



A redescription of *Mesocyclops pehpeiensis* Hu, 1943 and notes on *Mesocyclops ruttneri* Kiefer, 1981 (Copepoda, Cyclopidae)

Xiaoming Guo

Institut für Zoologie der Universität Wien, Althanstrasse 14, A-1090 Wien, Austria

Present address: Lake Sedimentation & Environment Laboratory, Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, 73 East Beijing Road, Nanjing 210008, China.

E-mail: guo57918@yahoo.com

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Abstract

A redescription of *Mesocyclops pehpeiensis* Hu, 1943 is given based on the author's collection from Caohai lake in Guizhou province, China, July 1997. This species was also obtained from Zhenzhuquan lake in Nanjing, Jiangsu province, China, August 1995. A comparison with the original descriptions of *M. pehpeiensis* and *Mesocyclops ruttneri* Kiefer, 1981 is made. *M. ruttneri* Kiefer, 1981 is synonymized with *M. pehpeiensis* Hu, 1943.

Introduction

Since *Mesocyclops pehpeiensis* was described by Hu in 1943, many researchers (Shen (1956), Tai & Chen (1979), Lim & Fernando (1985), Dussart & Fernando (1985, 1988), Reid (1993), Ueda, Ishida & Imai (1997)) were interested in this species, especially after *Mesocyclops ruttneri* was described by Kiefer (1981). Lim & Fernando (1985), Dussart & Fernando (1985, 1988), based on specimens from Malaysia and Sri Lanka, considered *M. ruttneri* a synonym of *M. pehpeiensis*, while Reid (1993), Ueda, et al. (1997), based on Kiefer's type specimens, and material from United States, China, Thailand, Viet Nam and Japan, thought *M. pehpeiensis* and *M. ruttneri* were different species. In the original description of *M. pehpeiensis* by Hu (1943), little information was provided, Shen (1956) and Tai & Chen (1979) also did not provide sufficient details, giving rise to controversy. Fortunately, during research on the freshwater copepods of China, *M. pehpeiensis* was found from Guizhou and Jiangsu provinces. It is here redescribed and compared to *M. ruttneri*.

Materials and methods

M. pehpeiensis was obtained from Caohai lake (26° 50'–57' N, 104° 11'–17' E, Alt. 2200 m) (Figure 1), a shallow freshwater lake with submerged vegetation, Guizhou province, China, in July 1997. Plankton nets with mesh sizes 112 μm and 64 μm were used and samples were preserved in 4–7% formalin solution. Specimens were dissected in glycerine or PVL (polyvinyl lactophenol) under a stereo zoom binocular microscope and a Leitz Laborlux K microscope with a camera lucida were used for identifying, measuring and drawing specimens. Measurements were taken following Kozminski (1936). Mounting was done in glycerine and PVL sealed under coverslip with nail polish. A small quantity of modeling clay under the corners of the coverslip was used to prevent the animal from being crushed.

Abbreviations used in the text: PVL – polyvinyl lactophenol; L – length; W – width; A1 – antennula; A2 – antenna; P1 – leg 1; P2 – leg 2; P3 – leg 3; P4 – leg 4; P5 – leg 5; P6 – leg 6; Cxp. – coxopodite (sometimes called coxa); Bsp – basipodite (sometimes

