

A new species of *Speocyclops* (Crustacea: Copepoda) from interstitial waters of the eastern Lesser Caucasus

Новый вид рода *Speocyclops* (Crustacea: Copepoda) из интерстициальных вод востока Малого Кавказа

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An illustrated description of *Speocyclops atropatenae* **sp. nov.** from eastern Lesser Caucasus (Talysh Mountains, at Gosmalyan and the vicinity of Stepanakert [Khankendi]) is presented. The new species differs from the related *S. demetiensis* Scourfield, 1932 and *S. plutonis* Kiefer, 1937 by having a triangular and better developed anal operculum with deep dents (2 to 8) along its outer margin, by a divided genital double-somite, strongly serrated abdominal somites, an elongated distal endopodal P4 segment with the index 1.3 (vs. 1.1 in the two species in comparison), and some other characters. The maxilliped is three-segmented (vs. four-segmented in *S. demetiensis*); the maxillar endopod two-segmented (vs. one-segmented in *S. demetiensis*). *Speocyclops atropatenae* **sp. nov.** possesses six setae on the second endopodal antennal segment (vs. eight in *S. demetiensis*), and the ornament on the first endopodal antennal segment is absent (vs. two transverse spinule rows present in *S. demetiensis*). The new species inhabits interstitial water of mountain streams, and its distribution is the most eastern range in the genus.

Представлено иллюстрированное описание нового вида циклопа *Speocyclops atropatenae* **sp. nov.** из интерстициали горных потоков востока Малого Кавказа (Талыш, поселок Госмальян и окрестности Степанакерта [Ханкенди]). Новый вид отличается от близких *S. demetiensis* Scourfield, 1932 and *S. plutonis* Kiefer, 1937 треугольной, более развитой анальной пластинкой с глубокими зубцами по внешнему краю (числом 2–8), разделенным генитальным сомитом, грубо зазубренными абдоминальными сомитами, удлинённым дистальным члеником P4 с индексом 1.3 (вместо 1.1 у двух других сравниваемых видов) и другими признаками. Максиллипеда 3-членистая (вместо 4-членистой у *S. demetiensis*), максиллярный эндоподит 2-членистый (вместо 1-членистого у *S. demetiensis*); на втором членике эндоподита антенны 6 щетинок (вместо 8 у *S. demetiensis*). Орнамент на первом членике эндоподита антенны отсутствует (у *S. demetiensis* два поперечных ряда колючек). Новый вид занимает восточную окраину области распространения рода.

Key words: Copepoda of mountain interstitial waters, morphology, Cyclopoida, Cyclopidae, *Speocyclops*, *Speocyclops atropatenae*, new species

Ключевые слова: копеподы горной интерстициали, морфология, Cyclopoida, Cyclopidae, *Speocyclops*, *Speocyclops atropatenae*, новый вид

INTRODUCTION

An almost cosmopolitan genus *Speocyclops* represents a distinct morphological, zoogeographical and ecological unity. Species of the genus inhabit subterranean waters of the Alpine formation in Southern Europe from the Pyrenees to the Western Caucasus. The genus contains about 40 species and subspecies (Monchenko, 1986, 2003; Dussart, Defaye, 1985, 2006) including 6 species inhabiting the western part of the Caucasus. Up to date the middle and eastern parts of the Greater Caucasus and the Lesser Caucasus were not sufficiently investigated and the data on the speocyclope fauna of these areas was not known. In this paper a new species of *Speocyclops* is described from interstitial waters of the northern part of the eastern Lesser Caucasus, in particular, the Talysh mountain system.

MATERIAL AND METHODS

The material of the new species and material used for comparisons were collected at different time by the author during his expeditions. *Speocyclops* specimens were fixed in formaldehyde solution in field conditions and then transferred to buffered ethyl alcohol.

