Redescription of *Speocyclops orcinus* KIEFER, 1937 (Copepoda Cyclopoida Cyclopidae) from the type locality, Cave Iriberi, in Southern France.

by Frank FIERS* & Ivan PANDOURSKI

Abstract
Female and male of the subterranean cyclopid copepod *Speocyclops orcinus* KIEFER, 1937 are described; the female for the first time. The material used in the present description was collected at the type locality, Cave Iriberi, a vast karst complex in the Department Atlantic Pyrenees, France. The specimens are compared with the type specimens lodged in the Friedrich Kiefer copepod collection at Karlsruhe, Germany. *Sp. orcinus* is found to be a true representative of the cyclopine genus *Speocyclops* and is reallocated to it from *Allocyclops* KIEFER, 1932 to which it has been recently assigned.

Key words: Cyclopidae, systematics, *Speocyclops orcinus*, redescription, female.

INTRODUCTION

With the initial exploration of the aquatic subterranean realm in the Pyrenees at the beginning of the former century, a wealth of new stygobiont harpacticoid and cyclopoid copepods were discovered and subsequently described (see species spectra in Lescher-Moutoué, 1986 for Cyclopidae and Rouch, 1986 for Harpacticoida). In general, the region has become known as one of the 3 areas in Western Europe with the highest diversity of subterranean groundwater taxa (DEHARVENG, *et al.*, in press, 2008).

Among the many subterraneous copepods known so far from the French Pyrenees, the cyclopid genus *Speocyclops* KIEFER, 1937 beats all of them in species number and number of localities (LESCHER-MOUTOUÉ, 1967; 1973). Out of 42 species and subspecies attributed to the genus, 16 have been described from this region (DUSSART & DEFAYE, 2006). However, several species have been described based on a fairly limited number of specimens obtained often from a single locality (mainly caves, rarely springs) which led to the fact that for many the morphological variation of the appendages is unknown and probably underestimated. The subdivision, for example, of *S. racovitzai* (CHAPPUIS, 1923) in numerous subspecies, each known from very few localities often from a single cave in the Pyrenean mountain range appears to be unrealistic and has to be re-analyzed in the future. For many species the original description is concise and lacks significant details or are known from a single sex only, and are in need to be redescribed according to modern standards.

In the following, *Speocyclops orcinus* KIEFER, 1937 is redescribed based on fresh material obtained from the type locality, Cave Iriberi near Bustince in the Atlantic Pyrenees. Thus far, this species has been reported once, and only the male was known. Here we present the first description of the female. Its systematic position among the other genera of the Cyclopinae is reconsidered since is has been challenged recently and transferred to *Allocyclops* KIEFER, 1932 (KARANOVIC, 2001; 2003).

MATERIAL AND METHODS

A total of 7♀♀ and 5♂♂ specimens were collected after repeatedly rinsing the water with a hand-held plankton net (mesh size 38 µm) of rimestone pools in the cave "Grotte d'Iriberi" (syn. of "Grotte de Bustince" or "Grotte des Confesseurs de la Foi") at Bustince, Department Atlantic Pyrenees, Pandourski *leg.* 9-10-1993. Associated fauna: Oligochaeta and Acari. Temperature of the water: 12.8° C; pH 7.30 and 7.95 (in the pools with guano). Collected specimens were transferred in 70% alcohol for long-term storage.

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Observations on specimens, transferred from ethyl alcohol to glycerine, were made on a Leitz Diaplan light microscope equipped with phase contrast at magnifications 625X and 1250X. Illustrations were made using a drawing tube, and prepared using the software Adobe Photoshop© 6.0. Undissected specimens are preserved in 75 % buffered ethyl alcohol. Material is partially incorporated in the copepod collection at the Royal Belgian Institute of Natural Sciences, Brussels (catalogue entries COP), partially in the collection of the Institute of Zoology, Bulgarian Academy of Sciences, Sofia, Bulgaria (catalogue entries No F-4). Abbreviations used in the description: Aesth., Aesthesasc; P1-P4, legs 1 to 4; Exo, End, exopodite and endopodite, respectively, FKCC, Friedrich Kiefer Copepod Collection, at Karlsruhe, Germany; L/W, length-width ratio.

SYSTEMATICS

Order CYCLOPOIDA RAFINESQUE, 1815
Family CYCLOPIDAE RAFINESQUE,1815
Genus SPEOCYCLOPS KIEFER, 1937

Speocyclops orcinus KIEFER, 1937

Cyclops (Diacyclops) racovitzai CHAPPUIS, 1923 - CHAPPUIS, 1933: p. 13 [partim].

Cyclops (Diacyclops) racovitzai CHAPPUIS, 1923 - CHAPPUIS, 1933: p. 24.

Speocyclops orcinus n. sp. - KIEFER, 1937: p. 436 - 437, Taf. 9, figs 83 and 85.

Speocyclops orcinus KIEFER - RYLOV, 1948 (1963): p. 288 (285); LINDBERG, 1954: p. 107, 109; PETKOVSKI, 1954: p. 23; LESCHER-MOUTOUÉ, 1967: p. 280; KIEFER, 1967: p. 179; DUSSART, 1969: p. 185; LESCHER-MOUTOUÉ, 1973: p. 310; MONCHENKO, 1974: p. 332; KIEFER, 1978: p. 216; DUSSART & DEFAYE, 1985: p. 136; LESCHER-MOUTOUÉ, 1986: p. 320; DUSSART & DEFAYE, 2006: p. 225.

