

# Redescription of the poorly known calanoid copepod *Pontella karachiensis* Fazal-Ur-Rehman, 1973 from the Red Sea with notes on its feeding habits

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**Abstract:** The neustonic calanoid copepod *Pontella karachiensis*, previously recorded only in the coastal waters of Pakistan and recently in the Arabian Gulf, is fully redescribed from the northern Red Sea because the previous description is insufficient to identify the species. This is the first record of its occurrence in the Red Sea and confirms that this copepod is a subtropical Indian Ocean species. The species belongs to the newly established *karachiensis* group because of closer similarity to *P. minocerami*, the other member of the group, than any species of the known species groups. Gut content analysis revealed that *P. karachiensis* is carnivorous, mainly feeding on planktonic copepods.

**Key words:** Copepoda, gut contents, *Pontella karachiensis*, Red Sea, zoogeography.

## Introduction

The family Pontellidae accommodates eight genera (Mauchline 1998). Most of its species are adapted for existence in the surface layer (0–30 cm) in tropical to warm temperate latitudes (Fleminger 1957, 1967, Voronina 1962, Sherman 1963, 1964, Matsuo & Marumo 1982, Ohtsuka et al. 1987, Mulyadi 1997, 2003, Mauchline 1998). Of the eight pontellid genera, five have been recorded from the Red Sea (*Calanopia* Dana, 1852, *Labidocera* Lubbock, 1853, *Pontella* Dana, 1846, *Pontellina* Dana, 1852 and *Pontellopsis* Brady, 1883) and include 12 species (Halim 1969, Unal & Shmeleva 2002).

According to Boxshall & Hasley (2004), the genus *Pontella* contains 43 species. Only one species, *Pontella fera* Dana, 1846, has been recorded from the Red Sea (Scott 1902, El-Sherbiny 1997) in contrast to 19 species recorded from the Indian Ocean (Silas & Pillai 1973). This indicates the diversity of the Red Sea pontellid copepods is very low as compared to that of the Indian Ocean. However, the low number of species may be partly due to sampling effort and/or to method of collection.

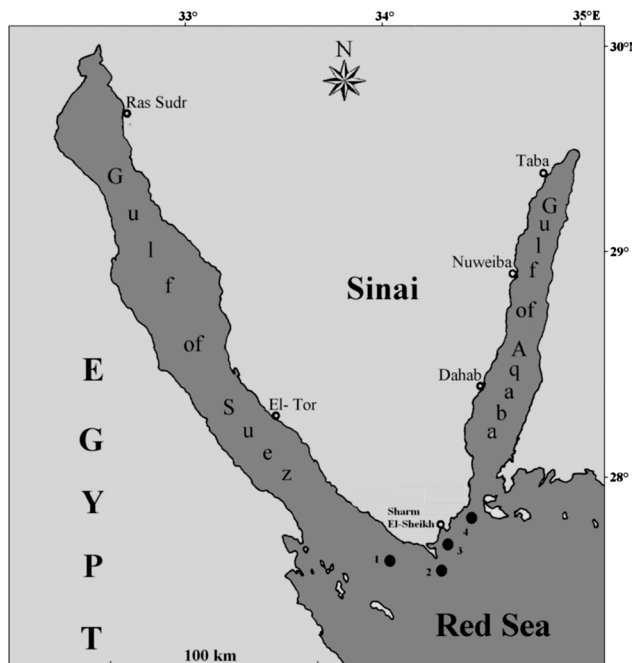
During an investigation of neuston plankton samples collected from the northern Red Sea, an unrecorded species of

*Pontella* was found. The general morphological characteristics of this species were close to those of *Pontella karachiensis* Fazal-Ur-Rehman, 1973, which was described from the inshore waters of Karachi, west Pakistan, by Fazal-Ur-Rehman (1973). We compared our specimens with the paratype deposited at the National Museum of Natural History, Leiden, Netherlands, and concluded that our specimens are *P. karachiensis*. Both specimens shared most of the diagnostic features of the species such as: shape of the fifth pediger, genital compound somite including both lateral and dorsal processes, symmetry of caudal rami and structure of female leg 5. Since the original description is poor and incomplete, the present paper provides a full redescription, as well as records the first occurrence of *P. karachiensis* in the Red Sea, with notes on its feeding.

## Materials and Methods

Specimens were sampled from different oceanic stations around the Sharm El-Sheikh area, northern Red Sea (Fig. 1), using a 40-cm diameter plankton net (325 µm mesh size) towed near the surface for 15 minutes at a speed of about 2 knots. They were fixed with 4% buffered formalin in seawater immediately after capture and then placed in 70% alcohol. Whole or dissected specimens were examined in lactophenol. For gut content analyses, 6 intact adult females were dissected, and the guts removed from the

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**Fig. 1.** Sampling sites (closed circles) of *Pontella karachiensis* around the Sharm El-Sheikh area, northern Red Sea.

cephalothoraxes, mounted on glass slides and examined. The percentage of occurrence of food items in the guts was calculated as: (number of individuals with a certain food item in their guts)/(total number of examined individuals)  $\times 100$ . Microscopic observations were made using a differential interference microscope (Olympus BH-2) and SEM (JOEL, JSM-5600LV). Drawings were made with the aid of a camera lucida and measurements were carried out with an ocular micrometer. Terminology follows Huys & Boxshall (1991). Two males and two females were deposited at the Zoological Institute, Russian Academy of Science, Saint Petersburg, Russian Federation (No. 91066).

