

## The Freshwater Calanoida (Crustacea: Copepoda) of Korea

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### 韓國 淡水産 칼라누스 目(甲殼類: 橈脚類)의 分類學的 研究

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#### 적 요

한국 담수산 요각류 중 칼라누스 목에 속하는 것들의 종류상을 밝히기 위하여 1983년 5월부터 1984년 10월까지 20개 지점의 강, 호수, 연못, 웅덩이, 논 등의 다양한 담수역에서 채집한 표본들과, 이어 앞서 1979년 5월부터 1983년 7월까지 6개 지점에서 채집되어 강릉대학 생물학과에 보관중이던 표본들의 형태적 형질들을 비교 관찰하여 모두 3과 8종을 동정하였다. 이 중 *Sinocalanus sinensis*, *Tropodiptomus oryzanus*, *Sinodiptomus sarsi*, *Neodiptomus schmackeri* 등 4종은 한국 미기록종인 바 이들에 대하여 기재 하였고 아울러 8종에 대한 도판을 작성하였다.

Key Words: Freshwater Calanoida, Copepoda, Korea.

#### INTRODUCTION

The freshwater Calanoida of Korea are poorly known and, until now, only 7 species [*Sinocalanus tenellus* (Kikuchi); *Pseudodiptomus inopius* Burckhardt; *Neurodiptomus okadai* (Horsawa); *Heliodiptomus kikuchii* Kiefer; *Acanthodiptomus pacificus* Burckhardt; *Eodiptomus japonicus* (Burckhardt); *Sinodiptomus valkanovi* Kiefer] are reported in process of researches on the limnological conditions (Yamamoto, 1941; Sato, 1941; Uéno, 1941; Yamamoto, 1944; Cho, 1965; Cho, 1968; Kang and Shin, 1968; Kim, 1968; Kang, 1969; Kim and Park, 1969; Cho and Ra, 1971; Cho, 1976; Cho and Mizuno, 1977; Cho *et al.*, 1978; Kim and Lee, 1978; Mizuno *et al.*, 1980). But nearly all of those limnological studies excluding Kim and Park (1969) have been accomplished not from taxonomical purposes with full description of plates, and limited mainly to the Han River. For those reasons, the aim of this paper is to clarify the calanoid fauna of Korea based on extensive collections from various freshwater habitats such as rivers, lakes, ponds, bogs, ricefields, etc.

