

Zeitschrift: Contributions to Natural History : Scientific Papers from the Natural History Museum Bern

Herausgeber: Naturhistorisches Museum Bern

Band: - (2013)

Heft: 22

Artikel: Nebria (Patrobonebria) paropamisos, a new species from the Hindu Kush (Coleoptera, Carabidae)

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DOI: <https://doi.org/10.5169/seals-786946>

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Nebria (Patrobonebria) paropamisos, a new species from the Hindu Kush (Coleoptera, Carabidae)

Charles Huber, Joachim Schmidt & Hannes Baur

ABSTRACT *Nebria (Patrobonebria) paropamisos* sp. nov. from the Hindu Kush Mountains of Afghanistan and Pakistan is described. Morphological and morphometric diagnoses to the related species *N. himalayica* BATES, 1889 and *N. elegans* ANDREWES, 1925 and a key are given. Species separation is mainly based on multivariate ratio analysis (MRA), a recently developed method for the analysis of morphometric data.

Keywords: Coleoptera, Carabidae, *Nebria*, *Patrobonebria*, taxonomy, new species, Hindu Kush, shape PCA, LDA ratio extractor.

Introduction

The carabid species *Nebria himalayica* BATES, 1889 and *N. elegans* ANDREWES, 1925 of the subgenus *Patrobonebria* BÄNNINGER, 1923 are widely distributed in the Hindu Kush and Himalaya Mountains from Afghanistan to Nepal (Andrewes 1929, 1930; Bänninger 1923, 1925, 1955; Ledoux & Roux 2005). Due to the variability in habitus and coloration, *N. himalayica* was additionally described three times as today's synonyms indicate (*macrocephala* BREIT, 1914, *pallidipes* BREIT, 1914, *thibetica* CSIKI, 1927). Newly examined specimens of this *himalayica* species group from several localities in the Hindu Kush Mountains of Afghanistan and Pakistan differ significantly in morphology and morphometry from *N. himalayica* and *N. elegans* respectively, and are herewith described as a new species.

Material and method

Abbreviations and material depository:

BMNH	The Natural History Museum, London, United Kingdom
CANICH	coll. Alexandre Anichtchenko Daugavpils, Latvia
CSCHM	coll. Joachim Schmidt, Admannshagen, Germany
CWRASE	coll. David Wräse, Berlin, Germany
ETHZ	Eidgenössische Technische Hochschule Zürich, Switzerland (coll. Max Bänninger)
MHNG	Muséum d'histoire naturelle de la ville de Genève, Switzerland
MNHN	Muséum nationale d'Histoire naturelle Paris, France
NHMB	Naturhistorisches Museum Basel, Switzerland (coll. Georg Frey)
NMBE	Naturhistorisches Museum der Burgergemeinde Bern, Switzerland
SMNS	Staatliches Museum für Naturkunde Stuttgart, Germany (coll. Walter Heinz)

In insect taxonomy multivariate statistical methods are widely applied to separate supposed species in difficult species complexes (e.g. Sorensen & Foottit 1992, Seifert 2002). Here we apply the multivariate ratio analysis (MRA) of Baur & Leuenberger (2011). MRA is an extension of principal component analysis (PCA) and linear discriminant analysis (LDA) that is especially suited for analyzing morphometric data in a taxonomic context. For a description and the application of the various MRA tools we refer to László et al. (2013). All calculations and graphics were done with the R language and environment for statistical computing (R Development Core Team 2013; version 3.0.2) using slightly modified R-scripts provided by Baur & Leuenberger (2011, under "Supplementary Material"). Scatterplots were generated with the package "ggplot2" (Wickham 2009).

The measurements for the MRA of the three examined species were taken using a stereo-microscope Leica MZ 16 with an ocular micrometer. The following distances were measured:

an1.l	Length of the 1 st antennomere
an1.w	Width of the 1 st antennomere
ely.l	Length of the elytra
ely.w	Width of the elytra
eye.l	Longitudinal eye length
fro.w	Frons width as minimal distance between the eyes
hea.w	Head width at the extreme points of the eyes
pro.aw	Apical width of the pronotum

pro.bw	Basal width of the pronotum
pro.mw	Maximal width of the pronotum
pro.l	Length of the pronotum
set.d	Apical distance of the lateral seta of the pronotum

We measured 53 specimens of the three taxa *N. paropamisos* sp. nov., *N. himalayica* and *N. elegans*. Measurements of males and females could be pooled, since their values were entirely overlapping in range.

Results and discussion

Morphometry

We first calculated a shape PCA to see how well the taxa delineated by qualitative characters were supported by morphometric variation. A PCA is convenient because it does not require *a priori* assignment of specimens to particular groups but assumes instead that they belong to a single group. It thus avoids bias with respect to particular groupings. In a shape PCA of the three taxa only the first two components explaining about 70% of the variation were informative. A scatterplot showed a clear separation of all taxa (Fig 1). The

