

A NEW SPECIES OF *PHYLLODIAPTOMUS* KIEFER (COPEPODA,
CALANOIDA) FROM THE SHATT AL-ARAB RIVER, SOUTHERN IRAQ

BY

T. A. KHALAF¹)

Department of Marine Biology, Marine Science Centre, Basrah University, Basrah, Iraq

ABSTRACT

A new species of the genus *Phyllodiaptomus* Kiefer, 1936, is herein described as *Phyllodiaptomus irakiensis* sp. nov. from the Shatt al-Arab River, southern Iraq. The species is closely similar to *Phyllodiaptomus blanci* (Guerne & Richard, 1889), but can be distinguished from that species by the left metasomal wing in the female, the second and third urosomal somites each having a conspicuous hyaline lobe on the dorsal side, the presence of fine hairs at the outer and inner margins of the furcal rami, and the structure of the fifth pair of legs in both sexes; moreover, the anal segment along with the furcal rami in the male are curved to the right inner side of the main axis of the urosome, in addition to differences noticed in the right antennule, etc. The new species is the eleventh member of the genus (cf. Sanoamuang & Teeramaethee, 2006) and the second species recorded from southern Iraq.

RÉSUMÉ

Une espèce nouvelle du genre *Phyllodiaptomus* Kiefer, 1936, *Phyllodiaptomus irakiensis* sp. nov. est décrite ici du Shatt al-Arab, au sud de l'Iraq. L'espèce est proche de *Phyllodiaptomus blanci* (Guerne & Richard, 1889), mais peut en être distinguée par l'expansion gauche du dernier somite thoracique femelle, par les deuxième et troisième urosomites qui présentent chacun dorsalement un lobe hyalin bien visible, par la présence de fins poils aux bords interne et externe des rames furcales, et par la structure de la cinquième paire de pattes dans les deux sexes; de plus, le somite anal ainsi que les rames furcales du mâle sont incurvés vers le bord interne droit de l'axe principal de l'urosome, s'ajoutant aux différences observées sur l'antennule droite, etc. La nouvelle espèce est la onzième du genre (cf. Sanoamuang & Teeramaethee, 2006) et la seconde connue du sud de l'Iraq.

INTRODUCTION

A surface plankton sample was collected from the Shatt al-Arab River opposite the town of Al-Faw, southern Iraq (fig. 1) on 28 April 2005, as a part of the monthly plankton monitoring project on the Shatt al-Arab River and its branches.

¹) e-mail: drtalibabbas@hotmail.com or talib_kh@yahoo.com

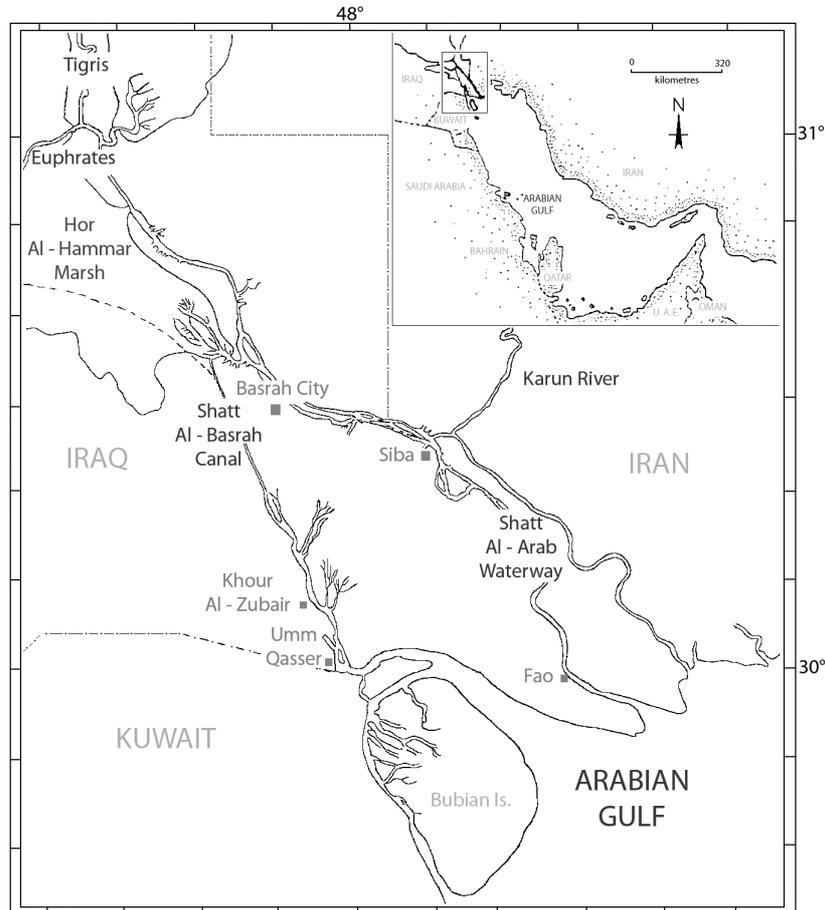


Fig. 1. Map of the sampling area near the town of Al-Faw.

