OPEN
출처표시 상업용금지 변경금지
공공누리 공공저작물 자유이용허락

Invertebrate Fauna of Korea

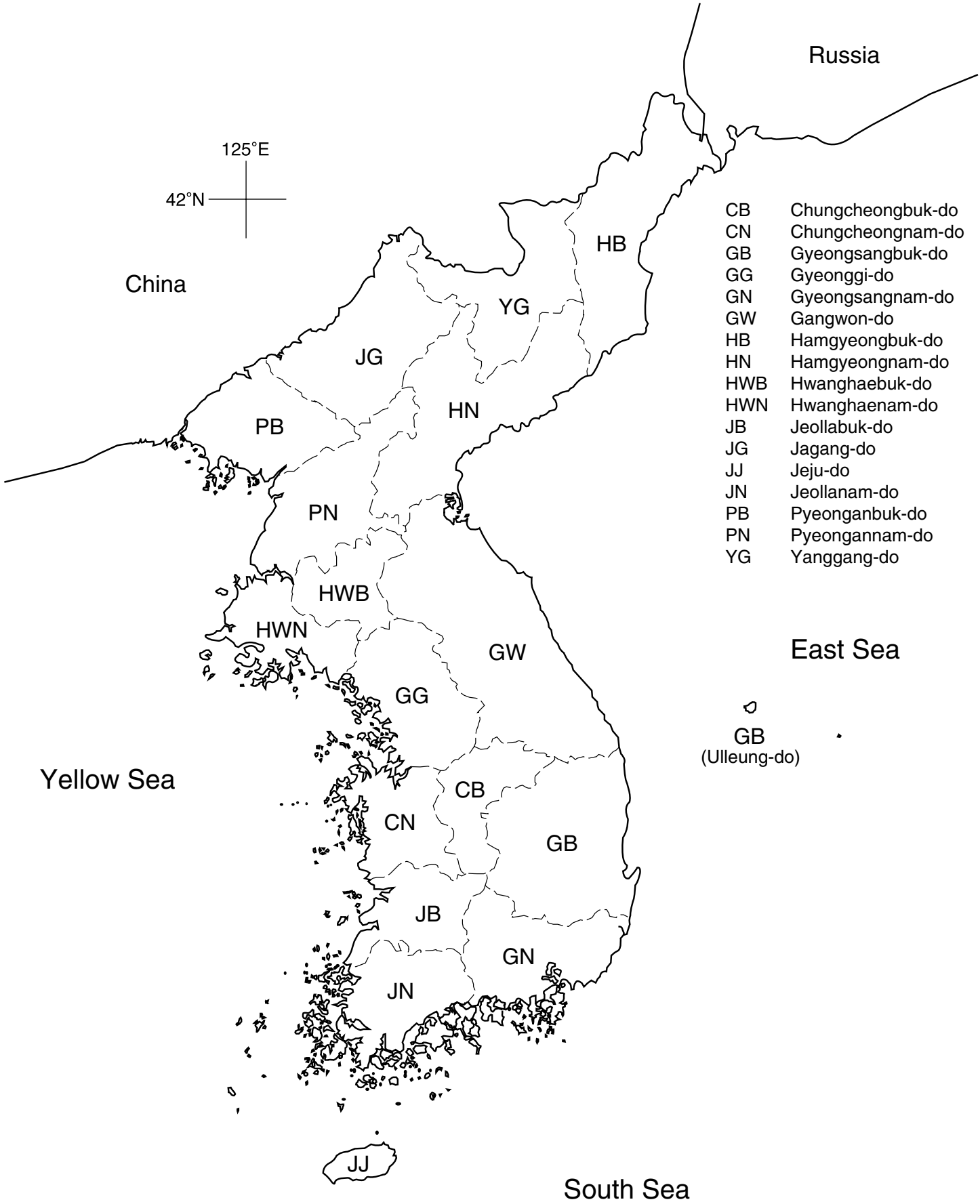
Volume 21, Number 26

Arthropoda: Maxillopoda: Copepoda: Cyclopoida:
Cyclopidae: Cyclopinae

Continental Cyclopoids II

Flora and Fauna of Korea

National Institute of Biological Resources
Ministry of Environment


Russia
125°E
42°N
China
HB
YG
JG
HN
PB
PN
HWB
HWN
GW
GG
CB
CN
GB
JB
GN
JN
JJ
East Sea
GB
(Ulleung-do)
Yellow Sea
South Sea
CB Chungcheongbuk-do
CN Chungcheongnam-do
GB Gyeongsangbuk-do
GG Gyeonggi-do
GN Gyeongsangnam-do
GW Gangwon-do
HB Hamgyeongbuk-do
HN Hamgyeongnam-do
HWB Hwanghaebuk-do
HWN Hwanghaenam-do
JB Jeollabuk-do
JG Jagang-do
JJ Jeju-do
JN Jeollanam-do
PB Pyeonganbuk-do
PN Pyeongannam-do
YG Yanggang-do

Invertebrate Fauna of Korea

Volume 21, Number 26

Arthropoda: Maxillopoda: Copepoda: Cyclopoida:
Cyclopidae: Cyclopinae

Continental Cyclopoids II

2013

National Institute of Biological Resources
Ministry of Environment

Invertebrate Fauna of Korea

Volume 21, Number 26

Arthropoda: Maxillopoda: Copepoda: Cyclopoida: Cyclopidae: Cyclopinae

Continental Cyclopoids II

Cheon Young Chang

Daegu University

Copyright © 2013 by the National Institute of Biological Resources

Published by the National Institute of Biological Resources
Environmental Research Complex, Hwangyeong-ro 42, Seo-gu
Incheon, 404-708, Republic of Korea
www.nibr.go.kr

All rights reserved. No part of this book may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission of the National Institute of Biological Resources.

ISBN : 9788968110689-96470
Government Publications Registration Number 11-1480592-000648-01

Printed by Junghaengsa, Inc. in Korea on acid-free paper

Publisher : Sang Pal Lee
Project Staff : Joo-Lae Cho, Ye Eun, Sang-Hoon Han

Published on December 20, 2013

The Flora and Fauna of Korea logo was designed to represent six major target groups of the project including vertebrates, invertebrates, insects, algae, fungi, and bacteria. The book cover and the logo were designed by Jee-Yeon Koo.

