

*Proc. Japn. Soc. syst. Zool.*, No. 35: 19-26. June 25, 1987.

**Planktonic Calanoid Copepod *Sinocalanus sinensis*  
(Centropagidae) from Estuaries of Ariake-kai,  
Japan, with a Preliminary Note on the  
Mode of Introduction from China**

Juro HIROMI and Hiroshi UEDA

**Synopsis**

HIROMI, J. and UEDA, H. 1987—Planktonic calanoid copepod *Sinocalanus sinensis* (Centropagidae) from estuaries of Ariake-kai, Japan, with a preliminary note on the mode of introduction from China. *Proc. Japn. Soc. syst. Zool., Tokyo*, No. 35: 19-26.

The planktonic calanoid copepod *Sinocalanus sinensis*, hitherto known only from brackish waters of China, is described from estuaries of Ariake-kai, Kyushu. Compared with previous descriptions and figures of this species from China, some minor morphological differences are found in our specimens. Considering the geological history of the Japanese Islands, the population in Ariake-kai may be a continental relict rather than having been recently introduced by ocean currents or ships from China.

*Sinocalanus* is a brackish and fresh water copepod genus endemic in eastern Asia, and five species *doerrii*, *laevidactylus*, *sinensis*, *solstitialis*, *tenellus* are currently recognized; *S. tenellus* is distributed on the coasts of both China and Japan, but the other species are known to be native to China (SHEN and SONG, 1979). Recently, however, TANAKA and MATSUMIYA (1982) encountered *S. sinensis* during their study of the Japanese sea bass *Lateolabrix japonicus* in the mouth of the Chikugo River, Ariake-kai. One of us (H. U.) was sent the copepod specimens by M. TANAKA for identification. More recently, the senior author (J.H.) also found this copepod species in a plankton sample collected in the downstream section of the Ushizu River near the Chikugo River. In this paper, we describe our specimens because there has been no taxonomical description of *S. sinensis* from Japan, and we also discuss its most possible mode of introduction from China to Ariake-kai.

**Descriptive Notes**

***Sinocalanus sinensis* (POPPE, 1889)**  
(Figs. 1, 2)

*Limnocalanus sinensis* POPPE, in GUERNE and RICHARD, 1889, 131-132, pl. 4, figs. 4, 15, 15a, 16; SCHACHT, 1898, 245-249.

*Sinocalanus sinensis*: BURCKHARDT, 1913, 346; SHEN, 1955, 76-78, 95, pl. 1, figs. 1-4; CHEN and ZHANG, 1965, 78-79, pl. 29, figs. 3-8; SHEN and SONG, 1979, 60-61, fig. 21.

*Material examined.* Ten females and 10 males from the Ushizu River, 22 February 1985. Four females and 8 males from the Chikugo River, 18 September 1981 (temperature 22.01°C, salinity 2.9‰) and 10 females and 10 males from the Chikugo River mouth, 14 March 1985 (temperature 9.2°C, salinity 1.58‰). Both rivers discharge into the northern-most part of Ariake-kai (Fig. 3).

*Measurements.* Ushizu River, females 1.79-2.05 mm (av. 1.91 mm), males 1.70-1.96 mm (av. 1.86 mm); Chikugo River, females 1.33-1.50 mm (av. 1.41 mm), males 1.10-1.33 mm (av. 1.22 mm); Chikugo River mouth, females 1.47-1.78 mm (av. 1.62 mm), males, 1.56-1.72 mm (av. 1.63 mm).

This species is easily distinguished from other members of *Sinocalanus* by its pointed medial process on the basipodite of the male leg 5 (SHEN and SONG, 1979). The Ariake-kai specimens are apparently referable to *S. sinensis*. However, compared with previous accounts from China waters, there are some minor differences as shown in Table 1: The anal segment and furcal ramus partly coalesce, although the line which separates the two parts is distinct laterally in both female and male (Fig. 1); the first exopodal segment of the male left leg 5 has a smooth round process at the middle of the inner margin in Ariake-kai specimens (Fig. 2 c-d), while this process is armed with hairy setae

Table 1. Descriptive differences in *Sinocalanus sinensis* between Ariake-kai and Chinese waters. Ansgm=anal segment; FR=furcal segment; P5=leg 5; Re1, 2=exopodite 1,2; St=terminal spine on distalmost exopodal segment of leg. +: yes or present, -; no or absent.