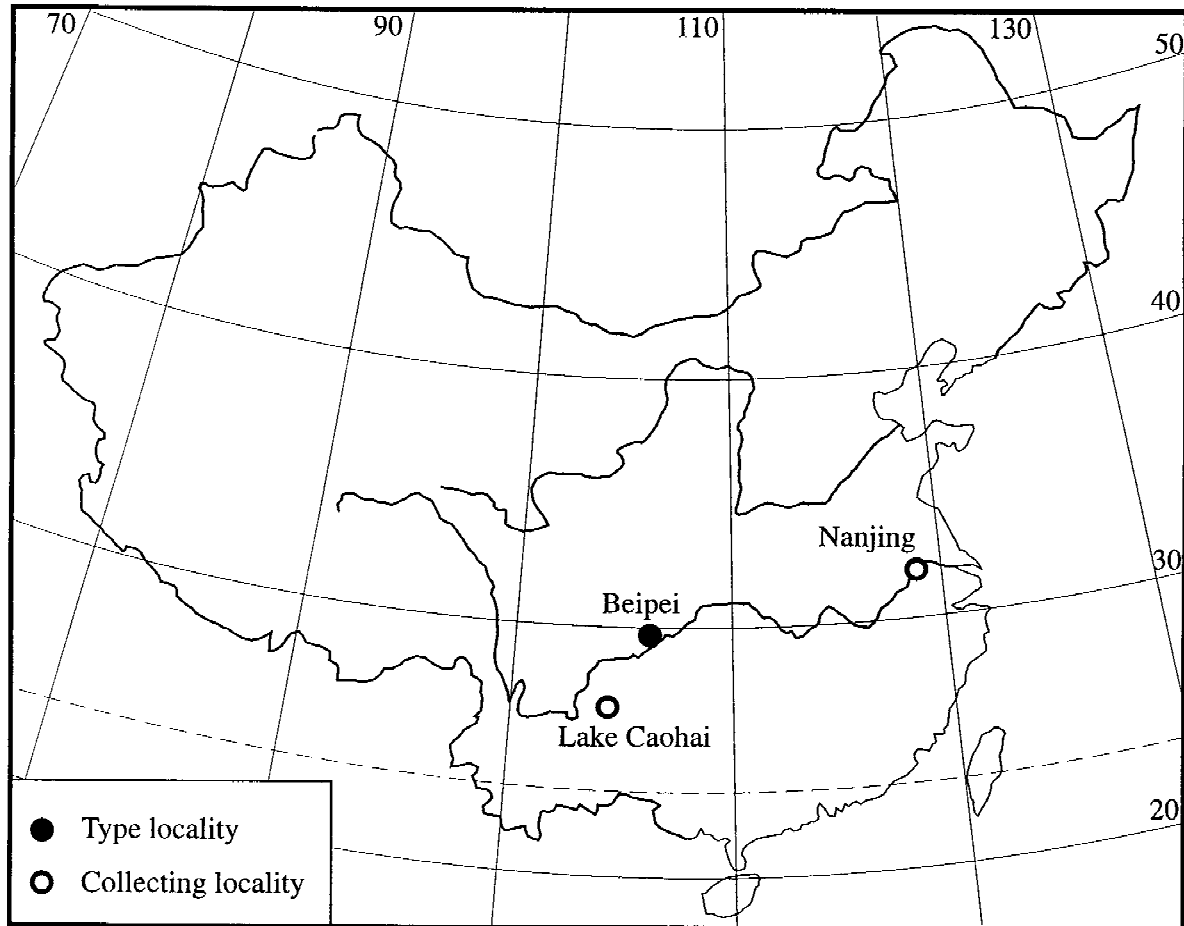


Figure 1. Sampling location of *Mesocyclops pehpeiensis*.

called basis); Enp – endopodite (Enp1 to Enp3); Exp – exopodite (Exp1 to Exp3); RS – seminal receptacle; Si – internal caudal seta; Smi – internal median caudal seta; Sme – external median caudal seta; Se – external caudal seta; Sd – dorsal caudal seta; Sl – lateral caudal seta.

Redescription of *Mesocyclops pehpeiensis*

Mesocyclops pehpeiensis Hu, 1943 (Figures 2 A–H; 3 A–D and 4 A–H) *Mesocyclops leuckarti pehpeiensis* Hu, 1943: 124–126, Table. 2, Figure c. *Mesocyclops pehpeiensis* Shen, 1956: 9, pl. 3, Figures 26–29; Tai & Chen, 1979: 409–410, Figures 247–248. *Mesocyclops ruttneri* Kiefer, 1981: 178–180, Figures 14 (1–6); Reid, 1993: 177–183, Figures 3, 4 and 5; Mirabdullayev, 1996: 98–99, Figures 23–26; Ueda, Ishida & Imai, 1997: 66–68, Figures 38–50. **Non:** *Meso-*

cyclops pehpeiensis Lim & Fernando, 1985: 83–85, Figures 57–59; Dussart & Fernando, 1985: 246; 1988: 249, Figures 24–27.

Diagnosis

Antennula 17-segmented with groups or rows of spinules on segment 1, 4, 5 and 7–13 and segment 17 with one deep notch. Antennary basis with caudal spinule pattern of *M. leuckarti* (Claus, 1857; Van de Velde, 1984), row of 6–7 spinules at level of medial setae and 2–4 spinules near distal margin. Maxillulary palp without spinules. Maxillar syncoxa shows frontally distinct rows of spinules. Medial distal margin of P1 basis without spine. Distal margin of connecting plate of P4 with two large acute outgrowths, medial expansion of P4 basis naked. Pediger 5 without hairs laterally and dorsally. Seminal receptacle with two short lateral arms, slightly curved at their ends

and transverse ducts from copulatory pore slightly V-shaped. Caudal rami without hairs on medial margin and armed with spinules at bases of lateral and external terminal setae.

Description of female

Average length to the end of caudal rami 1.34 mm ($n=10$); range 1.21–1.52 mm (Figure 2 A). *Antennula* (Figure 2 B): 17 segments, reaching distal margin of second proximal somite. Spinules on segments 1, 4, 5 and 7–13 arranged in groups or rows. Last two segments with serrate hyaline membrane, last one (17th) with deep notch. *Antenna*: General structure and setation like that of *M. leuckarti*; following Van de Velde's (1984) terminology, longitudinal row of spines on frontal surface (Figure 2 C) composed of 26 spinules and a row of tiny spinules near proximal margin; on caudal surface (Figure 2 D), a longitudinal row of 13 spinules and proximal to this row, a row of 7–9 spinules, an oblique row of 16–18 tiny spinules near medial edge of the segment, an irregular transverse row of 6–7 spinules at level of medial setae and 2–4 spinules near distal margin and a patch of 7–8 spinules near medio-proximal margin. *Mandibula* (Figure 2 E), *maxillula*, *maxillary palp* (Figure 2 F), and *maxilliped* (Figure 2 H) similar to *Mesocyclops leuckarti*. *Maxilla* (Figure 2 G): General structure similar to *M. leuckarti*, but syncoxa frontally ornamented with distinct longitudinal rows of spinules. *P1 to P4* (Figures 3 A–D): Spine and setae formulae typical for genus; connecting plates without any setules; medial expansion of P1 basipodite without spine. *P4* (Figure 3 D): Enp3 2.60–2.93 times as long as wide; the medial apical spine slightly longer than lateral one, these two spines shorter than segment. Caudal armature of P4 coxopodite consisting of an intermittent group of large spinules (5–8 + 3–5) near distal rim, an oblique row of long spinules (7–9) inserted on lateral distal corner, a row of spinules (15–18) near proximal rim and hairs presented between proximal rim and oblique row of long spinules. Medial expansion of basis naked. Two large acute outgrowths on distal margin of connecting plate. *P5* (Figure 4 A): Similar to *M. leuckarti*. Apical seta 1.2 times as long as medial spiniform seta. *P6* (Figure 4 B): Composed of a long medial seta and 2 short spines. Distal to implantation of P6 a group of six pores. *Pediger 5* (Figure 4 A) without hairs on each lateral side. *Seminal receptacle* (Figure 4 A): Two short lateral arms slightly curved at their ends; transverse ducts from copulatory pore slightly V-shaped;

pore-canal curved towards right. *Anal somite* (Figure 4 C, D): Distal margin with well-developed spinules ventrally and dorsally in a continuous row. *Caudal rami* (Figure 4 C–E): $L/W = 3.77$ ($n=10$), range 3.5–4.07; not pilose on medial margin; lateral and external terminal setae with spinules at their base; length of the terminal setae (Figure 4 E): $S_i = 287 \mu\text{m}$, $S_{mi} = 615 \mu\text{m}$, $S_{me} = 410 \mu\text{m}$, $S_e = 94 \mu\text{m}$, $S_d = 88 \mu\text{m}$, $S = 46 \mu\text{m}$.

