

# A new record of *Candacia varicans* Giesbrecht, 1892 (male) (Crustacea: Copepoda: Candaciidae) from the South China Sea

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## Abstract

The male of *Candacia varicans* Giesbrecht, 1892 from the South China Sea was recorded and described. In general, the male of *C. varicans* is morphologically similar to those of *C. armata* and *C. curta*. However, it is distinguished with them by below several morphological characters: (1) posterolateral corners of the fifth thoracic segment prominently sharp and symmetrical; (2) right side of posterior edge of genital segment with a small backward protuberance; and (3) the dorsal surface of the third segment of the fifth pereopod with a squama-shaped protuberance.

**Key words:** copepods, new record, *Candacia varicans*, the South China Sea

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## 1 Introduction

The calanoid family Candaciidae, defined by Giesbrecht in 1892 (as Candaciidae) and Giesbrecht and Schmeil in 1898 (as Candaciidae), includes two genera and 36 valid species (Razouls et al., 2017). This family was placed in the superfamily Diap-tomoidea by Andronov (1974) and Boxshall and Halsey (2004). The early history of taxonomy about this family was discussed by Grice (1963) in detail. Sars (1903) found that there were two morphological types of males in the species of genus *Candacia*, and he suggested this genus could be divided into two genera. Grice (1963) examined the specimens deposited in the U.S. National Museum, and established a new genus, *Paracandacia* Grice, 1963, based on two diagnostic characteristics, which were the finger-like terminal process on the apical segment of the female fifth pereopod and the non-chelate form of the male right fifth pereopod with its apical plumose seta. von Vaupel Klein and Gassmann (1998) analyzed the phylogenetic relationship of 27 available species in family Candaciidae based on 60 morphological characteristics. The results showed that three species of *Paracandacia* were in a terminal cluster, which indicated the genus *Paracandacia* was holophyletic. However, 23 species of *Candacia* could not form a separate clade, which indicated the genus *Candacia* was paraphyletic, at least based on morphological data in that study. More importantly, the family Candaciidae was also not monophyletic based on this phylogenetic analysis. Therefore, the current classification of genus taxon in this family is not in accord with the phylogenetic relationship among species, and the genus *Candacia* should be revised, especially based on molecular data in future. In the present study, we followed the treatment in Boxshall and

Halsey (2004), which regarded the family Candaciidae as a monophyly and thus combined four species of *Paracandacia* into *Candacia*.

The family Candaciidae was widely distributed in the tropical and temperate regions of the Atlantic, Pacific and Indian Oceans (Grice, 1963; Razouls et al., 2017). In China, Zheng et al. (1984) reported thirteen species distributed in China seas and a key of these species was given. Nineteen species of this family were recorded in the *Checklist of Marine Biota of China Seas* (Liu, 2008). More recently, Zhang et al. (2010) summarized eighteen Candaciidae species and provided an illustrated guide. The species *Candacia varicans* Giesbrecht, 1892 was recorded in China seas and the female specimens were illustrated and described by Lian and Lin (1978), but the male of this species had not been listed or confirmed in taxonomic literatures involving China seas. There were two possible reasons: first, the number of female individuals was over one time more than that of male individuals in natural population of pelagic copepods (Kjørboe, 2006) (in the author's personal observation (Liu Zhensheng), female specimens were over four times more than that of male individuals), thus female specimens were much easier to obtain; second, and there might be some misidentification, because of the existence of morphologically similar species (Table 1).

In the present study, we examined some specimens from the South China Sea. The diagnosis and microscope photos of female and male were given. Besides, a comparison of diagnosis characteristics about several confusing species was provided.