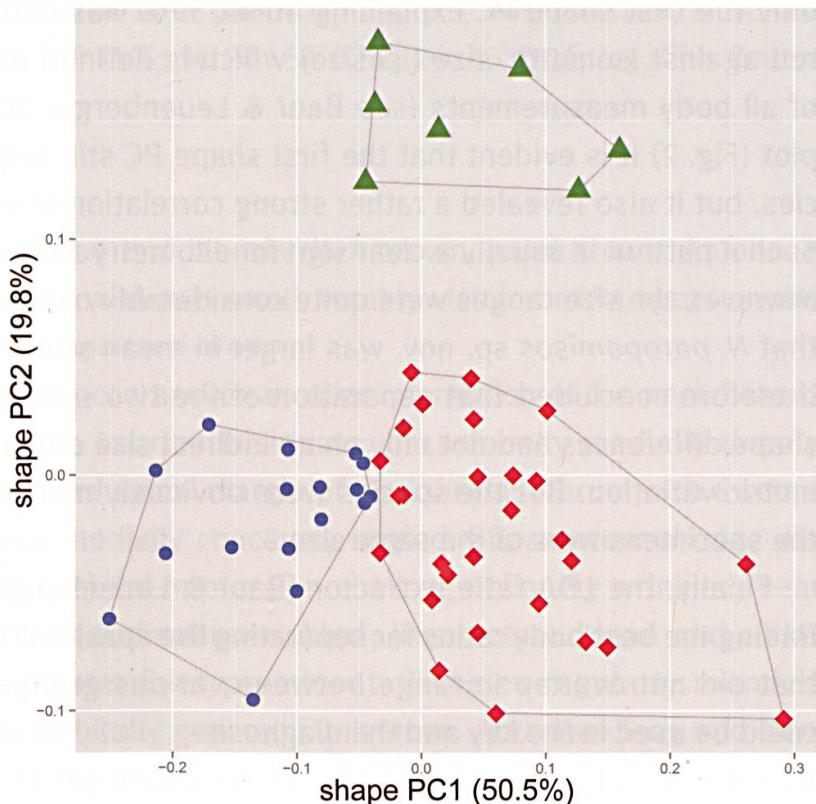


Fig 1: Scatterplot of first against second shape PC of the three species *Nebria (Patrobonebria) paropamisos* sp. nov. (blue dots), *N. himalayica* (red diamonds), and *N. elegans* (green triangles).

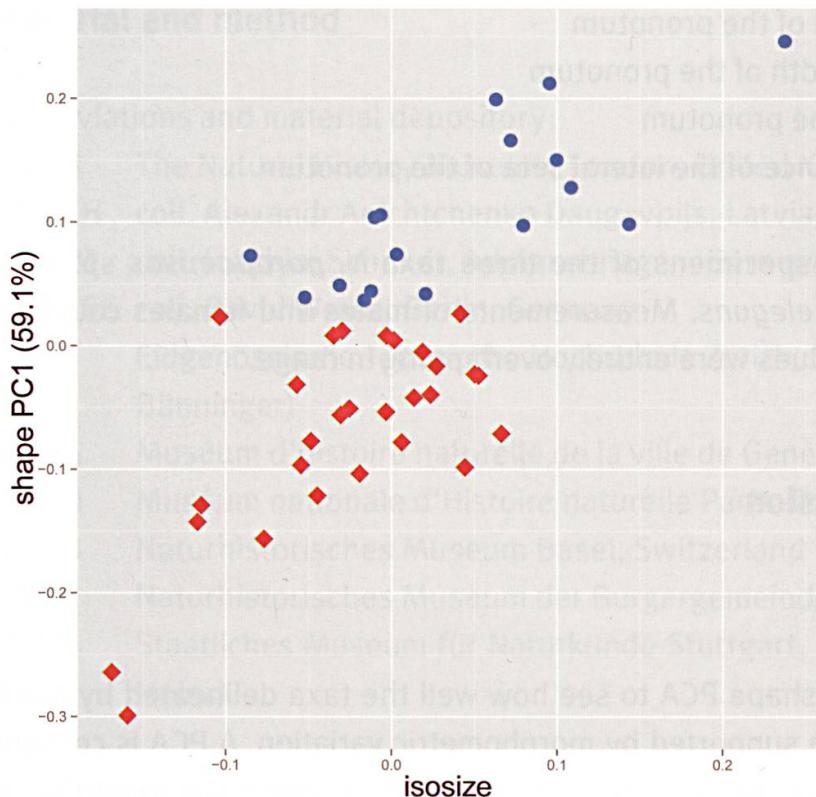


Fig 2: Scatterplot of iso-size against first shape PC of the two most similar species, *Nebria (Patrobonebria) paropamisos* sp. nov. (blue dots) and *N. himalayica* (red diamonds).

first shape PC differentiated *N. paropamisos* sp. nov. from *N. himalayica*, while the second shape PC widely separated the two taxa from *N. elegans*. Because the ranges of *N. paropamisos* sp. nov. and *N. himalayica* were almost touching, we performed a further shape PCA including only these two species. Here only the first shape PC explaining about 59% was informative and was plotted against isometric size (isosize) which is defined as the geometric mean of all body measurements (see Baur & Leuenberger 2011). From the scatterplot (Fig. 2) it is evident that the first shape PC still neatly separated the species, but it also revealed a rather strong correlation of isosize with shape PC1. Such a pattern is usually a clear sign for allometry (Baur & Leuenberger 2011). However, the size ranges were quite considerably overlapping despite the fact that *N. paropamisos* sp. nov. was larger in mean size than *N. himalayica*. We therefore concluded that separation of the two species was based on true shape differences and not only on an indirect size effect caused solely by allometric variation. But the species were obviously more similar in shape when the specimens were of the same size.

