

A new species of stygobiotic atyid shrimps of the genus *Xiphocaridinella* (Crustacea: Decapoda: Atyidae) from the Racha-Lechkhumi and Kvemo Svaneti, with a new record of *X. kumistavi* from the Imereti, Western Georgia, Caucasus

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ABSTRACT: An integrative approach resulted in a description of a new species of stygobiotic shrimps of the genus *Xiphocaridinella* Sadowsky, 1930 (Crustacea: Decapoda: Atyidae) from the southern part of the Racha-Lechkhumi and Kvemo Svaneti Region of the Western Georgia (SW Caucasus). The area and caves, from which this species is recorded will be flooded during the construction of the Tvishi hydroelectric power plant and it is unknown whether it will be possible to find the species again. *Xiphocaridinella lechkhimensis* sp.n. is easily separated from the other species of the genus both morphologically and genetically, as evidenced by barcoding segments of the mitochondrial COI gene marker (barcoding). In addition, we discovered a new population of *X. kumistavi* Marin, 2017 in the Satevzia Cave from Imereti Region. This population genetically diverged from the type series from the Prometheus Cave by the barcoding gap of 2.4%. The genus *Xiphocaridinella* in the Colchis Valley of the SW Caucasus now encompasses 15 species.

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Новый вид стигобионтных креветок рода *Xiphocaridinella* (Crustacea: Decapoda: Atyidae) из Рача-Лечхуми и Квемо Сванети, и новая находка *X. kumistavi* в Имеретии, Западная Грузия, Кавказ

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РЕЗЮМЕ: Интегративный подход позволил описать новый вид стигобионтных креветок рода *Xiphocaridinella* Sadowsky, 1930 (Ракообразные: Decapoda: Atyidae) из южной части региона Рача-Лечхуми и Квемо Сванети Западной Грузии (Южный Кавказ). Территория и пещеры, где обитал этот вид, будут в ближайшее время затоплены во время строительства гидроэлектростанции Твиши, и неизвестно, удастся ли найти его снова в будущем. *Xiphocaridinella lechkhumensis* sp.n. хорошо отделен от других видов рода морфологически и генетически с помощью штрихкодирования сегментов митохондриального гена COI. Также, нами обнаружена новая популяция *X. kumistavi* в пещере Сатевция из Имеретии, которая отличается от типовой из пещеры Прометей на 2.4% по генному маркеру цитохромоксидазы (COI). Разнообразие рода *Xiphocaridinella* из Колхидской низменности на Южном Кавказе увеличилось до 15 видов.

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КЛЮЧЕВЫЕ СЛОВА: штрихкодирование, COI мтДНК, стигобиотические креветки, гидрогеология, Кавказ.

Introduction

The stygobiotic atyid shrimp genus *Xiphocaridinella* Sadowsky, 1930 (Crustacea: Decapoda: Atyidae) currently includes 13 valid species described from the subterranean water habitats of the northern and northwestern part of Kolkhida coastal lowland plain of the eastern Black Sea (Colchis), SW Caucasus (e.g. Sadowsky, 1930; Birštein, 1939, 1948; Juzbaš'jan, 1940, 1941; Marin, Sokolova, 2014; Marin, 2017a, b, 2018a, b, 2019, 2020). Sadowsky (1930) proposed a new genus *Xiphocaridinella* for the Caucasian representatives of the subterranean *Troglocaris*-like shrimps, which was once placed in the subgenus *Troglocaris* Dormitzer, 1853 (e.g., De Grave, Fransen, 2011), but recently again restored to the full generic status (Marin, 2017b; WoRMS, 2021). Our knowledge about these stygobiotic shrimps living in underground habitats is still incomplete, and new species have been discovered and described in recent years.

In 2018, during a biospeleological study of the cave biodiversity of the Western Georgia

(Caucasus), two unknown populations of stygobiotic shrimps were discovered in the Imereti and Racha-Lechkhumi and Kvemo Svaneti Regions. In the Verdzistava II Cave near village Tvishi, Tsageri municipality of the Racha-Lechkhumi and Kvemo Svaneti region, we collected two small individuals representing a species described below as new. At present, the fate of the species and a possibility of new sampling are questionable, since a hydroelectric power plant is being built in the area and many caves are expected to be flooded. For this reason, the new species is described on the basis of only two individuals, but molecular genetic data confirm its validity. Shrimps collected from the Imereti region represent a new discovered population of *X. kumistavi* Marin, 2017 and also reported herewith with the help of an integrative approach.

Material and methods

SAMPLING AND REPOSITORIES. Shrimps were collected by hand net in a subterranean stream of the Verdzistava II Cave

(42°31'44.23"N, 42°47'38.79"E) located near village Tvishi, Tsageri Municipality, Racha-Lechkhumi and Kvemo Svaneti Region of Western Georgia (SW Caucasus) in May 2018. All specimens were preserved and stored in 96% ethanol for further DNA analysis. The postorbital carapace length (pcl., in mm), the length from the posterior margin of the orbit to the posterodorsal margin of carapace, and the total body length (tbl., in mm), measured from the tip of rostrum to the posterior margin of the telson, are used for measurements. The holotype is deposited in the collection of the Zoological Museum of Moscow University (ZMMU), Moscow, Russia; the paratype specimen is deposited in the collection of the Institute of Zoology, Ilia State University, Tbilisi, Georgia (IZ-ISU).

