



TWO HYPORHEIC SPECIES OF THE GENUS *CERCONEOTES* HUYS, 1992:  
*C. EURYHALINUS* (KRISHNASWAMY, 1957) AND *C. HUYSI* N. SP.  
(COPEPODA, HARPACTICOIDA, LEPTASTACIDAE) FROM INDIA

BY

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ABSTRACT

To date, the genus *Cerconeotes* Huys, 1992, has seven nominal species, all known mostly from marine interstitial waters. Here, *Cerconeotes euryhalinus* (Krishnaswamy, 1957), an incompletely described and little-known species, is redescribed in detail after designating the neotype, and an illustrated description is given for *Cerconeotes huysi* n. sp. Both species were collected from freshwater as well as brackish water hyporheic habitats in southeastern India. The morphological relationships of these species with their congeners are discussed, and two criteria of the original generic definition emended. *Cerconeotes huysi* n. sp. is unique in the genus in the shape and armature of leg 5 in both sexes, in the male leg 3 second endopodal segment with two smooth, spine-like reduced elements (one apical and one subapical), and the long caudal rami and their armature elements. It closely resembles *C. euryhalinus*. A brief note on the ecology of the species is also added.

ZUSAMMENFASSUNG

Bis heute umfasst die Gattung *Cerconeotes* Huys, 1992 sieben nominelle Arten, die vorwiegend im marinen Interstitial vorkommen. Hier wird *Cerconeotes euryhalinus* (Krishnaswamy, 1957), eine unvollständig beschriebene und wenig bekannte Art, nach der Designierung eines Neotypus im Detail neu beschrieben. Außerdem wird eine mit Detailzeichnungen versehene Beschreibung von *Cerconeotes huysi* n. sp. gegeben. Beide Arten wurden im hyporheischen Interstitial des Süß- und Brackwassers im südöstlichen Indien gesammelt. Die morphologischen Beziehungen dieser Arten mit den anderen Arten gleicher Gattungszugehörigkeit werden diskutiert und zwei Kriterien der ursprünglichen Gattungsdiagnose werden korrigiert. Innerhalb der Gattung ist *Cerconeotes huysi* n. sp. einzigartig in der Form und Bewehrung des fünften Beinpaars bei beiden Geschlechtern, in der Bewehrung des zweiten Endopoditensegments des dritten Beinpaars der Männchen mit zwei glatten dornartig reduzierten Elementen (eines apikal, das andere subapikal) und in den langen Furkalästen und ihrer Bewehrung. Es besteht eine große Ähnlichkeit mit *C. euryhalinus*. Einige kurze Angaben zur Ökologie der Arten werden auch gemacht.

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## INTRODUCTION

Huys (1992) established the genus *Cerconeotes* Huys, 1992, for eight species that had previously been placed in *Leptastacus* T. Scott, 1906, with *Cerconeotes mozambicus* (Wells, 1967) as the type species. Huys (1992) recognized the following species in the genus: *C. constrictus* (Lang, 1965), *C. japonicus* (Itô, 1968) and *C. jenneri* (Lindberg, 1975), and treated *C. nichollsi* (Krishnaswamy, 1951), *C. euryhalinus* (Krishnaswamy, 1957), *C. waltairensis* (Rao & Ganapati, 1969), and *C. operculatus* (Masry, 1970) as species inquirendae. Later, Huys & Conroy-Dalton (2005) reallocated *C. operculatus* to the genus *Stereoxiphus* Huys & Conroy-Dalton, 2005. Thus, *Cerconeotes* as yet contains only the aforementioned seven nominal species or “direct child taxa”, according to the latest World Copepoda database (Walter, 2015). Among the species of *Cerconeotes*, *C. nichollsi*, *C. euryhalinus*, and *C. waltairensis* are distributed mainly in the sandy beaches of southeastern India abutting the Bay of Bengal. The original descriptions of these species badly need to be supplemented.

During our ongoing stygofaunistic investigations on the Indian crustaceans, especially in the coastal deltaic belt of the Rivers Krishna and Godavari in Andhra Pradesh state of the southeastern peninsular zone, we came across *C. euryhalinus* (Krishnaswamy, 1957), and a new species, *C. huysi* n. sp., in the hyporheic core samples, collected from both freshwater and brackish water. This paper gives a redescription of *Cerconeotes euryhalinus* (Krishnaswamy, 1957) and a description of *C. huysi* n. sp. As for *C. euryhalinus*, the original description and figures are rather very incomplete and inaccurate. Hence, Lang (1965), McLachlan & Moore (1978) and Huys (1992) stressed the need for a redescription of this species before its validity can be accepted. No name-bearing types of this species exist in any of the repositories, including the Museum of the Zoological Survey of India, Kolkata (see also Wells, 1967: 321) as well as that of the University of Madras, Chennai. Further, according to Dr. G. C. Rao, an eminent Indian copepod taxonomist (pers. commun.), most Indian taxonomists of the 1960s and before were not in the habit of designating the types for the new species that they described. Hence we have designated a female as the neotype for *C. euryhalinus* in accordance with ICZN Art. 75.3 (ICZN, 1999) in order to clarify its taxonomic status vis-à-vis its congeners. The neotype comes from the same geographical horizon as the original name-bearing type, and its detailed description is consistent with the overall original description of the species. The description and figures given herein are based on the newly designated neotype and on a male specimen of the present type series. Because of its poor characterization, Wells (1967) and Huys (1992) considered *C. euryhalinus* and *C. mozambicus* identical, but our study shows beyond any doubt that they are distinct from each other (see Discussion). *Cerconeotes huysi* n. sp.

stands out in the genus, inter alia, by the shape and armature of leg 5 in both sexes, the presence of two smooth, spine-like reduced elements on the second endopodal segment of the male leg 3, and the long caudal rami and their armature elements. Brief notes are also given on the ecology of the two species.

#### MATERIAL AND METHODS

The specimens of *Cerconeotes euryhalinus* and *C. huysi* n. sp. were collected from both freshwater and brackish interstitial water of the hyporheic zone of the Rivers Godavari and Krishna in Andhra Pradesh state of southeastern India (fig. 1) by employing mainly the Karaman & Chappuis method (Chappuis, 1942). At each sampling site, a few holes of varying depths (30-50 cm) and a few meters apart from one another were dug in the alluvial deposits close to the water's edge of the river banks. When the subsurface water seeped and accumulated in the pits, it was collected with mugs and filtered through a bolting-silk plankton net (mesh size 70  $\mu\text{m}$ ), or sometimes directly filtered with a plankton net, and the filtrate fixed in 5% formaldehyde in plastic vials. A rigid PVC tube (70 cm length, 4 cm diameter) was used to extract cores from the sediment surface to a depth of 30-50 cm in the dug-out pits and also a few other spots in the submerged, as well as moist, exposed parts of the sandy banks. The samples were pooled in a bucket, filled with the same habitat water near the sampling sites and stirred vigorously. The supernatant was filtered through a plankton net and the filtrate fixed as above. Back in the laboratory, the specimens were stored in 70% alcohol and later transferred into glycerol.

The specimens were dissected in glycerol under a binocular stereo zoom microscope at a magnification of 90 $\times$ . Drawings were made with the aid of a drawing tube mounted on a Leica DM 2500 trinocular research microscope equipped with a UCA condenser, IC objective prism and 1-2 $\times$  magnification changer. Permanent preparations were mounted in glycerol and sealed with wax and Araldite. All the type material was deposited in the Muséum national d'Histoire naturelle (MNHN), Paris, France.

#### SYSTEMATIC ACCOUNT

Order HARPACTICOIDA Sars, 1903

Family LEPTASTACIDAE Lang, 1948, sensu Huys, 1992

Genus *Cerconeotes* Huys, 1992

***Cerconeotes euryhalinus*** (Krishnaswamy, 1957) (figs. 2-7)

Synonymy.—

*Leptastacus euryhalinus* Krishnaswamy, 1957: 94-96, fig. 20; Lang, 1965: 412; Wells, 1967: 321; McLachlan & Moore, 1978: 208

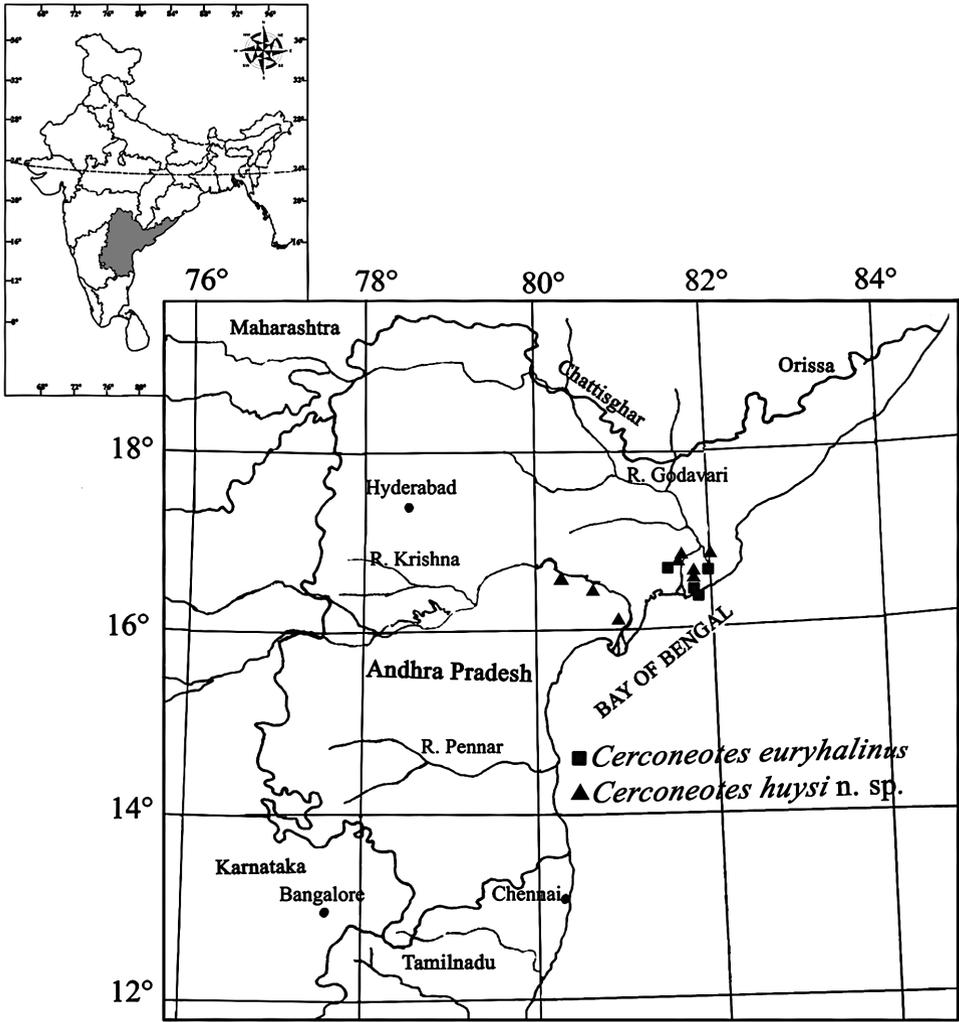


Fig. 1. Map showing the distribution of *Cerconeotes euryhalinus* (Krishnaswamy, 1957) (■) and *C. huysi* n. sp. (▲).

*Leptastacus vijayawadensis* n. sp.: Subhashini, 2001: 1-37 (Unpubl. M. Phil. Thesis) (unpublished, hence unavailable name)

*Cerconeotes euryhalinus* (Krishnaswamy, 1957): Huys, 1992: 162-164.

Type locality.— River Godavari at Kotipalli village (16°41'33.5"N 82°03'45.5"E, elevation 10.8 m amsl; water temperature 28°C, pH 7.5) in East Godavari District, Andhra Pradesh State (fig. 1).

Material examined.— Female neotype (MNHN-IU-2013-11908) from type locality dissected on 2 slides; 30 April 2008, coll. V. R. Totakura (all collected by V. R. Totakura unless stated otherwise).