Observations on specimens, transferred from ethyl alcohol to glycerine, were made on a MBI-11 light microscope equipped with phase contrast at standard magnifications. Illustrations were made using a drawing tube. The total specimens are preserved in 75% buffered ethyl alcohol. The material is deposited in the copepod collection of Department of Fauna and Systematics of Invertebrate Animals, Schmalhausen Institute of Zoology, National Academy of Sciences of Ukraine, Kiev (IZAN).

Abbreviations used in the description: P1–P4, legs 1 to 4; Exo, exopodite; End, endopodite; L/W, length–width ratio.

TAXONOMIC PART

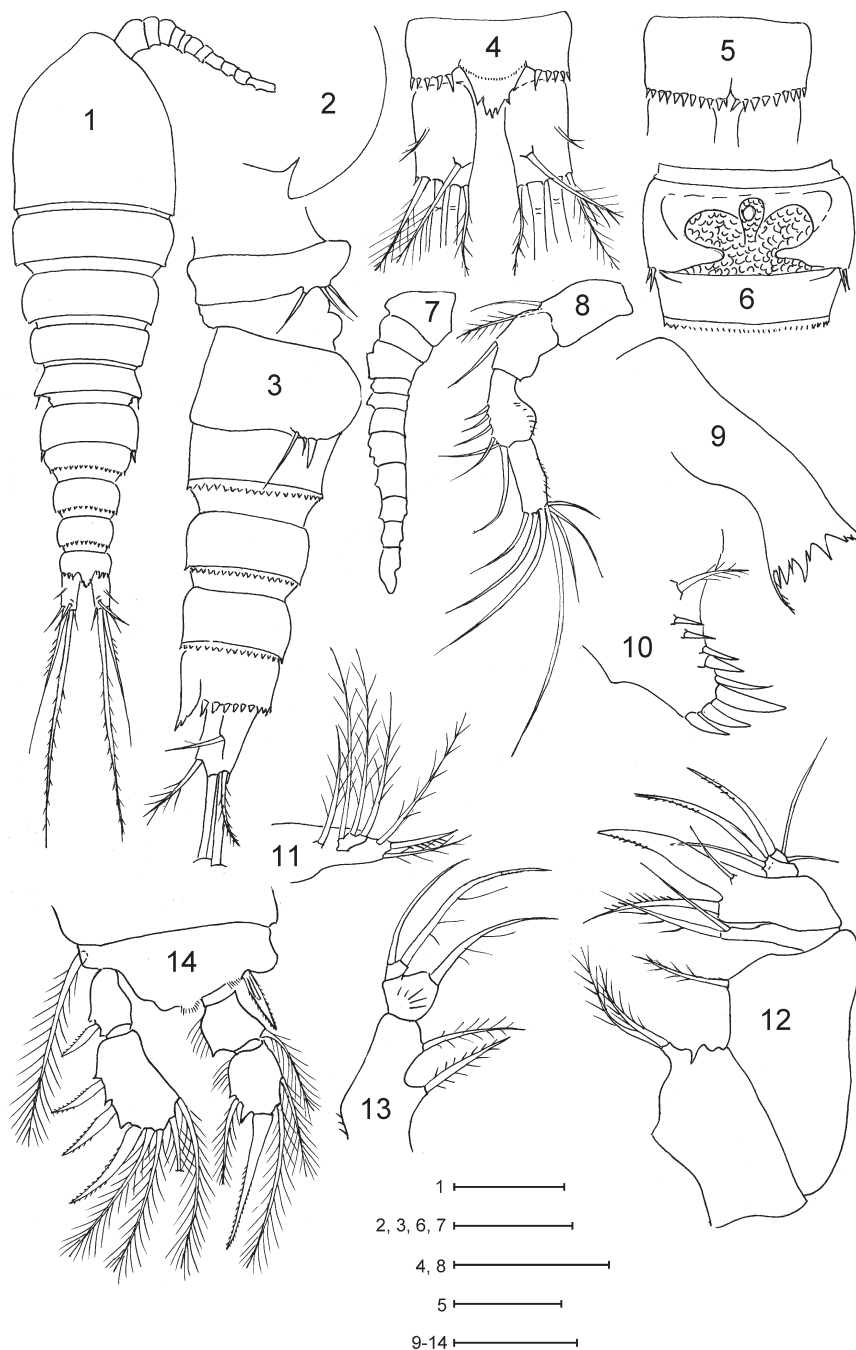
Speocyclops atropatenae sp. nov. (Figs 1–29)