## 2 Materials and methods

Samples examined in the present study were collected from

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**Table 1.** Diagnoses among male individuals of *C. varicans*, *C. armata* and *C. curta*

	Species name		
	<i>C. varicans</i>	<i>C. armata</i>	<i>C. curta</i>
Length of body/mm	2.15	1.70–2.40	2.20–2.25
Prosome	posterolateral corners of fifth thoracic segment prominently sharp and symmetrical; the terminal of posterolateral corner over the middle part of genital segment	posterolateral corners of fifth thoracic segment symmetrical; right corner sharp and lightly curved; the terminal of posterolateral corner over the posterior edge of genital segment	posterior edge of head with a small protuberance; terminal part of right posterolateral corner of fifth thoracic segment dark brown and curved; it near to the posterior edge of genital segment
Genital segment	genital segment trapezoidal and symmetrical; right side of posterior edge of this segment with a small backward protuberance	genital segment short and broad; right side of posterior edge of this segment with short and sharp protuberance	right side of posterior edge of genital segment with a long and robust curved-protuberance, near to right posterolateral corner
Fifth pereopod	left: 3rd segment longest, terminal segment approximately oval-shaped; right: the dorsal surface of 3rd segment with a squama-shaped protuberance	left: 1st and 3rd segments slender; inner and outer sides of terminal segment with tenellous spines	left: outer sides of 3rd and terminal segments with tenellous spines, inner side of terminal segment with a long spine; right: middle part of outer and dorsal sides of 3rd segment with a quadrangular protuberance and four small spines; top end of terminal segment with a long spine

the central basin of the South China Sea (10.996 5°N, 113.503°E), in the summer of 2012, by 0–200 m vertical tows using a WP2 plankton net (with a 0.25 m<sup>2</sup> mouth opening area and a mesh size of 200 μm). The collected samples were preserved immediately in 5% (v/v) buffered formalin-seawater solution. The specimens were observed and studied using a microscope (Zeiss Discovery V20) equipped with a digital camera (AxioCam ICc5). All photos were also obtained using the same microscope system. Specimens used in this study are preserved in the Second Institute of Oceanography, State Oceanic Administration. The descriptive terminology and measurements follows Zheng et al. (1984) and Boxshall and Halsey (2004).

### 3 Systematics and descriptions

Family Candaciidae Giesbrecht, 1893

Genus *Candacia* Dana, 1846

*Candacia varicans* Giesbrecht, 1892 (Figs 1 and 2)

Giesbrecht, 1892 (p. 424, 439, 771); Scott, 1894 (p. 62); Rose, 1933 (p. 252); Grice, 1962 (p. 234); Grice, 1963 (p. 179); Owre and Foyo, 1967 (p. 94); Zheng et al., 1984 (p. 250); Bradford-Grieve, 1999 (p. 174); Harding, 2004 (p. 25); Vives and Shmeleva, 2007 (p. 456); Liu, 2008 (p. 614); Zhang et al., 2010 (p. 158).

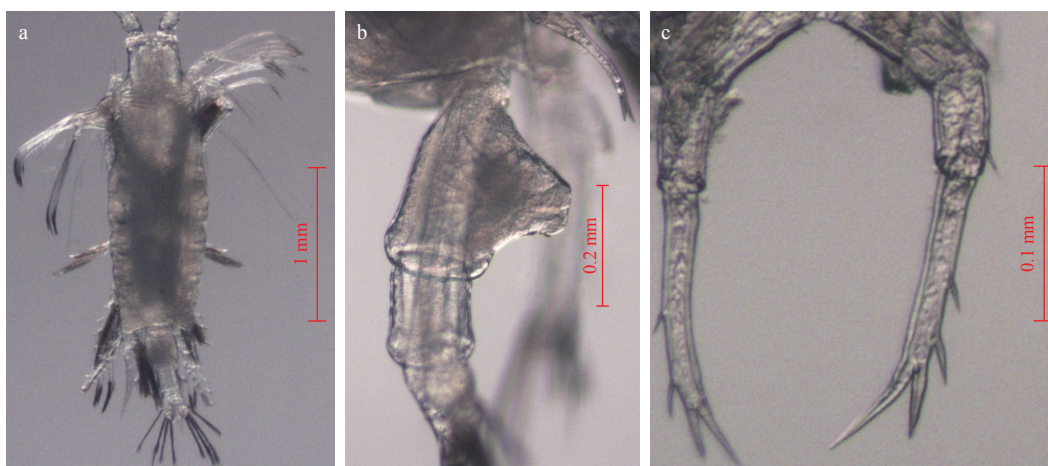
### Material examined

Type material not examined. Two adult female specimens and one adult male specimen were examined in the present study. The specimens were collected from the central basin of the South China Sea (10.996 5°N, 113.503°E), in the summer of 2012.