Speocyclops racovitzai (CHAPPUIS, 1923) ? – BORUTZKY, 1965: p. 838

Allocyclops (Allocyclops) orcinus (KIEFER, 1937) comb. nov. - KARANOVIC, 2001: p. 24.

A. (Allocyclops) orcinus (KIEFER, 1937) - KARANOVIC, 2003: p. 148.

Graeteriella sp. - PANDOURSKI & APOSTOLOV, 1998: p. 5.

not *Speocyclops orcinus* n. sp. - KIEFER, 1937: fig. 84.

MATERIAL EXAMINED

(1): 2♂♂ dissected on 2 slides (FKCC 2679-2680): syntypes, labeled *typus*; from "Grotte d'Iribery, Basse Pyrénées" (type-locality). CHAPPUIS *leg.*, 12-8-1926 ("Basse-Pyrenées" is the former name of the currently named "Département des Pyrenées Atlantiques"). Mounting medium partially crystallized.

(2): 7♀♀ and 5♂♂ from Grotte d'Iriberi at Bustince, Department Atlantic Pyrenees, in rimestone pools. Pandourski *leg.* 9-10-1993 (see PANDOURSKI & APOSTOLOV, 1998). 1♀ and 1♂ dissected, 4♀♀ and 3♂♂ preserved, deposited in the collection at the Institute of Zoology, Sofia (Col. No F-4-1, F-4-2 (dissected), F-4 (preserved); 1♀ and 1♂ dissected, 2♀♀ and 1♂ preserved and deposited at the Royal Belgian Institute of Natural Sciences, Brussels (COP 7113 A-D, COP 7114 A-C (dissected), and COP 7112 (preserved).

DESCRIPTION

Female: Habitus (Fig. 1A-B) typically dorso-ventrally flattened, widest at the posterior margin of the cephalothorax, and clearly constricted behind fourth pediger; mean body length about 520 µm; prosome slightly longer than urosome; fifth leg-bearing somite not expanded laterally; genital double-somite with well developed remnant of ancestral segmentation on dorsal and lateral sides, furnished with a distinct serrate hyaline fringe; both ancestral somites nearly equally long, caudal one narrower than preceding one; posterior margins of prosomal somites and first urosomal one (fifth leg bearing somite) straight; urosomites 3-5 encircled posteriorly with serrate hyaline fringe (Figs; 2A-B); integument of all body somites and of rostrum with dense pattern of minute refractile points (not illustrated).

Anal somite with crescentic, undulated, operculum; posterodorsal margin with triangular "spiniform" processes on both sides of operculum, increasing in length from outer to medial one; posterolateral and ventral margin set with continuous series of robust spinules; operculum with transverse ventral row of slender spinules; sensilla accompanied with pore orifice.

Caudal rami cylindrical, 1.4 times longer than wide; anterolateral seta arising in anterior half, positioned in dorsal plane, and accompanied with spinules at insertion; posterolateral element stout, longer than ramus, twice as long as medial one, and encircled with spinules at insertion; terminal outer and median setae with irregular long ovate lumen in basal part, lacking functional breaking plane; medial seta short, less than half the ramus length, stout, with spinules at insertion; dorsal seta longer than ramus, articulating on single basal part, and inserted on low pedestal ornamented with 4 to 5 spinules; anterolateral, posterolateral and medial seta with setule ornament arranged around stem, principal terminal seta with setules arranged in horizontal plane; dorsal seta plumose in distal half.

Rostrum (Fig. 4B) large, widely linguiform, and ventrally directed; with 2 pairs of sensilla, and pattern of 6 pores.

Antennule (Figs 3A-B) 11-segmented, reaching to end of third quarter of head shield in backwards bended condition; segment integument with dense pattern of minute refractile points (not illustrated), and a short comb of slender spinules on anterior margin of first segment; armament on segments I to XI: I(8)-II(4)-III(8)-IV(4)-V(2)-VI(2)-VII(3)-VIII(2+Aesth)-IX(2)-X(2+Aesth)-XI(7+Aesth); majority of setae pinnate, with setal ornamentation obviously more rigid on segments I and II than on subsequent segments; anterodistal element on segment V truncate, with hyaline appearance; aesthetascs on segment VIII and XI linguiform, former reaching to end of subsequent segment; later 1;5 times longer than segment XI, and fused at base with terminal seta; aethetasc on segment X filiform, short, about half as long as segment XI.

Antenna (Fig. 4A) typically cyclopid, but lacking exopodal element; praecoxal fold distinct, unornamented; coxobasis with 2 abexopodal setae, serrate along inner margin, and a short proximal row of slender spinules on frontal surface; first endopodite segment with 1seta, second endopodite segment with 7 setae (5 lateral 2 apical), and terminal segment with 7 apical elements; all setae on endopodite smooth.

Mandible (Figs 4C-D) with heavily sclerotized slender gnathobasis, lacking palp; bitting edge with multi-cuspidate ventral tooth, 4 sharp median teeth, 4 spinules and a serrate seta; Maxillular syncoxa (Fig. 4 E) compact, with 3 smooth claws and a serrated blunt element along medial margin, and 6 lateral setae, outermost long and plumose.Labrum (Fig. 4K) with prominent and rounded lateral edges; posterior margin with 12-13 small blunt teeth; surface with 2 rows of slender spinules. Paragnath (Fig. 4J) prominent, transparent, with 3 elements and several rows of slender spinules Maxillular palp with distinct endopodite, bearing 3 long ornamented seta, and long smooth exopodal seta; medial margin with 3 elements: 2 serrate ones, and one armed with some long setules. Maxilla (Fig. 4 H) with remnant of original separation between praecoxa and coxa; praecoxal endite with 2 equally sized setae; proximal coxal endite represnted by single smooth seta; distal coxal endite cylindrical with 2 terminal elements; basis typically claw shaped, toothless; proximal basal element nearly as long as claw, densely serrate along one side; accessorial seta on basis short and smooth; endopodite (Fig. 4I) one-segmented, bearing 5 elements: apical ones stout, densely serrate along outer side of stem. Maxilliped (Fig. 4G) 4-segmented, with (proximal to distal): 1, 1, 1, and 2 setae, respectively; spinule rows on proximal and median segments.