Preface

In 2010, the 10th Conference of the Parties of the Convention on Biological Diversity (CBD) adopted the Nagoya Protocol on access and benefit-sharing of biological resources. Since then, the national and international environment of the use and management of biological resources has been rapidly changed. Therefore, it is imperative to identify indigenous biological species in details and to build scientific data worthy of international recognition in order to take the initiative in bio-industry.

The National Institute of Biological Resources of the Ministry of Environment has been publishing the Flora and Fauna of Korea to generally manage biological resources and to enhance national competitiveness by setting the foundation for the sovereignty over biological resources. Professional research group consisting of professors of taxonomy and related experts has systematically examined a variety of and wide range of taxa for the last 6 years since 2006.

As a result, 90 issues of the Flora and Fauna of Korea, both in Korean and in English, covering a total of 8,888 species and 2 issues of World Monograph covering 216 species were published. And 30 issues of the Flora and Fauna of Korea, both in Korean and in English, covering 1,665 species of invertebrates, insects and algae are additionally published this year.

These efforts serve to identify indigenous species living in Korea, to investigate biota, to improve the quality of national biological resources management and to provide the opportunity to lay the groundwork for the biotechnological industrialization of biological resources.

I would like to express my sincere appreciation for those who spared no effort to publish the biological magazines; Professor Cheon Young Chang of Daegu University. And I hope he will help to discover useful biological resources in Korea and to create high value-added activities including natural product, gene resource and medical substance development.