(1) Type locality, 30 April 2008: 1 male (MNHN-IU-2013-11909), dissected on 2 slides; 4 males (MNHN-IU-2013-11910-11913), whole-mounted on 1 slide each;

(2) India, Andhra Pradesh, East Godavari District, River Godavari at Brahmapuri village, 13 May 2006: 2 males and 4 females, 1 female (MNHN-IU-2013-11915), whole-mounted on 1 slide;

(3) India, Andhra Pradesh, East Godavari District, River Godavari at Kapileswarapuram village, 15 May 2006: 5 females preserved whole, and 1 female dissected on 2 slides (MNHN-IU-2013-11914); same site, 15 May 2007: 3 males and 4 females;

(4) India, Andhra Pradesh, East Godavari District, River Godavari at Masakapalli village (16°43'N 82°07'E; elevation 8 m amsl; water temperature 25°C, pH 7.0), 18 May 2007: 2 males and 6 females;

(5) India, Andhra Pradesh, East Godavari District, River Godavari at Sundarapalli village (16°41'30.5"N 82°33'00.7"E, elevation 10 m amsl; pH 8.4, water temperature 28°C, salinity 0.01‰, conductivity 9.30  $\mu$ S, TDS 5.04 mg/l, DO 4.6 mg/l, turbidity 99 NTU), 2 April 2008: 4 females; same site, 22 July 2008: 3 males;

(6) India, Andhra Pradesh, East Godavari District, River Godavari at Kotipalli (16°41'33.5"N 82°03'45.5"E, elevation 10.8 m amsl; water temperature 28°C, pH 7.5), 30 April 2008: 4 males and 12 females; same site, 17 January 2010: 3 males and 8 females; 19 July 2008: 1 female;

(7) India, Andhra Pradesh, East Godavari District, River Godavari at Koolla village, 20 July 2008: 1 male;

(8) India, Andhra Pradesh, East Godavari District, River Godavari at Yanam town (16°12'25.9"N 82°12'55.3"E, elevation 3 m amsl; water temperature 27°C, pH 7.0), 1 May 2008: 3 female; same site, 19 July 2008: 4 females;

(9) India, Andhra Pradesh, East Godavari District, River Godavari at Bhiravapalem village (water temperature 26.9°C, pH 8.07, DO 7.8 mg/l, salinity 12.2‰, conductivity 18.9  $\mu$ S, TDS 10.5 mg/l, turbidity 100 NTU), 30 November 2008: 5 males and 2 females;

(10) India, Andhra Pradesh, Krishna District, River Krishna at Vijayawada city (16°29'13.0"N 80°37'38.6"E, elevation 10 m amsl; water temperature 30°C, pH 7.0), 9 August 2000: 1 female (MNHN Cy 2002. 39) and 1 male (MNHN Cy 2002. 40); 25 male and 25 female preserved in alcohol (MNHN Cy 2002. 41-90); same site, 20 March 2008: 1 male and 3 females; same site, 14 April, 2008: 2 males and 4 females; Coll. V. Subhashini;

(11) India, Andhra Pradesh, Krishna District, River Krishna at Suggunalanka village, 10 July 2008: 4 males and 16 females of which 2 males (MNHN-IU-2013-11916-11917), dissected on 2 slides each.

Redescription of adult female (neotype).— Total body length, measured from tip of rostrum to posterior margin of caudal rami, 390  $\mu$ m. Preserved specimens colourless. Nauplius eye absent. Body (fig. 2a, b) with thin, imperforated cuticle, cylindrical and slender, without any demarcation between prosome and urosome; prosome/urosome ratio about 0.9 in dorsal view; greatest width in dorsal view at distal half of cephalothorax. Free pedigerous somites without pronounced lateral or dorsal expansions. Integument without windows. Body length/width ratio about 6.8; all somites connected by well-developed arthrodial membranes. Hyaline fringes of all somites narrow and smooth. Each somite except anal somite with deeply and sharply serrulate, continuous hyaline fringe dorso-ventrally close to posterior edge.

Cephalothorax (fig. 2a, b): slightly tapering anteriorly, subquadrate in dorsal view, 1.4 times as long as wide, with 6 pairs of long sensilla, and free pedigers 2-4 each with 3 pairs of sensilla (2 pairs dorsal, 1 pair lateral). Second free prosomite shortest, slightly slenderer than cephalothorax, with 1 chitinous spinous process on

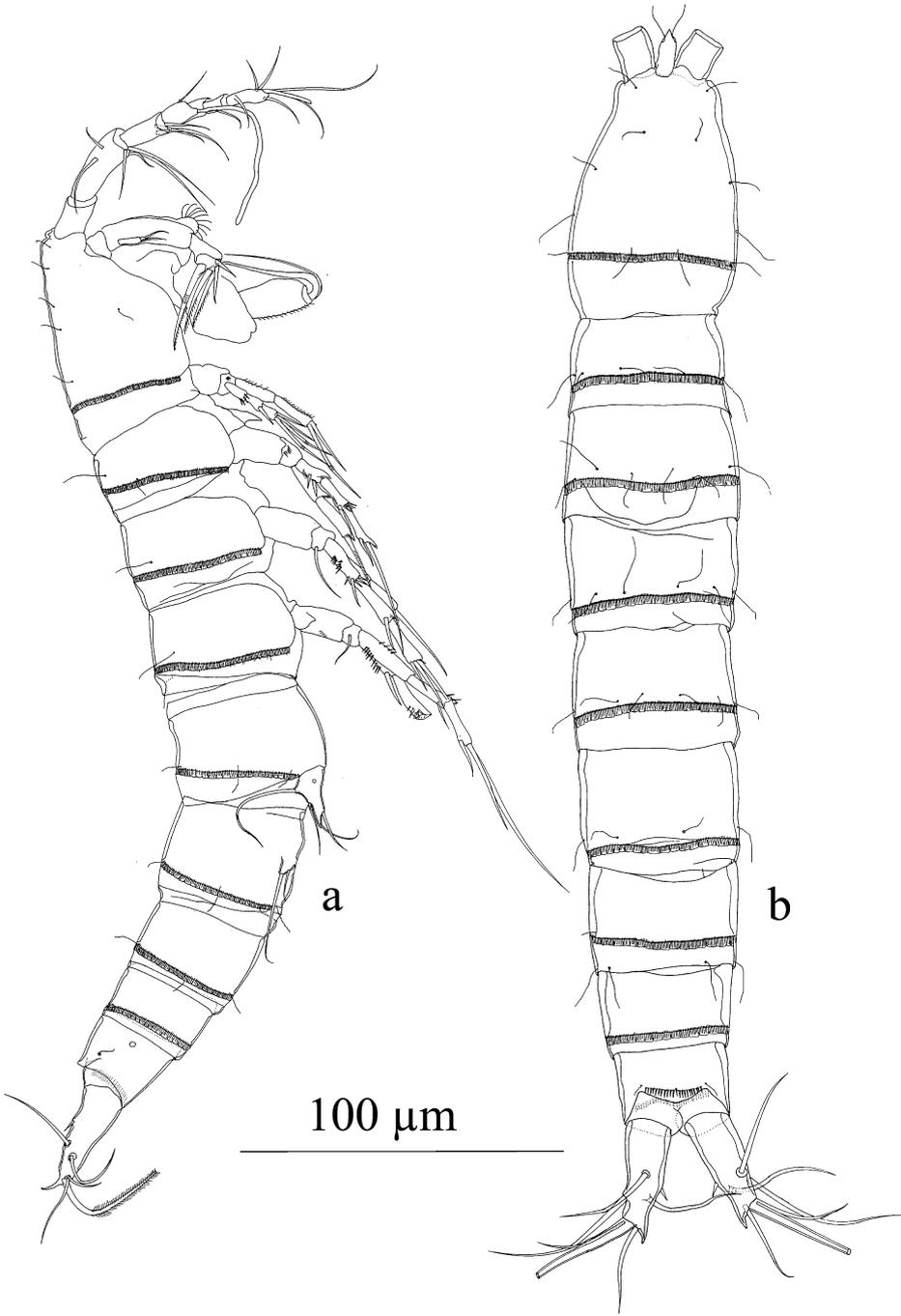


Fig. 2. *Cerconeotes euryhalinus* (Krishnaswamy, 1957), female neotype: a, habitus, lateral; b, same, dorsal.

ventral surface just anterior to intercoxal sclerite (fig. 2a). Third pediger as wide as cephalothorax, 1.4 times as long as second one; fourth pediger about as long as third one, but slightly narrower. Urosomites (figs. 2a, b, 3b) gradually narrowing posteriorly. First urosomite wider than long and longer than fourth prosomite, and with 3 pairs of sensilla (2 pairs dorsal, 1 pair lateral). Genital double-somite about as long as wide, without any transverse suture, with 2 pairs of sensilla distally. Third urosomite short, with 2 pairs of sensilla. Preanal somite 0.6 times as long as third urosomite, without sensilla. Anal somite 0.8 times as long as wide, with 2 large sensilla at base of anal operculum, 1 proximo-lateral pore and with 1 transverse row of small spinules on dorso-distal surface at base of anal operculum. Anal operculum convex, moderately developed, representing 44.1% of somite's width, not reaching distal margin of somite, and with very fine row of spinules on distal margin. Anal sinus wide open, with 2 long diagonal rows of fine spinules on ventral side.

Caudal rami (fig. 2a, b): divergent, 2.3 times as long as greatest width (dorsal and ventral views), about 1.4 times as long as anal somite, distal-third of ramus narrow with recurved unguiform process at inner distal corner; ramus gradually tapering in lateral view, with 1 spinule at 4/5 of ramus length on inner margin at level of disto-lateral seta, and 1 proximo-lateral pore (fig. 3a); armature consisting of 6 setae; proximo-lateral seta (II) stout, close to outer margin on dorsal surface, 0.8 times as long as caudal ramus and upturned; disto-lateral seta (III) smooth, 1.3 times as long as ramus; dorsal seta (VII) slender, and inserted at 4/5 of ramus length close to inner margin, about 0.8 times as long as caudal ramus, biarticulate at base (fig. 3a); inner apical seta (VI) smooth and short; inner medial apical seta (IV) and outer medial apical seta (V) fused basally; seta (V) strong, bipinnate, without breaking plane, about 1.5 times as long as ramus, pointing laterally, with blunt tip. Rostrum (fig. 2b) well developed, demarcated at base, elongated, almost reaching end of first antennular segment; tapering to a fine tip and bearing a pair of long sensilla.

Antennule (fig. 4a): 7-segmented, slender, and slightly longer than cephalothorax. Aesthetasc on fourth segment relatively slender and long, extending well beyond tip of appendage and fused basally with 1 short, subdistal seta; aesthetasc on ultimate segment much smaller, fused basally to 2 apical setae (acrothek). Setal formula: 0.7.6.2 + aes.1.1.9 + aes. All setae smooth except for 1 unipinnate, proximal seta on second segment. Proximal seta on second segment and 3 other setae on seventh segment articulate at base. First segment with 1 row of spinules on posterior surface. Length ratios of antennular segments along medial axis 1.0 : 1.4 : 1.1 : 0.5 : 0.4 : 0.4 : 0.8.

Antenna (fig. 4b): comprising coxa, allobasis, 1-segmented endopod and 1-segmented exopod. Coxa very short, unarmed. Allobasis about 3 times as long

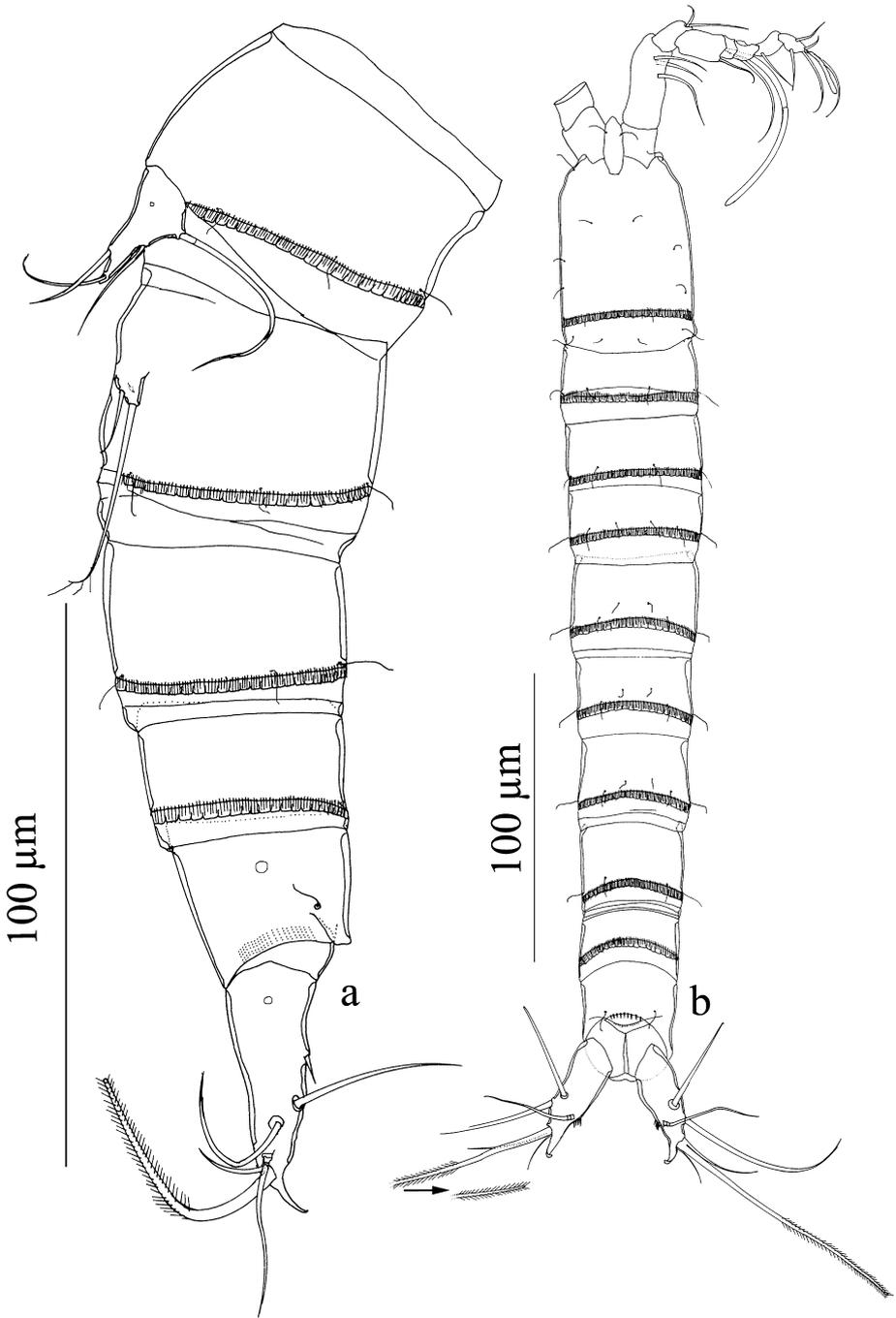


Fig. 3. *Cerconeotes euryhalinus* (Krishnaswamy, 1957), non-type: a, female urosome, lateral; b, male habitus, dorsal.



