

**Taxonomy on Genus *Mesocyclops*
(Copepoda: Cyclopoida: Cyclopidae) from South Korea**

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ABSTRACT

A taxonomic study on the genus *Mesocyclops* has been accomplished as one of the serial researches on the freshwater cyclopoid copepods in South Korea. As a result, five species are recognized: *M. leuckarti* (Claus), *M. pehpeiensis* Hu, *M. dissimilis* Defaye and Kawabata, *M. woutersi* Van de Verde, and *M. mariae* Guo. Of these, *M. dissimilis*, *M. woutersi*, and *M. mariae* are new to Korean fauna. Morphological details of each species and the intraspecific variabilities are commented. A key to the species of genus *Mesocyclops* known from Korea is provided.

Key words: taxonomy, *Mesocyclops*, Cyclopidae, Cyclopoida, freshwater Copepoda, Korea

INTRODUCTION

Genus *Mesocyclops* Sars, 1914 is one of the largest genera of the freshwater copepods, comprising 66 species in the family Cyclopidae (Ueda and Reid, 2003). It is known as common in the eutrophicated lentic warm waters, however, its occurrences extend to nearly all the type of habitats including ricefields, ponds, reservoirs, lakes, swamps, rivers, streams, mountain waters, wells, and brackish waters. *Mesocyclops leuckarti* (Claus, 1857), the representative and oldest

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known freshwater copepod species, is worldwide famous, and had been considered as a cosmopolitan species consisting of the various regional variants, until Van de Velde (1984) introduced the "microcharacters" for re-classifying the "*M. leuckarti*" species complex and its allied cryptic species.

In South Korea, since the limnological study by Cho (1965) from the Han River, numerous reports frequently mentioned the '*M. leuckarti*' in the collection lists. Kim and Chang (1989) dealt with '*M. leuckarti*' and *M. pehpeiensis* Hu in the taxonomic study on the freshwater Cyclopidae from Korea. Yoo and Lim (1989) also reported '*M. leuckarti*' in their faunal research on Youngsan Lake. However, the '*M. leuckarti*' in the papers above suspected to be misidentified or mixed up with more than one cryptic species, for their identifications were based on the old "macrocharacters". Therefore, the true *Mesocyclops* fauna in Korea still remains entirely unclear.

As one of the serial researches on the freshwater cyclopoid copepods from South Korea, the authors re-examined all the *Mesocyclops* specimens stocked in the Department of Biology, Daegu University since 1990, and confirmed five species. This paper presents the taxonomic accounts on their morphological details and intraspecific variabilities with the precise illustrations and a key to the *Mesocyclops* species from Korea.

MATERIALS AND METHODS

Samplings were made with a dipnet of no. 25 mesh aperture from the various freshwaters in South Korea. Copepods were fixed and stored in 4% buffered formalin. Specimens were dissected and mounted in lactophenol on H-S slide (Shirayama et al., 1993), a recent variation of Cobb slide, after the treatment in a solution of 5% glycerin-95% ethyl alcohol for 1-2 days, then observed using a differential interference contrast microscope (Olympus BX51) equipped with Nomarski optics. All drawings and measurements were made with the aid of a camera lucida.

Abbreviations used in the text and figures follow the conventional ones frequently used in the taxonomy of freshwater cyclopoid copepods: A1, antennule; A2, antenna; Fu, furcal branches (caudal rami); L/W, length to width ratio; P1-5, legs (pereiopods) 1-5; enp1-3 or exp1-3, the first to third endopodal or exopodal segments of each leg. Main collectors of the material examined are initialized as follows: C. Y. Chang as CYC, H. W. Lim as HWL, J. M. Jeon as JMJ, and J. M. Lee as JML.

SYSTEMATIC ACCOUNTS

Family Cyclopidae Sars, 1913

Subfamily Cyclopinae Kiefer, 1927

Genus *Mesocyclops* Sars, 1914

1. *Mesocyclops leuckarti* (Claus, 1857) (Fig. 1)

Cyclops Leuckarti Claus, 1857, p. 35, pl. I, fig. 4, pl. II, figs. 13-14.

Mesocyclops leuckarti: Kiefer, 1981, p. 158, pl. III, figs. 1-9; Van de Velde, 1984, p. 13, figs.

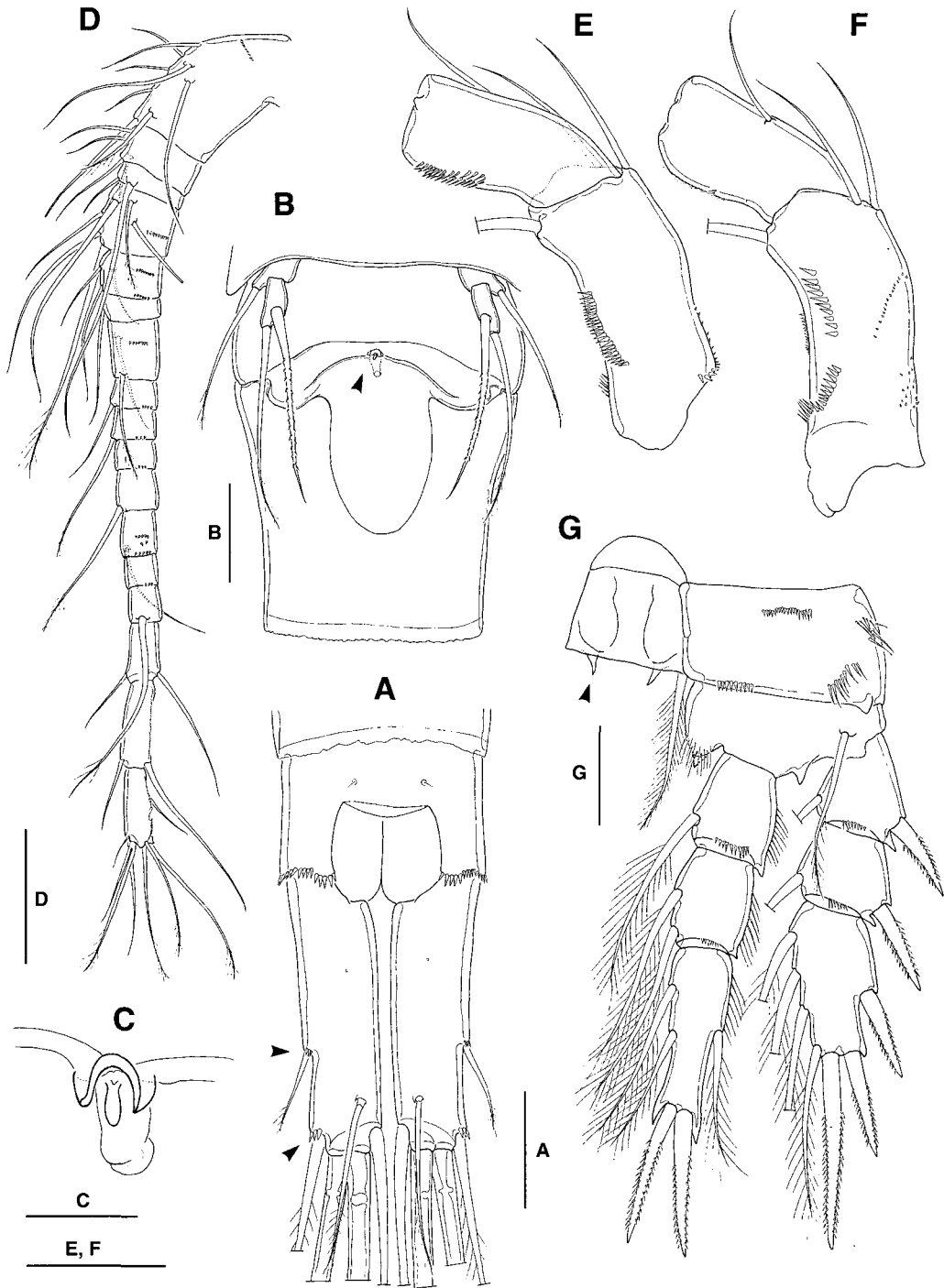


Fig. 1. *Mesocyclops leuckarti*, female. A, anal somite and Fu, dorsal; B, P5 and genital double-somite, ventral; C, copulatory pore and copulatory duct; D, A1; E, A2 basis, anterior; F, A2 basis, posterior; G, P4. Scale bars = 0.01 mm (C), 0.05 mm (A, B, E-G), and 0.1 mm (D).

