Ann. Limnol. - Int. J. Lim. 2005, 41 (2), 83-92

First *Haplocyclops* Kiefer (Crustacea, Copepoda) from Indian subterranean waters : the most reduced free-living cyclopoid

T. Karanovic[1]*, Y. Ranga Reddy[2]

[1] Western Australian Museum, Locked Bag 49, Welshpool DC WA 6986, Perth, Western Australia, Australia.
[2] Acharya Nagarjuna University, Department of Zoology, Nagarjunanagar 522510, Andhra Pradesh, India.

A new species of small cyclopoids from subterranean waters of India is described in a newly established subgenus, *Kiefercyclops* n.sg., of the genus *Haplocyclops* Kiefer, 1952. Genital double-somite with ovipores situated in the posterior half, antennula without the lateral seta on the ultimate segment, and caudal rami with the lateral seta inserted in the proximal half are among the most important characters of *H. (K.) fiersi* n.sp., that warrant its position in the genus *Haplocyclops.* Also, the new species differs from the other six congeners by several autapomorphic characters, most of them being reductions in armature and/or segmentation of the appendages. In particular, the degree of reductions concerning the segmentation of the swimming legs makes it the most reduced free-living cyclopoid, with both rami of third and fourth legs, as well as the endopod of second leg being one-segmented in both sexes. A key to species of *Haplocyclops* is given at the end of this paper.

Keywords : copepod, taxonomy, groundwater, stygofauna, new subgenus, new species.

Introduction

The stygofauna of the Indian subcontinent is very poorly known (Marmonier et al. 1993, Ranga Reddy 2002b, 2004), with only a few records until the mid-1980s (Botosaneanu 1986). As far as the freshwater subterranean copepods are concerned (Lescher-Moutoué 1986, Rouch 1986), by that time only six species of the genus *Parastenocaris* Kessler, 1913 from Sri Lanka (Enckell 1970) and one species of the genus *Elaphoidella* Chappuis, 1928 from the mainland (Chappuis 1954) had been described. The four cyclopoids, reported by Pesce & Pace (1984) from several freshwater wells near New Delhi, are actually all stygophiles (or even stygoxenes), not stygobites. The recently renewed interest in the Indian stygofauna has revealed a number of very interesting subterranean copepods (Ranga Reddy 2001, Karanovic & Pesce 2001, Karanovic & Ranga Reddy 2004a, 2004b), as well as some ancient bathynellids (Ranga Reddy 2002a, in press, Ranga Reddy & Schminke in press, a, b). The latter probably emerged from their marine ancestors as far back as the Permian (Schminke 1981, Pandourski & Ognjanova 2001), i.e. just after the Permo-Carboniferous glaciation, which occurred when India formed part of the Gondwana supercontinent (Frakes 1999, Playford 2003). In this paper one stygobiont of clear freshwater origin is described as a new species and new subgenus in the Gondwanian small-cyclopoid genus *Haplocyclops* Kiefer, 1952.

This genus was established by Kiefer (1952) to accommodate a single new species from Madagascar, *H. gudrunae.* A few years later Kiefer (1955, 1956) described (twice!) two additional new species of *Haplocyclops* from Madagascar : *H. pauliani* and *H. neuter.* Although barely more than repeated description, the latter publication (Kiefer, 1956) contained a few more drawings of the new species than the former one (Kiefer, 1955), as well as a partial redescription of *H. gudrunae* (although the illustrations in both descriptions are almost identical). Soon after that Lindberg (1956) dissolved *Haplocyclops* as a species group (among five others) in the genus *Bryocyclops* Kiefer, 1927, as a continuation of his previous subdividing of this genus into species groups (Lindberg 1954). Kiefer (1960a,

* Corresponding author : E-mail: karanovic@museum.wa.gov.au

Article available at http://www.limnology-journal.org or http://dx.doi.org/10.1051/limn/2005011

1960b) did not accept the complete dissolution of *Haplocyclops,* but rather considered it a subgenus of *Bryocyclops,* when he described (twice again!) one additional species from the continental Africa (today's Mali) as *Bryocyclops (Haplocyclops) monodi.* In one of the two above-mentioned publications, Kiefer (1960a) replaced the name *Haplocyclops pauliani* Kiefer, 1955 with *Bryocyclops (Haplocyclops) correctus,* as the binomen *Bryocyclops pauliani* had already been used to designate another taxon by Lindberg (1954). *Haplocyclops* was considered a subgenus of *Bryocyclops* by Dussart (1981, 1982), Dussart & Defaye (1985), Lescher-Moutoué (1986), Rocha & Carvalho Bjornberg (1987), and Pesce (1996). Dussart (1981) also reported *Bryocyclops (Haplocyclops) neuter* Kiefer, 1955 from Iran, but with some considerable differences from the Madagascan population. Although the subgeneric status of *Haplocyclops* seemed to be widely accepted, some authors hesitated and eventually, directly or indirectly, attributed the rank of genus to *Haplocyclops.* Monchenko (1972) did not include members of *Haplocyclops* in his key to species of *Bryocyclops* and Reid (1993) and Reid & Strayer (1994) actually used *Haplocyclops* as a generic name in their discussions. Finally, Rocha et al. (1998) formally reassessed and redefined the genus *Haplocyclops* and brought some previously overlooked characters to our attention, while describing *H. torresi* from Brazil. This was accepted by Reid (1999), Dussart & Defaye (2001) and Fiers (2002), and the last mentioned author also redescribed four species (including the type species) hosted in the Friedrich Kiefer Copepod Collection. Fiers (2002) also treated the specimens of *H. neuter* Kiefer, 1955 from Iran (reported by Dussart 1981) as a new species, *H. iranicus,* and accepted five other species as valid members of the genus : *H. gudrunae* Kiefer, 1952 ; *H. monodi* (Kiefer, 1960) ; *H. neuter* Kiefer, 1955 ; *H. pauliani* Kiefer, 1955 (not a homonym any more) ; and *H. torresi* Rocha, Torres & Maia-Barbosa, 1998. A key to aid in their identification is presented at the end of this paper.