A distinct species of diaptomid copepod was recognized in the sample, with males outnumbering females. A critical examination of both sexes of this species indicates that, in spite of some close similarities to *Phyllodiaptomus blanci* (Guerne & Richard, 1889) [generic allocation *blanci* according to Kiefer, 1978], that it possesses certain unique morphological features, justifying the recognition of a new species, here described under the name of *Phyllodiaptomus irakiensis* sp. nov.

Previous investigations on the freshwater zooplankton of southern Iraq were done mainly on selected groups, like Cladocera (cf. Khalaf & Smirnov, 1976), and Rotifera (cf. Abdul-Hussein et al., 1988), while Al-Saboonchi et al. (1986) referred to copepods as a minor group, represented by 6 cyclopoid species. The brackish and marine copepods of Iraq were earlier studied by the present author (Khalaf, 1988, 1991, 1992, 1994; Khalaf & Ajeel, 1994).

MATERIAL AND METHODS

More than 20 qualitative samples were collected from the surface water of the Shatt al-Arab River, at station al-Faw, during the period from April 2005 to March 2006, using a 120 μm mesh plankton net of 40 cm diameter mouth aperture, at daytime. The samples were preserved in 5% formaldehyde solution. Specimens were dissected in lactophenol, and the parts were mounted on slides (more than 25 slides for adults of both sexes, and their appendages), and examined using an Olympus dissecting microscope. All drawings were made using a Zeiss compound microscope equipped with a camera lucida.

DESCRIPTION

***Phyllodiaptomus irakiensis* sp. nov.** (figs. 2-5, pl. 1)

Type locality and material examined. — Shatt al-Arab River, station al-Faw (29°59'05.06"N 48°28'10.74"E, ~ 10 m depth) 100 km south of the centre of Basrah District, southern Iraq. Twenty males, 20 females from a plankton sample, 28 April 2005. Surface salinity and surface temperature 1.2‰ and 23.4°C, respectively. The male holotype, female allotype, and 19 male and 19 female paratypes have been deposited in the collection of the Department of Marine Biology, Marine Science Centre (MSC), Basrah University, Basrah. All type specimens have been preserved in whole, in 5% formalin.

Description of female. — Total length exclusive of caudal setae 1.2-1.8 mm (average of 30 specimens, 1.5 mm), body (fig. 2) rather stout; prosome slender in dorsal view, approximately 3 times as long as wide, rounded anteriorly; greatest width at the posterior margin of the second pedigerous somite (fig. 2A, B). Head separate from first pedigerous somite, narrow and rounded anteriorly, with one red median eye spot; fourth and fifth pedigerous somites completely fused. Postero-lateral angles of metasome produced into rounded, asymmetrical wings (fig. 2C, D, E, F), the left one of which is drawn over the genital double somite with a strong, hyaline terminal spine, and another sub-terminal one directed downward (fig. 2D, E). The right wing is smaller than the left one, bearing one smaller hyaline terminal spine directed outward. Rostrum (fig. 2I) short, bearing two small ventro-posteriorly directed, well developed spines. Urosome of three free somites; percentage length of these somites and caudal rami as follows: 55.2 : 12.5 : 17.7 : 14.6. Genital double somite slightly asymmetrical, with slight swellings laterally and prominent genital prominence ventrally (fig. 2D, F, H), and longer than the other two urosomites and the caudal rami combined. The genital double somite bears a small hyaline spine proximally on either side. Second urosomite the smallest, bearing a small, central hyaline lobe; third somite dilated at both ends and narrow in the middle, with a central hyaline lobe larger than that