Holotype. Female; 39°51'N 49°17'E, collected in interstitial waters in small gravel in a mountain stream flowing from the Peshtasar Ridge of the Thalysh mountain system, the vicinity of the Gosmalyan settlement, Lerik District, **Azerbaijan**; 17 May 1975, leg. Monchenko; deposited in IZAN (No. 4740) on one slide with paratypes from the same locality (see below).

Paratypes. In total, 30 specimens: 1. 22 females and three males from the same locality as holotype; fifteen females and two males were dissected; some females (slide IZAN 4740-2) will be sent to Zoological Institute, Russian Academy of Sciences, St. Petersburg; 2. five females; 39°52'N 46°45'E, collected in interstitial waters of the pebble in a mountain stream at the vicinity of Stepanakert [Khankendi], southern part of the Nagorny-Karabakh Mountain Ridge, 16 June 1967, leg. Monchenko; dissected, on three slides; deposited in IZAN (No. 3050).

Description. *Female*. Eye pigment absent. Habitus (Fig. 1) dorso-ventrally flattened, typically harpacticoid form, widest at second pedigerous somit, and constricted behind this by degrees to fourth pediger. Body length, excluding caudal setae, 469 µm; urosome slightly shorter (48%) than prosome, which has in front small rostrum (Fig. 2); 5th leg-bearing somite not extended laterally; width of genital double-somit almost equal to width of 5th thoracal somit and 1.5 times exceeds own length; strongly developed, with deep annular furrow (Figs 3, 6), with well developed remnant of ancestral segmentation on dorsal and lateral sides (Figs 1, 3). Two last somites nearly equally long, caudal one narrower than preceding one. Posterior margins of prosomal somites and first urosomal one (5th leg bearing somite) straight; urosomites 3–5 encircled posteriorly with serrate hyaline fringe (Figs 1, 3–6). Integument of all body somites with dense pattern of minute points (not illustrated).

Anal somite with triangular, not so long operculum (Figs 1, 4); posterodorsal margin of somite with “spiniform” processes, in-



Figs 1–14. *Speocyclops atropatenae* sp. nov., female (holotype): 1, total habitus, dorsal; 2, rostrum, lateral; 3, abdomen, lateral; 4, caudal rami, dorsal; 5, anal somite, ventral; 6, genital double-somite, ventral; 7, antennula; 8, antenna; 9, mandible; 10, maxillule; 11, maxillular palp; 12, maxilla; 13, maxilliped; 14, leg 1. Scale bar: 200 µm (1), 50 µm (2, 3, 6, 7), 30 µm (4, 5, 8–14).

creasing in length from outer to medial one; posterolateral and ventral margin set with continuous series of robust prickles (Figs 4, 5); operculum with transverse row of slender small prickles. Operculum prominent, strongly developed, with tip not reaching middle of caudal rami, precisely triangular form, with irregular rough, strong jagged external margins (Fig. 4).

Caudal rami cylindrical, 1.7 times longer than wide; anterolateral seta arising in middle part, positioned in dorsal plane; outermost seta little bit longer than ramus, and longer (or equal in length) than innermost one; all mentioned apical setae enough plumose with dorsal seta as most long one, which even longer than ramus (Fig. 4), principal terminal setae plumose in distal half.

Rostrum (Fig. 2) non separated. Antennule (Fig. 7) 11-segmented, reaching to end of third quarter of head shield in backwards bended condition; segment integument with dense pattern of minute retractile points (not shown in the figure).

Antenna (Fig. 8) typical for cyclopoid, four-segmented; comprising long coxobasis and three-segmented endopod. Coxobasis unornamented, armed with two seta (one from them plumose) at inner distal corner; seta representing exopod absent. First endopodal segment armed with one smooth seta. Second endopodal segment with six setae (five lateral and one apical), and terminal segment with seven apical elements; all setae on endopodite smooth, but two last segments ornamented with two rows of small prickles.

