

COPEPODS FROM GROUND WATERS OF WESTERN AUSTRALIA.
III. *DIACYCLOPS HUMPHREYSI* N. SP., AND COMMENTS ON THE
DIACYCLOPS CRASSICAUDIS-COMPLEX (COPEPODA, CYCLOPIDAE)

BY

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ABSTRACT

Diacyclops humphreysi n. sp. is described from the Cape Range karst area, North-west Cape Peninsula, Western Australia. The new species fits the *Diacyclops crassicaudis*-complex (Reid, 1992), being close to *D. longifurcus* Shen & Sung, 1963, from China and *D. alticola* Kiefer, 1935, from India.

The *Diacyclops crassicaudis*-complex is for the first time recorded in Australia.

RÉSUMÉ

Une nouvelle espèce de Copépodes cyclopoïdes, *Diacyclops humphreysi* n. sp., est décrite des eaux souterraines de l'Australie nord occidentale. L'espèce appartient au groupe *crassicaudis* du genre *Diacyclops* Kiefer, tel qu'il a été défini par Reid (1992) et est très proche de *D. longifurcus* Shen & Sung, 1963 de la Chine et *D. alticola* Kiefer, 1935 de l'Inde.

Jusqu'à présent le groupe *crassicaudis* n'avait pas été signalée en Australie.

INTRODUCTION

In a continuing study of cyclopid copepods from different groundwater habitats (anchialine caves, sinkholes, production drillings, wells) of the Cape Range karst area, North-west Cape Peninsula (tropical northwestern Australia), entrusted to us for determination through the kindness of Dr. W. F. Humphreys of the Western Australian Museum (Perth), a new species of the *Diacyclops crassicaudis*-complex, herein described as *Diacyclops humphreysi* n. sp., has been identified.

The present finding represents the first record of representatives of the *Diacyclops crassicaudis*-complex from the Australian continent; it also brings the total number of species of *Diacyclops* recorded to date from Australia and nearby Tasmania up to three, the others being *D. bisetosus* (Rehberg, 1880) and *D. cryonastes* Morton, 1985.

Another species, *Diacyclops crassicaudoides* (Kiefer, 1928), has been reported from Tasmania (Brehm, 1953) but, according to Morton (1985), it is to be considered a junior synonym of *D. bisetosus*.

MATERIAL AND METHODS

Specimens, completely dissected, were mounted on cover slips in commercial polyvinyl-lactophenol. The figures were prepared using a camera lucida on a Leitz Laborlux D phase-contrast microscope.

The holotype and some paratypes were deposited in the Western Australian Museum, Perth, Australia; remaining paratypes are deposited in the collections of the "Museo Civico di Storia Naturale", Verona, Italy.

Terminology applied to body and appendages is in accordance with Huys & Boxshall (1991).

Detailed information on the collecting area and localities is fully described in Humphreys (1993) and Pesce et al. (in press).

Cyclopidae Burmeister, 1834

Cyclopinae Kiefer, 1927

Diacyclops Kiefer, 1927

Diacyclops humphreysi n. sp. (figs. 1-12)