5-8; Ishida, 1999, p. 83; Guo, 2000b, p. 124; Ishida, 2002, p. 60, fig. 32a-h; Ueda and Reid, 2003, p. 101, figs. 40, 41.

Material examined. 3 ♀♀, Aengmu Bridge, Jindo Is., 29 Jun. 2004 (JMJ & HWL); 5 ♀♀ (4 ovi.), Jisancheon Stream, Jindo Is., 30 Jun. 2004 (JMJ & HWL); 2 ♀♀ (1 ovi.), Naeyeonje Res. Jindo Is., 30 Jun. 2004 (JMJ & HWL); 2 ♀♀ (1 ovi.), puddle, Gacheon Medical School, Ganghwa Is., 29 Sep. 2004 (G. S. Min); 1 ♀ (ovi.), Euisincheon Stream, Jindo Is., 18 Oct. 2004 (JMJ & HWL); 1 ♀, Paengmok, Jindo Is., 19 Oct. 2004 (JMJ & HWL).

Diagnosis. Body length 1.18-1.28 mm (n = 5, mean 1.23) in female; Fu (Fig. 1A) about 3.29-3.65 mm (n = 7, mean 3.48) times longer than wide, without special ornamentation on both lateral and medial faces, except spinules at implantations of lateral and lateralmost terminal caudal setae (Fig. 1A, arrows); pediger 5 not pilose laterally; genital double-somite (Fig. 1B) about 1.18 times longer than wide; seminal receptacle with relatively short lateral arms; large slit pore present posterior to horseshoe-shaped copulatory pore (Fig. 1C); copulatory duct very wide and sinuously curved internally, not laterally; A1 (Fig. 1D) furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennular segments 4-5, 7-10 and 12-13, spinule arrangement as in figure; anterior face of A2 basis (Fig. 1E) with longitudinal row of 18-23 spinules along proximal half of lateral margin; posterior face of A2 basis (Fig. 1F) ornamented with oblique spinule row around middle of medial margin, longitudinal row of about 8 spinules along lateral margin rather sparsely, while nearly smooth around implantation of distomedial setae; both exopods and endopods of P1-4 composed of 3 segments; spine formula of P1-4 exp3, 3,4,4,3; P1 basipodite without distomedial seta; P4 coupler smooth on both posterior and anterior surface, with pair of large and acute outgrowths on distal margin (Fig. 1G, arrow); P4 coxopodite with about 8-9 spinules along distal margin; lateral spine of P4 enp3 about 1.1 times longer than medial spine, apical spines much shorter than P4 enp3, lateral edge of medial spine with many spinules; P5 (Fig. 1B) 2-segmented, medial spine located just distal to half of medial margin of last segment, medial spine and apical seta subequal.

Remarks. *Mesocyclops leuckarti* is relatively rare among the congeneric species from Korea. This species has been collected usually from the eutrophicated littoral zones of both lentic and lotic waters, frequently from streams or the ditches for irrigation (sometimes from oligohaline streams) near southwest coast of South Korea. This species is known as "warm-water" form and active from spring to early autumn and resting in late autumn and winter, mainly in the copepodid V stage (Ueda and Reid, 2003).

Distribution of *M. leuckarti* s. str. in Northeast Asia was once regarded as suspicious, however, recently its existence has been confirmed from Hokkaido and Honshu, Japan by Ishida (1999, 2002), from northern China including Inner Mongolia and Manchuria by Guo (2000b). Specimens from Korea coincided well with Ishida's (2002) figures. This species has the character combination of the basic pattern of spinule ornamentation on A2 basis (simple oblique row of spinules along medial margin and longitudinal spinules along lateral margin, with smooth field around distal margin and implantation of distomedial setae), acute outgrowths on distal margin of P4 coupler, and very wide and not-laterally-curved copulatory duct. The shape of outgrowths on distal margin of P4 coupler were observed as a little variable, that is, from fully hooked ones to simple acute triangular ones.

Distribution. Palearctic.

2. *Mesocyclops pehpeiensis* Hu, 1943 (Fig. 2)

Mesocyclops Leuckarti pehpeiensis Hu, 1943, p. 124, figs. 1-6.

Mesocyclops pehpeiensis: Shen and Tai, 1979, p. 409, figs. 247, 248; Kawabata and Defaye, 1994, p. 151, figs. 6-7; Ishida, 1999, p. 84; Guo, 2000a, p. 33, figs. 1-4; Ishida, 2002, p. 61, fig. 33; Ueda and Reid, 2003, p. 138, fig. 57.

Mesocyclops ruttneri: Kiefer, 1981, p. 178, pl. 14; Reid, 1993, p. 177, figs. 3-5.

Material examined. 2 ♀♀, Seongsan reed marsh, Jeju Is., 20 Jul. 2001 (CYC & JML); 2 ♀♀, Daechong Lake, 27 Jul. 2001 (CYC & JML); 5 ♀♀, Jeongyangji Res., Hapcheon, 4 Aug. 2002 (CYC, JML & JMJ); 2 ♀♀, Weolsong Swamp, Uljin, 1 May 2003 (CYC & JML); 1 ♀, Haepyeong Swamp, Gumi, 29 Apr. 2003 (S. M. Yoon); 1 ♀ (ovi.), Bongwha Res., Kimhae, 28 Jun. 2003 (K. H. Ahn); 1 ♀, Ungcheon, Boryeong, 15 Jul. 2003 (CYC, JML & JMJ); 1 ♀, Seorang Res., Hwaseong, 1 Aug. 2003 (JML); 2 ♀♀, Deokjin Res., Jeonju, 15 Aug. 2003 (CYC); 1 ♀, Gonggeomji Res., Sangju, 23 Aug. 2003 (CYC & JML); 1 ♀ (ovi.), Samjeong-ri res., Pohang, 17 Apr. 2004 (JML & JMJ); 1 ♀, Dongcheongyo Br., Gongju, 27 Apr. 2004 (JMJ & HWL); 2 ♀♀ (2 ovi.), Jeonggak-ri Res., Nonsan, 30 Apr. 2004 (HWL); 1 ♀, Jangdeungdong ricefield, Gwangju, 10 May 2004 (CYC); 1 ♀, Hwado-ri streamlet, Ganghwado, 20 May 2004 (J. A. Baek); 1 ♀, Yeonhwaji Res., Gyeonsan, 24 Jun. 2004 (CYC & JMJ); 1 ♀, Gosan, Jeju Is., 26 Jun. 2004 (G. S. Min); 3 ♀♀, Aengmu Br., Jindo Is., 29 Jun. 2004 (JMJ & HWL); 2 ♀♀, puddle, Jeopdo, Jindo Is., 30 Jun. 2004 (JMJ & HWL); 2 ♀♀ (2 ovi.), Gahak-ri puddle, Jindo Is., 30 Jun. 2004 (JMJ & HWL); 1 ♀, Jeongji-ri streamlet, Jindo Is., 30 Jun. 2004 (G. S. Min & J. A. Baek); 2 ♀♀ (1 ovi.), Weolgaje Res., Jindo Is., 29 Jun. 2004 (JMJ & HWL); 5 ♀♀ (1 ovi.), Gagye-ri str., Jindo Is., 1 Jul. 2004 (JMJ & HWL); 2 ♀♀ (1 ovi.), Yeonhwaji Res., Haenam, 13 Aug. 2004 (JML); 1 ♀ (ovi.), Aegiji Res., Ahwa, Gyeongju, 4 Sep. 2004 (CYC, JML & JMJ); 2 ♀♀ (2 ovi.), Saemot Res., Ahwa, Gyeongju, 6 Sep. 2004 (JML & JMJ); 4 ♀♀ (1 ovi.), Ingeum-ri puddle, Andong, 9 Sep. 2004 (CYC & JMJ); 2 ♀♀ (1 ovi.), puddle, Maneulbong Hill, Andong, 9 Sep. 2004 (CYC & JMJ); 1 ♀, ditch, Yecheon, 13 Sep. 2004 (CYC & JMJ); 1 ♀, Chojijin Grand Br. Res., 29 Sep. 2004 (G. S. Min); 2 ♀♀, Sinpyeong-ri Res., Gyeongju, 7 Oct. 2004 (JML, JMJ & HWL); 2 ♀♀ (1 ovi.), Geumcheon Str., Ulsan, 3 Oct. 2004 (CYC, JML & JMJ); 1 ♀, puddle, Ulsan, 3 Oct. 2004 (CYC, JML & JMJ); 1 ♀, Hwangtojeon Br., Ulsan, 3 Oct. 2004 (CYC, JML & JMJ); 2 ♀♀ (2 ovi.), Upo Swamp, Changnyeong, 27 Nov. 2004 (CYC & JML).