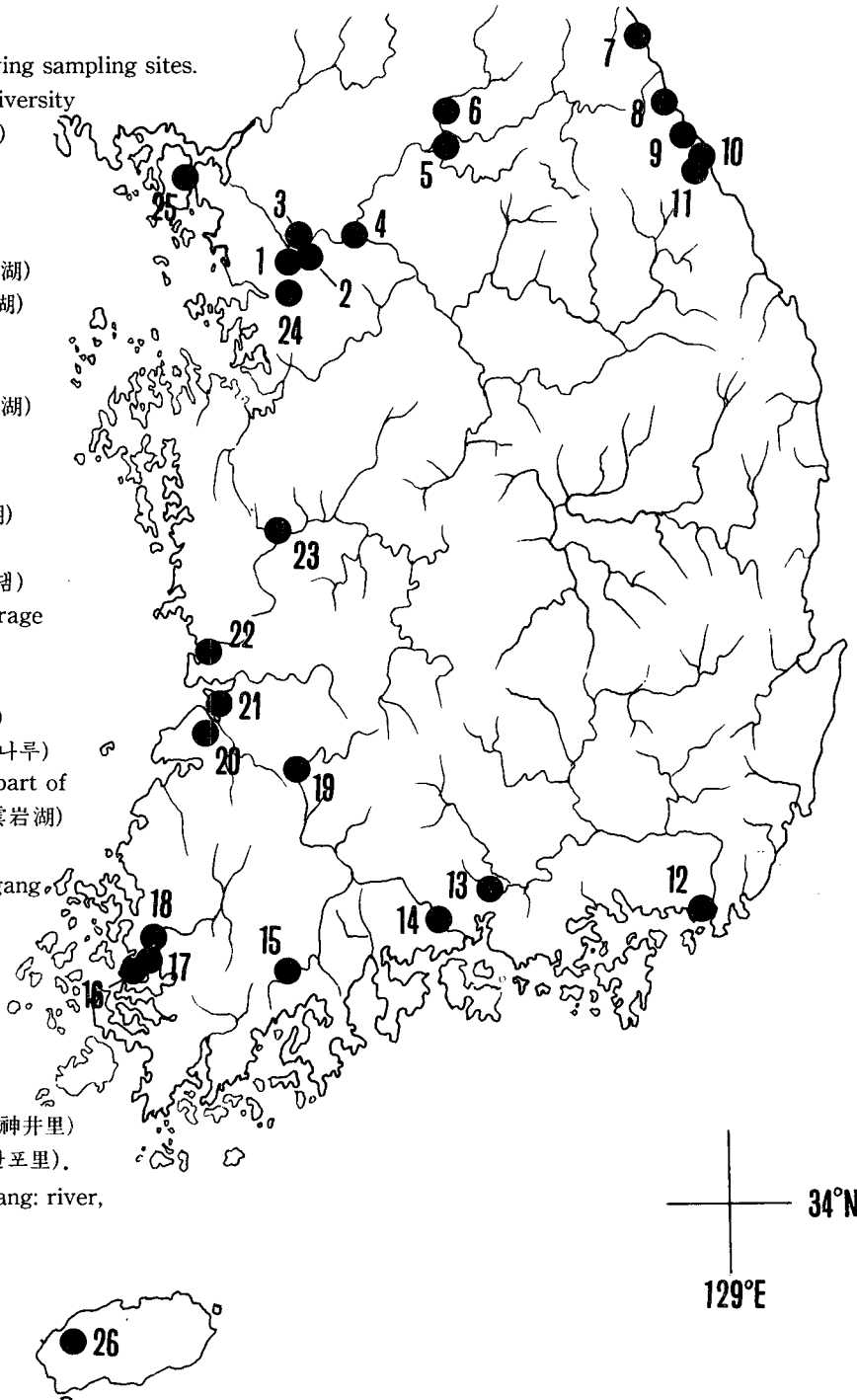
## MATERIALS AND METHODS

Materials consist of both specimens collected from 20 localities during the period from May, 1984 to October, 1985 and other specimens collected during the period from May, 1979 to July, 1983 and deposited at Kangreung National University (Fig. 1).

Fig. 1. The map showing sampling sites.

1. Seoul national University
2. Sökch'onho(石村湖)
3. Kwangnalu
4. Yangsu-ri(兩水里)
5. Uiamho(衣岩湖)
6. Ch'unch'önho(春川湖)
7. Yöngnangho(永郎湖)
8. Hajodae(하조대)
9. Sach'ön(沙川)
10. Kyöngp'oho(鏡浦湖)
11. Kaugnūng(江陵)
12. Noksan(낙산)
13. Chinyangho(晋陽湖)
14. Hadong(河東)
15. Posöng Dam(寶城댐)
16. Yöngsan-gang Barrage(榮山江 河口堰)
17. Pognyong Res.  
(務安郡 북룡저수지)
18. Mongt'annalu(夢灘나루)
19. Sannaе(the lower part of Unamho)(山內, 雲岩湖)
20. Puan(扶安)
21. Mouth of Tongjin-gang(東津江 河口)
22. Kūmgang Barrage(綿江 河口堰)
23. Puyō(扶餘)
24. Kwanggyo Res.  
(水原광교저수지)
25. Shinjöng-ri(江華島 神井里)
26. P'anp'o-ri(翰京面 판포里).

\*ho: lake, nalu: ferry, gang: river,  
Res.: reservoir.



Collections were made from various freshwater habitats in Korea with a dipnet or a conical plankton net of No. 10 (or No. 25) mesh aperture. All samples were preserved in 95 % alcohol. The isolated specimens were dissected and later mounted in polyvinyl lactophenol and stained with methyl blue if necessary. Drawings and measurements were made with a camera lucida. All specimens reported here are deposited in the Department of Zoology, Seoul National University.

## SYSTEMATICS

Order Calanoida Sars, 1903

Family Centropagidae Sars, 1903

Genus *Sinocalanus* Burckhardt, 1913

### 1. *Sinocalanus sinensis* (Poppe, 1889) (Pl. I, figs. 1-3)

*Limnocalanus sinensis* Poppe, 1889, [cited from Burckhardt, 1913, (p. 346)].

*Sinocalanus sinensis*: Burckhardt, 1913, (pp. 346-347); Shen, 1979, [transl. by Mizuno, 1984, (pp. 73-74, fig. 21)].

**Material:** Tongjin-gang, 5 ♂, 4 ♀, 27 V 1979, (I.H. Kim); Küm-gang, 4 ♂, 3 ♀, 9 X 1984, (B.L. Choi); Kanghaiwado Shinjõng-ri, 7 ♂, 9 ♀, 9 X 1984, (C.Y. Chang).

**Measurement:** body length of female 1.07-1.23 mm, of male 0.70-1.01 mm.

**Females:** Body very slender and anterior part of cephalothorax somewhat protruded. Ends of 5th thoracic segment symmetrical and with a small spine. Antennules reaching nearly to end of 3rd abdominal segment. Genital segment slightly swollen laterally, and its length subequal to its width. Caudal rami comparatively long, proportions of length to width about 5:1. Leg 5 symmetrical and natatory; both endopod and exopod 3-segmented. Exopod 2 produced into a prominent protrusion at the median distal corner, armed with 9 tooth-like marginal processes or more; exopod 3 with 2 spinules and 5 setae. Both endopods 1 and 2 ciliated on inner margin, and endopod 3 with 6 setae.

**Males:** Antennules reaching beyond the middle of caudal ramus. Caudal rami about 4 times as long as wide. Endopod of leg 5 natatory; endopod 3 with 6 setae. Exopod 1 with a stout spinule near distal margin. Basipod 2 with a sharp process on its proximal inner edge. Right exopod 2 forming a long, claw-like process. The inner margin of left endopod 1 and endopod 2 swollen, especially with a few spinules on the latter.

Collected at the mouth of rivers.

**Remarks:** newly known from Korea.

**Distribution:** Korea (estuaries of the west coast), China.

### 2. *Sinocalanus tenellus* (Kikuchi, 1928) (Pl. I, figs. 4-5)

*Limnocalanus sinensis* var. *tenellus* Kikuchi, 1928, (pp. 67-68, pl. 18, figs. 1-8).

*Sinocalanus tenellus*: Uéno, 1935, (p. 89); Shen, 1979, [transl. by Mizuno, 1984, (pp. 74-75, fig. 22)]; Lai & Fernando, 1981, (pp. 161-163, figs. 1-2).

**Material:** Yōngrangho, 1♂, 1♀(young), 22 VIII 1984, (C.Y. Chang); Kyōngp'oho, 7♂, 3♀, 17 VII 1983, (I.H. Kim); Noksan (mouth of Naktonggang), 4♂, 3♀, 23 IV 1984, (C.Y. Chang); Myōngji Res., 1♂, 25 IV 1984, (C.Y. Chang).