Material examined. — 1 ♀ (holotype), 1 ♀ (paratype), Stn BES 2088, Area C, well no. 3, Exmouth, Cape Range Peninsula (Western Australia); 22°20'10"S 114°02'03"E; 18.v.1993, coll. Humphreys & Brooks. 1 ♂, 2 juv., Stn BES 2006, BES 2018, Riffle Range Piezometer, Exmouth; 22°01'34"S 114°06'38"E; 11.v.1993, coll. Humphreys & Brooks. 1 ♀, 2 juv., Stn BES 2034, BOF, Exmouth production field, Mowbowra Creek, Exmouth; 21°59'28"S 114°06'09"E; 13.v.1993, coll. Humphreys & Brooks. 1 ♀, Stn BES 2037, BOD WAWA no. 44, Exmouth production field between Mowbowra Creek and North West Cape; 21°59'40"S 114°05'55"E; 13.v.1993, coll. Humphreys & Brooks. 1 ♀, Stn BES 2215, Milyering Quarters drilling no. 2, Exmouth; 22°01'53"S 113°55'43"E; 2.vi.1993, coll. Brooks. 1 juv., Stn BES 2217, Milyering Quarters, Exmouth; 22°02'00"S 113°56'03"E; 9.vi.1993, coll. Brooks. 2 ♂♂, 3 juv., Stn BES 2241, BES 2276, ETB E1, Exmouth; 21°55'35"S 114°06'55"E; 17, 19.vi.1993, coll. Humphreys & Brooks. 1 ♀, 1 ♂, Stn BES 2296, WAWA no. 44, Exmouth; 21°56'16"S 114°06'00"E; 22.vi.1993, coll. Humphreys & Brooks. 1 ♀, Stn BES 2332, Mount Well 026, Ashburton R., Onslow; 22°21'43"S 115°14'18"E; 27.vi.1993, coll. Humphreys & Brooks. 1 ♂, Stn BES 2335, Nanutarra Roadhouse drilling 029, Onslow; 22°33'16"S 115°30'32"E, coll. Humphreys & Brooks.

Description. — Adult female, body length excluding caudal setae and antennule, 600 μm (holotype), 595-605 μm (paratypes). Hyaline frills of all prosomites smooth. Genital double somite broader than long, expanded into two medio-lateral protuberances. Hyaline frills of genital double somite and two sub-

sequent somites weakly crenulate; fourth somite with small spines dorsally. Seminal receptacle with poorly developed anterior and posterior expansions. Anal operculum not sclerotized.

Caudal rami 3 times (holotype), 2.9-3.2 times (paratypes) longer than broad in dorsal view; innermost apical seta about 1.5 times longer than outermost; dorsal seta long, more than two times longer than caudal ramus; lateral seta inserted at posterior 3/5ths of ramus. Inner margin of ramus smooth.

Antennule 12-segmented, and armed as in fig. 1.

Antenna 5-segmented, comprising coxa, basis, and 3-segmented endopod. Exopodal vestigial seta absent; basis without ornamentation both on frontal and caudal side, but bearing two plumose setae on the inner distal angle [type 2a, according to Reid (1991)]; first endopodal segment with one outer seta; second endopodal segment with 4 setae arranged along the inner margin and 2 setae on the subdistal angle; third endopodal segment armed with 7 setae around distal margin.

Mandible consisting of a well-developed coxa with gnathobasis, and reduced palp, represented by three setae, two long and plumose, the other much shorter and naked.