Diagnosis. Body length 1.30–1.82 mm ($n = 7$, mean 1.65) in female; L/W of Fu about 3.47–3.93 mm ($n = 5$, mean 3.68); Fu without special spinule or setule ornamentation on both lateral and medial faces, except spinules at implantations of lateral and lateralmost terminal caudal setae (Fig. 2A); pediger 5 without hairs laterally; genital double-somite (Fig. 2B) a little longer than wide; seminal receptacle with wide and long lateral arms; copulatory duct widely curved laterally (Fig. 2C); A1 (Fig. 2D) furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennular segments 4–5 and 7–13, showing spinule arrangement as in figure; anterior face of A2 basis (Fig. 2E) with longitudinal row of 28–30 spinules along lateral margin; posterior face of A2 basis (Fig. 2F) ornamented with oblique spinule row around middle of medial margin, 2 longitudinal rows each of about 15–18, 6–8 spinules along lateral

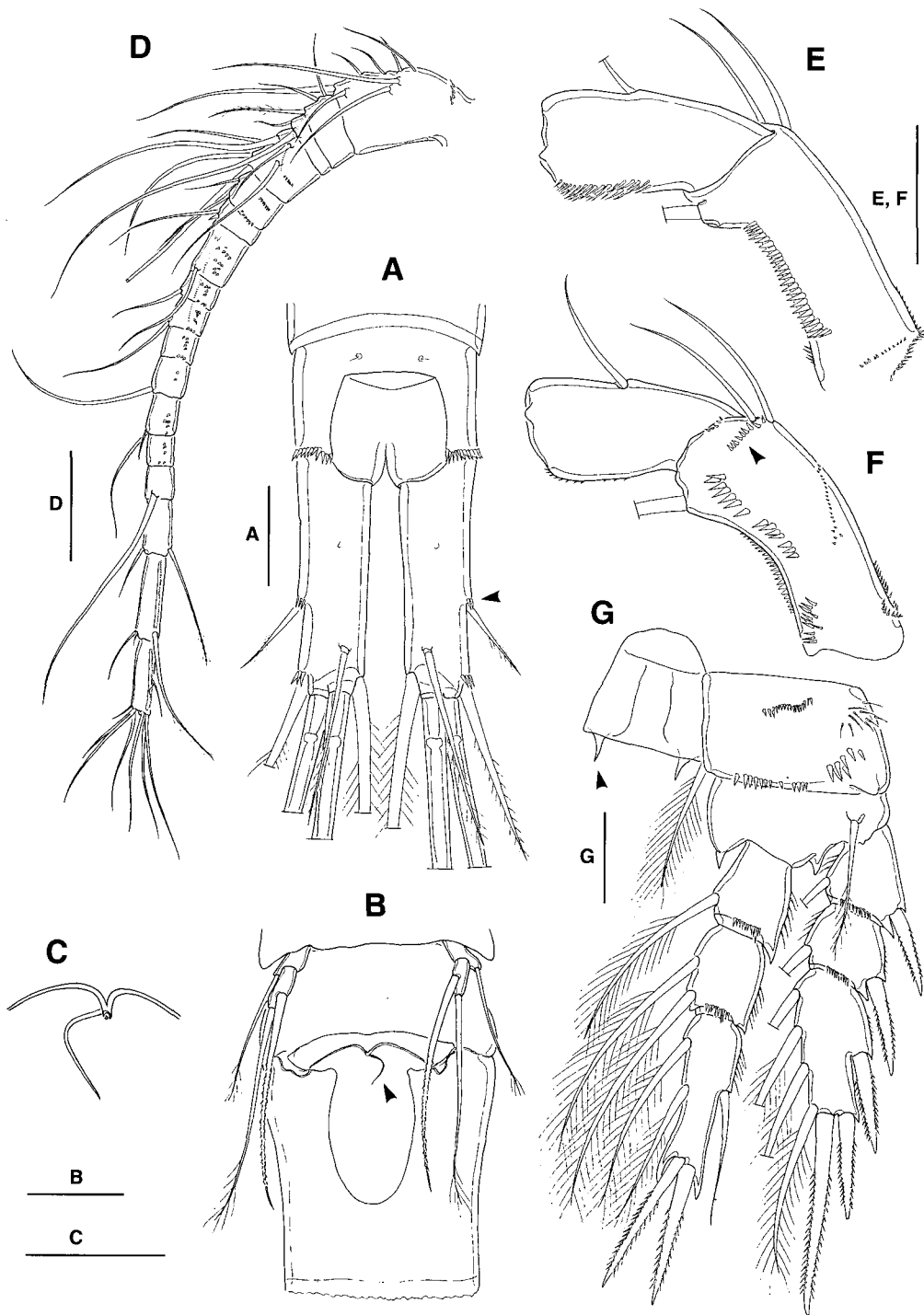


Fig. 2. *Mesocyclops pehpeiensis*, female. A, anal somite and Fu, dorsal; B, P5 and genital double-somite ventral; C, copulatory pore and copulatory duct; D, A1; E, A2 basis, anterior; F, A2 basis, posterior; G, P4. Scale bars = 0.05 mm (A, C, E-G) and 0.1 mm (B, D).

margin, and a few spinules near distal margin and implantation of distomedial setae; both exopods and endopods of P1-4 composed of 3 segments; spine formula of P1-4 exp3, 3,4,4,3; P1 basipodite lacking distomedial seta; P4 (Fig. 2G) coupler smooth on both posterior and anterior surface, with pair of acute hook-shaped outgrowths on distal margin; P4 coxopodite with 8-10 spinules along distal margin; apical spines of P4 enp3 nearly subequal, a little shorter than P4 enp3, medial apical spine with more than 10 spinules on lateral edge; P5 (Fig. 2B) 2-segmented, medial spine located near middle of medial margin of distal segment, apical seta a little longer than medial spine.

Remarks. *Mesocyclops pehpeiensis*, the commonest species as well as *M. dissimilis* in Korea, seems to favor the detritus-rich littoral zone of various habitats, including lotic waters like streams and ditches for irrigation.

This species was described as a subspecies of *M. leuckarti* from Pehpei, Sichuan Province, China by Hu (1943), and afterwards redescribed from China (Shen and Tai, 1979), Japan (Kawabata and Defaye, 1994) and Korea (Kim and Chang, 1989). However, as all the records above, including the original description, were based on the traditional 'macrocharacters', so the controversies on the identity of this species were long-lasting. Guo (2000a) redescribed *M. pehpeiensis* precisely based upon the so-called 'microcharacters' of Van de Velde (1984). This species is clearly distinguished from the other congeners by the following characteristics: much bigger body (usually more than 1.50 mm in female) and relatively longer Fu (about 3.80 times longer than wide); acute hook-shaped outgrowths on posterior margin; copulatory duct widely curved laterally; and spinules present near distal margin and implantation of distomedial setae. Korean specimens coincides well with Guo (2000b) and Ishida (2002), except a little stronger spinule ornamentation near distal margin of A2 basis and along distal margin of P4 coxopodite than in the Chinese specimens and Japanese ones.

Distribution. China, Central Asia, India, Indochina, Japan and Korea.