Character	Sex	Ariake-kai		Chinese waters			
		Present study	GUERNE & RICHARD (1889)	SCHACHT (1898)	SHEN (1955)	CHEN & ZHANG (1965)	SHEN & SONG (1979)
Ansgm and FR completely separated	♀	-	+	+?	+?	+	+
	♂	-	?	+?	+?	+	+
Inner protuberance of Re1 of left P5 with spinules	♂	-	?	-	+	?	+
		(smooth)		(smooth)			
St of left P5 ornamented	♂	+	-	-	-	-	-

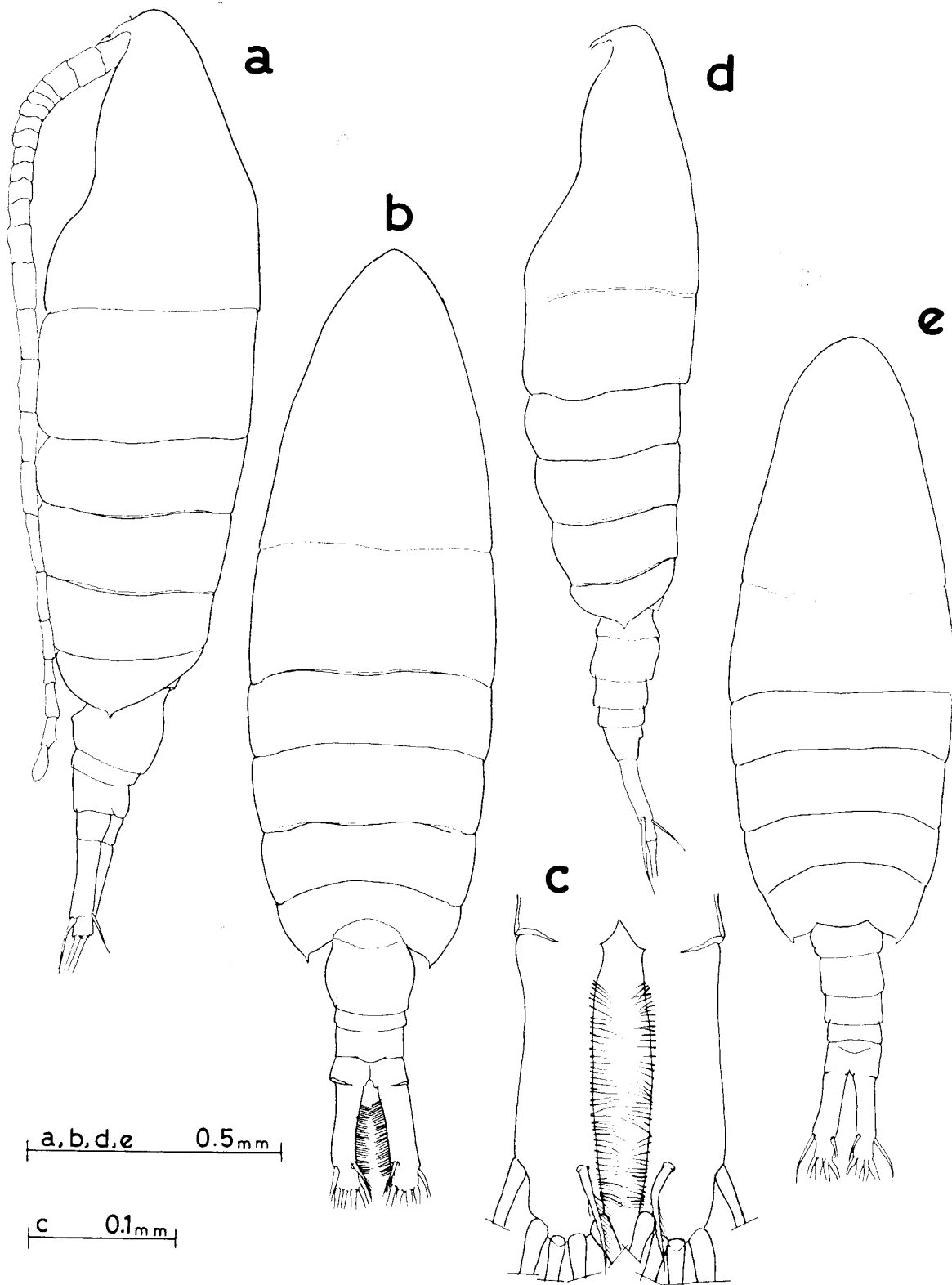


Fig. 1. *Sinocalanus sinensis* (POPPE): a, female, lateral; b, female, dorsal; c, female furcal segments, dorsal; d, male, lateral; e, male, dorsal.