DNA EXTRACTION. Partial fragment of the cytochrome c oxidase subunit I gene (COI) of the mitochondrial DNA is used as one of the most informative markers for assessing species status within *Xiphocaridinella* (Avisé, 1993; Sket, Zakšek, 2009; Marin, 2017a, b, 2018a, b, 2019, 2020). Total genomic DNA was extracted from muscle tissue of the pleon using the innuPREP DNA Micro Kit (AnalytikJena, Germany). The COI mtDNA gene marker was amplified with the help of the universal primers LCO1490 (5'-GGTCAACAAATCATAAA-GATATTGG-3') and HC02198 (5'-TAAACTCAGGGTGACCAAAAAATCA-3') (Folmer *et al.*, 1994). PCR was performed on amplifier T100 (Bio-Rad, USA) under the following conditions: initial denaturation at 96 °C for 1.5 min followed by 42 cycles of 95 °C for 2 min, 49 °C for 35 seconds, and 72 °C for 1.5 min, followed by chain extension at 72 °C for 7 min. The volume of 10 µL of reaction mixture contained 1 µL of total DNA, 2 µL of 5xPCR mix (Dialat, Russia) and 1 µL of each primer (60 µM). The amplification products were separated by using gel electrophoresis of nucleic acids on a 1.5% agarose gel in 1xTBE, and then stained and visualized with 0.003% EtBr using imaging UV software. Direct sequencing of the purified PCR products was performed with the ABI 3500l Genetic Analyzer (Applied Biosystems,

USA) and dye-labeled terminators (BigDye terminator v. 1.1; Applied Biosystems, Foster City, CA, USA). Dataset of aligned sequences of COI mtDNA gene markers of other congeneric species (617 base pairs in length) were taken from GenBank (NCBI).

PHYLOGENETIC ANALYSIS. Consensus of complementary sequences was obtained with MEGA 7.0. PartitionFinder v. 2. for finding best-fitting partitions for the COI mtDNA gene marker (Lanfear *et al.*, 2016), which is usually characterized by a strong heterogeneity in nucleotide substitution rates among all three coding positions. The best evolutionary substitution model was also determined using MEGA 7.0 and jModeltest2.1.141 as GTR+G+I. Further PhyML 3.0 (<http://www.atgc-montpellier.fr/phyml/>) (Guindon *et al.*, 2010) with several models based on BIC (Bayesian Information Criterion) and AIC (Akaike Information Criterion) with 1000 bootstrap replicates was used to create Maximum Likelihood (ML) phylogenies used for visualization of the phylogenetic relationships. Pairwise genetic divergences (*p*-distances) was calculated using MEGA 7.0 with the Kimura 2-parameter (K2P) model of evolution (Kimura, 1980) to show interspecific genetic divergence.

Results

DNA ANALYSIS. The interspecific *p*-distance between two specimens of *Xiphocaridinella lechkhumensis* sp. n. (n=2) collected in the Verdzistava II Cave (Racha-Lechkhumi and Kvemo Svaneti, Georgia) is very low, 0.005±0.0003 substitutions per 100 nucleotide positions (about 0.5%), indicating that the two specimens belong to the same species, and being similar to other known species of the genus *Xiphocaridinella* (see Marin, 2017a, 2018a, b, 2019, 2020; Marin, Turbanov, 2021). The interspecific K2P-distances between *Xiphocaridinella lechkhumensis* sp.n. (n=2) and other 13 Caucasian congeneric species are about 0.08 substitutions per 100 nucleotide positions (about 8%) (Table 1).

Table 1. Uncorrected pairwise genetic distances (the number of substitutions per 100 nucleotides) of the barcoding segments of the COI gene marker between *Xiphocaridinella lechkhumensis* sp.n. (n=2) and the other 14 known Caucasian species of the genus *Xiphocaridinella* arranged by the degree of genetic divergence (from low to high).

Таблица 1. Нескорректированные попарные генетические дистанции (число замен на 100 нуклеотидов) результатов штрихкодирования генного маркера COI между *Xiphocaridinella lechkhumensis* sp.n. (n=2) и другими 14 известными кавказскими видами рода *Xiphocaridinella*, упорядоченные по степени генетической дивергенции (от низкой к высокой).

<i>Xiphocaridinella kumistavi</i> Marin, 2017 (n=18)	0.077±0.011
<i>Xiphocaridinella kelasuri</i> Marin et Turbanov, 2021 (n=15)	0.079±0.011
<i>Xiphocaridinella smirnovi</i> Marin, 2020 (n=1)	0.079±0.011
<i>Xiphocaridinella kutaissiana</i> Sadowsky, 1930 (n=16)	0.081±0.014
<i>Xiphocaridinella demidomi</i> Marin, 2021 (n=1)	0.095±0.014
<i>Xiphocaridinella motena</i> Marin, 2019 (n=10)	0.096±0.014
<i>Xiphocaridinella fagei</i> (Birštein, 1939) (n=17)	0.101±0.012
<i>Xiphocaridinella dbari</i> Marin, 2019 (n=7)	0.102±0.013
<i>Xiphocaridinella otapi</i> Marin, 2018 (n=18)	0.103±0.013
<i>Xiphocaridinella jusbaschjani</i> (Birštein, 1948) (n=14)	0.102±0.013
<i>Xiphocaridinella osterloffii</i> (Juzbaš'jan, 1941) (n=15)	0.105±0.014
<i>Xiphocaridinella shurubumu</i> Marin, 2018 (n=15)	0.107±0.015
<i>Xiphocaridinella falcirostris</i> Marin, 2020 (n=11)	0.110±0.015
<i>Xiphocaridinella ablaskiri</i> (Birštein, 1939) (n=5)	0.115±0.015

The specimens from the Satevzia Cave (n=2) (Imereti, Georgia) are genetically close to *Xiphocaridinella kumistavi* (Marin, 2017) (n=18) from the Kumistavi Cave (type locality) (see Fig. 1), with the K2P-distances between the populations about 0.024±0.004 substitutions per 100 nucleotides (about 2.4%). Such values of genetic divergence are significantly lower than interspecific divergence within *Xiphocaridinella*, which is approximately 5% (e.g., Marin, 2020).

Taxonomic part

Order Decapoda Latreille, 1802

Family Atyidae De Haan, 1849

Genus *Xiphocaridinella* Sadowsky, 1930

Xiphocaridinella lechkhumensis sp.n.

Fig. 2.

TYPE MATERIAL. HOLOTYPE, non-ovigerous ♀ (pcl. 4.2 mm, tbl. 14.0 mm) (damaged, without pereopods), ZMMU Ma-6215, SW Caucasus, Georgia, Racha-Lechkhumi and Kvemo Svaneti, Tsageri Municipality, inside Verdzistava II Cave located near the village of Tvishi, 42°31'44.23"N 42°47'38.79"E, about 400 m a.s.l., coll. G. Nebieridze, 16.05.2018.