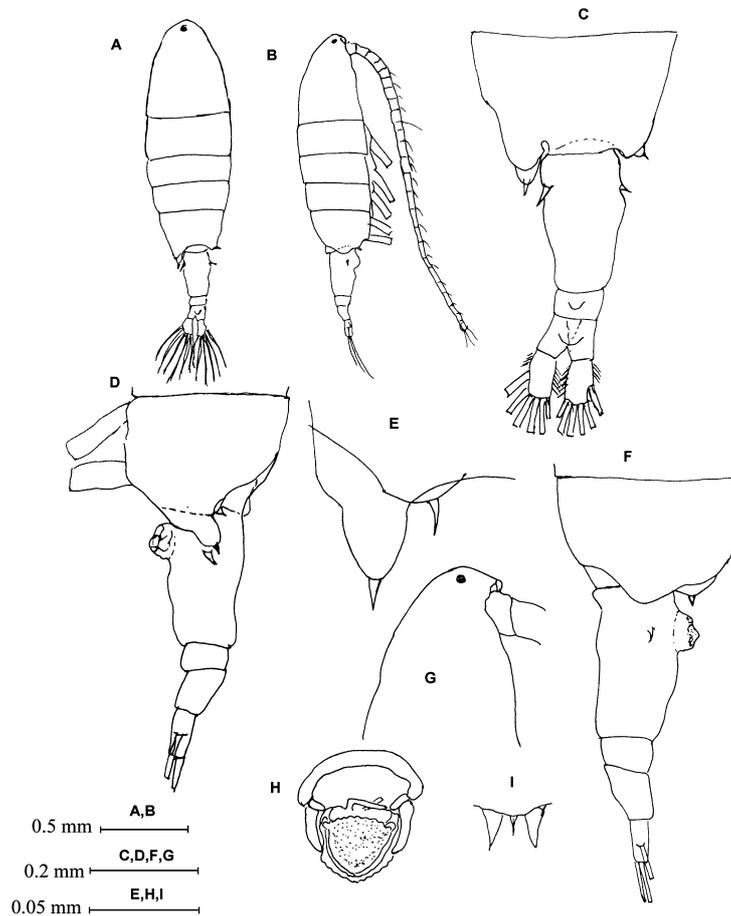


Fig. 2. *Phyllodiptomus irakiensis* sp. nov., adult female. A, dorsal view; B, lateral view; C, D, posterior part of prosome and urosome, dorsal and right lateral view, respectively; E, right metasomal wing; F, posterior part of prosome and urosome, left lateral view; G, frontal part of head, right lateral view; H, genital double somite, ventral view; I, rostrum, ventral view.

of the second somite (fig. 2C). The caudal rami are symmetrical and broad, twice as long as wide, and furnished with hairs along their inner and outer margins (fig. 2C). Lateral seta of both rami somewhat stouter than the other setae; innermost seta shorter than the other setae.

Antennules 25-segmented, left and right identical, reaching halfway the caudal setae. Proportional length of segments, and the arrangement and numbers of setae, spines, and aesthetascs are shown in fig. 3A.

Antennae (fig. 3B) with basipod bearing one proximal and two distal setae; exopod 2-segmented, first segment as long as basipod, bearing two lateral setae; second segment smaller than first, bearing seven terminal and six sub-terminal

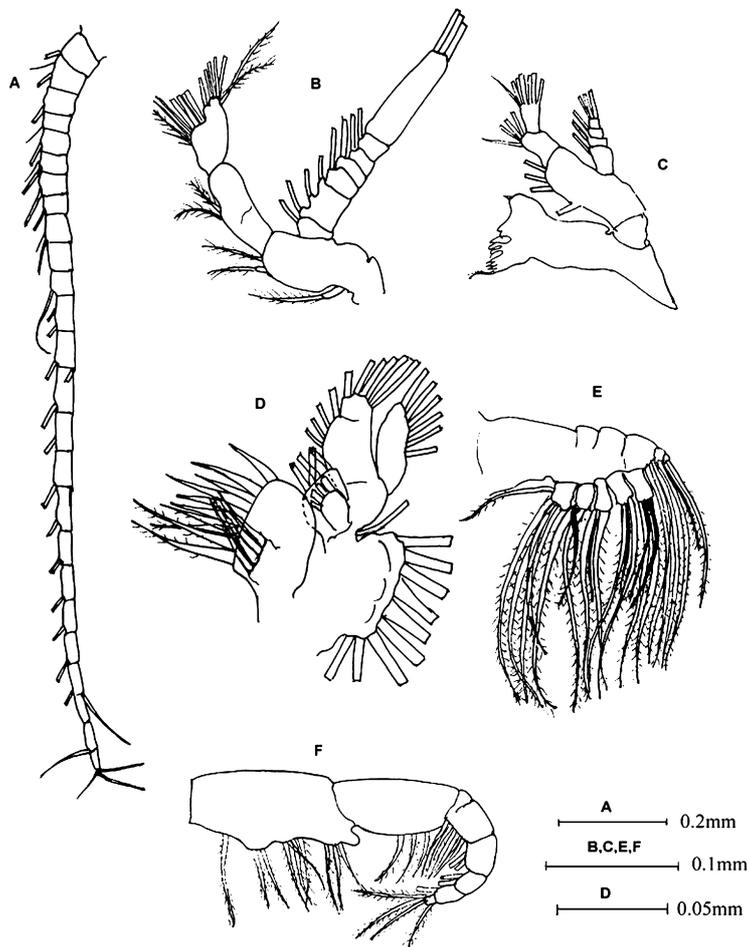


Fig. 3. *Phyllodiaptomus irakiensis* sp. nov., adult female. A, antennule; B, antenna; C, mandible; D, maxillule; E, maxilla; F, maxilliped.

setae, and one smaller lateral seta. Endopod apparently 7-segmented, segments of different sizes, segments 1 and 3-6 nearly of equal length, bearing one lateral seta each; second segment twice as long as third, bearing three lateral setae, seventh segment as long as all other segments combined, with three terminal setae.

