

## *Kruberia abchasica*, a new genus and species of troglobiont amphipods (Crustacea: Gammaridae) from Krubera Cave (Western Transcaucasia)

### *Kruberia abchasica*, новый род и вид троглобионтных амфипод (Crustacea: Gammaridae) из пещеры Крубера (Западное Закавказье)

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КЛЮЧЕВЫЕ СЛОВА: Amphipoda, Gammaroidea, таксономия, биоразнообразие, Кавказ.

**ABSTRACT.** A new species of peculiar troglobiont (stygobiont) amphipod — *Kruberia abchasica* sp.n. of the family Gammaridae is described, for which a new genus is proposed. *Kruberia* gen.n. is characterized by a specific habitus (stocky body, elongate appendages densely covered with hairs) and modified mouthparts (outer plate of maxilla I with comb-like spines, spine row of right mandible with modified spine). Two gammarid specimens were found in the siphon Dva Kapitana (at the depth of 2175 m) in the deepest underground system — Krubera Cave in Abkhazia.

**РЕЗЮМЕ.** В статье описывается новый своеобразный вид троглобионтных (стигиобионтных) амфипод — *Kruberia abchasica* sp.n. из семейства Gammaridae, для которого обосновывается новый род. *Kruberia* gen.n. характеризуется особой морфологией тела, позволяющей обитать в условиях подземных озер (коренастое тело, удлиненные конечности густо покрытые волосками), и модифицированными ротовыми частями (внешняя пластинка максиллы I с гребневидными шипами, правая мандибула с модифицированным шипом в добавочном ряду). Гаммариды найдены в сифоне Два Капитана (глубина 2175 м), в глубочайшей подземной системе — пещере Крубера, в Абхазии.

#### Introduction

The taxonomic richness of underground gammarids of Western Transcaucasia is not very diverse. In partic-

ular for Abkhazia only 3 stygobiont genera of Gammaridae Leach, 1814 and Typhlogammaridae Bousfield, 1978 families are known [see Birstein, 1940; Derzhavin, 1945; Sidorov et al., 2015]; two of them — *Anopogammarus* Derzhavin, 1945 and *Adaugammarus* Sidorov, Gontcharov et Sharina, 2015 each represented by the single species, whereas from the genus *Zenkevitchia* Birstein, 1940 four species are known.

The increasing interest in the study of caves and their inhabitants allows to discover a new and often surprising forms of life [Holsinger, 1988; Culver, Pipan, 2009; Kováč et al., 2014]. Thus, recently new findings of invertebrates from the Krubera Cave have been reported [Jordana et al., 2012], including amphipods [Sendra, Reboleira, 2012]. During the speleological expedition of Ukrainian Speleological Association (USA) to the Caucasus to the Krubera Cave [Klimchouk et al., 2009], the second author of this paper collected amphipods of previously unknown species. Detailed description of this amphipod as the type species of a new genus named *Kruberia abchasica* gen. et sp.n. are given below.

#### Material and Methods

Two amphipod specimens were caught by a hand-net at a depth of about 30 meters by G.V. Samokhin in August 2013 during one of the dives in the siphon Dva Kapitana at the deep part of the Krubera Cave. Sample were preserved with 80% ethanol. Body length of the amphipods was recorded by holding the specimen

straight and measuring the distance along the dorsal side of the body from the base of the first antenna to the base of the telson using a micrometer eye piece in a Lomo MBS-9 dissecting microscope. Permanent preparations were made by using polyvinyl lactophenol (PVL) and a methylene blue staining solution was used as mounting medium. Appendages were drawn using a Carl Zeiss NU-2 compound microscope equipped with a drawing device as described in Gorodkov [1961]. The nomenclature for setal patterns on article 3 of the mandibular palp follows the standard introduced by Karaman [1970] and Stock [1974]. The following description is based on the type series, and the material examined is deposited in the Zoological Museum of the Far East Federal University, Vladivostok, Russia (FEFU hereafter).