PARATYPE, 1 juv. (pcl. 3.8 mm, tbl. 12.0 mm) (damaged), IZISU AC-T-00001, same locality and data as holotype.

ETYMOLOGY. The new species is named after Lechkhumi region of the Western Georgia, where it was discovered.

DESCRIPTION. Small-sized shrimp with swollen, subcylindrical body.

CARAPACE (Fig. 2A–C, E) smooth, dorsally unarmed. ROSTRUM (Fig. 2A–C, E) dorsoventrally flattened, broadly triangular in dorsal view, distally slightly upturned in holotype (Fig. 2 A, B), straight in paratype (Fig. 2C, E); dorsal surface unarmed, but

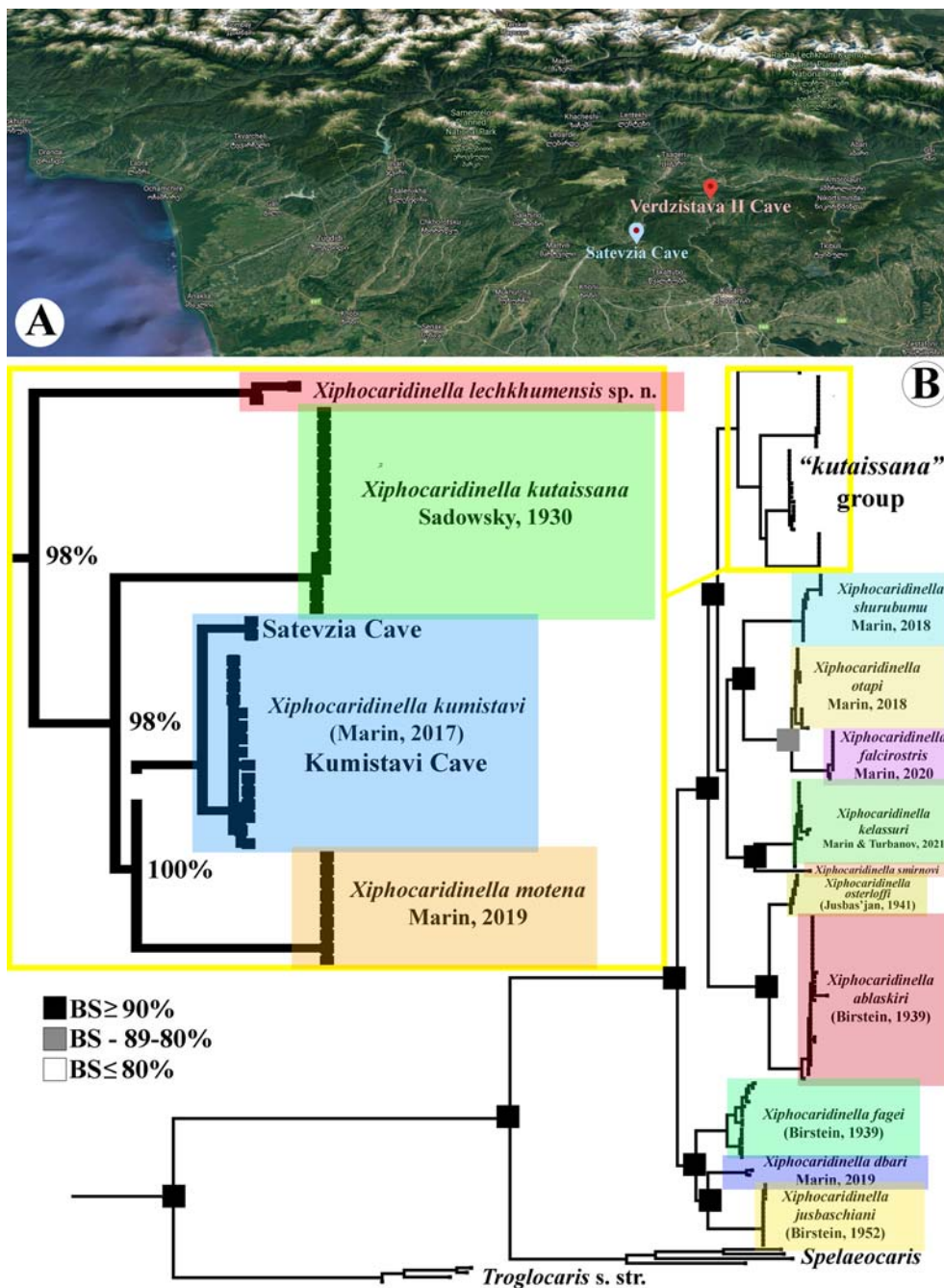


Fig. 1. The map indicating the locality, where shrimps were collected (A), and phylogenetic reconstruction (tree) of the Caucasian species of *Xiphocaridinella* (GTR+G+I model) (below) using mitochondrial COI mtDNA gen marker with the support (BS) based on ML method (B).

Рис. 1. Карта с указанием района, где были собраны креветки (A), и филогенетическая реконструкция (дерево) Кавказских *Xiphocaridinella* (модель GTR+G+I) (ниже) с использованием генного маркера COI мтДНК с поддержкой на основе метода ML (B).

