



## Copepods from ground waters of Western Australia, VII. *Nitokra humphreysi* sp. nov. (Crustacea: Copepoda: Harpacticoida)

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### Abstract

*Nitokra humphreysi* sp. nov. (Harpacticoida: Ameiridae) is described from anchialine ground waters of the Cape Range karst area in northwestern Australia. The new species belongs to those species of the genus *Nitokra* Boeck, 1865 with a reduced number of spines/setae on the basoendopodite of the female fifth leg. It is remarkably similar to *N. reunionensis* Bozic, 1969 and to *N. laingensis* Fiers, 1986, but there are clear distinguishing features. *Nitokra humphreysi* sp. nov. has clear stygomorphic features, being colourless and lacking the nauplius eye.

### Introduction

The genus *Nitokra* Boeck, 1865 is a relatively speciose harpacticoid genus, with about 60 valid species and subspecies (Dussart & Defaye, 1990; Bodin, 1997). Species of this genus occur in fresh, brackish and marine water habitats, and several species are even known as commensals of some marine invertebrates (Humes, 1953; Bowman, 1988). Great interspecific variability, as well as relatively small differential characteristics among species, caused numerous synonyms in the genus, many known of long standing (Lang, 1948, 1965; Por, 1964; Wells & Rao, 1987; Apostolov & Marinov, 1988; Bodin, 1997). Nevertheless, large harpacticoid genera always accumulate numerous synonyms, and it is highly possible that there are still several undiscovered ones. The original descriptions of many *Nitokra* taxa are incomplete and they do not meet the high standards of modern alpha-taxonomy (Brian, 1928; Chappuis, 1930; Marcus & Por, 1961; Por, 1964; Kunz, 1975; Reid, 1988; etc.). The genus also contains several previously unrecognised homonyms: *N. baltica* Arlt, 1983 is a junior homonym of *N. fallaciosa baltica* Lang, 1965; *N. mediterranea pontica* Apostolov, 1980 of *N. pontica* Jakubisiak, 1938; and *N. stygia* (Apostolov, 1969) is a junior homonym of *N. affinis stygia* Por, 1968. The

respective authors are presently resolving that problem. In addition, the spelling of the generic name is confused. Bowman (1988) pointed out the erroneous spelling of the generic name (as *Nitocra*) for more than a 100 years, and proposed returning to the original spelling (*Nitokra*). In contrast Mielke (1993) suggested suppressing the original spelling and validating the spelling *Nitocra* "in accordance with usage", which was accepted by Bodin (1997). Unfortunately we cannot suppress the original spelling without the decision of the International Commission on Zoological Nomenclature and we prefer to follow Bowman's point of view.

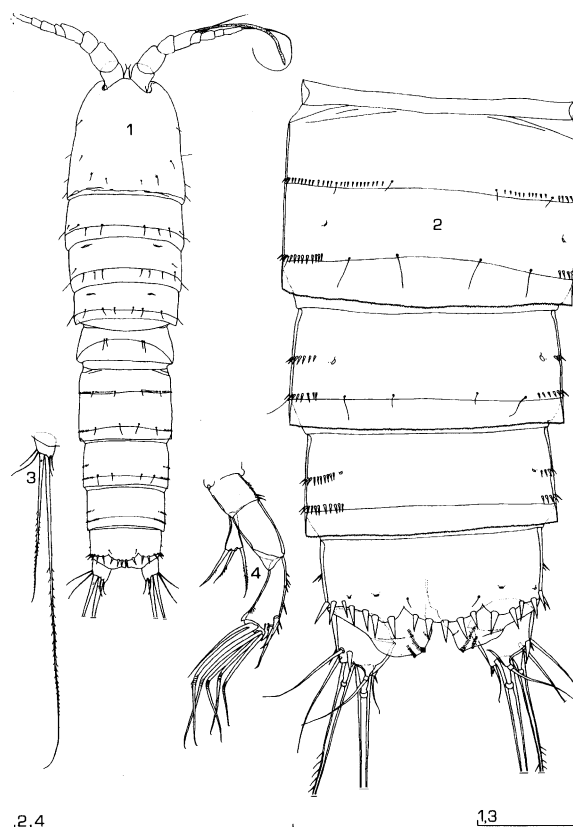
In Australia only one cosmopolitan species from the genus *Nitokra* has been previously known (Bayly, 1972; Dussart & Defaye, 1990): *N. lacustris* (Schmankevitch, 1875). During an investigation of the copepod fauna from ground waters of Western Australia a new species of this genus was identified and herein described as *Nitokra humphreysi* sp. nov.