Fig. 4. *Cerconeotes euryhalinus* (Krishnaswamy, 1957), female neotype: a, antennule, ventral; b, antenna, posterior; c, labrum, ventral; d, maxilla, ventral; e, maxilliped, ventral.

as maximum width, unarmed, with 1 row of spinules near inner margin. Exopod cylindrical, 2.6 times as long as wide, with 2 slender, unequal apical setae. Endopod 0.6 times as long as allobasis and 2.5 times as long as wide, with 1 longitudinal spinular row on inner margin, surface frill occurring subdistally, and with 2 short, bipinnate unequal spines laterally and with 5 strong apical elements (2 spines, 3 geniculate setae), of which outermost seta with 1 large spinule at geniculation and 1.8 times as long as endopod.

Labrum (fig. 4c): large, broadly subtriangular, reaching distal margin of allobasis of antenna in lateral view; free margin with a row of tiny denticles on either side, and with 1 group of spinules on 2 small lobes and long setules on dorsal surface, as illustrated.

Mandible (fig. 5a): with narrow gnathobase on elongate coxa, with 2 coarse teeth ventrally, 1 unipinnate seta dorsally and several smaller teeth. Palp 2-segmented, consisting of basis and endopod. Basis twice as long as wide, with 1 seta at outer distal corner; endopod 3.5 times as long as wide, about twice as long as basis, with 1 subapical inner seta and 2 apical setae.

Maxillule (fig. 5b, c): praecoxa as elongate chitinous segment with anteriorly directed arthrite having 8 claws around distal margin; no setules discernible on anterior surface. Coxa represented by endite, 1.4 times as long as wide, positioned between praecoxal arthrite and elongate basis, and with 1 pinnate strong seta and 1 simple seta apically. Basis produced into subcylindrical endite, 1.7 times as long as wide, distally with 4 slender setae and 1 pinnate spiniform seta; anterior margin spinulose. Endopod fused at base, oval, with 2 long, unequal setae. Exopod represented by 1 unipinnate seta.

Maxilla (fig. 4d): syncoxa tapering distally, with 2 well developed endites (derived from coxa); proximal endite small, subcylindrical, bearing 3 short, modified spines (1 apical and 2 subapical); distal endite with 1 spinulose claw, 1 slender seta distally and 1 subapical modified seta. Allobasis drawn out into strong, recurved claw with 1 outer and 1 inner setae at base, outer seta shorter than inner one. Endopod well developed, 2-segmented; proximal segment long, with 1 outer seta; distal segment with 2 slender apical setae fused at base.

Maxilliped (fig. 4e): composed of syncoxa, basis and endopod. Syncoxa small, twice as long as wide, with a row of fine spinules at inner distal corner and unarmed. Basis strongly developed, 2.6 times as long wide, 2.5 times as long as syncoxa, with 1 row of spinules along outer and inner margins. Endopod 1-segmented, small, with 1 strong apical claw, distal 2/3 sparsely spinulose, and 1 long, slender, smooth seta.

Legs 1-4 (fig. 6a-d): with 3-segmented exopods and 2-segmented endopods; endopods shorter than exopods except for the endopod of leg 1. Legs 1-3 gradually



Fig. 5. *Cerconeotes euryhalinus* (Krishnaswamy, 1957), female neotype (a-c), male non-type (d, e): a, mandible, ventral; b, praecoxa of maxillule, anterior; c, coxa and basis of maxillule, anterior; d, antennule, dorsal; e, leg 3, posterior.

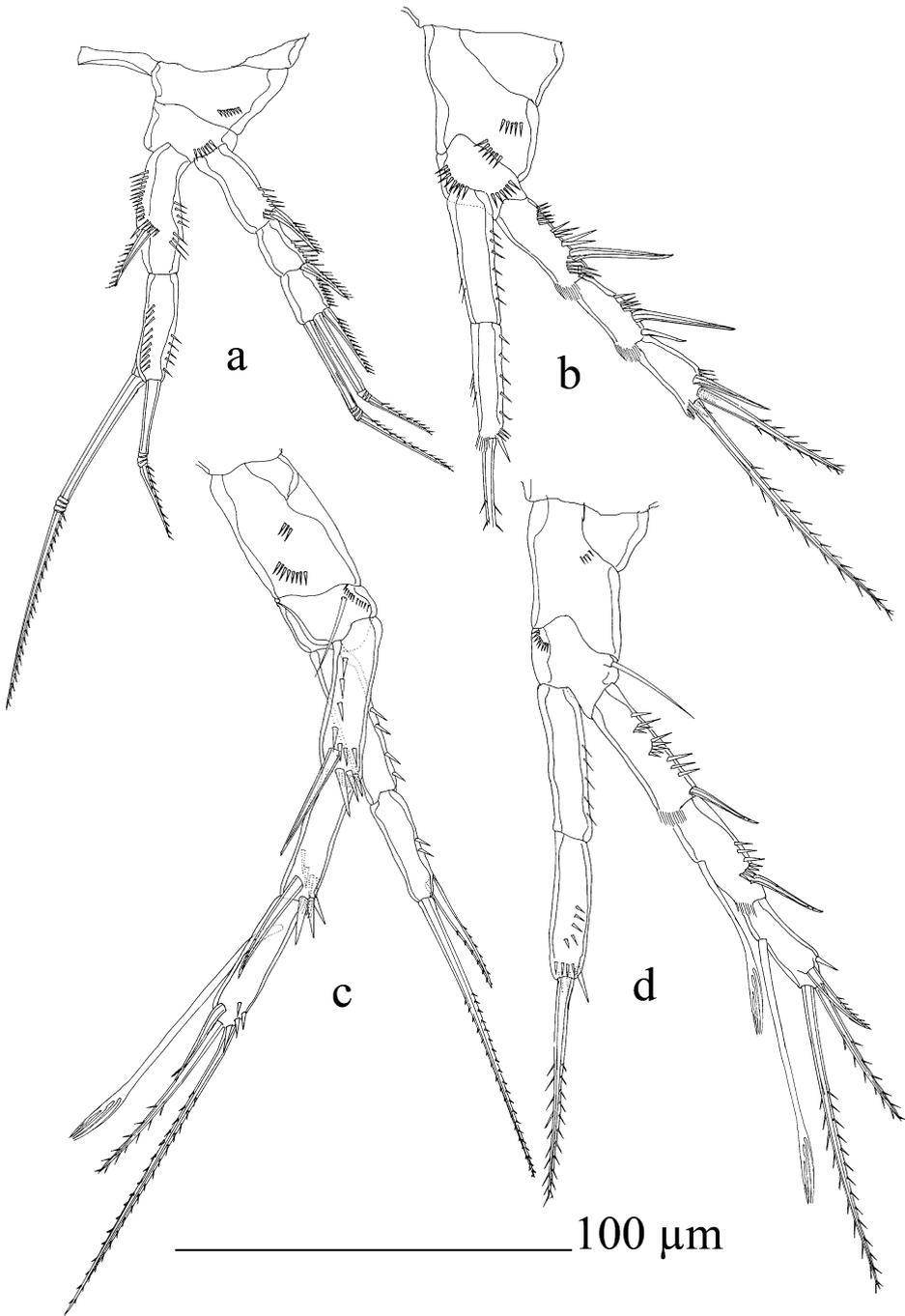


Fig. 6. *Cerconeotes euryhalinus* (Krishnaswamy, 1957), female neotype: a, leg 1, anterior; b, leg 2, posterior; c, leg 3, anterior; d, leg 4, posterior.

increasing in length; leg 4 somewhat shorter than leg 3. Intercoxal sclerite small, concave, unarmed.

Leg 1 (fig. 6a): coxa trapezoidal, with 1 row of spinules at outer distal corner. Basis shorter than coxa, trapezoidal, with 1 row of spinules at base of exopod and unarmed. First and second exopodal segments with 1 outer spine each subdistally; first segment 1.6 times as long as second one; third segment with 3 apical elements (1 spine and 2 geniculate setae); all exopodal segments with spinules along outer margin. Endopod 1.2 times as long as exopod, with spinules along outer and inner margins, as illustrated. First endopodal segment 0.9 times as long as first 2 exopodal segments combined, 3.5 times as long as wide; with 1 spine at 3/4 of segment's length. Second segment slender, apically with 2 unequal geniculate setae; inner geniculate seta 1.4 times as long as entire endopod, 1.6 times as long as larger geniculate exopodal seta and almost 2.3 times as long as outer geniculate seta on endopod. All exopodal and endopodal armature elements unipinnate along outer margin.

Leg 2 (fig. 6b): coxa with 1 row of spinules near outer margin and 1 medial row of spinules on distal surface. Basis shorter than coxa, trapezoidal, with 2 arched rows of spinules at base of exopod and endopod, and unarmed. All exopodal segments with spinules along outer margin and also with hyaline frill at inner distal corner. First and second exopodal segments with 1 outer pinnate spine each; first segment 1.2 times as long as second one and third segment with 3 elements (1 subapical spine and 2 apical setae), innermost seta about as long entire exopod, 3.5 times as long as outer spine. Endopod with spinules along outer and inner margins, as illustrated; first segment 3.2 times as long as wide, unarmed; second segment 0.8 times as long as first one, with 1 apical, bipinnate seta and another one, presumably represented by a small spine, arising from outer distal margin.

Leg 3 (fig. 6c): coxa with 2 medial rows of spinules on distal half of anterior surface. Basis shorter than coxa, trapezoidal, with 1 row of spinules near outer margin and with outer seta. Exopodal ornamentation same as in leg 2, but no hyaline frill on third exopodal segment; first and second segments with 1 outer spine each on outer margin subdistally; first segment 1.2 times as long as second one; third segment with 1 subapical spine, 2 apical, bipinnate setae and 1 inner pectinate seta located at proximal third. Endopod with spinules along outer margin; first segment 4 times as long as wide, unarmed; second segment 0.7 times as long as first one, with 1 apical seta, about as long as entire endopod, 0.9 times as long as innermost seta on third exopodal segment and almost 2.3 times as long as subapical outer seta on endopod.

Leg 4 (fig. 6d): coxa with 1 row of spinules proximally. Basis shorter than coxa, trapezoidal, with 1 arched row of small spinules on proximal inner corner and with 1 outer seta. Exopodal ornamentation same as in leg 3. First segment 0.6 times as

long as next 2 segments combined and with 1 outer spine; second segment with 1 outer bipinnate spine and 1 inner pectinate seta, 1.3 times as long as its segment; and third segment with 4 elements (1 subapical spine, 2 apical setae and 1 inner seta); inner pectinate seta 2.5 times as long as segment. Endopod with spinules along outer margin. First segment 3.5 times as long as wide, unarmed; second segment 0.9 times as long as first one, apically with 1 well developed inner apical seta, which is 0.7 times as long as entire endopod; second one presumably reduced to a small spine. All exopodal and endopodal armature elements bipinnate except inner modified seta on second and third exopodal segments, and outer diminutive spine on second endopodal segment smooth. Spine and setal formulae of legs 2-4 as follows:

	Exopod	Endopod
Leg 2	0.0.021	0.010
Leg 3	0.0.121	0.011
Leg 4	0.1.121	0.010

Leg 5 (figs. 2a, 7a): distinct at base; intercoxal sclerite narrow, medially concave; exopod and baseoendopod confluent, represented by simple, conical plate, which is about twice as long as wide; with 1 small cuticular pore proximally and 4 setae (basal seta articulate at base; 1 small seta on outer margin, probably ancestral exopodal seta); another long seta apically and 1 small seta on inner margin (perhaps ancestral endopodal seta); also 1 tiny spiniform process occurring at inner apical corner.

Leg 6 (fig. 7a, b): reduced, fused with the somite at base, with 1 long, apical and 1 short subapical setae; apical seta incurved, 3.7 times as long as inner seta and unipinnate distally. Genital field (fig. 7b) small, positioned anteriorly on mid-ventral surface of genital double somite, consisting of 2 separate opercula, closing off paired genital apertures; copulatory pore openings at about 1/3 of mid-ventral surface.

Redescription of adult male.— Body length excluding caudal setae 385  $\mu\text{m}$ . Habitus (fig. 3b) 7.6 times as long as wide, prosome/urosome ratio 0.9. Ornamentation of prosomites, colour and nauplius eye as in female, except genital and third urosomite.

Caudal rami (fig. 3b): divergent, 1.5 times as long as anal somite, about 2.5 times as long as wide in ventral view; armature and ornamentation as in female.