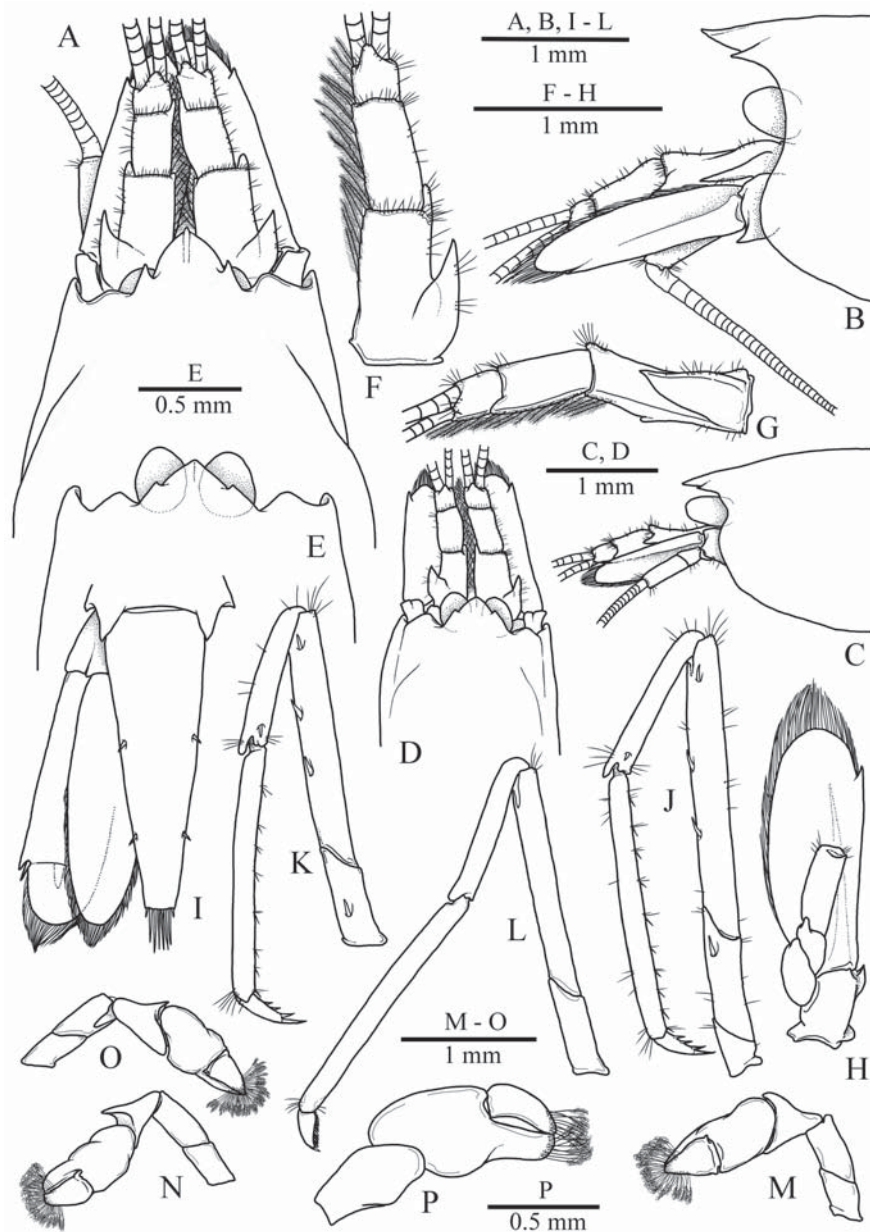


Fig. 2. *Xiphocaridinella lechkhumensis* sp.n., holotype, ♀, pcl. 5.0 mm, tl. 16.0 mm, ZMMU Ma-6215 (A, B, F-P); paratype ♀, pcl. 3.2 mm, tl. 12.0 mm, IZISU AC-T-00001 (C-E): A, C, E — front of carapace, dorsal view; B, D — front of carapace, lateral view; F — antennula, dorsal view; G — antennula, lateral view; H — antenna; I — telson and uropods, dorsal view; J — pereopod III; K — pereopod IV; L — pereopod V; M — pereopod I; N, O — pereopod II, different views; P — chela of pereopod II, ventral view.

Рис. 2. *Xiphocaridinella lechkhumensis* sp.n., голотип, ♀, pcl. 5,0 мм, tl. 16,0 мм, ZMMU Ma-6215 (A, B, F-P); паратип, ♀, pcl. 3,2 мм, tl. 12,0 мм, IZISU AC-T-00001 (C-E): A, C, E — передняя часть карапакса, вид сверху; B, D — передняя часть карапакса, вид сбоку; F — антеннула, вид сверху; G — антеннула, вид сбоку; H — антенна; I — тельсон и уropоды, вид сверху; J — pereopod III; K — pereopod IV; L — pereopod V; M — pereopod I; N, O — pereopod II, разные виды; P — клешня pereopod II, вид снизу.

with short carina in distal half; lateral margins slightly convex or straight, each with small tooth located at about midlength; ventral surface unarmed.

EYES (Fig. 2A–C, E) reduced, without pigment; eyestalk stout, swollen, subcylindrical, about as long as wide.

PLEON (not illustrated) smooth, unarmed; tergites non-carinate; pleura of pleomeres I–IV marginally rounded, posteroventral margins of pleomere V slightly produced posterodorsally. Telson (Fig. 2I) about 3.7 times as long as proximal width, tapering distally, with 2 pairs of small dorsal submarginal spines, set at about 0.45 and 0.75 telson length respectively; distal margin almost straight, with 4 pairs of spines.

ANTENNULE (Fig. 2F, G) with robust basal peduncular segment, about twice longer than proximal width, without ventromedial tooth, distolateral angle with broadly produced; stylocerite tapering distally to acute tip, reaching beyond mid-length of basal peduncular segment; second and third peduncular segments stout, unarmed; second segment about 1.8 times as long as wide and about 1.5–2 times as long as distal segment; distal segment about as long as wide; flagellum well developed, about as long as body length.

ANTENNA (Fig. 2H) with basicerite stout, with ventrolateral distal spine; carpocerite robust, about 2 times as long as wide, reaching midlength of scaphocerite; scaphocerite well developed, broad, with small but well-marked distolateral tooth not reaching to rounded distal margin of lamella.