### Material and methods

The copepods were sampled from ground water in karst terrain, accessed by temporary bores drilled for a seismic survey. The bores were located on a wave-

cut limestone terrace overlain by Quaternary deposits on the northwestern tip of the Cape Range peninsula, Western Australia. Bore A7 is within 1 km of Vlaming Head at an altitude of 10 m above sea level and ca. 350 m from the seashore: the water table is about on sea level and had a salinity of 25.7 g/dm<sup>3</sup>. Ground water on the eastern side of the peninsula, where it has been recorded, typically tracks the marine tides but exhibits a temporal and amplitude lag (Humphreys et al., 1999). The waters are typically anachialine (Stock et al., 1986; Sket, 1996; Humphreys, 1999) and exhibit a marked physico-chemical stratification (Humphreys, 1999). The site was sampled using baited traps and haul-nets from 'uphole' bore drilled to locate recording equipment for a seismic survey. In both samples *Nitokra humphreysi* sp. nov. co-occurred with a harpacticoid from the genus *Phyllopodopsyllus* T. Scott, 1906 (Tetragonicipitidae Lang, 1944) (Karanovic et al., in press). All samples were sorted while alive using a dissecting microscope and the copepods were then fixed in 70% ethanol and assigned a field number (prefix BES). Specimens were dissected in a mixture of equal parts of distilled water and glycerol, with fine entomological needles (No. 000). Dissected appendages were placed on a slide, in the same mixture of distilled water and glycerol, and covered with a coverslip. For larger parts (abdomen, etc.) two human hairs were mounted between slide and coverslip, so the parts could not be crushed. By moving the coverslip carefully by hand, the whole animal or a particular appendage was placed in different positions, making possible the observation of morphological details. During the examination the water slowly evaporated, and after some time the appendages remain in pure glycerol. All drawings have been prepared using a drawing attachment (tube) on a Leica DMLS microscope, with C-plan achromatic objectives. Dissected appendages were preserved in Faure's medium which was prepared following the traditional procedure, recently discussed by Stock & Vaupel Klein (1996). All material is deposited in the Western Australian Museum, Perth, Australia. Following material of *Nitokra humphreysi* sp. nov. was examined:

1. Holotype (female), allotype (male), and three paratypes (one male and two females): Cape Range, AB7, Western Australia, Australia, 21° 49' S, 114° 06' E, 11 November 1995, leg. R.D. Brooks (BES: 4676).



Figures 1–4. *Nitokra humphreysi* sp. nov., holotype: 1, habitus, dorsal view; 2, abdomen, dorsal view; 3, furcal ramus, dorsal view; 4, antenna. Scales = 0.1 mm.

2. Two topotypes (females): Cape Range, AB7, Western Australia, Australia, 21° 49' S, 114° 06' E, 5 November 1995, leg. R.D. Brooks (BES: 4673).

## Results

Family Ameiridae Monard, 1927

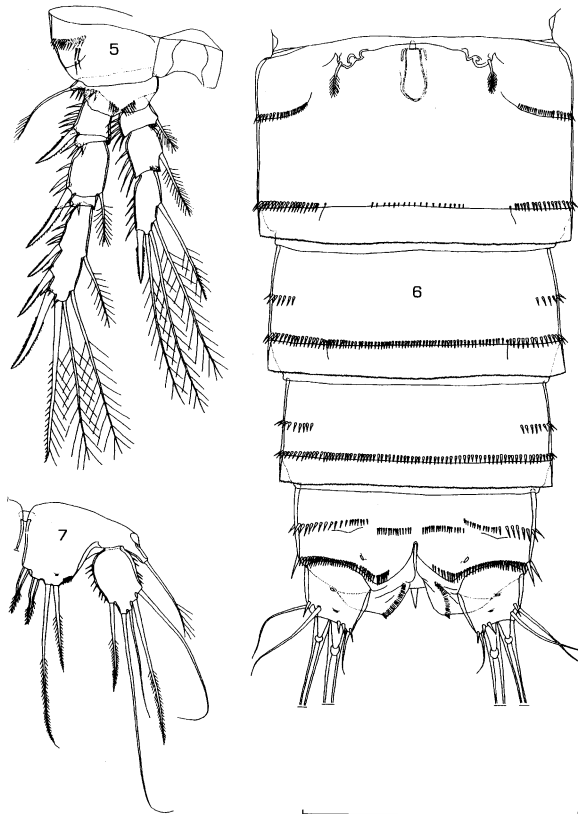
Genus *Nitokra* Boeck, 1865

*Nitokra humphreysi* sp. nov.