**Measurement:** body length of females 1.34-1.41 mm, of males 1.15-1.30 mm.

**Remarks:** This species is conspicuously different from *S. sinensis* in having bilobed process on the inner proximal edge of basipod 2 of male's leg 5 and extremely long caudal rami (more than 8 times as long as wide).

This species was first recorded by Kikuchi (1928) under the name of *Limnocalanus sinensis* var. *tenellus*, and then referred to *Limnocalanus sinensis* by many investigators in Japan, to be amended thereafter (Mizuno & Miura, 1984:476-477). In Korea, Sato (1941) recorded "*Limnocalanus sinensis*" in his collection list from a brackish-water lake (Kangdongho) at northern Kangwōn-do. To the authors' mind, it must be the same case with that of Japan as mentioned above. On the other hand, Cho(1976) reported "*S. tenellus*" from Namyangho. According to our studies, till now, it appears that *S. sinensis* and *S. tenellus* have distinctly different distribution ranges, that is, *S. sinensis*—river mouths of western coast; *S. tenellus*—brackish-water lakes and river mouths adjoining to eastern coast or southeastern coast.

**Distribution:** Korea (brackish-water lakes and river mouths adjoining to eastern or southeastern coast), China, Japan, Sakhalin.

Family Pseudodiaptomidae Sars, 1903

Genus *Pseudodiaptomus* Burckhardt, 1913

3. *Pseudodiaptomus inopius* Burckhardt, 1913 (Pl. I, figs. 6-9)

*Pseudodiaptomus inopius* Burckhardt, 1913, (pp. 379-394, pl. 11E, figs. 2-5, 7, 8, pl. 11F, figs. 1-4, 9, 10, pl. 11G, figs. 1-4, 6-8, pl. 11H, figs. 1-4, 7, 8, 10, 11); Brehm, 1925, (p. 269); Kikuchi, 1936, (p. 280).

*Schmackeria inopius*: Shen, 1979, [transl. by Mizuno, 1984, (pp. 27-28)].

**Material:** Songnim (Hadong-kun, near the mouth of Sōmjīn-gang), 7♂, 5♀, 3 VII 1984, (K.S. Min); Tongjin-gang, 5♂, 9♀, 27 V 1979, (I.H. Kim); Kūmgang, 2♂, 2♀, 16 IX 1984, (B.L. Choi).

**Measurement:** body length of female 1.16-1.25 mm, of male 0.96-1.10 mm.

**Remarks:** Two forms found concurrently (finger-like form and shoe-like form according to the shape of male's leg 5). The samples obtained from Songnim (near the mouth of Sōmjīn-gang) lived close to sand bottom.

**Distribution:** Korea (mouth of Han-gang, Kūmgang, Tonjin-gang, Sōmjīn-gang), China, Japan, U.S.S.R.

Family Diaptomidae Sars, 1903

Genus *Tropodiaptomus* Kiefer, 1932

4. *Tropodiaptomus oryzanus* Kiefer, 1937 (Pl. II, figs. 6-8)

*Tropodiaptomus oryzanus* Kiefer, 1937 (pp. 63-64, figs. 12-16); 1938, (pp. 37-41, Abb. 1-5); Uéno,

1938, (pp. 162-163); Shen, 1979, [transl. by Mizuno, 1984, (pp. 103-104, fig. 39)].

**Material:** Yöngsan-gang (in the vicinity of tide embankment), 4 ♂, 4 VII 1984, (C.S. Lee).

**Measurement:** body length of males 1.30 mm more or less.

**Description:** Thoracic segments IV and V of male not fused. Genital segment a little asymmetrical with the right side slightly swollen. Right antennule with tooth-like processes of segments 10 and 11, and the long spines of segments 13 and 15; Segments 12 and 14 without spinous process. Antepenultimate segment with a long, distally placed process like an index finger; its tip pointed the exterior, not reaching beyond the end of the next segment.

Right basipod 2 of the 5th thoracic leg bearing a short and stout spine on the proximal inner half of the anterior face; the outer distal edge sharply protruded; the lateral spine comparatively long (1.5 times as long as the exopod 2); endopod short and slightly beyond the exopod 1. Left exopod not divided and peculiar; its inner margin with serrated hyaline plate densely arranging sensory hairs on the inner portion of the segment; endopod with one segment and reaching near to the middle of exopod 2.

This species is known to live in lakes, ponds or ricefields as well as rivers.

**Remarks:** Only a few males collected from the mouth of Yöngsan-gang. Newly known from Korea.

**Distribution:** Korea, China, Tiwan, Japan.

#### Genus *Heliodiaptomus* Kiefer, 1932

##### 5. *Heliodiaptomus kikuchii* Kiefer, 1932 (Pl. II, figs. 1-5)

*Diaptomus viduus* (non Gurney, 1916): Kikuchi, 1928, (p. 72, pl. 20, figs. 29-32, pl. 21, fig. 34).

*Heliodiaptomus kikuchii* Kiefer, 1932, (pp. 473-474, fig. 83) (cited from Shen, 1979); Kikuchi, 1936, (p. 279); Shen, 1979, [transl. by Mizuno, 1984, (pp. 132-134, fig. 56)].