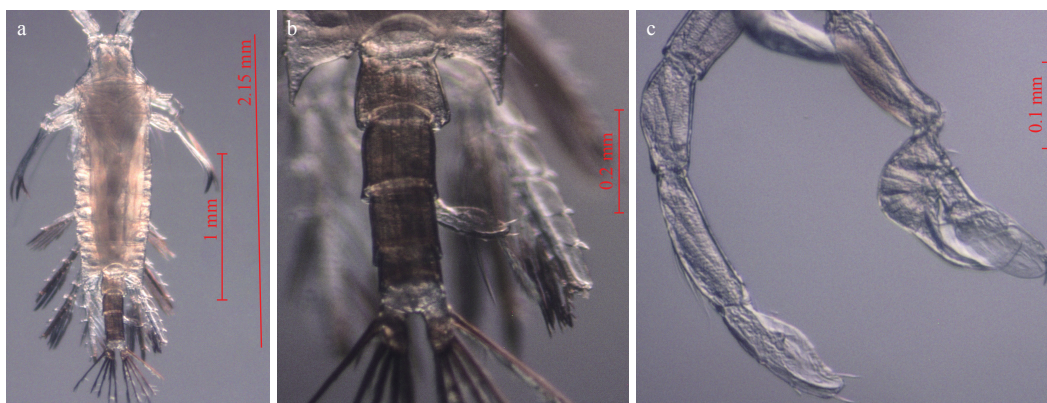
### Diagnosis of female

Prosome cylindraceous and rather narrow; forehead wide and truncate; the posterolateral corners of fifth thoracic segment prominently sharply protuberant and symmetrical, with spines; the terminal of posterolateral corners reached the middle part of genital segment. Urosome 3-segmented; genital segment symmetrically oval-shaped for dorsal view and with a prominently triangular protuberance towards ventral surface for lateral view; the terminal of this protuberance truncate; the second segment approximately square; anal segment rather short; caudal furca longer than wide slightly; caudal setae showed dark brown; ventral surface of urosome segments also showed dark brown in some specimens.

Antennule 24-segmented, reached up to the posterior of anal segment of urosome; basal seven segments of antennule robust. The first to fourth pereopods showed dark brown; endopod of first pereopod 2-segmented. The fifth pereopod uniramous, 3-



**Fig. 1.** *Candacia varicans* Giesbrecht, 1892 (female). a. Dorsal view, b. ventral right lateral view, and c. the fifth pereopoda posterior view.



**Fig. 2.** *Candacia varicans* Giesbrecht, 1892 (male). a. Dorsal view, b. ventral view, and c. the fifth pereopoda posterior view.

segmented, and with slightly asymmetrical third segments; lateral surface of terminal segment with two spines, and inner surface without spine; the terminal of the third segment with two asymmetrical strong spines; these two spines of right pereopod stronger than those of left pereopod.

Body length, 2.30–2.53 mm (two specimens)

#### Diagnosis of male

New record in China seas.

Prosoma also cylindraceous, but narrower than that of female; forehead wide and truncate; the posterolateral corners of the fifth thoracic segment prominently sharply protuberant and symmetrical; the terminal of posterolateral corners over the middle part of genital segment. Urosome 4-segmented; the surface of urosome segments showed dark brown; genital segment trapezoidal and symmetrical; right side of posterior edge of this segment with a small backward protuberance; the second and third segments approximately square; anal segment rather short; caudal furca longer than wide (length/width $\approx$ 1.6); caudal setae showed dark brown.

Antennule reached up to the middle part of urosome. The first to fourth pereopods showed dark brown; endopod of first pereopod 2-segmented. The fifth pereopod asymmetric. In left fifth pereopod, the length of the second segment equaled to that of terminal segment; the length of the third segment 1.5 times longer than that of the second segment, and with a lateral spine; terminal segment approximately oval-shaped, with a lateral spine and two terminal spines; the inner surface of terminal segment obviously swollen. In right fifth pereopod, terminal two segments pincer-shaped; the base of the second segment obviously robust, posterior of this segment bended outward and fan-shaped; the dorsal surface of the third segment with a squama-shaped protuberance; the terminal of this segment with a short and thick spine.

Body length, 2.15 mm (one specimen).