3. **Mesocyclops dissimilis* Defaye and Kawabata, 1993 (Figs. 3-5)

Mesocyclops dissimilis Defaye and Kawabata, 1993, p. 121, figs. 1-25; Hołyńska, 2000, p. 440, fig. 56; Guo, 2000b, p. 128, fig. 9; Ishida, 2002, p. 61, fig. 34a-f; Ueda and Reid, 2003, p. 210, fig. 93.

Material examined. 2 ♀♀ (2 ovi.), Baksilji Res., Hapcheon, 14 May 2002 (CYC, JML & JMJ); 6 ♀♀, Daecheong Lake, 9 Jul. 2001 (CYC & JML); 3 ♀♀ (2 ovi.), Jeongyangji Swamp, Hapcheon, 4 Aug. 2002 (CYC, JML & JMJ); 2 ♀♀, Janghyeon Res., Boryeong, 14 Jul. 2003 (JML, JMJ & K. H. Ahn); 1 ♀, Ungcheon, Boryeong, 15 Jul. 2003 (CYC & JML); 4 ♀♀ (1 ovi.), Judong Res., Jeongeup, 20 Jul. 2003 (JML); 2 ♀♀ (1 ovi.), Bujeon Res., 20 Jul. 2003 (JML); 2 ♀♀, Seorang Res., Hwaseong, 1 Aug. 2003 (JML); 2 ♀♀ (1 ovi.), pond, Chungnam Univ. Daejeon, 19 Aug. 2003 (CYC, JML & JMJ); 5 ♀♀ (4 ovi.), Hoam Res., Chungju, 23 Aug. 2003 (CYC & JML); 2 ♀♀ (1 ovi.), Tobong Res., Yeongcheon, 24 Apr. 2004 (JMJ); 2 ♀♀ (1 ovi.), Sambu Res., Yeongcheon, 24 Apr. 2004 (JMJ); 2 ♀♀, Jeongtosa Temple Res., Seocheon, 30 Apr. 2004 (HWL); 1 ♀, Baedari Res., Seocheon, 30 Apr. 2004 (HWL); 1 ♀, Eunpa Res., Gunsan, 4 Jun. 2004 (JMJ);

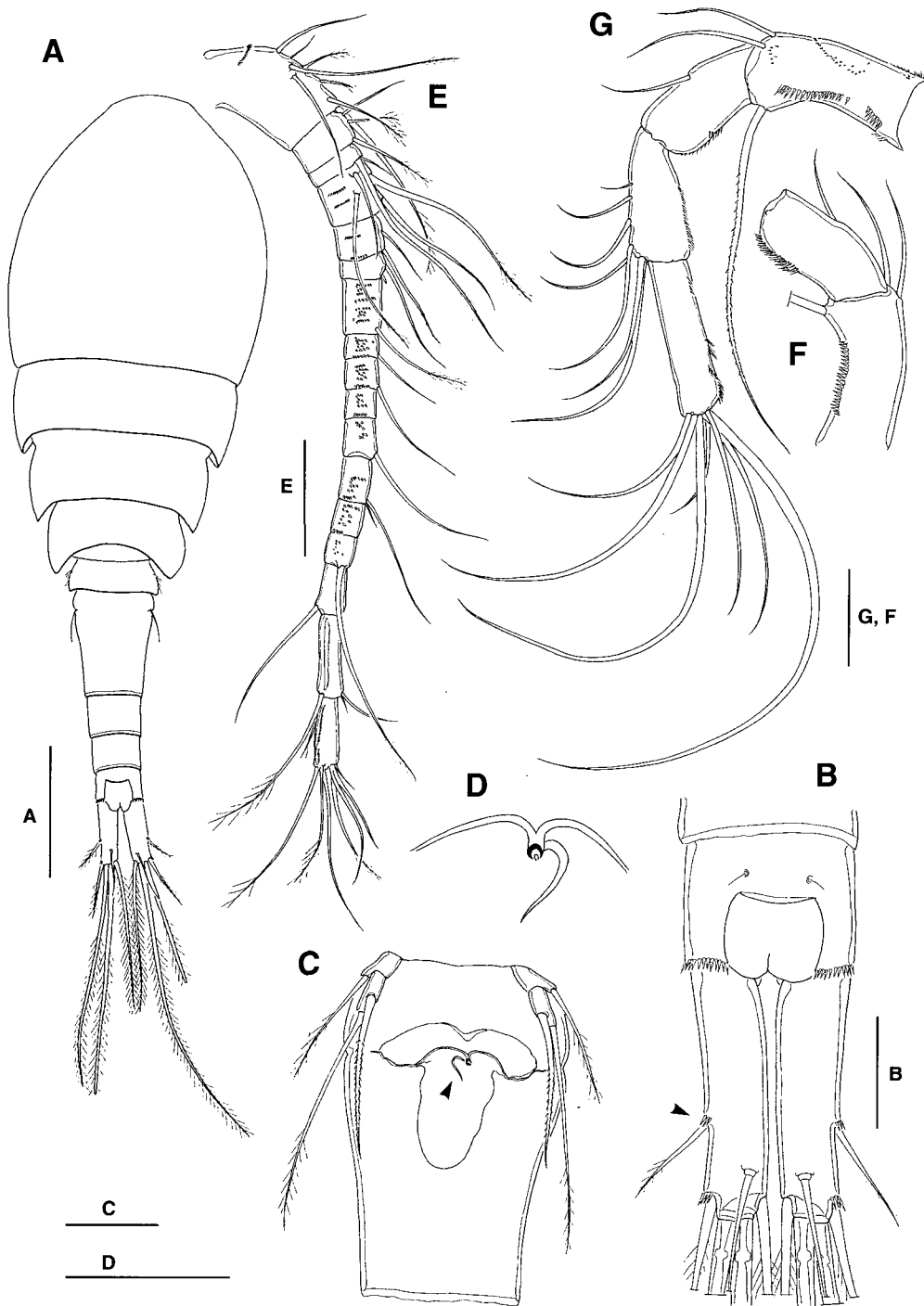


Fig. 3. *Mesocyclops dissimilis*, female. A, habitus, dorsal; B, anal somite and Fu, dorsal; C, P5 and genital double-somite, ventral; D, copulatory pore and copulatory duct; E, A1; F, A2 basis, anterior; G, A2 basis, posterior. Scale bars = 0.03 mm (D), 0.05 mm (B, C, F, G), 0.1 mm (E), and 0.2 mm (A).