Material and methods

The sample was collected from a freshwater borewell by filtering the groundwater with plankton net (mesh size 70 µm). The net was tied to the inlet delivery tube that opens into an overhead storage tank, and left there for three hours, until the tank was filled to the brim. The material was preserved in 10% formaldehyde, and later separated with a dissecting microscope and moved to 70% ethanol. Specimens were dissected in Faure's medium, prepared following the procedure of Stock & Vaupel Klein (1996), and dissected appendages were then covered with a coverslip. For the urosome or the entire animal, two human hairs were mounted between the slide and coverslip, so the parts could not be compressed. By manipulating the coverslip carefully by hand, the whole animal or a particular appendage could be positioned in different aspects, thus making possible the observation of morphological details. During the examination water slowly evaporated, and appendages or whole animals eventually remained in completely dry Faure's medium. All drawings were prepared using a drawing tube attached to a Leica-DMLS brighfield compound microscope, with C-PLAN achromatic objectives. Specimens, which were not drawn, were examined in a mixture of equal parts of distilled water and glycerol. Morphological terminology follows Huys & Boxshall (1991), except for small differences in the spelling of some appendages (antennula, mandibula, maxillula instead of antennule, mandible, maxillule), as an attempt to standardize the terminology for homologue appendages in different groups of crustaceans. A much more simplified armature formula of the swimming legs is also used, and caudal rami setae numeration is abandoned. The material is deposited in the Western Australian Museum, Perth (prefix WAM).

Results

Order : Cyclopoida Burmeister, 1834

Family : Cyclopidae Burmeister, 1834

Subfmily : Cyclopinae Burmeister, 1834

Genus : *Haplocyclops* Kiefer, 1952

Subgenus : *Kiefercyclops* n. sg.

Diagnosis

Very small Cyclopinae, with almost harpacticoidal habitus and smooth integument. Genital double-somite strikingly large compared to rest of urosome, swollen both laterally and ventrally, with copulatory pore and ovipores situated at 3/4 of double-somite length. Anal somite with large crescentic anal operculum, which produced well beyond somite limit. Caudal rami about twice as long as wide, parallel, with lateral seta inserted in proximal half almost dorsally and principal apical setae without breaking planes. Antennula in female 11-segmented, very short, without lateral seta on ultimate segment and with only two setae on seventh segment. Antennula in male strongly digeniculate, 13-segmented. Antenna four-segmented, with setal for-

mula 1.1.5.6 and without seta representing exopod. Mouth appendages with reduced armature and/or segmentation: mandibular palp completely reduced; maxillular palp one-segmented; maxilla without lateral small seta on basis; and maxilliped three-segmented. All swimming legs without any coxal armature and with only outer seta on basis; exopods of first and second legs, as well as endopod of first leg, two-segmented, while all other rami one-segmented (although armature of exopods reflects ancestral two-segmented condition, the same could not be traced on endopods); spine formula of second exopodal segments (ancestral in case of third and fourth leg) 2.2.2.2 and setal formula 5.4.4.3. Endopod of third swimming leg in male with one seta more than in female. Fifth leg completely fused to somite, represented by three slender setae. Sixth leg distinct cuticular plate, armed with single seta in both sexes.

Type and only species

Haplocyclops (Kiefercyclops) fiersi n. sp.

Etymology

The new subgenus is named in honour of late Friedrich Kiefer, who was one of the most productive taxonomists working on freshwater cyclopoids, and who also described most of *Haplocyclops* species. His surname is prefixed to the existing generic name *Cyclops.* Gender masculine.

Haplocyclops (Kiefercyclops) fiersi n. sp.

(Figures 1-31)

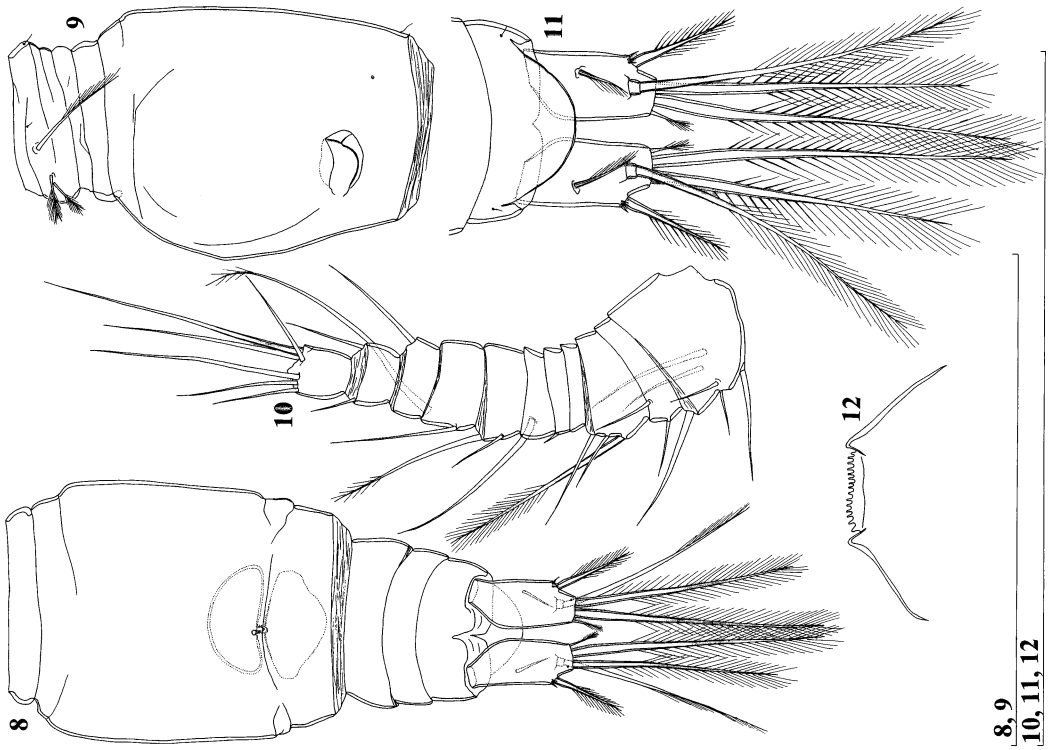
Material examined

India, Andhra Pradesh, a freshwater bore-well near Block II in the Acharya Nagarjuna University Campus, 13 km from Guntur town (16°18'N 80°29'E), 9 December 1998, leg. Y. Ranga Reddy: holotype female (WAM C34228) and allotype male (WAM C34229) dissected on one slide each; paratypes - seven males + 16 females + six copepodids [one male (WAM C34230) and one female (WAM C34231) dissected on one slide each; two males and four females (WAM C34232) mounted on a SEM stub; others (WAM C34233) in alcohol].