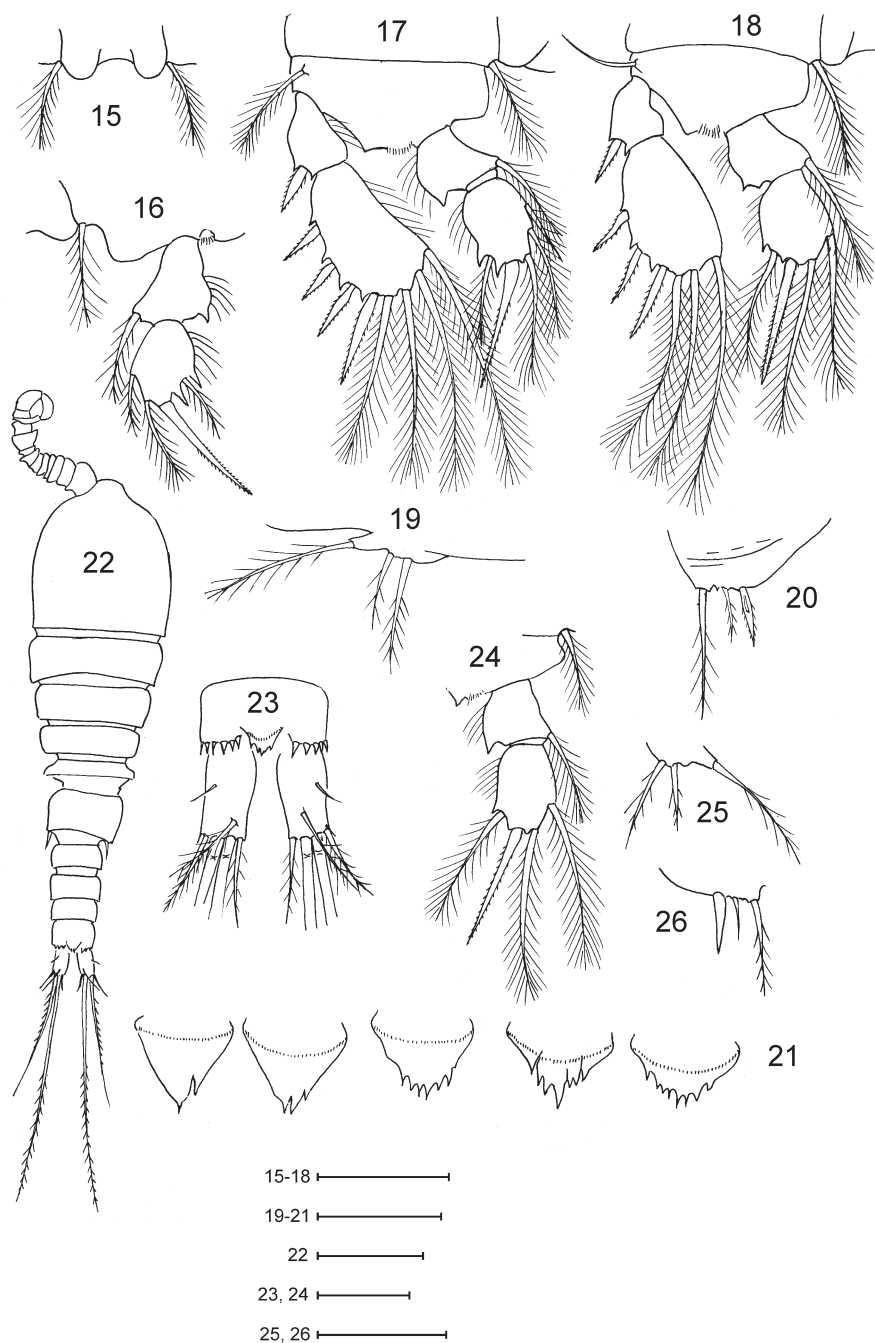
Mandible (Fig. 9) lacking palp; coxal gnathobase cutting edge with enough strong teeth and outermost pinnate seta. Maxillular syncoxa (Fig. 10) compact, with 3 smooth claws and blunt elements along medial margin.

