar extending from the apex of the two-horned juxta noticeably dorsal to the sacculi of the valvae, a humped valva without dorsal spine, and a wide, short saccus, which are not characteristic of most other species of the genus. The genitalia of females of *Catarhoe rubidata*, with a distinctly bipartite antrum and a longitudinal position of the strongly elongated sclerites at the base of the corpus bursae, morphologically correspond to those in the genus *Epirrhoe*, and not to the genitalia of females of other species of the genus *Catarhoe*.

3. *Catarhoe cuculata* species group. The most extensive group of the genus includes 8 species, the males of which have a (probably autapomorphic) ventro-distal comb-shaped expansion of the medial wall of the costa of the valva. Additionally, males differ from the *Catarhoe basochesiata* species group by having small cornuti

on the vesica, and females—by the presence of a membranous portion of ductus bursae between the antrum and sclerotisation at the base of the corpus bursae, and in a comparatively large lamellar signum.

This group can be divided into 2 subgroups:

3a. *Catarhoe cuculata* species subgroup. Includes two closely related species: *Catarhoe cuculata* and *Catarhoe yokohamae*. Unlike other *Catarhoe* spp., males of this subgroup have a distinctly curved aedeagus and, similar to species from the *Catarhoe basochesiata* species group, a short saccus on vinculum and a short calcar, and females have extensive wrinkled sclerotisation in the area of the base of the corpus bursae.

3b. *Catarhoe putridaria* species subgroup. Males have a calcar with a long peduncle and a long saccus, and females have an oblique "U-shaped sclerite" (Viidalepp 2008) in the area of the base of the corpus bursae. The subgroup includes *Catarhoe putridaria*, *Catarhoe permixtaria*, *Catarhoe renodata*, *Catarhoe arachne*, and *Catarhoe mazeli*. *Catarhoe mosulensis* can also be classified in this subgroup based on most of the genital features, although the ventro-distal expansion of the costa in it is rudimentary.

4. *Catarhoe narynensis* species group includes a single newly described species. Within the genus, the unique features of the species in the wing venation are the minute proximal accessory cell on the forewing and the absence of vein 2A on the hindwing, in the male genitalia—costa with dorsal scobination and rounded apex, the absence of needle-like cornuti on the vesica, and in females—a strictly transverse ring of sclerotisation ductus bursae at the base of the corpus bursae.

5. *Catarhoe obscura* species group includes the single South and East Asian species morphologically most divergent in the genus. Its males differ from other *Catarhoe* spp. by wide valvae, large labides, the presence of a sclerotised "transverse connection of the tegumen" (as in *Protorhoe*) and a tongue-like calcar similar to that in the genera *Epirrhoe* and *Protorhoe*, and females—by the presence of a narrow membranous constriction between the antrum and colliculum (as in *Protorhoe*), and a unique large signum with a longitudinal median rib.

Thereby, the genus *Catarhoe* does not appear to be homogeneous within the present assemblage of species, as previously noted by Viidalepp (2008). If for the genus *Protorhoe* a distinct (probably autapomorphic) diagnostic character was proposed—the presence of a signum in the shape of a conical, stout spine on the corpus bursae (Rajaei *et al*. 2017), then for the entire genus *Catarhoe* no autapomorphies have been detected, and the mosaic distribution of morphological characters in this genus precludes the construction of a distinct hierarchy of probable synapomorphies.

In the molecular-phylogenetic COI analysis, the obtained NJ and ML trees (Figs 23, 24) are similar to each other in the branching pattern and in the bootstrap value except for some basal nodes with a negligible bootstrap value, which do not disturb the composition and position of the most clusters. Therefore, they will be discussed together.

On both trees, most species of the genus *Catarhoe* are located in two separate clusters. One cluster encompasses species from two morphological groups: the *Catarhoe basochesiata* species group and the *Catarhoe rubidata* species group. The sister relationship between these groups is supported by a moderate bootstrap value (70% on the NJ tree and 84% on the ML tree). The second cluster consists of the cluster with *Catarhoe cuculata* species group (including both its subgroups), and the sister branch with *Catarhoe narynensis*. However, the basal node of this cluster has low bootstrap support (much less than 50% on both trees). This suggests significant genetic divergence in the second group for this mitochondrial gene, resulting in the loss of a distinct phylogenetic signal. However, this cluster is stable in its species composition and general branching pattern in all NJ analyses with different nucleotide substitution models.