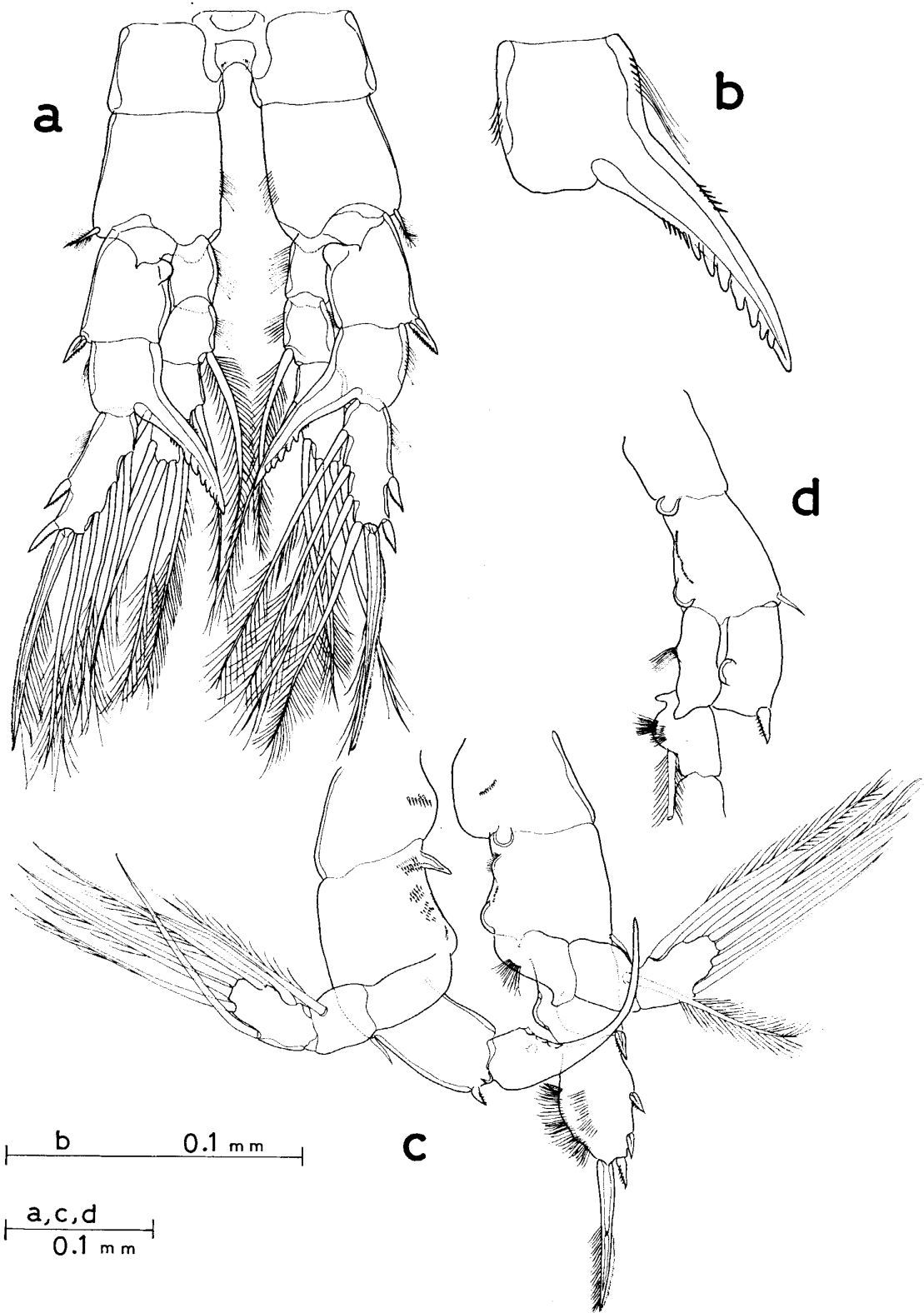


Fig. 2. *Sinocalanus sinensis* (POPPE): a, female leg 5, posterior; b, female, second exopodal segment of leg 5; c, male leg 5, anterior; d, male left leg 5, anterior.

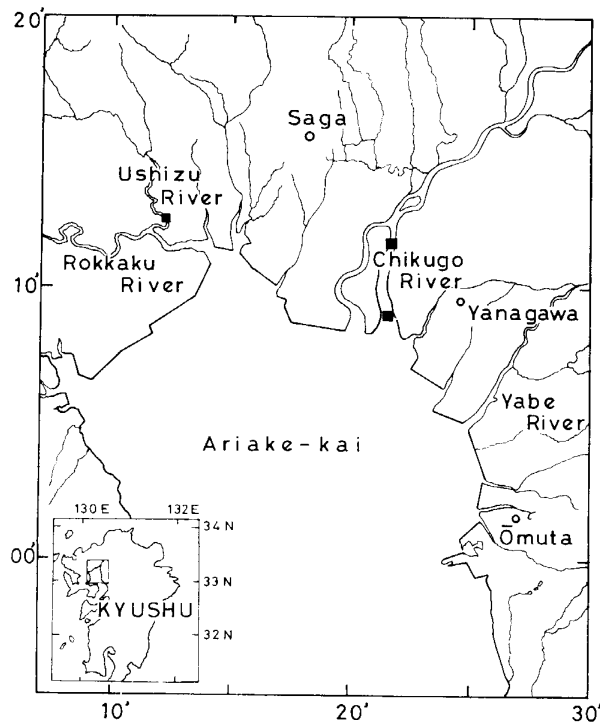


Fig. 3. Locations of plankton collections containing *Sinocalanus sinensis* (■).

in Chinese specimens (SHEN, 1955; SHEN and SONG, 1979), but it is worthy of note that SCHACHT (1898) also noted a smooth rounded process in Chinese specimens which had been sent by S. A. POPPE; the terminal spine of the second exopodal segment of the male left leg 5 is ornamented with a serrate hyaline membrane and fine hairs along the outer and inner margins, respectively (Fig. 2 c). However, it is not certain until the Chinese specimens are directly examined whether such differences are due only to oversight or to geographical variation.

### Discussion

*Sinocalanus sinensis*, first discovered in the Whangpoo River, Shanghai by POPPE (after GUERNE and RICHARD, 1889), is restricted to brackish waters along the coasts of the Yellow Sea and the East China Sea (SHEN and SONG, 1979; CHEN *et al.*, 1980). In Japan, there are several records reporting the occurrence of *Limnocalanus sinensis* (TAKAYASU and KONDO, 1934—cited from MIZUNO, 1984—MIYAUCHI, 1935; KOKUBO and SATO, 1947; TAMURA, 1952), but they have all to be revised as *S. tenellus*, of which the senior synonym is *L. sinensis* var. *tenellus* (MASHIKO, 1954, 1955; ITO, 1957). *S. sinensis* was recorded from a brackish lake of Tanegashima Island, southern Kyushu by SUZUKI and NISHITA (1963),

but it is not certain whether this copepod is conspecific to *S. sinensis* s. str. because they provided neither a description nor a comment on this species that had not previously been recorded from Japan (MIZUNO, 1984). HIROTA (1972) did not record *S. sinensis* in his zooplankton study at the estuary of the Midorikawa River, which discharges into the southern part of Ariake-kai. This fact suggests that this copepod is restricted to the northernmost part of Ariake-kai.