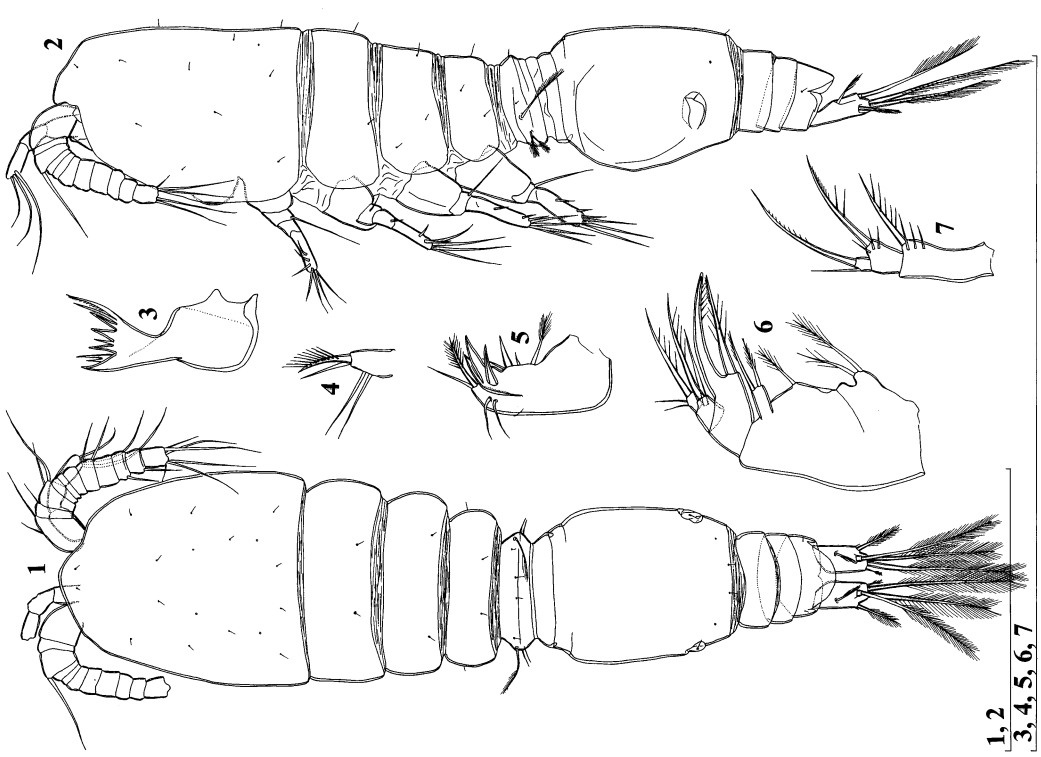
Description

Female (holotype). Total body length, measured from tip of rostrum to posterior margin of caudal rami (excluding caudal setae), 0.287 mm. Habitus (Fig. 1) very slender (almost harpacticoidal), with prosome/urosome ratio 1.2 and greatest width at posterior part of cephalothorax. Body length/width ratio about 3.7; cephalothorax about 1.4 times as wide as genital double-somite. Rostral expansion not well developed. Free pedigerous somites without particular expansions laterally. Preserved specimen colourless. Nauplius eye absent. Rostrum small, membranous, broadly rounded and furnished with two large sensilla. Cephalothorax 1.1 times as long as wide; represents 30% of body length. Integument smooth, not strongly chitinized and no cuticular windows visible. Surface of cephalothorax shield with a few large sensilla and cuticular pores. Free pedigerous somites with few sensilla dorsally and laterally; their pleural areas not well developed, as such coxae of swimming legs clearly exposed in lateral view (Fig. 2). Hyaline fringes of all somites very narrow and smooth. Fifth pedigerous somite ornamented with four large dorsal sensilla. Intersomitic membranes well developed, making whole body very flexible. Strongly sclerotized joint (as pseudosomite) present between fifth pedigerous and genital double-somite. Genital double-somite (Figs 8 and 9) enormous compared to rest of urosome (1.5 times as long as rest of abdomen, including caudal rami), swollen both laterally and ventrally, 1.2 times as long as wide (ventral view), ornamented just with pair of dorsal sensilla and two dorsal cuticular pores posteriorly. Copulatory pore small, ovoid, situated near 3/4 of somite length; copulatory duct short, narrow, curved and well sclerotized. Seminal receptacle small, represents 39% of double-somite's length, with clear distinction between anterior and posterior expansions; both expansions semicircular, anterior one much more sclerotized and slightly smaller (Fig. 8). Ovipores situated laterally at 3/4 of somite length, covered with reduced sixth legs (Fig. 9). Third and fourth urosomal somites without any ornamentation and with smooth fringes both ventrally and dorsally; third somite about 1.3 times as long as fourth somite. Anal somite with large, crescentic and smooth anal operculum, which produced posteriorly well beyond somite limit (reaching almost middle of caudal rami length); ornamented with two large dorsal sensilla only (Fig. 11). Anal sinus smooth.

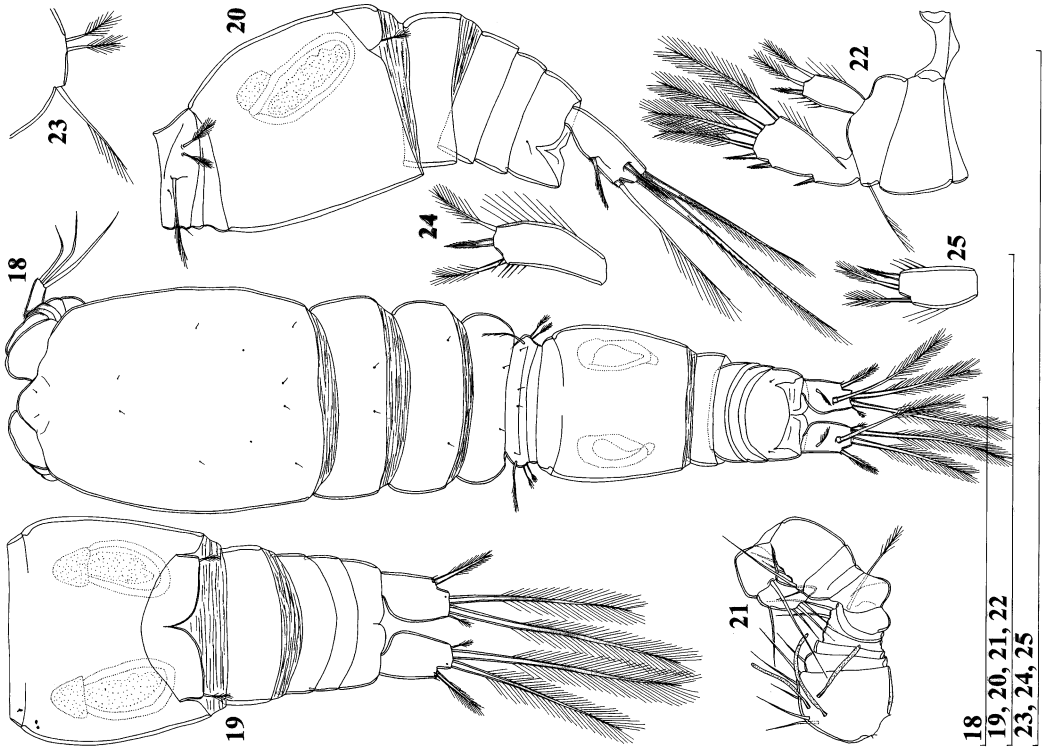
Caudal rami (Figs 1, 2, 8 and 11) parallel, inserted close to ventral margin, with small space between them and 2.2 times as long as wide; basal part of either ramus much narrower than the rest; ornamented only with few spinules at base of outermost apical seta and a single cuticular pore ventrally, near posterior end. Dorsal seta very long, about 2.5 times as long as ramus and about as long as outer principal apical seta; inserted at 3/4 of ramus length, uniarticulate at base, with pinnate distal part. Lateral seta arising almost dorsally