#### Remarks

In China seas, this species is morphologically associated with male individuals of *Candacia curta* (Dana, 1849) and *Candacia armata* (Boeck, 1872). Several key diagnoses were provided here to distinguish them (Table 1).

#### References

- Andronov V N. 1974. Phylogenetic relations of large taxa within the suborder Calanoida (Crustacea, Copepoda). *Zoologicheskii Zhurnal*, 53: 1002–1012
- Boxshall G A, Halsey S H. 2004. *An Introduction to Copepod Diversity*. London: Ray Society
- Bradford-Grieve J M. 1999. The marine fauna of New Zealand: pelagic calanoid copepoda: bathypontiidae, arietellidae, augaptilidae, heterorhabdidae, lucicutiidae, metridinidae, phyllopodidae, centropagidae, pseudodiaptomidae, temoridae, candaciidae, pontellidae, sulcanidae, acartiidae, tortanidae. *NIWA Biodiversity Memoirs*, 111: 5–268
- Giesbrecht W. 1892. Systematik und faunistik der pelagischen Copepoden des Golfes von Neapel und der angrenzenden meeresabschnitte. *Fauna und Flora des Golfes von Neapel*, 19: 1–831
- Grice G D. 1962. Calanoid copepods from equatorial waters of the Pacific Ocean. *Fishery Bulletin of the Fish and Wildlife Service*, 61(186): 171–246
- Grice G D. 1963. A revision of the genus *Candacia* (Copepoda: Calanoida) with an annotated list of species and a key for their identification. *Zoologische Mededelingen Leiden*, 38(10): 171–194
- Harding G. 2004. Key to the adult pelagic calanoid copepods found over the continental shelf of the Canadian Atlantic coast. *Dartmouth: Bedford Institute of Oceanography*, 68
- Kjørboe T. 2006. Sex, sex-ratios, and the dynamics of pelagic copepod populations. *Oecologia*, 148(1): 40–50, doi: [10.1007/s00442-005-0346-3](https://doi.org/10.1007/s00442-005-0346-3)
- Lian Guangshang, Lin Jinmei. 1978. A study of *Calanoida* from South Yellow Sea and East China Sea (in Chinese). *Marine Science and Technology*, 11: 59–112
- Liu Ruiyu. 2008. *Checklist of Marine Biota of China Seas* (in Chinese). Beijing: Science Press
- Owre H B, Foyo M. 1967. *Copepods of the Florida Current*. Miami, Florida: University of Miami
- Razouls C, De Bovée F, Kouwenberg J, et al. 2017. Diversity and geographic distribution of marine planktonic copepods. *France: Observatoire Océanologique de Banyuls sur Mer*
- Rose M. 1933. Copépodes pélagiques. In: *Faune de France*. Paris: Paul Lechevalier, 26: 1–374
- Sars G O. 1903. *An Account of the Crustacea of Norway, with Short Descriptions and Figures of all the Species. Copepoda Calanoida*: Bergen Museum
- Scott T. 1894. I. Report on Entomostraca from the Gulf of Guinea, collected by John Rattray, B.Sc. *Transactions of the Linnean Society of London, 2nd Series, Zoology*, 6(1): 1–161
- Vives F, Shmeleva A A. 2007. Crustacea, copépodos marinos I. Calanoida. In: Ramos M A, ed. *Fauna Iberica*. Vol 29. Madrid, Spain: Museo Nacional de Ciencias Naturales, 1152.
- Von Vaupel Klein J C, Gassmann D. 1998. Character phylogenies in *Candacia* and *Paracandacia* (Copepoda, Calanoida) and the inevitably paraphyletic nature of many nominal taxa above subspecies level. *Journal of Marine Systems*, 15(1–4): 441–449, doi: [10.1016/S0924-7963\(97\)00055-9](https://doi.org/10.1016/S0924-7963(97)00055-9)
- Zhang Wuchang, Zhao Nan, Tao Zhenyue, et al. 2010. *An Illustrated Guide to Marine Planktonic Copepods in China Seas* (in Chinese). Beijing: Science Press
- Zheng Zhong, Li Shaojing, Xu Zhenzu. 1984. *Marine Planktology* (in Chinese). Beijing: China Ocean Press