Maxillular palp (Fig. 11) with distinct endopodite, bearing three long pinnate setae (two apical and one lateral), and armed laterally with one exopodal smooth seta and apically with two smooth slender setae and one robust, strongly pinnate spine. Maxilla

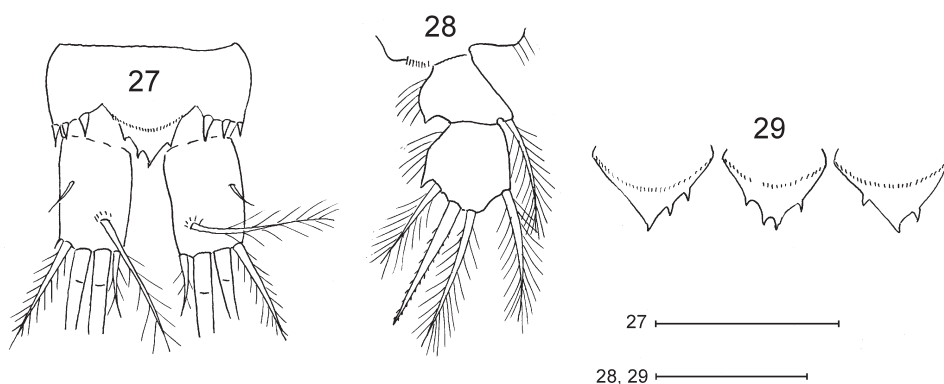
(Fig. 12) with separated praecoxa and coxa; praecoxal endite with two equally sized setae; proximal coxal endite represented by single plumose seta; distal coxal endite cylindrical with two terminal elements; basis typically claw shaped, toothless; proximal basal element nearly as long as claw, serrate along one side; accessorial seta on basis short and smooth; endopodite (Fig. 12) two-segmented, bearing five elements: two on first and three on second segment; two apical ones stout, densely serrate along outer side of stem.

Maxilliped (Fig. 13) three-segmented (with proximal to distal): two, one, and two setae, respectively; ornamentation with spinule rows only on median segment. Legs 1–4 (Figs 14, 16–18) with well developed and distinct coxa and basis, and two-segmented rami; intercoxal sclerites with rounded apical corners and smooth surface (Fig. 15); basis on all pairs furnished with minute spinules near median distal margin, basis with triangular extension in legs 2–4, crescent in leg 1; medial setae on coxae well developed, reaching beyond distal margin of first endopodite segment in all legs (Figs 16–18); outer seta on basis of P1 very long, bipinnate (Fig. 14); those on other legs shorter, on second and third legs pinnate, on fourth leg smooth (Fig. 18). All first segments of exopodite without medial seta, only with outer spine. Inner spine of leg 1 basis, as long as first endopodite segment, stout and ornamented with short prickles. Spine formula of exopodites: 3/4/4/3, seta formula: 4/4/4/3; spines long, well developed, setae on contrary, relatively short.

All first endopodal segments P1–P4 with one inner seta; the second ones with well developed apical spines, stout, partially serrate, and 2.0 times (on P1) or 1.5 times (on P2 and P3) as long as segment. From these segments only endopodite P3 armed by three inner setae, all other by two setae (Figs 14–18). Last segment of endopodite P4 1.3 times longer than wide, bearing single, partially serrate, terminal spine about 1.4 times longer than segment (Fig. 18).



Figs 15–26. *Speocyclops atropatenae* sp. nov. 15–21, female (holotype): 15, connective plate leg 2; 16, endopodite P2; 17, P3; 18, P4; 19, P5; 20, P6; 21, diversity of anal plates. 30 µm (15–18), 20 µm (19–21). 22–26, male (type locality): 22, total habitus, dorsal view; 23, caudal rami, dorsal view; 24, endopodite P1; 25, P5; 26, P6. Scale bar: 30 µm (15–18), 20 µm (19–21), 100 µm (22), 50 µm (23, 24), 30 µm (25, 26).