Antennule (figs. 3b, 5d): 8-segmented, strongly digeniculate, geniculation between segments 3 and 4, and 6 and 7; slender, approximately 1.2 times as long as cephalothorax. Long and relatively slender aesthetasc on fourth segment, over-reaching tip of appendage and fused basally with subdistal seta; fifth segment smallest; aesthetasc on eighth segment small, slender, staff-like and fused basally

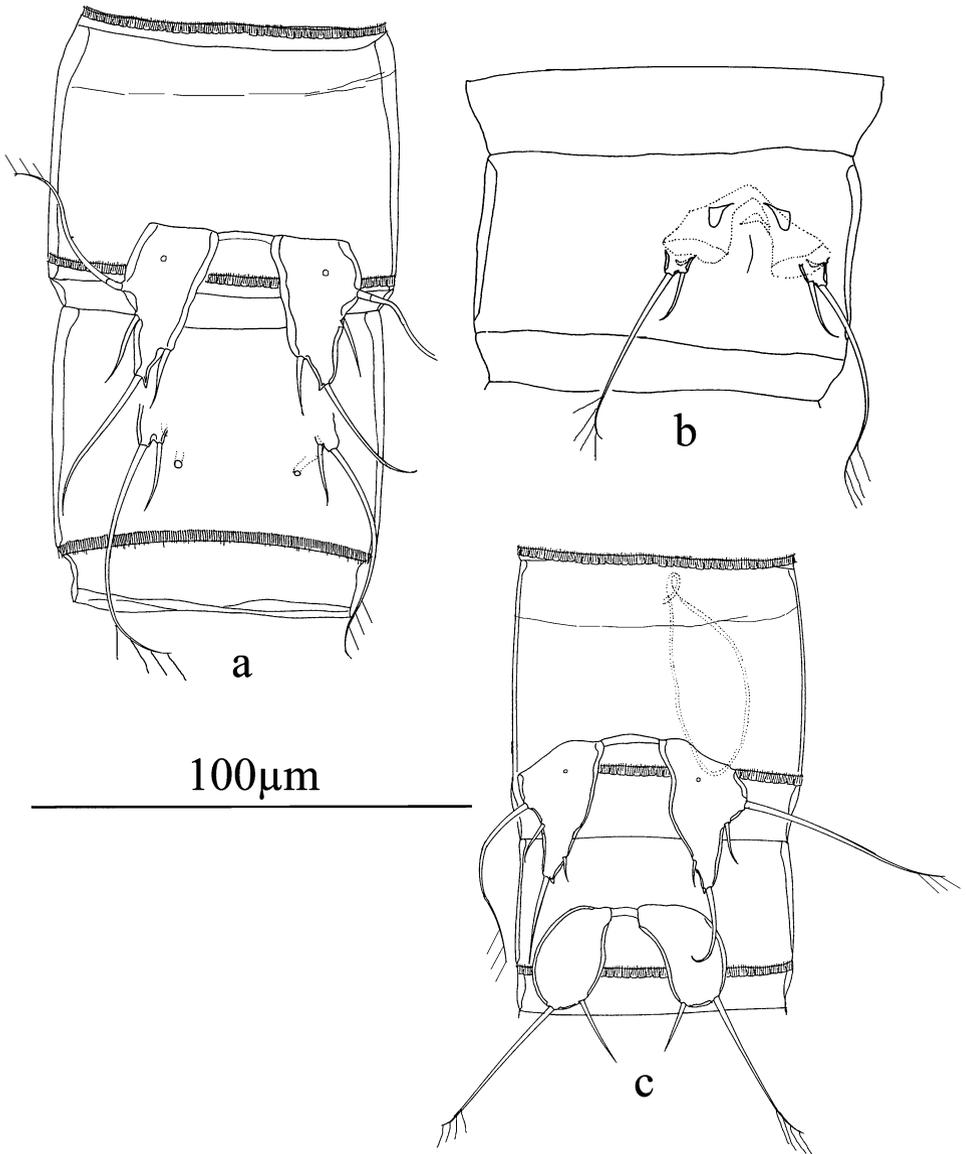


Fig. 7. *Ceroneotes euryhalinus* (Krishnaswamy, 1957), female neotype: a, female urosomites 1-2, ventral; b, genital double-somite, ventro-lateral; c, male non-type, urosomites 1-2, ventral.

to 2 apical setae (acrothek). Setal formula: 0.8.6.3 + aes.1.1.0.9 + aes. Length ratio of antennular segments, along medial axis 1.0 : 1.4 : 0.6 : 0.6 : 0.2 : 0.4 : 0.5 : 0.8.

Antenna, labrum, mandible, maxillule, maxilla, maxilliped, all legs (except leg 3 endopod) and caudal rami as in female.

Genital somite (figs. 3b, 7c) about as long as wide, with 3 pairs of sensilla. Third urosomite slightly longer than genital somite, with 3 pairs of sensilla. Fourth urosomite, preanal somite and anal somites as in female.

Leg 3 (fig. 5e): first endopodal segment 3.1 times as long as wide, unarmed and with spinules along outer margin; second segment bifurcate, with modified spinous processes, inner process about half as long as outer one, recurved and with 2 tiny denticulate structures halfway down margin; distal half of outer process slender, recurved and without ornamentation.

Leg 5 (fig. 7c): as in female but distal half narrower and all armature elements except outer basal seta smaller than in female.

Leg 6 (fig. 7c) well developed, separate, represented by oval plate, proximal half narrow, inner margin slightly concave and with 2 setae: outer (basal) seta 2.3 times as long as inner one. Intercoxal sclerite narrow, concave medially.

A single, large, oval, spermatophore (fig. 7c) visible through fifth pedigerous somite, about 2.7 times as long as wide, with narrow and curved neck.

Variation and abnormality.— Total body length of males 320-420  $\mu\text{m}$ , mean 0.370  $\mu\text{m}$  ( $n = 35$ ), and of females 370-440  $\mu\text{m}$ , mean 0.410  $\mu\text{m}$  ( $n = 30$ ). Caudal rami with 1-3 spinules on inner margin in both sexes; unguiform process of caudal ramus straight or incurved (figs. 2b, 3a, b), pointed or blunt, bearing one or two spinules on one or both of the caudal rami (not illustrated).

### ***Cerconeotes huysi* n. sp. (figs. 8-15)**

Type locality.— River Godavari at Yanam town ( $16^{\circ}43'15.9''\text{N}$   $82^{\circ}12'08.4''\text{E}$ , elevation 4 m asml; salinity 13-15‰), approximately 28 km from Kakinada city, Puducherry state, approximately 12 km from the coast of the Bay of Bengal (fig. 1).

Type material examined.— Holotype female (MNHN-IU-2013-11918), and allotype male (MNHN-IU-2013-11919), dissected on 3 slides each; paratypes are 2 females (MNHN-IU-2013-11920-11921) and 1 male whole-mounted on 1 slide each (MNHN-IU-2013-11922); 2 males and 2 females in alcohol in V.R.T.'s personal collections; 1 May 2008, coll. V. R. Totakura.

Other material examined.— South India, Andhra Pradesh, East Godavari District, River Godavari: (1) at Kotipalli village (water temperature  $27^{\circ}\text{C}$ ; pH 7.5); 18 July 2007: 2 males and 5 females; (2) at Kotipalli village (water temperature  $25^{\circ}\text{C}$ ; pH 7.0); 30 April 2008: 1 male and 2 females; and (3) at Brahmपुरi village, 13 May 2006: 1 male and 2 females, coll. V. R. Totakura.

Description of adult female (holotype).— Total body length measured, from tip of rostrum to posterior margin of caudal rami, 461  $\mu\text{m}$ . Preserved specimens colourless. Nauplius eye absent. Body (fig. 8a) slender, cylindrical, with thin, imperforated integument; without any demarcation between prosome and urosome; prosome/urosome ratio about 0.8 in dorsal view; greatest width in lateral view at distal end of cephalothorax. Free pedigerous somites without pronounced lateral or dorsal expansions. Integument without cuticular windows. Body length/width

ratio about 6.4; all somites connected by well developed arthrodial membranes. Hyaline fringes of all somites narrow and smooth. Each somite except anal somite with deeply and sharply serrulate, continuous hyaline fringe dorso-ventrally close to posterior edge.

Cephalothorax (fig. 8a): trapezoidal in lateral view, 1.2 times as long as wide, with 8 pairs of long sensilla. Second free prosomite shortest; with 3 pairs of sensilla and 2 unequal spinous processes on ventral surface just behind intercoxal sclerite (fig. 8a-c); third urosomite slightly shorter than fourth pediger; with 3 pairs of large sensilla and 1 spinous process on ventral surface. Fourth pediger with 3 long sensilla. Urosomites (fig. 8a) gradually narrowing behind. First urosomite with 3 pairs of sensilla distally. Genital double-somite about as long as wide, not subdivided by any suture, with 3 pairs of sensilla distally. Third urosomite with 2 pairs of sensilla. Preanal somite 1.2 times as long as anal somite, without any sensilla. Anal somite 0.8 times as long as wide, with 2 large sensilla at base of anal operculum, 2 rows of unequal spinules on ventro-distal margin and 1 proximo-lateral pore. Anal operculum (fig. 13a) convex, smooth, moderately developed, representing 52.1% of somite's width, not reaching distal margin of somite. Anal sinus wide open, smooth.

Caudal rami (figs. 8a, 13a): divergent, 4.1 times as long as greatest width (dorsal and ventral views), about 1.3 times as long as anal somite, distal-third of ramus narrow; disto-inner angle produced into elongate, unguiform process near the base of which is a short spinous projection; with 6 setae (1 lateral, 1 outer subapical, 1 dorsal and 2 apical, 1 inner) and 1 proximo-lateral pore. Proximo-lateral seta (II) stout, close to outer margin on dorsal surface, pointing upwards, 0.8 times as long as caudal ramus: disto-lateral seta (III) on lateral margin, 1.3 times as long as ramus; dorsal seta (VII) slender, plumose and inserted at 4/5 of ramus length close to inner margin, about 0.8 times as long as caudal ramus, biarticulate at base; inner apical seta (VI) smooth, short, as long as unguiform process; inner medial apical seta (IV) and outer medial apical seta (V) fused basally; seta (V) strong, bipinnate, without breaking plane, about 1.5 times as long as ramus, pointing laterally, with blunt tip. Rostrum (fig. 10a, b) well developed, defined at base, elongated, almost reaching distal margin of first antennular segment and tapering distally to acuminate tip and with a pair of strong sensilla at distal-third dorso-laterally.

Antennule (fig. 9a): 7-segmented, slender, and slightly longer than cephalothorax. Aesthetasc on fourth segment over half as long as same appendage and fused basally with short, subdistal seta; aesthetasc on ultimate segment much smaller, fused basally to 2 apical setae (acrothek). Setal formula: 0.7.6.1 + aes.1.1.9 + aes. Only 1 seta on second segment unipinnate, all other setae smooth. Proximal seta on second segment and 1 seta on seventh segment articulate at base. First

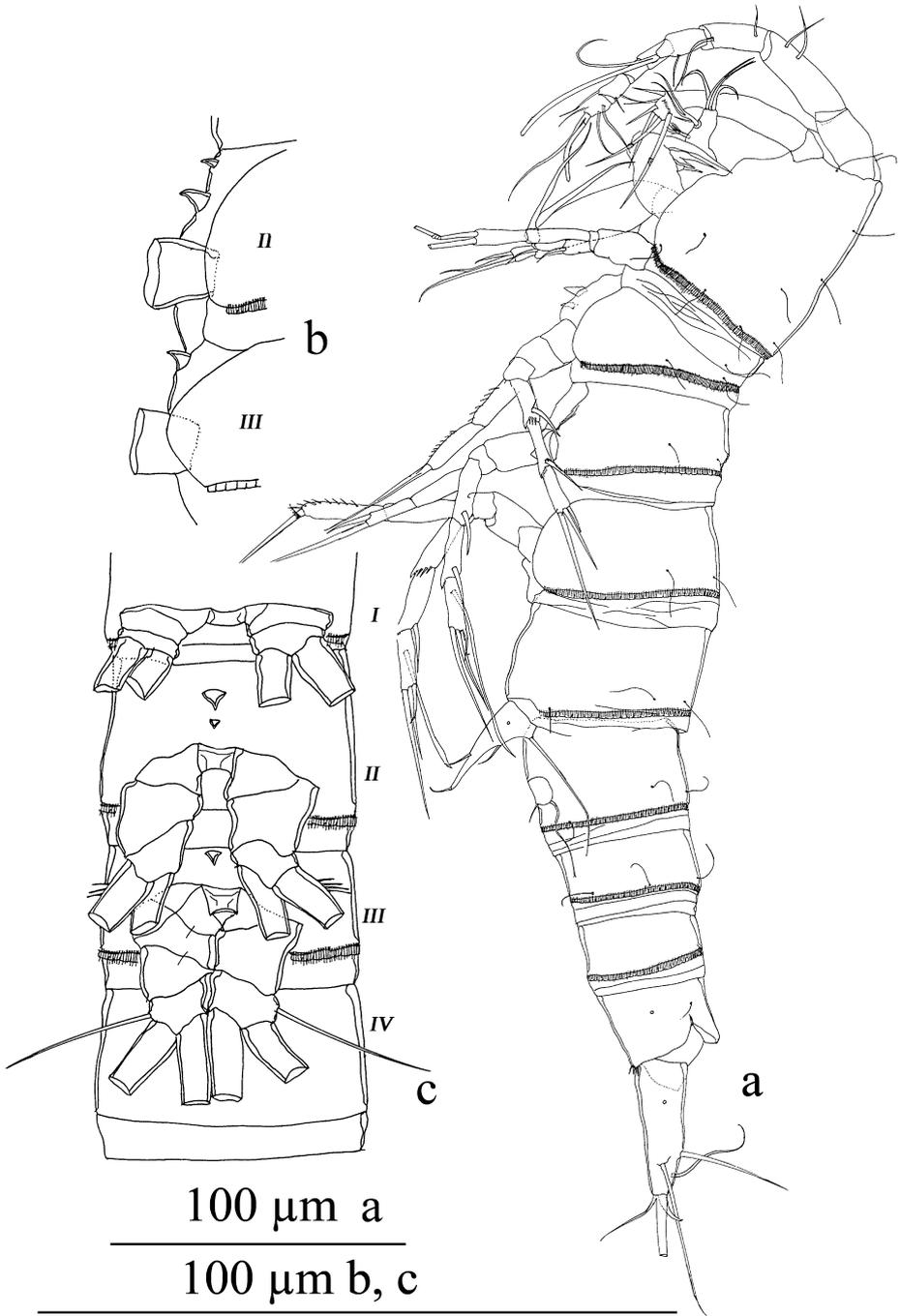


Fig. 8. *Cerconeotes huysi* n. sp., female paratype: a, habitus, lateral; b, ventral projection on prosomites 2 and 3, lateral; c, same, ventral.

segment with row of spinules on posterior surface and unarmed. Length ratios of antennular segments along medial axis 1.0 : 3.0 : 2.0 : 1.3 : 0.9 : 0.7 : 1.4.