Finally, the LDA ratio extractor (Baur & Leuenberger 2011) was used for finding the best body ratios for separating the species. Three ratios were found that did not overlap in range between various groupings (Tab 1) and thus could be used in the key and the diagnosis.

group comparison	best ratio	range group 1	range group 2
<i>paropamisos-himalayica</i>	set.d : eye.l	1.23–1.51	0.78–1.25
<i>paropamisos-elegans</i>	an1.l : eye.l	0.90–1.00	1.10–1.18
<i>himalayica-elegans</i>	an1.l : eye.l	0.85–1.01	1.10–1.18

Tab 1: Best separating ratios found by the LDA ratio extractor for various groupings of the three species *Nebria (Patrobonebria) paropamisos* sp. nov., *N. himalayica*, and *N. elegans*.

Description

Nebria (Patrobonebria) paropamisos sp. nov. (Fig 3)

Holotype ♂: Pakistan (Swat), Utrot, 2200–2800 m, 12.–14. 7. 1982, Erber & Heinz leg. (SMNS).

Paratypes: 6 ♂ 4 ♀ same data as holotype (SMNS, NMBE); 3 ♂ 3 ♀ Pakistan (Swat), Utrot, 2300/2600 m, 15./19. 7. 1997, Heinz leg. (SMNS, CWRASE, NMBE); 1 ♂ Pakistan, Swat, s/Utrot, 2500–2600 m, 14. 5. 1983, leg. Besuchet & Löbl (MHNG).

Additional material examined:

3 ♂ Pakistan (Chitral), Madaglasht, 2500–3700 m, 5.–7. 7. 1982, Erber & Heinz leg. (SMNS, NMBE); 1 ♀ Pakistan, Chitral, Bumburet, 2200–2350 m, 24. 5. 1983, leg. Besuchet & Löbl (MHNG); 1 ♂ 3 ♀ Afghanistan, Nuristan (Kunar) Parun, 2600 m, 35° 15'55 N, 70° 54'02 E, 26. 6. 2006, leg. Chr. Reuter (CSCHM; CWRASE)..

Body length: 14–17 mm.

Colour black, mandibulae und labrum dark brown, palpi brown. Antennae dark brown to black. Head with two small, weakly visible brown spots on the vertex. Legs black, knees and tarsi brown.

Head large, with a distinct transverse collar impression of the neck behind the eyes. Mandibles long. Labrum trisinuate, occasionally medially deeply notched, causing a V-shaped apical margin of the labrum; labrum with 6 setae. Apical margin of clypeus medially concavely angled. Supraantennal edge distinctly rebordered. Supraorbital impression shallow, obliquely wrinkled, near the supraorbital seta longitudinally wrinkled; impunctate. Head and collar impression faintly punctate. Eyes prominent. Temples regularly rounded towards the neck. Supraorbitally generally unisetose. Antennae long and slender, extending almost to the middle of the elytra. Antennal scape weakly sub-