### Taxonomy

Class Malacostraca Latreille, 1806  
Order Amphipoda Latreille, 1816  
Family Gammaridae Leach, 1814

#### *Kruberia*, gen.n.

TYPE SPECIES. *Kruberia abchasica* sp.n., by monotypy.

ETYMOLOGY. The generic name (*Kruberia*) is given in honor of Professor A.A. Kruber (22.08.1871 – 15.12.1941), geographer, founder of the Russian school of karstology. By the name of A.A. Kruber is also called cave from which this amphipod species describes.

GENERIC DIAGNOSIS (females). Subterranean (stygobiont) eyeless genus of gammaridean amphipods with modified mouthparts and elongated limbs adapted to living in a cave lake (lake ecomorph). Body large, without eminent cuticular elements but with indistinct small cuticular bulging (tubercles) on urosomal segments I and II. Pigmentation absent. Antenna I long, reaching 90% total length of body; 2.5 times longer than antenna II; aesthetascs present. Right mandible with modified spine in accessory spine row. Maxilla I with comb-like spines on the outer plate. Gnathopods I and II well-developed, subchelate. Pereopods VI and VII much longer than pereopod V. Urosomites with dorsolateral groups of spines; urosomite III elongate. Uropod III long, densely covered with hairs, with unarticulated outer ramus. Telson entirely cleft. Coxal gills II–VII stalked, sacciforme, largest on gnathopod II, successively smaller on pereopods III to VII, gill VII smallest. Oostegites II–V broad, with long marginal setae. Body length: ~19.0–28.0 mm.

DISCUSSION OF AFFINITIES. In a recently published paper of Z.-E. Hou and B. Sket [Hou, Sket, 2015] it is proposed to abolish the family Typhlogammaridae and its representatives to consider by a part of the family Gammaridae. This proposal, in our view, is not unreasonable because apparently a special “filtering structure” of typhlogammarid mouthparts is exclusively adaptive and has a convergent nature among

underground gammarids (cf., *Albanogammarus* Ruffo, 1995, *Sinogammarus* Karaman et Ruffo, 1995). On the other hand, a number of important groups was not analyzed in the work of the above-mentioned authors. Comparative-morphological analysis of *Kruberia* gen.n. revealed the presence of features characteristic of both families, for example, the presence of aesthetascs (estetascs) was not previously noted for typhlogammarids which again speaks in favor of the merger. However, after weighing all the arguments in detail we believe that *Kruberia* gen.n. though occupying an intermediate position is closer to the Gammaridae family. Additionally, to avoid the confusion we reserve the right below to use the name “typhlogammarids”<sup>1</sup> in order not to distinguish them from the typical Gammaridae.

A new species of amphipods *K. abchasica* cannot be attributed to any of the known genera of gammarids (41 genus) or to typhlogammarids such as Balkan (3 genera) and inhabiting the underground waters of the Caucasus (2 genera) — as there are too significant differences in the general morphology of the body and mandibles. *Kruberia* gen.n. discovers a peculiar morphology that is typical for lake ecomorphs — a large and stocky body, elongated urosomal segments, elongated appendages densely covered with hairs and a powerful well-armed gnathopods. However, such morphology of the body known for a number of underground forms of amphipods inhabiting a cave lakes is purely adaptive [Delić et al., 2016]. *Kruberia* gen.n. the unique taxon that has features which are characteristics of a number of groups: the armament of the outer plate and the structure of maxilla I palp unite with *Typhlogammarus* Schäferna, 1907, *Adaugammarus* and *Zenkevitchia* (*sandroruffoi*-group); the structure of gnathopods brings with *Typhlogammarus*, *Adaugammarus* and *Anopogammarus*. However, *Anopogammarus* differs in asymmetric palp of maxilla I and in two-segmented exopodite of uropod III. A typical species of the genus *Adaugammarus* — *A. pilosus* [see Sidorov et al., 2015] and in species of the genus *Typhlogammarus* has a different structure of the front edge of the head with recess; also, these genera is different in the shape of basipodite of pereopods V–VII and uropod III. From the *sandroruffoi*-group (*Zenkevitchia*) it differs in short antennal cone of antenna II, not reduced palp of maxilla I and in large predatory gnathopod propodi. From *admirabilis*-group (*Zenkevich*) it differs by non-filterative structure of maxilla I. From the single species of the genus *Accubogammarus* Karaman, 1974 — *A. algor* (Karaman, 1973), a new species differs in structure of the front edge of the head, short antennal cone of antenna II, maxilla I and structure of uropod III. From the genus *Metohia* Absolon, 1927 (type species *M. carinata* Absolon, 1927) it differs in the absence of cuticular elements on pleosomal segments. We consider the presence of a small cuticular bulging (tubercles) on urosomal segments I and II, aesthetascs on the flagellar segments of antenna I and modified spine in acces-