Antenna (fig. 9b): comprising coxa, allobasis, 1-segmented endopod and 1-segmented exopod. Coxa very short and with 1 row of spinules. Allobasis about 3.4 times as long as maximum width, unarmed and with 2 rows of spinules on proximal inner margin. Exopod cylindrical, 2.7 times as long as wide and with 2 unequal apical setae. Endopod about half as long as allobasis, 2.6 times as long as wide, with surface frill subdistally and 1 transverse spinular row on inner margin; laterally with 2 short pinnate unequal spines and apically with 5 strong elements (2 spines, 3 geniculate setae, of which innermost one longest, 1.6 times as long as endopod and with 1 spinule at the base of geniculation).

Labrum (fig. 9c): broadly subtriangular, large, reaching distal margin of allobasis of antenna in lateral view; free margin deeply concave with a row of spinules on either side; with group of spinules on 2 small lobes and 6 long setules on dorsal surface.

Mandible (fig. 9d, e) with narrow gnathobase on elongate coxa, with 2 coarse teeth dorsally, 1 unipinnate seta ventrally and several smaller teeth. Palp 2-segmented, consisting of basis and endopod; basis twice as long as wide, incurved and with 1 ventral seta (shown in dots) at outer distal corner; endopod 4 times as long as wide, 1.4 times as long as basis; with 1 subapical and 3 apical setae.

Maxillule (fig. 10c, d): praecoxa elongate, chitinous segment with anteriorly directed arthrite having 8 claws along the distal margin; no setules discernible on the anterior surface. Coxa positioned between praecoxal arthrite and elongate basis, represented by endite, 2.5 times as long as wide and with 1 pinnate seta and 1 simple long seta distally. Basis subcylindrical, endite 2.9 times as long as wide; distal armature consisting of 4 slender simple setae and 1 unipinnate seta; proximal margin spinulose. Endopod fused at base and with 1 short, pinnate seta, 1 simple long seta. Exopod represented by 1 bipinnate spiniform seta, fused at base.

Maxilla (fig. 10e): syncoxa tapering distally and with 2 well-developed endites (derived from the coxa); proximal endite small, somewhat squarish, with 3 modified spines (1 apical and 2 subapical); distal endite with 1 spinulose claw, 1 slender seta distally and 1 modified seta subapically. Allobasis drawn out into strong claw, bearing 1 outer and 1 inner setae at base. Endopod well developed, 2-segmented; proximal segment unarmed; distal segment with 3 slender apical setae of which outer 2 setae fused at base.

Maxilliped (fig. 9g): composed of syncoxa, basis and endopod. Syncoxa small, 1.6 times as long as wide, with 1 row of fine spinules at inner distal corner and unarmed. Basis strong, 2.7 times as long wide, with 1 row of spinules each along outer and inner margins, and unarmed. Endopod 1-segmented, small, with 1 strong apical claw, distal 2/3 of which spinulose, and 1 slender, smooth seta.

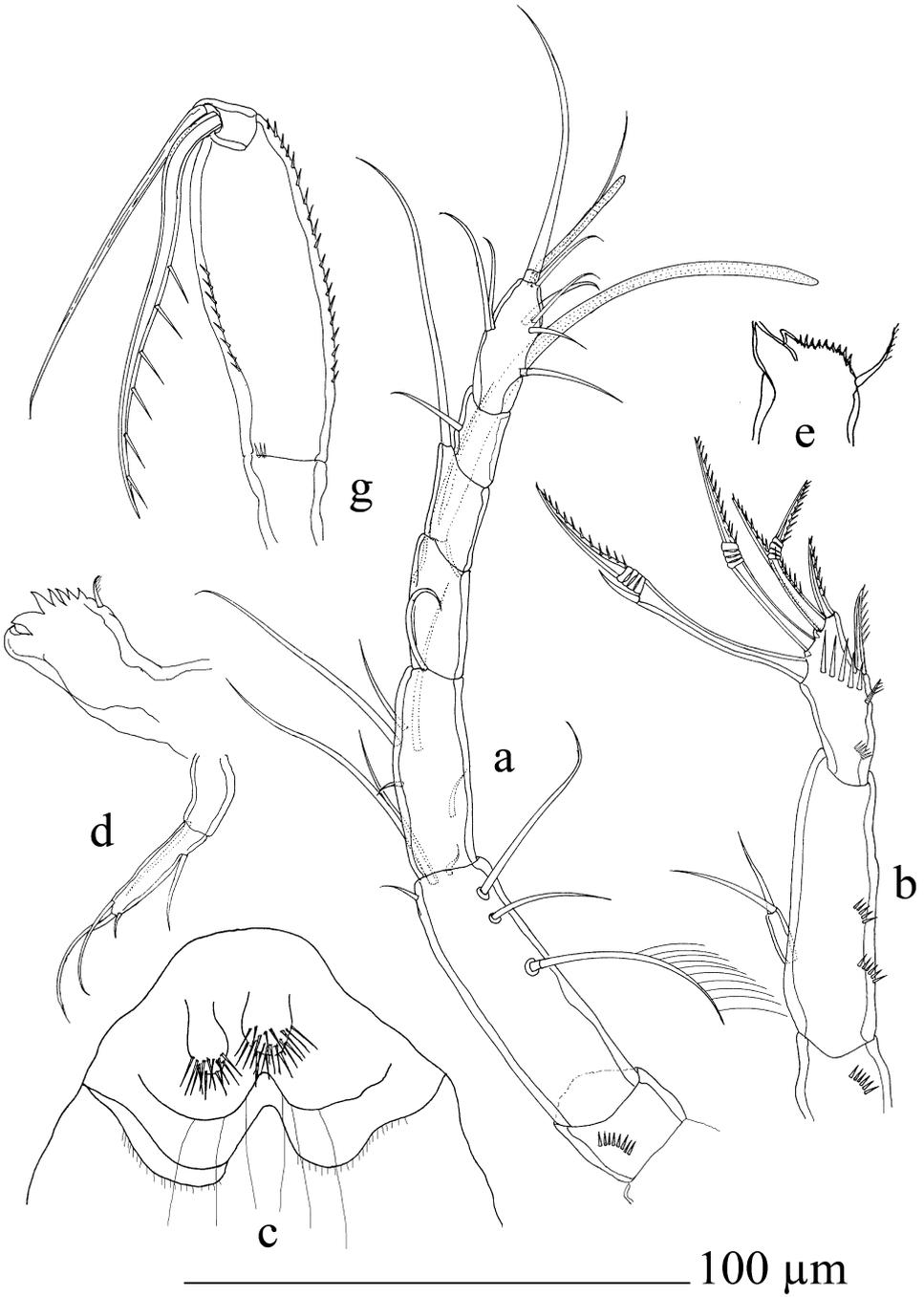


Fig. 9. *Cerconeotes huysi* n. sp., female holotype: a, antennule, dorsal; b, antenna, posterior; c, labrum, ventral; d, mandible, posterior; e, same, gnathobase; g, maxilliped, lateral.

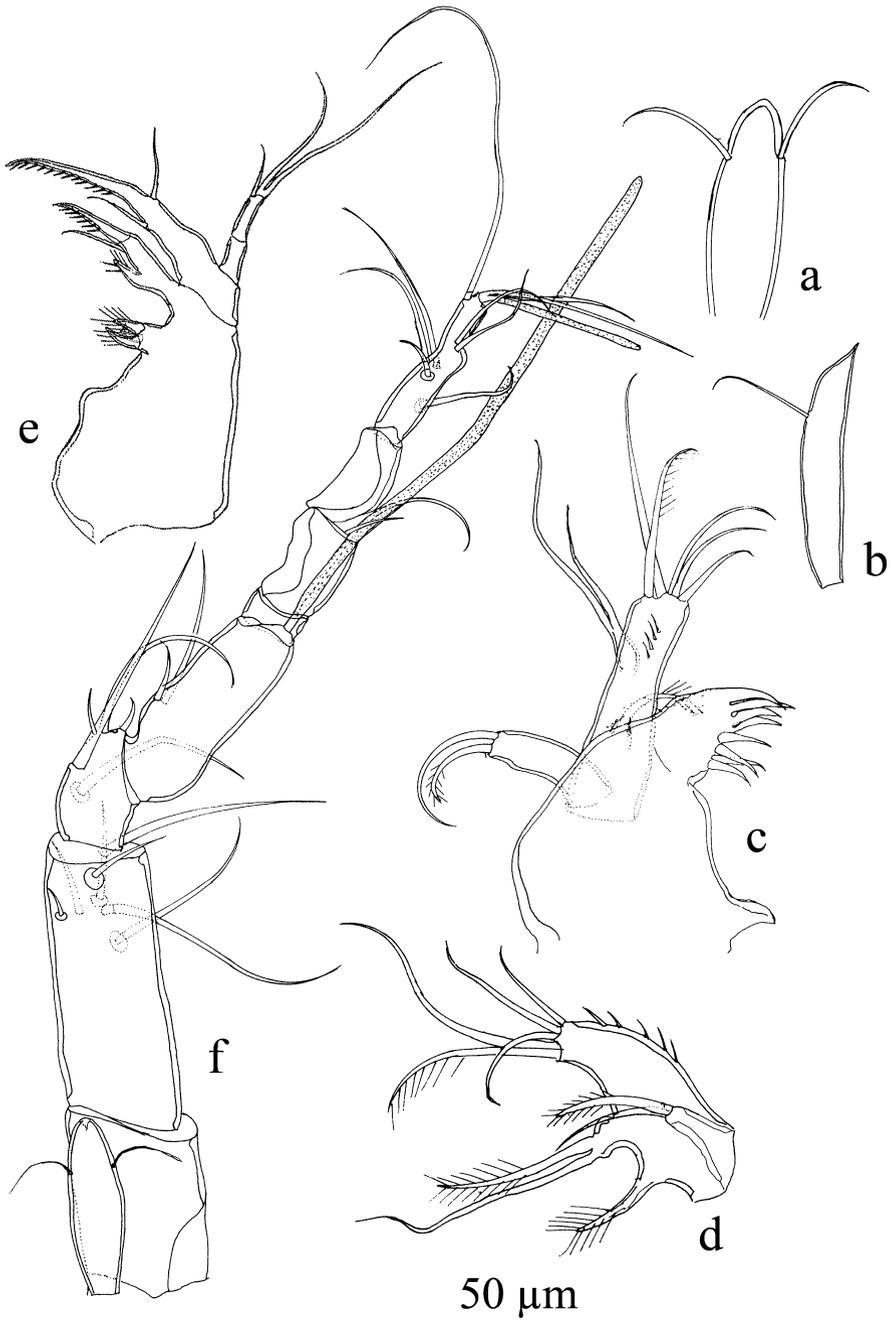


Fig. 10. *Cerconeotes huysi* n. sp., male paratype (a, b, d), female holotype (c, e), male allotype, (f): a, rostrum, dorsal; b, same, lateral; c, maxillule, ventral; d, coxa and basis of maxillule, anterior; e, maxilla, ventral; f, antennule, ventral.