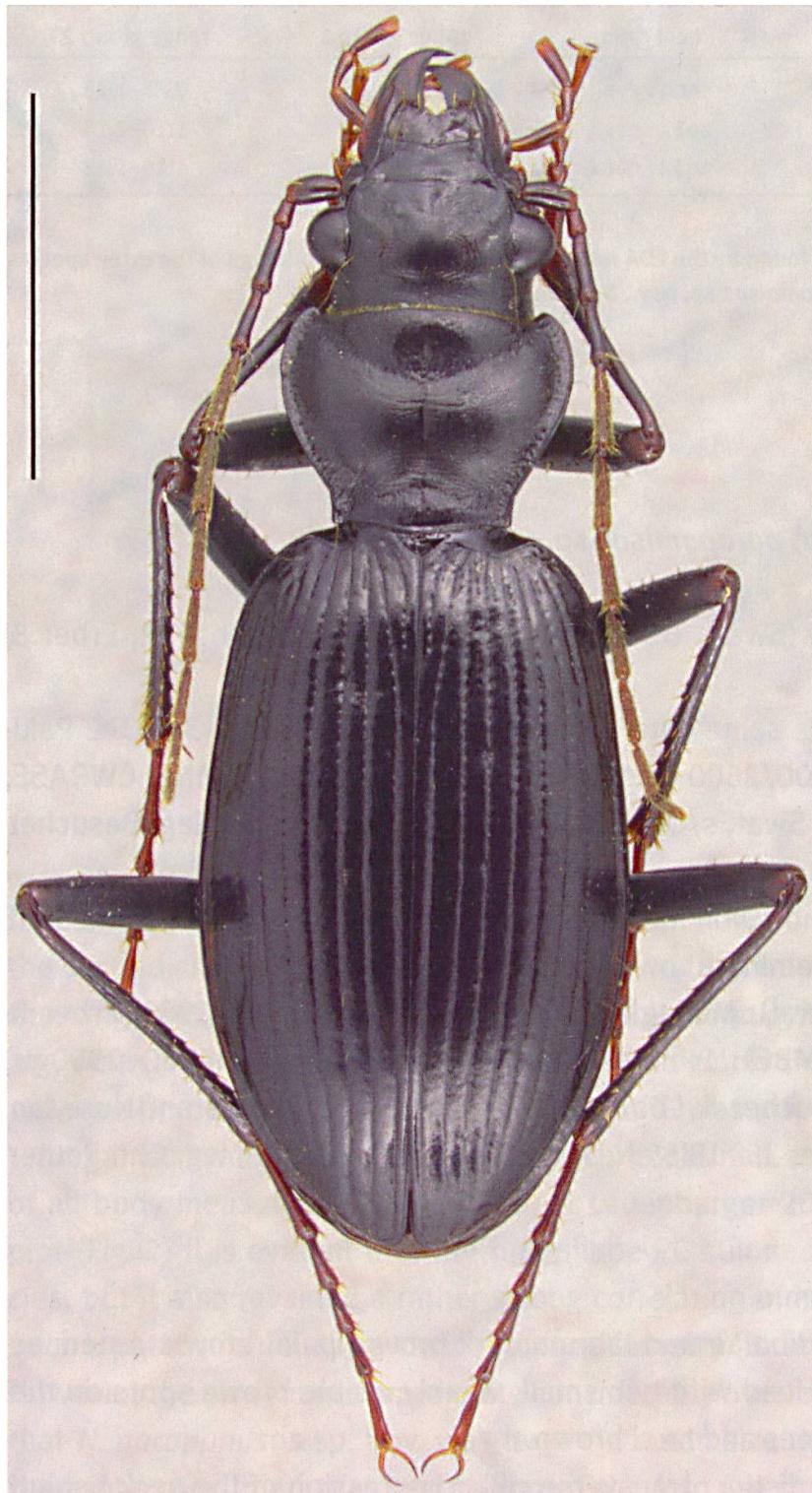
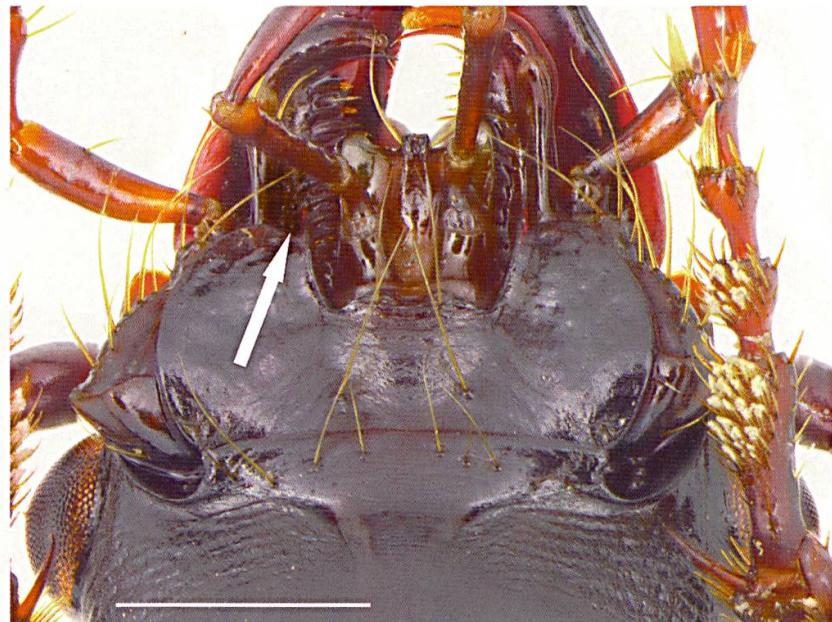


Fig 3: *Nebria (Patrobo-nebria) paropamisos*
sp. nov., Holotype male.
Scale bar = 5 mm.

oval, basally narrowed, with 1 dorsal seta. 2nd antennomere with 1 ventral seta, 4th antennomere with an apical collar of long setae, with several additional short setae apically. 1st antennomere shorter than the eye's diameter, ratio 1st antennomere : diameter of eye = 0.95 (0.90–1.00). Ligula blunt, with 2 long apicolateral setae. Penultimate labial palpomere bisetose. Tip of the medial tooth of the mentum truncated with a distinct notch. Apex of the mental lobe

Fig 4: Mentum of *Nebria (Patrobonebria) paropamisos* sp. nov. with a distinct incision of the lateral lobe (arrow). Holotype. Scale bar = 1 mm.



short, spiny, lateral lobe of the mentum with a distinct concave incision (Fig 4). Submentum with a row of 6–10 setae. Microsculpture of the head isodiametric.

Pronotum cordiform (Fig 5), transverse, anteriad considerably widened, widest at apical fifth; ratio width : length of the pronotum = 1.34 (1.26–1.44). Lateral margin convex without a break in outline near the lateral marginal pore. Pronotum strongly rounded towards the anterior angles, narrowed towards the posterior angles, concavely and roundly angled slightly before the posterior angles. Anterior angles regularly rounded to a triangular lobe, which is distinctly protruding. Posterior angles laterally short, with the tip outwards. Posterior angles narrower than the anterior ones, ratio = 0.79 (0.74–0.87). Lateral channel large, near anterior angle as large as the width of the 1st antennomere; channel narrowed posteriad. Lateral margin blade-like, obliquely upturned. Basal margin bisinuate. Pronotal disc convex, slightly transversally wrinkled. Prebasal fovea deep, oblong, reaching the base. Anterior and posterior transverse impressions deep, the median longitudinal impression weak. Prebasal fovea, the anterior and the posterior transverse impressions and the lateral groove tightly and coarsely punctate. Apical and basal margination absent, but finely longitudinally wrinkled. 1 lateral and 1 basolateral seta present. Insertion of the lateral seta on the channel's border behind the widest diameter of the pronotum. Microsculpture of the pronotum isodiametric. Disc impunctate. Proepisternum caudad tightly punctate. Prosternal process large, triangular, obtusely acuminate, impunctate and immarginated, medially with a faint bulge.