Legs 1-4 (Figs 5A-D) with well developed and distinct praecoxa, coxa and basis, and 2-segmented rami; intercoxal sclerites with rounded apical corners and smooth surface; surface of praecoxa smooth; coxa furnished with minute spinules along apical margins, surface smooth, except for short crescent spinule row on anterior face in leg 1; median distal margin of basis with triangular extension in legs 1-3, crescent in leg 4; medial margin of basis rounded, hairy in legs 1-3, smooth in leg 4; medial setae on coxae well developed, reaching beyond distal margin of first endopodite segment in all legs; medial spine of leg 1 basis, as long as first endopodite segment, stout and ornamented with long and slender spinules; spine formula of exopodites 3/4/4/3, seta formula 3/4/4/3.

LEG ARMAMENT:

	coxa	basis	Exopodite	Endopodite
P1	1	I	I.0 - II-I1-3	0.1 - 1.I1.1
P2	1	0	I.0 - III.I1.3	0.1 - 1.I1.1
P3	1	0	I.0 - III.I1.3	0.1 - 1.I1.2
P4	1	0	I.0 - II.I1.2	0.1 - 1.I1.1

Leg 1 terminal spine on endopodite stout, partially serrate, and twice as long as segment; second endopodite segment of leg 4 about 1.2 times longer than wide, bearing a single, partially serrate, terminal spine, as long as segment; outer subdistal element on second segment as long as terminal spine.

Leg 5 (Fig. 2A-B) with basal segment completely obsolete, represented by short plumose seta; exopodite well distinct, quadrate, bearing 2 terminal pinnate elements: medial one twice as long as segment length

Table I. Principal measurements.

	KIEFER, 1937 (♂: n=2)	Material studied herein: ♀♀	♂♂
Body length (♂: n=2)	0.400 mm	0.512-0.535 mm	0.446-0.465 mm
Caudal rami (L/W)	1.45/1	1.43-1.45/1	1.45/1
End_2P4 (L/W)	1.1-1.2/1	1.26/1	1.24/1
Term. spine End_2P4	25-27 µm	28-29 µm	27 µm
Terminal caudal setae:			
outer one:	broken	148-154 µm	142 - 147 µm
inner one:	broken	220 µm	235 - 238 µm

and half as long as outer seta. Leg 6 vestige (Fig. 2A-B) located ventrolateral, semi-triangular, having 3 elements: inner one minute, conical and with hyaline appearance, median and outer one setiform and pinnate; median seta slightly longer than half the outer element; surface of leg vestige smooth.

Genital complex (Fig. 2A-B) ovate, and wide; copulatory pore small, leading to lateral expansions and receptacle via a rather thick U-shaped copulatory duct; lateral expansions wide, slightly protruded posteriorly.

Male: Habitus (Fig. 1 C) as in female but with narrow urosome, the latter equally long as prosome; body length about 430 µm, widest at posterior end of cephalothorax and second leg- bearing somite; integument, margins of somites, and ornamentation of anal somite as in female.

Antennule (Figs 3 C-E) typically geniculated, 16-segmented, with robust appearance; setal armament: I(8+3Aesth)-II(4)-III(2)-IV(2+Aesth)-V(2)-VI(1)-VII(1)-VIII(3)-IX(1+Aesth)-X(1)-XI(2)-XII(1)-XIII(1+Aesth)-XIV(1)-XV(1)-XVI(12+Aesth); palmal margin of segments XIV and XV with 1 and 2 plate shaped structures, respectively; aethetascs on segments I, IX, XIII linguiform, ensiform on segment IX, linear sided on segments IX and XVI; aesthetasc on terminal segment tubiform, fused at base with slender seta; setae on segments I to III ornamented with rigid setules as in female (not illustrated); terminal segment with crescentic apical margin; integument of segments smooth, except for row of slender and long spinules on anterior margin of segment I.

Cephalic appendages, legs 1-4, and leg 5 (Fig. 2 C) as in female.

Leg 6 (Fig. 2 C) large, with smooth surface, and bearing 3 elements on outer caudal corner: outer one pinnate and setiform, slightly longer than median and inner elements; median one slender, inner one robust, both finely serrated.

VARIABILITY

The female illustrated in Fig 1A lacks (but not detached) the posterolateral element on the left caudal ramus. The opposite ramus has the normal armament. In addition, the tips of the median terminal setae on the caudal rami of this female are not completely stretched, are slightly nodded and bear a cluster of setules, giving the seta end a brush-like appearance.

Variation in dimensions are summarized in the following table. Besides measurements from the specimens observed here, the original notes made by KIEFER (archived at Karlsruhe) are included.

The female with aberrant caudal rami armature (COP 7112, illustrated in Fig. 1 A) is only 465 µm long. The inner terminal seta on the caudal rami measures 220 µm but is not completely expanded. The other female specimens have the terminal seta partially broken.