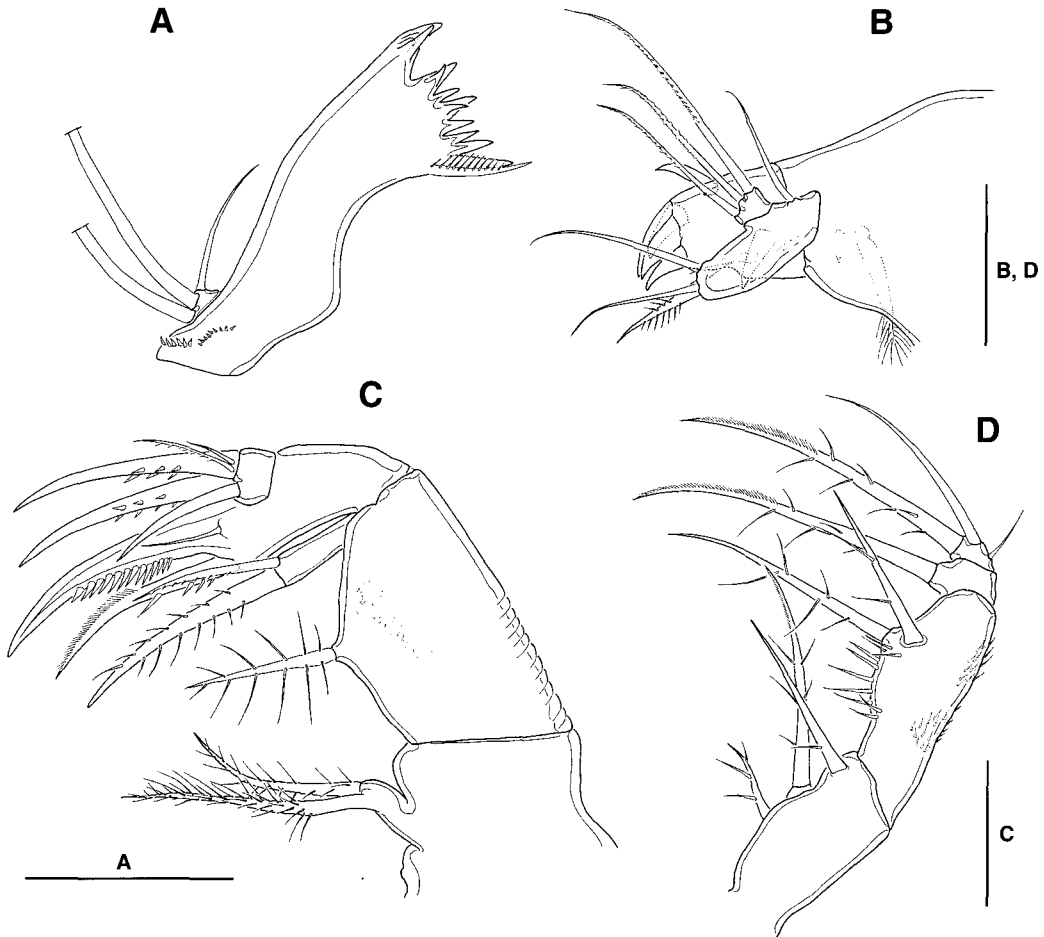


Fig. 4. *Mesocyclops dissimilis*, female. A, mandible; B, maxillule; C, maxilla; D, maxilliped. All scale bars = 0.05 mm.

1 ♀, Bomun Res., Gyeongju, 29 Jun. 2004 (CYC & JML); 3 ♀ ♀, Cheonchon Res., Gyeongju, 6 Sep. 2004 (CYC, JML & JMJ); 2 ♀ ♀, Weoneodam puddle, Andong, 9 Sep. 2004 (CYC & JMJ); 2 ♀ ♀, Majeonji Res., Euisong, 9 Sep. 2004 (CYC & JMJ); 1 ♀, Eunhaesa Temple str., Yeongcheon, 8 Oct. 2004 (CYC & JMJ); 2 ♀ ♀ (2 ovi.), Gugyeoji Res., Changnyeong, 21 Oct. 2004 (JMJ); 2 ♀ ♀ (2 ovi.), Gabryeong puddle, Yeongcheon, 15 Oct. 2004 (CYC & JMJ).

Diagnosis. Body (Fig. 3A) length 1.19–1.23 mm ($n = 9$, mean 1.21) in female; L/W of Fu about 3.15–3.57 mm ($n = 7$, mean 3.35); Fu with spinules at implantation of lateral and lateralmost terminal caudal setae (Fig. 3B); pediger 5 with hairs laterally; genital double-somite (Fig. 3C) a little longer than wide; seminal receptacle with wide and short lateral arms; copulatory pore horseshoe-shaped; copulatory duct conspicuous, strongly curved; A1 (Fig. 3E) furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennular segments 4–5 and 7–13, showing arrangement as in figure; anterior face of A2 basis (Fig. 3F) with

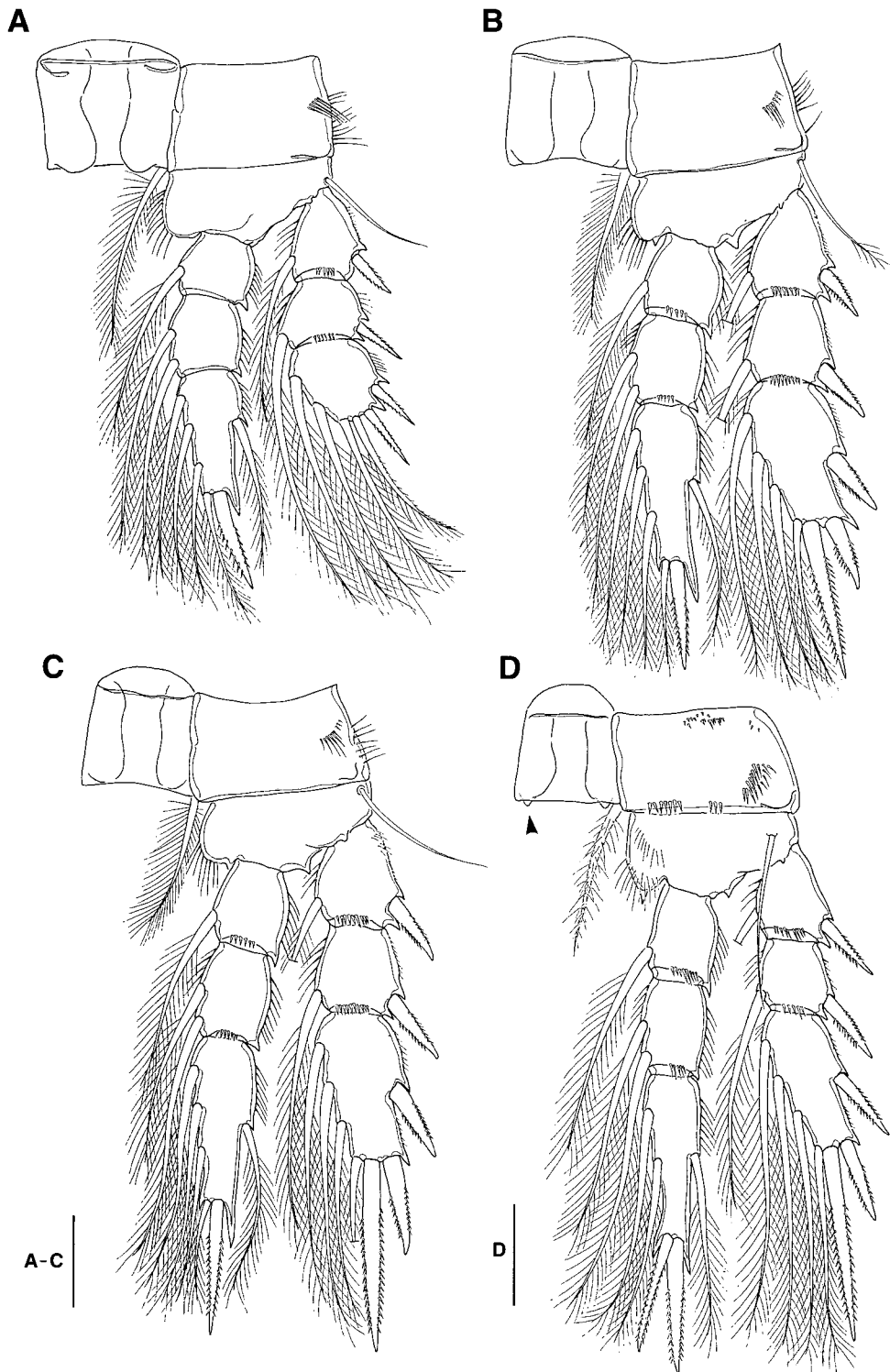


Fig. 5. *Mesocyclops dissimilis*, female. A-D, P1-P4. All scale bars = 0.05 mm.

longitudinal row of 23–30 spinules along lateral margin; posterior face of A2 basis (Fig. 3G) ornamented with oblique spinule row around middle of medial margin, dispatch of minute spinules proximal to implantation of distomedial setae and distal margin, a few minute spinules beside distal margin and longitudinal row of 13–20 spinules along lateral margin; mandible, maxillule, maxilla and maxilliped shown in Fig. 4A–D, respectively; both exopods and endopods of P1–4 composed of 3 segments; spine formula of P1–4 exp3, 3,4,4,3 (Fig. 5A–D); P1 basipodite lacking distomedial seta (Fig. 5A); P4 coupler smooth on both posterior and anterior surface, with pair of obtuse triangular outgrowths on distal margin (Fig. 5D); P4 coxopodite with 7–12 spinules in intermittent arrangement along distal margin; apical spines of P4 enp3 nearly subequal (medial spine generally a little shorter than lateral one), both spines a little shorter than P4 enp3, medial apical spine with more than 15 spinules on lateral edge (Fig. 5D); P5 (Fig. 3C) 2-segmented, medial spine located on middle of medial margin of distal segment, apical seta much longer than medial spine, lateral seta of proximal segment slightly shorter than medial spine.

