Zoological Studies **43**(2): 323-331 (2004)

Zoological Studies

Calanoid Copepods of the Kuroshio Current East of Taiwan, with Notes on the Presence of *Calanus jashnovi* Huslemann, 1994

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(Accepted February 9, 2004)

Shih-Hui Hsiao, Chun-Yein Lee, Chang-tai Shih, Jiang-Shiou Hwang(2004) Calanoid copepods of the Kuroshio Current east of Taiwan, with notes on the presence of *Calanus jashnovi* Huslemann, 1994. *Zoological Studies* **43**(2): 323-331. In this work, part of a project on the species composition and distribution of planktonic calanoid copepods in the section of the Kuroshio Current east of Taiwan, we studied samples taken by plankton net towed obliquely from depths of 200 to 0 m and 800 to 0 m. We identified 144 species of calanoids in total, with 111 species in the 200~0-m samples and 96 in the 800~0-m samples. There were 63 species in common in samples from the 2 depths, with 48 species found only in the shallow and 33 species only in the deep samples. Elimination of species known to be widely distributed in the northwestern Pacific Ocean from our species list produced a short list of 24 species. Nine of these species, predominant in the 200~0-m samples, were determined to be related to southerly waters and 12 species, mainly in the 800~0-m samples, were determined to be affiliated with northerly waters. Another 3 species, *Pareucalanus langae*, *Heterorhabdus spinosus*, and *Spinocalanus usitatus*, are new to the northwestern Pacific. *Calanus jashnovi*, an inhabitant of the transitional waters in the northwestern Pacific and frequently appearing in our 800~0-m samples, is considered to be an indicator species of the North Pacific Intermediate Water. http://www.sinica.edu.tw/zool/zoolstud/43.2/323.pdf

Key words: Taiwan Current, Calanoid composition/distribution, Indicator species.

Knowledge of both physicochemical and biological aspects of the oceanography of the section of the Kuroshio Current east of Taiwan (called the Taiwan Current by such authors as Liu et al. 1998 and Yang et al. 1999) is very poor. Despite an international cooperative study on the Kuroshio Current having been conducted in the 1960s (Marr 1970), and a number of very active oceanographic research programs, such as KEEP (Kuroshio-East China Sea Exchange Process), jointly undertaken in the last decade by scientists from several universities and research institutions in Taiwan and abroad (e.g., Liu 1997), biological information, including copepod distribution, of this section of the Kuroshio is practically unknown.

The present work is part of a biological oceanographic project to study copepod composition and distribution in the Taiwan Current, also known as the Kuroshio Current east of Taiwan.

MATERIALS AND METHODS

In 5 cruises on board the *Fishery Researcher I*, we took 2 kinds of plankton samples at 17 fixed stations of 1 north-south and 3 east-west transects in an area roughly bounded by 22~24°N and 121~123°E (Fig. 1). Of the 5 stations of each of the east-west transects, the middle 3 stations were located in the center of the Kuroshio, while the stations at both ends were outside the current. At each station, we took samples from 5 water layers (at depths of 500, 300, 200, 100, and 50 m) using a multilayer plankton sampler (Hydro-Bios multi-

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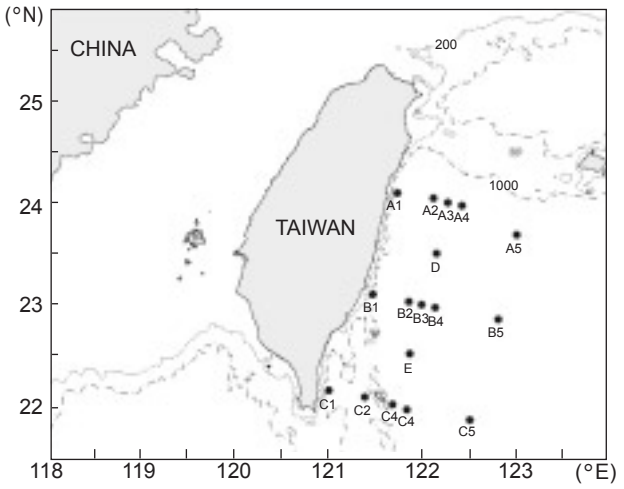

Fig. 1. Sampling stations of the present study.

net) and made an oblique tow with a Norpac net from 800 to 0 m. The mesh size for both nets was 330 μm. In addition we also took an oblique tow with the Norpac net from 200 to 0 m at stations of the north-south transect. The material reported on herein was acquired from plankton samples collected by the Norpac net.

The morphological terminology follows that of Huys and Boxshall (1991).

