



УДК 595.34(267.37)

I. Yu. Prusova, research scientist

The A.O. Kovalevsky's Institute of Biology of the Southern Seas,
National Academy of Sciences of Ukraine, Sevastopol, Ukraine

***PAREUCALANUS SMITHAE* SP. NOV. (COPEPODA: EUCALANIDAE),
A NEW COPEPOD SPECIES FROM THE ARABIAN SEA**

A new copepod species, *Pareucalanus smithae* sp. nov., is described from the Arabian Sea based upon features of morphological structure and integumental perforation pattern. Information on horizontal and vertical distribution of *P. smithae* in the Arabian Sea is given.

Key words: *Pareucalanus*, Eucalanidae, Copepoda, abundance, distribution, Arabian Sea.

Calanoid copepods of the family Eucalanidae are widely distributed in the World Ocean. To the present, in the NW Indian Ocean 11 eucalanid species have been recorded, including 2 species of the genus *Pareucalanus* – *P. attenuatus* and *P. sewelli* [1, 4, 5, 7, 8]. In zooplankton samples collected by US scientists in 1994 - 1995 in the US Joint Global Ocean Flux Study (JGOFS) from the RV Thomas G. Thompson and in the Global Ocean Ecosystem Dynamics (GLOBEC) program from the RV Malcolm Baldrige in the oceanic area east of 55°E and north of 10°N in the Arabian Sea, parallel with *P. attenuatus* and *P. sewelli*, specimens of the genus *Pareucalanus* different from these two species were found. On the basis of thorough comparative analysis, a new species, *Pareucalanus smithae* sp. nov., was revealed.

Depth-stratified samples were collected using a 1m² MOCNESS fitted with 153µm mesh nets and equipped with a General Oceanics 2030R flowmeter. To identify taxonomic status of all representatives of the genus *Pareucalanus* in the analyzed material, we used the standard method of copepod identification based on particulars of morphologic construction, and an additional method based on integumental pore pattern, proposed for eucalanid identification by A. Fleminger [3]. To investigate the pore patterns, 13 females

and 10 males of *P. attenuatus*, 10 females and 4 males of *P. sewelli* and 13 females and 5 males of the newly described species were stained according to [3]. To describe horizontal and vertical distribution of new species, 176 samples, treated quantitatively using a subsampling method [2] in a Bogorov chamber, were analyzed. Drawings were made with the aid of a Leica DM LS2 microscope equipped with a camera lucida. The following abbreviations are used for the description: Ans – anal somite; A1 – antennule; A2 – antenna; Ce – cephalosome; Enp – endopod; Exp – exopod; Fu – caudal ramus; Gns – genital somite; Md – mandible; Mdp – mandibular palp; Md Gn – mandible gnathobase; Mx1 – maxillule; Mx2 – maxilla; Mxp – maxilliped; P1 - P5 – swimming legs 1 - 5; Pd1 - Pd5 – pedigerous somites 1 - 5; Pr – prosome; R – rostrum; Ur – urosome.

***Pareucalanus smithae* Prusova, sp. nov.**
(figs. 1, 2)

Holotype: female, № IZNANU EUCAL001/1995; allotype: male, № IZNANU EUCAL002/1995. Type locality 16°77' N., 55°47' E. Holotype and allotype are deposited in I.I. Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine, Kiev.