**Material:** Sökch'onho, 2 ♂, 4 ♀, 31 V 1984, (C.Y. Chang); Ttuksöm Resort, 2 ♂, 1 ♀, 28 IV 1981, (H.S. Kim); Uiamho, 1 ♂, 1 ♀, 19 X 1984, (C. Y. Chang); Yangsu-ri, 3 ♂, 2 ♀, 12 VII 1984, (C.Y. Chang); Ch'unch'önho, 1 ♂, 3 ♀, 25 VII 1984, (C.Y. Chang); Posöng Dam, 8 ♂, 6 ♀, 14 VIII 1984, (C.S. Lee); Puyö, 1 ♂, 11 X 1984, (C.Y. Chang); Chinyangho, 3 ♂, 2 ♀, 4 VII 1984, (K.S. Min); Mongt'annalu, 4 ♂, 3 ♀, 3 VII 1984, (C.S. Lee); Pognyong Res., 2 ♂, 1 ♀, 4 VII 1984, (C.S. Lee).

**Measurement:** body length of female 1.30-1.51 mm, of male 1.13-1.29 mm.

**Remarks:** This species is the most common of calanoids in Korea and widely distributed throughout the country. It appears that the northern limit of this species is the Amnokkang (the Yalu River) in the light of a record from Supung Dam (North Korea) by Shen (1979), whilst there has not been yet reported from China.

**Distribution:** Korea, Japan.

#### Genus *Sinodiaptomus* Kiefer, 1932

##### 6. *Sinodiaptomus sarsi* (Rylov, 1923) (Pl. III, figs. 6-8, Pl. IV, figs. 1-2)

*Diaptomus chaffanjonii* (non Richard, 1897) Sars, 1903, (pp. 17-19, pl. 2, figs. 1a-1g); Kikuchi,

1928, (p. 71, pl. 19, figs. 21-22, pl. 20, figs. 23-28).

*Diaptomus chaffanjonii* var. *sarsi* Rylov, 1923, (pp. 71-73) (cited from Shen, 1979).

*Diaptomus sarsi*: Smirnov, 1932, (pp. 288-290).

*Sinodiaptomus sarsi*: Kikuchi, 1936, (p. 278); Kikuchi, 1940, (pp. 291-292, figs. 4, a-e); Shen, 1979, [transl. by Mizuno, 1984, (pp. 139-141, fig. 61)].

**Material:** Chahayŏn (a pond in Seoul National University), 4 ♂, 2 ♀, 10 VIII 1984; 5 ♂, 2 ♀, 6 VI 1984, (C.Y. Chang); Mongt'annalu, 1 ♂, 1 ♀, 3 VII 1984, (I.H. Kim); Puan Haengan Taech'o, 9 ♂, 15 ♀, 13 VIII 1981, (I.H. Kim).

**Measurement:** body length of female 1.71-1.95 mm, of male 1.50-1.75 mm.

**Females:** Body robust. The thoracic segment IV with triangular (conical) protuberance on the back, though very variable in size and form. Antennules with 25 segments exceeding the tip of terminal seta; genital segment somewhat large and a little asymmetrical; the first half of it swollen and armed with an apical spinule on each side. Endopod of leg 5 with 2 segments slightly not reaching to the middle of exopod 1; the claw of exopod serrated inside only; the third segment bearing 3 spines of which the middle is the longest.

**Males:** Antepenultimate segment of right antennule bearing a hyaline lamella with distal serration: no process on segment 16. Right basipod 2 of leg 5 with a triangular (or wave-formed) projection on the hind face, not surpassing the exopod 1. Lateral spine of exopod 2 very short, about 1/3 times as long as the width of the segment. Endopod very small, not reaching (or nearly reaching) to the distal end of inner margin of exopod 1; that of left leg as long as the first segment of exopod.

Occurring all the year round, generally in small ponds or fishponds abundant in aquatic vegetations.

**Remarks:** Newly reported from Korea. All the female individuals examined did not have denticles on the outer margin of claw of leg 5. This species differs from *S. chaffanjonii* and *S. valkanovi* in bearing short lateral spine (1/3 times as long as the width of exopod 2) and a triangular projection in right basipod 2 of male's leg 5 not compassing the distal end of exopod 1. Up to the present, it is believed that *S. chaffanjonii* and *S. sarsi* distributed in Manchuria and Mongolia, while *S. valkanovi* in Japan (Shen, 1979; Mizuno & Miura, 1984). In Korea, Mizuno *et al.* (1979) once reported *S. valkanovi* from a fishpond at Kimhae in their collecting list.

**Distribution:** Korea, China, U.S.S.R.

#### Genus *Acanthodiaptomus* Kiefer, 1932

##### 7. *Acanthodiaptomus pacificus* (Burckhardt, 1913) (Pl. III, figs. 1-5)

*Diaptomus pacificus* Burckhardt, 1913, (pp. 408-416, pl. 14M, figs. 1-7, 9, 11, 13, pl. 14N, figs.

1, 3, 4, 8-10); Kikuchi, 1928, (pp. 75-76, pl. 21, fig. 46, pl. 22, 50-53).

*Diaptomus pacificus* var. *yamanacensis* Brehm, 1925, (pp. 273-274).

*Acanthodiaptomus yamanacensis*: Kikuchi, 1940, (p. 293, figs. 7, a-e).

*Acanthodiaptomus pacificus*: Shen, 1979, [transl. by Mizuno, 1984, (pp. 155-157, fig. 69)].

**Material:** Han-gang, 1 ♂, 28 IV 1981, (H.S. Kim); Hajodae, 1 ♂, 1 ♀, 24 V 1981, (I.H. Kim); Sach'ŏn (Kangwŏn-do), 3 ♂, 2 ♀, 29 V 1984, (I.H. Kim); P'anp'o-ri, 1 ♂, 4 ♀, 28 VIII 1984, (C.K. Ham).