Elytral silhouette elongate-ovoid, widest behind middle. Ratio elytral length : elytral width = 1.69 (1.63–1.78). Lateral margin straight (not concavely

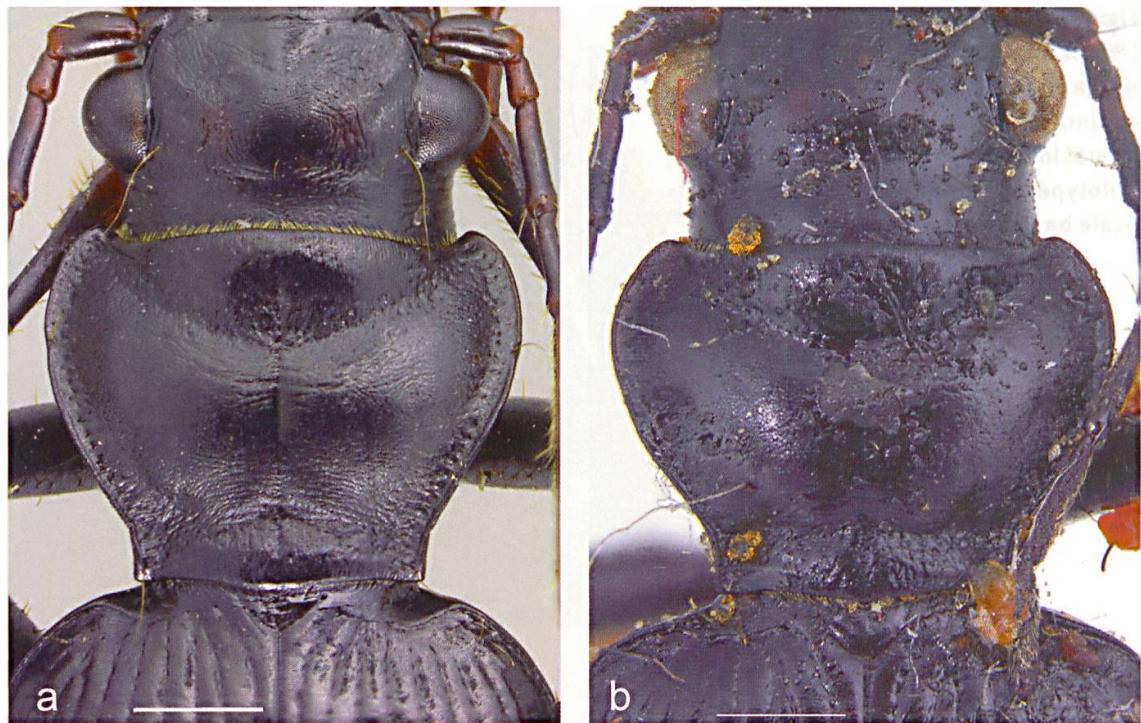


Fig 5: Pronota of (a) *Nebria (Patrobonebria) paropamisos* sp. nov., Holotype male, and (b) *N. (Patrobonebria) himalayica*, Lectotype male (MNHN). Scale bar = 1 mm.

sinuate) at basal fourth; subapically concavely sinuate. Elytral apex rounded. Basal margination curved, joined at an obtuse angle with the lateral margination. Humeral carina absent. Striae distinctly impressed, punctate. Striae 1–3 reaching the apex, the other striae and their punctuation obliterate just before the apex. Short faint carina at apex. Intervals flat, 3rd interval with 6–9 short setae. Scutellar setae present. Microsculpture isodiametric. Mesepisterna tightly punctate. Metepisterna twice as long as wide, coarsely and tightly punctate. Metacoxa with 4–6 basal and 1 apical setae. Hindwings fully developed. 2nd sternum (sensu Ledoux & Roux 2005) laterally rough, coarsely punctate. 3rd sternum laterally and medially asetose. Sterna 4–6 each with 4–5 posterior paramedial setae. Anal sternum with 1 paramedial seta in the male and 2–3 in the female. All sterna with faint impressions laterally.

Legs long and slender. Tarsi robust; all tarsi dorsally glabrous. Protarsomeres 1–2 of the males slightly dilated, ventrally with pads of adhesive setae. Metatarsomere 4 with a large, triangular ventroapical tooth, bearing long setae. In males metatarsomeres 2–4 at base laterally compressed.

Aedeagus (Fig 6): Median lobe basally regularly rounded, mid-shaft to the apex straight, deflected towards the left. Tip of the apex acute, short (Fig 6c).