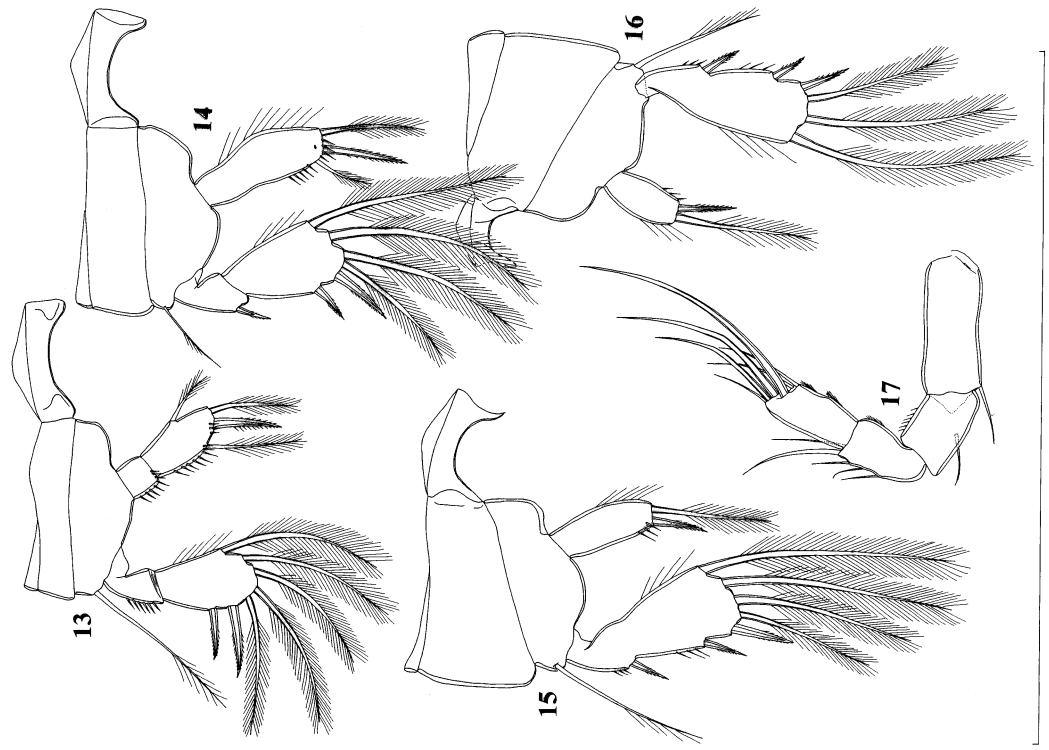
Figs 8-12. *Haplocyclops (Kiefercyclops) fiersi* n. sp., holotype (female): 8 - abdomen, ventral view; 9 - fifth pedigerous and genital double-somite, lateral view; 10 - antennula; 11 - anal somite and caudal rami, dorsal view; 12 - labrum. Scales = 0.1 mm.



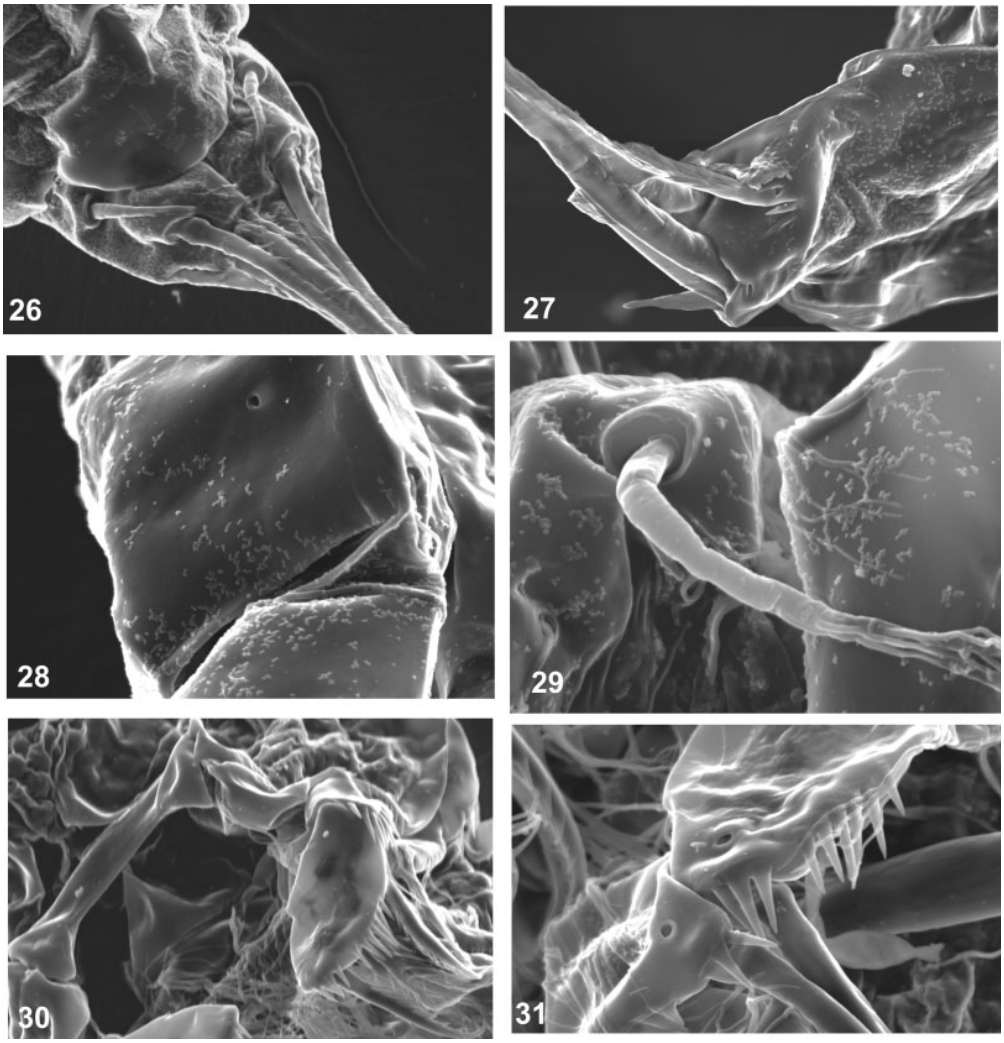
Figs 1-7. *Haplocyclops (Kiefercyclops) fiersi* n. sp., holotype (female): 1 - habitus, dorsal view; 2 - habitus, lateral view; 3 - mandibula; 4 - maxillular palp; 5 - maxillula; 6 - maxilla; 7 - maxilliped. Scale = 0.1 mm.