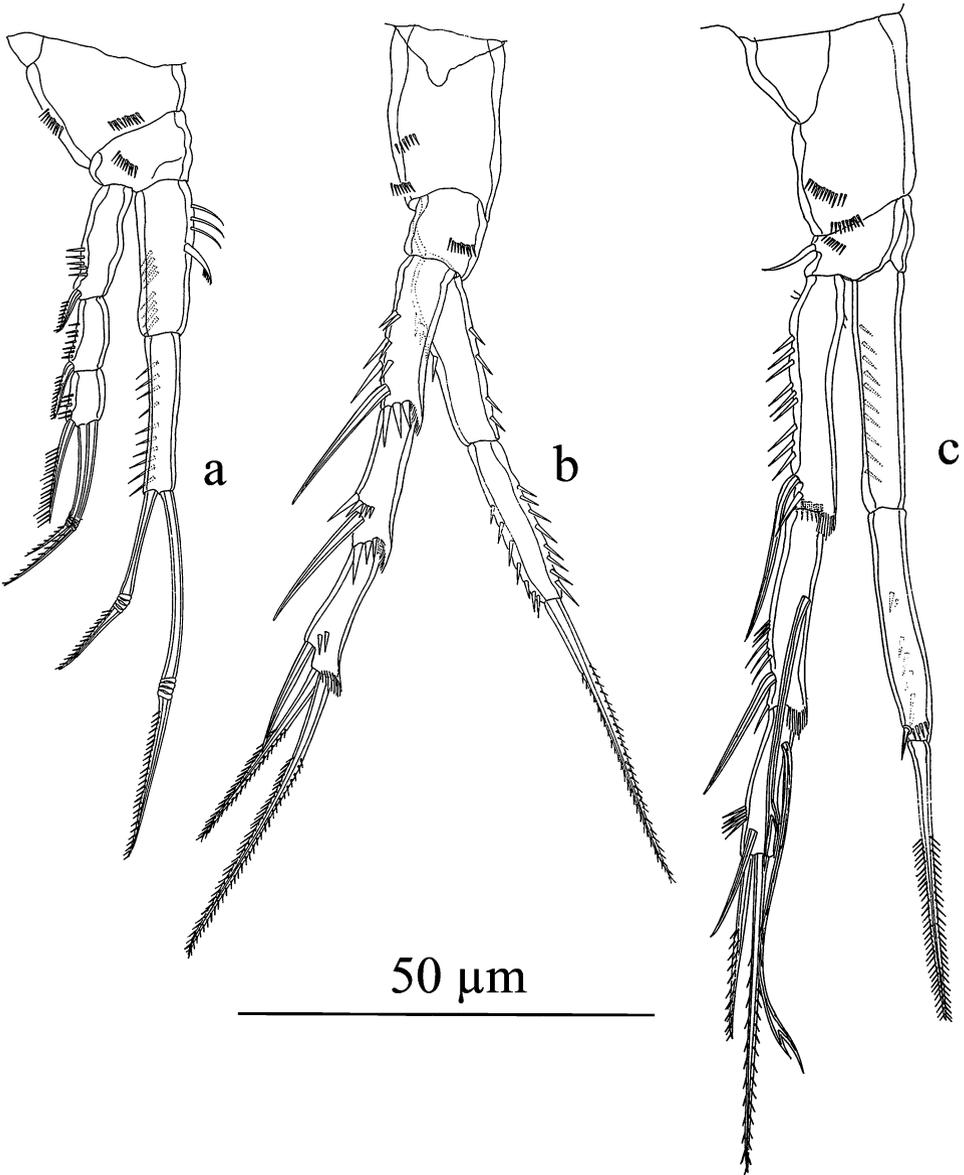


Fig. 11. *Cerconeotes huysi* n. sp., female holotype: a, leg 1, anterior; b, leg 2, anterior; c, leg 4, anterior.

Legs 1-4 (figs. 11a-c, 12a): with 3-segmented exopods and 2-segmented endopods. Endopods shorter than exopod on all legs save leg 1. Legs 1-3 gradually increasing in length; leg 4 shorter than leg 3. Intercoxal sclerite small, medially concave.

Leg 1 (fig. 11a): coxa trapezoidal, with 1 row of spinules on outer margin and 1 medial row on distal surface. Basis smaller than coxa, trapezoidal, with 1 row of spinules at base of exopod and unarmed. First and second exopodal segments each with 1 outer spine subdistally; first segment 1.2 times as long as second one; third segment with 3 apical elements (1 spine and 2 geniculate setae); all exopodal segments bearing spinules along outer margin. Endopod 1.3 times as long as exopod, with large spinules on proximal inner margin of first segment and on outer margin of second segment. First segment strong, 2.7 times as long as wide, 0.8 times as long as first 2 exopodal segments combined and with 1 much reduced spiniform element at 3/4 of segment's length. Second segment with 2 unarmed equal geniculate setae apically; inner geniculate seta 1.2 times as long as entire endopod, 1.9 times as long as largest geniculate exopodal seta and almost 1.8 times as long as outer geniculate seta on endopod. All exopodal and endopodal armature elements unipinnate along outer margin.

Leg 2 (fig. 11b): coxa with 1 row of spinules near outer margin and 1 medial row of spinules on distal surface. Basis shorter than coxa, somewhat squarish, unarmed and with 1 arched row of spinules near outer margin. First and second exopodal segments with 1 outer smooth spine each; first segment 1.2 times as long as second one, and third segment with 3 elements (1 subapical outer spine and 2 apical setae); inner apical seta 0.7 times as long as entire exopod, 2.8 times as long as outer seta. Endopod with spinules along outer and inner margins. First segment 3.2 times as long as wide, unarmed. Second segment 0.8 times as long as first one, with 1 apical, bipinnate seta.

Leg 3 (fig. 12a): coxa with 1 medial row of spinules and another row near distal border on anterior surface. Basis shorter than coxa, trapezoidal, with 1 row of medial spinules and with 1 outer seta. Exopod ornamentation almost as in leg 2, but no hyaline frill on third segment; with 1 spine each on first and second segments on outer subdistal margin; first segment about as long as second one and third segment with 1 outer subapical smooth spiniform element, 2 apical, bipinnate setae, and 1 inner bifurcate seta located at proximal third. Endopod with spinules along inner margin; first segment 3.8 times as long as wide, unarmed; second segment 0.7 times as long as first one, with 1 apical spiniform element, about as long as entire endopod, 0.8 times as long as inner apical seta on third exopodal segment and almost 3.1 times as long as outer seta on endopod.

Leg 4 (fig. 11c): coxa rhomboidal, with 1 row of spinules near outer distal corner and another row close to posterior border. Basis shorter than coxa, trapezoidal, with arched row of small spinules on proximal outer corner and with 1 short outer seta. Exopodal ornamentation almost as in leg 3. First segment 0.6 times as long as next 2 segments combined and with 1 outer spine; second segment with 1 outer spine and 1 inner modified seta, which is 1.2 times as long segment; and third

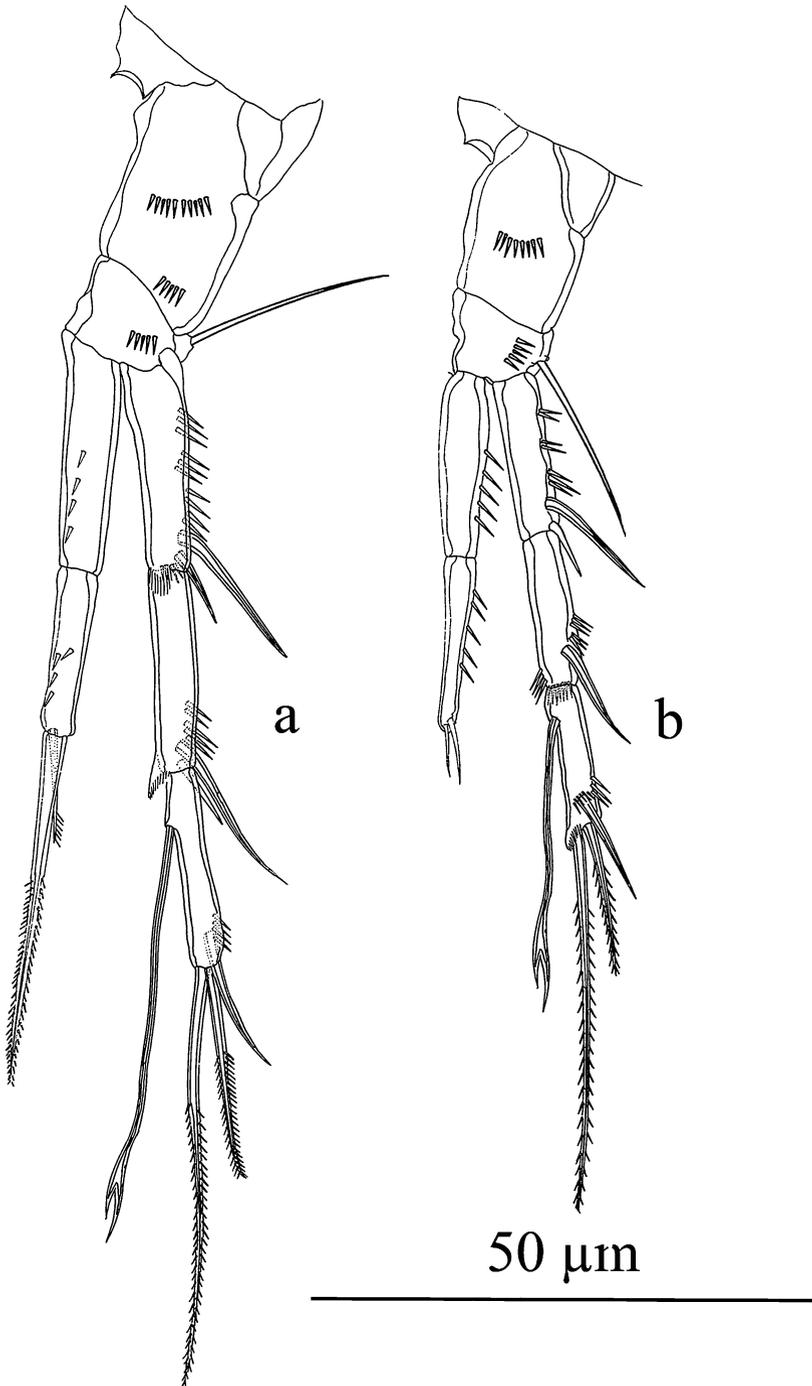


Fig. 12. *Cerconeotes huysi* n. sp.: a, female holotype leg 3, posterior; b, male allotype leg 3, posterior.

segment with 4 elements (1 subapical spiniform seta, 2 apical setae and 1 inner, modified seta), inner seta 2.2 times as long as segment. Endopod with spinules along outer margin. First endopodal segment 4.8 times as long as wide, unarmed; second segment 0.9 times as long as first one, with 1 well developed inner apical seta, which is 0.6 times as long as entire endopod and 0.8 times as long as inner apical seta on third exopodal segment; second segment with spine-like rudimentary element on outer side. Spine and seta formulae of legs 2-4 as follows:

	Exopod	Endopod
Leg 2	0.0.021	0.010
Leg 3	0.1.121	0.011
Leg 4	0.1.121	0.010

Leg 5 (figs. 13b, 14a): distinct at base; intercoxal sclerite narrow, medially concave; exopod and baseopod confluent, simple, conical plate, 2.2 times as long as wide, distal half much narrower and spiniform; with 1 small cuticular pore proximally and 4 setae (basal seta plumose, articulate at base and arising from small setophore; 1 small seta, probably ancestral exopodal seta, on outer margin; 1 still smaller seta subapically, and 1 seta, perhaps ancestral endopod, on inner margin).

Leg 6 (figs. 13c, 14a): reduced, fused at base, with 1 long, unipinnate apical and 1 short, simple subapical setae; apical seta incurved, 3.4 times as long as inner seta. Genital field (fig. 13c) small, located anteriorly on mid-ventral surface of genital double-somite, consisting of 2 separate opercula, closing off paired genital apertures; copulatory pores at about 1/3 of mid-ventral surface. Egg sac (fig. 13d) single, compact, elongate, containing 4-7 eggs arranged in 2 rows.

Description of adult male (allotype).— Body length, excluding caudal setae, 436  $\mu\text{m}$ . Body (fig. 14a, b) 6.2 times as long as wide, prosome/urosome ratio 0.7. Ornamentation of prosomites, colour and nauplius eye, caudal rami as in female, except genital somite and third urosomite.

Antennule (fig. 10f): 8-segmented, strongly digeniculate, geniculation between segments 3 and 4, and 6 and 7; slender, approximately 1.2 times as long as cephalothorax. Aesthetasc on fourth segment about half as long the same appendage, fused basally with subdistal seta; fifth segment smallest; aesthetasc on eighth segment short and slender, fused basally to 2 apical setae (acrothek). Setal formula: 0.7.5.3 + aes.0.1.0.9 + aes. Length ratios of antennular segments along medial axis 1.0 : 1.5 : 0.6 : 1.2 : 0.2 : 0.6 : 0.6 : 1.0.

Antenna, labrum, mandible, maxillule, maxilla, maxilliped, all legs except leg 3, and caudal rami as in female.

Genital somite (figs. 14a, b, 15a) shorter than wide, with 2 pairs of sensilla. Third urosomite only slightly longer than genital somite, with 2 pairs of sensilla. Fourth urosomite and preanal and anal somites as in female.