Description of male

Average length to end of caudal rami 0.81 mm ($n=7$); range 0.74–0.88 mm. Antennula has 17 segments and 3 aesthetascs on the first segment, 1 on the 4th, 1 on the 9th and 1 on the 13th segment (Figure 4 F). Mouth parts are the same as in female and similar spinule pattern on basipodite of antenna as in female except no spinules on distal margin (Figure 4 G). Caudal rami without hairs on medial margin and 3.3 times as long as wide. Lateral and external terminal setae with spinules at their base. No hairs on lateral edges of the pediger 5 (Figure 4 H). P1–P5 with similar structure as in female. Enp3 P4 2.42–2.78 times as long as wide and medial terminal spine longer than lateral one. Caudal armature of coxopodite and medial expansion of basis of P4 similar to female. P6 composed of one stout ventral spine, one short medial seta and one long dorsal seta; dorsal seta 1.33 times as long as ventral spine.

Discussion

Mesocyclops peheiensis was found by Hu in 1943. Unfortunately, the original description provided little information. Later, Shen (1956) and Tai & Chen (1979) also did not provide sufficient details so that this species has given rise to controversy, especially when *Mesocyclops ruttneri* was described by Kiefer in 1981 (Figure 5 A–G). However, nobody properly redescribed of *M. peheiensis*. The main problem is therefore what is the genuine *M. peheiensis*.

Based on Table 1, most characteristics from my species conform with the original description except the ratio of Enp3 P4 (L/W) and body length, which are smaller than in the type specimen. In my opinion, body length shows variation within a species, while the different ratio of Enp3 P4 (L/W) may reflect a different measurement method adopted. According to Kozminsky's method, the original description of the Enp3 P4