Figs 18-25. *Haplocyclops (Kiefercyclops) fiersi* n. sp., 18-24, allotype (male); 25, paratype male (0.219 mm): 18 - habitus, dorsal view; 19 - abdomen, ventral view; 20 - urosome, lateral view; 21 - antennula; 22 - third swimming leg; 23 - fifth leg; 24 - endopod of second swimming leg; 25 - endopod of third swimming leg. Scales = 0.1 mm.



Figs 13-17. *Haplocyclops (Kiefercyclops) fiersi* n. sp., holotype (female): 13 - first swimming leg; 14 - second swimming leg; 15 - third swimming leg; 16 - fourth swimming leg; 17 - antenna. Scale = 0.1 mm.



Figs 26-31. Scanning electron micrographs of *Haplocyclops (Kiefercyclops) fiersi* n. sp., 26, 28 and 29, paratype female (0.269 mm); 27, paratype male (0.223 mm); 30 and 31, paratype female (0.281 mm): 26 - anal somite and caudal rami, dorsal view; 27 - right caudal ramus, lateral view; 28 - left posterior corner of genital double-somite, dorsal view; 29 - basal seta of left fifth leg, dorsal view; 30 - intercoxal sclerite and endopod of first swimming leg; 31 - distal parts of endopods of second swimming leg.

at 1/3 of ramus length, slightly shorther than ramus width. Outermost apical seta stout, spiniform, about 0.85 times as long as ramus, bipinnate. Innermost apical seta shorter than lateral one and less than 0.4 times as long as outermost apical seta. Principal apical setae without breaking planes; inner seta 1.15 times as long as outer one and 0.18 times as long as body length.

Antennula (Fig. 10) 11-segmented, very short, not reaching middle of cephalothorax length. No aesthetascs visible on any segment and setal formula as follows: 6.2.3.0.1.1.2.2.1.2.6. Lateral seta on ultimate segment absent. One seta on third, one on seventh and one on eigth segment pinnate; all other setae smooth. Only seta on fifth segment spiniform and very short. Length ratio of antennular segments, from proximal end and along caudal margins, 1 : 0.3 : 0.34 : 0.2 : 0.3 : 0.3 : 0.6 : 0.7 : 0.5 : 0.7 : 1.

Antenna (Fig. 17) four-segmented, comprising long

coxobasis and three-segmented endopod. Coxobasis unornamented, armed with single smooth seta on distal inner corner; seta representing exopod absent. First endopodal segment ornamented with longitudinal row od spinules along outer (caudal) margin; armed with single smooth seta at mid-inner margin. Second endopodal segment about 1.7 times as long as wide, ornamented with longitudinal row of minute spinules, armed with five smooth setae (three lateral, one subapical and one apical; subapical seta robust and recurved). Third endopodal segment twice as long as wide, ornamented also with longitudinal row of minute spinules, armed with six smooth apical setae (three of them very robust and recurved).

Labrum (Fig. 12) trapezoidal, relatively small and without any ornamentation. Cutting edge straight, with 15 small teeth between produced, bluntly pointed, lateral corners.

Mandibula (Fig. 3) palpless. Coxal gnathobase cutting edge clearly devided into three regions: ventral group of three complex teeth (ventralmost tooth strongest, dorsalmost sharpest), central group of four simple teeth, and dorsal group of two setae (dorsal one unipinnate and somewhat longer than ventral smooth seta).

Maxillula (Figs 4 and 5) composed of well developed praecoxa and one-segmented palp. Arthrite of praecoxa with three very strong apical spines, only one of which distinct at base. Praecoxa armed with four armature elements along inner margin, proximalmost longest one and pinnate; others smooth. Palp armed laterally with two smooth and slender setae (probably endopodal ones) and apically with one slender and smooth seta and one robust, bipinnate spine.

Maxilla (Fig. 6) five-segmented, but praecoxa fused to coxa on posterior surface and also partly on anterior surface. Proximal endite of praecoxa armed with two pinnate setae, distal endite small, unarmed. Proximal endite of coxa with one bipinnate seta; distal endite highly mobile, elongate and armed apically with two pinnate and subequal setae. Basis expanded into robust claw, ornamented with longitudinal short row of strong spinules along concave margin, and armed with single strong and pinnate seta, almost as long as claw (small lateral seta absent). Endopod two-segmented; proximal segment armed with two robust setae; distal segment with one robust apical seta and two slender subapical setae. Longest seta on distal endopodal segment almost as long as seta on basis.

Maxilliped (Fig. 7) three-segmented, composed of large coxobasis and two-segmented endopod. Coxobasis about 2.5 times as long as wide, armed with single unipinnate and strong seta and ornamented with three strong spinules at distal part. First endopodal segment 0.4 times as long as coxobasis, also armed with single unipinnate seta and ornamented with three strong spinules. Second endopodal segment minute and unornamented, armed with strong and unipinnate seta apically and much shorter, slender and smooth seta subapically.

All swimming legs (Figs 13-16) with intercoxal sclerites concave along distal margin and without any surface ornamentation.All coxae without any ornamentation or armature. Basis of each swimming leg armed with slender, long, uniplumose outer seta; without any visible surface ornamentation or additional armature. Exopods of first and second legs, as well as endopod of first leg, two-segmented; all other rami one-segmented, although armature of exopods reflects ancestral two-segmented condition (which could not be traced any more on endopods).

First swimming leg (Fig. 13) without any armature on first exopodal segment and with two spines and five setae on the second one; first endopodal segment also unarmed, while second armed with one spine and three setae (one seta on inner margin, one seta and one spine apically and one seta on outer margin); endopod and first exopodal segment ornamented with strong spinules along outer margin, while second exopodal segment ornamented with hairs (setules) along inner margin.