RESULTS

Species composition

During our examination of the material, we identified 111 calanoid species in the 200~0-m samples and 96 in the 800~0-m samples (Table 1). There are 63 species in common in samples from the 2 depths, while 48 species were found only in the shallow and 33 species only in the deep samples.

Remarks on the morphology of *Calanus jashnovi*

Some specimens in our samples belong to the genus *Calanus*. These specimens, rather large in size for *C. sinicus*, were identified as *Calanus jashnovi*, based on a brief description given by Huslemann (1994). Detailed descriptions of the adult female and female copepodite V are given below.

Adult Female (Figs. 2a, b, 3a-k). Total length 3.72~4.20 mm. Prosome length 2.96~3.32 mm, prosome width/length ratio 0.36~0.40. Cephalosome and pedigerous somite 1 separate; pedigerous somites 4 and 5 separate. Anterior profile of cephalosome rounded. Rostrum with 2 long thin filaments. Both sides of prosome nearly parallel from cephalon to pedigerous somite 3, widest at posterior 1/2 of pedigerous somite 1. Posterior corners of prosome triangular dorsally and laterally, with tip bent slightly outward from dorsal view. Urosome 4-segmented. Genital double-somite symmetrical and slightly convex on both lateral margins, widest slightly anterior to middle of somite. Length of urosomites 2~4 decreasing posteriorly. Caudal rami subequal to combined length of urosomites 3 and 4. All caudal setae broken in our specimens.

Antennule 25 segmented, reaching distal margin of urosomite 3 when stretched. Protopod of antenna (Fig. 3a) 2-segmented, coxa with a single inner seta, basis bearing 2 inner setae; exopod nearly as long as endopod, 10-segmented; segments 1 partially fused to 2 and 3 to 4; each of segments 1~8 with an inner seta; segment 9 elongate, with 1 seta on mid-posterior surface; distal segment small, with 3 apical setae; endopod 2-segmented, proximal segment elongate with 2 inner setae near distal end and some fine setae at outer distal corner; distal segment bilobed, armed with 9 and 7 apical setae on inner and terminal lobes, respectively. Gnathobase of mandible (Fig. 3b) bearing a single dorsal seta and 7 blades, being single-cusped at both dorsal and ventral ends and multicusped in middle blades; a triangular process between the 1st 2 ventral blades; basis with 4 setae; exopod 5-segmented, each of the 4 proximal segments bearing an inner seta; distal segment with 2 apical setae; endopod 2-segmented, proximal segment with a semicircular inner margin, bearing 4 inner setae at distal end, and some fine setae on inner and distal outer margins, distal segment with 11 apical setae and some fine setae on both inner and outer margins. Medial arthrite (1st inner lobe) of praecoxa of maxillule (Fig. 3c) armed with 10 spines on outer margin, 4 setae on posterior surface, and a minute spine on posterior surface near distal margin; coxa bearing a single endite (2nd inner lobe) armed with 4 apical setae and an epipodite (1st outer lobe) possessing 9 setae, the 2 proximal setae much finer; basis bearing 2 endites (3rd and 4th inner lobes) and an exite (2nd outer lobe), both endites armed with 4 apical setae, exite equipped with a single small seta; exopod 1-segmented, bearing 11 setae on outer and distal margins; endopod 3-segmented with 4 outer setae on each of the 2 proximal

Table 1. Calanoid copepod species found in the collections of our study. Species in boldface are either related to southern (S) or northern (N) waters. Species marked with an asterisk are new to the northwestern Pacific