### Description

#### *Pontella karachiensis* Fazal-Ur-Rehman, 1973

(Figs. 2–6)

**Material examined.** Ten adult females and 8 adult males collected from the northern Red Sea.

**Body length.** Female 3.4–4.4 mm (mean  $\pm$  SD =  $3.9 \pm 0.38$  mm,  $n=10$ ); male 3.2–3.9 mm ( $3.6 \pm 0.25$  mm,  $n=8$ ).

**Female.** Body (Fig. 2A) robust; prosome about 3.7 times as long as urosome; posterior corner of fifth pediger produced posteriorly into symmetrical, somewhat acuminate lobes extending one-third of urosome length. Rostrum (Fig. 2B) bifid, thickened basally, tapering distally and directed ventrally. Urosome (Fig. 2C–F) 3 free somites; genital compound somite asymmetrical, with small, slightly bi- or trilobed dorsolateral process on left side, large posterodorsal elevation directed posterodorsally and protrusion on right side. Genital operculum (Fig. 2D) located distally

without any processes. Second free urosomite symmetrical and as long as genital compound somite; anal somite considerably shorter and narrower than second urosomite. Caudal rami symmetrical, each ramus nearly 1.9 times as long as its maximum width.

Antennule (Fig. 2G) symmetrical, 24-segmented with incomplete suture between ancestral segments XIII and XIV, not extending beyond third pediger, with row of hairs on posterior surface from segment 2 to segment 12. Segmentation pattern and setal armature as follows: I (1)=3+ae+thetasc (ae), II–IV (2)=4+ae, V (3)=2+ae, VI (4)=2+ae, VII (5)=2+ae, VIII (6)=2+ae, IX (7)=2+ae, X (8)=2+ae, XI (9)=2+ae, XII (10)=2+ae, XIII–XIV (11)=4+2ae, XV (12)=2+2ae, XVI (13)=2+ae, XVII (14)=2+ae, XVIII (15)=2+ae, XIX (16)=2+ae, XX (17)=2+ae, XXI (18)=2+ae, XXII (19)=1, XXIII (20)=1, XXIV (21)=1+1, XXV (22)=1+1+ae, XXVI (23)=1+1, XXVII–XXVIII (24)=4+ae. Distal seta on segment 13 modified into spine-like element.

Antennary coxa (Fig. 2H) with plumose seta medially; basis with 2 distomedial setae of unequal length; exopod 5-segmented with setal formula of 1, 3, 1, 2, 4; endopod with 2 setae on first segment, 6 long and 3 short setae on proximal lobe of second segment, and 6 long and 1 median setae and row of posterior spinules on distal lobe of second segment.