The anal operculum is basically a crescentic flap reaching towards the caudal end of the anal sinus, at the most, and is ornamented with blunt processes along the posterior margin (Fig 6 A-F). The number of marginal expansions range from 2 to 8 in females, and from 5 to 6 in males. The number of spiniform processes along the posterodorsal margin of the anal somite is in general 3 on both sides of the operculum, but can be less (2: Fig. 6 D) or more (5: Fig. 6 E), or asymmetrical with 2 or 3 at one side of the operculum and 3 or 5 at the opposite (Figs 6 C, F).

DIFFERENTIAL DIAGNOSIS

The original description of *Speocyclops orcinus*, featuring between several descriptions of other highly advanced and specialized cyclopids, is very concise and has been documented with 3 drawings depicting the most relevant distinguishing features. Unfortunately, the

description of the fourth leg contradicts fundamentally with the illustration of it (RYLOV, 1948; LINDBERG, 1954; MONCHENKO, 1974).

KIEFER (p. 436) described the fourth leg endopodite as follows (p. 436, translated from German): "*Terminal segment of the P4 endopodite 1.1 - 1.2 as long as wide, the single terminal spine 25 - 27 µm long.*". The accompanying illustration, however (plate 9, fig. 84) clearly depicts an endopodal ramus with a terminal segment being 1.5 times as long as wide, and bearing 2 terminal spines. Re-examination of the type specimens revealed that the illustration of the fourth leg does not originates from them but from another, unspecified, cyclopine specimen. Curiously, the preserved original pencil drawing of the leg is identical with the illustration in the published version, while the indications on the drawing refer to slides 2679 and 2680 which contain the two specimens of *S. orcinus*.

The type specimens are only partially dissected with the head left undissected. Several parts are impossible to illustrate because of their position and compression by the cover glass. The mounting medium is partially crystalized, covering the detached legs largely. However, most of the morphology is still observable, but the finer details on the different appendages became unclear. The redescription presented herein in based on the specimens obtained from the species type locality, Cave d' Iriberi.

In the absence of the female, and because the controversial description of leg 4, *Sp. orcinus* could not be assigned to a particular species group within the genus.

Although its affiliation to the genus *Speocylops* has commonly accepted on the basis of the leg 5 morphology and the shape of the caudal rami and anal operculum, *Sp. orcinus* does not figures in the available keys (LINDBERG, 1954; BORUTZKY, 1965; DUSSART, 1969). Currently, species of the genus *Speocyclops* are recognized according to (1) the presence/absence of a distinct segment in leg 5 (a feature observable in both sexes), (2) presence/absence of a transverse girdle on the genital double-somite, and (3) the robustness of the female leg 6 elements. Females of *Sp. orcinus* possess a distinct segment in the fifth leg, and have a well developed transverse rim on the genital double-somite which is, contrary to some other species, ornamented with a distinct hyaline undulated fringe and possess. Both key features, in combination with the morphology of the female sixth leg (dwarfed medial element, median and outer element setiform) relate *Sp. orcinus* to *Sp. racovitzai sens. lat.*, *Sp. gallicus* CHAPPUIS & KIEFER, 1952, *Sp. castereti* LINDBERG, 1954, and *Sp. fontinalis* FIERS, 2005. Among these and the several subspecies of *Sp. racovitzai*, *Sp. orcinus* resembles most *Sp. racovitzai gouillonensis* KIEFER, 1954. However (pers. obs. of syntypes, F.F.) the latter has longer caudal rami (1.75/1), a female leg 6 with the outer element 3 times longer than the median on, lacks a hyaline frill on the dorsal girdle of the genital double-somite, and shows triangular processes along the margin of the anal operculum instead of the blunt structures on the operculum as in *Sp. orcinus*.

In routine identifications, *Sp. orcinus* can be easily confused with the much wider distributed *Sp. demetiensis* SCOURFIELD, 1932 because of the rounded anal operculum with small marginal extensions. However, the presence of the transverse ridge on the genital double-somite in the former is so obvious that only a slight closer look reveal the difference.

BORUTZKY (1965) assumed *Sp. orcinus* to be a junior synonym of *Sp. racovitzai* (CHAPPUIS, 1923). Re-examination of a female type specimen of the latter (undissected, mounted in glycerine, Chappuis *det.*, from Cave Bétharram, Arthez-d'Asson, Atlantic Pyrenees, catalogued FKCC 10803, pers. obs. F.F.) revealed clear differences between both species. The most obvious are: (1) the considerable smaller size of *Sp. racovitzai* (365 µm versus 520 µm); (2) the dorsal girdle on the genital double-somite lacking the hyaline ornamentation, and (3) the small blunt triangular anal operculum instead of a crescent one as in *Sp. orcinus*. The caudal rami of *Sp. racovitzai* are as long as the anal and penultimate somite together (far less in *Sp. orcinus*), and bear a longer medial apical seta (at least half as long as outer lateral seta, less than ½ the outer one one in *Sp. orcinus*).

In the controversial revision of the genus *Allocyclops* KIEFER, 1932, KARANOVIC (2001) removed *Sp. orcinus* from its initial destination to *Allocyclops* and assigned it to the nominate subgenus. KARANOVIC (2001) clearly overlooked the contradictions in the original description of *S. orcinus* and simply ignored former criticism (LINDBERG, 1954; DUSSART, 1969; MONCHENKO, 1974). *S. orcinus* remained assigned to *Allocyclops* in subsequent work (KARANOVIC, 2003), whereas DUSSART & DEFAYE (2006) maintained the original designation to the genus *Speocyclops*.