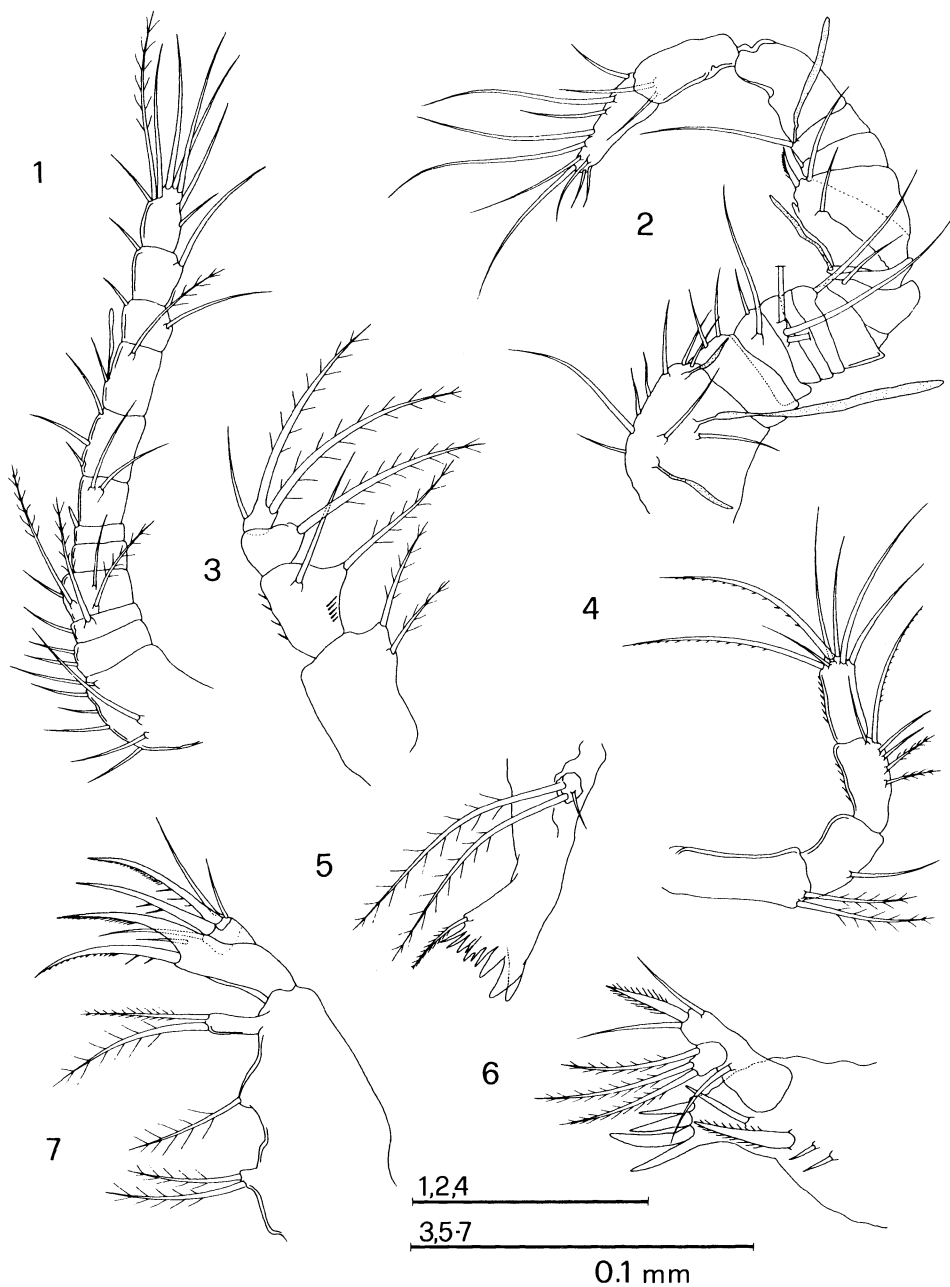
Maxillula with precoxa bearing reduced, 2-segmented palp; precoxal endite with 4 spiniform setae and 4 stout spines fused to the segment; proximal segment of palp with 3 apical and one outer setae; distal segment armed with 3 setae.

Maxilla 4-segmented, including syncoxa, basis, and 2-segmented endopodite. Syncoxa bearing 3 endites; proximal endite armed with two plumose setae, middle endite consisting of a single plumose seta, distal endite with well-developed process bearing 2 apical plumose setae; beak-like extensions finely denticulated or ciliated.