Species	200~0 m	800~0 m
ACARTIIDAE		
Acartia bifilosa (Giesbrecht, 1881)	+	+
Acartia danae Giesbrecht, 1889	+	+
Acartia negligens Dana, 1849	+	+
Acartia omorii Bradford, 1976	+	-
Acartia pacifica Steuer, 1889	+	-
AETIDEIDAE		
Aetideus acutus Farran, 1929	+	-
Aetideus giesbrechti Cleve, 1904	+	+
Chiridius gracilis Farran, 1908	-	+
Chirundina streetsii Giesbrecht, 1892	+	-
Euchirella amoena Giesbrecht, 1888	+	-
Euchirella curticauda Giesbrecht, 1888	+	-
***Euchirella indica* Vervoort, 1949 (S)**	+	+
Euchirella venusta Giesbrecht, 1888	-	+
Gaetanus minor Farran, 1905	-	+
***Undeuchaeta incisa* Esterly, 1911 (N)**	-	+
Undeuchaeta major Giesbrecht, 1888	+	+
Undeuchaeta plumosa (Lubbock, 1856)	+	+
ARIETELLIDAE		
Arietella setosus Giesbrecht, 1892	-	+
Arietella simplex Sars, 1905	-	+
AUGAPTILIDAE		
***Centraugaptilus porcellus* Johnson, 1936 (N)**	-	+
***Euaugaptilus elongatus* (Sars, 1905) (S)**	+	-
***Euaugaptilus filigerus* (Claus, 1863) (N)**	-	+
Euaugaptilus hecticus(Giesbrecht, 1892)	+	-
***Euaugaptilus magnus* (Wolfenden, 1904) (N)**	-	+
Haloptilus acutifrons (Giesbrecht, 1892)	+	-
***Haloptilus austini* Grice, 1959 (S)**	+	-
Haloptilus ornatus (Giesbrecht, 1892)	+	-
Haloptilus oxycephalus (Giesbrecht, 1892)	+	-
***Haloptilus paralongicirrus* Park, 1970 (S)**	+	-
Haloptilus spiniceps(Giesbrecht, 1892)	+	-
***Pachyptilus eurygnatha* Sars, 1925 (N)**	-	+
BATHYPONTIIDAE		
***Temorites brevipes* Sars, 1900 (N)**	-	+
CALANIDAE		
Calanoides carinatus (Kroyer, 1849)	+	+
***Calanus jashnovi* Huslemann, 1994 (N)**	+	+
Canthocalanus pauper (Giesbrecht, 1888)	+	+
Cosmocalanus darwini (Lubbock, 1860)	+	+
Mesocalanus tenuicornis (Dana, 1863)	+	+
Nannocalanus minor (Claus, 1863)	+	+
Neocalanus gracilis (Dana, 1849)	+	+
Neocalanus robustior (Giesbrecht, 1888)	+	+
Undinula vulgaris (Dana, 1849)	+	+
CANDACIIDAE		
Candacia bipinnata (Giesbrecht, 1892)	+	+
Candacia catula (Giesbrecht, 1892)	+	+
Candacia curta (Dana, 1849)	+	-
Candacia discaudata A. Scott, 1909	+	+
Candacia ethiopica (Dana, 1849)	+	+
Candacia longimana(Claus, 1863)	+	-
Candacia pachydactyla (Dana, 1849)	-	+
Paracandacia bispinosa (Claus, 1863)	+	+
Paracandacia simplex (Giesbrecht, 1888)	+	-
Paracandacia truncata (Dana, 1849)	+	+
CENTROPAGIDAE		
Centropages calaninus (Dana, 1849)	+	+
Centropages elongatus Giesbrecht, 1896)	+	+
Centropages furcatus (Dana, 1849)	+	+
Centropages gracilis (Dana, 1849)	+	+
Centropages orsini Giesbrecht, 1889	+	-
CLAUSOCALANIDAE		
Clausocalanus arcuicornis (Dana, 1849)	+	+
Clausocalanus farrani Sewell, 1929	+	+
Clausocalanus furcatus (Brady, 1883)	+	+
Clausocalanus jobei Frost & Fleminger, 1968	-	+
Clausocalanus lividus Frost & Fleminger, 1968	+	-
Clausocalanus mastigophorus (Claus, 1863)	+	+
Clausocalanus minor Sewell, 1929	+	+
Clausocalanus parapergens Frost & Fleminger, 1968	-	+
Clausocalanus pergens Farran, 1926	+	-
EUCALANIDAE		
Eucalanus elongatus (Dana, 1849)	+	-
Eucalanus hyalinus (Claus, 1866)	-	+
Pareucalanus attenuatus (Dana, 1849)	+	+
**Pareucalanus langae* Fleminger, 1973	+	-
Pareucalanus sewelli (Fleminger, 1973)	-	+
Rhincalanus nasutus Giesbrecht, 1888	+	+
Rhincalanus rostrifrons (Dana, 1852)	+	+
Subeucalanus crassus (Giesbrecht, 1888)	+	+

Table 1. (Cont.)