MOUTHPARTS typical for the genus, without specific features, not figured. Mandible well developed, without palp; molar process well developed, relatively slender, with several small and large distodorsal teeth; incisor process slender, tapering distoventrally, with slender serrated sharp lamina distally. Maxillule with dorsal lobe bearing completely fused lacinia, ventral lobe small, covered with curved setae distally, palp well-developed, with 2 distal setae. Maxilla with small, tapering palp; endites moderately broad, well developed; basal endite feebly bilobed, furnished with elongated stiff setae; coxal endite obsolete; scaphognathite broad, furnished with short plumose setae. Maxilliped I with reduced epipod; exopod small and slender, basally with expanded caridean lobe bearing plumose marginal setae; basal and coxal endites completely fused, excavate, furnished with long simple setae distally. Maxilliped II without epipod; exopod long and slender, reaching distal segments. Maxilliped III slender, with small epipod on coxa bearing

feebly developed terminal hook interacting seto-branch on pereopod I, and with arthrobranch; exopod slender, almost reaching distal margin of antepenultimate segment; antepenultimate segment slender, about 8 times as long as wide; penultimate segment about 7–8 times as long as wide, with straight lateral margin; ultimate (distal) segment slender, about 7 times as long as wide, tapering distally, with tufts of short simple stick-like setae along ventral and lateral margins.

PEREOPOD I (present in paratype only) (Fig. 2M) stout; coxa with well-developed slender epipod bearing feebly developed terminal hook and seto-branch; basis about as long as wide, with feebly developed exopod (not illustrated); ischium about 1.5 times longer than wide; merus stout, about 1.5–2 times as long as wide, slightly longer than ischium and equal in length to carpus; carpus relatively stout, significantly widening distally, about as long as maximal width; palm stout, about 1.3 times as long as wide, subcylindrical in cross-section; fingers stout, about 1.5 times as long as the length of palm and about 1.3–1.5 times as long as their proximal width, blunt distally, armed with a row of stout strong plumose setae fringing terminal margins.

PEREOPOD II (present in paratype only) (Fig. 2N–P) stout, subequal in length to pereopod I; coxa with epipod and setobranchs; basis about as long as wide, with short exopod, probably because of feebly development in the juvenile specimen; ischium about 1.5 times as long as wide; merus slender, about 2 times as long as wide, slightly longer than ischium; carpus relatively slender, about 1.3 times as long as wide, widening distally; palm (Fig. 2P) stout, similar to that of pereopod I, about as long as wide, subcylindrical in cross-section; fingers stout, about 1.5 times as long as palm, blunt distally, about as long as proximal width, with simple and straight cutting edge, with row of strong plumose setae on terminal margins.

PEREOPOD III (Fig. 2J) relatively slender; coxa with seto-branch and small epipod without terminal hook; basis about as long as wide, with well-developed exopod overreaching mero-carpal articulation ischium about 2.0–2.5 times as long as wide, with 1 subdistal small movable spine on lateral surface ventrally; merus about 6 times as long as wide, with 3 spines on lateral surface along ventral margin; carpus relatively slender, about 7 times as long as wide, slightly widening distally, about half-length of merus or propodus, with small subdistal spine on lateral surface; propodus straight, about 10 times as long as wide, armed with 9 spinules on proximal half

of flexor margin and a row of short simple setae on its distal half; dactylus about 2.5–3 times longer than maximal width, biunguiculate, flexor margin armed 2 accessory spinules on the flexor margin in addition to the penultimate unguis and several small simple setae, ultimate unguis smooth, curved; penultimate unguis triangular, sharp, larger than other accessory spines on flexor margin, about half-length of ultimate unguis.

PEREOPOD IV (Fig. 2K) generally similar and slightly shorter than pereopod III; coxa with tuft of setobranchs and small epipod; basis about as long as wide, with well-developed exopod overreaching carpo-meral articulation; ischium about 1.7 times as long as wide, with small distoventral movable spine; merus about 6 times as long as wide, armed with 3 spines on lateral surface along ventral margin; carpus about 5 times as long as wide with small subdistal spine on lateral surface; propodus about 8 times as long as wide, with straight margins, armed with 7 spinules along ventral margin; dactylus about 2.5–3 times longer than wide, biunguiculate; flexor margin armed with 2 small accessory spinules in addition to the penultimate unguis, ultimate unguis smooth, curved and sharp, penultimate unguis sharp, about twice larger than ventral teeth, about twice shorter than ultimate unguis.

PEREOPOD V (Fig. 2L) similar to pereopods III and IV; basis without exopod; propodus about 10 times as long as wide, with straight margins, ventrally unarmed; dactylus with ventral margin armed with a dense “brush” consisting of small simple sharp setae; without penultimate and accessory unguis, ultimate unguis curved, triangular, sharp distally.

PLEOPODS without specific differentiating features.

UROPODS (Fig. 4I) relatively slender, slightly exceeding telson; lateral margin of exopod straight, with 1 large spine mesial to posterolateral tooth; dieresis simple, unarmed.

COLORATION IN LIFE. Body and appendages translucent white; cornea of eye albescent.

GENBANK ACCESSION NUMBERS. OL704738 (holotype), OL704739 (paratype).

DISTRIBUTION. The species is currently known only from the type locality — Verdzistava II Cave.

TAXONOMIC REMARKS. The new species belongs to the genetically and geographically separated “*kutaissiana*” group (clade) in *Xiphocaridinella* distributed in Western Georgia (see Fig. 1), including *X. kutaissiana* Sadowsky, 1930 (the type species of the genus) from the Tskal-Tsiteli (=Iazoni) Cave, Kutaisi (see Sadowsky, 1930; Marin,

Sokolova, 2014), *X. kumistavi* (Marin, 2017) from the Prometheus Cave, Imereti region (see Marin, 2017) and *X. motena* Marin, 2019 from the Motena Cave, Samegrelo-Zemo Svaneti region (see Marin, 2018b, 2019). However, *X. lechkhumensis* sp.n. is unique in the “*kutaissiana*” group by the relatively short rostrum, not reaching the midlength of the basal segment of the antennular peduncle (see Fig. 2A, B), while other species of the group have rostrum distinctly overreaching the distal margin of the basal segment of the antennular peduncle. The unarmed rostrum is shared only with *X. motena*, whereas in *X. kutaissiana* and *X. kumistavi* the rostrum is dorsally and ventrally armed. We have only two individuals, probably both immature, but the rostrum is still much smaller than that of immature individuals in other species of the group.