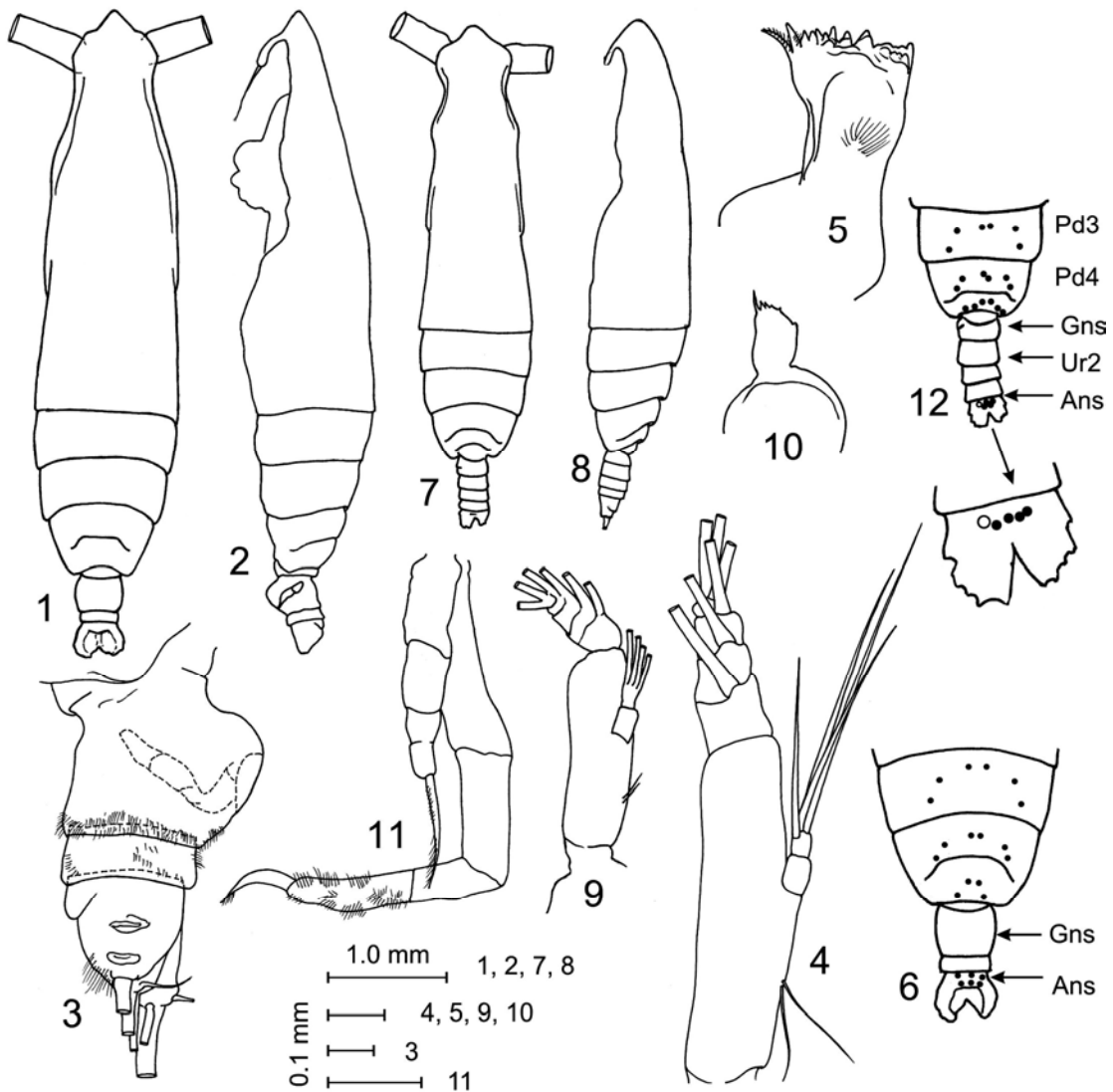


Fig. 1. *Pareucalanus smithae* sp. nov. Female: 1 – habitus, dorsal view; 2 – habitus, lateral view; 3 – Ur, right lateral view; 4 – Mdp; 5 – Md Gn, 6 - integumental perforation pattern on dorsal surface of Pd3 - Pd5 and Ur.

Male: 7 – habitus, dorsal view; 8 – habitus, lateral view; 9 – Mdp; 10 – Md Gn; 11 – P5, 12 – integumental perforation pattern on dorsal surface of Pd3-Pd5 and Ur. On Ans, 4 pores were revealed in 4 specimens, 5 pores – in 1 specimen, localization of the fifth pore is indicated by open circle.

Рис. 1. *Pareucalanus smithae* sp. nov. Самка: 1 – габитус, вид сверху; 2 – габитус, вид сбоку; 3 – Ур, вид сбоку (справа); 4 – Мдп; 5 – Мд Гн, 6 - схема расположения пор на дорсальной поверхности Pd3-Pd5 и Ур.