Species	200~0 m	800~0 m
Subeucalanus mucronatus (Giesbrecht, 1888)	+	+
Subeucalanus subcrassus (Giesbrecht, 1888)	+	+
Subeucalanus subtenuis (Giesbrecht, 1888)	+	+
EUCHAETIDAE		
Euchaeta concinna (Dana, 1849)	+	+
Euchaeta indica Wolfenden, 1905	+	-
Euchaeta longicornis Giesbrecht, 1888	+	-
Euchaeta media Giesbrecht, 1888	+	+
Euchaeta rimana Bradford, 1973	+	+
Paraeuchaeta bisinuata Sars, 1907 (N)	-	+
***Paraeuchaeta tuberculata* (A. Scott, 1907)**	-	+
Paraeuchaeta vorax (Grice & Huslemann, 1968)	-	+
HETERORHABDIDAE		
Disseta palumboi Giesbrecht, 1892	-	+
Heterorhabdus abyssalis (Giesbrecht, 1892)	+	+
Heterorhabdus papilliger (Claus, 1863)	+	+
Heterorhabdus spinifrons (Claus, 1863)	+	+
**Heterorhabdus spinosus* Bradford, 1971	-	+
***Heterorhabdus subspinifrons* Tanaka, 1964 (N)**	+	-
Heterorhabdus vipera (Giesbrecht, 1892)	+	-
LUCICUTIIDAE		
***Lucicutia aurita* Cleve, 1904 (N)**	-	+
Lucicutia bicornuta Wolfenden, 1905	-	+
Lucicutia clausi (Giesbrecht, 1889)	+	+
Lucicutia curta Farran, 1905	+	-
Lucicutia flavicornis (Claus, 1863)	+	+
Lucicutia gaussae Grice, 1963	+	-
Lucicutia gemina Farran, 1936	+	-
Lucicutia ovalis (Giesbrecht, 1889)	+	-
MECYNOCERIDAE		
Mecynocera clausi Thompson, 1888	+	-
MEGACALANIDAE		
Bathycalanus richardi Sars, 1905	-	+
Megacalanus princeps Wolfenden, 1904	-	+
METRIDINIDAE		
***Metridia curticauda* Giesbrecht, 1889 (N)**	-	+
Metridia princeps Giesbrecht, 1889	-	+
Pleuromamma abdominalis (Lubbock, 1856)	+	+
Pleuromamma gracilis (Claus, 1863)	+	+
***Pleuromamma robusta* (Dahl, 1893) (S)**	+	+
Pleuromamma xiphias (Giesbrecht, 1889)	+	+
PARACALANIDAE		
Acrocalanus gibber Giesbrecht, 1888	+	+
Acrocalanus gracilis Giesbrecht, 1888	+	+
Acrocalanus longicornis Giesbrecht, 1888	+	-
Acrocalanus monachus Giesbrecht, 1888	+	+
Calocalanus pavo (Dana, 1849)	+	-
Calocalanus plumulosus (Claus, 1863)	+	-
Paracalanus aculeatus Giesbrecht, 1888	+	-
Paracalanus parvus (Claus, 1863)	+	-
***Paracalanus serrulus* Shen & Lee, 1963 (S)**	+	-
PHAENNIDAE		
Phaenna spinifera Claus, 1863	+	-
PHYLLOPODIDAE		
Phyllopus helgae (Farran, 1908)	-	+
PONTELLIDAE		
Calanopia elliptica (Dana, 1849)	+	+
Calanopia minor A. Scott, 1902	+	+
Labidocera acuta (Dana, 1849)	+	+
Labidocera bipinnata Tanaka, 1936	-	+
***Pontella danae* Giesbrecht, 1889 (S)**	+	-
Pontellina morii Fleminger & Huslemann, 1974	+	-
Pontellina plumata (Dana, 1849)	+	+
SCOLECITRICHIDAE		
Scaphocalanus brevicornis Sars, 1900	+	-
Scolecithricella dentata (Giesbrecht, 1892)	+	-
***Scolecithricella longispinosa* Chen & Zhang, 1965 (S)**	+	-
***Scolecithricella minor* (Brady, 1893) (N)**	+	-
Scolecithricella ovata (Farran, 1905)	-	+
Scolecithricella tenuiserrata (Giesbrecht, 1892)	+	+
Scolecithricella vittata (Giesbrecht, 1892)	+	-
Scolecithrix bradyi Giesbrecht, 1888	+	+
Scolecithrix danae (Lubbock, 1856)	+	+
Scottocalanus helenae A. Scott, 1909	-	+
Scottocalanus securifrons (T. Scott, 1893)	+	+
SPINOCALANIDAE		
***Monacilla gracilis* (Wolfenden, 1911) (S)**	+	-
Monacilla typica Sars, 1905	-	+
**Spinocalanus usitatus* Park, 1970	-	+
TEMORIDAE		
Temora discaudata (Giesbrecht, 1889)	+	+
Temora stylifera (Dana, 1849)	+	-
Temora turbinata (Dana, 1849)	+	+
Temoropia mayumbaensis T. Scott, 1894	+	-

segments and 7 apical setae on distal segment. Praecoxa of maxilla (Fig. 3d) bearing 2 endites (1st and 2nd inner lobes) with 6 and 4 apical setae; coxa also bearing 2 endites (3rd and 4th inner lobes), each with 3 apical setae, and an outer seta; basis with a single endite (5th inner lobe) armed with 4 setae; endopod 4-segmented, bearing 3, 2, 2, and 3 setae, respectively. Syncoxa of maxilliped (Fig. 3e) possessing 4 shallow endites with 1, 2, 4, and 4 setae, respectively; basis with 3 setae on inner margin; endopod 6-segmented, segments 1~5 from proximal to distal, each with 2, 4, 4, 3, and 3 setae, respectively, on inner margin, segment 6 with 3 apical setae, segments 5 and 6 each also bearing an outer seta.