(Figures 1–33)

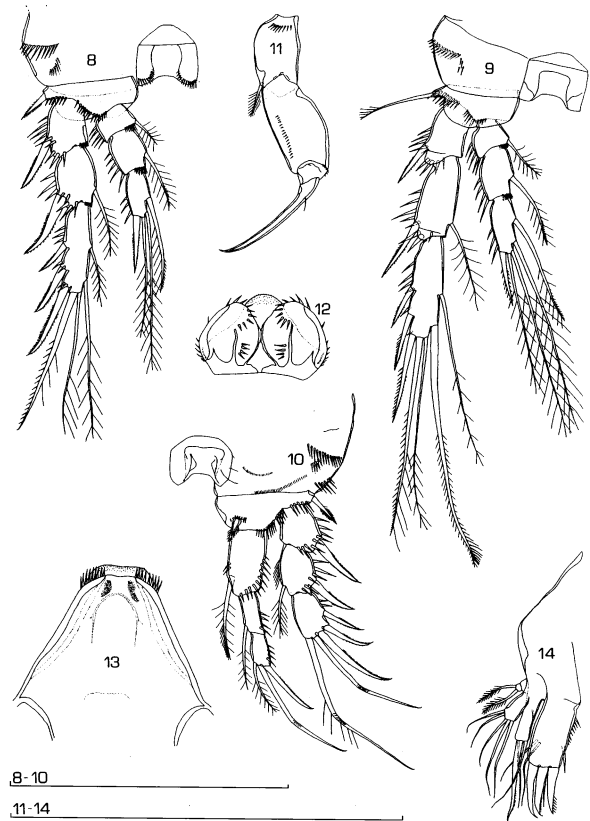
## Description

*Female (holotype)*: Body length 0.467 mm measured from anterior tip of rostrum to rear margin of caudal rami. Habitus elongated, cylindrical, with largest width at second pedigerous (first free) somite (Fig. 1). Body colourless, and nauplius eye absent. Integument



Figures 5-7. *Nitokra humphreysi* sp. nov., holotype: 5, third swimming leg; 6, abdomen, ventral view; 7, fifth leg. Scale = 0.1 mm.

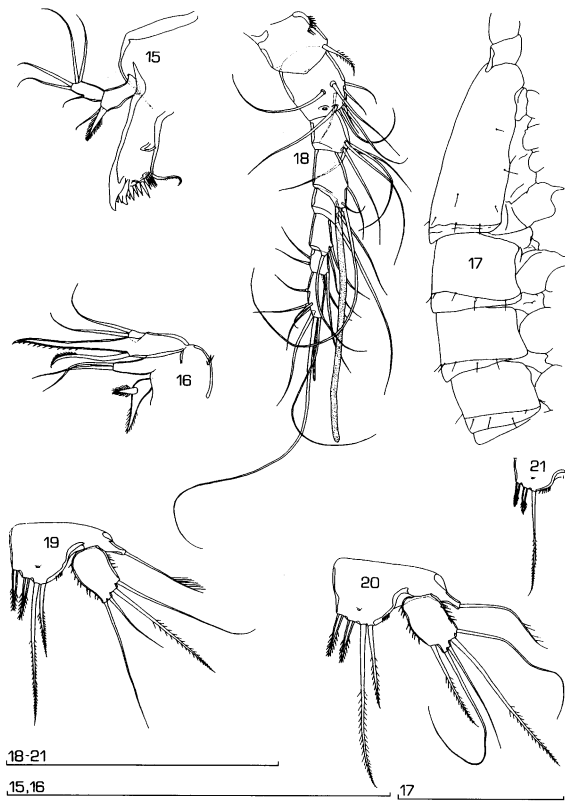
smooth, not strongly chitinized. Prosome comprising cephalothorax and three free pedigerous somites. Pleural areas of cephalothorax not well developed, as such cephalic appendages clearly exposed in lateral view (Fig. 17). Surface of dorsal shield covering cephalothorax, as well as tergites of three free pedigerous somites, with large sensillae. Their hind margins smooth. Rostrum triangular, elongate, but not reaching to end of first segment of antennula with two delicate dorsal sensillae. Intersomitic membranes weakly developed, except between prosome and urosome. Urosome comprising fifth pedigerous somite, genital double-somite (representing fused genital and first abdominal somite) and three free abdominal somites. Genital double-somite about 1.5 times broader than long, with subdivision line dorsolaterally, which furnished with row of small cuticular spines (interrupted dorsally) and with four small sensillae dorsally (Fig. 2). This somite posteriorly with four large sensillae on dorsal side, with row of spines laterally, and two sensillae and one row of very small spines vent-