Mandible (fig. 3C) with gnathal lobe heavily chitinized, bearing seven fine teeth and a larger one in addition to a finely plumose seta. Basipod of palp with four inner marginal setae, one middle and three distal. Exopod 2-segmented, first segment bearing three terminal and one smaller distal marginal setae, second segment with seven terminal setae. Endopod small, 4-segmented, proximal segment largest, remaining three segments of equal size, distal segment bearing three terminal setae, while segments 1-3 have one distal marginal seta each.

TABLE I

Setation and spinulation of the swimming leg of *Phyllodiptomus irakiensis* sp. nov. si, armature elements of internal margin; se, ditto of external margin; st, terminal elements

Leg	Basipod				Endopod						Exopod								
	1		2		1		2		3		1		2		3				
	si	se	si	se	si	se	si	se	st	si	se	st	si	se	si	se	st		
P1	1	0	0	0	1	0	2	1	3	–	–	–	1	1	1	0	2	1	3
P2	1	0	0	0	1	0	2	0	–	2	2	3	0	1	0	1	3	1	3
P3	1	0	0	0	1	0	2	0	–	2	2	3	1	1	1	1	3	1	3
P4	1	0	0	0	1	0	2	0	–	2	2	3	1	1	1	1	3	1	3

Maxillule (fig. 3D) with first inner lobe (or gnathobase) bearing ten strong outer spines and four posterior smaller ones, second inner lobe and third inner lobe each bearing four inner terminal setae. Outer lobe or coxal epipod bearing nine long setae. Exopod with six marginal setae, and one small marginal seta arising between outer lobe and exopod. Endopod 2-segmented, bearing four setae on first and seven on second segment.

Maxilla (fig. 3E) with five large medial lobes or endites and three smaller terminal lobes; antepenultimate lobe bearing three setae, sub-terminal lobe with two setae, terminal lobe the smallest, with one seta; marginal lobes bearing 4, 3, 3, 3, and 4 setae, respectively, as well as one separate proximal seta near base of first endite.

Maxilliped (fig. 3F) 7-segmented, two proximal segments large, five distal segments small and decreasing in size distally. First segment longer and thicker than second, bearing one plumose seta proximally, 2 and 4 plumose setae medially, 3 plumose setae distally, and a small distal inner lobe directed upwards; second segment with three medial setae; third segment with two setae proximally and two peculiarly divided setae distally; fourth and fifth segments with 2 setae each; sixth segment with one seta, and seventh segment the smallest, with three terminal setae and one outer seta.

Swimming legs 1-4 biramous (fig. 4A-F), with 2-segmented basipod, first segment with a plumose marginal seta distally on inner margin. First pair (fig. 4A, B), differs from following three pairs by: endopod 2-segmented, second exopodal segment without outer marginal spine, and presence of fine hairs along outer margin of second and third exopodal segments with fewer setae on terminal segments of exopod and endopod.

Fifth pair of legs (fig. 4G-I), biramous, symmetrical, coxae of both legs large, truncate, with small hyaline spine at outer distal corner; basis smaller than coxa, triangular, bearing one plumose seta at outer distal corner reaching halfway first exopodital segment. Exopod 3-segmented, first segment cylindrical, longer than