Remarks. *Mesocyclops dissimilis* is the most frequent and abundant *Mesocyclops* species in the freshwaters of South Korea. Usually as a pelagic plankter, it tends to inhabit the large lentic waters like dam or large reservoirs a little eutrophicated, but sometimes found also in the relatively cold and oligosaprobic waters. In case of pelagic plankters, individuals showed the tendency of relatively smaller body than the “nearshore” ecotype, as mentioned in Ueda and Reid (2003). In ‘cold-water’ season (usually from November to March in Korea), *M. dissimilis* diapauses in the copepodid IV or V stages.

‘*Mesocyclops leuckarti*’ reported from Youngsanho Lake by Yoo and Lim (1989) should be corrected to this species in consideration of the obtuse triangular outgrowths on distal margin of P4 coupler and the presence of spinules at implantations of lateral and lateralmost terminal caudal setae, although those were figured rather insufficiently or inadequately. Likewise, most of the previous records reported as ‘*M. leuckarti*’ in the limnological studies in Korea might be the misidentifications of this species, for the samplings of the researches were usually made upon the pelagic plankters, especially generally upon the common species only for limnological purposes, living in the large dams or main streams of large rivers. Korean specimens coincides well with Guo (2000b) and Ishida (2002) even in minute details.

Distribution. Japan, China, Vietnam, easternmost Siberia and Korea.

4. **Mesocyclops woutersi* Van de Velde, 1987 (Fig. 6)

Mesocyclops woutersi Van de Velde, 1987, p. 156, figs. 31–44; Hołyńska, 2000, p. 414, figs. 35–37; Guo, 2000b, p. 128; Ishida, 2002, p. 61, fig. 34g–m; Ueda and Reid, 2003, p. 207, figs. 91, 92.

Mesocyclops quangxiensis Reid and Kay, 1992, p. 332, figs. 1–2, 3a–c.

Material examined. 2 ♀♀, pond, Daegu Univ., 11 May 1996 (CYC & JML); 9 ♀♀, Jangcheokji Res., Changnyeong, 2 Jul. 2003 (CYC & JML); 2 ♀♀, Sacheon Res., Jindo Is., 29 Jun. 2004 (JMJ & HWL); 1 ♀, Jeongji-ri streamlet, Jindo Is., 30 Jun. 2004 (G. S. Min & J. A. Baek); 1 ♀, Gahyangje Res., Jindo Is., 1 Jul. 2004 (JMJ & HWL); 1 ♀, Jimak-ri streamlet, Jindo Is., 1 Jul.

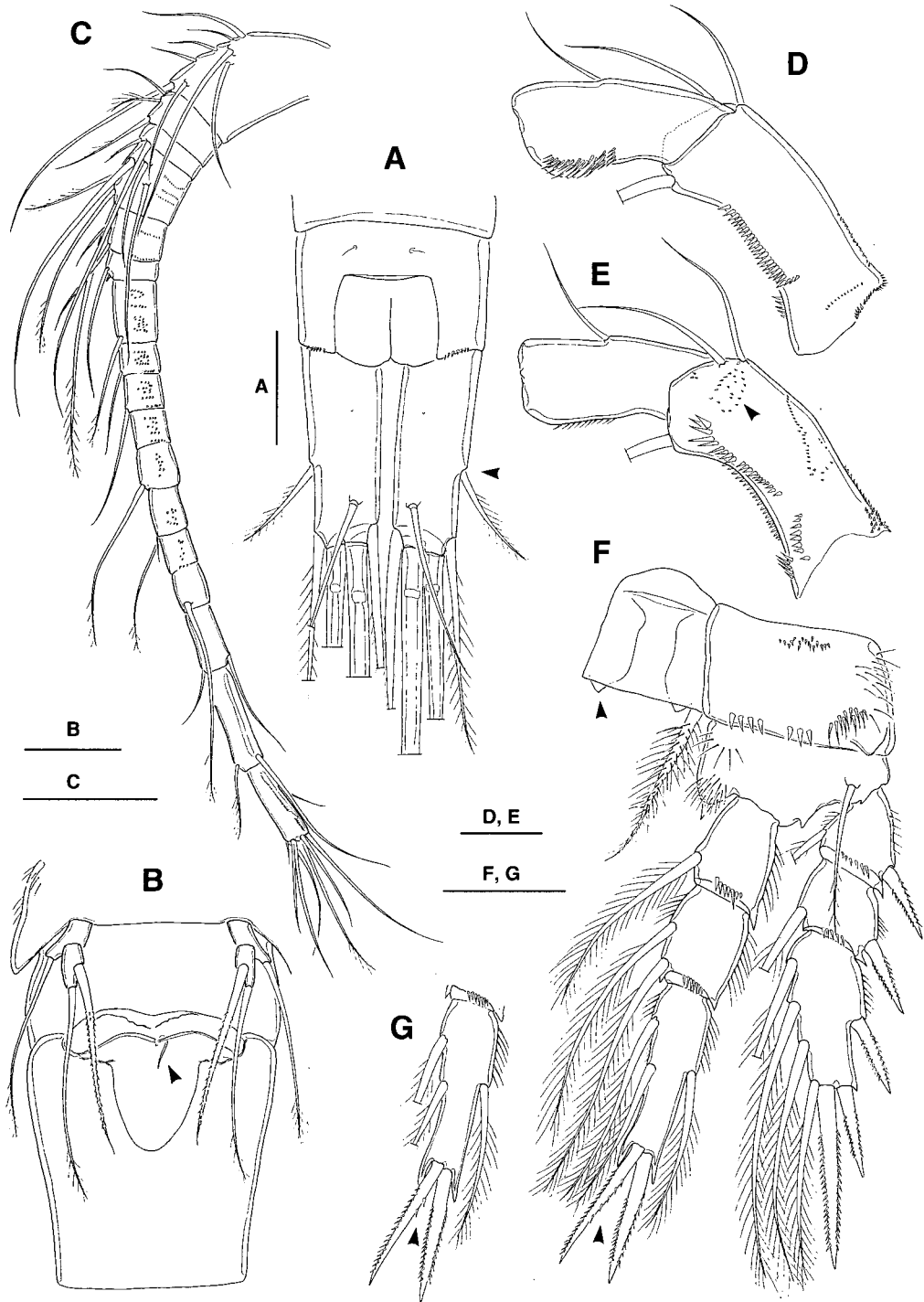


Fig. 6. *Mesocyclops woutersi*, female. A, anal somite and Fu, dorsal; B, P5 and genital double-somite, ventral; C, A1; D, A2 basis, anterior; E, A2 basis, posterior; F, P4; G, P4 enp3 (variation). Scale bars = 0.05 mm (A, C-G) and 0.1 mm (B).

2004 (JMJ & HWL); 6 ♀♀ (1 ovi.), Gagye-ri streamlet, Jindo Is., 1 Jul. 2004 (JMJ & HWL); 1 ♀ (ovi.), Aengmu Br., Jindo Is., 29 Jun. 2004 (JMJ & HWL); 1 ♀, lower reaches of Hupocheon Str., Uljin, 4 Aug. 2004 (CYC, JML & JMJ); 1 ♀, lower reaches of Wolpocheon Str., Pohang, 7 Aug. 2004 (JML, JMJ & HWL); 1 ♀, Yeonhwaji Res., Haenam, 13 Aug. 2004 (JML); 1 ♀, Ingeum-ri puddle, Andong, 9 Sep. 2004 (CYC & JMJ); 1 ♀, Noryang-ri well, Hadong, 19 Sep. 2004 (JMJ & HWL); 1 ♀, lower reaches of Taehwa R., Ulsan, 3 Oct. 2004 (CYC, JML & JMJ); 2 ♀♀ (2 ovi.), puddle, Goireung, Gyeongju, 3 Oct. 2004 (CYC, JML & JMJ).