<sup>1</sup> Here is accepted in the subfamily rank.

sory spine row of right mandible as the most significant differences from the all aforesaid groups.

*Kruberia abchasica*, **sp.n.**

Figs 1–3.

syn.: *Zenkevitchia* sp. *sensu* Jaume in Sendra, Reboleira, 2012: 224, fig. 6B.

**DIAGNOSIS** (females). As for the genus.

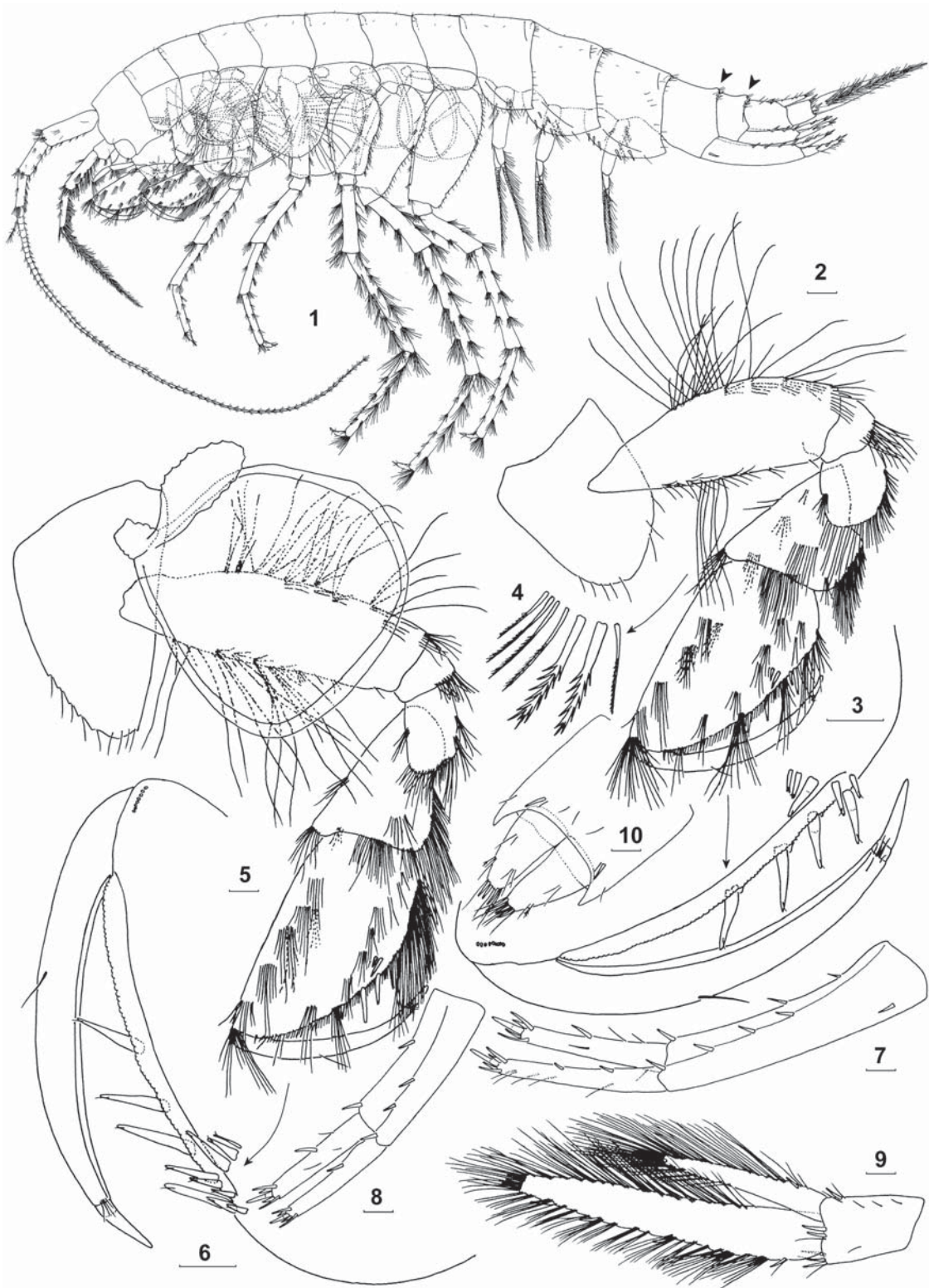
**MATERIAL EXAMINED.** Holotype ♂, No. XII45325/Cr-1828-FEFU; body length 19.0 mm (oostegites initial, non-setose); Western Transcaucasia, Abkhazia, Gagra District, Arabika Massif, Kruberia Cave (43°24'35"N, 40°21'44"E), Dva Kapitana siphon, collection depth –2175 m, 10 Aug 2013, collected by G.V. Samokhin; paratype ♂, No. XII45485/Cr-1829-FEFU; body length 28.0 mm (oostegites developed, setose); same data as for holotype.