The redescription presented here, including the first observations on the female, and comparison with the type specimens, clearly show that *Sp. orcinus* KIEFER, 1937 has to be retained in the genus *Speocyclops* KIEFER, 1937 as was suggested originally.

ACKNOWLEDGEMENTS

The senior author is most indebted to H.-W. Mittmann (Staatliches Museum für Naturkunde, Karlsruhe) for arranging the facilities to work at the Institute at Karlsruhe and study the Friedrich Kiefer collection. We thank Eric Dupré (Bayonne, France) for his valuable help during the field work.

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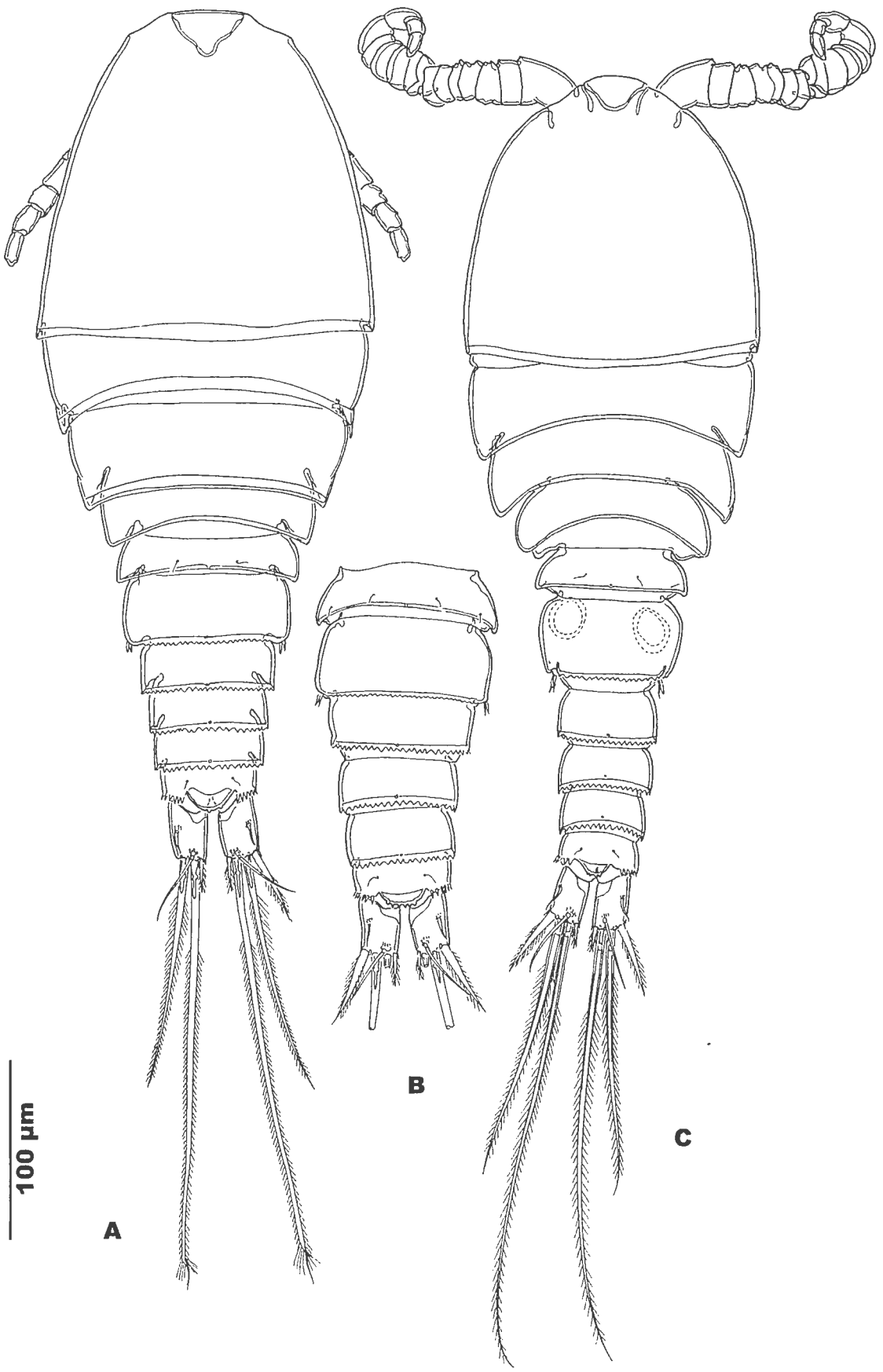

Fig. 1. *Speocyclops orcinus* KIEFER, 1937: A, female habitus (specimen with aberrant armament on left caudal ramus); B, female urosome, dorsal; C, male habitus (fine pattern of refractile points of the integument not shown; A: COP 7112, B: COP 7113; C: COP 7114).