**Measurement:** body length of female 1.54-1.60mm, of male 1.24-1.43 mm.

**Remarks:** This species shows distinct preference for cold waters like mountain lakes in Korea, recorded from Chönji (crater lake of Mt. Paektu) by Sato (1941) and Paengnoktam of Mt. Halla by Kim (1968), but also tolerates various type of waters—rivers, reservoirs, temporary pools and ricefields.

**Distribution:** Korea, China, Japan, U.S.S.R., Europe, North America.

Genus *Neodiaptomus* Kiefer, 1932

8. *Neodiaptomus schmackeri* (Poppe et Richard, 1892) (Pl. IV, figs. 3-7).

*Diaptomus schmackeri* Poppe et Richard, 1892, (pp. 149-151, figs. 1-6).

*Diaptomus handeli* Brehm, 1921, (pp. 194-195).

*Neodiaptomus handeli*: Kikuchi, 1940, (p. 292, figs. 6, a-f); Mashiko, 1951, (pp. 8-9, figs. 3, a-j); Lai & Fernando, 1978, (pp. 113-115, figs. 1-8).

*Neodiaptomus schmackeri*: Shen, 1979, [transl. by Mizuno, 1984, (pp. 159-162, fig. 71)].

**Material:** Fountain in Kangreung National University, 2♂, 1♀, 18 VIII 1981, (I.H. Kim); Mont'annalu, 4♂, 3 VII 1984, (C.S. Lee).

**Females:** Genital segment somewhat long; the anterior half of it swollen and asymmetrical (the right side more expanded than the other side and the apex of it bifid). Abdominal segment II much smaller and stumpy; basipod 1 produced into a large wing-like process from dorsal surface near anterior distal edge. Endopod not divided and its distal portion very steep bearing a spine and a group of short bristles; the segment almost equal to exopod 1 in length.

**Males:** Antennules extremely long, extending beyond the end of terminal seta; right antennule of 22 segments of which segments 10, 11, 13, 14 and 15 bearing stout spines; spines of segment 13 conspicuously long, reaching nearly to the middle of the next segment; the process of antepenultimate segment nearly reaching the distal end of next segment and pointing outward. Abdomen consisting of 5 segments; the left side of genital segment with a nipple-like protrusion and the right side with a bristle. Right basipod 1 of leg 5 produced into a bifid plate (the outer lobe a little larger than the other) on inner distal edge and a wave-formed protrusion on posterior margin; basipod 2 with a big nipple-like projection near the middle of inner margin; the outer distal edge shaply expanded; lateral spine at the midale of the outer margin of exopod 2 stout and 2/5 times as long as the claw; endopod not divided and reaching beyond the middle of exopod 2. Left exopod 2 of leg 5 bearing a stump protrusion and a long cuspid-like protrusion armed with many fine bristles along its inner margin and a few long bristles on outer distal end; endopod reaching the middle of exopod 2.

Rare and occurred in small ponds and fishponds containing much vegetable matter, like *S. sarsi*.

**Remarks:** Continual debates on the taxonomic position of the Schmackeri group of calanoids, i.e. *Neodiaptomus schmackeri* (Poppe et Richard, 1892), *N. handeli* (Brehm, 1921) and *N. strigilipes* (Gurney, 1907) especially on the preceding two, were made [Kiefer, 1932 (cited from Mashiko, 1951); Mashiko, 1951; Brehm, 1953; Rajendran, 1971; Lai & Fernando, 1978; 1980; Shen, 1979].

Shen (1979) considered all the three species as synonymous after careful examination on the specimens collected from many sites having previous records in China. The specimens examined

here are identical with Shen (1979)'s, and the present authors cannot find any significant difference between them and *N. schmackeri* of Poppe et Richard (1892) as well as *N. handeli* of Brehm (1921).

Rajendran (1971) and Lai & Fernando (1978, 1980, 1981) treated *N. schmackeri* and *N. handeli* as different species, but their "*N. schmackeri*" is different from that of Poppe et Richard (1892) in respects of having conspicuous short endopods of male's leg 5 and female's leg 5.

### ABSTRACT

A taxonomic study was carried out on the freshwater copepods of Order Calanoida from Korea during the period from May, 1983 to November, 1984.

Materials consist of both specimens deposited at the Department of Biology, Kangreung National University and the specimens collected from various freshwater regions (excluding the subterranean waters) such as rivers, lakes, ponds, bogs, ricefields, etc. during this period.

As a result of examining the specimens collected at the 26 localities in South Korea, 8 species of 3 families were identified, of which 4 species are newly known from Korea: *Sinocalanus sinensis* (Poppe, 1889); *Tropodiptomus oryzanus* Kiefer, 1937; *Sinodiptomus sarsi* (Rylov, 1923); *Neodiptomus schmackeri* (Poppe et Richard, 1892).