These two clusters of the genus *Catarhoe* are separated by branches of other genera, which on the NJ tree arranged in the sequence (((*Epirrhoe*) *Mimoclystia*) *Protorhoe*) (*Costaconvexa* (*Juxtephria*)), and on the ML tree in the sequence ((*Epirrhoe*) *Mimoclystia*) (*Juxtephria* + *Costaconvexa*). In comparison with the NJ tree, the ML tree dropped the *Protorhoe* cluster (which joined *Xanthorhoe* and *Scotopteryx*), and *Juxtephria* and *Costaconvexa* formed a common cluster. However, all nodes of these clusters possess a negligible bootstrap value (much less than 50%) on both trees, except the cluster *Juxtephria* (*Catarhoe rubidata* + *Catarhoe basochesiata* species groups) on the NJ tree, whose bootstrap value reaches 42%. This value is comparable with that for the clusters of the genera *Epirrhoe* (57% on the NJ tree and 65% on the ML tree) and *Protorhoe* (30% on the NJ tree and 38% on the ML tree)—morphologically clearly defined, probably monophyletic genera.

The clade with *Catarhoe obscura* is distant from the rest species of the genus on both trees. On the NJ tree it is placed basal to the cluster containing the rest of the *Catarhoe* spp. along with *Epirrhoe*, *Mimoclystia*, *Protorhoe*, *Costaconvexa*, and *Juxtephria*. On the ML tree, *Catarhoe obscura* is clustered as a sister clade to the cluster united *Protorhoe*, *Xanthorhoe*, and *Scotopteryx*. However, on both trees the bootstrap value of this clustering is negligible.

The genetic pairwise distances of species between the *Catarhoe cuculata* species group and (*Catarhoe rubidata* + *Catarhoe basochesiata* species groups) clusters are in the range of 8.3–12.2%. *Catarhoe narynensis* has distances with species from *Catarhoe cuculata* species group of 9.3–11.6%, with species from the cluster (*Catarhoe rubidata* + *Catarhoe basochesiata* species groups) of 10.8–13.6%, with species from the genera *Epirrhoe*, *Protorhoe*, *Mimoclystia*, *Juxtephria* and *Costaconvexa* of 10.8–14.9%, with *Xanthorhoe* spp. of 12.9–14.4%, and with *Scotopteryx* sp. of 16.6–17.4%. In *Catarhoe obscura*, the distances with the *Catarhoe cuculata* species group are 9.7–12.4%, with species from the cluster (*Catarhoe rubidata* + *Catarhoe basochesiata* species groups)—10.8–13.8%, with species from the genera *Epirrhoe*, *Protorhoe*, *Mimoclystia*, *Juxtephria* and *Costaconvexa*—10.5–13.6%, with *Xanthorhoe* spp.—11.8–12.0%, with *Scotopteryx* sp.—14.9–15.2%.

Species of the genus *Epirrhoe* have distances with species of *Catarhoe cuculata* species group of 7.6–9.9%, with samples of *Catarhoe rubidata* of 9.0–10.7%, with species from *Catarhoe basochesiata* species group of 11.8–14.6%, with *Catarhoe narynensis* of 10.8–11.6%, with *Catarhoe obscura* of 10.5–12.3%, with the rest Epirrhoini (*Mimoclystia*, *Juxtephria*, *Costaconvexa* and *Protorhoe*) of 9.4–13.3%, with *Xanthorhoe* spp. –9.3–12.3%, and with *Scotopteryx* sp.—14.6–15.7%.

Species of the genus *Protorhoe* have distances with species of *Catarhoe cuculata* species group of 9.1–11.7%, with samples of *Catarhoe rubidata* of 9.6–11.9%, with species from *Catarhoe basochesiata* species group of 11.8–14.6%, with *Catarhoe narynensis* of 11.8–13.9%, with *Catarhoe obscura* of 10.9–12.5%, with the rest Epirrhoini (*Epirrhoe*, *Mimoclystia*, *Juxtephria* and *Costaconvexa*) of 9.4–13.9%, with *Xanthorhoe* spp.—10.0–13.1%, and with *Scotopteryx* sp.—13.7–15.6%.

P-distances between species selected according to the criterion of maximum morphological diversity in the genus *Epirrhoe* were 6.7–7.6%, and between species of the genus *Protorhoe*—8.6–10.3%.

Species of the genus *Xanthorhoe* have distances with species of *Catarhoe* in the range of 9.3–15.5%, with species of *Protorhoe*—10.0–13.1%, with species of *Epirrhoe*—9.3–12.3%, with *Juxtephria* sp.—11.5–12.3%, with *Costaconvexa* spp.—12.2–13.5%, and with *Scotopteryx* sp.—12.0–13.1%.