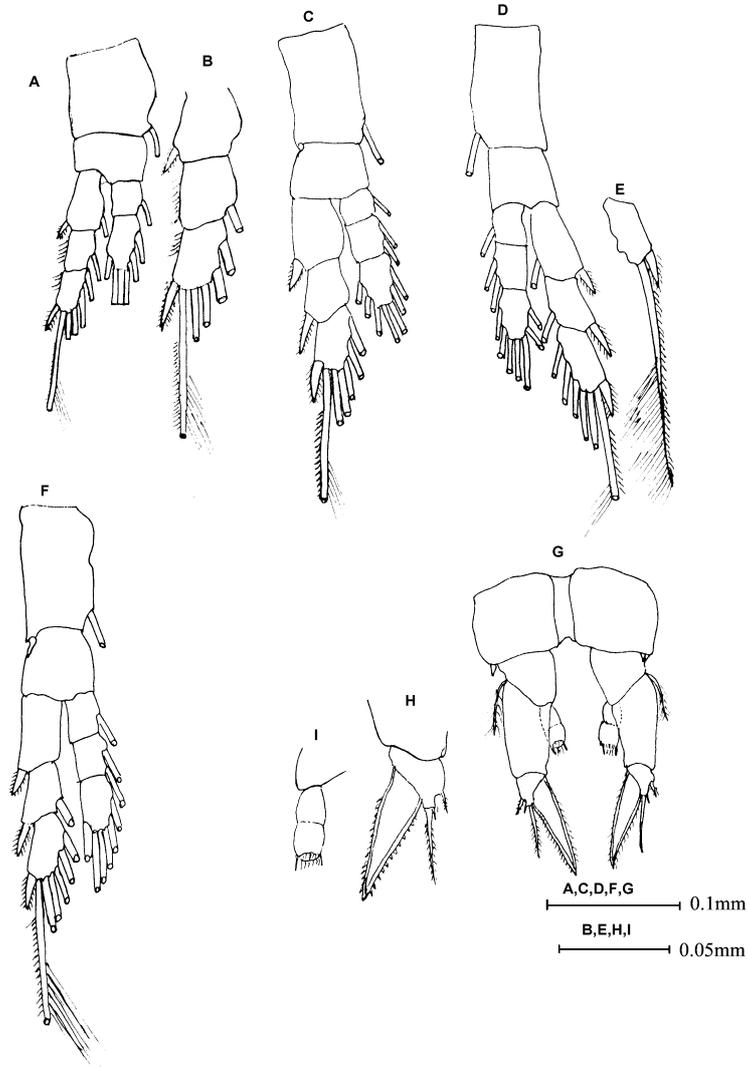


Fig. 4. *Phyllodiaptomus irakiensis* sp. nov., adult female. A, first swimming leg (P1); B, exopod of P1; C, P2; D, P3; E, third exopodal segment of P3; F, P4; G, P5; H, second and third exopodal segments of P5; I, endopod of P5. (P1-P5 = first-fifth swimming legs.)

broad, second segment the smallest (fig. 4H), triangular, with small serrated spine at distal outer margin, two unequal apical spines, and a longer inner serrated spine almost reaching end of third exopodal segment. This third segment shaped as a large, serrated claw, with hyaline spines along inner and outer margins, which spines are basally connected by a hyaline membrane.

Description of male. — Total length 1.2-1.5 mm (average of 30 specimens, 1.35 mm), prosome (fig. 5A, B) similar to that of female, but slenderer, tapering

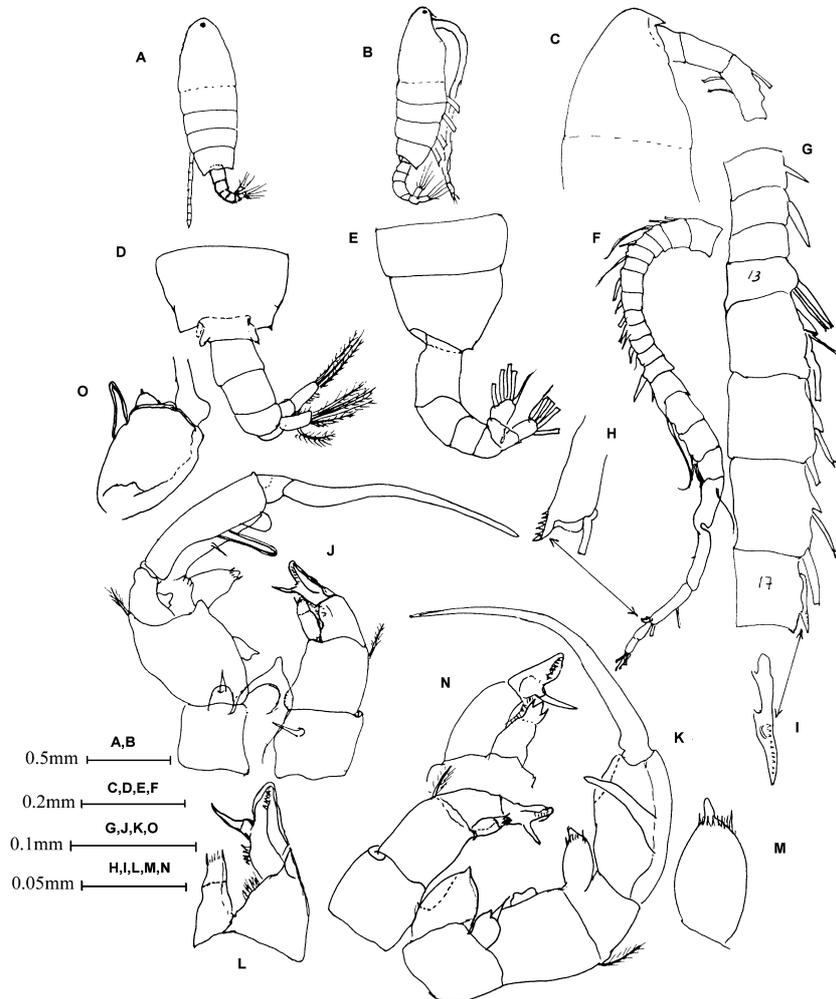


Fig. 5. *Phyllodiptomus irakiensis* sp. nov., adult male. A, dorsal view; B, lateral view; C, head and rostrum in lateral view from right side; D, urosome and last thoracic somite, dorsal view; E, urosome and last two thoracic somites in lateral view from right side; F, right antennule; G, right antennule, segments 10-17; H, comb-like process; I, knife-like process; J, K, fifth pair of legs, outer and inner aspect; L, N, exo- and endopod of left fifth leg; M, endopod of right fifth leg.