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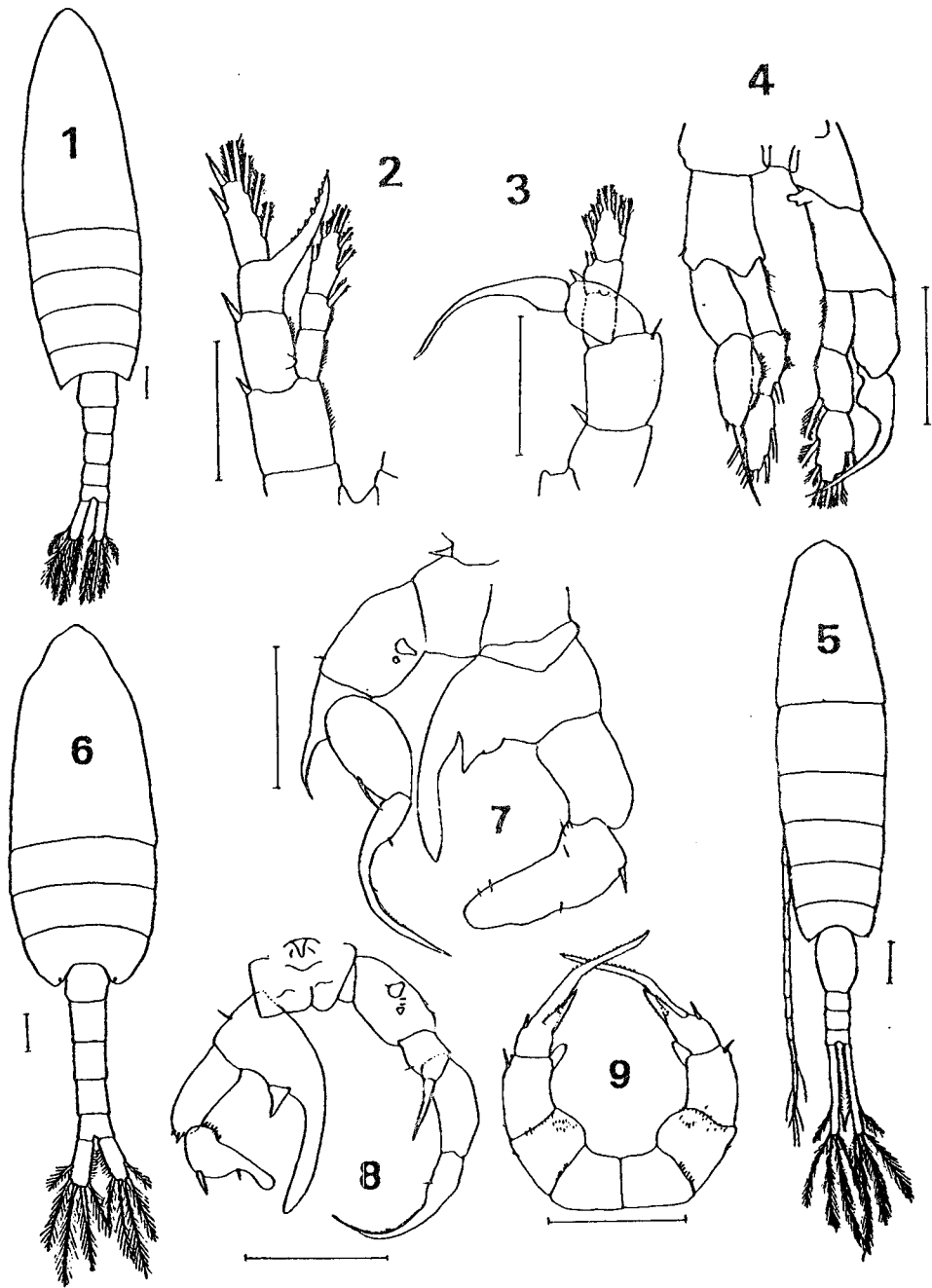
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RECEIVED: 16 APRIL 1986