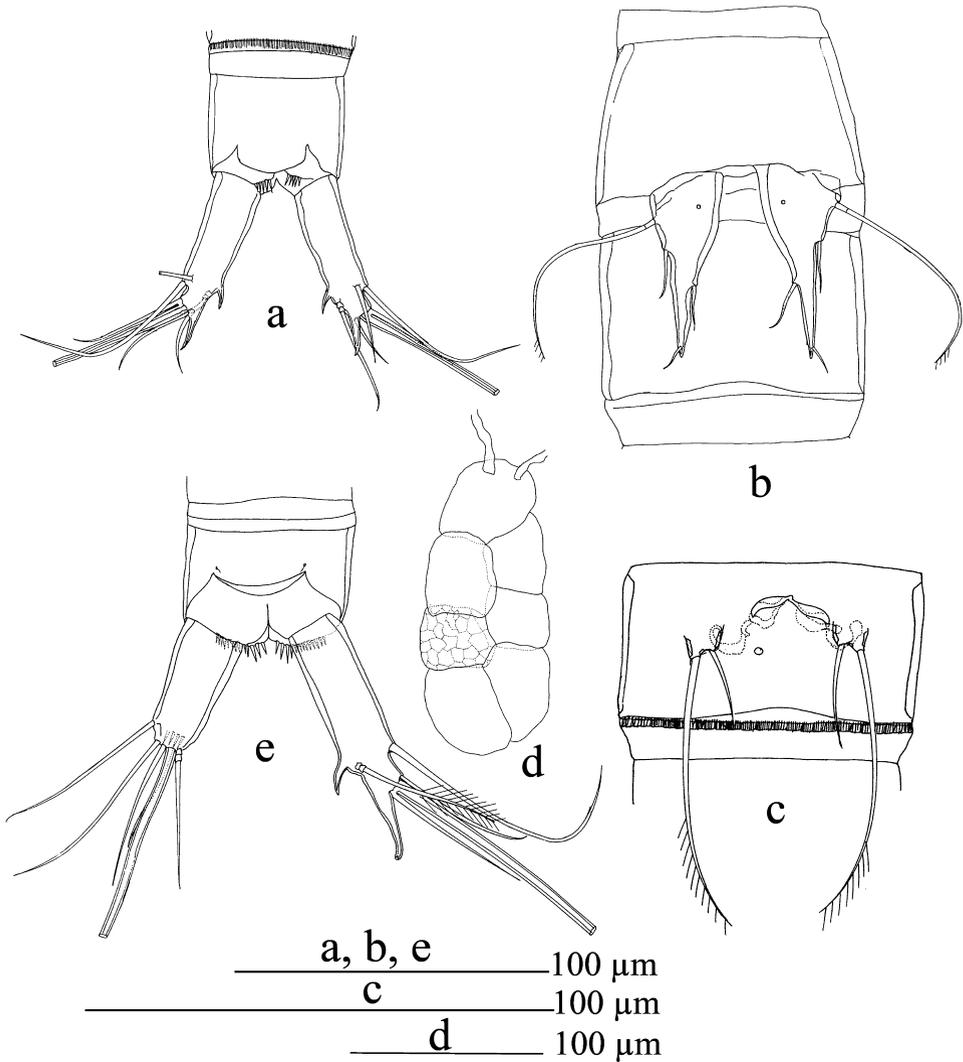


Fig. 13. *Cerconeotes huysi* n. sp., female holotype (a-c, e), female paratype (d): a, urosome, dorsal; b, urosomites 1-2, ventral; c, genital somite, ventral; d, egg sac; e, abnormal left caudal ramus, dorsal.

Leg 3 (fig. 12b): ornamentation and armature elements same as in female. First endopodal segment 3.7 times as long as wide, unarmed; second segment much slender, nearly as long as first segment and with 2 unequal, greatly reduced setae.

Leg 5 (fig. 15a, b): as in female but distal half much slenderer and longer; armature elements smaller than in female.

Leg 6 (fig. 15a, b): well developed, separate, represented by oval plate; proximal half narrow and with 2 strongly unarmed equal setae; outer (basal) seta 3.2 times as long as inner one. Intercoxal sclerite narrow, concave medially. A single large,

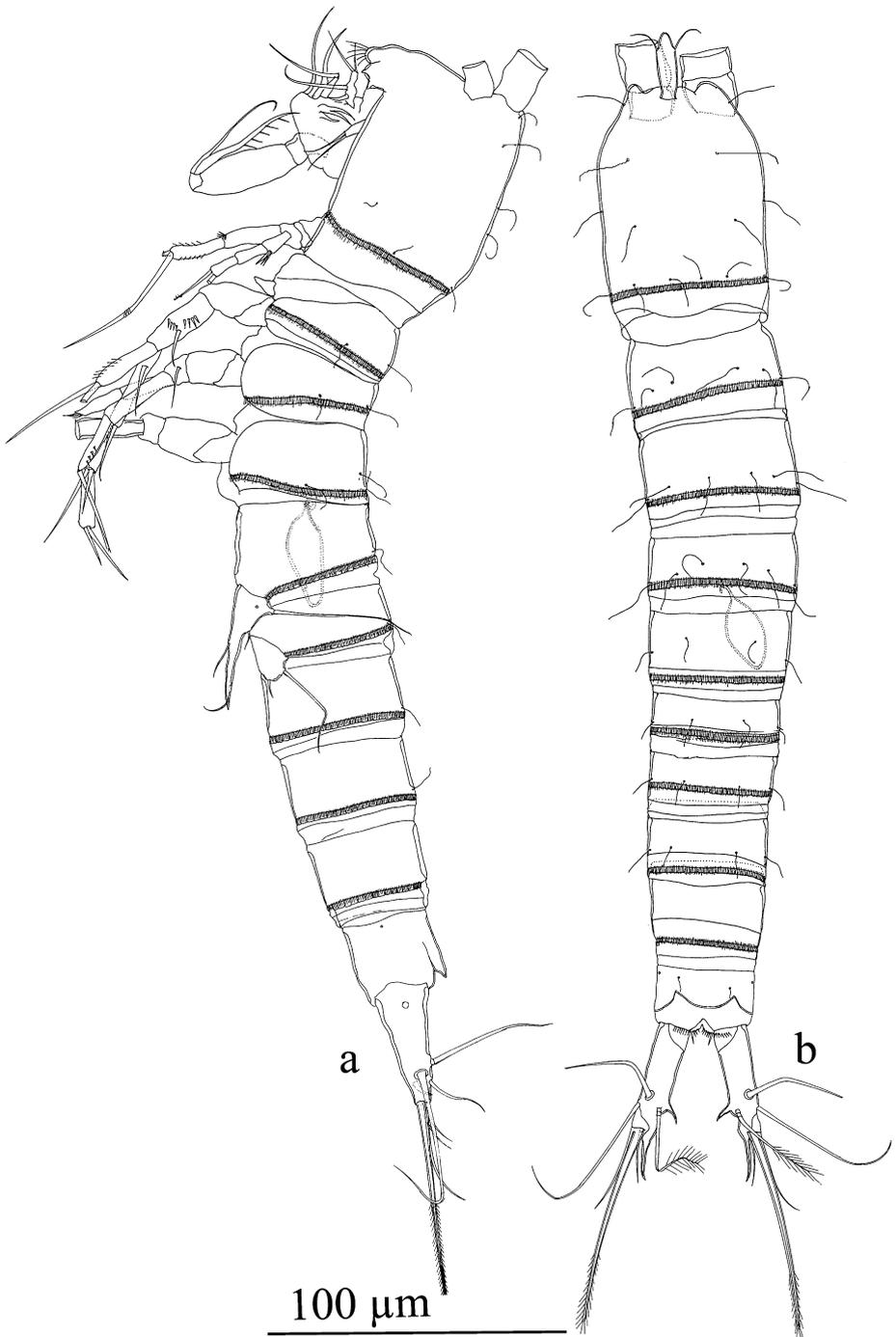


Fig. 14. *Ceroneotes huysi* n. sp., male paratype habitus: a, lateral; b, dorsal.

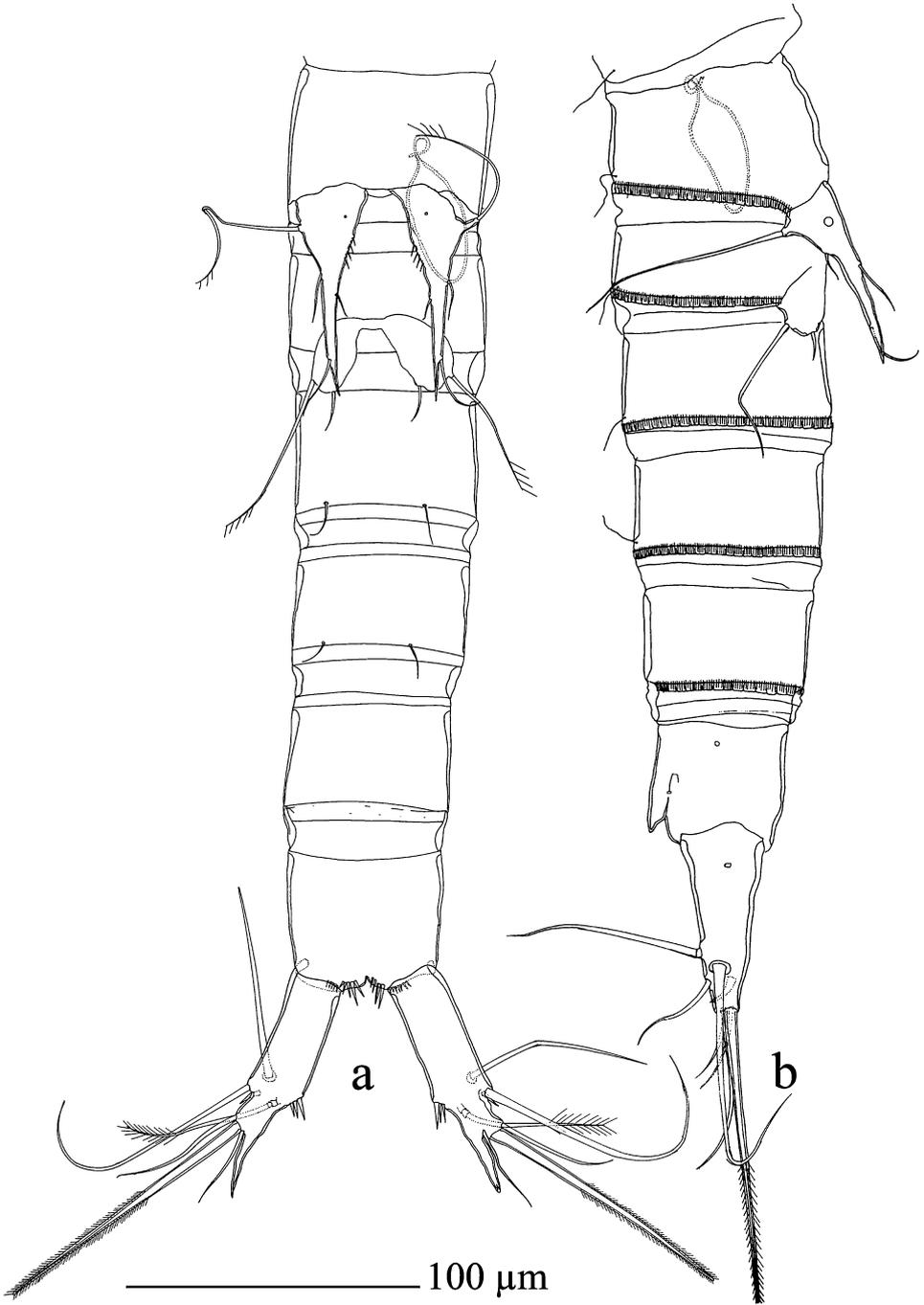


Fig. 15. *Cerconeotes huysi* n. sp.: a, male allotype urosome, ventral; b, male paratype, same, lateral.

longitudinally placed, oval spermatophore (fig. 15a, b), visible through somite 5-6, about twice as long as wide, with narrow and curved neck.

**Etymology.**— The new species is named in honour of Prof. Rony Huys, a well-known copepodologist.

**Variation.**— Caudal ramus sometimes with 1-3 spinules instead of small spinous process on subapical inner margin (fig. 15a).

**Abnormality.**— Left caudal ramus in one male shorter than, and different in form from, right one, 1.8 times as long as wide with 5 armature elements of unusual lengths, and without unguiform process (fig. 13e).

#### DISCUSSION

*Cerconeotes euryhalinus* can easily be separated from its congeners by the following features: the shape and armature of leg 5 in both sexes; the elongate second endopodal segment of the male leg 3 and its fused, unornamented apical elements; the armature of legs 1-4; and the unguiform process of the caudal rami. The material under study closely corresponds with the original account of this species by Krishnaswamy (1957), which is not only incomplete but also erroneous in certain details: (i) the largest female observed by us measured only 440  $\mu\text{m}$  in length against 950  $\mu\text{m}$  (the size of male is said to be “slightly smaller”) reported by Krishnaswamy; (ii) the female antennule has only seven segments rather than eight segments (the second segment was wrongly depicted as divided); (iii) the male antennule consists of eight instead of six segments; (iv) the second endopodal segment of the male leg 3 has two fused, apical spinous processes instead of setae; and (v) the female leg 6 has two unequal setae instead of one seta. No further comparison of the present specimens with the original account is possible because it lacks illustrations of the habitus, caudal rami and their armature details.