Figs 27–29. *Speocyclops atropatense* sp. nov., female (vicinity of Stepanakert): **27**, caudal rami, dorsal view; **28**, endopodite P4; **29**, anal plates. Scale bar: 50 μ m (27), 30 μ m (28, 29).

Leg 5 (Fig. 19) with basal segment fused to 5th thoracal somite, armed with basal outer long plumose seta, inner apical seta on vestige second segment bipinnate and 1.3 times as long as plumose outer setae. Leg 6 vestige (Fig. 20), located ventral–lateral on middle of genital double-somite, armed with inner strong spine and sitting nearly its more short plumose seta; outer seta pinnate and enough long.

Genital complex (Fig. 6) ovate and wide: copulatory pore small, leading to lateral expansions and receptacle via rather thick U-shaped copulatory duct; lateral expansions wide, slightly protruded posteriorly (some details not illustrated).

Male. Habitus (Fig. 9) as in female but with narrow urosome, which about 44% of prosome length; total body length, excluding caudal setae, about 420 μ m, widest at posterior end of cephalothorax and second leg-bearing somite; integument, margins of somites, and ornamentation of anal somite (Fig. 23) as in female. Antennule (Fig. 22) typically geniculated, 14-segmented.

Cephalic appendages, legs 1–4, endopodite of leg 4 (Fig. 24) as in female. Leg 5 (Fig. 25) is similar to that in females. Leg 6 (Fig. 26) large, with smooth surface, and bearing three elements on outer caudal corner: outer one pinnate and seta-form, longer

than median and inner elements; median one slender, inner one robust spine.

Etymology. The species name is derived from Atropatena – the ancient name of Azerbaijan.

Variability and variation

The total body length is one of the most important diagnostic features. In the new species, it varies from 437 to 496 μ m (mean 464 μ m), measured in 23 females from the type locality. Males have somewhat smaller total body length that averages 421 μ m. Another significant character, the number of marginal dents on the anal operculum, ranges from 2 to 8 in the females (Fig. 21), averaging 5.75 with the following frequency of occurrence: 2 (1 specimen), 3 (2), 6 (5), 7 (13), 8 (2). It is interesting that neither 4 nor 5 dents were found in the examined females. On the contrary, in three examined males there were found 4 (in two specimen) and 3 dents on the operculum. Besides smaller body length, the males is different from females in having a 14-segmented antennula, the ratio of length of the outermost apical seta to length of the innermost apical seta 1.0 (vs. 0.9 in females), somewhat larger relative length of the apical spine of the distal segment of P4 (152% of segment

length vs. 142% in females) and some other less significant features.

Five females from the second locality, the vicinity of Stepanakert that is at about 200 km distance from the type locality differ in some aspects from the Gosmalyan specimens. At least four taxonomic parameters distinguish the females from Stepanakert which probably deserve the status of a distinct subspecies if the Coefficient of Difference (CD) is taken into account (Mayr et al., 1956). These features are listed below:

(1) the relation between lengths of the innermost and the outermost apical setae of the caudal rami – 0.69 in the females from the vicinity of Stepanakert (Fig. 27) vs. 0.92 in the females from Gosmalyan (the Talysh Mountains) (Fig. 4);

(2) the relation of the dorsal seta length to the length of the caudal rami – 153% in the females from the former locality (Fig. 27) vs. 113% in the females from the latter one (Fig. 4);

(3) the index of the distal endopodal segment of P4 – 1.14 in the females from the former locality (Fig. 28) vs. 1.29 in the females from the latter one (Fig. 18);

(4) the number of the marginal dents (on the anal operculum) – 2–4 in the females from the former locality (Fig. 29) vs. 2–8 in the females from the latter one; the difference may be due to the small number of specimens from the Talysh Mountains;

(5) the index of the caudal rami in the Stepanakert females is 1.5 (Fig. 27) vs. 1.6 in the sample from the Talysh Mountains (Fig. 4).