ACCEPTED: 30 APRIL 1986

# PLATE I

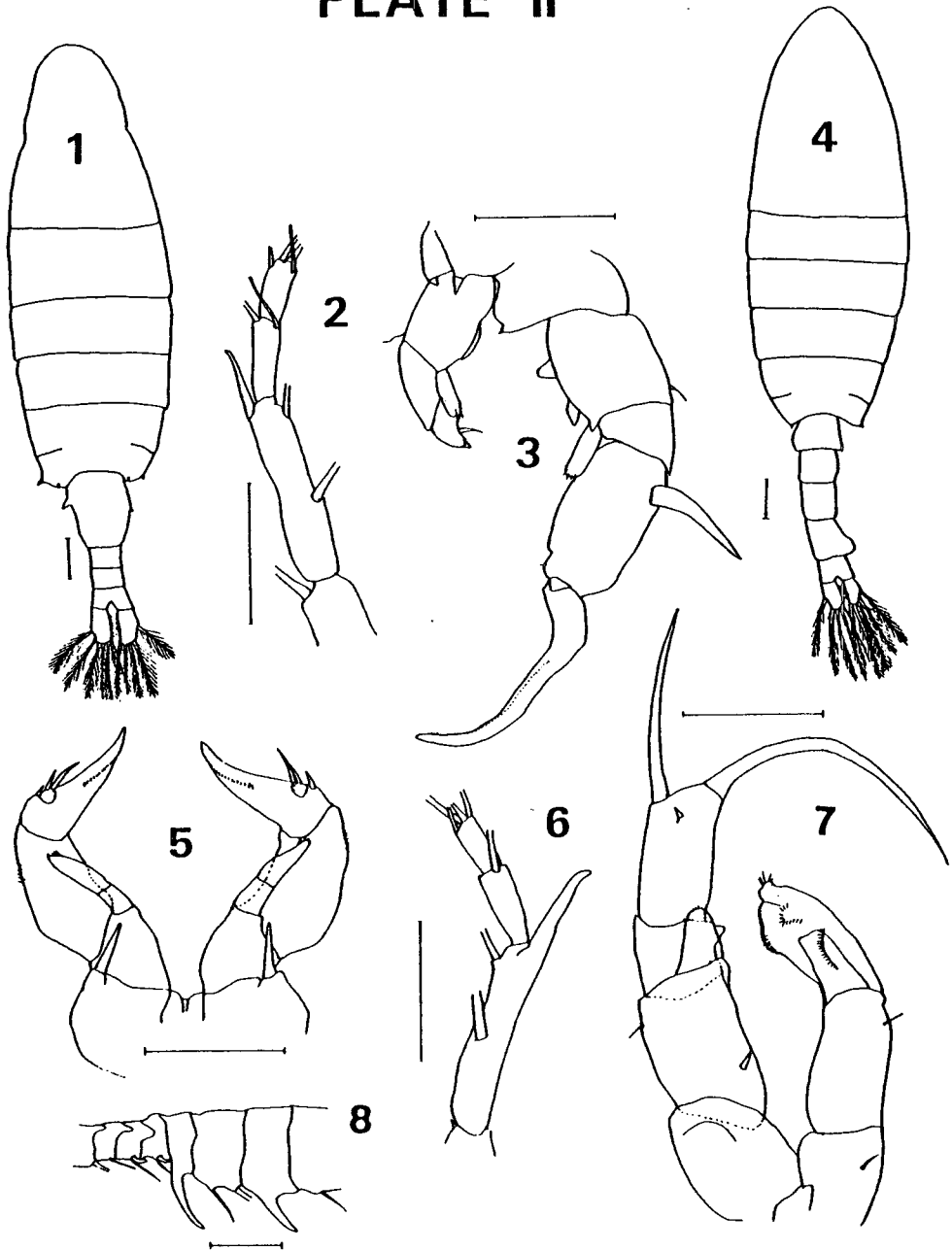


**Figs. 1-3.** *Sinocalanus sinensis* (Poppe): 1. male; 2. right leg 5 of male; 3. right leg of female.

**Figs. 4-5.** *Sinocalanus tenellus* (Kikuchi): 4. leg 5 of male; 5. female.

**Figs. 6-9.** *Pseudodiaptomus inopius* (Burckhardt): 6. male; 7. leg 5 of male (shoe-form); 8. leg 5 of male (finger-like form); 9. leg 5 of female. (Scale bar: 0.1mm)

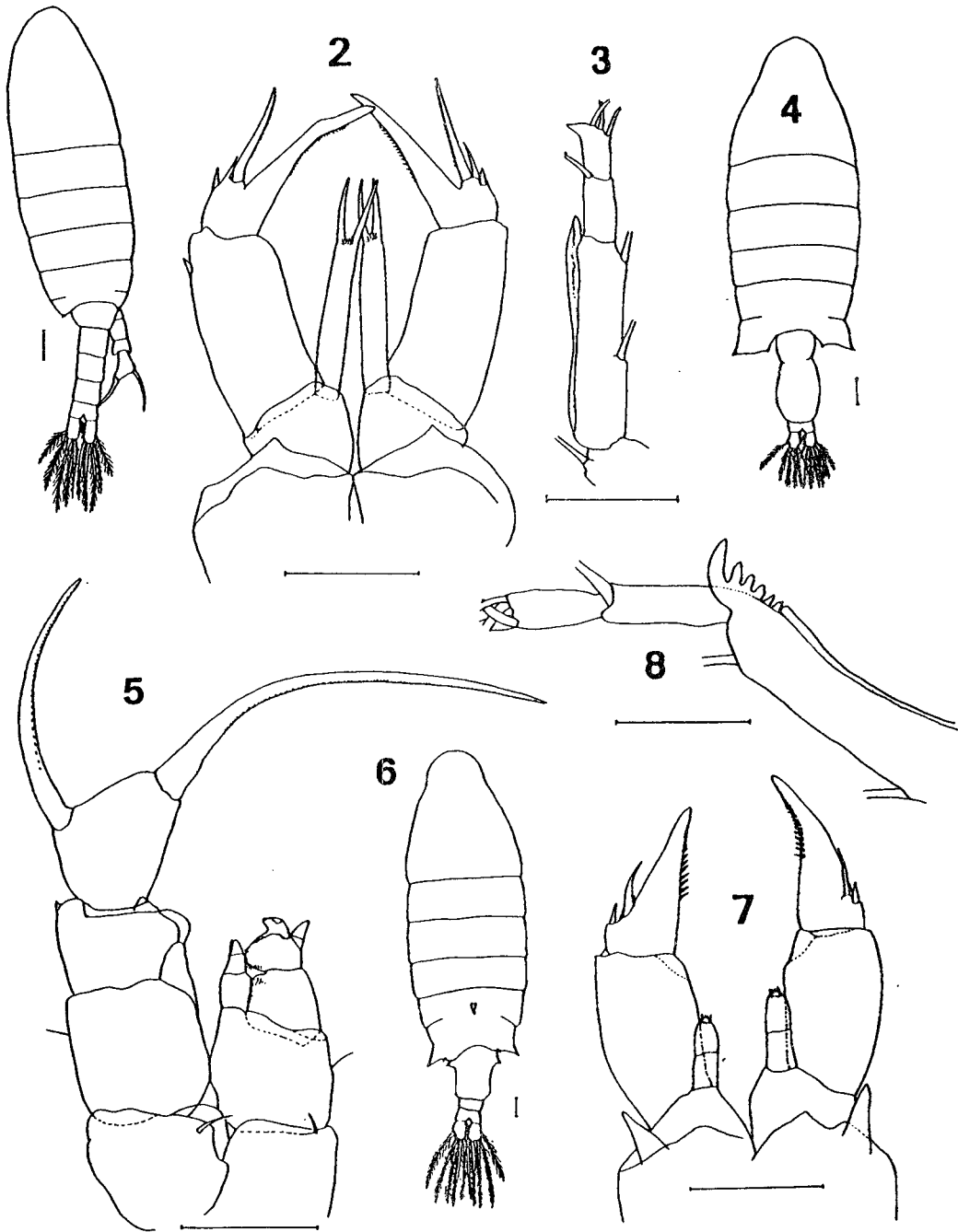
## PLATE II



**Figs. 1-5.** *Heliodiaptomus kikuchii* Kiefer: 1. female; 2. right antennule of male, distal portion; 3. leg 5 of male; 4. male; 5. leg 5 of female.