**TYPE LOCALITY.** Abkhazia, Kruberia Cave, Dva Kapitana siphon.

**ETYMOLOGY.** The specific epithet (*abchasica*) refers to the country name, where it was collected.

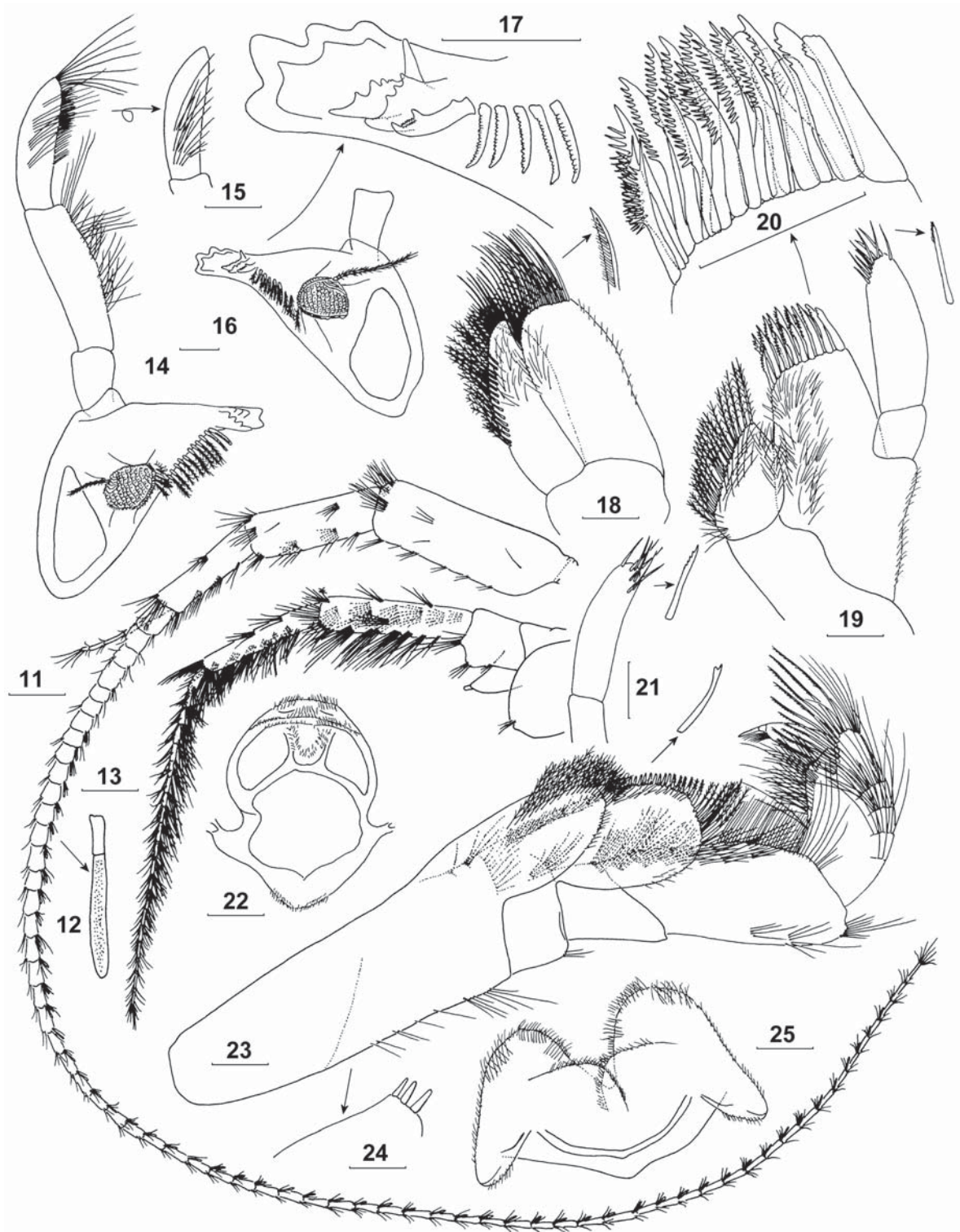
**DESCRIPTION.** Female, 19.0 mm long [XII45325/Cr-1828-FEFU]. **General body morphology** (Figs 1, 10, 31). Body stout, smooth, covered with fine setules, discriminative dorsal cuticular outgrowths (keels, denticles, humps) on pereonal and pleonal segments missing. Head as long as pereonite I; rostrum indistinct; lateral cephalic lobe without recess, inferior antennal sinus shallow, rounded. Eyes absent. Epimeral plates I–III with medial and lateral groups of setae; postero-ventral corner sub-acute (acute and somewhat produced in plate I), corners unarmed; posterior margin with 5 setae along; ventral margin of plate III bearing 5 notched spines, plate II with 6 notched spines, plate I with 10 stiff setae. Urosomites I–III on dorsal surface with small cuticular tubercles surrounded by lateral groups of spines and setae; armed with notched spines in the following manner: I (2-2), II (3-3), III (1-1); urosomite III elongated, nearly twice as long as adjacent urosomite II. **Antennae** (Figs 1, 11–13). Antenna I: 90% length of body, 2.5 times longer than antenna II; peduncular articles I–III with a length ratio of 1.0 : 0.65 : 0.55; primary flagellum with 64 articles, each flagellar articles bearing lanceolate aesthetascs accompanied by short setae; accessory flagellum 5-articulate. Antenna II: gland cone short; peduncular articles IV and V in length ratio 1 : 0.8, both densely setose with tight bundles of long stiff setae on lateral and medial faces; flagellum 1.3 times longer than peduncle (articles 4+5), with 20 articles densely setose with stiff setae; calceoli absent. **Mouth parts**, (Figs 14–25). Upper lip sub-rhomboid, rounded, with group of minute setae on apical part. Mandibles subequal: left mandible: incisor with 5 teeth, lacinia mobilis with 4 teeth; between lacinia and molar a row of 9 plumose and 2 serrate spines. Right mandible: incisor process with 4 teeth, lacinia mobilis bifurcate, with several denticles, between lacinia and molar a row of 6 serrate spines (first of them modified — bifurcate with fine serration); triturative molar process with plumose seta; mandibular palp article 2 longer than article 3 (distal); proximal