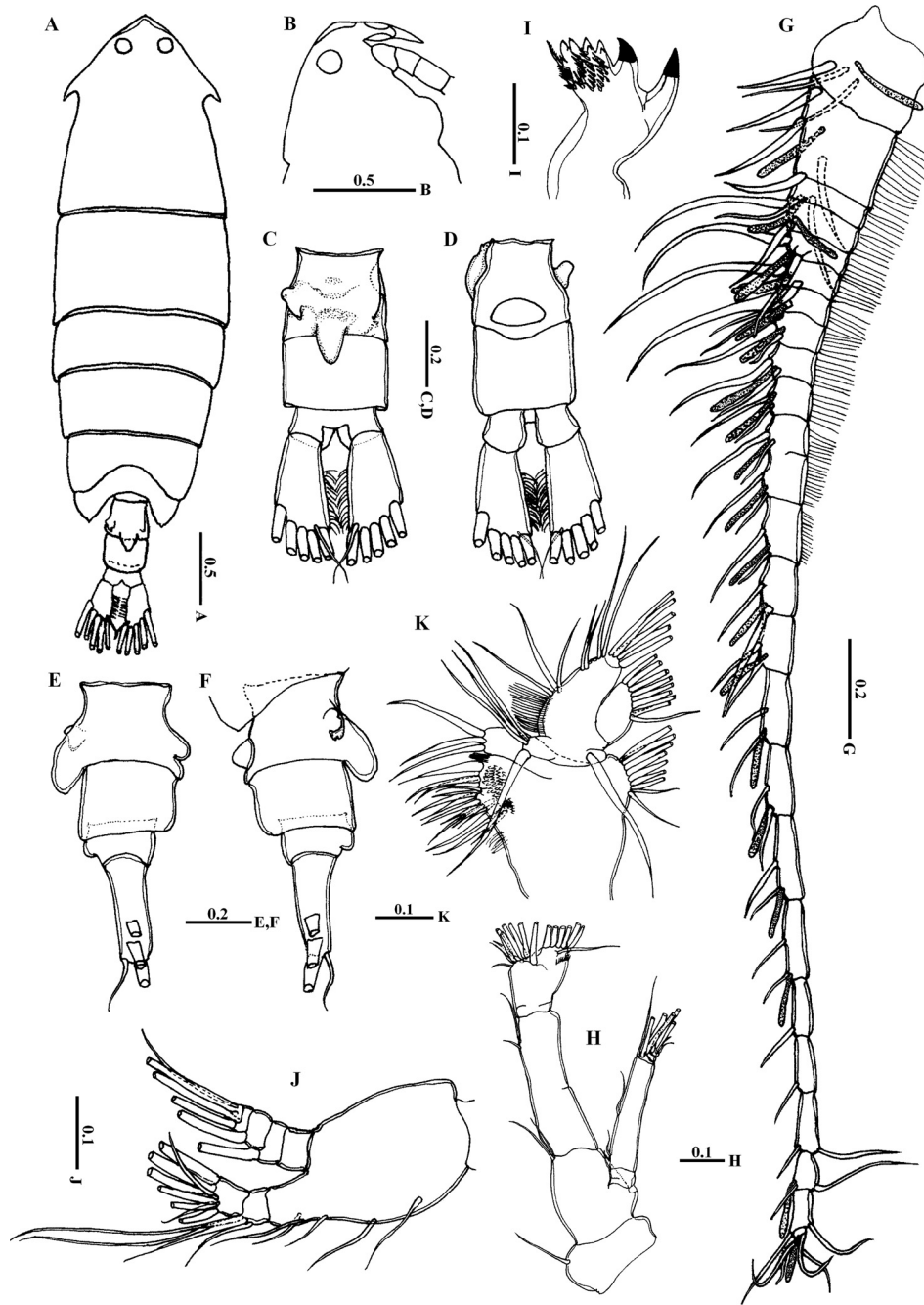
Mandibular gnathobase (Fig. 2I) heavily chitinized with cutting edge bearing 7 teeth and spinulose seta; third and fourth teeth bicuspidate; and third to seventh teeth with patch of dagger-like spinules anterodistally at base. Palp (Fig. 2J) basis longer than wide, bearing 5 setae; exopod 5-segmented with setal formula of 0, 1, 1, 1, 3; endopod 2-segmented with 4 setae on first segment and 6 long and 2 short setae on second segment.

Maxillule (Fig. 2K) with praecoxal arthrite well developed carrying 15 setae on and around distal margin; coxal endite with 3 unequal apical stout setae; coxal epipodite with 9 plumose setae; basis with 1 long seta representing basal exite; first and second endites with 4 and 3 setae, respectively; basis fused to endopod with 2 setae on each first and second endopodal segments, respectively; and 5 apical setae on distal segment; exopod 1-segmented with 9 setae distally.

Maxilla (Fig. 3A) with praecoxa and coxa fused; first and second praecoxal endites with 5 and 3 setae, respectively; first and second coxal endites each armed with 3 setae; basis carrying 1 long and 2 short setae; endopod with 6 long and 1 small setae.

Maxilliped (Fig. 3B) 7-segmented; syncoxal endites with setal formula of 2, 3, 3 setae; basis medial margin fringed with row of stout teeth and bearing 2 setae distally; endopod 6-segmented, with 2 setae on first segment almost fused to basis, 2 setae distally on second segment, 1 distal seta on third to fifth segments, and 4 unequal setae each on distal segment.