Since its habitat is strictly confined to brackish waters, it is less likely that *Sinocalanus sinensis* has been introduced to Japan by ocean currents. If the Chinese population could disperse naturally to Japanese waters, this species should be found in many other waters of southern Japan. Recently ORSI *et al.* (1983) recorded *S. doerrii* (BREHM), a native of rivers of China, from the Sacramento-San Joaquin Estuary of California and they considered that it had been transported by ships (*e.g.*, ballast water) from China. However, this ships-transport hypothesis seems a less likely explanation for the present finding, because the ports in the northern part of Ariake-kai are not so large. Considering the geological history of the Japanese Islands and the characteristics of the fauna in Ariake-kai, it is most likely that *S. sinensis* in Ariake-kai is a continental relict. Before the Würm glacial period, when Japan was linked to the Continent of China as a result of regression, the Chinese population could have spread out in a northeasterly direction because the East China Sea at that time was mostly covered with brackish water. Later, about 6,000–10,000 years ago, Japan began to be isolated as the sea level rose with the Jômonian transgression and an isolated population would have remained in Ariake-kai. This brackish area is characteristically inhabited by many other organisms such as the mud hoppers *Boleophthalmus pectinirostris*, which are considered to be continental relicts (MIYAZI *et al.*, 1953).

This paper is the first to show the morphology of *S. sinensis* from Japan, but the following interesting problems remain to be elucidated. First, the Ariake-kai specimens need to be compared directly with the Chinese ones; a comparative study based on specimens may show geographic divergence between the Chinese and Japanese populations. We have tried to obtain Chinese specimens, but unfortunately neither information nor specimens have yet been forthcoming. Second, studies are needed to elucidate the ecology of this species, in particular, seasonal occurrences in the two localities appear to differ; this species in Chinese waters occurs abundantly during summer and autumn (CHEN and ZHANG, 1965; CHEN *et al.*, 1980), while in the estuaries of Ariake-kai it is abundant during winter and spring although its seasonal pattern of occurrence

has not received adequate investigation (TANAKA and MATSUMIYA, 1982).

### Acknowledgements

We wish to express our hearty thanks to Dr. M. TANAKA, Faculty of Agriculture, Kyoto University for providing specimens and ecological information from the Chikugo River mouth, Mr. K. KIMOTO of Seikai Regional Fisheries Research Laboratory for specimens from the Chikugo River and Mr. H. HYODO of Chemicals Inspection and Testing Institute, Kurume City, Kyushu for the Ushizu River specimens. Particular thanks are also due to Professor S. KADOTA, Department of Fisheries, Nihon University and Dr. D. D. SWINBANKS, Ocean Research Institute, University of Tokyo for their critical reading of the original manuscript.

### 摘 要

広海十期（日本大学農獣医学部）・上田拓史（琉球大学理学部）——有明海に出現した橈脚類 *Sinocalanus sinensis* の形態と本種の分布由来に関する一考察。

中国の汽水域に固有の橈脚類とされていた *Sinocalanus sinensis* が有明海の河口域から見出された。従来わが国には本種形態の記載例がないので、本論文ではこれを記載し検討した。本種の分布由来については 1) 海流, 2) 人為的輸送(例えば貨物船のバラスト水経由) および 3) 大陸系遺留, などのルートが考えられる。本種の生活史, 耐塩分性や分布の詳細など解明すべき点は残されているが, 本種が典型的な汽水種であることや日本列島の地史的背景などから判断すれば有明海の本種個体群は大陸系遺留(群)と考えられる。