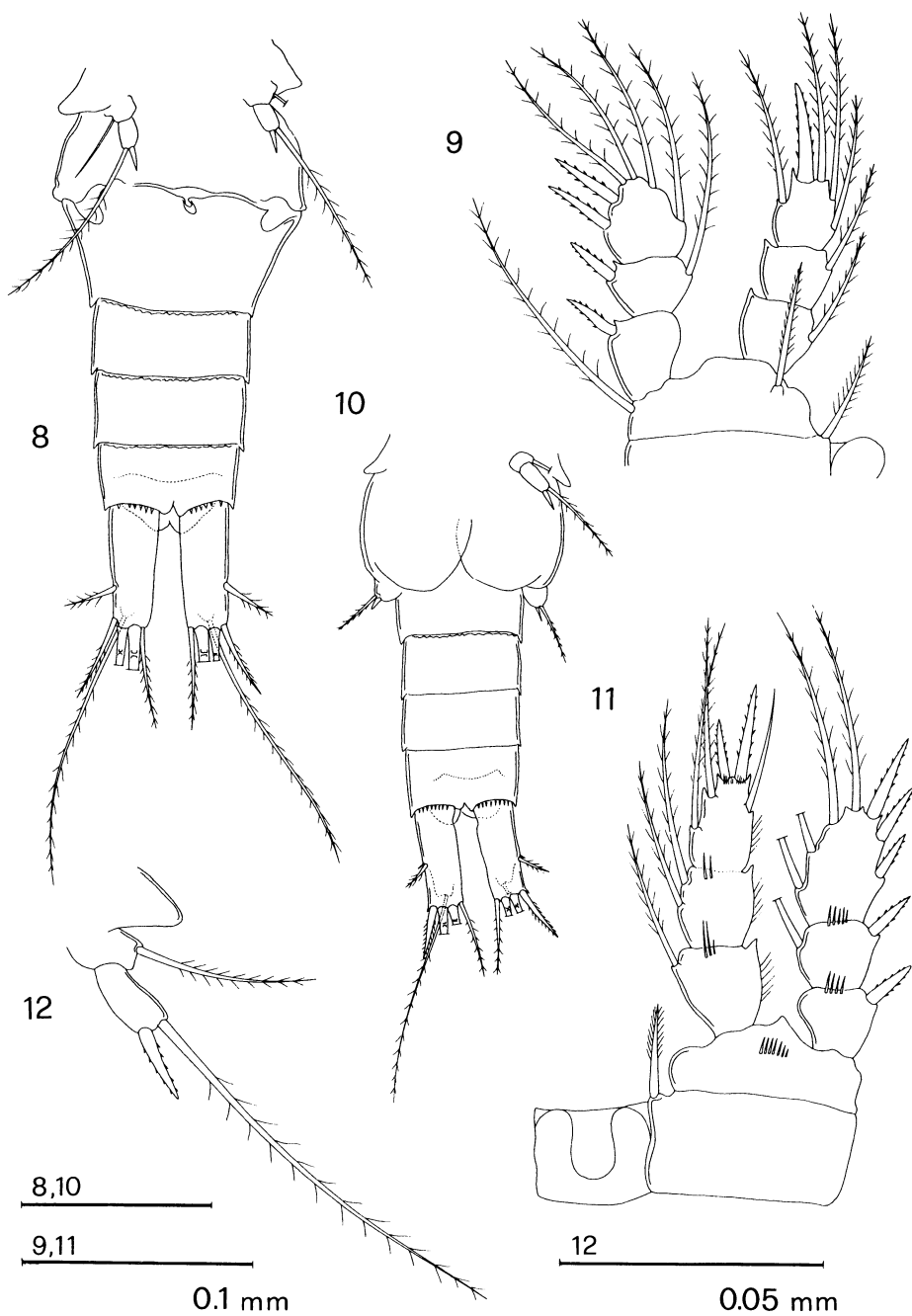
Maxilliped 4-segmented, comprising syncoxa, basis, and 2-segmented endopodite; syncoxa armed with two inner setae representing vestigial endites; basis with one inner and one subdistal setae; first endopodal segment bearing a single plumose seta, second endopodal segment with 3 setae, outermost the shortest.

Swimming legs 1-4 with 3-segmented rami, terminal articles of exopodite with total of 2.3.3.3 spines and 4.4.4.4 setae, respectively; couplers without ornament. Basis of leg 1 with inner setiform spine, overreaching half of second article of endopodite. Endopodite 3 of leg 4 about 1.5 times longer than broad; terminal inner spine much shorter than outermost.

Terminal spine of leg 5 equal to or slightly longer than article 2 in length; lateral seta about 6 times longer than article.