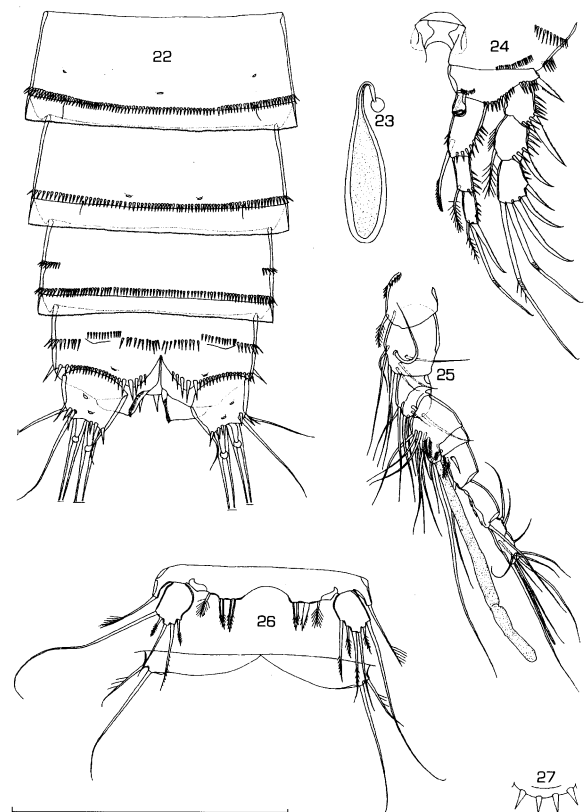
Figures 8-14. *Nitokra humphreysi* sp. nov., holotype: 8, second swimming leg; 9, fourth swimming leg; 10, first swimming leg; 11, maxilliped; 12, paragnath; 13, labrum; 14, maxillula. Scales = 0.1 mm.

rally (Fig. 3). Fused sixth leg with only one plumose seta. First and second free abdominal somites with lateral row of spines proximally, and with uninterrupted ventrolateral row of spines at distal part (Figs 2 and 6). First somite bearing several sensillae, second without any ones. Fringes of genital double-somite, first and second free abdominal somites, finely serrated both on ventral and dorsal surfaces. Anal somite (last abdominal somite) ornamented with pair of sensillae dorsally, with one irregular (but not really interrupted) ventrolateral row of spines in proximal part, with one interrupted and arched row of spines at base of furcal rami ventrally, and with several very large cuticular spines laterally and dorsally (Fig. 6). Anal operculum convex, with five strong spines, and not reaching beyond limit of anal somite (Fig. 2). Anal sinus with three rows of hairs on both sides.

Furcal rami slightly divergent, about 1.2 times broader than long, and with six armature elements (two lateral, one dorsal, and three apical setae). There



Figures 15–21. *Nitokra humphreysi* sp. nov., 15–18, holotype; 19, paratype (female 0.424 mm); 20, toptype (female 0.446 mm); 21, toptype (female 0.392 mm): 15, mandibula; 16, maxilla; 17, prosome, lateral view; 18, antennula; 19, fifth leg; 20, fifth leg; 21, basoendopodite of fifth leg. Scales = 0.1 mm.



Figures 22–27. *Nitokra humphreysi* sp. nov., allotype: 22, abdomen, ventral view; 23, spermatophore; 24, first swimming leg; 25, antennula; 26, fifth and sixth legs; 27, anal operculum. Scale = 0.1 mm.

are two cuticular spines at base of proximal lateral seta, which inserted dorsolaterally, and three spines on distal edge of furcal ramus ventrally. Dorsal seta inserted on tip of long and produced chitinous ridge. Inner apical seta thin, smooth, curved, and shorter than caudal ramus (Fig. 6). Outer apical seta very strong, plumose, and somewhat longer than three free abdominal somites together with caudal rami. Middle apical seta strongest one, also plumose, and about twice as long than outer apical seta (Fig. 3).