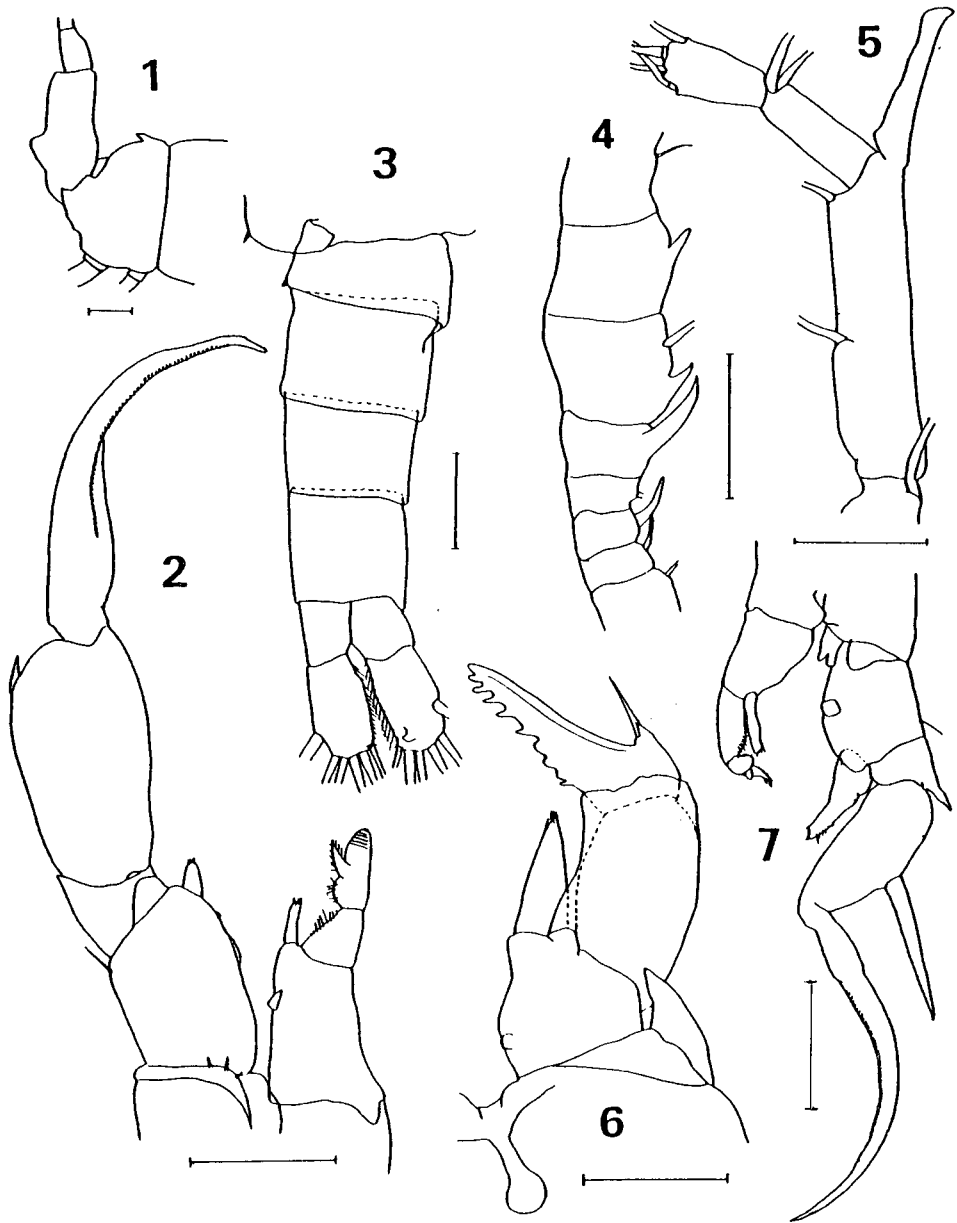
**Figs. 6-8.** *Tropodiaptomus oryzanus* Kiefer: 6. right antennule of male, distal portion; 7. right leg 5 of male; 8. right antennule of male, segments 9-16. (Scale bar: 0.1mm)

# PLATE III



**Figs. 1-5.** *Acanthodiptomus pacificus* (Burckhardt): 1. male; 2. leg 5 of female; 3. right antennule of male, distal portion; 4. female; 5. leg 5 of male.  
**Figs. 6-8.** *Sinodiptomus sarsi* (Rylov): 6. female; 7. leg 5 of female; 8. right antennule of male, distal portion.  
(Scale bar: 0.1mm)

## PLATE IV



**Figs. 1-2.** *Sinodiaptomus sarsi* (Rylov): 1. lateral view of female, thoracic segment 3 to abdominal segment 2; 2. leg 5 of male.

**Figs. 3-7.** *Neodiaptomus schmackeri* (Poppe et Richard): 3. urosome of male; 4. right antennule of male, segments 9-16; 5. right antennule of male, distal portion; 6. leg 5 of female; 7. leg 5 of male. (Scale bar: 0.1mm)