The new species can be easily separated genetically from the species of the “*kutaissiana*” species group, as well as other congeners (see Fig. 1; Table 1). The minimum genetic divergence of COI between other Caucasian congeners is 8%, which supports the validity of the new species.

Currently, Khvampli karst massif is located in Lechkhumi historic region of Western Georgia (Tatashidze *et al.*, 2009), where cave dwelling invertebrates are poorly investigated. Only two species are recorded in this karst massif: collembolans *Argonychiurus multiocellatus* Djanashvili, Barjadze, Jordana et Burkhardt, 2014 (Colembola: Onychiuridae) (troglobiont) and *Plutomurus birsteini* Djanashvili et Barjadze, 2011 (Colembola: Tomoceridae) (troglophile) (Djanashvili, Barjadze, 2011; Djanashvili *et al.*, 2014). Both of them are living in the Tvishi Cave.

Xiphocaridinella kumistavi (Marin, 2017)

Fig. 3.

MATERIAL EXAMINED. 1 non-ovigerous ♀ (pcl. 6.8 mm, tl. 18.0 mm), 1 ♂ (pcl. 7.0 mm, tl. 20.0 mm), ZMMU Ma-6216, SW Caucasus, Georgia, Imereti region, Tskaltubo district, Dzedzileti village, Sataplia–Tskaltubo karst massif, Satevzia Cave, 42°25′52.01″N 42°33′58.12″E, coll. E. Maghradze, 2.12.2020; 1 ♂, 3 ♀♀, 2 juvs, IZISU AC-NT-00001-6, same locality and data as above.

BRIEF DESCRIPTION. Medium-sized shrimp with swollen body. CARAPACE (Fig. 3A–D) smooth, with short dorsal postrostral carina in frontal part. ROSTRUM relatively long, slender, reaching midlength to distal margin of second antennular segment, sharply pointed distally, unarmed. EYES

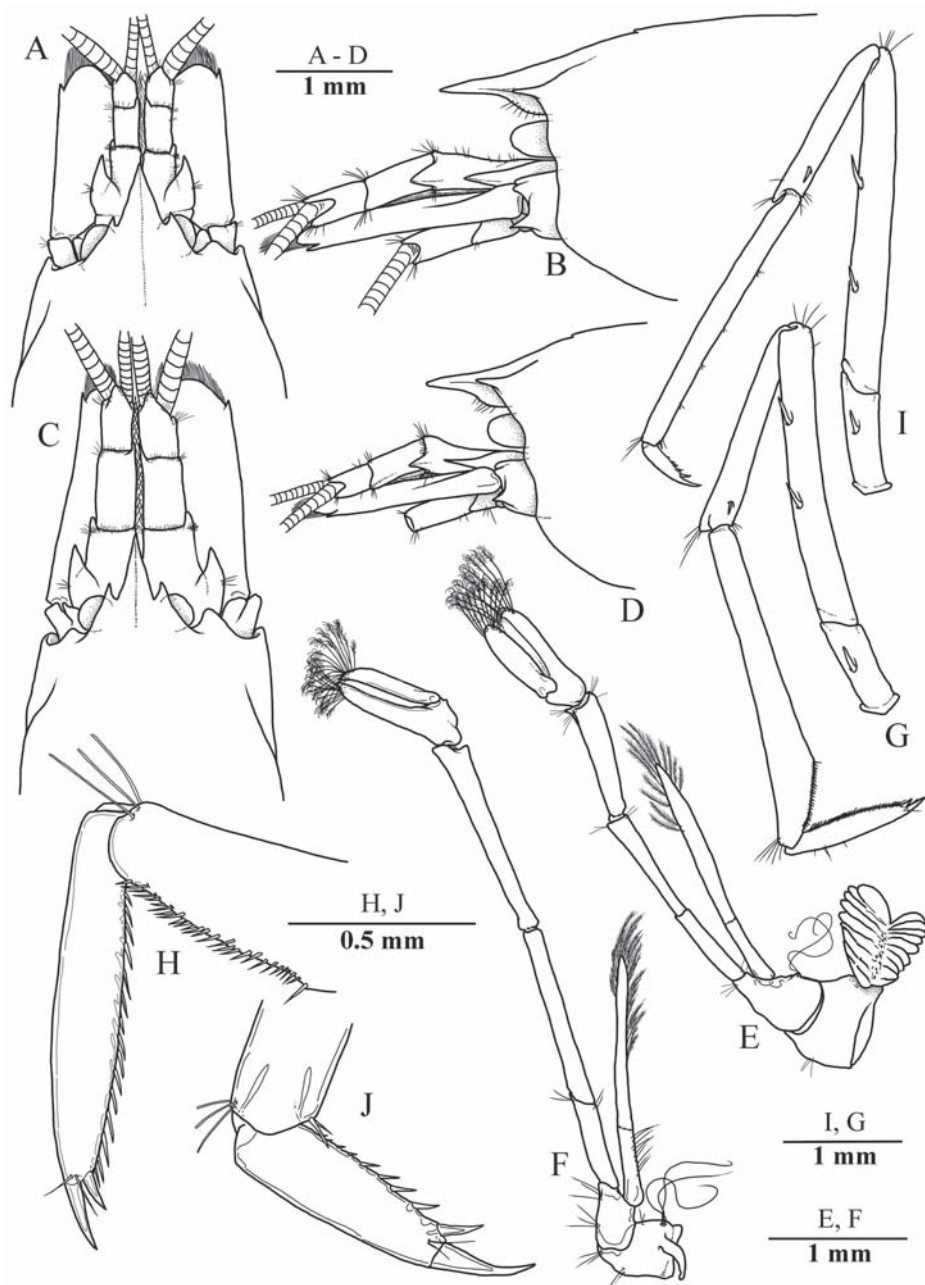


Fig. 3. *Xiphocaridinella kumistavi* (Marin, 2017) from the Satevzia Cave, ♂ (pcl. 7.0 mm, tl. 20.0 mm) (A, B, E-G, H) and ♀ (pcl. 6.8 mm, tl. 18.0 mm) (C, D, I, J), ZMMU Ma-6216: A, C — front of carapace, dorsal view; B, D — front of carapace, lateral view; E — pereopod I; F — pereopod II; G, I — pereopod III; H, J — dactyli of pereopod III.