All swimming legs (Fig. 3f-j) biramous, symmetrical, and 3-segmented on both exopod and endopod. Setation patterns of these legs are represented by the spine and setal formula (Table 2). Terminal spine of legs 1~5 with smooth outer margin. On swimming leg 5 (Fig. 3k), coxa bearing 20~26 small teeth on curved inner border, length/width proportion of the segment 1.38~1.45.

Copepodite V of female (Fig. 2c, d). Total length 2.88~3.44 mm. Prosome length 2.28~2.72 mm, prosome width/length ratio 0.35~0.40.

Table 2. Spine and setal formula of swimming legs 1~5 of *Calanus jashnovi*

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

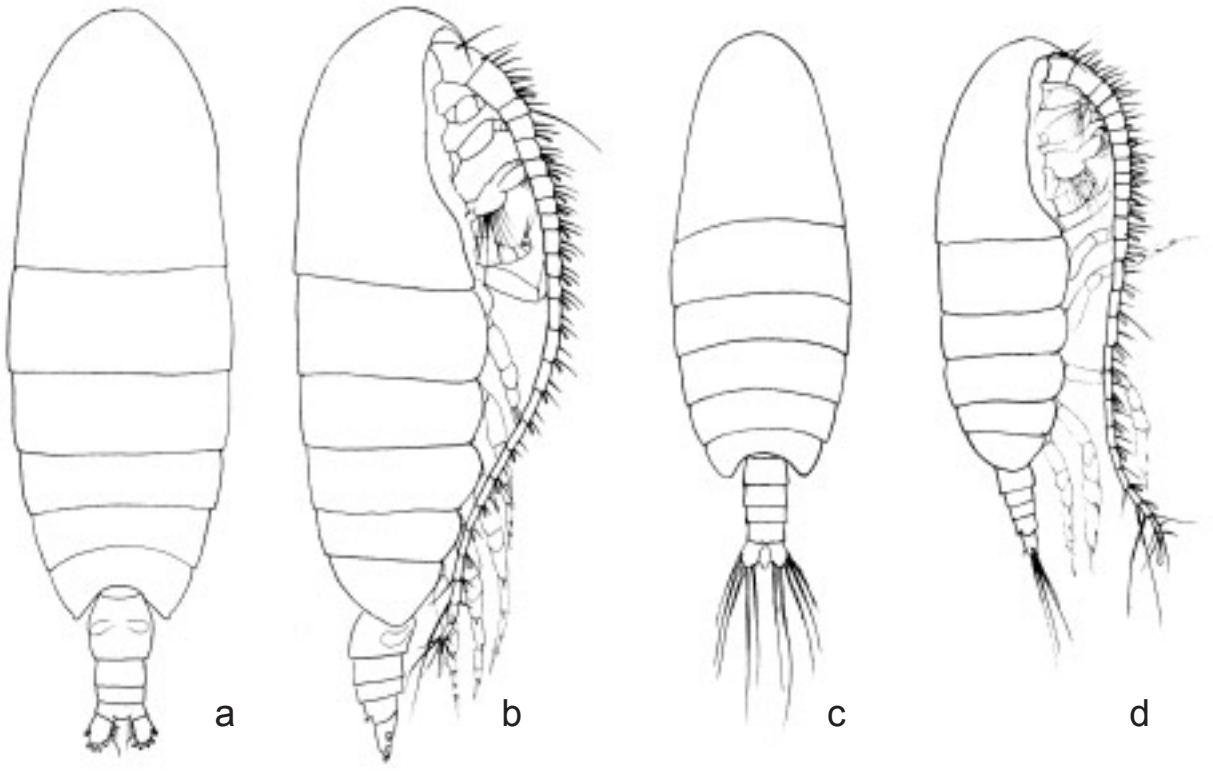

Fig. 2. *Calanus jashnovi* from station A3 on cruise 4. Dorsal (a) and lateral (b) views of adult female, 3.96 mm; dorsal (c) and lateral (d) views of copepodite V, 3.36 mm.