Figs. 1-7. *Diacyclops humphreysi* n. sp. 1, antennula (♀); 2, antennula (♂); 3, maxilliped (♀); 4, antenna (♀); 5, mandible (♀); 6, maxillula (♀); 7, maxilla (♀).



Figs. 8-12. *Diacyclops humphreysi* n. sp. 8, abdomen and caudal rami, dorsal view (♀); 9, leg 1 (♀); 10, abdomen and caudal rami, ventral view (♂); 11, leg 4 (♀); 12, leg 5 (♀).

Male with habitus much slenderer than female. Length 580-590 μm . Antenna, mouthparts, swimming legs, leg 5, and caudal rami similar to those of female. Antennule geniculate, 16/17-segmented, armed as in fig. 2. Urosoma 6-segmented. Genital somite bearing paired genital pores ventrally. Leg 6 consisting of opercular plates closing off genital apertures and bearing one outer plumose seta and one inner, shorter spine.

Etymology. — Named after Dr. W. F. Humphreys, who collected the new species.

Affinities. — *Diacyclops humphreysi* n. sp. is a member of the *Diacyclops crassicaudis* species-complex (Reid, 1992), whose species and subspecies are characterized by a 12-segmented antennula and swimming legs 1-4 with both rami 3-segmented.

The complex presently includes 15 named species and subspecies, viz.: *D. alticola* Kiefer, 1935; *D. antrincola* Kiefer, 1967; *D. crassicaudis crassicaudis* G. O. Sars, 1863; *D. crassicaudis brachycercus* Kiefer, 1927; *D. crassicaudis cosana* Stella & Salvadori, 1954; *D. crassicaudis cretensis* Kiefer, 1928; *D. crassicaudis lagrecai* Pesce & Galassi, 1987; *D. crassicaudis trinacriae* Pesce & Galassi, 1987; *D. fontinalis* Naidenov, 1969; *D. karamani* Kiefer, 1932; *D. iranicus* Pesce & Maggi, 1982; *D. longifurcus* Shen & Sung, 1963; *D. ruffoi* Kiefer, 1981; *D. skopljensis* Kiefer, 1932; and *D. talievi* (Mazepova, 1970).

Some subspecies, such as *D. crassicaudis cretensis* and *D. crassicaudis brachycercus*, which are very similar to each other, have been much discussed (Dussart, 1969; Monchenko, 1974; Rylov, 1948; Pesce & Galassi, 1987), and recently Reid (1992) hypothesized that there is no good reason for distinguishing these nominal taxa, at least not in North America.

For the most part, species of the above complex are stygophilic or stygoxene inhabitants of local (ground) freshwater systems of Asia, North America, and Africa. The others are known from subterranean (caves, wells) habitats of Europe (*D. antrincola*, *D. crassicaudis* var. *cosana*, *D. crassicaudis cretensis*, *D. fontinalis*, *D. karamani*, *D. ruffoi*, *D. skopljensis*) or in Iran (*D. iranicus*) but, with the exception of *D. antrincola* and *D. ruffoi*, they do not possess peculiar stygobiontic morphological characteristics.

Two species of the *Diacyclops crassicaudis*-complex, viz. *D. longifurcus* and *D. alticola*, from China and India, respectively, are similar to *D. humphreysi* n. sp. in having the inner apical spine of the endopodite 3 of leg 4 shorter than the outermost one.

From these species *D. humphreysi* n. sp. can be readily distinguished by the differing length of the caudal rami ($L/l = 7.5$ in *D. longifurcus*; 6.5 in *D. alticola*; about 3 in *D. humphreysi*), the different length ratio between inner and outer apical caudal setae (subequal both in *D. longifurcus* and *D. alticola*; inner seta longer than outermost in *D. humphreysi*), and the remarkable length of the dorsal caudal seta; moreover, the endopodal segment 3 of leg 4 is much more elongated in *D. longifurcus* (L/l about 2) than in *D. humphreysi* n. sp. (L/l about 1.5).