Second swimming leg (Fig. 14) armed with outer spine on first exopodal segment and with two spines and four setae on the second one; single endopodal segment about 0.8 times as long as entire exopod, armed with one spine and two setae on distal part of segment (one seta on outer margin and seta and spine apically); endopod ornamented with large cuticular pore near distal margin, strong spinules along outer and distal margin and longitudial row of setules along inner margin, while exopod ornamented only with few setules along inner margin of second segment.

Third swimming leg (Fig. 15) with exopod armed exactly like that of second leg, although without distinctive membrane between ancestral segments; single endopodal segment about 0.6 times as long as exopod, armed with one spine and one seta apically; both exopod and endopod ornamented with spinules along outer margin and with setules along inner one.

Fourth swimming leg (Fig. 16) very similar to third leg, just with one seta less on exopod and with endopod even shorter (0.45 times as long as exopod).

Spine formula of second exopodal segments (ancestral in case of third and fourth leg) 2.2.2.2 and setal formula 5.4.4.3. All setae on endopods and exopods relatively slender and plumose; no modified setae observed. All spines on swimming legs stout and pinnate.

Fifth leg (Fig. 9) completely fused to somite, represented by three slender setae. Remnant of basal segment represented by barely visible elevation, bearing unipinnate outer basal seta; two other setae (armature of ancestral distal segment) subequal, plumose and about 0.4 times as long as basal one.

Sixth leg (Fig. 9) distinct, small cuticular plate, unornamented and armed with single, smooth, short seta.

Male (allotype). Body length, excluding caudal setae, 0.242 mm. Habitus (Fig. 18) slender, similar to female, but with prosome/urosome ratio about 1.4 and greatest width at middle of cephalothorax. Body length/width ratio about 3.7; cephalothorax about 1.4 times as wide as genital somite. Rostral expansion well developed. Cephalothorax 1.3 times as long as its greatest width, representing 36% of total body length. Ornamentation of prosomites and colour similar to female. Hyaline fringes of all somites narrow and smooth. Genital somite about as wide as long, with two small, completely formed, ellipsoidal spermatophores visible inside. Third, fourth and fifth urosomites short and unornamented. Anal somite (Figs 18 and 20) similar to female, although more dorsally curved abdomen gives a false impression of somewhat shorter anal operculum in dorsal view.

Caudal rami (Figs 18-20) similar to female, about 2.5 times as long as wide. Armature and ornamentation similar to female, although dorsal seta slightly shorter than outer principal apical one.

Antennula (Fig. 21) very small, strongly digeniculate, 13-segmented (with completely fused ancestral sixteenth and seventeenth; twelfth and thirteenth and fourteenth; and seventh and eighth segments), with geniculations between ancestral fourteenth and fifteenth segments and eighth and ninth segments. First segment with three slender aesthetascs; no other aesthetascs could be distinguished with certainty. Setal formula as follows: 5.1.0.0.2.0.1.0.0.1.3.1.4. Some setae probably could not be discerned and insertion points of some others hardly visible.

Antenna, labrum, mandibula, maxillula, maxilla, maxilliped, first swimming leg, second swimming leg (Fig. 24), fourth swimming leg and fifth leg (Figs 20 and 23) similar to female.

Third swimming leg (Fig. 22) with endopod armed with two setae and one spine (one seta and one spine apically; one seta on inner margin), although none of these elements modified in any way. Exopod similar to female.

Sixth legs (Figs 19 and 20) partly fused medially, large cuticular plates, each armed with single slender and pinnate seta.

Variability

Body length of females ranges from 0.256 mm to 0.287 mm (0.278 mm average; n = 10), while in males it ranges from 0.219 mm to 0.253 mm (0.232 mm average; n = 5). No other type of variability was observed (Figures 26-31) and all males have a very similar endopod of the third swimming leg, displaying sexual dimorphism by the presence of one additional seta on the inner margin (Fig. 25).

Etymology

The new species is named in honour of Dr. Frank Fiers from the Royal Belgian Institute of Natural Sciences, who recently redescribed majority of the *Haplocyclops* species (Fiers 2002), thus making the taxonomy of this copepod group much less confusing. The name is a noun in the genitive singular.

Discussion

Genital double-somite with ovipores situated in the posterior half, antennula without lateral seta on the ultimate segment, and caudal rami with lateral setae inserted in the proximal half are three important autapomorphies of the genus *Haplocyclops* Kiefer, 1952 (see Rocha et al. 1998, Fiers 2002) and are shared by the new Indian species. Other morphological characters that matter in assigning the new species to the genus *Haplocyclops* are as follows: large anal operculum; principal apical setae on the caudal rami without breaking planes; seventh antennular segment armed with only two setae; both rami of the fourth swimming leg one-segmented; setal formula of swimming legs exopods 5.4.4.3; reduced armature of the male sixth leg; and fifth leg completely fused to somite and represented by three slender setae in both sexes. The last mentioned character is also common to the genus *Bryocyclops* Kiefer, 1927, which is the closest to Haplocyclops and at the moment subdivided into three subgenera, although Fiers (2002) considered *Rybocyclops* Dussart, 1982 and *Palaeocyclops* Monchenko, 1972 as separate genera, not as subgenera of *Bryocyclops.*

However, *Haplocyclops (Kiefercyclops) fiersi* n. sp. differs from other six representatives of *Haplocyclops*

by several morphological characters, most of them concerning reductions in armature and/or segmentation: many setae on antennula are missing; coxobasis of antenna is armed with only one seta; mandibular palp is completely reduced; maxillular palp is one-segmented; maxilla is without lateral small seta on basis; maxilliped is three-segmented; all swimming legs are without any coxal armature; first exopodal segment of first leg is unarmed; exopod of third leg, as well as endopods of second and third legs are one-segmented; endopods of all legs have reduced armature; and sixth leg is armed with only one seta in both sexes. The level of reductions in the segmentation and armature of the swimming legs, makes the new species the most reduced free-living cyclopoid. Yet another important morphological character is the presence of sexual dimorphism in the armature of third swimming leg, with male having one additional seta, although even this is a consequence of reduction (incomplete in male) and has nothing to do with the modified elements on the third leg endopod in males of *Bryocyclops.* Finally, the spine formula of (ancestral) exopodal segments is 2.2.2.2 in the Indian new species, while it is 2.3.3.2 in all other *Haplocyclops* species. All these differences, although mostly simple reductions, may suggest quite a significant time of an independent evolution of this new species, which prompted us to separate it into the newly described subgenus *Kiefercyclops* n. sg.