Thus, the clustering of species of *Catarhoe* on the obtained trees generally coincides with the proposed morphological species groups of this genus, although most basal branches have very low support by bootstrap value. Nevertheless, the clustering pattern of the obtained trees remains stable under different models of nucleotide substitutions and under different models of tree construction.

Based on the barcoding fragment COI, the genetic distances between species from the two large *Catarhoe* spp. clusters (excluding *Catarhoe narynensis* and *Catarhoe obscura*) are comparable to intergeneric distances within the tribe Epirrhoini. The negligible bootstrap value of basal nodes in both trees is likely explained by the high genetic saturation of this DNA fragment at this divergence level of the analysed taxa. The high saturation can lead to a long branch attraction effect, resulting in the co-clustering of *Xanthorhoe* and *Scotopteryx* in the NJ tree, and the co-clustering of *Protorhoe*, *Xanthorhoe* and *Scotopteryx* in the ML tree. In the phylogeny of larenthiines based on multigene analyses of the nuclear data, the genus *Scotopteryx* is clustered significantly basal to Xanthorhoini and Epirrhoini (Brehm *et al.* 2019; Õunap *et al.* 2024).

It should be mentioned that in Õunap *et al.* (2024) the *Catarhoe* cluster consists of two species, *Catarhoe rubidata* and *Catarhoe cuculata*, which represent both large clusters of this genus in our *COI* trees. The support values of this cluster are moderately high (72.8% of SH-like and 79% of UFBoot values) and are comparable with the support of its sister cluster (*Costaconvexa* + *Epirrhoe*) (74.3% of SH-like and 72% of UFBoot values). These data also indirectly support the hypothesis of taxonomic heterogeneity of *Catarhoe* in the current species composition. Regarding the problem of morphological similarity of the female genitalia of *Catarhoe rubidata* with those of the genus *Epirrhoe*, both our COI data and the multigene data of Õunap *et al.* (2024) do not support the possibility of a monophyly of this species with the latter genus. Probably, the noted similarity is a homoplasy or symplesiomorphy.

Overall, the obtained data allow us to speak about a high degree of genetic diversification in the genus *Catarhoe* according to the barcode COI DNA fragment, and about the isolation of the two main clusters of the genus, *Catarhoe narynensis* and *Catarhoe obscura*, at the level of differences between the generally accepted genera of Epirrhoini.

However, the minimum genetic distance between the clusters of *Catarhoe cuculata* species group and (*Catarhoe rubidata* + *Catarhoe basochesiata* species groups) is only 8.3% (between one sample of *Catarhoe rubidata* and one sample of *Catarhoe cuculata*) and is identical to the minimum genetic distance within the second cluster (8.3% between one sample of *Catarhoe rubidata* and one sample of *Catarhoe hortulanaria*), which is lower than any intergeneric distances in the analysed sample of taxa. Moreover, the range of p-distances between these two *Catarhoe* clusters (8.3–12.2%) are close to those between the species of the genus *Protorhoe* (8.6–10.3%). Therefore, the hypothesis of paraphyly of the main composition of the genus *Catarhoe* cannot be considered sufficiently substantiated, and we do not offer any taxonomic solutions for these two clusters here.

For the remaining two species of the genus *Catarhoe* we propose the following taxonomic solutions. For *Catarhoe narynensis* we propose an independent subgenus within the genus *Catarhoe*: *Catarhoe* (*Hyporhoe* **subgen. nov.**) *narynensis* **sp. nov.**, as described above. This solution is made considering the level of morphological differences from other species of the genus *Catarhoe*, the stable clustering as a sister branch to the *Catarhoe cuculata* species group, and the genetic distances to other species of the genus *Catarhoe* located within the range of distances between the clusters of *Catarhoe cuculata* species group and (*Catarhoe rubidata* + *Catarhoe basochesiata* species groups).

For *Catarhoe obscura* we propose to restore the name *Microcalcarifera* from the synonym of *Catarhoe* as a valid genus: *Microcalcarifera* Inoue, 1982, **stat. rev.** This decision was made due to the significant morphological differences of the type species of the genus from other representatives of the genus *Catarhoe*, its stable clustering by the barcode COI fragment outside the rest of *Catarhoe*, and also due to the significant genetic distances between this species and the rest *Catarhoe* spp., close to those with the genera *Epirrhoe*, *Protorhoe*, *Mimoclystia*, *Juxtephria* and *Costaconvexa*.

The genus *Microcalcarifera* was described based on the single species *Cidaria obscura* (Butler, 1878), which was historically also associated with the genera *Coenotephria* Prout, 1914 (Prout 1914; Inoue, 1957, 1977) and *Euphyia* Hübner, 1825 (Prout, 1939). Relatively recently, Choi (2002) synonymised *Microcalcarifera* with *Catarhoe* based on comparison with *Catarhoe basochesiata*, the type species of the genus *Catarhoe*, without taking into account the morphological diversity in this genus and its relatives.