Самец: 7 – габитус, вид сверху; 8 – габитус, вид сбоку; 9 – Мдп; 10 – Мд Гн; 11 – P5, 12 – схема расположения пор на дорсальной поверхности Pd3-Pd5 и Ур. 4 поры на Ans отмечены у четырех особей и 5 – у одной особи, местоположение пятой поры показано открытым кружком.

Female (fig. 1: 1 - 6; fig. 2: 1 - 9). Total body length 5.0 - 5.6 mm (n = 14). Ratio of Pr to Ur length is about 7 : 1. Anterior region of Ce markedly constricted in front of A1 and triangular in dorsal view. Top of the head not curved in ventral view. R well developed, elongated, ending in two fine filaments. Pd1 and Ce completely fused.

Pd4 and Pd5 partly fused. Posterolateral corners of Pd5 smoothly rounded. Ur of 3 somites; first somite (Gns) composed of 2 fused somites, third somite formed of fused Ans and Fu. Proximal part of Gns and Ur2 with small hairs. Gns wider than long, projecting ventrally in a round swelling. Left Fu slightly larger than the right, right Fu

with fascicle of hairs. Second medial terminal seta on left Fu markedly stouter and much longer than others. **A1** total number of segments unknown since distal edges in all investigated specimens were lost. Ancestral segments I - IV and X - XI fused. **A2** biramous; coxa and basis with 1 and 2 setae on distomedial angle, respectively. Exp 8-segmented with 2, 2, 1, 1, 1, 1, 1, 3 setae, correspondingly. Enp 2-segmented, with 2 medial setae

on Enp1, with 9 medial and 7 terminal setae on Enp2. **Mdp** biramous, basis with 2 setae on inner margin. Exp 5-segmented, setal formula 1, 1, 1, 1, 2. Enp 2-segmented; Enp1 without setae, Enp2 with 4 setae. **Md Gn** cutting edge with 1 row of short teeth and 1 seta. **Mx1** with the first prae-coxal arthrite carrying 15 spines. Prae-coxal arthrites 2 - 3 with 4, 4 setae, respectively.