Antennula eight-segmented, with one slender aesthetasc on ultimate segment, one very long aesthetasc (more than twice as long as four distal segments together), and with setal formula as follows: 1.9.5.3.2.3.4.7 (Fig. 18). All setae smooth, except that on first segment.

Antenna comprising coxobasis with some spinules, one-segmented exopodite, and two segmented endopodite (Fig. 4). Exopodite armed with three finely plumose setae. First endopodite segment unarmed.

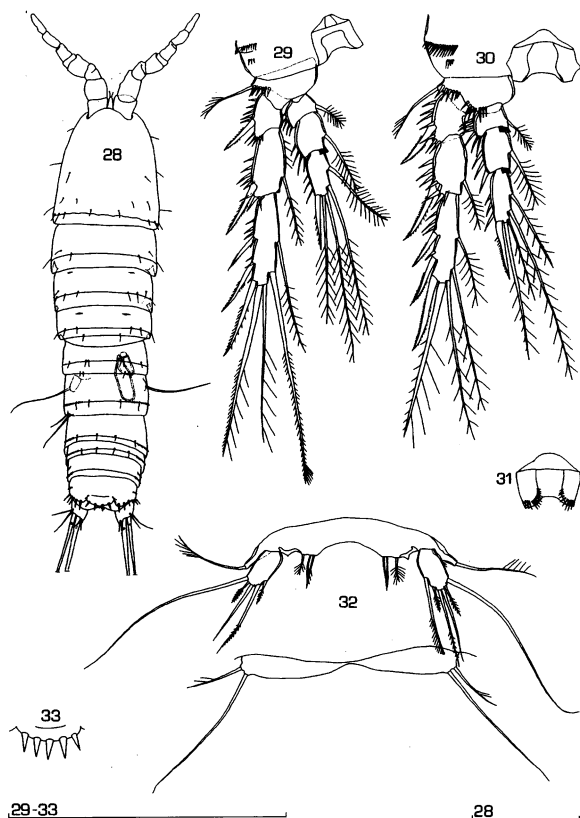
Second endopodite segment armed with some spinules, two lateral curved spines, and apically with five geniculate setae (posterior one basally fused with one slender seta).

Labrum trapeziform (Fig. 13), with short cutting edge with two subapical rows of spines (nine spines in each row).

Paragnaths oviform, with one arched apical row of cuticular spines and some spines on lateral edge, as well as one group of four spines on proximal inner part of each lobe (Fig. 12).

Mandibula with biting edge of coxa with row of teeth of different thickness and with single lateral seta (Fig. 15). Basis slender, with one very strong and plumose seta, and one thin and smooth one. Endopodite twice as long as wide, with one lateral and four apical smooth setae.

Maxillula with three strong curved spines and one thin seta on distal edge of precoxa (Fig. 14). Inner edge of precoxa with row of cuticular spines and one spine-



Figures 28–33. *Nitokra humphreysi* sp. nov., 28–31, allotype; 32 and 33, paratype (male 0.318 mm): 28, habitus, dorsal view; 29, fourth swimming leg; 30, third swimming leg; 31, coupler of second swimming leg; 32, fifth and sixth legs; 33, anal operculum. Scales = 0.1 mm.

like appendage. Coxa with one strong and two slender setae apically. Basoendopodite with five apical smooth setae. Exopodite of maxillula two-segmented, with two apical plumose setae on distal segment (Fig. 14).

Maxilla with two endites on syncoxa (Fig. 16). Proximal one having one pronged appendage seemingly fused with endite and one distinct strong seta (both plumose). Distal endite with two slender apical setae. Basis of maxilla with one claw, serrate along inner edge, and one strong seta. Endopodite one-segmented, with two long smooth setae apically.

Syncoxa of maxilliped with one plumose seta subapically and one arched row of cuticular spines proximally (Fig. 11). Basis with long row of spinules parallel with inner margin. Endopodite one-segmented, armed with strong recurved apical claw and smooth thin seta.