Seta and spine formula of legs 1 to 4 (Fig. 3C–F) is



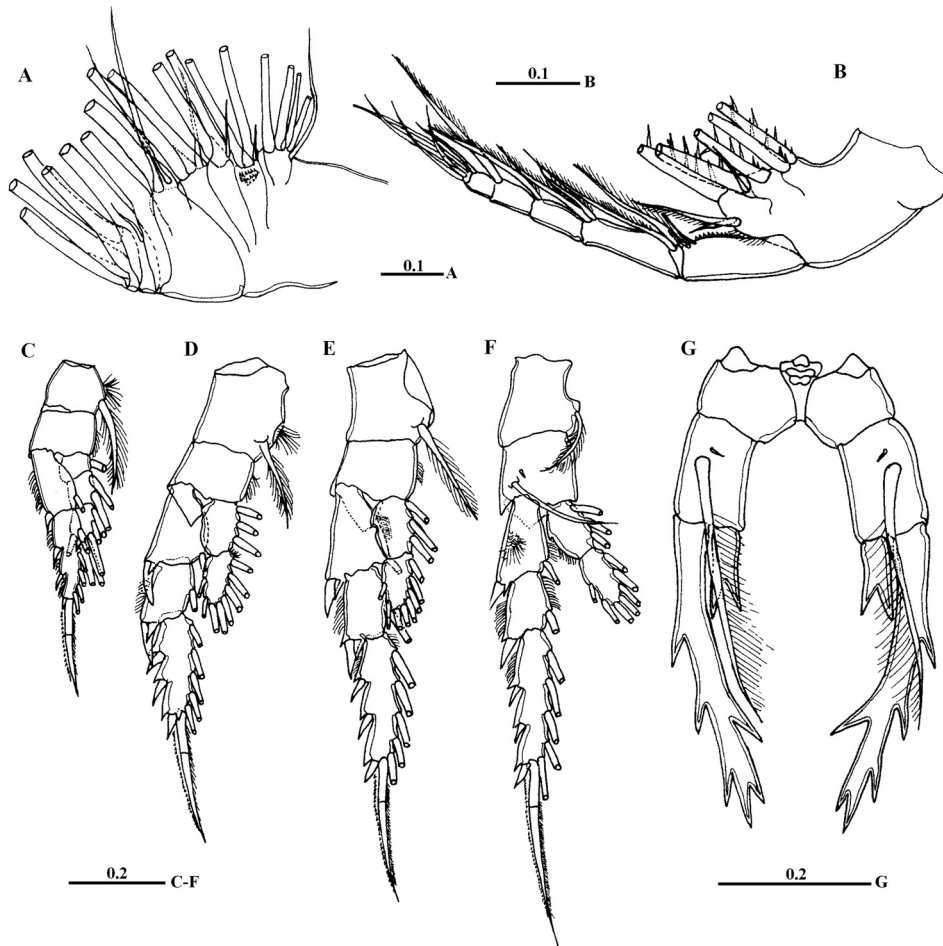
**Fig. 2.** *Pontella karachiensis* female from the northern Red Sea. A: habitus, dorsal view; B: rostrum, lateral view; C: urosome, dorsal view; D: urosome, ventral view; E: urosome, lateral view (right); F: urosome, lateral view (left); G: antennule; H: antenna; I: mandibular cutting edge; J: mandibular palp; K: maxillule. All scale bars in mm.

shown in Table 1. Leg 1 with 3-segmented endopod; legs 2 to 4 with 2-segmented endopod; leg 4 with setule near seta on basis and patch of hairs on posterior surface of first exopodal segment.

Leg 5 (Fig. 3G) nearly symmetrical; basis posteriorly with long plumose seta reaching nearly two-thirds of exopodal segment and very fine setule proximally to seta; exopod and endopod 1-segmented; exopod slightly curved smoothly inward, terminating in 2 unequal processes; each

exopod with 3 large processes along lateral margin and process on medial margin; endopod bifid at tip, not exceeding one-third of exopod.

**Male.** Body (Fig. 4A) robust; prosome about 3.4 times as long as urosome; fifth pediger with symmetrical lateral expansions. Rostrum (Fig. 4B, C) bifid; bulbous with 2 lenses. Urosome (Fig. 4D, E) 5-segmented; genital somite asymmetrical with 2 sensilla on each side; left side weakly swollen with genital aperture located ventrolaterally at pos-



**Fig. 3.** *Pontella karachiensis* female from the northern Red Sea. A: maxilla; B: maxilliped; C–G: legs 1 to 5; anterior view. All scale bars in mm.

**Table 1.** Spine and setal formula of female legs 1 to 4 of *Pontella karachiensis* collected from the northern Red Sea. Roman and Arabic numerals indicate the numbers of spines and setae, respectively.

	Coxa	Basis	Exopod			Endopod		
			1	2	3	1	2	3
Leg 1	0-1	0-0	I-1;	I-1;	II, I, 4	0-1;	0-2;	1,2,3
Leg 2	0-1	0-0	I-1;	I-1;	III, I, 5	0-3;	2, 2, 4	
Leg 3	0-1	0-0	I-1;	I-1;	III, I, 5	0-3;	2, 2, 4	
Leg 4	0-1	1-0	I-1;	I-1;	III, I, 5	0-3;	2, 2, 3	