### References

- BURCKHARDT, G. 1913. Wissenschaftliche Ergebnisse einer Reise um die Erde von M. Pernod und C. Schröter. III. Zooplankton aus ost- und süd-asiatischen Binnengewässern. *Zool. Jb. Abt. Syst. Ökol. Geog. Tiere*, 31: 341-472, pls. 9-17.
- CHEN, Q. C., Y. Q. CHEN and Y. Z. HU 1980. Preliminary study on the plankton communities in the Southern Yellow Sea and the East China Sea. *Acta oceanol. sinica*, 2: 149-157. (In Chinese with English abstract.)
- CHEN, Q. C. and S. Z. ZHANG 1965. The planktonic copepods of the Yellow Sea and the East China Sea I. Calanoida. *Stud. mar. sinica*, 7: 20-131.
- GUERNE, J. and J. RICHARD 1889. Révision des Calanoides d'eau douce. *Mem. Soc. Zool. France*, 2: 55-181, 4 pls., 60 figs.
- HIROTA, R. 1972. Plankton fauna and flora of Ariake- and Yatsushiro-kai III. Zooplankton occurring in the vicinity of the mouth part of River Midorikawa. *Calanus*, No. 3, 14-29. (In Japanese.)
- ITO, T. 1957. Chlorine contents and plankton fauna of eel-culture ponds on the west coast of Ise Bay. *Rept. Fac. Fish. Mie Pref. Univ.*, 2: 473-500, pls. 25-31. (In Japanese with English abstract.)

- KOKUBO, S. and S. SATO 1947. Plankters in Jû-san Gata. *Physiol. Ecol.*, 4: 209-224. (In Japanese.)
- MASHIKO, K. 1954. A note on the brackish-water copepods. *Jap. J. Ecol.*, 4: 13-16. (In Japanese with English abstract.)
- 1955. A study of the brackish-water plankton in Japan, with special reference to the relation between the plankton fauna and the salinity of the water. *Sci. Rept. Kanazawa Univ.*, 1: 135-150.
- MIYAZI, D., T. KURODA and T. HABE 1953. On marine biogeographical areas of Japanese coast. *Biol. Sci., Tokyo*, 5: 145-148. (In Japanese.)
- MIYAUCHI, T. 1935. Plankters in Lake Kasumigaura. *Jap. J. Limnol.*, 5: 26-32. (In Japanese.)
- MIZUNO, T. 1984. Fresh water Copepoda of Japan. In C. J. SHEN and T. MIZUNO (eds.), *Fresh Water Copepoda of China and Japan*, pp. 475-499. Tataro Shobô, Tottori. (In Japanese.)
- ORSI, J. J., T. E. BOWMAN, D. C. MARELLI and A. HUTCHINSON 1983. Recent introduction of the planktonic calanoid copepod *Sinocalanus doerrii* (Centropagidae) from mainland China to the Sacramento-San Joaquin Estuary of California. *J. Plankton Res.*, 5: 357-375.
- SCHACHT, F. W. 1898. The North American Centropagidae belonging to the genera *Osphranticum*, *Limnocalanus*, and *Epischura*. *Bull. Illinois State Lab. nat. Hist.*, 5: 235-249.
- SHEN, C. J. 1955. On some marine crustaceans from the coastal waters of Fengsien, Kiangsu Province. *Acta zool. sinica*, 7: 75-100. (In Chinese with English abstract.)
- SHEN, C. J. and D. X. SONG 1979. Calanoida. In C. J. SHEN (ed.), *Fauna Sinica Crustacea, Freshwater Copepoda* (by Research group of Carcinology, Institute of Zoology, Academia Sinica), pp. 55-163. Peking Science Press. (In Chinese.)
- SUZUKI, S. and H. NISHITA 1963. Freshwater organisms of Tanegashima Island, southern Kyushu. *Jap. J. Limnol.*, 24: 16-21. (In Japanese with English abstract.)
- TAMURA, T. 1952. Physical, chemical and plankton observations of the brackish water Lake Jusangata in the winter of 1949. *Jap. J. Limnol.*, 16: 6-14. (In Japanese with English summary.)
- TANAKA, M. and Y. MATSUMIYA 1982. The early life history of the Japanese sea bass—special focussing on the ecological changes through the transforming process into juveniles. *Farming Fish. Technol. Res.*, 11: 49-65. (In Japanese.)

*Author's addresses:* Juro HIROMI, Department of Fisheries, College of Agriculture and Veterinary Medicine, Nihon University, Shimouma 3-34-1, Setagaya-ku, Tokyo 154, Japan;  
Hiroshi UEDA, College of Science, University of the Ryukyus, Nishihara-cho, Okinawa 903-01, Japan.