Рис. 3. *Xiphocaridinella kumistavi* (Марин, 2017) из пещеры Сатевция, ♂ (pcl. 7,0 мм, тл. 20,0 мм) (A, B, E-G, H) и ♀ (pcl. 6,8 мм, тл. 18,0 мм) (C, D, I, J), ZMMU Ma-6216: A, C — передняя часть карапакса, вид сзади; B, D — передняя часть карапакса, вид сбоку; E — переопод I; F — переопод II; G, I — переопод III; H, J — дактилусы переоподы III.

(Fig. 3A, C) partly covered by carapace; cornea rounded, reduced and feebly marked, without pigment; eyestalk stout, swollen, cylindrical, about as long as wide. PEREOPODS I (Fig. 3E) similar in males and females; basis with well-developed exopod overreaching carpo-meral articulation; ischium about 4 times as long as wide; merus slender, about 4 times as long as wide, equal to ischium in length; carpus relatively stout in males and slightly more slender in females, significantly widening distally, slightly longer than merus, about 4 times as long as maximal width; palm relatively stout, about as long as wide, subcylindrical in cross-section, smooth; fingers relatively slender, smooth, with blunt distal margins, about 4 times as long as proximal width, furnished with a row of stiff plumose setae. PEREOPODS II (Fig. 3F) similar to pereopod I in males and females; coxa with well-developed slender epipod and setobranch; basis with well-developed exopod overreaching carpo-meral articulation; ischium about 3 times as long as wide, with straight margins, unarmed; merus slender, about 5 times as long as wide, longer than ischium; carpus slender, about 8 times as long as wide, slightly widening distally, longer than merus; palm relatively stout, similar to palm of pereopod I, about as long as wide, subcylindrical in cross-section, smooth; fingers relatively slender, smooth, tapering distally, about 4 times as long as proximal width, with simple and straight cutting edges, with broad blunt distal margin, armed with a row of stout strong plumose setae. PEREOPOD III (Fig. 3G, I) with coxa bearing setobranchs and small distally blunt epipod; basis nearly as long as wide, with well-developed exopod almost reaching midlength of merus; ischium with well-marked distoventral spine; merus about 6 times as long as wide, with 2 well marked spines along ventral margin; carpus with small subdistal spine; propodus in males (Fig. 3G) widening distally, armed with numerous short spinules along distal 1/3 of its flexor margin and pair of long slender spines at distal flexor angle; dactylus in males (Fig. 3H) with flexor margin armed with dense brush of small, simple spine-like setae; with curved acuminate unguis; propodus in females not particularly widened distally, armed with 4–5 spines along proximal half of flexor margin; dactylus in females (Fig. 3J) about 3 times longer than wide, ventral margin armed with 6–7 small spines, unguis curved and acuminate; second (accessory) unguis triangular, sharp, slightly larger than flexor spines, about half length of terminal unguis.

REMARKS. The studied specimens from the Satevzia Cave are morphologically similar to the

specimens from the Kumistavi Cave. Minor morphological differences are as follows: 1) the toothless rostrum in all examined specimens (n=8) from the Satevzia Cave, while the and armature of the rostrum is greatly in the Kumistavi Cave from a short toothless to a long curved rostrum with a large number of dorsal and ventral spines (see Marin, 2017); and 2) the meri of ambulatory pereopods, especially pereopod III, armed with 2 spines (vs. usually 3 spines in the specimens from the Kumistavi Cave (see Marin, 2017)). However, significant differences in these traits have also been observed in a series of samples from the type locality (see Marin, 2017a) and can be explained by the intraspecific variability with an evidence of a low genetic divergence between the two populations (see above). The development of a long, armed rostrum in *Troglocaris*-like shrimps is usually associated with the presence of active predators in the subterranean habitats, for example, cave salamander *Proteus anguinus* Laurenti, 1768 (Amphibia: Caudata: Proteidae) (Jugovic *et al.*, 2011) or fishes (common river goby *Neogobius cf. melanostomus* (Pallas, 1811) (Teleostei: Gobiidae) in the Kumistavi cave (see Marin, 2017a)). It is obvious that in the small Satevzia Cave such predators are absent.

GENBANK ACCESSION NUMBERS. OL704740, OL704741.

DISTRIBUTION. The species was originally described from the Kumistavi Cave, 42°22'35.8"N 42°36'03.2"E. The newly discovered population from the Satevzia Cave, 42°25'52.01"N 42°33'58.12"E, expands the distributional range of the species in the Sataplia-Tskaltubo karst massif.

Compliance with ethical standards

CONFLICTS OF INTEREST: The authors declare that they have no conflicts of interest.