palp article without setae; second article with 37 setae; distal article with 4 A-groups of 3, 4, 5 and 2 setae, respectively, 3 B-groups of 4, 6 and 4 setae, respectively, 28 D-setae and 8 E-setae. Maxilla I: inner plate sub-triangular, with 19 plumose setae, outer plate with 18 comb-like, multi-toothed spines; palp long, sub-symmetrical, palp article I 0.3 shorter than palp article II; distal palp article with 7–10 simple and serrate stiff setae on apical and sub-apical margin. Maxilla II with both plates narrowed, inner plate with oblique row of 15 plumose setae; outer plate bearing apically 19 long setae with fine serration. Lower lip: outer lobes broad, rounded, densely covered with setae marginally, mandibular process moderate, inner lobes broad. Maxilliped: inner plate sub-ovoid, with 3 subtile spines and 23 plumose setae on ventral face; outer plate broad, with a row of 16 simple and 9 plumose setae along outer margin, and numerous bicuspid stiff setae sub-marginally; maxilliped palp article III broad, with 4 groups of long, stiff setae along outer margin; palp article IV (distal) 0.6 shorter than palp article III, nail slender bearing 6 setae at base. **Coxal plates, gills and oostegites** (Figs 1, 2, 5, 26–30). Coxal plates I–IV of different shape, deeper than broad; coxal plates V and VI with anterior and posterior lobes, posterior margin slightly pointed bearing few setae; coxal plate VII much smaller, lobes indistinct. Coxal gills II–VII stalked, saccular, large but progressively smaller towards the posterior; gill VII smallest, with long stalk. Oostegites II–V underdeveloped in holotype; but typically gammarid, very broad, with long marginal setae in paratype, oostegite V smallest. **Gnathopods I and II** (Figs 1–6). Gnathopod I: basis with long and short setae on anterior and posterior margins; carpus stout, with group of stiff, serrate setae on inner face; propodus oblong, coniform, palm convex with cutting margin ribbed and longer than posterior margin, palmar margin with short, notched (bifid) setae along outer and inner faces, palmar angle undefined, a group of 6 distally-notched, strong spines on both faces (with 3 strong mid-palmar spines in the place where tip of nail close); nail short, 0.15 of total length of dactylus, 1 seta along anterior margin, with a group of minute setules at hinge. Gnathopod II generally similar to gnathopod I, but a little larger; propodus armed with a group of 9 distally-notched, strong spines on both faces (with 3 strong mid-palmar spines in the place where tip of nail close); dactylus similar to that of gnathopod I. **Pereopods III–VII** (Figs 1, 26–30). Pereopods III and IV sub-similar, but pereopod III a little shorter; bases narrow, with sets of short setae on anterior and long setae on posterior margins; lengths of merus : carpus : propodus is 1.0 : 0.8 : 0.8. Pereopods V–VII sub-similar; lengths of bases V : VI : VII is 0.7 : 0.9 : 1.0. Pereopods VI and VII sub-similar, but pereopod VII 0.1 shorter than pereopod VI; bases narrowed distally, postero-distal lobes weakly expressed, marginal serrations with short setae posteriorly (expressed in basis VII) and with 5–6 groups of notched spines accompanied with setae ante-