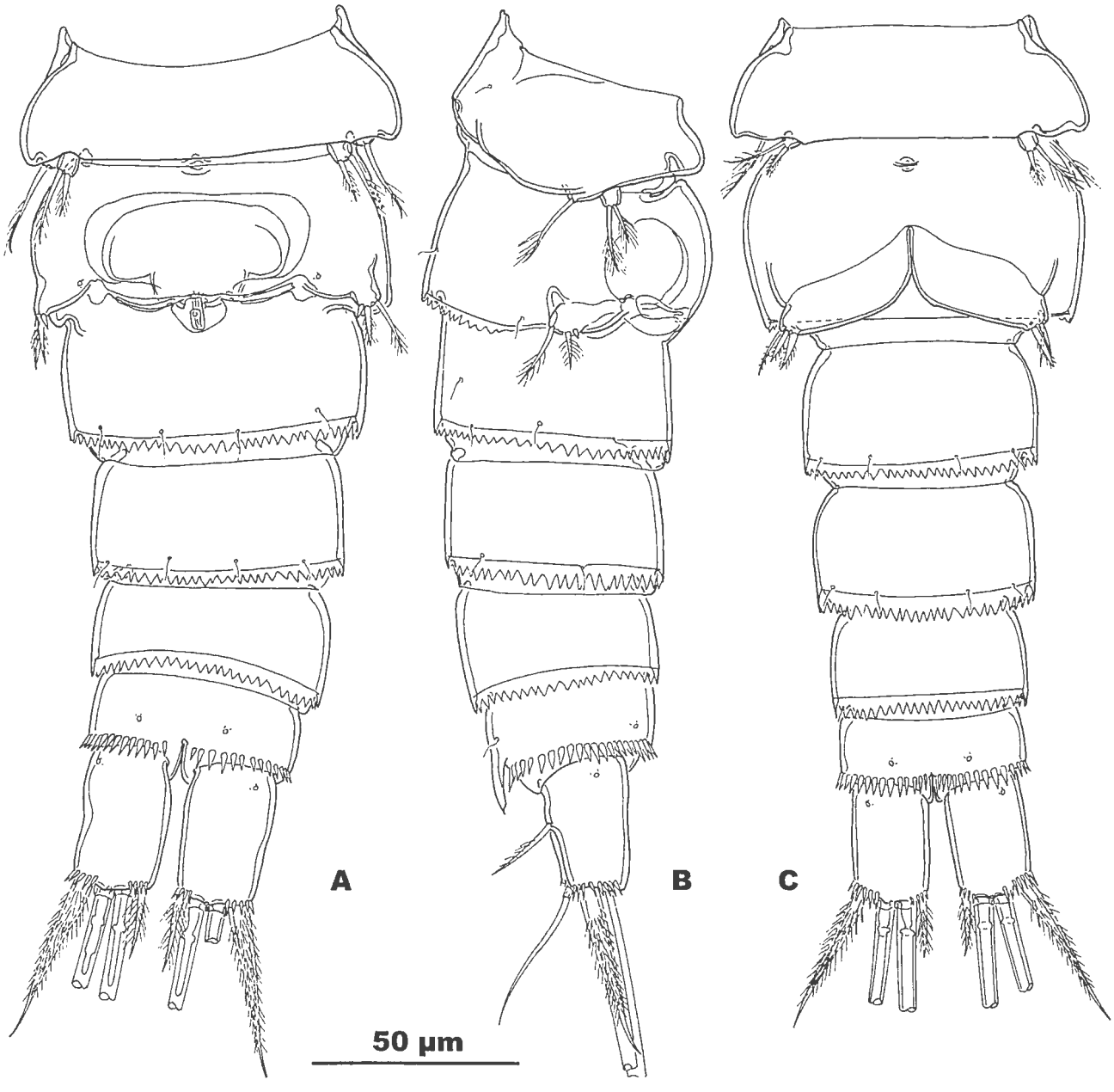

Fig. 2. *Speocyclops orcinus* KIEFER, 1937: A, female urosome, ventral; B, idem, lateral; C, male urosome, ventral (A-B: COP 7113, C: COP 7114).