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References

- Birštein Ya.A. 1939. [About cave shrimps of Abkhazia] // Zoologicheskyy Zhurnal. Vol.18. No.6. P.960–974 [in Russian].
- Birštein Ya.A. 1948. [The occurrence of the cave shrimp *Troglocaris* in underground water of Mazesta and related problems] // Byulleten' Moskovskogo Obshchestva Ispytatelei Prirody, Otdel Biologicheskii. Vol.53. No.3. P.3–10 [in Russian].
- De Grave S., Fransen C.H.J.M. 2011. Carideorum catalogus: the recent species of the dendrobranchiate, stenopodidean, procarididean and caridean shrimps (Crustacea: Decapoda) // Zoologische Mededelingen. Vol.85. No.9. P.195–589.
- Djanashvili R., Barjadze Sh. 2011. A new species of the genus *Plutomurus* Yosii, 1956 (Collembola, Tomoceridae) from Georgian caves // Journal of cave and karst studie. Vol.73. No.1. P.28–30.
- Djanashvili R., Barjadze Sh., Jordana R., Burkhardt U. 2014. Redefinition of the genus *Argonychiurus* Bagnall, 1949 (Collembola, Onychiuridae) with description of a new species from Georgia // Zootaxa. Vol.3835. No.3. P.381–391.
- Folmer O., Black M., Hoeh W., Lutz R., Vrijenhoek R. 1994. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit 1 from diverse metazoan invertebrates // Molecular Marine Biology and Biotechnology. Vol.3. No.5. P.294–299.
- Guindon S., Dufayard J.F., Lefort V., Anisimova M., Hordijk W., Gascuel O. 2010. New Algorithms and Methods to Estimate Maximum-Likelihood Phylogenies: Assessing the Performance of PhyML 3.0 // Systematic Biology. Vol.59. No.3. P.307–321. <https://doi.org/10.1093/sysbio/syq010>
- Jugovic J., Prevorenik S., Aljančič G., Sket B. 2010. The atyid shrimp (Crustacea: Decapoda: Atyidae) rostrum: phylogeny versus adaptation, taxonomy versus trophic ecology // Journal of Natural History. Vol.44. No.41–42. P.2509–2533. <https://doi.org/10.1080/00222933.2010.502258>
- Juzbaš'jan S.M. 1941. [On the subspecies and intraspecific differentiation in *Troglocaris kutaissiana* Sadowsky. Communication I] // Soobshcheniya Akademii Nauk Gruzinskoy SSR. Vol.2. No.10. P.929–935 [in Russian].
- Kimura M. 1980. A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences // Journal of Molecular Evolution. Vol.16. No.2. P.111–120. <https://doi.org/10.1007/BF01731581>
- Lanfear R., Frandsen P.B., Wright A.M., Senfeld T., Calcott B. 2016. PartitionFinder 2: new methods for selecting partitioned models of evolution formolecular and morphological phylogenetic analyses // Molecular Biology and Evolution. <https://doi.org/10.1093/molbev/msw260>.
- Marin I. 2017a. *Troglocaris (Xiphocaridinella) kumistavi* sp. nov., a new species of stygobiotic atyid shrimp (Crustacea: Decapoda: Atyidae) from Kumistavi Cave, Imereti, Western Georgia, Caucasus // Zootaxa. Vol.4311. No.4. P.576–588. <https://doi.org/10.11646/zootaxa.4311.4.9>
- Marin I.N. 2017b. COXI based phylogenetic analysis of Caucasian clade of European *Troglocaris* s.l. (Crustacea: Decapoda: Atyidae) with the suggestion of a new taxonomic group structure // Biosystems Diversity. Vol.25. No.4. P.323–327. <https://doi.org/10.15421/011749>
- Marin I. 2018a. Cryptic diversity of stygobiotic shrimp genus *Xiphocaridinella* Sadowsky, 1930 (Crustacea: Decapoda: Atyidae): the first case of species co-occurrence in the same cave system in the Western Caucasus // Zootaxa. Vol.4441. No.2. P.201–224. <https://doi.org/10.11646/zootaxa.4441.2.1>
- Marin I. 2018b. *Xiphocaridinella shurubumu* Marin sp.n. (Crustacea: Decapoda: Atyidae) – a new stygobiotic atyid shrimp species from Shurubumu and Mukhuri caves, Chkhorotsku, Western Georgia, Caucasus // Zoologicheskyy Zhurnal. Vol.97. No.10. P.1238–1256. <https://doi.org/10.1134/S0044513418100082>
- Marin I.N. 2019. Crustacean “cave fishes” from the Arabika karst massif (Abkhazia, Western Caucasus): new species of stygobiotic crustacean genera *Xiphocaridinella* and *Niphargus* from the Gegskaya Cave and adjacent area // Arthropoda Selecta. Vol.28. No.2. P.225–245. <https://doi.org/10.15298/arthscl.28.2.05>
- Marin I.N. 2020. Stygobiotic atyid shrimps (Crustacea, Decapoda, Atyidae) from the Amtkel karst system, western Abkhazia, Caucasus, with a redescription of *Xiphocaridinella osterloffii* and the description of two new co-occurring species // Zoologicheskyy Zhurnal. Vol.99. No.11. P.1203–1222.
- Marin I.N. 2021. The shrimps from the bottom: a new species of stygobiotic atyid shrimps of the genus *Xiphocaridinella* from the world-deepest Verevkina Cave // Arthropoda Selecta. Vol.30. No.4. P.521–530. <https://doi.org/10.15298/arthscl.30.4.07>
- Marin I., Sokolova A. 2014. Redescription of the stygobiotic shrimp *Troglocaris (Xiphocaridinella) jusbaschjani* Birštein, 1948 (Decapoda: Caridea: Atyidae) from Agura River, Sochi, Russia, with remarks on other representatives of the genus from Caucasus // Zootaxa. Vol.3754. No.3. P.277–298. <https://doi.org/10.11646/zootaxa.3754.3.3>
- Marin I., Turbanov I. 2021. Molecular genetic analysis of stygobiotic shrimps of the genus *Xiphocaridinella* (Crustacea: Decapoda: Atyidae) reveals a connection between distant caves in Central Abkhazia, southwestern Caucasus // International Journal of Speleology. Vol.50. No.3. P.301–311. <https://doi.org/10.5038/1827-806X.50.3.2378>
- Sadowsky A.A. 1930. [*Xiphocaridinella kutaissiana* nov. gen. et sp. (Fam. Atyidae) aus einer unterirdischen Höhle bei Kutais] // Zakavkazskiy kraevedstvenniy sbornik nauchnoissledovatel'nogo kraevedstvennogo kabineta Universiteta Tiflis. Vol.1. P.93–104 [in Russian with German abstract].
- Tatashidze Z.K., Tsikarishvili K.D., Jishkariani J.M. 2009. [The Cadastre of the Karst Caves of Georgia]. Tbilisi: Petiti Publishing House. 670 pp. [In Georgian]
- WoRMS 2021. *Xiphocaridinella* Sadowsky, 1930. Accessed at: <http://www.marinespecies.org/aphia.php?p=taxdetails&id=586744> on 2021-12-01

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