Sang-pal Lee
President
National Institute of Biological Resources

Contents

List of Taxa 3
Introduction 5
Materials and Methods 6
Taxonomic Notes 7

1. *Cyclops vicinus* Uljanin 8
2. *Cyclops kikuchii* Smirnov 10
3. *Megacyclops viridis* (Jurine) 13
4. *Megacyclops magnus* (Marsh) 15
5. *Acanthocyclops vernalis* (Fischer) 19
6. *Acanthocyclops orientalis* Borutzky 21
7. *Acanthocyclops robustus* (Sars) 24
8. *Acanthocyclops sensitivus* (Graeter and Chappuis) 26
9. *Acanthocyclops tokchokensis* Kim and Chang 28
10. *Acanthocyclops fonticulus* Lee and Chang 32
11. *Diacyclops bicuspidatus* (Claus) 36
12. *Diacyclops crassicaudis* (Sars) 39
13. *Diacyclops nanus* (Sars) 42
14. *Diacyclops disjunctus* (Thallwitz) 44
15. *Diacyclops languidoides* (Lilljeborg) 47
16. *Diacyclops leeae* Karanovic, Grygier and Lee 49
17. *Itocyclops yezoensis* (Ito) 52
18. *Psammophilocyclops paucisetosus* Lee and Chang 56
19. *Microcyclops varicans* (Sars) 64
20. *Microcyclops rubellus* (Lilljeborg) 66
21. *Microcyclops longiramus* Shen and Sung 68
22. *Cryptocyclops bicolor* (Sars) 70
23. *Cryptocyclops javanus* (Kiefer) 72
24. *Apocyclops borneoensis* Lindberg 74
25. *Mesocyclops leuckarti* (Claus) 78
26. *Mesocyclops pehpeiensis* Hu 80
27. *Mesocyclops dissimilis* Defaye and Kawabata 82
28. *Mesocyclops woutersi* Van de Velde 85
29. *Mesocyclops mariae* Guo 87
30. *Thermocyclops crassus* (Fischer) 90
31. *Thermocyclops taihokuensis* (Harada) 92
32. *Thermocyclops dybowskii* (Landé) 94
33. *Thermocyclops uenoi* Ito 96

Literature Cited 99
Index to Korean Names 104
Index to Korean Names as Pronounced 105
Index to Scientific Names 107

List of Taxa

Phylum Arthropoda Latreille, 1829
  Subphylum Crustacea Brünnich, 1772
    Class Maxillopoda Dahl, 1956
      Subclass Copepoda H. Milne-Edwards, 1840
        Order Cyclopoida Burmeister, 1834
          Family Cyclopidae Dana, 1846
            Subfamily Cyclopinae Kiefer, 1927
              Genus *Cyclops* O.F. Müller, 1776
                Cyclops vicinus Uljanin, 1875
                Cyclops kikuchii Smirnov, 1932
              Genus *Megacyclops* Kiefer, 1927
                Megacyclops viridis (Jurine, 1820)
                Megacyclops magnus (Marsh, 1920)
              Genus *Acanthocyclops* Kiefer, 1927
                Acanthocyclops vernalis (Fischer, 1853)
                Acanthocyclops orientalis Borutzky, 1966
                Acanthocyclops robustus (Sars, 1863)
                Acanthocyclops sensitivus (Graeter and Chappuis, 1914)
                Acanthocyclops tokchokensis Kim and Chang, 1991
                Acanthocyclops fonticulus Lee and Chang, 2007
              Genus *Diacyclops* Kiefer, 1927
                Diacyclops bicuspidatus (Claus, 1857)
                Diacyclops crassicaudis (Sars, 1863)
                Diacyclops nanus (Sars, 1863)
                Diacyclops disjunctus (Thallwitz, 1927)
                Diacyclops languidoides (Lilljeborg, 1901)
                Diacyclops leeae Karanovic, Grygier and Lee, 2013
              Genus *Itocyclops* Reid and Ishida, 2000
                Itocyclops yezoensis (Ito, 1953)
              Genus *Psammophilocyclops* Fryer, 1956
                Psammophilocyclops paucisetosus Lee and Chang, 2011
              Genus *Microcyclops* Claus, 1893
                Microcyclops varicans (Sars, 1863)
                Microcyclops rubellus (Lilljeborg, 1901)
                Microcyclops longiramus Shen and Sung, 1965
              Genus *Cryptocyclops* Sars, 1927
                Cryptocyclops bicolor (Sars, 1863)
                Cryptocyclops javanus (Kiefer, 1930)
              Genus *Apocyclops* Lindberg, 1942
                Apocyclops borneoensis Lindberg, 1954
              Genus *Mesocyclops* Sars, 1914
                Mesocyclops leuckarti (Claus, 1857)