Diagnosis: *N. paropamisos* sp. nov. differs from *N. himalayica* by the ovoid elytra, by the not pronounced shoulders which are distinct in *N. himalayica*, in the shape of the pronotum (Fig 5), by the upturned lateral margin of the

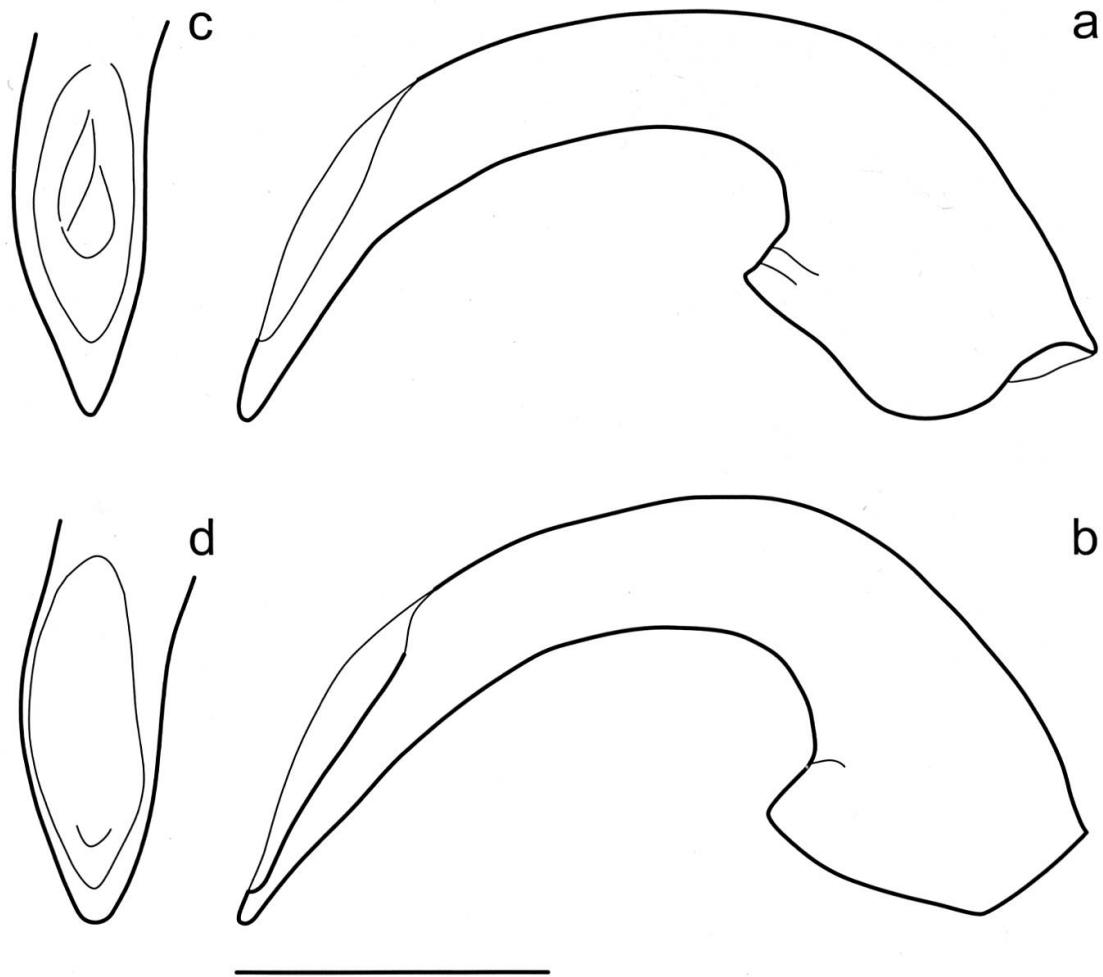


Fig 6: Aedeagi of *Nebria (Patrobonebria) himalayica* (a) and *N. (Patrobonebria) paropamisos* sp. nov. (b), Holotype male. Apices in frontal view of *N. (Patrobonebria) himalayica* (c) and *N. (Patrobonebria) paropamisos* sp. nov. (d). Scale bar = 1 mm.

pronotum, and by the wide lateral groove of the pronotum being as wide as the width of the 1st antennomere, whereas in *N. himalayica* the narrow groove is of half the width of the 1st antennomere. Ratio set.d : eye.l = 1.23–1.51 in *N. paropamisos* sp. nov., 0.78–1.25 in *N. himalayica*. In *N. paropamisos* sp. nov. the anterior angles of the pronotum protrude distinctly and triangularly, whereas in *N. himalayica* the angles are largely rounded and only little protruding. Tip of the aedeagus in *N. paropamisos* sp. nov. short, in *N. himalayica* longer and slender.

N. paropamisos sp. nov. differs from *N. elegans* by the large upturned lateral channel of the pronotum, which is narrow in *N. elegans*, and the strongly protruding anterior angles of the pronotum, which only slightly protrude in *N. elegans*. In *N. paropamisos* sp. nov. the 1st antennomere is generally shorter than the eye's diameter in contrast to *N. elegans* where it is longer; ratio an1.l : eye.l = 0.90–1.00 in *N. paropamisos* sp. nov., 1.10–1.18 in *N. elegans*. In *N. paropamisos* sp. nov. the scutellar setae of the elytra are present, in *N. elegans* absent.