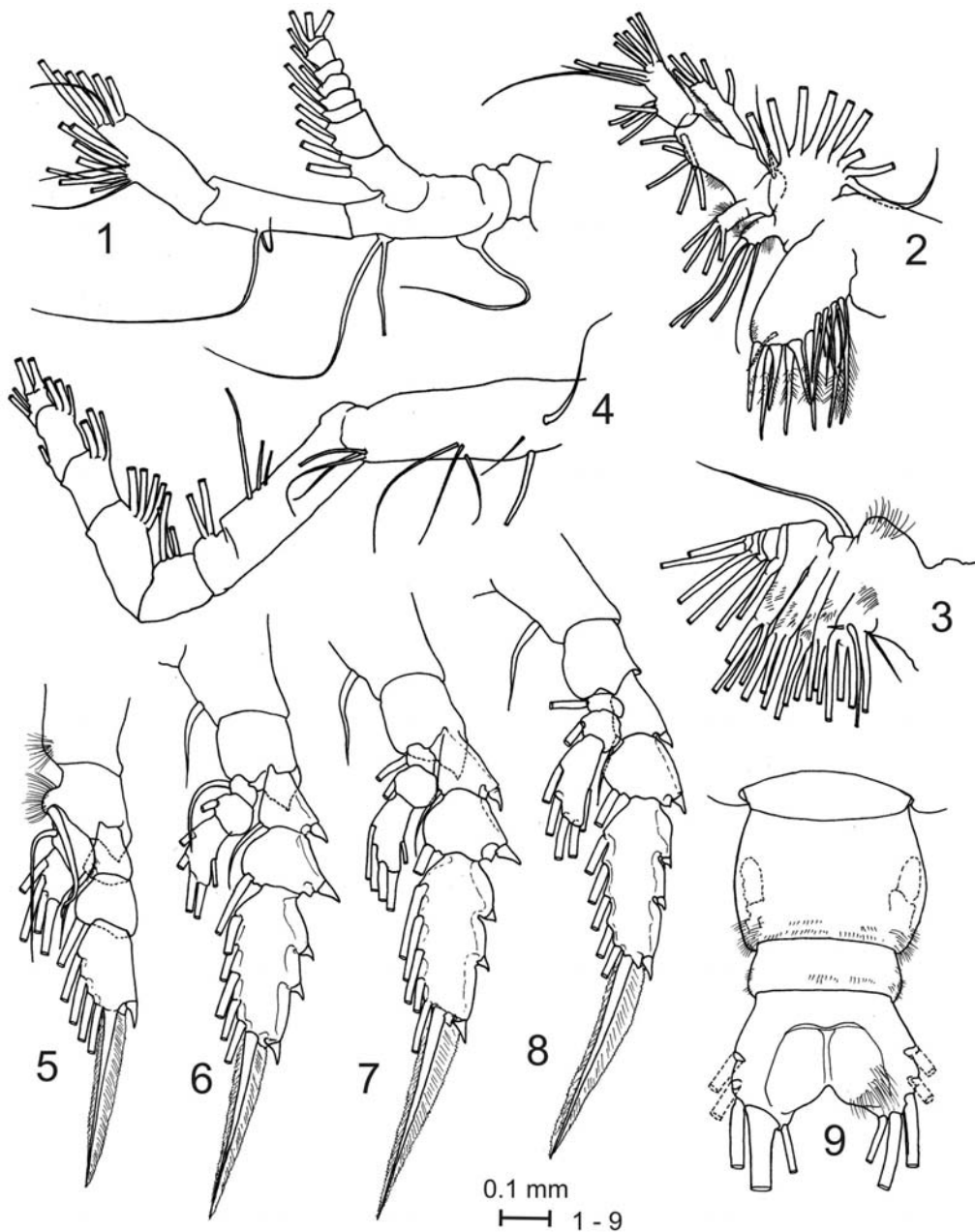


Fig 2. *Pareucalanus smithae* sp. nov. Female: 1 – A2; 2 – Mx1; 3 – Mx2; 4 – Mxp; 5 – P1; 6 – P2; 7 – P3; 8 – P4; 9 – Ur, dorsal view. Рис. 2. *Pareucalanus smithae* sp. nov. Самка: 1 – A2; 2 – Mx1; 3 – Mx2; 4 – Mxp; 5 – P1; 6 – P2; 7 – P3; 8 – P4; 9 – Ur, вид сверху.

Coxal endite 1 with 9 stout setae; coxal endite 2 is not pronounced, with 1 medium-sized seta. Basis with 5 setae, Exp with 5 setae, Enp with 13 setae. **Mx2** with well developed endites; endite 1 with 6 setae and 1 spine; endites 2 - 6 with 3, 3, 3, 4, 1 setae, respectively. Enp 4-segmented, setal formula 1, 1, 1, 2. Outer margin of coxa has round swelling with hairs and long plumose seta. **Mxp** 7-segmented. Coxa with 1, 2, 3, 3 setae on medial margin. Basis partly fused with Enp1; with 3 medial and 2 distal setae. Free Enp2 - Enp6 setal formula 3, 4, 3, 3 + 1 and 2 + 2. **P1** coxa with hairs on inner margin, basis with curved plumose seta at internal apex. Exp 3-segmented; Exp1 and Exp2 devoid of outer spines and with 1 inner seta each; Exp3 with 1 outer spine at distal corner, 1 slender terminal spine, and 4 inner setae. Enp 2-segmented; Enp1 with 1 inner seta, Enp 2 with 2 inner and 2 terminal setae. **P2**, **P3** and **P4** alike. Coxa with 1 inner seta, basis lacking setae. Exp 3-segmented; Exp1 and Exp2 with 1 strong outer spine and 1 inner seta each; Exp3 with 3 outer spines, 5 inner setae and 1 slender terminal spine. Enp 3-segmented; Enp1 and Enp2 with 1 inner seta each, Enp3 with 1 outer seta, 2 inner setae and 2 terminal setae. **P5** lacking.