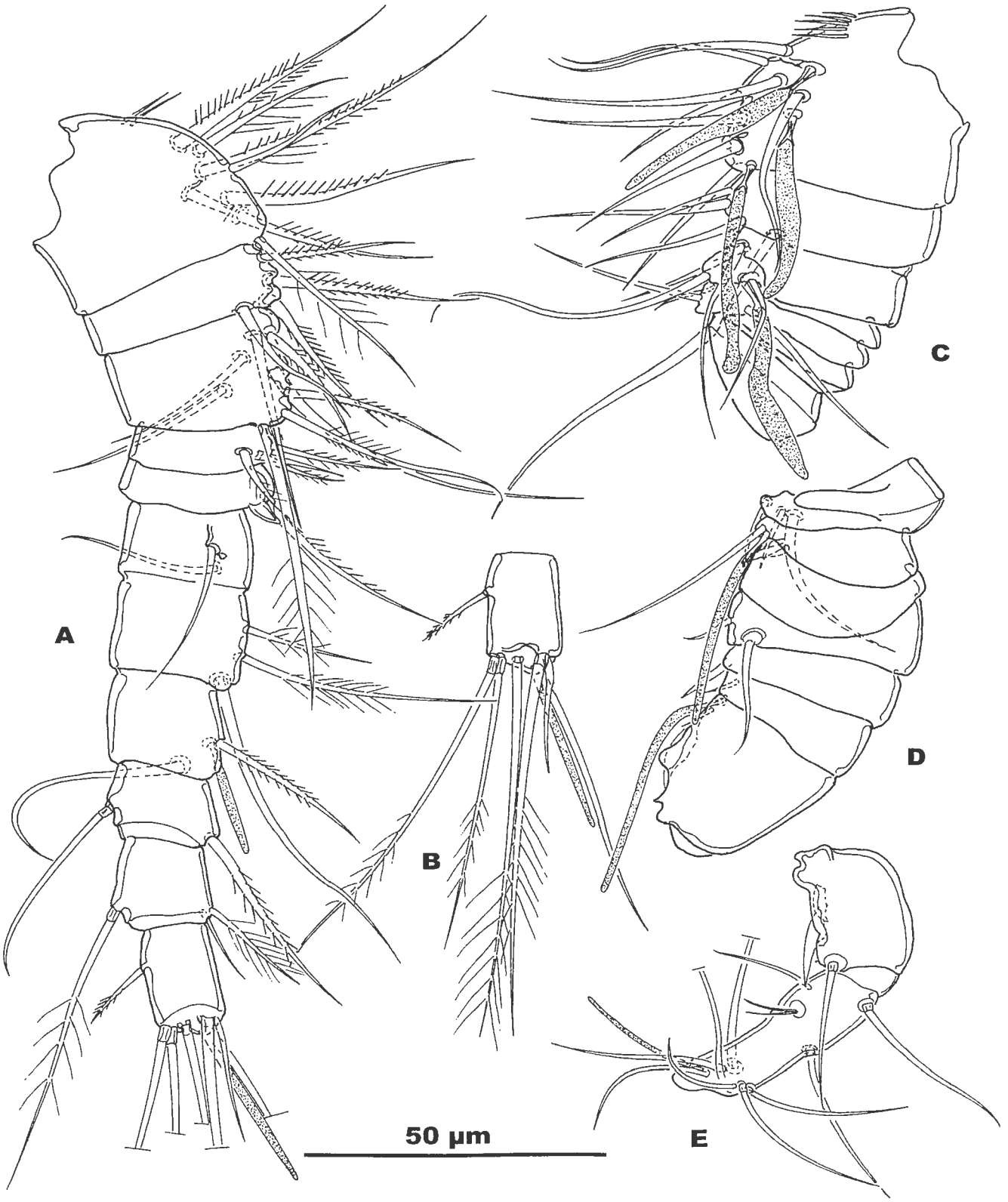

Fig. 3. *Speocyclops orcinus* KIEFER, 1937: A, female antennule, dorsal; B, terminal segment of female antennule; C, segments 1-7 of male antennule, ventral; D, segments 8-14 of male antennule, ventral; D, segments 15-16 of male antennule (A-B: COP 7113, C-E: COP 7114).