Diagnosis. Body length 1.09–1.29 mm ($n = 4$, mean 1.19) in female, generally a little smaller than other congeners from Korea; L/W of Fu about 2.97–3.36 mm ($n = 8$, mean 3.11); Fu without special spinule or setule ornamentation on both lateral and medial faces, lacking spinules at implantation of lateral and lateralmost terminal caudal setae (Fig. 6A); pediger 5 with hairs laterally; genital double-somite (Fig. 6B) a little longer than wide, seminal receptacle with wide and short lateral arms; copulatory duct strongly curved; A1 (Fig. 6C) furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennular segments 4–5 and 7–13, showing arrangement as in figure; anterior face of A2 basis (Fig. 6D) with longitudinal row of 25–30 spinules along lateral margin; posterior face of A2 basis (Fig. 6E) ornamented with oblique spinule row around middle of medial margin, ellipsoidal dispatch of minute spinules lateral to implantation of distomedial setae, a few spinules beside distal margin and longitudinal row of about 20 different-sized spinules along lateral margin; both exopods and endopods of P1–4 composed of 3 segments; spine formula of P1–4 exp3, 3, 4, 4, 3; P1 basipodite without distomedial seta; P4 coupler smooth on both posterior and anterior surface, with pair of obtuse triangular outgrowths on distal margin (Fig. 6F); P4 coxopodite with 7–9 spinules along distal margin; apical spines of P4 enp3 nearly same in length each other, a little shorter than P4 enp3, medial apical spine with 5–7 spinules on lateral edge (Fig. 6F, arrow); P5 (Fig. 6B) 2-segmented, medial spine located on middle of medial margin of distal segment, apical seta a little longer than medial spine, lateral seta of proximal segment slightly shorter than medial spine.

Remarks. *Mesocyclops woutersi* constitutes the *woutersi*-superspecies with *M. dissimilis* (see Hołyńska, 1997), and they are distinguished from other three congeners from Korea by having the small triangular protrusion on the posterior margin of P4 coupler and the dispatch of minute spinules on distomedial corner of A2 basis. *Mesocyclops woutersi* differs from *M. dissimilis* by the absence of spinules at implantations of lateral and lateralmost terminal caudal setae, and the sparsely spinulose lateral blade of medial apical spine of P4 enp3. Among the characteristics, last one was a little variable in the Korean population, that is, generally with 5–7 spinules sparsely, but rarely with only 2–3 spinules or even nothing in some variations (Fig. 6G, arrow).

This species has been collected from the eutrophicated littoral zone mainly of lakes, reservoirs and puddles beside streamlets mostly in summer in Korea. Considering the zoogeographical distribution of this species, *M. woutersi* appeared to have a tropical origin, and favor the warm and heavily eutrophicated stagnant waters in warm-water season.

Distribution. Papua New Guinea, Australia, Indochina, South China, Japan and Korea.

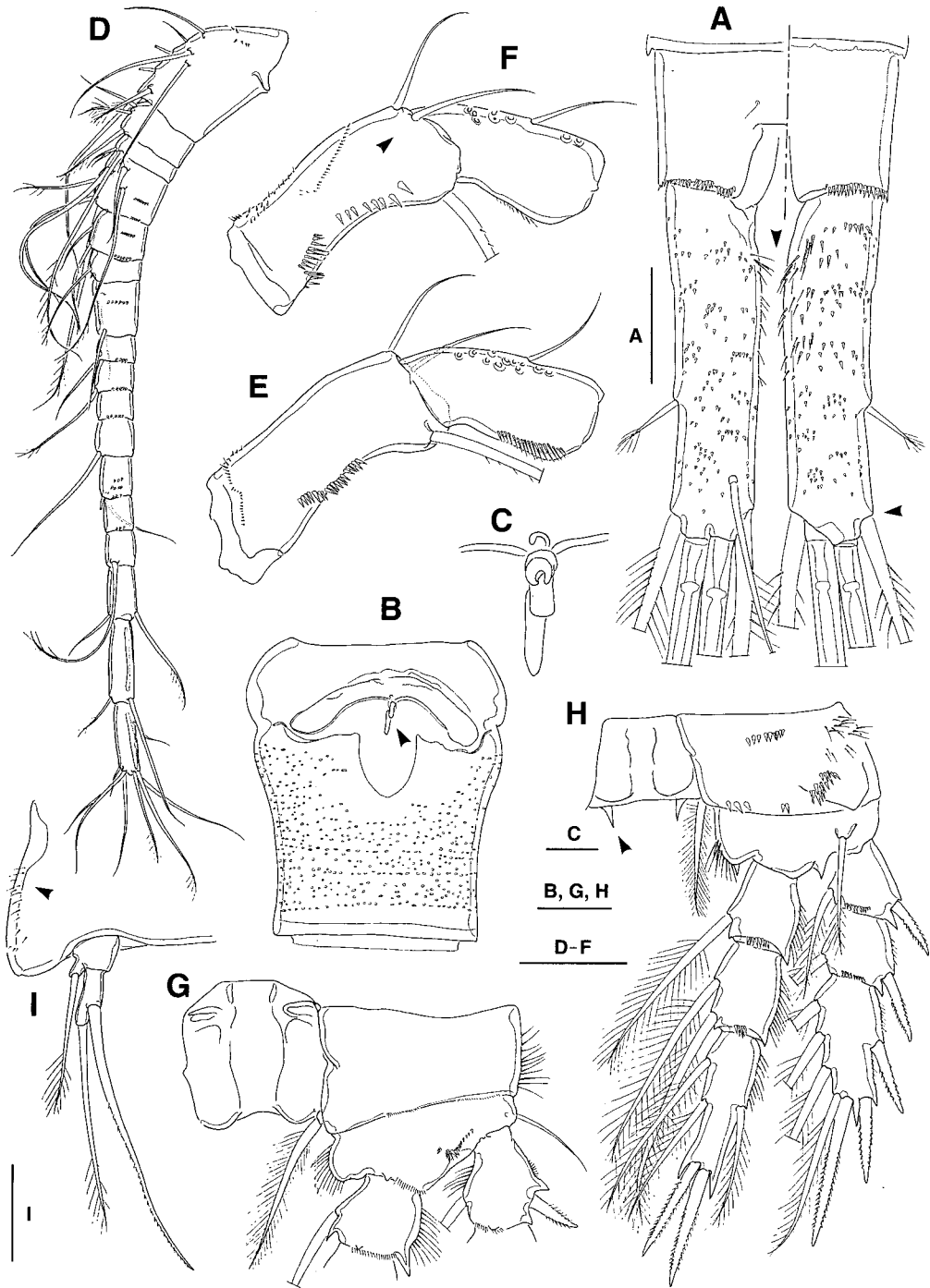


Fig. 7. *Mesocyclops mariae*, female. A, anal somite and Fu, dorsal and ventral; B, genital double-somite, ventral; C, copulatory pore and copulatory duct; D, A1; E, A2 basis, anterior; F, A2 basis, posterior; G, P1 coupler and protopodite, posterior; H, P4; I, pediger 5 and P5. Scale bars = 0.01 mm (C), 0.05 mm (A, B, E-I), and 0.1 mm (D).

5. **Mesocyclops mariae* Guo, 2000 (Fig. 7)

Mesocyclops mariae Guo, 2000b, p. 116, figs. 1-4; Ueda and Reid, 2003, p. 98, figs. 38, 39.

Material examined. 1 ♀, ditch for irrigation, Hwado-ri, Ganghwado Is., 20 May 2004 (J. A. Baek & S. J. Kim).