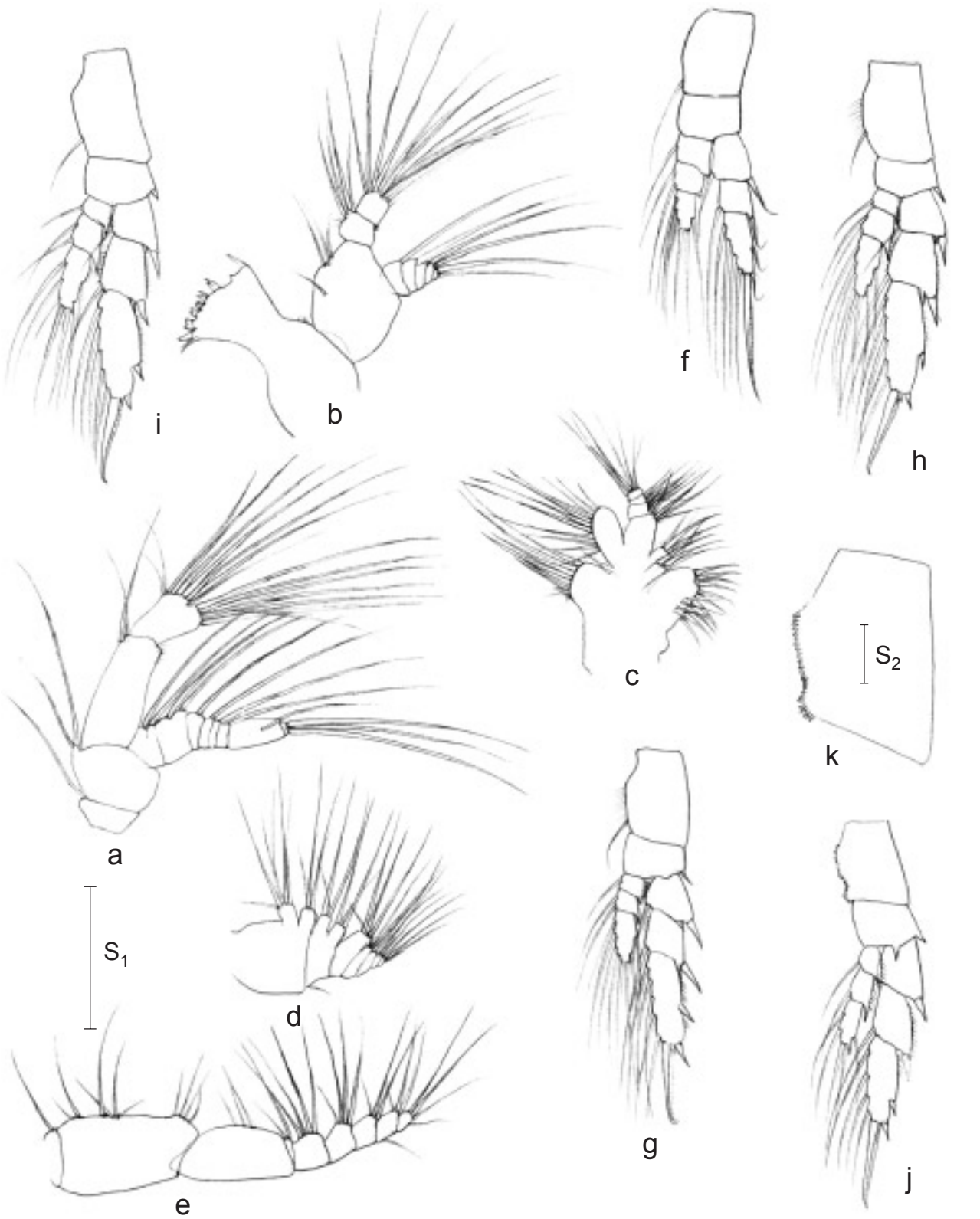

Fig. 3. Right appendages of *Calanus jashnovi* adult female, 3.96 mm, from station A3 on cruise 4. (a) Antenna; (b) mandible; (c) maxillule; (d) maxilla; (e) maxilliped; (f~j) swimming legs 1~5; (k) enlargement of coxa of swimming leg 5. (a, c, and f~j: posterior view; b, d, and e: anterior view) Scales: S_1 = 0.5 mm in a~j; S_2 = 0.1 mm in k.