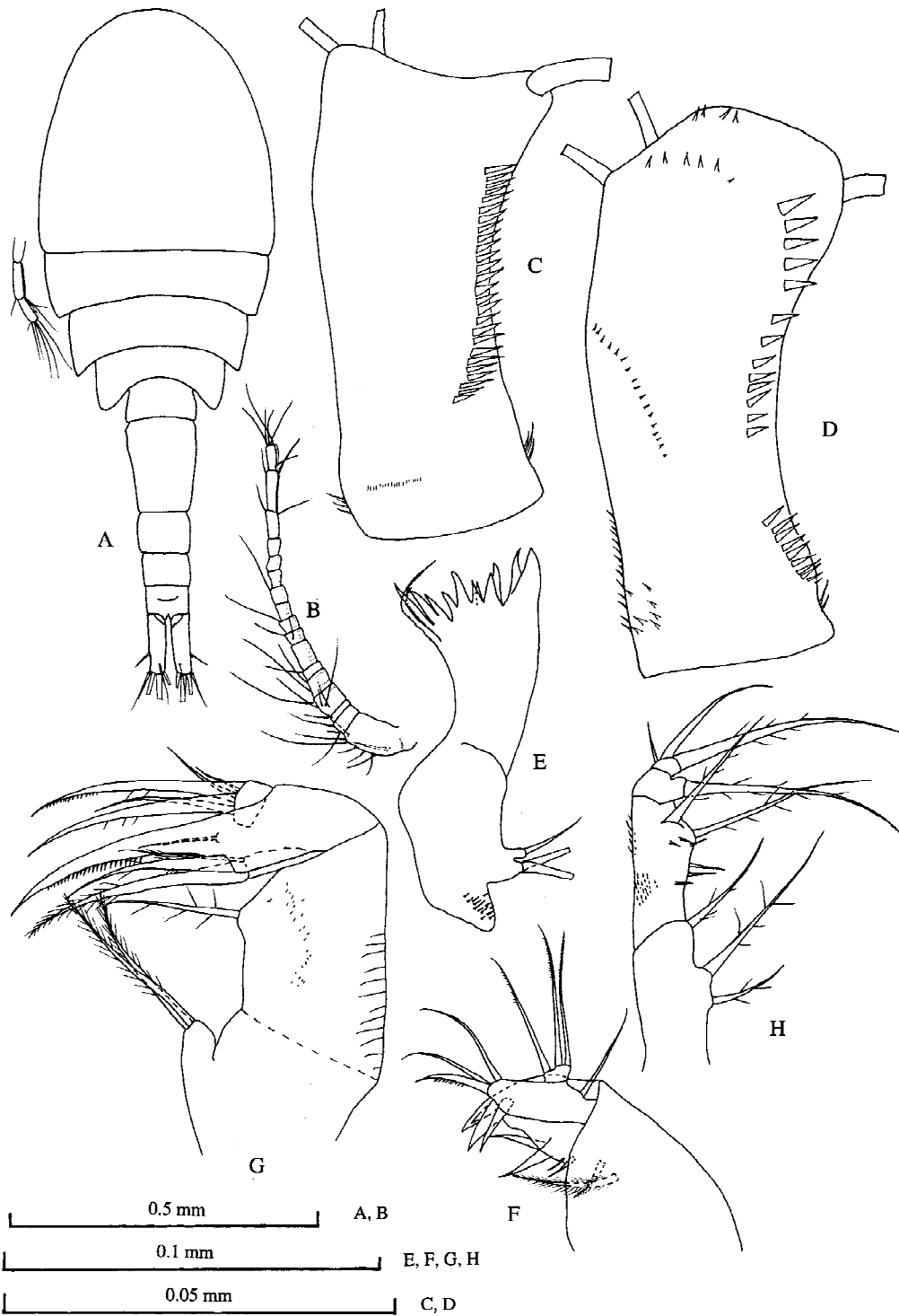


Figure 2. *Mesocyclops pehpeiensis*. Female: A, habitus; B, A1; C, Bsp A2, frontal; D Bsp A2, caudal; E, mandibula; F, maxillula; G, maxilla; H, maxilliped.

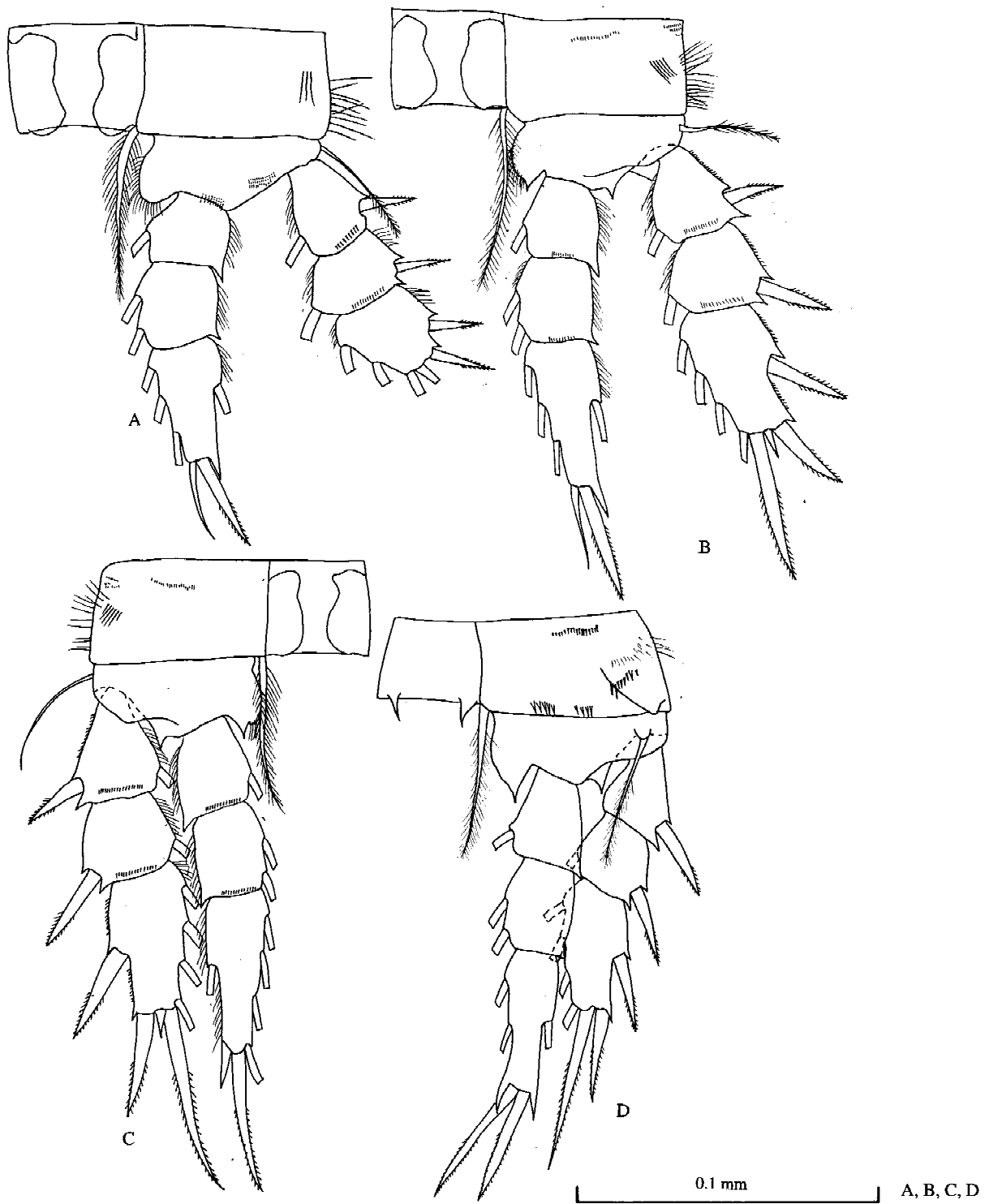


Figure 3. *Mesocyclops pehpeiensis*. Female: A, P1; B, P2; C, P3; D, P4.