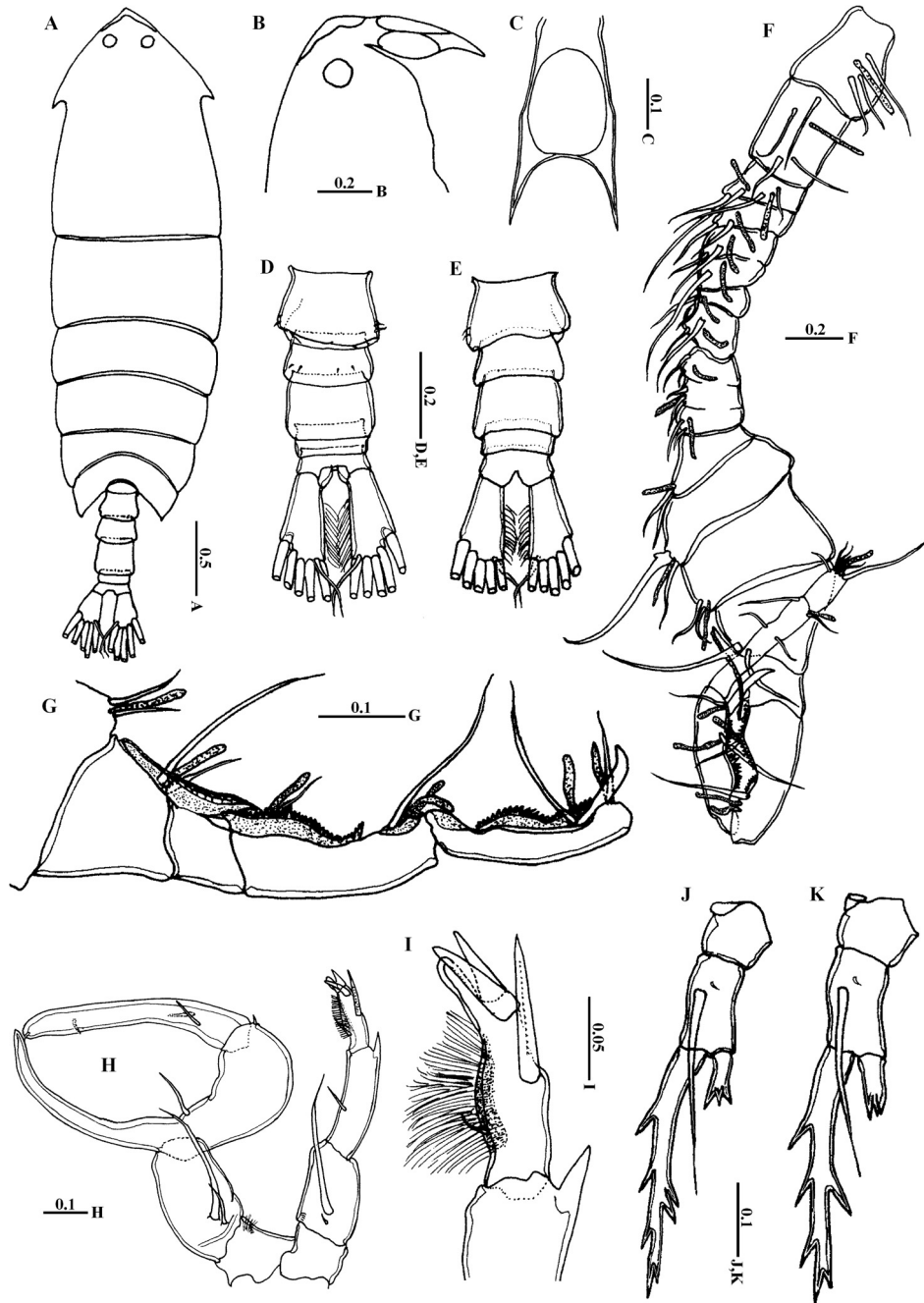
anterior rim; second urosomite with 2 dorsal sensilla on each side; third urosomite longer than following 2 somites combined; caudal rami symmetrical and approximately 1.9 times as long as its maximum width.

Right antennule (Fig. 4F, G) geniculated; 20-segmented, extending to middle of third pediger. Segments 5–6 and 9–11 partly fused; segment 13 (XIV) with long modified spine; anterior margin of segment 16 (XVII) with coarse-lamellate plate extending to segment 15; segment 17 (XVIII) with 2 plates carrying acuminate sharp teeth; fused segment 18 (XIX–XXI) with spur-like strong process fused

at base distally and 2 toothed plates; proximal plate with sharp elevated acuminate teeth and distal one with lamelliform teeth. Left antennule as in female.

Leg 5 (Fig. 4H) typical of pontellids; left leg 5 short; basis with 1 long and 1 very small setae; exopod 2-segmented; first segment with 1 medial plumose seta on posterior surface; second segment (Fig. 4I) with long pointed spine on lateral margin; apex with 2 spines and round-tip process surrounded by flange of membrane and fused at base to segment; medial margin of second exopodal segment hirsute, carrying spine proximally. Right leg 5 basis





**Fig. 4.** *Pontella karachiensis* male from the northern Red Sea. A: habitus, dorsal view; B: rostrum, lateral view; C: rostrum, frontal view; D: urosome, dorsal view; E: urosome, ventral view; F: right antennule; G: geniculate part of right antennule; H: leg 5, posterior view; I: second exopodal segment of left leg 5, posterior view; J, K: variation in female left leg 5, posterior view. All scale bars in mm.

(Fig. 4H) with 1 long plumose and 1 small-naked articulated setae; exopod 2-segmented, forming stout chela; first segment forming thumb of chela ending in long slender process curving inward, with naked seta at medial margin of palm and tiny spine on lateral margin near base of second exopodal segment; second exopodal segment (finger) elongate, not tapering and armed with small apical spine, 2 setae proximally and 1 seta distally.

*Variation.* The dorsolateral process on left side and dor-

sal projection of female genital compound somite vary in shape among individuals (Fig. 5A–D). Female left leg 5 also varies (Fig. 4J, K); some specimens have trifurcated endopod and/or exopod with 2 processes on medial margin. Number of sensilla on first and second male urosomites differs among individuals.