Diagnosis. Body length about 1.3 mm; Fu (Fig. 7A) about 3.95 times longer than wide, with 3-4 oblique rows of hairs along proximal half of medial face; lateral caudal seta located at distal third of lateral margin of Fu; lacking spinules at implantations of lateral and lateralmost terminal caudal setae (Fig. 7A); pediger 5 pilose laterally; genital double-somite (Fig. 7B) a little longer than wide; seminal receptacle with wide and long lateral arms; transverse ducts meeting at straight or concave angle anteriorly to horseshoe-shaped copulatory pore (Fig. 7C); copulatory duct wide and sinuously curved or shown as folded in overview; A1 (Fig. 7D) furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennular segments 4-5, 7-10 and 12-13, spinule arrangement as in figure; anterior face of A2 basis (Fig. 7E) with longitudinal row of 18-20 spinules along proximal half of lateral margin; posterior face of A2 basis (Fig. 7F) ornamented with oblique spinule row around middle of medial margin, longitudinal row of about 8 spinules along lateral margin rather sparsely, while nearly smooth around implantation of distomedial setae; both exopods and endopods of P1-4 composed of 3 segments; spine formula of P1-4 exp3, 3,4,4,3; P1 basipodite lacking distomedial seta (Fig. 7G); P4 coupler smooth on both posterior and anterior surface, with pair of large, acute hook-shaped outgrowths on distal margin (Fig. 7H); P4 coxopodite with about 5 spinules sparsely along distal margin; apical spines of P4 enp3 nearly subequal (lateral spine about 1.1 times longer than medial spine), apical spines much shorter than P4 enp3, lateral edge of medial spine with many spinules; P5 (Fig. 7I) 2-segmented, medial spine located just anterior to half of medial margin of distal segment, lateral seta of proximal segment much shorter than medial spine and apical seta.

Remarks. *Mesocyclops mariae* was described originally from a pool at southern China (Guangxi Province) by Guo (2000b), and thereafter no additional reports have been existed yet. So, this record from South Korea is the first one outside the type locality. In Korea, only one female was found at a small ditch flowing into Yellow Sea, near westernmost mud flat of Ganghwa Is., about 50 km west from Seoul. Korean specimen fits well with the original description except the relative length of apical spines on P4 enp3 (medial spine is shorter than lateral one in Korean specimen, while vice versa in the original description), the size arrangement of setae/spine armature on P5 (medial spine is longest in Korean specimen, while apical seta is slightly longer than medial spine in the original description), and the spinule ornamentation on ventral surface of first segment of A1 (simple in Korean specimens, while several rows of minute spinules in the original description).

Among five *Mesocyclops* species from Korea, this species is most similar to *M. leuckarti* in sharing the important characteristics as follows: wide and sinuously folded copulatory duct, basic ornamentation pattern on A2 basis, and possession of large and acute hook-shaped outgrowths on distal margin of P4 coupler. However, *M. mariae* is easily distinguished from *M. leuckarti* by medial hairs on Fu (Fig. 7A, arrow), absence of spinules at implantations of lateral and lateralmost terminal caudal setae, and pilose pediger 5 (Fig. 7I, arrow).

Distribution. South China (Guangxi Province) and Korea.

A key to the species of genus *Mesocyclops* from Korea

1. Fu pilose on anterior half of medial face *M. mariae* Guo
Fu not pilose on anterior half of medial face 2
2. Copulatory duct broad, sinuously folded *M. leuckarti* (Claus)
Copulatory duct narrow, widely curved laterally 3
3. P4 coupler with large, hooked outgrowths *M. pehpeiensis* Hu
P4 coupler with small, blunt triangular outgrowths 4
4. Spinules present at implantations of lateral and lateralmost terminal caudal setae
..... *M. dissimilis* Defaye and Kawabata
Spinules absent at implantations of lateral and lateralmost terminal caudal setae
..... *M. woutersi* Van de Velde

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REFERENCES

- Cho, K. S., 1965. A study on limnological condition and plankton of Lake Paro. Chunchon Teachers College Journal, **2**: 45-57.
- Claus, C., 1857. Das Genus *Cyclops* und seine einheimischen Arten. Arch. Naturgesch., **23**: 1-40.
- Defaye, D. and K. Kawabata, 1993. *Mesocyclops dissimilis* n. sp. from Lake Biwa, Japan (Copepoda, Cyclopoida). Hydrobiologia, **257**: 121-126.
- Guo, X., 2000a. A redescription of *Mesocyclops pehpeiensis* Hu, 1943 and notes on *Mesocyclops ruttneri* Kiefer, 1981 (Copepoda, Cyclopidae). Hydrobiologia, **418**: 33-43.
- Guo, X., 2000b. Two new species of *Mesocyclops* from southern China and notes on the genus *Mesocyclops* in China. Hydrobiologia, **429**: 115-131.
- Holyńska, M., 1997. Tracing the routes of speciation in *Mesocyclops woutersi*-superspecies (Copepoda: Cyclopoida). Ann. Zool., **47**(3/4): 321-336.
- Holyńska, M., 2000. Revision of the Australasian species of the genus *Mesocyclops* Sars, 1914 (Copepoda: Cyclopidae). Ann. Zool., **50**(3): 363-447.
- Hu, Y. T., 1943. Notes on fresh-water copepods from Pehpei, Szechwan. Sinensia, **14**(1-6): 115-128.
- Ishida, T., 1999. *Mesocyclops yesoensis* sp. nov., *M. leuckarti* and *M. pehpeiensis* (Crustacea: Copepoda) from Hokkaido, northern Japan. Biogeography, **1**: 81-85.
- Ishida, T., 2002. Illustrated fauna of the freshwater cyclopoid copepods of Japan. Bull. Biogeogr. Soc. Jpn.,

575: 37-106.

- Kawabata, K. and D. Defaye, 1994. Description of planktonic copepods from Lake Kahoku-gata, Japan. Jpn. J. Limnol., **55**: 143-158.
- Kiefer, F., 1981. Beitrag zur Kenntnis von Morphologie, Taxonomie und geographischer Verbreitung von *Mesocyclops leuckarti* auctororum. Arch. Hydrobiol., Suppl. **62**(1): 148-190.
- Kim, H. S. and C. Y. Chang, 1989. Freshwater cyclopoid copepods (Cyclopoida, Cyclopidae) of Korea. Korean J. Syst. Zool., **5**(2): 225-256.
- Reid, J. W., 1993. New records and redescriptions of American species of *Mesocyclops* and of *Diacyclops bernardi* (Petkovski, 1986) (Copepoda: Cyclopoida). Bijdr. Dierk., **63**(3): 173-191.
- Reid, J. W. and B. H. Kay, 1992. *Mesocyclops guangxiensis* new species, and new records of four congeners (Crustacea: Copepoda: Cyclopidae) from China, Laos, and Vietnam. Proc. Biol. Soc. Wash., **105**(2): 331-342.
- Shen, C. J. and A.-Y. Tai, 1979. Harpacticoida. Freshwater Copepoda. Fauna Sinica, Science Press, Peking, pp. 1-650.
- Shirayama, Y., T. Kaku, and R. P. Higgins, 1993. Double-sided microscopic observation of meiofauna using an HS-slid. Benth. Res., **44**: 41-44.
- Ueda, H. and J. W. Reid, 2003. Copepoda: Cyclopoida. Genera *Mesocyclops* and *Thermocyclops*. Backhuys Publishers, Leiden. pp. 1-318.
- Van de Velde, I., 1984. Revision of the African species of the genus *Mesocyclops* Sars, 1914 (Copepoda: Cyclopoida). Hydrobiologia, **109**: 3-66.
- Van de Velde, I., 1987. New *Mesocyclops* species (Copepoda, Cyclopidae) from Papua New Guinea. Bull. Inst. Roy. Sci. Nat. Belg. (Biol.), **57**: 149-162.
- Yoo, K.-I. and B. J. Lim, 1989. Systematic studies on the freshwater Copepoda (Crustacea) in Lake Youngsan, Korea. Korean J. Limnol., **22**(2): 127-146.

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한국산 보통검물벼룩속 (요각아강, 검물벼룩목, 검물벼룩과)의 분류

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요 약

한국 담수산 검물벼룩류에 대한 분류학적 연구의 일환으로, 보통검물벼룩 (*Mesocyclops*)속의 5종을 분류하였다: 보통검물벼룩 (*M. leuckarti*), 갈고리보통검물벼룩 (*M. pehpeiensis*), 꼭지보통검물벼룩 (*M. dissimilis*), 민가시보통검물벼룩 (*M. woutersi*), 털줄보통검물벼룩 (*M. mariae*). 이 중 뒤의 3종은 한국미기록종이다. 이들 5종의 분류학적 미세 형질과 종내 변이성을 검토하였다. 한국산 보통검물벼룩속의 종 검색표를 작성하였다.