All swimming legs with three-segmented endopodites and exopodites (Figs 5, 8, 9 and 10). Spine and

setal formula on exopodites and endopodites from first to fourth swimming legs (legend: inner/outer spine or seta; inner/terminal/outer):

Segments	Exopodite			Endopodite		
	1	2	3	1	2	3
First leg	0/1	1/1	0/2/3	1/0	1/0	1/2/0
Second leg	0/1	1/1	2/2/3	1/0	1/0	1/2/1
Third leg	0/1	1/1	2/2/3	1/0	1/0	2/2/1
Fourth leg	0/1	1/1	2/2/3	1/0	1/0	2/2/1

Couplers (intercoxal plates) of all swimming legs with concave distal margin. Coupler of second leg with two arched apical rows of spinules, while those of other legs without surface ornamentation. Coxa and basis of all swimming legs with several rows of spinules. Basis of first and second swimming leg with spine on outer margin, third and fourth leg bearing long, distally plumose, setae. Basis of first swimming leg with one stout and short spine on inner margin (Fig. 10). First endopodite segment of first leg significantly shorter than first two exopodite segments combined. Exopodites and endopodites of all swimming legs with rows of cuticular spines on outer margins. Their inner margins smooth, except in first leg where proximal endopodite segment bears two spines, and median exopodite segment bears row of hairs.

Fifth leg with basoendopodite protruding till middle of exopodite (Fig. 7), bearing two strong spines and two plumose setae. Inner seta almost twice as long as outer one. Between outer seta and exopodite one short row of spinules and pore on distal part. Seta on outer corner of basoendopodite well developed and plumose distally. Exopodite subquadrangular, about 1.6 times as long as broad, and armed with five setae apically and subapically, and with cuticular spines laterally. Only first and fourth setae (from inner side) plumose, while second one longest. Length ratio of five exopodite setae (from inner side) 1: 2.5: 1.24: 1.67: 2.

*Male (allotype)*: Body similar to female in general appearance, but shorter (0.39 mm). Urosome comprising fifth pedigerous somite, genital somite, and four free abdominal somites (Fig. 28). First abdominal somite (genital somite) about two times broader than long. Ornamentation of somites with sensillae and rows of spines similar to female. Cuticular spines on

anal somite somewhat longer (Fig. 22). Anal operculum with four strong spines (Fig. 27). Spermatophore almost completely formed (Fig. 23).

Antennula geniculate, eight-segmented, ultimate segment subdivided (Fig. 25). Aesthetasc on fourth segment shorter but broader than in female. Aesthetasc on ultimate segment slender. Setal formula as follows: 1.8.6.10.1.3.1.10. Fourth, fifth, and sixth segments bearing one plumose spiniform seta each.

Antenna, mandibula, maxillula, maxilla, maxilliped, second swimming leg (Fig. 31), and fourth swimming leg (Fig. 29) as in female. Spine on inner side of basipodite of first swimming leg modified, with characteristic shape and smooth (Fig. 24). Outer spine on ultimate endopodite segment of third swimming leg slightly modified, without spinules on inner margin (Fig. 30).

Basoendopodite of fifth leg with characteristic dentiform edge near exopodite, and with two strong spines and one plumose seta somewhat shorter than spines (Fig. 26). Exopodite with six setae on left leg, but only five setae on right leg. Outermost exopodite seta longest one, about twice as long as all other exopodite setae. First and third setae (from outer side) smooth.

Sixth leg armed with two setae, inner one twice as long as outer one (Fig. 26).

#### Variability

All collected specimens (two males and five females) of *Nitokra humphreysi* sp. nov. were completely dissected and examined. Body length, measured from the tip of rostrum to the posterior margin of furcal rami, ranges from 0.367 to 0.467 mm (0.42 average) in females, and from 0.318 to 0.39 mm (0.35 mm average) in males. Outermost seta on the basoendopodite of the fifth leg in topotype female (0.392 mm) is missing on one side (Fig. 21), while on the other side the fifth leg appears to be normal. Innermost seta on the exopodite of the fifth leg in paratype female (0.424 mm) is also missing on one side (Fig. 19). Second exopodite seta (from outer side) in topotype female (0.446 mm) is somewhat longer comparing with the other setae (Fig. 20). Paratype male (0.318 mm) with only one spine and one seta on the basoendopodite of the fifth leg (Fig. 32), and with five spines on the anal operculum (Fig. 33). All others characteristics are the same as in the holotype and allotype.

#### Etymology

The species is named in honour of Dr W. F. Humphreys, of the Western Australian Museum in Perth, who placed this interesting material at our disposal for identification.