*Comparison.* Examination of *P. karachiensis* from the Egyptian Red Sea waters allowed us to provide a more accurate description of this species, some aspects of which

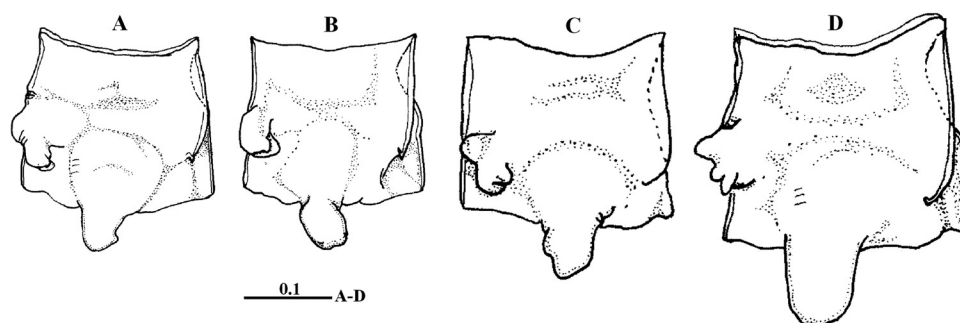


Fig. 5. *Pontella karachiensis* female from the northern Red Sea. A–D: variation in shape of genital compound somite. All scale bars in mm.

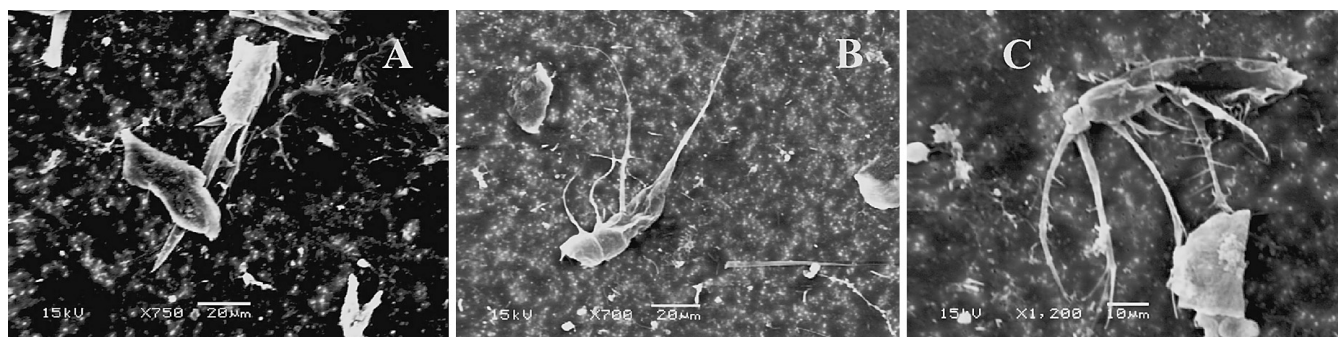


Fig. 6. SEM micrographs of gut contents of *Pontella karachiensis* female from the northern Red Sea. A: piece of exopod of leg of a copepod; B–C: piece of cephalic appendage of a copepod.

were probably undescribed or incorrectly described by Fazal-Ur-Rehman (1973). For example, he mentioned that the female urosome bears two free somites, while we observed that the paratype obviously has 3 free somite urosome as in the Red Sea specimens. Setae on most cephalic appendages are fewer in Fazal-Ur-Rehman's description than in ours. This is probably due to overlooking in the former description because numbers of setae in our description are more general for the genus; for example, second endopodal segment of the antenna with 16 setae (13 in the original description), which is the same as in *P. atlantica* (Edwards, 1840) described by Giesbrecht (1892, plate 24) and *P. rostraticauda* Ohtsuka, Fleminger & Onbé 1987.

**Distribution.** *Pontella karachiensis* has been recorded only from the coastal waters of Karachi, Pakistan (Fazal-Ur-Rehman 1973), offshore waters of the west coast of the United Arab Emirates, Arabian Gulf (Sharaf & Al-Ghais 1997) and the northern Red Sea (present study). In the study area, *P. karachiensis* is considered as a rare species since it appeared solely during the warm period (June–August) with its highest abundance of 1.5 indiv. m<sup>-3</sup> during June (average 0.5 indiv. m<sup>-3</sup>). As many *Pontella* species are, the present one is restricted to the subtropical, neritic and oceanic waters of the Indian Ocean region.

**Feeding.** Gut content investigations of *P. karachiensis* revealed that this species fed mainly on planktonic copepods dominant in the area of study during the sampling period (El-Sherbiny unpublished data). Copepods found in the

guts were crushed into pieces (66.7%), apparently macerated by mandible teeth action (Fig. 6A–C). Some cyclopoid copepods (*Oithona* spp.) were frequently found intact (50%). No phytoplankton fragments, such as the shells of diatoms, were found. Results of the gut content analyses suggest that this species is carnivorous.