posteriorly, posterior angles of metasomal wings less conspicuous and slightly asymmetrical, right side with a small outer marginal, posteriorly directed spine, left side without spine (fig. 5D, E). Rostral filaments shorter than those of female.

Urosome (fig. 5D, E) 5-segmented, half the length of prosome, more uniformly slender than in female, first somite swollen laterally, bearing a lateral spine on right distal margin, remaining somites of nearly equal size, anal somite together with furcal rami conspicuously curved to right side.

Caudal rami symmetrical, twice as long as wide (fig. 5D, E), furnished with fine hairs along inner margins. Antennulae, antennae, oral appendages, and legs similar to those of female except for right antennule and fifth pair of legs. Right antennule (fig. 5F-I) geniculate, 22-segmented, joint between segments 18 and 19, segments 13-18 distal to articulation free and swollen, segments 19 and 20 longest. Segments 8, 10, and 11 with a medial spine each, gradually enlarging towards a large bifid spine distally on segment 13. Spines of segments 14, 15, and 16 decrease in size towards a small one on segment 16. Long and broad hyaline, forwardly directed, knife-like process (fig. 5I), parallel to segment arising from outer proximal margin of segment 17, thin bifid seta arising from inner base of each spine on segments 13 to 17: all these setae as long as spine on segment 13, and segment 19 has a small, thin spine medially. Antepenultimate segment with a short, comb-like process (fig. 5H) with about six unequal teeth at end of inner margin. Proportional lengths of antennular segments, and arrangement of aesthetascs and setation as shown in fig. 5F.

Fifth pair of legs (fig. 5J-O) asymmetrical, right leg being much longer than the left, twisted inwards, coxa roughly spherical, bearing a small hyaline spine at distal outer corner; two unequal hyaline lobes arising from inner margin of coxa, one of which conspicuously larger, umbrella-shaped, directed obliquely downwards, and filling the space between coxae and proximal parts of bases of left and right legs; the other a smaller, spherical, hyaline lobe with stout spine arising from mid-distal margin. Basis longer than broad, with a small hyaline lobe at middle of inner margin and a small seta at distal outer margin. Exopod 2-segmented, first segment small, as long as broad, bearing one large hyaline lobe with triangular apex and two smaller hyaline lobes; all three lobes directed inwards. Second segment of exopod spoon-shaped, more than twice as long as wide, curved inwards, carrying a small, short, hyaline spine near mid-inner margin, and a strong, laterally directed, finger-shaped process on the opposite side: this process slightly curved outwards, arising from middle of segment, and folded over its surface, while lined with a narrow hyaline membrane along its inner margin. A small hyaline lobe with a small spine apically arising from distal outer corner of this segment. End claw twisted at its base, gradually attenuating distally, powerfully developed. Endopod unsegmented (fig. 5M), 1.5 times as long as first exopodal segment, apex triangular, provided with a cirlet of short, stiff hairs and three spinules; apical spine strong, stout, flanked by two smaller, sub-apical spines.

Left fifth leg with coxa roughly rectangular, larger than that of right leg, with hyaline spine of moderate length near its distal inner corner and a small, stout hyaline spine at distal outer corner. Basis with inner proximal corner swollen, with a small seta on distal outer margin and a small hyaline lobe projecting from distal inner corner. Exopod 2-segmented, first segment nearly twice as long as

second, dilated at base and narrowed distally, with a small hyaline spine at its distal outer corner and an inner distal hairy lobe. Second exopodal segment small, triangular, with long, strong, hyaline, distally serrated spine arising from mid-inner margin, a small hyaline lobe with short stiff hairs underneath, and above it a row of small hyaline spines that arise from the inner margin of the triangular apex, and with a hyaline membrane extending from the apex downwards, directed at the inner margin (fig. 5L, N). Endopod imperfectly 2-segmented, as long as proximal exopodal segment (fig. 5N); proximal segment twice as long as distal segment, the latter with triangular apex with slightly larger hyaline spine at the apex and two smaller, hyaline lateral spines, one on each side with a cirlet of stiff hairs around apex.