#### Discussion

*Nitokra humphreysi* sp. nov. belongs to those species of the genus *Nitokra* Boeck, 1865 characterised by the reduced number of spines/setae on the basoendopodite of the female fifth leg (four instead of five). A similar reduction can be observed in the following seven species: *N. balli* Rouch, 1972 from Long-Island near New Ireland, Papua New Guinea, Pacific; *N. blochi* Soyer, 1974 from the Kerguelen archipelago, Indian Ocean; *N. cari* Petkovski, 1954 from the Adriatic Sea, Mediterranean; *N. laingensis* Fiers, 1986 from Papua New Guinea, Pacific; *N. pseudospinipes* Yeatman, 1983 from Tonga and Fiji, Pacific; *N. reunionensis* Božić, 1969 from Réunion Island, Indian Ocean; and *N. uenoi* Miura, 1962 from Ryukyu Islands, Pacific (Petkovski, 1954; Miura, 1962; Božić, 1969; Rouch, 1972; Soyer, 1974; Yeatman, 1983; Fiers, 1986). From all these species *N. humphreysi* differs by the setal formula on the swimming legs. *Nitokra blochi*, *N. cari*, and *N. pseudospinipes* differ from the new species also by the shape of the fifth leg exopodite in females, which bears six setae, and by some other features. *Nitokra balli* and *N. uenoi* have the first endopodite segment of the second, third, and fourth swimming legs without any seta. *Nitokra reunionensis* is very similar to the new species, but it can be readily distinguished by the shape of the endopodite of the third swimming leg (without seta on the first segment and with only four setae/spines on the ultimate one), the shape of the basis of mandibula (with only one very long seta), and by some other minor differences in shape of the male fifth leg as well as by the ornamentation of abdominal somites. The new species is perhaps most similar to *N. laingensis*, but unfortunately because of its incomplete description we can not compare many details (especially in males). However these two species differ in the following features: armature of the fourth swimming leg (without seta on the second exopodite segment in *N. laingensis*); armature of the basis of mandibula (only one seta in *N. laingensis*); relative length of setae on the exopodite of the female fifth leg; shape of the female sixth

leg (bearing two setae in *N. laingensis*); ornamentation of the abdominal somites in female (uninterrupted row of spines on first free somite, and interrupted row of spines on the ventral side of the anal somite in *N. laingensis*), and ornamentation of the abdominal somites in male (uninterrupted rows of spines on all somites in *N. laingensis*, except on the anal one). Reduction of the armature on the basoendopodite of the female fifth leg appears to represent an example of convergence. In all mentioned species the innermost spine (or spiniform seta) is reduced, except in *N. blochi* where the outermost seta is reduced. Even some specimens of the cosmopolitan species *N. lacustris* (Schmankevitch, 1875) have reduced number of these setae (Božić, 1965), but that is an exception.

Amongst species of *Nitokra* we can observe some examples of stronger reduction of the armature of the female fifth leg basoendopodite. In *N. phreatica* Božić, 1964, from Reunion (Božić, 1964), there are only three armature elements. A similar situation exists, as an exception, in the new species (Fig. 21) and in *N. pseudospinipes* Yeatman, 1983. In *N. bisetosa* Mielke, 1993, from Costa Rica (Mielke, 1993), that number is only two. All the other species in the genus have the basoendopodite of the fifth leg in female with five spines/setae.

Spine and setal formula on exopodites and endopodites of the swimming legs in *N. humphreysi* is the same as in the following nine species: *N. affinis* Gurney, 1927; *N. australis* Soyer, 1974; *N. bdelluriae* (Liddell, 1912); *N. elegans* (Scott, 1904); *N. fragilis* Sars, 1905; *N. intermedia* Pesce, 1983; *N. medusae* Humes, 1953; *N. sewelli* Gurney, 1927; and *N. spinipes* Boeck, 1864. All these species differ from the new one by the shape of the female fifth leg, and by the shape of the first swimming leg (first endopodite segment equal or longer than first two exopodite segments combined, while in *N. humphreysi* it is considerably shorter). There are also some other differences between *N. humphreysi* and every mentioned species separately. At the end we can emphasize extremely long outermost seta on the exopodite of the male fifth leg, which seems to be the only unique character of the new species, but unfortunately in some *Nitokra* species this character has not been described, while for some species males are still unknown.

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