Besides, there are some less significant structural differences, e.g. larger dents on the hind margin of the anal somite the Stepanakert females (Fig. 27).

COMPARATIVE REMARKS

The genus *Speocyclops* comprises about 30 species or up to 40 taxa if subspecies are included into account (Monchenko, 1986, 2003; Dussartn & Defaye, 2006). It forms a compact morphological assemblage. The

differences between species of the genus are most prominent in the number of spines and setae on the distal segments of the thoracal legs (spine-formula and seta-formula), the degree of development of the transverse furrow on the genital double-somite, the degree of reduction of P5 segments (these differences are recognised according to the presence/absence of a distinct segment in leg 5), in the robustness of elements in the female leg 6, and some other characters such as the operculum morphology and some others characteristics are also enough important.

Speocyclops atropatenae **sp. nov.** belongs to the complex of East-European species of the genus *Speocyclops* that includes the following six species: *S. demetiensis*, *S. psezuapsensis* Borutsky, 1965, *S. colchidanus* Borutsky (1930), *S. tauricus* Borutsky, 1965, *S. lussianus* Borutsky, 1950, and *S. cinctus* Monchenko, 1983. Three from them (*S. cinctus*, *S. lussianus* and *S. tauricus*) have a smooth margin of the weakly developed anal operculum along with some other shared characters. Thus, this is a feature that clearly distinguishes the three other species of the group (*S. demetiensis*, *S. psezuapsensis* and *S. colchidanus*) and the new species *S. atropatenae*. *Speocyclops colchidanus* is unique in the absence of any appendages on the first endopodal segment P1. *Speocyclops psezuapsensis* is unique by having only one seta on the distal endopodal segment P1 (vs. three in other species of the genus).

In routine identification *S. atropatenae* **sp. nov.** can be easily confused with the widely distributed *S. demetiensis* which possesses the largest range among all other species of the genus (see below). *Speocyclops demetiensis* was earlier re-described in details (Monchenko, 1986) from ten different geographic localities of its range. This allows me to provide a detailed comparison between *S. atropatenae* **sp. nov.** and *S. demetiensis*. The two species have a number of common features, e.g. the shape and proportions of the caudal rami and their armament, the spine formula of exopodites

(3/4/4/3), the seta formula (4/4/4/3), the pattern of reduction of P5 and P6, and some others.

Speocyclops atropatenae **sp. nov.** differs well from the Gurney's (1933) description of *S. demetiensis* from Great Britain. The differences consist of the presence, in *S. atropatenae* **sp. nov.**, a triangular anal operculum with deep dents on the outer margin of anal operculum (vs. semicircular or half-rounded in *S. demetiensis*), an elongated innermost apical seta of the caudal rami (index with the outermost one is 0.9 vs. 0.5 in *S. demetiensis*), a divided genital double-somite (vs. not divided in *S. demetiensis*). Further, there are seta-like inner appendages P5 in *S. atropatenae* **sp. nov.** (vs. spine-like in *S. demetiensis*), the index of distal segment of endopodite P4 is 1.3 in *S. atropatenae* **sp. nov.** (vs. 1.1 in *S. demetiensis*), and, finally, the presence of a 3-segmented maxilliped in *S. atropatenae* **sp. nov.** (vs. 4-segmented in *S. demetiensis*, mentioned and illustrated by Gurney. The latter character state is present also in all specimens of *S. demetiensis* examined by me.