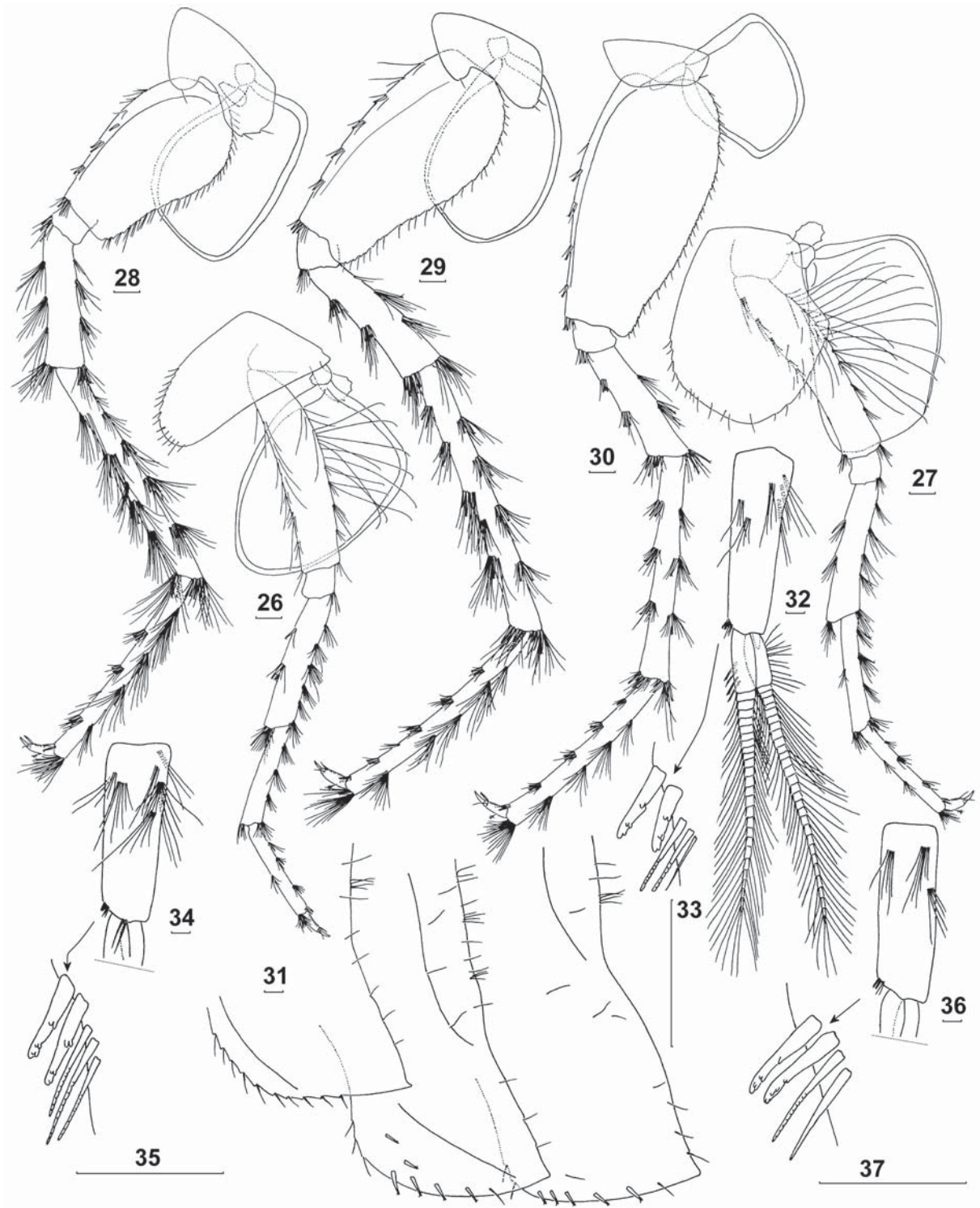
Figs 1–10. *Kruberia abchasica* sp.n., holotype No. XII45325/Cr-1828-FEFU, 1 — habitus, left view (arrows indicate tubercles in the terminal part of the urosomites I and II), 2 — gnathopod I, 3 — palmar margin of gnathopod I, 4 — group of serrate setae, 5 — gnathopod II, 6 — palmar margin of gnathopod II, 7 — uropod I, 8 — uropod II, 9 — uropod III, 10 — telson. Scale bars 0.4 mm.

Рис. 1–10. *Kruberia abchasica* sp.n., голотип No. XII45325/Cr-1828-FEFU, 1 — габитус, вид слева (стрелками указаны бугорки-вздутия в терминальной части уросомитов I и II), 2 — гнатопод I, 3 — пальмарный край гнатопода I, 4 — группа зазубренных щетинок, 5 — гнатопод II, 6 — пальмарный край гнатопода II, 7 — уропод I, 8 — уропод II, 9 — уропод III, 10 — тельсон. Линейки 0,4 мм.