## Discussion

Fleminger (1986) divided species of *Pontella* from the Indo-West Pacific into three species groups (*alata*, *andersoni* and *fera* groups) without defining the basis of division. Subsequently, Ohtsuka et al. (1987) established the characteristics of the *alata* group. Based on the shape of the genital compound somite, rostrum, caudal rami, and leg 5 of both sexes, Mulyadi (1997, 2003) grouped the Indo-Pacific species of *Pontella* into 6 species groups, namely *alata*, *andersoni*, *fera*, *danae*, *labuanensis* and an unassigned group. *Pontella karachiensis* is closely related to the *andersoni* group (including *P. andersoni* Sewell, 1912 and *P. chierchiae* Giesbrecht, 1889) due to their similarity in the following characteristics: symmetry of female caudal rami; female leg 5 symmetrical terminating in 2 processes, with 3 lateral processes; male rostrum bulbous with 2 lenses; first exopodal segment of male right leg 5 with slender elongated thumb; second exopodal segment of male left leg 5 elongated with 1 medial long and 2 apical spines and 1 aesthetasc-like process. Also in *P. karachiensis*, the genital

compound somite has a dorsal process as in *P. chierchiae*. However, *P. karachiensis* differs from the members of the *andersoni* group in the asymmetry of the female genital compound somite that has a small, slightly dorsolateral process, female leg 5 with a single medial process (instead of 2 in the *andersoni* group), medial margin of the palm of first exopodal segment of male right leg 5 without any processes, distal part of male second exopodal segment of right leg 5 not dilated.

*Pontella karachiensis* more closely resembles the Atlantic species *P. mimocerami* Fleminger, 1957 collected from the Gulf of Mexico in the structure of prosomal ends, urosomes and fifth legs of both sexes. Therefore, a distinct species group (*karachiensis* group) can be established on the basis of *P. karachiensis* and *P. mimocerami* characteristics. This group is defined as follows: posterior corners of prosome are symmetrical in both female and male; female urosome 3-segmented; female genital compound somite asymmetrical with small, slightly dorsolateral process in the left side and without any ventral processes; caudal rami symmetrical; female leg 5 symmetrical and terminating in 2 processes, with 1 medial and 3 lateral processes; male rostrum bulbous with 2 small lenses; first exopodal segment of male right leg 5 with slender elongated thumb curving inward; palm of first exopodal segment of male right leg 5 without processes; second exopodal segment of male left leg 5 elongated with medial long spine on lateral margin and 2 spines and process at distal end.

The pontellid genera *Labidocera*, *Epilabidocera*, *Pontella* and *Anomalocera* are considered as omnivores (Park 1966, Turner 1977, 1978, 1984, 1985, Ohtsuka & Onbé 1991), while other genera (*Pontellina* and *Pontellopsis*) are typically carnivores based on the structure of mouth parts and gut contents (Ohtsuka & Onbé 1991). Gut content analysis of the 6 intact specimens showed that *P. karachiensis* of the Red Sea is a carnivorous feeder, which did not agree with results of Ohtsuka & Onbé (1991). Our finding may be explained by the following reasons: 1) phytoplankton in the Red Sea is very limited and characterized by low biomass (chlorophyll *a* < 0.8 mg m<sup>-3</sup>, Klinker et al. 1978, Sommer 2000, Sommer et al. 2002), 2) phytoplankton of the northern Red Sea are constituted mainly of ultraphytoplankton (Lindell & Post 1995, Li et al. 1998, Yahel et al. 1998) which are too small (< 8 µm) to be manipulated by its mouth parts, 3) this species may change its food items opportunistically as in some other pontellid species (Ohtsuka & Onbé 1991), and 4) the number of analyzed specimens was too small to detect vegetative foods in their guts.