Halicyclops (Kiefercyclops) fiersi n.sp. has the endopod of fourth swimming leg armed apically with one spine and one seta, a character shared with the South American *H. (H.) torresi* Rocha, Torres & Maia-Barbosa, 1998, but the two species could not differ more as *H. (H.) torresi* has the greatest number of plesiomorphic features in the genus. A «separate position» of the South American representative was noted by Fiers (2002), although he did not find the level of differences significant enough to separate *H. (H.) torresi* into a different subgenus or genus. All other species of *Haplocyclops* have two apical spines on the endopod of fourth swimming leg, besides several other very similar morphological characters. From the zoogeographical standpoint also, these species have close kinship. *Haplocyclops (H.) gudrunae* Kiefer, 1952, *H. (H.) neuter* Kiefer, 1955, and *H. (H.) pauliani* Kiefer, 1955 are known from Madagascar (Kiefer, 1952; 1955; 1956; Fiers, 2002); *H. (H.) monodi* (Kiefer, 1960) was described from continental Africa (Kiefer 1960a, 1960b, Fiers 2002); and *H. (H.) iranicus* Fiers, 2002 was recorded in Iran (see Dussart 1981, Fiers 2002). At present, the distribution of the genus *Haplocyclops* shows clear Gondwana connections, a pattern noted in many other freshwater copepods (Karanovic 2004a, in press). The genus is missing so far from Australia, but the investigations of subterranean waters are still in an early stage on this continent. However, they resulted in discovery of several small cyclopoids from the genera *Allocyclops* Kiefer, 1932, *Goniocyclops* Kiefer, 1955, *Metacyclops* Kiefer, 1927 and a newly described endemic genus (see Karanovic 2003, 2004a, 2004b, in press), and future discovery of *Haplocyclops* would certainly not been unexpected. Coincidentally and as if to further reinforce the biogeographical affinity of all these taxa, the new Indian species co-occured with an ancient parabathynellid crustacean *Habrobathynella nagarjunai* Ranga Reddy, 2002, whose first-known congeners (viz. *H. milloti* (Delamare and Paulin, 1954) and *H. jeanelli* (Delamare and Paulin, 1954)) were also described from Madagascar (Ranga Reddy 2002a).

As the literature for *Haplocyclops* is pretty scattered and a key to species has never been provided, we are presenting one bellow.

Key to species of *Haplocyclops* Kiefer, 1952

1. Spine formula 2.3.3.2 ..... *Haplocyclops* s. str.
- Spine formula 2.2.2.2 ....*H. (Kiefercyclops) fiersi* n.sp.
2. Endopod of fourth leg with two apical spines ... 3
- Same segment with one spine ....*H. (H.) torresi* Rocha et al., 1998
3. Anal operculum crescentic and smooth 4
- Anal operculum triangular, with bifid or trifid apex ..... *H. (H.) gudrunae* Kiefer, 1952
4. Second exopodal segment of second leg with four setae 5
- Same segment with three setae .... *H. (H.) iranicus* Fiers, 2002
5. Caudal rami less than twice as long as wide; outermost apical seta inserted at level of dorsal seta 6
- Caudal rami 2.5 times as long as wide; outermost apical seta inserted near posterior margin .... *H. (H.) monodi* (Kiefer, 1960)
6. Genital double-somite longer than wide ....*H. (H.) neuter* Kiefer, 1955
- Same somite wider than long .... *H. (H.) pauliani* Kiefer, 1955

References

Botosaneanu L. (ed.). 1986. - Stygofauna Mundi; A faunistic, distributional and ecological synthesis of the World Fauna inhabiting subterranean waters (including the marine interstitial). *E. J. Brill,* 1-740. (Leiden).

Chappuis P.A. 1954. - Copépodes Harpacticoides des Indes et de l'Iran. *Bull. Soc. Hist. Nat. Toulouse,* 89, 213-224.

Dussart B.H. 1981. - Contribution à l'étude des Copépodes d'Iran.