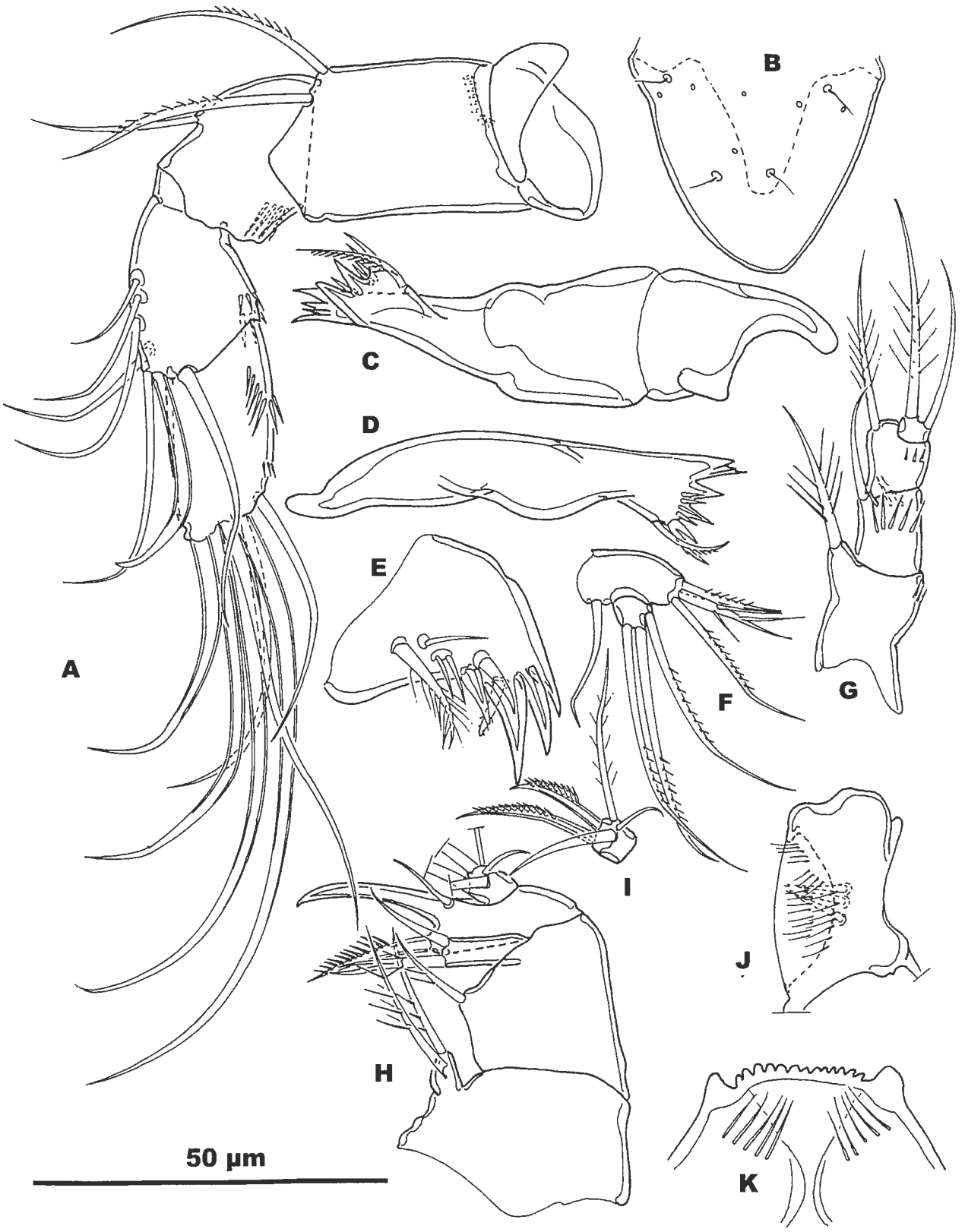

Fig. 4. *Speocyclops orcinus* KIEFER, 1937: A, antenna, caudal; B, rostrum, frontal; C, mandibula, dorsal; D, mandibula, ventral; E, maxillular arthrite; F, maxillular palp; G, maxilliped; H, maxille; I, maxillar endopodite; J, paragnath; K, labrum (A, C, E, F, G, J, K: COP 7113, B, D, H, I: COP 7114).

Fig. 5. *Speocyclops orcinus* KIEFER, 1937: A, leg 1, frontal; B, leg 2, frontal; C, leg 3, frontal; D, leg 4 frontal (A, B, D: COP 7113, C: COP 7114).

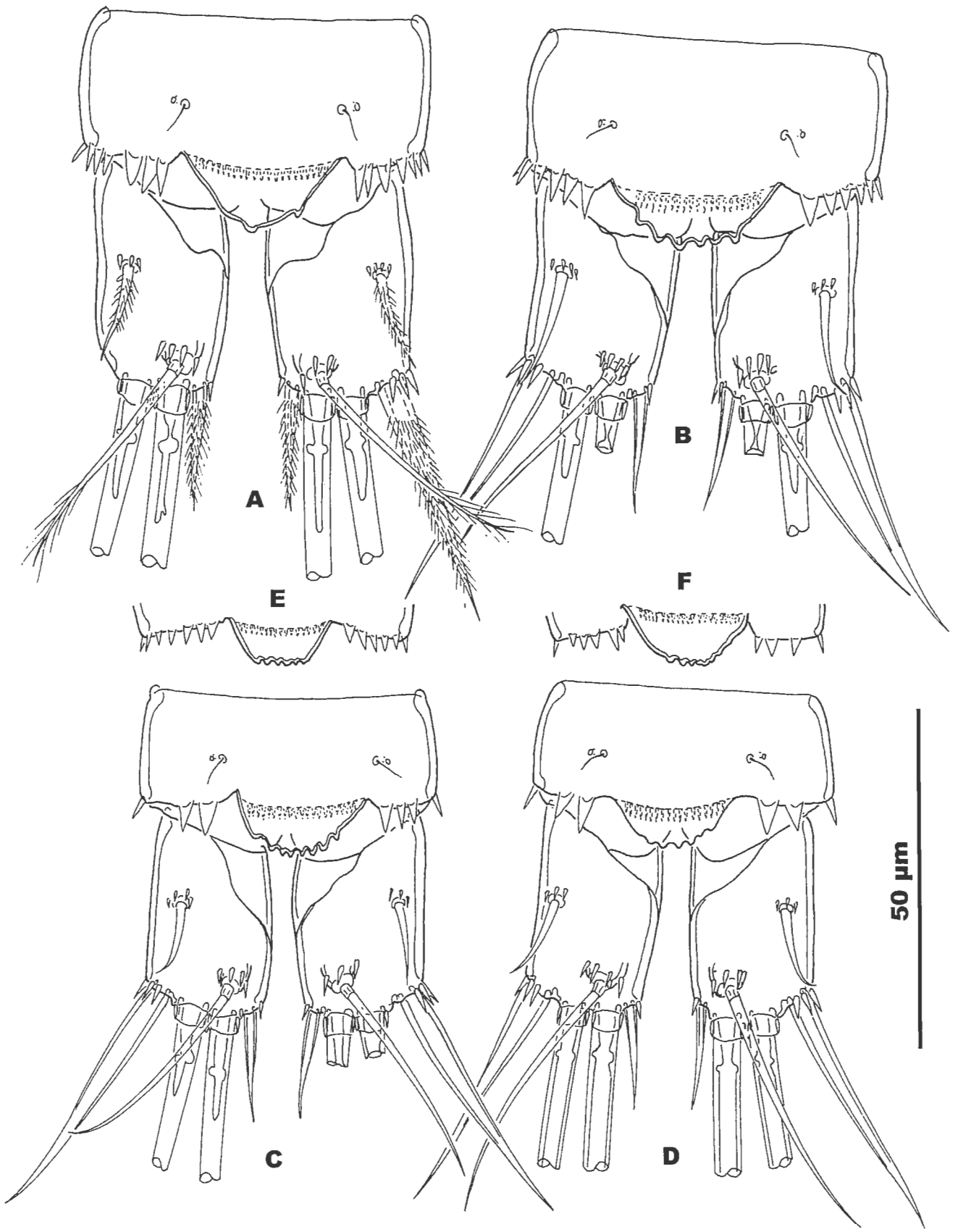

Fig. 6. *Speocyclops orcinus* KIEFER, 1937: A-B, C-D, anal somite and caudal rami, dorsal; E-F, posterodorsal margin of anal somite and anal operculum (A: COP 7112, female, B: COP 7114, male; C-D: COP 7112, females; E-F: FKCC 2679, males, syntypes; ornamentation of setae and spines not illustrated in B, C-D).