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### References

- Boxshall GA, Hasley SH (2004) An Introduction to Copepod Diversity I. The Ray Society, London, 421 pp.
- El-Sherbiny MM (1997) Some ecological studies on zooplankton in Sharm El-Sheikh (Red Sea). M. Sc. Thesis, Marine Science Department, Suez Canal University, 151 pp.
- Fazal-Ur-Rehman F (1973) A new calanoid copepod; *Pontella karachiensis* sp. nov., from West Pakistan. *Crustaceana* 24: 151–156.
- Fleminger A (1957) New calanoid copepods of *Pontella* Dana and *Labidocera* Lubbock with notes on the distribution of the genera in the Gulf of Mexico. *Tulane Studies in Zool* 5: 19–34.
- Fleminger A (1967) Taxonomy, distribution and polymorphism in *Labidocera jollae* group (Calanoida: Copepoda) with remarks on evolution within the group. *Proc US Nat Mus* 120: 1–16.
- Fleminger A (1986) The Pleistocene equatorial barrier between the Indian and Pacific Oceans and a likely cause for Wallace's line. *UNESCO Techn Pap Mar Sci* 49: 84–97.
- Giesbrecht W (1892) Systematik und Faunistik der pelagischen Copepoden des Golfes von Neapel. *Fauna und Flora des Golfes von Neapel* 19: 1–831, pls. 1–54.
- Halim Y (1969) Plankton of the Red Sea. *Oceanogr Mar Biol Ann Rev* 7: 231–275.
- Huys R, Boxshall GA (1991) Copepod Evolution. The Ray Society, London, 468 pp.
- Klinker J, Reiss Z, Kropach C, Levanon J, Harpaz H, Shapiro Y (1978) Nutrients and biomass distribution in the Gulf of Aqaba (Elat), Red Sea. *Mar Biol* 45: 53–64.
- Li H, Veldhuis MJW, Post AF (1998) Alkaline phosphatase activities among planktonic communities in the northern Red Sea. *Mar Ecol Prog Ser* 173: 107–115.
- Lindell D, Post AF (1995) Ultraphytoplankton succession is triggered by deep winter mixing in the Gulf of Aqaba (Elat), Red Sea. *Limnol Oceanogr* 40: 1130–1141.
- Matsuo Y, Marumo R (1982) Diurnal vertical migration of pontellid copepods in the Kuroshio. *Bull Plankton Soc Japan* 29: 89–98.
- Mauchline J (1998) The biology of calanoid copepods. *Advances in Marine Biology* 33 [Series ed: Blaxter JHS, Southward & Tyler PA] Academic Press, London, 710 pp.
- Mulyadi (1997) Three new species of Pontellidae (Copepoda, Calanoida) from coastal waters of Java, Indonesia. *Crustaceana* 70: 653–675.
- Mulyadi (2003) Three new species of *Pontella* (Copepoda, Calanoida) from Indonesian waters, with notes on their species-groups. *Crustaceana* 76: 385–402.
- Ohtsuka S, Fleminger A, Onbé T (1987) A new species of *Pontella* (Copepoda: Calanoida) from the Inland Sea of Japan with notes on its feeding habits and related species. *J Crust Biol* 7: 554–571.

- Ohtsuka S, Onbé T (1991) Relationship between mouthpart structures and in situ feeding habits of species of the family Pontellidae (Copepoda: Calanoida). *Mar Biol* 111: 213–225.
- Park TS (1966) The biology of a calanoid copepod *Epilabidocera amphitrites* McMurrich. *Cellule* 66: 127–251.
- Scott A (1902). On some Red Sea and Indian Ocean Copepoda. *Trans Liverpool Biol Soc* 16: 397–428.
- Sharaf GM, Al-Ghais SM (1997) Distribution of zooplankton in offshore waters of the west coast of the United Arab Emirates. *Kuwait J Sci Eng* 24: 131144.
- Sherman K (1963) Pontellid copepod distribution in relation to surface water types in the central North Pacific. *Limnol Oceanogr* 8: 214–227.
- Sherman K (1964) Pontellid copepod occurrence in the central south Pacific. *Limnol Oceanogr* 9: 476–484.
- Silas EG, Pillai PP (1973) The calanoid copepod family Pontellidae from the Indian Ocean. *J Mar Biol Ass India* 15: 771–858.
- Sommer U (2000) Scarcity of medium-sized phytoplankton in the Red Sea explained by strong bottom-up and weak top-down control. *Mar Ecol Prog Ser* 197: 19–25.
- Sommer U, Berninger UG, Böttger-Schnack R, Cornils A, Hagen W, Hansen T, Al-Najjar T, Post AF, Schnack-Schiel SB, Stibor H, Stübing D, Wickham S (2002) Grazing during early spring in the Gulf of Aqaba and the northern Red Sea. *Mar Ecol Prog Ser* 239: 251–261.
- Turner JT (1977) Sinking rates of fecal pellets from the marine copepod *Pontella meadi*. *Mar Biol* 40: 249–259.
- Turner JT (1978) Scanning electron microscope investigations of feeding habits and mouthpart structures of three species of copepods of the family Pontellidae. *Bull Mar Sci* 28: 487–500.
- Turner JT (1984) Zooplankton feeding ecology: contents of fecal pellets of the copepod *Acartia tonsa* and *Labidocera aestiva* from the continental shelf waters near the mouth of Mississippi River. *Publ Staz Zool Napoli* 5: 265–282.
- Turner JT (1985) Zooplankton feeding ecology: contents of fecal pellets of the copepod *Anomalocera ornata* from the continental shelf waters near the mouth of Mississippi River. *Publ Staz Zool Napoli* 6: 285–298.
- Unal E, Shmeleva AA (2002) A new species of *Calanopia* (Copepoda, Calanoida) from the central Red Sea. *Crustaceana* 75: 1–11.
- Voronina NM (1962) On the surface plankton of Indian Ocean. *Trudy Inst Okeanol* 58: 67–79.
- Yahel G, Post AF, Fabricius K, Marie KD, Vulot D, Genin A (1998) Phytoplankton distribution and grazing near coral reefs. *Limnol Oceanogr* 43: 551–563.