The Gurney's description of *S. demetiensis* coincides in all mentioned aspects with my observations (Monchenko, 1986). I used these data for a comparison with other descriptions of the species from different parts of Europe. The presence of the dorsal transverse furrow on the genital double-somite in *S. demetiensis hellenicus* Lindberg, 1953 from Greece and the presence of the extended innermost apical seta in *S. demetiensis acrotirii* Lindberg, 1956 from the Crete Island (Lindberg, 1956) do not affect the significance of differences between *S. atropatenae* **sp. nov.** and *S. demetiensis* s. l. I can also provide some quantitative differences that were of little use in systematic of the genus *Speocyclops* yet. Thus, the ratio between the length of the dorsal seta and the rami length in 23 females of *S. atropatenae* **sp. nov.** is 113% vs 145% in 31 females *S. demetiensis* s. l. from Greece (Lindberg, 1956), but the ratio of lengths of the innermost and outermost apical setae of the fur-

cal rami in *S. atropatenae* **sp. nov.** is 0.9 vs. 0.7 in *S. demetiensis* 0.74 (the difference is statistically significant).

Emphasising the great systematic significance of the presence/absence of the transverse furrow on the genital double-segment, Kiefer (1968) says about the constant absence of this furrow in specimens of *S. demetiensis* investigated by him from Italy (in *S. atropatenae* **sp. nov.** it is present, see Figs 1, 3, 6).

To summarise data from the publications mentioned above and my own data (Monchenko, 1986, 2003), *S. atropatenae* **sp. nov.** differs from *S. demetiensis* by the following characters: (1) genital double-somite divided by deep transverse furrow (vs. fused genital double-somite); (2) anal operculum reaching first quarter of caudal rami (vs. anal operculum not coming out of anal operculum base); (3) presence of strong two to eight dents on operculum (vs. very small denticles on short operculum); (4) maxilliped three-segmented (vs. four-segmented); (5) maxillar endopod two-segmented (vs. one-segmented); (6) distal endopodal segment P4 with index 1.3 (vs. 1.1); (7) six setae on second endopodal antennal segment (vs. eight); (8) absence of ornamentation on first endopodal antennal segment (vs. presence of two transverse spinule rows); (9) longest inner endopodal seta P1 equal to neighbouring apical spine (considerably shorter); (10) seta-like inner appendage P5 (vs. spine-like). Besides, *S. demetiensis* lacks any hillocks at the outer side of the endopodite base P1–P4 while in *S. atropatenae* **sp. nov.** they are well developed though small; functional role of these hillocks is unknown.

Using the keys for *Speocyclops* species by Kiefer (1937), Lindberg (1954) and Borutsky (1965) I found some similarity of *S. atropatenae* **sp. nov.** and *S. plutonis* from a cave in the Dinaric Balkans. However, the two species are different in the structure of the genital double-somite, the shape of the anal operculum and its indentation, index of the distal endopodal segment P4 (near

1.3 vs. 1.0–1.1). The two species also differ by relative length of the P6 elements.

The description presented here gives reasons to assign *S. atropatenae* **sp. nov.** to the genus *Speocyclops*. Remarkable is the weak morphological affinities of this species with the majority of the Caucasian speocyclopes that inhabit the western part of the Greater Caucasus (*S. psezuapsensis*, *S. colchidanus*, *S. tauricus*, *S. lussianus*, *S. cinctus*) excluding *S. demetiensis*. This may be due to the geographic isolation of the new species' range from the areas of distribution of the nearest Western Caucasian species and also from the main area of distribution of the whole genus *Speocyclops* (Pyrenees, Alps, Apennines, Balkan, Crete, western Carpathians, Crimea).

A hypothesis may be put forward that during the early Miocene period of Alpine orogeny the genus *Speocyclops* survived the period of active evolutionary formation. Its species diversity was probably richer than 40 species and subspecies occurring at present, and the area of distribution was much wider and probably included the Armenian Upland and Turkish Anatolia where species of the genus are not known now. But this geographic region represents the shortest migration way between the Lesser Caucasus and the Balkans, the latter being the center of recent species diversity and, perhaps, the center of speciation of *Speocyclops*. These territories constitute the most direct connection between this presumed center of speciation and the extant range *S. atropatenae* **sp. nov.** Thus, *S. atropatenae* **sp. nov.** is the easternmost species among the known species of the genus. Its occurrence in this area including a northern ridge of the Iranian mountains makes possible its occurrence in other mountain systems of the Middle East.

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