General appearance similar to that of adult female except in some areas. For instance, cephalosome narrowing anteriorly, posterior corners of prosome more rounded, and antennules reaching almost caudal rami. Cephalic appendages and maxillipeds similar to those of adult female in segmentation and setation with a few exceptions of setal numbers. Antennary endopod bearing 8 apical setae on inner lobe. Endopod of mandible with 10 apical setae on its distal segment. On maxillule, a basal exite not seen; exopod with 10 marginal setae only. Maxillary endopod segment 3 bearing a single seta. On maxilliped, numbers of inner setae on endopod segments 2~5 are 3, 3, 2, and 2, respectively. Swimming legs 1~4 with identical segmentation and setation as in adult female. Swimming leg 5 not fully developed, with 2-segmented exopod and endopod. Spine and setal formula for distal segment of exopod III,I,5 and for endopod 2,2,3. Swimming leg 5 coxa bearing 16~24 small teeth on the curved inner border, length/width proportion of segment 1.29~1.37.

DISCUSSION

Based on the distributional information extracted from several faunistic studies on marine calanoids of the northwestern Pacific from the equator to 50°N (Scott 1909, Vervoort 1946, Tanaka 1956-1965, Grice 1962, Brodskii 1967, Frost and Fleminger 1968, Park 1968 1993 1995, Shih and Young 1995, Chihara and Murano 1997, Shih and Chiu 1998), 120 of the total 144 species identified are known to be widely distributed in the waters covered by those reports. Three species (marked with an asterisk in Table 1), namely *Pareucalanus langae*, *Heterorhabdus spinosus*, and *Spinocalanus usitatus*, are new to the area. *Pareucalanus langae* is a resident of the circumglobal Transition Zone in the Southern Hemisphere (Fleminger 1973). *Heterorhabdus spinosus* was reported from New Zealand waters (Bradford 1971), and *Spinocalanus usitatus* is known from the Caribbean Sea and Gulf of Mexico (Park 1970). The other 21 species (in boldface in Table 1) are either related to waters from the south or north. Nine of these species (hereafter called the southern species) have been recorded from waters south of Taiwan but are not known from north of Taiwan. They are *Euchirella indica*, *Euaugaptilus elongatus*, *Haloptilus austini*, *H. paralongicirrus*, *Pleuromamma robusta*, *Paracalanus serrulus*, *Pontella danae*, *Scolecithricella longispinosa*, and *Monacilla gracilis*. Twelve species (hereafter called the northern species),

Table 3. Capture records of adult female (F) and copepodite V (CV) of *Calanus jashnovi* in the present collection of 0~800-m samples

Station	Latitude (N)	Longitude (E)	Cruise 1		Cruise 2		Cruise 3		Cruise 4		Cruise 5	
			y/m/d	Specimens	y/m/d	Specimens	y/m/d	Specimens	y/m/d	Specimens	Y/m/d	Specimens
A1	24°02.7'	121°44.0'	00/05/17	-	00/09/07	3 CV	00/12/15	-	01/07/25	-	02/01/09	-
A2	23°59.7'	122°07.2'	00/05/17	-	00/09/07	2 CV	00/12/16	-	01/07/25	-	02/01/09	-
A3	23°57.0'	122°16.0'	00/05/17	-	00/09/07	-	00/12/16*	5F, 116 CV	01/07/25	1F, 2CV	02/01/09	-
A4	23°55.0'	122°25.1'	00/05/17	-	00/09/06	-	00/12/16	-	01/07/25	-	02/01/09	7 CV
A5	23°38.0'	123°00.5'	00/05/16	-	00/09/06	-	00/12/16	-	01/07/24	3 CV	02/01/08	2 F, 55 CV
B1	23°03.0'	121°28.3'	00/05/18	-	00/09/04	-	00/12/17	-	01/07/24	-	02/01/08	-
B2	22°58.5'	121°51.5'	00/05/18	-	00/09/04	-	00/12/17	-	01/07/23	2 CV	02/01/07	-
B3	22°57.3'	121°59.2'	00/05/19	-	00/09/05	8 CV	00/12/18	-	01/07/23	-	02/01/07	-
B4	22°55.3'	122°08.2'	00/05/19	-	00/09/05	-	00/12/18	-	01/07/23	1 CV	02/01/07	3 CV
B5	22°48.0'	122°48.5'	00/05/19	12 CV	00/09/05	-	00/12/18	-	01/07/23	16 CV	02/01/07	1 CV
C1	22°06.3'	121°00.2'	00/05/21	-	00/09/03	-	00/12/20	-	01/07/22	-	02/01/06	-
C2	22°02.5'	121°23.0'	00/05/20	-	00/09/03	-	00/12/20	1 CV	01/07/22	-	02/01/06	1 CV
C3	21°58.0'	121°41.0'			00/09/03	-	00/12/20	-	01/07/21	2 CV	02/01/05	-
C4	21°55.0'	121°50.0'			00/09/02	3 CV	00/12/19	2F, 28CV	01/07/21	2 CV	02/01/05	-
C5	21°49.0'	122°30.0'			00/09/02	-	00/12/19	-	01/07/20	-	02/01/04	-
D	23°26.9'	122°08.8'	00/05/18	-	00/09/06	-	00/12/17	-	01/07/24	4 CV	02/01/08	-
E	22°28.1'	121°51.9'	00/05/20	-	00/09/04	1 CV	00/12/19	-	01/07/22	1 CV	02/01/06	-