Mesocyclops pehpeiensis Hu, 1943
Mesocyclops dissimilis Defaye and Kawabata, 1993
Mesocyclops woutersi Van de Velde, 1987
Mesocyclops mariae Guo, 2000
Genus *Thermocyclops* Kiefer, 1927
Thermocyclops crassus (Fischer, 1853)
Thermocyclops taihokuensis (Harada, 1931)
Thermocyclops dybowskii (Landé, 1890)
Thermocyclops uenoi Ito, 1952

Introduction

A monographic study on non-marine cyclopoid copepods from Korea, belonging to the subfamily Cyclopinae of family Cyclopidae, is presented, following the author's previous study on the subfamilies Halicyclopinae and Eucyclopinae (Chang, 2012).

Cyclopinae is a group of species that typically inhabit freshwaters, and comprises about 530 species in 41 genera (Boxshall and Halsey, 2004). In Korea, since Kim and Chang (1989) first published a taxonomic paper on freshwater cyclopoids from South Korea, which included 25 species of 12 genera, a series of faunistic studies on continental cyclopids has been accomplished by the author and his colleagues: a new species (*Acanthocyclops tokchokensis*) from wells on Deokjeok Island in the Yellow Sea (Kim and Chang, 1991), a new species and a new record (*Ochridacyclops coreensis* and *Itocyclops yezoensis*) from springs (Lee et al., 2004), new records of 5 species of the genus *Mesocyclops* (Lee, Jeon and Chang, 2005), an illustrated key to freshwater cyclopoid species including two brackish-water cyclopids (*Mesocyclops marinus* and *Thermocyclops uenoi*) (Chang and Min, 2005), a new species, *Acanthocyclops fonticulus* from mountain springs (Lee and Chang, 2007a), 4 troglobiontic species (*Megacyclops magnus*, *Acanthocyclops orientalis*, *A. robustus* and *Diacyclops suoensis*) (Lee et al., 2007), and 1 brackish-water species (*Apocyclops borneoensis*) from the south coast (Yoon and Chang, 2008). Summing up the above fragmentary records on continental cyclopids and those of calanoids and harpacticoids from South Korea, a monograph on the continental copepods of Korea was published, which included 59 cyclopoid species of 20 genera in three families (Chang, 2009). Recently, discoveries on interstitial cyclopoids have been accomplished: Lee and Chang recorded a new psammobiontic species, *Psammophilocyclops paucisetosus*, from a sand filter in a water-purification plant (Lee and Chang, 2011); Karanovic et al. (2012) erected a new genus *Monchenkocyclops* to accommodate a new species *M. changi* from sandy bank at Odae Valley; Karanovic et al. (2013) described two new interstitial species of *Diacyclops languidoides* group (*D. parasuoensis* and *D. hanguk*), and corrected *D. suoensis* sensu Lee et al., 2007 as a distinct new species (*D. leeae*).

Largely based on the above book (Chang, 2009), the author has comprehensively reexamined the previous records, as well as new material obtained during this research period. As a part of the results, the present issue is provided for 33 species of 11 genera belonging to the subfamily Cyclopinae of the family Cyclopidae in South Korea.