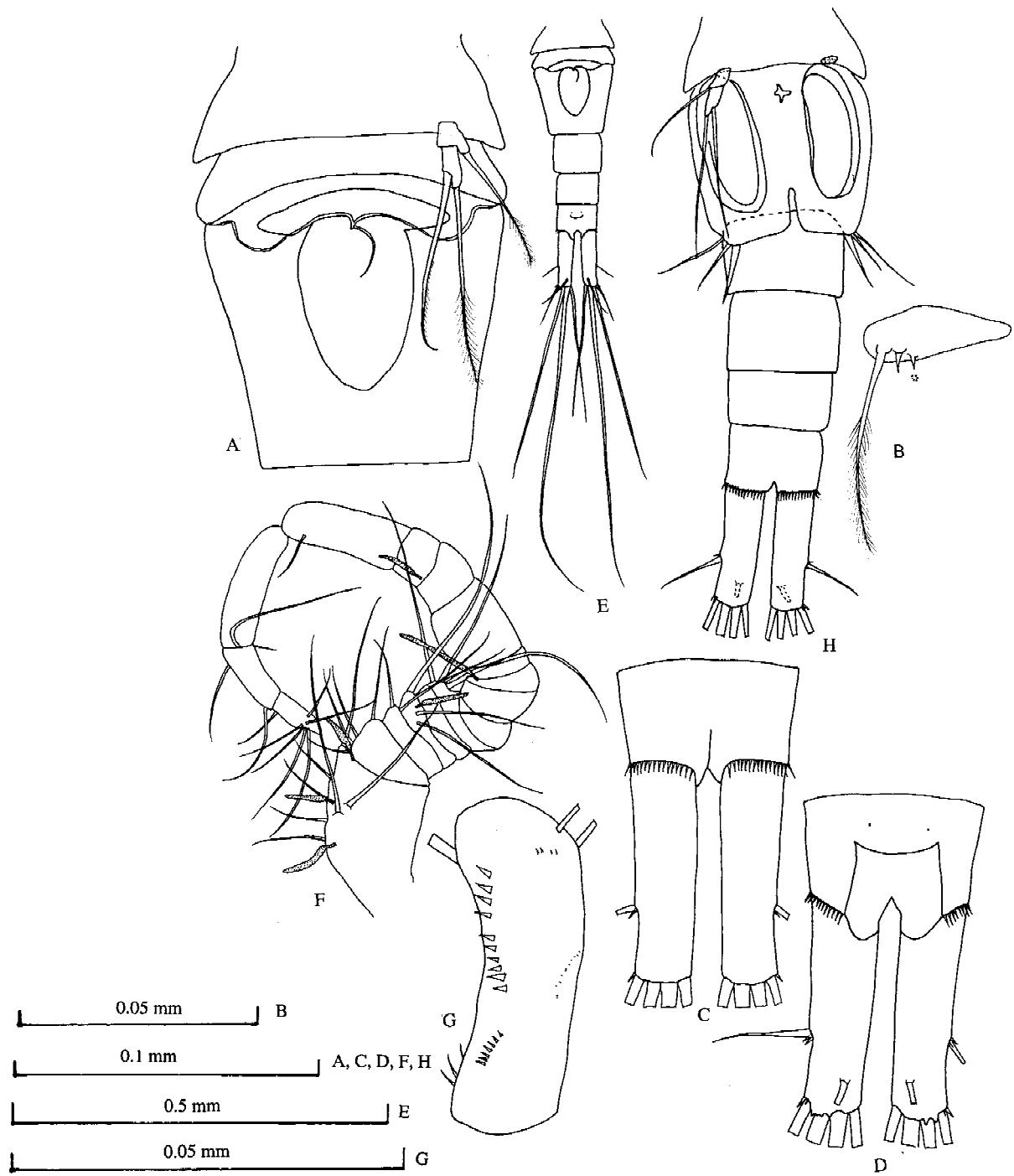


Figure 4. *Mesocyclops pehpeiensis*. Female: A, pediger 5 and genital double somite; B, P6; C, anal somite and caudal rami, ventral; D, anal somite and caudal rami, dorsal; E, urosome with terminal setae. Male: F, A1; G, Bsp A2, caudal; H, urosome, ventral.