Figs 11–25. *Kruberia abchasica* sp.n., holotype No. XII45325/Cr-1828-FEFU, 11 — antenna I, 12 — aesthetasc, 13 — antenna II, 14 — left mandible, 15 — third segment of palp, ventral view, 16 — right mandible, 17 — cutting edge of right mandible, 18 — maxilla II, 19 — maxilla I, 20 — outer plate of maxilla I, 21 — palp of left maxilla I, 22 — upper lip, 23 — maxilliped, 24 — inner plate of maxilliped, 25 — lower lip. Scale bars 0.4 mm.

Рис. 11–25. *Kruberia abchasica* sp.n., голотип No. XII45325/Cr-1828-FEFU, 11 — антенна I, 12 — эстетаска, 13 — антенна II, 14 — левая мандибула, 15 — третий членик шупика с вентральной стороны, 16 — правая мандибула, 17 — режущий край правой мандибулы, 18 — максилла II, 19 — максилла I, 20 — внешняя пластинка максиллы I, 21 — шупик левой максиллы I, 22 — верхняя губа, 23 — ногочелюсть, 24 — внутренняя пластинка ногочелюсти, 25 — нижняя губа. Линейки 0,4 мм.



Figs 26–37. *Kruberia abchasica* sp. n., holotype No. XII45325/Cr-1828-FEFU, 26 — pereopod III, 27 — pereopod IV, 28 — pereopod V, 29 — pereopod VI, 30 — pereopod VII, 31 — epimeral plates I–III, 32 — pleopod I, 33 — coupling setae (retinacula) of pleopod I, 34 — pleopod II, 35 — coupling setae (retinacula) of pleopod II, 36 — pleopod III, 37 — coupling setae (retinacula) of pleopod III. Scale bars 0.4 mm.

Рис. 26–37. *Kruberia abchasica* sp. n., голотип No. XII45325/Cr-1828-FEFU, 26 — переопод III, 27 — переопод IV, 28 — переопод V, 29 — переопод VI, 30 — переопод VII, 31 — эпимеральные пластинки I–III, 32 — плеопод I, 33 — ретинакулы плеопода I, 34 — плеопод II, 35 — ретинакулы плеопода II, 36 — плеопод III, 37 — ретинакулы плеопода III. Линейки 0,4 мм.

riorly; lengths of merus : carpus : propodus is 0.5 : 1.0 : 0.85. **Pleopods, uropods and telson** (Figs 1, 7–10, 32–37). Pleopods I–III sub-equal, each with 2 coupling setae accompanied by 2–3 stiff setae; peduncular articles fringed with long, thin setae; proximal article of inner rami fringed with 4–5 bifurcate setae; rami with 25–30 articles each. Uropod I protopodite with basofacial spine, with 4 dorso-lateral spines and 3 dorso-medial spines; endopodite almost twice shorter than protopodite, with 1 spine on outer margin and with 5 notched spines (1 of them strong) apically; exopodite slightly longer than endopodite, bearing few short setae on ventral face and 5 notched spines (1 of them strong) apically. Uropod II exopodite 0.75 shorter than protopodite and as long as endopodite; in distal part rami armed similar to that of uropod I. Uropod III: protopodite with 2 groups of spines in distal part; endopodite slender, narrowed distally and slightly curved, 1.75 of protopodite length, densely covered with long setae and with 1 small spine and set of long setae apically; exopodite unarticulated, almost twice longer than endopodite, with 7 spines and 18 sets of long setae on outer margin, with sets of long simple setae along inner margin, 4 spines and about 12 setae in terminal part. Telson as long as uropod 3 protopodite; entirely cleft; 3 apical spines per lobe, each accompanied by 3–6 setae.

**VARIABILITY.** Couple of the studied female specimens are varied greatly in body size, in number of spines on gnathopod propodi and in form of bases of pereopods V–VII. Males unknown.

**DISTRIBUTION AND ECOLOGY.** *Kruberia abchasica* sp.n., inhabits a cave lake at the bottom part of the Kruberia Cave (at depth –2175 m); water temperature +8.0 °C. On appendages among the bristles is abundantly represented the sucking ciliates of the genus *Tokophrya* Bütschli. In the same biotope the presence of translucent troglobiont fishes was also observed.

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