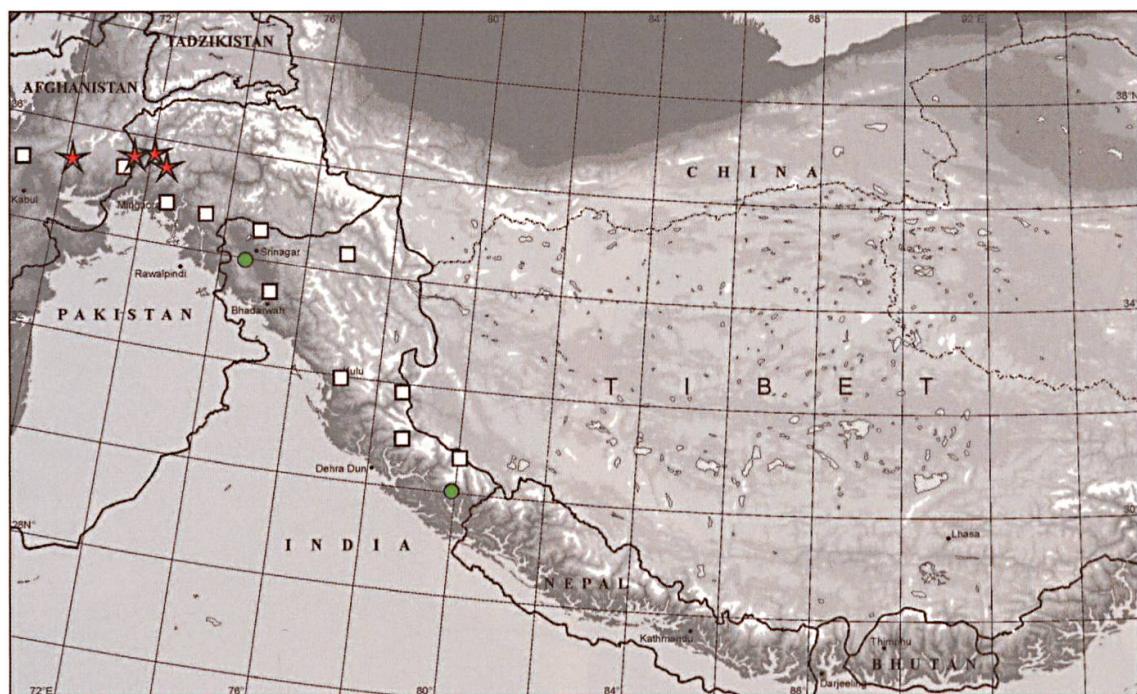


Fig 7: Relief map of western High Asia showing the distribution of *Nebria (Patrobonebria) paropamisos* sp. nov. (red stars), *N. (Patrobonebria) elegans* (green dots), and *N. (Patrobonebria) himalayica* (white squares).

Etymology: The name (noun in apposition) refers to the Paropamisos Mountains, the Ancient Greek name for the Hindu Kush Mountains.

Distribution: The new species is known from the Hindu Kush Mountains in North-Eastern Afghanistan (Kunar Province) and North-Western Frontier Province (Chitral, Swat) of Pakistan (Fig 7).

Key

Step 4 of the determination key in Huber & Geiser (2012) of the *Patrobonebria* species, which have the legs and the appendices of the head brown to black, has to be modified as follows:

- 4 Anterior angles of the pronotum rounded, faintly protruding. 4a
- Anterior angles of the pronotum triangular, distinctly protruding. 4b
- 4a Outline slender, elytra ovoid, shoulder obliterate. Lateral groove of the pronotum narrow. 1st antennomere elongate, ratio 1st antennomere : length of the eye >1.10. Scutellar setae generally absent. Kashmir to Kumaon Himalaya. ***N. elegans* ANDREWES, 1925**
- Outline robust, elytra parallel, shoulder distinctly produced. Lateral groove of the pronotum large. 1st antennomere stocky, ratio 1st antennomere : length

of the eye generally <1.0. Scutellar setae generally present. Afghanistan to Nepal. ***N. himalayica* BATES, 1889**

4b Elytra elongate-ovoid. Lateral groove of the pronotum large, apically upturned, lateral outline of the pronotum not disturbed near the insertion site of the midlateral seta. Basal incision of the pronotum just before the posterior angles smoothly rounded; posterior angles of the pronotum short, not parallel. Hindu Kush (Afghanistan, Pakistan). ***N. paropamisos* sp. nov.**

– Elytra elongate-parallel. Lateral groove of the pronotum narrow, lateral margin with a distinct concave impression at the insertion site of the midlateral seta. Basal incision of the pronotum sharp, distinctly before the posterior angles; posterior angles of the pronotum long. Cang Shan/Yunnan. ***N. megalops* HUBER & GEISER, 2012**

Additional material examined

***Nebria (Patrobonebria) himalayica* BATES, 1889**

N. macrocephala BREIT, 1914

N. pallidipes BREIT, 1914

N. thibetica CSIKI, 1927

Type material of *N. himalayica*:

N. himalayica: Lectotype ♂, Goorais Valley, May 1887, J. H. Leech [printed label] // *himalayica* Bates [handwritten label] // Ex Musaeo H. W. Bates 1892 [printed label] // Museum Paris, ex. Coll. R. Oberthür [printed label] // Lectotype [red printed label] (MNHN).

Type material of *N. macrocephala* and *N. pallidipes*:

2 ♂, 1 ♀ Type [red printed label] // Po-o, S. W. Thibet [printed label] // *Nebria macrocephala* n. sp. Breit [in Breit's handwriting] // ex. Orig. Samlg. J. Breit Wien [printed label] (NHMB);

1 ♂, same data // Type [red label] // ex. Coll. Breit [handwritten] // *Nebria macrocephala* n. sp. Breit [in Breit's handwriting] // H. E. Andrewes Coll., B. M. 1945-97 (BMNH);

1 ♂, same data, with additional label: *pallidipes a. macrocephala* Brt. (NHMB); [Remark: Breit (1914) did not correctly recognize the sex, when he described his type specimen series of five females. Four of these five type specimens are available in the Breit collection (in the Frey collection in the NHMB). Andrewes (1929) made the note "I have in my collection a cotype of *macrocephala* Breit".];

1 ♂ Poo, West-Himal., coll. Splichal // Bashar gegen Shipki Pass nicht Tibet aber a. d. Grenze, Andrewes vid. 6. 9. 1926 [handwritten by Bänninger] //

Nebria macrocephala Breit, Co-Type 6. 1922 [handwritten by Bänninger] (ETHZ). [Remark: This is probably not a specimen of Breit's type series. Andrewes (1929) cited the locality "Punjab: Bashahr State, Poo" referring possibly to this specimen of the Bänninger collection.]