Commenting on the relationships of *C. mozambicus* with its congeners, Wells (1967) observed that “a proper redescription of *C. euryhalinus* may well show that *C. mozambicus* is identical with this species”. However, a critical comparison of the present redescription of *C. euryhalinus* with that of *C. mozambicus* by Huys (1992) leaves no doubt that they are quite distinct from each other in several respects. For example, the proximal and distal segments of the mandibular palp have, respectively, one and three setae vs. none and four setae; leg 5 in both sexes is a somewhat triangular plate-like vs. bilobed structure; the outer spine on the first and second exopodal segments of the female legs 2-4 are slender and elongate vs. short and sturdy; the outer spinous process of the second endopodal segment of the male leg 3 is unornamented vs. ornamented, and the inner spinous

process of the same segment has fine spinules halfway down the outer margin vs. an inner apical “barb”; and the spine on the first exopodal segment of leg 4 is normal vs. modified (“long and recurved”). Huys (1992: 64) postulated that the latter recurved armature element as a synapomorphy of the genus-group consisting of *Cerconeotes*, *Schizothrix* Huys, 1992, and *Belemnopontia* Huys, 1992 (see below). In addition, the body ornamentation is quite different between the two species.

Among its congeners, *C. huysi* n. sp. shows a closer resemblance with *C. euryhalinus*. This is evident from, inter alia, the sharply serrulate, dorso-ventral hyaline fringe on all somites except for the anal somite; the armature details of legs 1-6 in both sexes including the unmodified spine on the first exopodal segment of leg 4; and the presence of a seta on the proximal segment of the mandibular palp. However, *C. huysi* n. sp. can easily be separated from *C. euryhalinus* based on the length/width ratio of the caudal rami (about four vs. two times as long as wide), the shape of leg 5 in both sexes (remarkably elongate vs. short), the nature of the two armature elements on the third endopodal segment of the male leg 3 (small spine-like setae vs. large spinous processes), the number of setae on the distal segment of the mandibular palp (four vs. three), etc. *Cerconeotes huysi* n. sp. is unique in the genus especially by its elongate caudal rami as well as leg 5 in both sexes, and the armature elements on the second endopodal segment of the male leg 3.

It is to be noted that though both *C. euryhalinus* and *C. huysi* n. sp. perfectly fit into the generic diagnosis of *Cerconeotes*, they do not agree with two of the original criteria: (i) the proximal segment of mandibular palp has one seta, but this seta is absent in all other species for which the mandibular armature is fully depicted (Lang, 1965, fig. 228e; Wells, 1967, fig. 63E; Itô, 1968, fig. 2-5; and Mielke, 1983, fig. 2c); and (ii) the outer spine on the first exopodal segment of leg 4 is unmodified, like in *C. japonicus*, *C. nichollsi*, and *C. waltirensis*, as opposed to the same being “elongated and curved” in the other species. Hence, it is necessary to emend the generic diagnosis of *Cerconeotes* regarding the two generic features as follows: the proximal segment of the mandibular palp either with or without a seta; and the outer spine of the first exopodal segment of leg 4 either normal or modified as an elongated and curved element.

### Ecology

*Cerconeotes euryhalinus*, as its name implies, occurs in water bodies showing a wide range of salinity. Krishnaswamy (1957) first met with this species in the brackish waters of the Cooum Estuary near the city of Madras (now Chennai) on the southeastern coast of peninsular India. Later, it was found by Ranga

Reddy (2001) in the sandy banks of the River Krishna at Vijayawada city in purely freshwater conditions. Subhashini (2001), in her unpublished Master of Philosophy dissertation, described the same species as "*Leptastacus vijayawadensis* n. sp.", but as that name was not published according to ICZN criteria, it is not available and thus not relevant in the synonymy of *C. euryhalinus*. In the present study, it was also found in several hyporheic habitats experiencing either brackish or true freshwater conditions (see below). On one occasion, this species was found sympatrically with *C. huysi* n. sp. under brackish conditions in the hyporheic zone. Coincidentally, another brackish water harpacticoid species, *Delavalia madrasensis* (Wells, 1971), which is known to occur in brackish or saline conditions (see Wells & Rao, 1987: 75), was well established in true freshwater conditions of the River Krishna (see Radhakrishna & Ranga Reddy, 1978).

In a year-round study (June 2000-May 2001) of the sandy bed of the River Krishna at Vijayawada, *C. euryhalinus* was found to be the most common and dominant member in the interstitial community, attaining its highest population density (21 animals per cm<sup>3</sup>) in the upper 5 cm of the sandy bottom, but the density tapered off gradually and consistently from 5 to 20 cm. Oviparous females carry a single, ventro-medial ovisac each, generally with 3-5 serially arranged eggs. It was found to breed throughout the year as borne out by the presence of gravid females, copepodids, and presumably nauplii, too; breeding activity was most intense in the month of August. Females always outnumbered males, with the sex ratio ranging from 1:1.5 to 1:2.0, average 1:2.6. The preponderance of females over males is more or less a general condition in the meiobenthic marine harpacticoid copepods (Itô, 1971; Mielke, 1976; Nodot, 1978; Palmer, 1980). During summer months (March-June), *C. euryhalinus* was the most dominant dietary constituent in the guts of the early juveniles (length ca. 4 cm) of a commercially important gobioid fish, *Glossigobius giuris* (Hamilton, 1822), which heavily preyed upon the interstitial fauna (see Ranga Reddy, 2001: 731).

In the samples under examination, *C. euryhalinus* was accompanied by various taxa at different localities (table I).

In sharp contrast to *C. euryhalinus*, *C. huysi* n. sp. has a rather limited ecological distribution in our study area, having been recorded only in a few hyporheic habitats of the lower reaches of the River Godavari, as listed above. Generally, these localities experience brackish water conditions only during summer (March-June) due to the incursion of the sea water from the nearby Bay of Bengal. On the whole, *C. huysi* n. sp. seems to be a predominantly brackish water species.

TABLE I  
Occurrence of *Cerconeotes euryhalinus* (Krishnaswamy, 1957) and accompanying taxa at different localities

Date of collection	Locality: brackish/freshwater	Co-occurring fauna
13 May 2006	River Godavari (herein after abbreviated as RG): Brahmapuri, brackish	<i>Parastenocaris mahanadi</i> Ranga Reddy & Defaye, 2007, and nematodes
15 May 2006	RG: Kapileswarapuram, slightly brackish	<i>Parvulobathynella distincta</i> Ranga Reddy, Bandari & Totakura, 2011, unidentified harpacticoids and cladocerans
15 May 2007	RG: Kapileswarapuram, slightly brackish	<i>Parvulobathynella distincta</i> , cyclopoids and unidentified harpacticoids
18 May 2007	RG: Masakapalli, brackish	Cyclopoids, unidentified harpacticoids and polychaetes
2 April 2008	RG: Atreyapuram, freshwater	Cyclopoids and <i>P. mahanadi</i>
2 April 2008	RG: Sundarapalli, slightly brackish	Cyclopoids, <i>Parastenocaris curvispinus</i> Enckell, 1970, and unidentified harpacticoids
30 April 2008	RG: Kotipalli, brackish	<i>Habrobathynella plenituda</i> Ranga Reddy & Schminke, 2009, and unidentified harpacticoids
1 May 2008	RG: Yanam, core sample, brackish	<i>Cerconeotes huysi</i> n. sp., unidentified harpacticoids, nematodes and polychaetes
19 July 2008	RG: Kotipalli, brackish	Cyclopoids and <i>P. curvispinus</i>
19 July 2008	RG: Yanam, brackish	Harpacticoids and oligochaetes
20 July 2008	RG: Koolla, slightly brackish	<i>P. distincta</i> , <i>P. curvispinus</i> , cyclopoids, and oligochaetes
22 July 2008	RG: Sundarapalli, brackish	None
30 November 2008	RG: Bhiravapalem, ca. 3-4 km from Bay of Bengal, brackish	Unidentified harpacticoids
30 November 2008	RG: Sundarapalli, brackish	<i>Allocyclopina inopinata</i> Defaye & Ranga Reddy, 2008, <i>Andhracoides</i> sp. (Isopoda), nematodes and insect larvae
14 January 2009	River Krishna (herein after abbreviated as RK): Kanaka Durga Varadhi (abbreviated as KDV), Vijayawada, freshwater	Cyclopoids, harpacticoids ( <i>P. curvispinus</i> , <i>P. gayatri</i> Ranga Reddy, 2001), mites, ostracods, nematodes, oligochaetes and insect larvae
18 January 2009	RG: Kotipalli, brackish	<i>A. inopinata</i> , harpacticoids, mites and nematodes
18 January 2009	RG: Kotipalli, brackish	Nematodes and insect larvae
20 March 2008	RK: KDV, Vijayawada, freshwater	<i>P. distincta</i> , <i>Rybocyclops</i> sp. and <i>P. curvispinus</i>

TABLE I  
(Continued)

Date of collection	Locality: brackish/freshwater	Co-occurring fauna
14 April 2008	RK: KDV, Vijayawada, freshwater	<i>P. curvispinus</i> , unidentified cyclopoids and harpacticoids
17 June 2008	RK: KDV, Vijayawada, freshwater	<i>P. curvispinus</i> , <i>Kinnecaris godavari</i> Ranga Reddy & Schminke, 2009, oligochaetes, mites and molluscs
10 July 2008	RK: Suggunalanka, freshwater	<i>Serbanibathynella secunda</i> Totakura & Ranga Reddy, 2014, cyclopoids, <i>Folioquinpes chathamensis</i> (G. O. Sars, 1904), <i>P. curvispinus</i> and nematodes
5 July 2009	RK: KDV, Vijayawada, freshwater	Unidentified cyclopoids and harpacticoids, <i>P. gayatri</i> and <i>P. curvispinus</i>

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## REFERENCES

- CHAPPUIS, P. A., 1942. Eine neue Methode zur Untersuchung der Grundwasserfauna. Acta scient. math. nat. Univ. Franc. Jos. Koloszvar, **6**: 1-7.
- HUYS, R., 1992. The amphiatlantic distribution of *Leptastacus macronyx* (T. Scott, 1892) (Copepoda: Harpacticoida): a paradigm of taxonomic confusion; and a cladistic approach to the classification of the Leptastacidae Lang, 1948. Meded. k. Acad. Wet. Lett. sch. Kunarmedst. Belg., **54**: 21-196.
- HUYS, R. & S. CONROY-DALTON, 2005. *Aquilastacus* gen. nov. from the southern North Sea and the taxonomic position of *Leptastacus operculatus* Masry, 1970 (Copepoda: Harpacticoida: Leptastacidae). Cah. Biol. Mar., **46**: 347-363.
- ICZN (INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE), 1999. International code of zoological nomenclature (4<sup>th</sup> ed.): xxx + 306 pp. (The International Trust for Zoological Nomenclature, London).
- ITÔ, T., 1971. The biology of a harpacticoid copepod, *Harpacticus uniremis* Kröyer. J. Fac. Sci. Hokkaido Univ. Ser. Zool., **18**: 235-255.

- KRISHNASWAMY, S., 1957. Studies on the Copepoda of Madras. (Ph.D. Dissertation, University of Madras, Madras).
- LANG, K., 1965. Copepoda Harpacticoidea from the Californian Pacific coast. K. svenska Vetens Akad. Handl., **10**: 1-560.
- MCLACHLAN, A. & C. G. MOORE, 1978. Three new species of Harpacticoida (Crustacea, Copepoda) from sandy beaches in Algoa Bay, South Africa, with keys to the genera *Arenosetella*, *Hastigerella*, *Leptastacus* and *Psammastacus*. Ann. S. Afr. Mus., **76**: 191-211.
- MIELKE, W., 1976. Ökologie der Copepoda eines Sandstrandes der Nordseeinsel Sylt. Mikrofauna Meeresboden, **59**: 1-86.
- NODOT, C., 1978. Cycles biologiques de quelques espèces de Copépodes Harpacticoïdes psammiques. Téthys, **8**: 241-248.
- PALMER, M. A., 1980. Variation in life-history patterns between intertidal and subtidal populations of the meiobenthic copepod *Microarthridion lottorale*. Mar. Biol., **60**: 159-165.
- RADHAKRISHNA, Y. & Y. RANGA REDDY, 1978. A new species of *Stenhelia* Boeck (Copepoda, Harpacticoida) from south India. Crustaceana, **35**: 152-158.
- RANGA REDDY, Y., 2001. Discovery of Parastenocarididae (Copepoda, Harpacticoida) in India, with the description of three new species of *Parastenocaris* Kessler, 1913, from the River Krishna at Vijayawada. Crustaceana, **74**: 705-733.
- SUBHASHINI, V., 2001. A study on the interstitial faun of the River Krishna at Vijayawada, with special reference to a dominant harpacticoid copepod, *Leptastacus vijayawadensis* n. sp. (Crustacea). (Unpubl. M. Phil. Thesis, Nagarjuna University, Nagarjunanagar).
- WALTER, T. C., 2015. *Cerconeotes* Huys, 1992. In: T. C. WALTER & G. BOXSHALL (eds.), World of copepods database. Available online at <http://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=149956> (accessed 11 September 2015).
- WELLS, J. B. J., 1967. The littoral Copepoda (Crustacea) of Inhaca Island, Mozambique. Trans. R. Soc. Edinb., **67**: 189-358.
- WELLS, J. B. J. & G. C. RAO, 1987. Littoral Harpacticoida (Crustacea: Copepoda) from Andaman and Nicobar Islands. Mem. Zool. Survey India, **16**: 1-385.