Currently, the synonymous list of the genus *Microcalcarifera* is as follows:

*Microcalcarifera* Inoue, 1982: 475.

Type species: *Cidaria obscura* Butler, 1878

*Microcalcarifera obscura* (Butler, 1878: 450) (*Cidaria*), **comb. rev.** T.l.: Japan, Yokohama.

= *Cidaria butleri* Leech, 1897: 644. Unnecessary replacement name to *Cidaria obscura* Butler, 1878.

Note. Leech (1897: 644) introduced the name *butleri* in the remark to "*Cidaria obscura*": "As Moore described a *Cidaria obscurata* in 1867, it would be better perhaps to rename this species *Butleri*". So, this name based on the same holotype, as *Cidaria obscura*, and is the objective junior synonym of the name *Cidaria obscura* (ICZN 1999: article 72.7). So, the consideration of the name *Cidaria butleri* as subjective synonym of *Cidaria obscura* with its own types and type locality "Yokohama; Western China, Moupin" (Scoble 1999; Xue & Zhu 1999) are incorrect.

= †*Cidaria (Coenotephria) obscura* ab. *subobscura* Prout, 1914: 252, pl. 11: f. Unavailable name.

*Microcalcarifera obscura fecunda* (Swinhoe, 1891) (*Cidaria*), **comb. rev.** T.l.: [India, Meghalaya], "Khasia Hills".

*Microcalcarifera obscura multilinea* (Hampson, 1891: 31, 120, pl. 152, fig. 2) (*Anticlea*)**, comb. rev.** T.l.: [India, Tamil Nadu], Nilgiri district, the plateau, 6700 ft.

= *Cidaria multilineata* Hampson, 1891: 31, 121, pl. 153, fig. 8. T.l.: [India, Tamil Nadu], Nilgiri district, S slopes, 3000 ft.

## Conclusion

In Kyrgyzstan in 2023, a new species of geometrid moth from the subfamily Larentiinae was discovered. A unique set of morphological features in the male genitalia and wing venation made it difficult to determine its generic association. Based on the female genitalia morphology and phylogenetic analysis of the mitochondrial DNA barcode fragment COI, this species was assigned to the genus *Catarhoe*, and based on the unique morphology of the male genitalia, wing venation, and the presence of large genetic distances with congeneric species, it was separated into a new monotypic subgenus: *Catarhoe* (*Hyporhoe* **subgen. nov.**) *narynensis* **sp. nov.**

Morphological and genetic review of the genus *Catarhoe* reveals the probable heterogeneity of this genus in relation to other genera of the tribe Epirrhoini. The level of genetic divergence of the COI barcode fragment between morphological species groups of *Catarhoe* is comparable to the intergeneric distances observed in the compared larentiines. However, basal nodes of the reconstructed Epirrhoini phylogenetic trees have low support values, which does not allow us to consider the resulting clustering as a robust. A revision of this genus is required using nucleotide sequences of the nuclear genome.

Nevertheless, we propose restore the name *Microcalcarifera* from the synonym of *Catarhoe* as a valid genus: *Microcalcarifera* Inoue, 1982, **stat. rev.** This decision is based on the set of morphological differences of the type species, *Cidaria obscura* Butler, 1878, from the all other *Catarhoe* spp., on the phylogenetic analysis of the COI barcode fragment in the tribe Epirrhoini, where this species stably clustered outside the *Catarhoe* spp. and most other included genera of the tribe, and on the considerable genetic distances from the rest of *Catarhoe* spp. As a consequence, the following nomenclatural acts for species group names were proposed: *Microcalcarifera obscura* (Butler, 1878), **comb. rev.**; *Microcalcarifera obscura fecunda* (Swinhoe, 1891), **comb. rev.**; *Microcalcarifera obscura fecunda* (Swinhoe, 1891) (*Cidaria*), **comb. rev.** Also, taxonomic status of the name *Cidaria butleri* Leech, 1897 is validated as an unnecessary replacement name to *Cidaria obscura* Butler, 1878.

Thereby, the genus *Catarhoe* currently contains 13 valid species. However, generic association of *Catarhoe nyctichroa* (Hampson, 1912) needs to be examined as its genitalia morphology remains unknown, *Catarhoe arachne hissarica* Viidalepp, 1988 is necessary to check whether it belongs to a separate species, and "*Catarhoe semnana*" sensu Kemal *et al*. (2020) could be an undescribed species.

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