REMARKS

Due to the scarcity of literature and identification guides concerning fresh- and brackish water copepods in Iraq, the original description of *Diaptomus blanci* by De Guerne & Richard (1896) could not be consulted; the species was placed in *Phyllodiaptomus* as *P. blanci* by Kiefer (1936). Gurney (1921) was the first author who published on freshwater crustaceans of Mesopotamia and Persia, depending on a limited number of samples collected in a very short time. His paper contains a list of mostly cyclopoid copepods and two diaptomid calanoids, one of which was a new species and the other *Phyllodiaptomus blanci* from Umara District, 300 km north of the present sampling area. So the present author depended mainly on the illustrations available in some keys and in publications on fresh- and brackish water species, to differentiate the present species from *P. blanci* (cf. Dussart & Defaye, 2001).

A critical examination of the present specimens reveals that they differ from *Phyllodiaptomus blanci* in the following characters: the left metasomal wing of the female of *P. irakiensis* n. sp. differs from that of *P. blanci* in consisting of two overlapping lobes of different size, each ending with a small, stout spine, whereas in *P. blanci* this wing ends in a sharp, triangular apex. The second and third urosomal somites in the female of the present species each have a conspicuous hyaline lobe on the dorsal side, whereas these lobes are absent in *P. blanci*. The furcal rami of the female of *P. irakiensis* are furnished with fine hairs at the inner and outer margins, whereas in the female of *P. blanci* such hairs are present on the inner margins of the caudal rami only. In addition, there is one small spine on the proximal dorsal surface of each caudal ramus in both sexes of *P. blanci*, which spines are not found in the present species. On the coxa of the fifth pair of legs of female *P. irakiensis*, the hyaline spine of the outer distal corner is much



Pl. 1. *Phyllodiaptomus irakiensis* sp. nov. A, left, female, dorsal view; right, male, dorsal view; B, left, urosome and last metasomal somites of female, dorsal view; right, ditto, male.

smaller than that on the coxa of *P. blanci*, and the plumose seta at the outer distal corner of the basis reaches the middle of the first exopodal segment in the present species, while reaching the end of the first exopodal segment in *P. blanci*. However, more considerable differences between the two species were noted in the second

exopodal segment, and in the endopod of the female fifth pair of legs. The second exopodal segment is distinctly larger than that of *P. blanci*, in which it is very small or even vestigial. Also, the endopod of the fifth pair of legs is 2-segmented in the female of the present species, whereas it is one-segmented in the female of *P. blanci*.

The right metasomal wing of the *P. irakiensis* male is without spine but there is a small spine in *P. blanci*. Another difference is in the anal somite, that along with the furcal rami is curved to the right inner side of the main axis of the urosome in all male specimens examined of the present species, whereas the urosome of *P. blanci* is normal and in line with the main body axis. The inner margins of the furcal rami of the male are furnished with fine hairs, that are absent in *P. blanci*. The right antennule of the male of *P. irakiensis* differs slightly from that of *P. blanci* in having a knife-like process arising from segment 17 (fig. 5I), in addition to the presence of bifid setae arising from the inner base of each spine on segments 13-17 (fig. 5G), whereas the right antennule of *P. blanci* lacks such a process and also the bifid setae. Moreover, the comb-like process arising from the distal end of the antepenultimate segment has about six unequal teeth in the present species (fig. 5H), while the illustrations of *P. blanci* in Dussart & Defaye (2001) show 4 different options, in which the comb-like process has 1 to 4 small, unequal teeth.

The first exopodal segment of the right fifth leg in the male of the present species has a large hyaline lobe in the middle of the segment in addition to two smaller lobes; illustrations in Dussart & Defaye (2001) of that segment in *P. blanci* show only the two smaller hyaline lobes. The terminal hyaline lobe of the second exopodal segment bears a small hyaline spine in *P. irakiensis*, which is not figured for *P. blanci*, and finally the endopod of the left fifth leg of the male of the present species is indistinctly 2-segmented, the second endopodal segment is small with a triangular apex and two sub-apical spines (fig. 5L, N), whereas that endopod in *P. blanci* is one-segmented only.

ACKNOWLEDGMENTS

I would like to express my deep appreciation to Dr. Danielle Defaye of the Muséum National d'Histoire Naturelle, Paris, for reading the manuscript and confirmation of the taxonomy. Thanks are also due to Dr. Salman D. Salman of the Marine Science Centre, Basrah, for reading the manuscript. My great appreciation goes also to Prof. Dr. G. H. Boxshall from the Natural History Museum, London and to Dr. Janet M. Grieve-Bradford, NIWA, Wellington, New Zealand, for their comments and advising to contact the precise specialists on the family Diaptomidae. I am also grateful to Dr. Malik H. Ali, general director of MSC for his support in the publishing of my manuscript.