Crustaceana, 41, 162-166.
Dussart B.H. 1982. - Crustacés Copépodes des eaux intérieurs. *Faune Madagascar,* 58, 1-146.
Dussart B.H. & Defaye D. 1985. - Répertoire mondial des Copépodes Cyclopoïdes. C.N.R.S., *Centre Rég. Publicat. Bordeaux,* 1-236. (Bordeaux).
Dussart B.H. & Defaye D. 2001. - Introduction to the Copepoda (2nd edn.). *Guides to the Identification of the Microinvertebrates of the Continental Waters of the World,* 16, 1-344.
Enckell P.H. 1970. - Parastenocarididae (Copepoda Harpacticoida) from Ceylon. *Arkiv för Zool.,* 22, 545-556.
Fiers F. 2002. - The genus *Haplocyclops* Kiefer, 1952 (Copepoda, Cyclopoida, Cyclopidae): Redescription of the type-species, *H. gudrune,* and its congeners. *Hydrobiologia,* 474, 155-169.
Frakes L.A. 1999. - Evolution of Australian environments. *Flora of Australia (2nd edition), Introduction,* 1, 163-203.
Huys R. & Boxshall G.A. 1991. - Copepod evolution. *The Ray Society,* 1-468. (London).
Karanovic T. 2003. - First representative of the genus *Allocyclops* Kiefer, 1932 (Crustacea, Copepoda, Cyclopoida) from the Australian subterranean waters. *Ann. Limnol. - Int. J. Lim.,* 39, 141-149.
Karanovic T. 2004a. - Subterranean Copepoda from arid Western Australia. *Crustaceana Monographs,* 3, 1-366.
Karanovic T. 2004b. - The genus *Metacyclops* Kiefer in Australia (Crustacea: Copepoda: Cyclopoida), with description of two new species. *Rec. W. Austral. Mus.,* 22, 193-212.
Karanovic T. in press. - Subterranean copepods (Crustacea, Copepoda) from the Pilbara region in Western Australia. *Rec. W. Austral. Mus., supplementi.*
Karanovic T. & Pesce G.L. 2001. - A new genus and species of the family Ectinosomatidae (Crustacea: Copepoda: Harpacticoida) from the groundwaters of India. *Ann. Limnol. - Int. J. Lim.,* 37, 281-292.
Karanovic T. & Ranga Reddy Y. 2004a. - First record of *Phyllognathopus bassoti* Rouch, 1972 from India, with remarks on the family Phyllognathopodidae Gurney, 1932 (Crustacea, Copepoda, Harpacticoida). *Ann. Limnol. - Int. J. Lim.,* 40, 121-132.
Karanovic T. & Ranga Reddy Y. 2004b. - A new genus and species of the family Diosaccidae (Copepoda: Harpacticoida) from the groundwaters of India. *J. Crust. Biol.* 24, 246-260.
Kiefer F. 1952. - *Haplocyclops Gudrunae* n. g. et n. sp., ein neuer Ruderfuβkrebs (Crustacea Copepoda) aus Madagascar. *Zool. Anz.,* 149, 240-243.
Kiefer F. 1955. - Neue Cyclopoida Gnathostoma (Crustacea Copepoda) aus Madarascar, II. Cyclopinae. *Zool. Anz.,* 154, 222-232.
Kiefer F. 1956. - Recherches sur la faune interstitielle des sédiments marins et d'eau douce à Madagascar, VI. Cyclopides de Madagascar (Crustacea Copepoda). *Mém. Inst. Sci. Madagascar,* 10, 43-68.
Kiefer F. 1960a. - Zwei neue Cyclopiden (Crust. Cop.) als Bewohner des Sandlückensystems im Niger (Französischer Sudan). *Bull. de l'I.F.A.N.,* 22, 395-401.
Kiefer F. 1960b. - Beiträge zur Copepodenkunde (XX). *Zool. Anz.,* 165, 37-45.
Lescher-Moutoué F. 1986. - Copepoda Cyclopoida Cyclopidae des eaux douces souterraines continentales. Pages 299-312 in L. Botosaneanu, ed. *Stygofauna Mundi.* E. J. Brill. (Leiden).
Lindberg K. 1954. - Un cyclopide (Crustacé Copépode) troglobie de Madagascar. *Hydrobiologia,* 6, 97-119.
Lindberg K. 1956. - Les cyclopides (Crustacés Copépodes) très evolués en tant qu'habitants des eaux souterraines; Revue des travaux récents concernant les *Bryocyclops* Kiefer et *Speocyclops* Kiefer. *Actes prem. Congr. Internat. Spéléol.,* Paris, 1953, 71-83.
Marmonier P., Vervier P., Gibert J. & Dole-Olivier, M.J. 1993. - Biodiversity in ground waters. *Trends Ecol. Evol.,* 8, 392-395.
Monchenko V.I. 1972. - Cikopy (Copepoda, Cyclopoidae) gruntovyx vod pustyni Kyzylkum. *Trudy Zool. Inst. Akad. Nauk SSSR,* 51, 78-97.
Pandourski I. & Ognjanova N. 2001. - Le genre *Hexabathynella* Schminke, 1972 (Crustacea: Syncarida: Bathynellacea) dans les eaux souterraines de la péninsule Balkanique: distribution et remarques paléozoogéographiques. *Hist. nat. bulgarica,* 13, 69-78.
Pesce,G.L. 1996. - Towards a revision of Cyclopinae copepods (Crustacea, Cyclopidae). *Fragm. Entomol. Roma,* 28, 189-200.
Pesce G.L. & Pace R. 1984. - *Thermocyclops oblongatus* (Sars) (Crustacea: Copepoda): A new cyclopoid for the Fauna of India, and zoogeography of the species. *Proc. Indian nat. Sci. Acad.,* B 50, 133-138.
Playford F. 2003. - The Permo-Carboniferous glaciation of Gondwana: its impact on Western Australia. *Western Wildlife,* 7, 1-5.
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.
Ranga Reddy Y. 2002a. - *Habrobathynella nagarjunai* n. sp., the second representative of Bathynellacea (Crustacea, Syncarida) from groundwaters of South India. *Hydrobiologia,* 470, 37-43.
Ranga Reddy Y. 2002b. - Why neglect groundwater biology? *Current Science,* 83, 931-932.
Ranga Reddy Y. 2004. - Little known biodiversity of subterranean freshwater habitats in India, with special reference to crustacean fauna. *J. Bombay Nat. Hist. Soc.*m 101, 186-189.
Ranga Reddy Y. in press. - Existence of the order Bathynellacea (Crustacea, Syncarida) in South Asia; a new species of the genus *Habrobathynella* Schminke from River Pennar near Cuddapah, South India. *J. Bombay Nat. Hist. Soc.,* 101.
Ranga Reddy Y. & Schminke H.K. in press a. - A new bathynellid from India with unusual mouthparts (Bathynellacea: Bathynellidae). *J. crust. Biol.,* 25.
Ranga Reddy Y. & Schminke H.K. in press b. - Morphological diversity of habrobathynellids (Parabathynellidae, Bathynellacea) in India, with the description of a new species. *J. Nat. Hist.*
Reid J.W. 1993. - *Fimbricyclops jimhensoni,* new genus, new species (Copepoda: Cyclopoida: Cyclopidae), from bromeliads in Puerto Rico. *J. Crust. Biol.,* 13, 383-392.
Reid J.W. 1999. - New records of *Bryocyclops* from the continental U.S.A., Puerto Rico, and Brazil (Copepoda: Cyclopoida: Cyclopidae). *J. Crust. Biol.,* 19: 84-92.
Reid J.W. & Strayer D.L. 1994. - *Diacyclops dimorphus,* a new species of copepod from Florida, with comments on morphology of interstitial cyclopine cyclopoids. *J. N. Am. Benthol. Soc.,* 13, 250-265.
Rocha C.E.F. da & Carvalho Bjornberg M.H.G. de 1987. - Copepods of the Juréia Ecological Reserve, State of São Paulo, Brazil, II. The genera *Hesperocyclops, Muscocyclops,* and *Bryocyclops* (Cyclopoida, Cyclopidae). *Hydrobiologia,* 153, 97-107.
Rocha C.E.F. da Torres I.C. & Maia-Barbosa P. 1998. - *Haplocyclops torresi* n.sp. and *Potamocaris estevesi* Reid, 1991 from Brazil, with a proposal for revalidation of the genus *Haplocyclops* Kiefer, 1952 (Copepoda). *Beaufortia,* 48, 1-15.
Rouch R. 1986. - Copepoda: Les Harpacticoïdes souterrains des eaux douces continentales. Pages 321-355 in L. Botosaneanu, ed. *Stygofauna Mundi.* E. J. Brill. (Leiden).
Schminke H. K. 1981. - Perspectives in the study of the zoogeography of interstitial Crustacea: Bathynellacea (Syncarida) and Parastenocarididae (Copepoda). *Intern. J. Speleol.,* 11, 83-89.
Stock J.H. & von Vaupel Klein J.C. 1996. - Mounting media revisited: the suitabillity of Reyne's fluid for small crustaceans. *Crustaceana,* 69, 794-798.