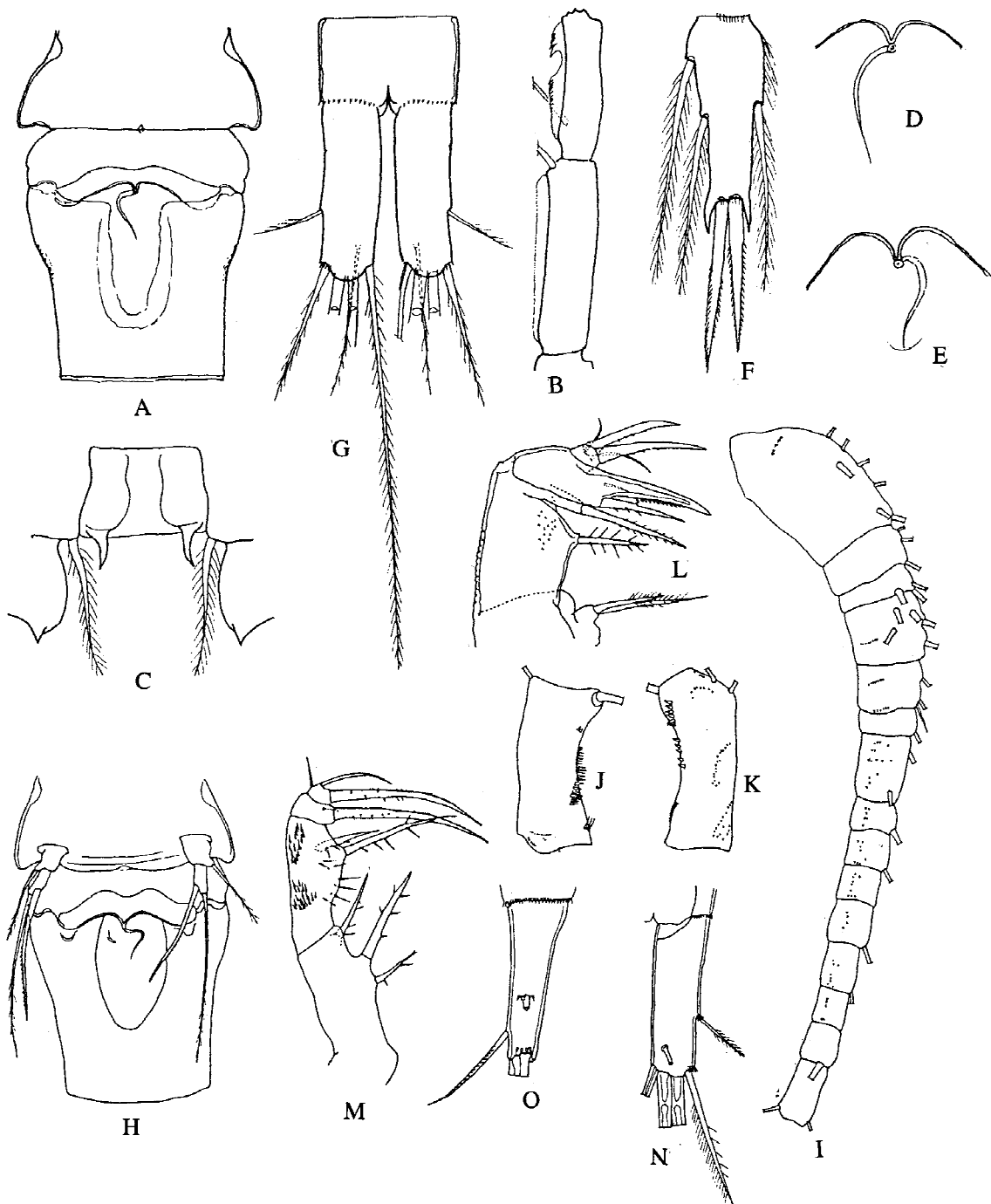


Figure 5. *Mesocyclops rutneri* A-G (copy from Kiefer, 1981). Female: A, pediger 5 and genital somite; B, segments 16–17 of antennula; C, connecting plate of P4; D–E, R.S.; F, Enp3P4; nG, anal somite and caudal somite. H–O (copy from Ueda et al. 1997). Female: H, pediger 5 and genital somite with P5; I, segments 1–15 of A1; J, basis of A2, anterior; K, basis of A2, posterior; L, maxilla; M, maxilliped; N, right caudal ramus, dorsal; O, right caudal ramus, lateral.

Table 1. Comparison of characteristics of female *M. pehpeiensis* with Hu and Tai & Chen

	Body length (mm)	Caudal rami (L/W)	Enp3P4 (L/W)	Si (μm)	Smi	Sme	Se	Sd	Sl
Hu (1943)	1.525–1.710	3.5–4.0	3.6–4.0	2/3 of Sme	ca.1/2 of body length		<1/3 of Si	<Se	
Tai & Chen (1979)	1.45–1.70	3.8	ca.3.0			ca.4/5 of Smi	ca.1/3 of Si	<Se	
Author	1.21–1.52	3.5–4.07	2.60–2.93	287	615	410	94	88	46

by Hu (1943, Figure C-5) is about 2.7 times as long as wide. Although the specimens of *M. pehpeiensis* collected by me are not from the type locality (Beipei, Sichuan province of China), the locality, Caohai lake in Guizhou province, is not far from the type locality. According to Hu's record, *M. pehpeiensis* lives in various freshwater bodies of Beipei, whereas according to Tai & Chen (1979)'s record, it occurs in Sichuan, Yunnan, Jiangsu, Hubei, Shaanxi, Shanxi, Beijing and Inner Mongolia. Since the species has a wide distribution in China, the specimens from Caohai lake in Guizhou indeed belong to *M. pehpeiensis*.

Originally, I did not find the long caudal rami forms, but only the forms which conform to *M. ruttneri*, with a row of spinules at the level of the medial setae on the caudal surface of basipodite of antenna, pediger 5 without hairs, two large acute outgrowths on the distal margin of connecting plate of P4, medial expansion of P4 basipodite naked, armature of coxopodite of P4 and caudal rami armed with spinules at base of lateral and external terminal setae. However, recently, I found the long caudal rami forms (described above) from Guizhou and Jiangsu and compared them with *M. pehpeiensis* and *M. ruttneri*. It is clear that *M. ruttneri* is conspecific with *M. pehpeiensis*. Both of them only differ by the length of caudal rami. In addition, specimens with different lengths of caudal rami were found in the same locality (Nanjing, Jiangsu) where the ratio of caudal rami (L/W) was 2.87–4.00. It is, therefore, obvious that the length of the caudal rami shows variation within the species.

Reid (1993) (Figure 6 A–L) and Ueda et al. (1997) (Figure 5 H–O) redescribed *M. ruttneri*. Compared with *M. pehpeiensis* described above, most characteristics are the same. Ueda et al. (1997) mentioned that “the medial spine on the P5 of *M. ruttneri* is apparently shorter than the terminal seta, which are ap-

proximately equal in Hu's *M. pehpeiensis*”. Although Hu (1943) described the medial spinous seta as approximately as long as the terminal seta, the former is always shorter than the latter. The P5 in my specimens are similar to Tai & Chen's (1979) description, therefore P5 gives no reason to distinguish *M. pehpeiensis* and *M. ruttneri*. Mirabdullayev (1996) reported *M. ruttneri* from Uzbekistan. According to his description and figures, most features conform with *M. pehpeiensis*, especially the caudal rami (L/W) 3.0–3.9 and the proportion of the medial spine and terminal seta of P5. Doubtlessly, this population is *M. pehpeiensis* too. The descriptions of *M. pehpeiensis* by Lim & Fernando (1985) (Figure 7 E–H) and Dussart & Fernando (1988) (Figure 7 A–D) are evidently not conspecific with *M. pehpeiensis*, because there are different spine patterns on the caudal surface of the basipodite of the antenna (Figure 7 B, F, G) and different seminal receptacles (Figure 7 A, E), while the lateral setae on caudal rami have no spinules at their base (Figure 7 D, E). The figures by Lim & Fernando (1985) show thick hairs on the medial expansion of Bsp P4 (Figure 7 H), which is naked in *M. pehpeiensis*.