Additional material of *N. himalayica*:

1 ♂, 1 ♀ J. Klapperich, Qulatak [sic!], 1950 m, Salangtal, 9. 10. 1952, Hindukusch, O-Afghanistan // *N. (Patrobon.) himalayica* Bts. [handwritten], det. Bänninger 1954 (ETHZ); 1 ♀ same data (NHMB) [Remark: Klapperich (1954, p. 117) wrote the locality in his paper "Qualatak, 1950 m, Ort im Salang-Tal"]; 1 ♂ J. Klapperich, Bashgultal, 1200 m, Nuristan, 11. 5. 1953, Afghanistan // *N. (Patrobon.) himalayica* Bts. [handwritten], det. Bänninger 1954 (ETHZ); 1 ♀ Khalatse [= Khalsi/Jammu and Kashmir/India], 15000 [feet] // *N. thibetica* Cs. (= *N. macrocephala* Br.), Übergang zu *pallidipes*, Bänninger det. 1929, Andrewes vid. 19. 11. 1929 (ETHZ); 1 ♂ India, Milam, Gori V., 11500 ft. [printed] // *macrocephala* Breit, Bänninger det. [handwritten] // H. E. Andrewes Coll., B. M. 1945-97 (BMNH); 1 ♀ India, Milam, Gori V., 11500 ft. [printed] // *N. pallidipes* Breit, v. *macrocephala* Breit, H. E. Andrewes det. [handwritten] // H. G. Champion Coll, B. M. 1953-156 // G. Ledoux det. 1982 (BMNH); 2 ♂, 6 ♀ India, Milam, Gori V., 11500 ft. [printed] // H. G. Champion Coll, B. M. 1953-156 // G. Ledoux det. 1982 (BMNH); 1 ♂ India, Parbatti V., Kulu, Punjab, 6–8000 ft., H. C. G. [printed] // H. E. Andrewes Coll., B. M. 1945-97 (BMNH); 4 ♀ same data // H. G. Champion Coll., B. M. 1953-156 // *N. himalayica* Bates, G. Ledoux det. 1982 (BMNH); 1 ♂ Ramsu 4500, Ramban Div., Kashmir, 8. V. 1928, B. M. Bhatia [printed] // under wet stones [handwritten] // For. Res. Inst., Dehra Dun [printed] // *Nebria himalayica*, H. E. Andrewes det. // H. E. Andrewes Coll., B. M. 1945-97 (BMNH); 3 ♂ 1 ♀ N India, Uttarakhand, Uttarkashi distr., N30°57'41.57", E78°41'54.75" left tributary of Bhagirathi, 2300 m, 13.–15.04.2012, Anichtchenko A. leg. (CANICH); 3 ♂ 2 ♀ India, Uttarakhand, Uttarkashi distr., Gangnani, left tributary of Bhagirathi, 2150 m, N30°57'43", E78°41'54", 13.–15.04.2012, R. Cibulskis leg. (CANICH); 1 ♂ Pakistan, Swat, Malam Jabba, 2300–2400 m, 9. 5. 1983, leg. Besuchet & Löbl.

***Nebria (Patrobonebria) elegans* ANDREWES, 1925**

Type material of *N. elegans*:

1 ♂, Type [red round label] // Sunderdhunga V., W. Almora Divn., 8000–12000 feet, June 19., H. G. C. [= Champion; printed label] // 3118 // 1928.129 // *Nebria Elegans* Andr., Type (♂), H. E. Andrewes det. [handwritten] (BMNH).

1 ♀, Sunderdhunga V., W. Almora Divn., 8000–12000 feet, June 19., H. G. C. [printed] // 3118 // *Nebria Elegans* Andr., cotype (♀), H. E. Andrewes det. [handwritten] (BMNH).

Additional material of *N. elegans*:

2 ♂ Cachemire, 3800 m, Gulmarg env., 2. 8. 1978, leg. G. Ledoux (SMNS); 1 ♀ Inde, Cachemire, 3000 m, Gulmarg env., 3. 8. 1978, leg. G. Ledoux, det. G. Ledoux (SMNS); 3 ♂, 1 ♀ Cachemire, 3800 m, Gulmarg env., 7. 8. 1979, leg. G. Ledoux (NMBE, SMNS).

Acknowledgements

We gratefully acknowledge for specimen loan Thierry Deuve and Azadeh Taghavian (MNHN), Beulah Garner and Michael Geiser (BMNH), Wolfgang Schawaller (SMNS), Franziska Schmid (ETHZ), Eva Sprecher (NHMB), Giulio Cuccodoro (MHNG), Alexander Anichtchenko, Daugavpils, Latvia, and David Wräse, Berlin. We are very grateful to Elsa Obrecht for help with the manuscript, and to Christoph Germann (both NMBE) with the photographs.

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