Male (figs. 1: 7 - 12). Total body length 3.8 - 4.3 mm (n = 6). Ratio of Pr to Ur length is about 6 : 1. Forehead in dorsal view almost triangular with apex smoothly rounded and less produced than in female. **R** elongated, ending in two fine filaments. Ce and Pd1 fused. Pd4 and Pd5 partly fused. Posterolateral corners of Pd5 smoothly rounded. **Ur** of 5 somites, Ur5 formed

of fused Ans and Fu. Gns slightly produced on left side, with distinct genital operculum. Left Fu slightly larger than the right, second medial terminal seta on left Fu markedly stouter and much longer than others. **A1** total number of segments unknown since distal edges in all investigated specimens were lost. Ancestral segments II - IV and X - XI fused. **A2**, **Mdp**, **Mx1**, **Mx2** and **Mxp** slightly reduced, much smaller than in female, but resemble the latter in details of arrangement. **Md Gn** degenerated, with single spinelike tooth. **P1** - **P4** nearly identical with those of female. **P5** both left and right uniramous, 4-segmented; left ramus long, distal segment tipped with hook-like spine; right ramus short, third and fourth incompletely separated, distal segment tipped with seta.

Differential diagnosis. *P. smithae* is similar to *P. attenuatus* and *P. sewelli* in setation of Mdp: these three species have 2 setae on Mdp basis, whereas two other species of this genus (*P. langae* and *P. parki*) have 4 setae. *P. smithae* can be distinguished from *P. attenuatus* and *P. sewelli* by more expressed anteriorly and not curved forehead, more narrow and elongated shape of seminal receptacles in lateral view, larger size (length of females of *P. attenuatus* and *P. sewelli* in the analyzed material 4.0 - 4.6 mm, males - 3.0 - 3.7 mm), and proportional lengths of setae on Mdp Enp2. The ratio of these setae length in *P. smithae* 1 : 1.2 : 1.5 : 1.7, in *P. attenuatus* - 1 : 1.7 : 2.7 : 4.1, in *P. sewelli* - 1 : 1.8 : 3.5 : 4.5. Additionally, *P. smithae* differs from *P. attenuatus* and *P. sewelli* in pore pattern on Pd3, Pd4 and Ur (table 1).

Table 1 Integumental perforation pattern in different species of the genus *Pareucalanus* in the analyzed material

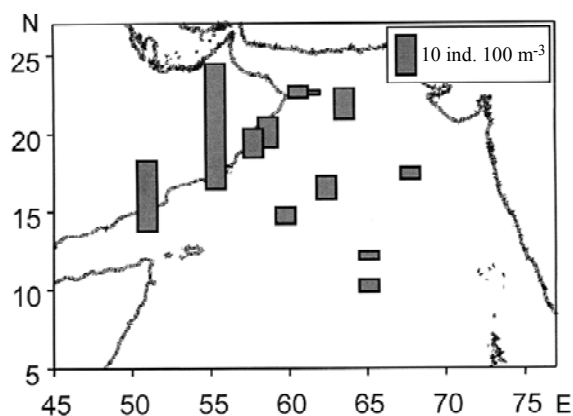
Табл. 1 Количество пор на наружных покровах у разных видов рода *Pareucalanus* в проанализированном материале

Species	Pd3 dorsal		Pd4 dorsal		Gns		Ans		Ur2 dorsal	
	♀	♂	♀	♂	dorsal	lateral	dorsal	lateral		
	♀	♂	♀	♂	♀	♂	♀	♂		
<i>P. attenuatus</i>	10	10	10	10	2	3	3	3	3	2
<i>P. sewelli</i>	6	6	6	6	0	2	5	3	0	0
<i>P. smithae</i> sp. nov.	6	6	6	6	0	2	6	4(5)	0	0

Etymology. The specific name honours Prof. Sharon L. Smith (the Rosenstiel School of Marine and Atmospheric Science, University of

Miami), for her contributions to investigation of the Atlantic and Indian Ocean zooplankton.