*A single specimen of CV was found in the 200~0-m sample at this station.

Undeuchaeta incisa, *Centraugaptilus porcellus*, *Euaugaptilus filigerus*, *E. magnus*, *Pachyptilus eurygnatha*, *Temorites brevipes*, *Calanus jashnovi*, *Paraeuchaeta bisinuata*, *Heterorhabdus subspinifrons*, *Lucicutia aurita*, *Metridia curticauda*, and *Scolecithricella minor*, are known from Japanese waters or further north but have no records south of Taiwan. It is interesting to note that among the southern species, 7 were found in 200~0-m samples, 2 in both the 200~0- and 800~0-m samples, and only 1 in 800~0-m samples. Of the 12 northern species, on the other hand, 9 were noted in 800~0-m samples, 1 in both the 800~0- and 200~0-m samples, and 2 in 200~0-m samples. It is apparent that the southern copepod species dominant in the upper 200 m are mostly related to the Kuroshio Current from the south, while the northern copepod species dominant in deeper waters may be strongly influenced by deep water from the north.

Of the northern species, *Calanus jashnovi* merits special mention. According to Huslemann (1994), *C. jashnovi* was wrongly assigned to a number of other species, particularly to *C. sinicus* and *C. pacificus*. After reviewing all literature records, as well as based on her personal examination of a number of specimens from various localities in the northwestern Pacific, Huslemann concluded that *C. jashnovi* occurs nearly year round (Feb., July, and Sept. to Nov.) in the northwestern Pacific between 30°N and 42°30'N, and 138°E and 155°W. This coincides with the area where the North Pacific Intermediate Water (NPIW) originates (Tally 1993). In Sagami Bay, Japan, Kidachi and Yamamoto (1980) recorded (as large-sized *C. sinicus*) only 1 generation (in spring) per year. Toda and Hirose (1991) also found the egg structure of this large-sized "*C. sinicus*" differed from that of smaller-sized *C. sinicus*.

We found adult females and copepodite V of *Calanus jashnovi* in the 800~0-m oblique tow samples from all cruises and adult females in collections in Jan., July, and Dec. (Table 3). A single CV specimen was noted in a 200~0-m sample. Both adult females and copepodite V were most numerous in winter (Dec. and Jan.) but seemed to occur more widely in July. *Calanus jashnovi* strongly resembles *C. sinicus*, but may be separated by size (adult female total length 3.72~4.20 mm, copepodite V 2.88~3.44 mm vs. adult female 2.22~3.04 mm, copepodite V 1.48~2.12 mm), length of antennule (shorter than body length vs. 2 segments exceeding body length), and the length/width proportion of the coxa of swimming leg 5 (1.38~1.45 vs. 1.60~1.75).

We attribute the presence of *Calanus jashnovi* in our collection to the NPIW. Part of the population of this species was brought to the NPIW from upper water where the NPIW originates. Through the equator-ward movement of the NPIW (McCreary and Lu 2001) this species is transported to the south. According to those authors, the NPIW in the area east of Taiwan where our samples were taken rises to 300~600 m and was thus within our collecting depth. The predominance of copepodite V in our collection is probably an indication that *C. jashnovi* may be entering dormancy to avoid adverse conditions in this section of the NPIW, far away from its origin.

Calanus jashnovi as well as the 9 northern species mentioned above may be indicator species of the NPIW. The presence of adult females almost year round in our samples does not conform to the suggestion by Kidachi and Yamamoto (1980) that *C. jashnovi* produces only 1 generation per year.

Acknowledgments: This study was partially supported by a research grant (NSC89-2313-B-056A-006) from the National Science Council of the R.O.C. to CtS. We thank the captain and crew of the *Fishery Researcher I* who helped us collect samples and other environmental data related to this study. We are very grateful to Dr. I-Chiu Liao, Director General of the Taiwan Fisheries Research Institute, for providing laboratory facilities and other logistic support to CtS.

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