Materials and Methods

The material in this study comprises the cyclopoid collection stored in the Department of Biological Science, Daegu University, Korea, which has been collected from various fresh and brackish waters of South Korea since June 1985, and the previous records from taxonomic papers published in the past, mostly by the author and his colleagues.

Collections were made mostly with a dipnet or a conical plankton net of 64 μm mesh aperture. Copepods were fixed and stored in 4% buffered formalin or 80% ethanol.

Specimens were dissected and mounted in lactophenol on H-S slides (Shirayama et al., 1993), a recent variation of the Cobb slide, after treatment in a solution of 20% glycerin - 80% ethyl alcohol for 1–2 days. Dissection was performed using two needles made with 0.3 mm diameter tungsten wire sharpened by electrolysis (Huys and Boxshall, 1991; Huys et al., 1996). Mounted specimens were observed under a differential interference phase-contrast microscope (Olympus BX51) with Nomarski optics.

Figures were prepared with the aid of a camera lucidA. Measurements were made with a digital camera for microscope (Cool SNAP 5.0M, Roper Scientific Co., USA) and the calibration software QCapture Pro (ver. 5.0, Media Cybernetics Inc., USA).

Type specimens examined are deposited in the National Institute of Biological Resources, Incheon, Korea (NIBR), the Natural History Museum of Ewha Womans University, Seoul (EWNHM), the U.S. National Museum of Natural History, Smithsonian Institution (USNM), the Natural History Museum, London (NHM), and the collection of the Department of Biological Science, Daegu University, Korea (DB).

The number of taxa currently recorded is based on the "World Copepoda database" by Walter and Boxshall (2013).

Abbreviations used in the text and figure legends follow the conventional ones frequently used in the taxonomy of copepods: A1, antennule; A2, antenna; Fu, caudal rami; L/W, length to width ratio; P1–P5, legs (pereiopods) 1–5; enp1–3 or exp1–3, the first to third endopodal or exopodal segments of each leg. Sewell's system is adopted for seta/spine armature of P1–P4, where setae are denoted by Arabic numerals, and spines by Roman numerals (cf. Huys and Boxshall, 1991, fig. 1.5.7).

Taxonomic Notes

Family Cyclopidae Dana, 1846

Geom-mul-byeo-ruk-gwa (검물벼룩과)

Subfamily Cyclopinae Kiefer, 1927

Geom-mul-byeo-ruk-a-gwa (검물벼룩아과)

Posterolateral corner of fifth pedigerous somite not pilose, without setules. P1–P4 biramous, basically with both exopods and endopods 3-segmented, but sometimes 2-segmented. P5 1- or 2-segmented; free distal, exopodal segment bearing 1 spine and 1 seta.

Genera 42 (12 in Korea), species 530 (36 in Korea).

Key to the genera of subfamily Cyclopinae

1. P5 basis partly incorporated into fifth pedigerous somite; P3–P4 exopod 3-segmented, endopod 2-segmented ····· *Itocyclops*
– P5 2-segmented, basis not fused with fifth pedigerous somite; P3–P4 exopod and endopod 3-segmented ····· 2
– P5 basis fully incorporated into fifth pedigerous somite; P3–P4 exopod and endopod 2-segmented ·· ····· 8
2. Spine on exopodal segment of P5 shorter than exopodal segment ····· 3
– Spine on exopodal segment of P5 much longer than segment ····· 7
3. Fourth and fifth pedigerous somites with wing-like protrusions posterolaterally; Fu elongated, with longitudinal dorsal ridge ····· *Cyclops*
– Characters not as above ····· 4
4. P5 basis expanded laterally; exopod with minute spinule medially ····· *Megacyclops*
– P5 basis not expanded laterally; exopod with spine distally ····· 5
5. Spine on P5 exopod shorter than width of exopod ····· 6
– Spine on P5 exopod longer than width of exopod ····· *Diacyclops*
6. P1–P4 endopods 3-segmented ····· *Acanthocyclops*
– P1–P4 endopods 2-segmented ····· *Monchenkocyclops*
7. Spine on P5 exopod issuing from midway on inner margin of exopod ····· *Mesocyclops*
– Spine on P5 exopod issuing from near distal end of exopod ····· *Thermocyclops*
8. P5 exopod cylindrical, bearing minute spinule on inner margin of exopod ····· 8
– P5 exopod subtriangular, bearing prominent spine ····· *Apocyclops*
– P5 exopod shaped as a small protuberance, with 2 slender setae apically ····· *Psammophilocyclops*
9. P4 similar in size to P2 and P3, with normal intercoxal sclerite (coupler) ····· *Microcyclops*
– P4 much smaller than P2 and P3, with distinctly broadened intercoxal sclerite (coupler) ····· ····· *Cryptocyclops*