From both the other species mentioned, *D. humphreysi* n. sp. also differs by some distinctive stygobiotic morphological characteristics, such as the small size, the enlarged genital double somite, the reduced ornamentation of the antennule and antenna, and the length of the caudal setae.

ACKNOWLEDGEMENTS

We are grateful to Dr. W. F. Humphreys of the Western Australian Museum, Perth, for the loan of material, and for his precious assistance, and Dr. J. W. Reid, Smithsonian Institution, Washington, D.C., for helpful suggestions.

REFERENCES

- BREHM, V., 1953. Contribution to the freshwater microfauna of Tasmania. Part 1. Copepoda. Pap. Proc. R. Soc. Tasmania, **87**: 33-62.
- DUMONT, H. J. & S. MAAS, 1985. *Mesocyclops cuttacutiae* n. sp. from a cave in northern Australia (Crustacea: Copepoda, Cyclopoida). The Beagle occ. Pap. Northern Territory Mus. Arts Sci., **1** (13): 115-122.
- DUSSART, B. H., 1969. Les Copépodes des eaux continentales d'Europe occidentale. II. Cyclopoïdes et biologie. (Éditions N. Boubée & Cie, Paris).
- DUSSART, B. H. & C. H. FERNANDO, 1988. Sur quelques *Mesocyclops* (Crustacea, Copepoda). Hydrobiologia, **157**: 241-264.
- HAMOND, R., 1987. Non-marine harpacticoid copepods of Australia. I. Canthocamptidae of the genus *Canthocamptus* Westwoods s. lat. and *Fibulocamptus*, gen. nov., and including the description of a related species of *Canthocamptus* from New Caledonia. Invertebr. Taxon., **1** (8): 1023-1247.
- HUMPHREYS, W. F. (ed.), 1993. The biogeography of Cape Range, Western Australia. Rec. Western Australian Museum, (suppl.) **45**: 1-248.
- MONCHENKO, V. I., 1974. Cyclopidae. Fauna Ukrainii, **27**: 1-452.
- MORTON, D. W., 1985. Revision of the Australian Cyclopidae (Copepoda: Cyclopoida). I. *Acanthocyclops* Kiefer, *Diacyclops* Kiefer and *Australocyclops*, gen. nov. Australian Journ. mar. Freshwat. Res., **36**: 615-634.
- , 1990. Revision of the Australian Cyclopidae (Copepoda: Cyclopoida). II. *Eucyclops* Claus and *Ectocyclops* Brady. Australian Journ. mar. Freshwat. Res., **41**: 657-675.
- PESCE, G. L. & D. P. GALASSI, 1987. Copepodi di acque sotterranee della Sicilia. Animalia (Univ. Catania), **14**: 193-235.

- PESCE, G. L., P. DE LAURENTIIS & W. F. HUMPHREYS, in press. Copepods from ground waters of Western Australia. II. *Halicyclops longifurcatus* n. sp. and *Halicyclops spinifer*, from the North West Cape Peninsula (Crustacea Copepoda: Cyclopidae). Rec. Western Australian Mus.
- REID, J. W., 1991. Use of morphological structures in interpreting the taxonomy and ecology of continental cyclopoid copepods (Crustacea). Anais IV. Encontro Brasileiro de Plancton: 261-282.
- —, 1992. Redescription of *Diacyclops nearcticus* (Kiefer, 1934) and description of four similar new congeners from North America, with comments on *D. crassicaudis* (G. O. Sars, 1863) and *D. crassicaudis* var. *brachycercus* (Kiefer, 1927) (Crustacea: Copepoda). Canadian Journ. Zool., **70**: 1445-1469.
- RYLOV, V. M., 1948. Freshwater Cyclopoida. Crustacea. Fauna SSSR, **3**: 1-314. (National Science Foundation, Washington D.C., and Israel Program for Scientific Translations, Jerusalem, 1963).
- TIMMS, B. V. & D. W. MORTON, 1988. Crustacean zooplankton assemblages in freshwater of tropical Australia. Hydrobiologia, **164**: 161-169.