REFERENCES

- ALEKSEEV, V. R., 1998. Key to freshwater Cyclopidae of Russia and adjacent lands (Crustacea). *Zoosystematica Rossica*, **70**: 25-43.
- AL-SABOONCHI, A. A., N. A. BARAK & A. M. MOHAMED, 1986. Zooplankton of Garma Marshes. *Iraqi Journ. biol. Sci. Res.*, **17** (1): 33-40.
- AL-YAMANI, F. & I. PRUSOVA, 2003. Common copepods of the northwestern Arabian Gulf: 1-162. (Kuwait Institute for Scientific Research, Kuwait City).
- BORUTSKII, E. V., L. A. STEPANOVA & M. S. KOS, 1991. *Opredelitel'i Calanoida Presnykhvod SSSR*. [A handbook of Calanoida from the freshwaters of the USSR]. *Opredeliteli po Faune SSSR*, **157**: 1-503, figs. 1-196. [In Russian.]
- DAMIAN-GEORGESCU, A., 1966. Calanoida (forme de apa dulce). *Fauna Republicii Popular Romaniaia, (Crustacea)* **4** (8): 1-130. [In Romanian.]
- DUSSART, B. H. & D. DEFAYE, 2001. Introduction to the Copepoda (2nd Ed.): 1-344. (Backhuys, Leiden).
- GUERNE, J. DE & J. RICHARD, 1896. *Diaptomus blanci*, Copépode nouveau recueilli par M. Edouard Blanc à Boukhara (Turkestan). *Bull. Soc. zool. France*, **21**: 53-56.
- GURNEY, R., 1921. Fresh-water Crustacea collected by Dr. P. A. Buxten in Mesopotamia and Persia. *Journal of the Bombay Natural History Society*, **27**: 835-843, figs. 1-2.
- KHALAF, A. N. & M. N. SMIRNOV, 1976. On littoral Cladocera of Iraq. *Hydrobiologia*, **51** (1): 90-94.
- KHALAF, T. A. 1984. Zooplankton of the western coast of Africa: 1-125. (Ph.D. Thesis, Moscow). [In Russian with English abstract.]
- , 1988. Calanoid copepods of Iraqi waters of the Arabian Gulf, systematic account, I. Calanoida, families Calanidae through Temoridae. *Marina Mesopotamica*, **3** (2): 173-207.
- , 1991. A new calanoid copepod of the genus *Acartia* from Khor Abdulla and Khor Al-Zubair waters, Iraq. *Marina Mesopotamica*, **6** (1): 80-91.
- , 1992. Three calanoid copepods new to the Arabian Gulf. *Marina Mesopotamica*, **7** (2): 263-274.
- , 1994. Seasonal fluctuations in the distribution and abundance of copepods in the Khor Al-Zubair, south west Iraq. *Marina Mesopotamica*, **9** (1): 29-38.
- KHALAF, T. A. & S. G. AJEEL, 1994. Zooplankton distribution and abundance in N.W. Arabian Gulf. *Marina Mesopotamica*, **9** (2): 397-424. [In Arabic with English abstract.]
- KIEFER, F., 1936. Indische Ruderfusskrebse (Crustacea Copepoda). III. *Zool. Anz.*, **113** (11-12): 321-325.
- MICHEL, H. B., M. BEHBEHANI & D. HERRING, 1986. Zooplankton of the western Arabian Gulf south of Kuwait waters. *Kuwait Bull. mar. Sci.*, **8**: 1-36.
- MICHEL, H. B., M. BEHBEHANI, D. HERRING, M. ARAR, M. AL-SHOUSHANI & I. BRAKONEIKI, 1986. Zooplankton diversity, distribution and abundance in Kuwait waters. *Kuwait Bull. mar. Sci.*, **8**: 37-104, figs.
- PESTA, O., 1912. Copepoden aus dem Golf von Persien. *Wissenschaftliche Ergebnisse der Expedition nach Mesopotamien. Crustacea. Ann. naturhist. Hofmuseums Wien*, **26**: 39-62.
- SALMAN, D. S., M. H. ALI & B. A. MARINA, 1986. Zooplankton of Khor Abdulla, north west Arabian Gulf. *Marina Mesopotamica*, **5** (1): 11-26.
- SANOAMUANG, L. & J. TEERAMAETHEE, 2006. *Phyllodiaptomus thailandicus*, a new freshwater copepod (Copepoda, Calanoida, Diaptomidae) from Thailand. *Crustaceana*, **79** (4): 475-487.
- WILSON, M. S., 1959. Calanoida. In: H. B. WARD & G. C. WHIPPLE, *Freshwater Biology* (ed. 2): 738-794, figs. 2-96. (John Wiley & Sons, New York).

First received 2 October 2006.

Final version accepted 8 August 2007.