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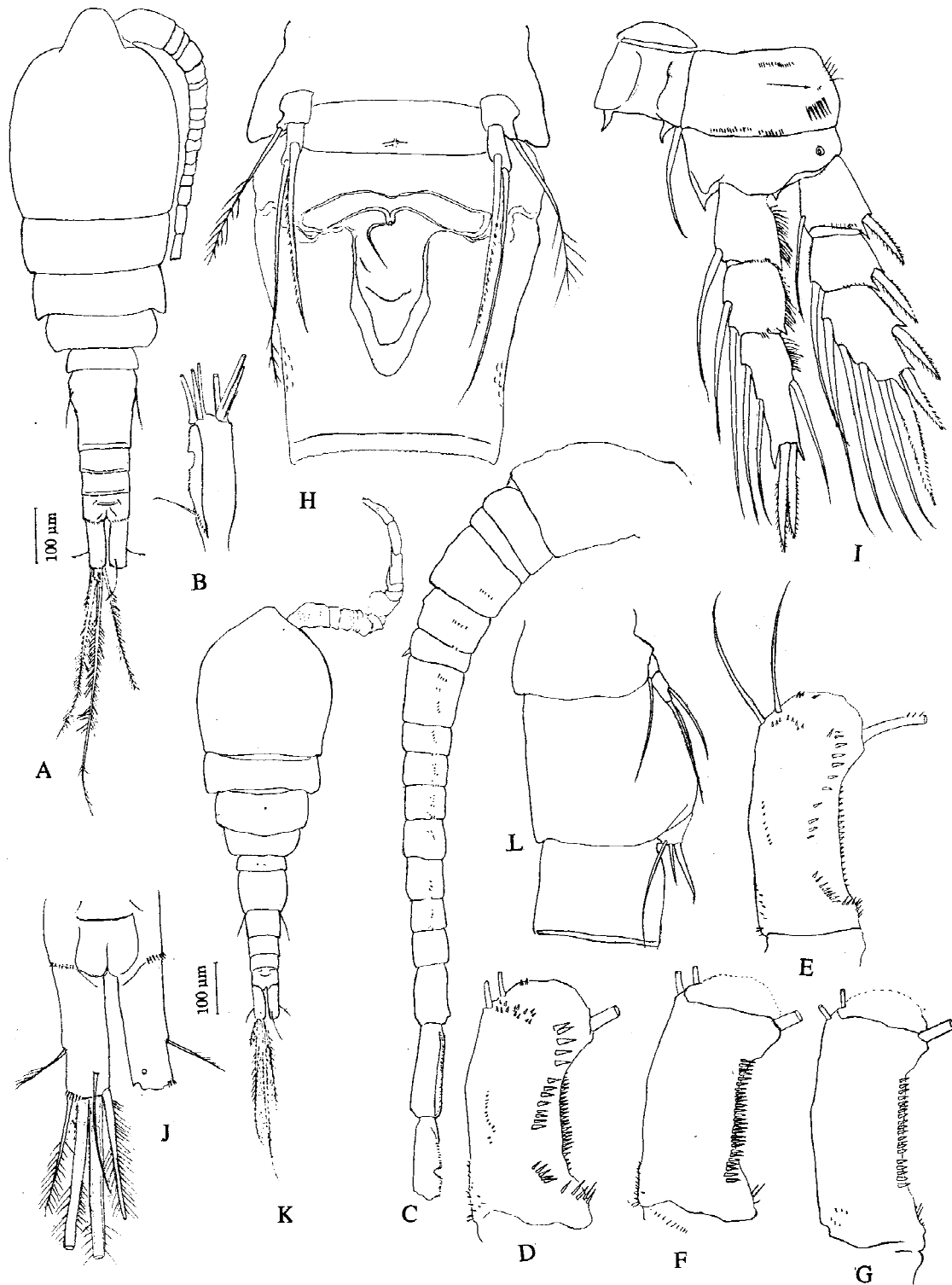


Figure 6. *Mesocyclops rutneri* (copy from Reid, 1993). Female: A, habitus; B, segment 17 of A1; C, A1; D-E, basis of A2, caudal; F-G, basis of A2, frontal; H, pediger 5 and genital somite with P5; I, P4; J, anal somite and caudal rami. Male: K, habitus; L, pediger 5, 6 and succeeding urosomite.