Spatial distribution. *P. smithae* was found in all the investigated area (in 14 of 19 sampled stations) in the depth range 0-1300 m. Its abundance was generally low, averaging 26, 48, 11, 2, 4 and 5 (standard deviation value 82, 147, 23, 3, 7 and 8) ind. 100 m⁻³ in the layers 0-50, 50-100, 100-300, 300-500, 500-1000 and 1000-1300 m, respectively. The highest abundance values (38.9 and 22.4 ind. 100 m⁻³ in the water column 0-1300 m) were recorded nearshore in the upwelling area (fig. 3).



In general, nearly 60 % of the *P. smithae* population in the investigated layers were found deeper than 100 m, i.e., within the oxygen minimum zone that occurs in the Arabian Sea in the depth range from 50 - 100 to 1000 - 1250 m and is characterized by extremely low dissolved oxygen concentrations (far less than 1 ml l⁻¹) [6]. On the basis of vertical distribution patterns, a wide range of tolerance to oxygen concentrations in *P. smithae* can be assumed.

Acknowledgements. This study was partly supported by US NSF grant OCE-9310599 and US Office of Naval Research contract N00049510042. The author thanks S. Smith (RSMAS – the Rosenstiel School of Marine and Atmospheric Science, University of Miami) for her kind permission to analyze the samples; P. Lane (RSMAS) for his assistance in eucalanid staining and the reviewers for their valuable remarks.

Fig. 3. Distribution of *P. smithae* in the Arabian Sea.
Рис. 3. Распространение *P. smithae* в Аравийском море.

1. Moryakova V.K. Composition and distribution of zooplankton in the Arabian Sea during the Southwest Monsoon season // *Biologiya Morya*. – 1971. – № 24. – P. 141 - 152 (In Russian).
2. Yashnov V.A. Instruction on methods of plankton collection and its analysis in a field environment. – M.: Publ. VNIRO, 1939. – 22 p. (In Russian).
3. Fleminger A. Pattern, number, variability and taxonomic significance of integumental organs (sensilla and glandular pores) in the genus Eucalanus (Copepoda: Calanoida) // *Fish. Bull.* – 1973. – 71, № 4. – P. 965 - 1010.
4. Madhupratap M., Haridas P. Epipelagic calanoid copepods of the northern Indian Ocean // *Oceanol. Acta*. – 1986. – 9, № 2. – P. 105 - 117.

5. Madhupratap M., Haridas P. Zooplankton, especially calanoid copepods, in the upper 1000 m of the south east Arabian Sea // *J. Plankt. Res.* – 1990. – 12, № 2. – P. 305 - 321.
6. Morrison J.M., Codispoti L.A., Smith S.L., et al. The oxygen minimum zone in the Arabian Sea during 1995 // *Deep Sea Res.* – 1999. – 46, № 8 - 9. – P. 1903 - 1931
7. Sewell, R.B.S. The Copepoda of Indian Seas. Calanoida // *Memoirs of the Indian Museum, Calcutta*. – 1932. – 10. – P. 223 - 407.
8. Sewell R.B. The free swimming planktonic Copepoda. Systematic account // *Sci. Rep. John Murray Exped.* – 1947. – 8, № 1. – P. 1 - 303.

Поступила 06 июля 2007 г.

***Pareucalanus smithae* sp. nov. (Copepoda: Eucalanidae), новый вид в Аравийском море. И. Прусова.** Описан новый вид копепод *Pareucalanus smithae* sp. nov. из Аравийского моря, дифференцированный по особенностям морфологического строения и рисунку пор на наружных покровах. Приведены сведения о горизонтальном и вертикальном (в слое 0-1300 м) распределении *P. smithae* в Аравийском море.

Ключевые слова: *Pareucalanus*, Eucalanidae, Copepoda, численность, распределение, Аравийское море.

***Pareucalanus smithae* sp. nov. (Copepoda: Eucalanidae), новый вид в Аравийському морі. І. Прусова.** Описано новий вид копепод, *Pareucalanus smithae* sp. nov., з Аравійського моря на підставі особливостей морфологічної будови і схеми пор на зовнішніх покритках. Наведені відомості про горизонтальний і вертикальний (у шарі 0-1300 м) розподіл *P. smithae* в Аравійському морі.

Ключові слова: *Pareucalanus*, Eucalanidae, Copepoda, чисельність, розподіл, Аравійське море.