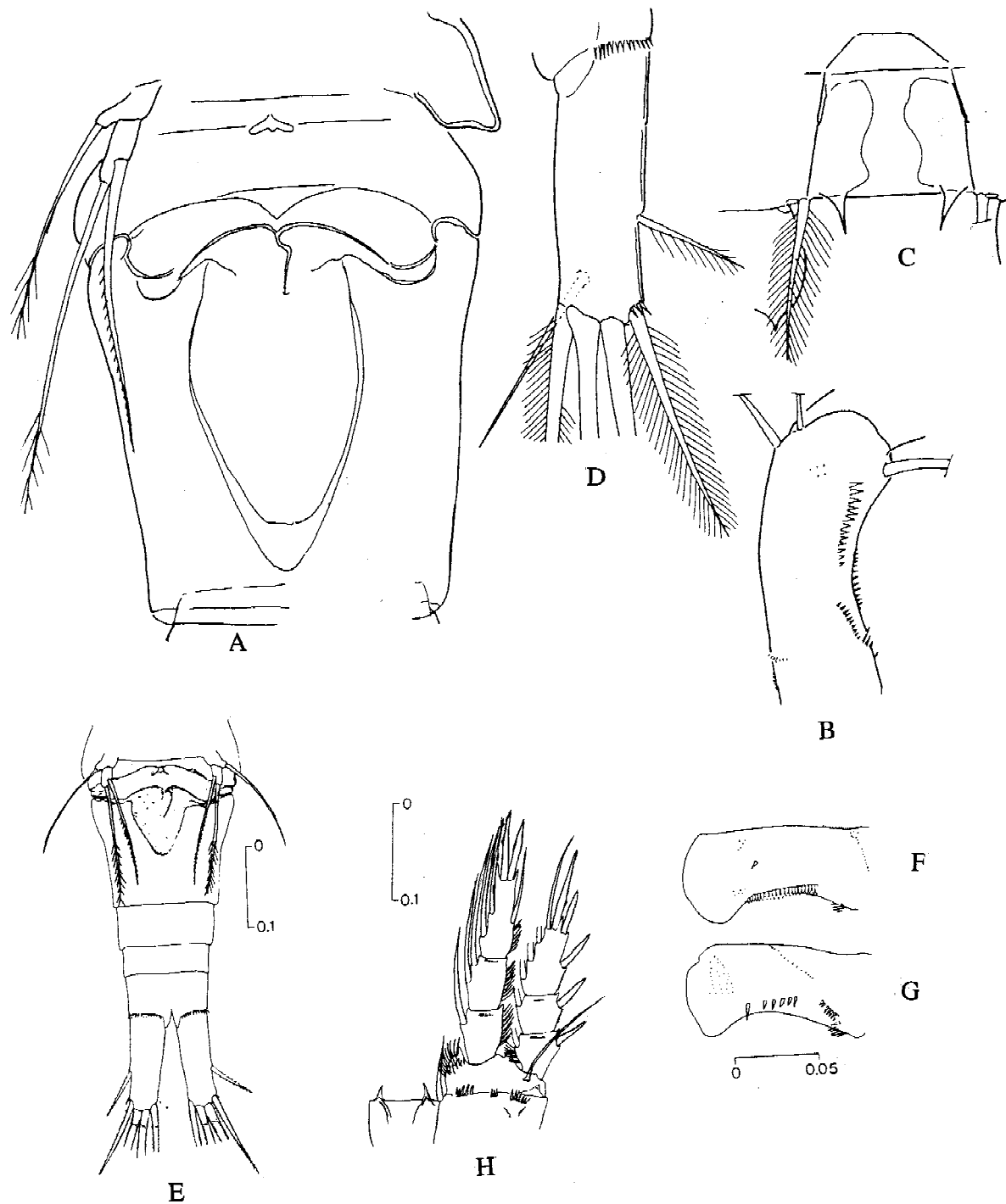


Figure 7. *Mesocyclops pehpeiensis* A–D (copy from Dussart & Fernando, 1988). Female: A, pediger 5 and genital somite with P5; B, basis of A2, caudal; C, connecting plate of P4; D, left caudal ramus, ventral. E–H (copy from Lim & Fernando, 1985). Female: E, pediger 5 with P5 and abdomen with caudal rami; F, basis of A2, frontal; G, basis of A2, caudal; H, P4.

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References

- Dussart, B. H. & C. H. Fernando, 1985. Le genre *Mesocyclops* (Crustacé, Copépode) en Amérique du Nord. *Can. J. Zool.* 63: 961–964.
- Dussart, B. H. & C. H. Fernando, 1988. Sur quelques *Mesocyclops* (Crustacea, Copepoda). *Hydrobiologia* 157: 241–264.
- Hu, Y. T., 1943. Notes on fresh-water copepods from Pehpei, Szechwan. *Sinensia* 14 (1–6): 115–128.
- Kiefer, F., 1981. Beitrag zur Kenntnis von Morphologie, Taxonomie und geographischer Verbreitung von *Mesocyclops leuckarti* auctorum. *Arch Hydrobiol Suppl.* 62: 148–190.
- Kozminski, Z., 1936. Morphometrische und ökologische Untersuchungen an Cyclopiden der strenuus-Gruppe. *Int. Rev. ges. Hydrobiol. Hydrogr.* 33: 161–240.
- Lim, R. P. & C. H. Fernando, 1985. A review of Malaysian freshwater Copepoda with notes on new records and little known species. *Hydrobiologia* 128: 71–89.
- Mirabdullaev, I. M., 1996. The Genus *Mesocyclops* (Crustacea: Copepoda) in Uzbekistan (Central Asia). *Int. Rev. ges. Hydrobiol.* 81: 93–100.
- Reid, J. W., 1993. New records and redescription of American species of *Mesocyclops* and *Diacyclops bernardi* (Petkovski, 1986) (Copepoda: Cyclopoida). *Bijdr Dierk* 63: 173–191.
- Shen, C. J., 1956. On a collection of Copepoda from Chinghai Province and Inner Mongolia. *Acta Zool. Sin.* 8: 1–16 (in Chinese).
- Tai, A. Y. & G. X. Chen, 1979. Cyclopoida. *Fauna Sinica, Crustacea, Freshwater Copepoda*. Science Press, Beijing, China: 406–410 pp. (in Chinese).
- Ueda, H., T. Ishida & J. Imai, 1997. Planktonic cyclopoid copepods from small ponds in Kyushu, Japan. II. Subfamily Cyclopinae. *Hydrobiologia* 356: 61–71.
- Van de Velde, I., 1984. Revision of the African species of the genus *Mesocyclops* Sars, 1914 (Copepoda: Cyclopidae). *Hydrobiologia* 109: 3–66.