Genus *Cyclops* O.F. Müller, 1776

Cham-geom-mul-byeo-ruk-sok (참검물벼룩속)

Body length around 2 mm. Fourth and fifth pedigerous somites with wing-like protrusions posterolaterally. Fu elongated, about 6–8 times longer than wide, with hairs along inner margin, and longitudinal dorsal ridge. A1 17-segmented; distal end extending slightly beyond posterior margin of second pedigerous somite. P5 2-segmented; free exopod bearing 1 subterminal spine and 1 apical seta.

Type species: *Cyclops strenuus* Fischer, 1851.

Species 135 (2 in Korea).

Key to the species of genus *Cyclops*

1. Spinules on caudal surface of A2 basis much enlarged distally, reaching nearly to basis of lateral seta ····· *C. vicinus*
– Spinules on caudal surface of A2 basis relatively small, not enlarged distally, far from level of basis of lateral seta ····· *C. kikuchii*

1. *Cyclops vicinus* Uljanin, 1875 (Fig. 1)

Cham-geom-mul-byeo-ruk (참검물벼룩)

Cyclops vicinus Uljanin, 1875, p. 30, pl. 10, figs. 1–7; Lilljeborg, 1901, p. 26, pl. 11, figs. 16–19; Gurney, 1933, p. 175, figs. 1549–1562; Rylov, 1948, fig. 43; Mizuno and Miura, 1984, p. 594, fig. 336; 1–2; Kim and Chang, 1989 (part.), p. 239; Einsle, 1996, p. 26, fig. 16; Chang and Min, 2005, p. 65, fig. 34A–F; Chang, 2009, p. 435, fig. 236.

Female: Body relatively small, about 1.4–2.3 mm long, excluding caudal setae. Prosome comprising cephalothorax incorporating first pedigerous somite and 3 free pedigerous somites. Cephalothorax slightly protruding anteriorly; much longer than next prosomites combined. Fourth and fifth pedigerous somites typically with wing-shaped protrusion. Genital double-somite with sclerotized ridges dorsolaterally, each armed with 3 elements representing P6. Anal operculum rounded, with smooth posterior margin.

Fu elongate, about 6–8 times longer than wide; rami nearly parallel to each other; with longitudinal ridge dorsally and pilose inner face. Lateral caudal seta arising from about distal fifth of lateral margin of ramus. Inner caudal seta longer than ramus, about 2.3 times as long as outer caudal seta. Dorsal caudal seta arising slightly proximal to basis of inner caudal seta, slightly shorter than outer caudal seta.

A1 extending far past posterior margin of cephalothorax; 17-segmented. Last 3 segments elongated, without conspicuous hyaline membrane along anterior margin. A2 3-segmented, comprising coxobasis and 2-segmented endopod. Coxobasis armed with 2 inner distal setae, and 1 outer distal seta representing exopod; on caudal surface, about 20 or more spinules aligned along lateral margin, increasing in size distally, distalmost spinule nearly reaching to level of outer distal seta; on frontal

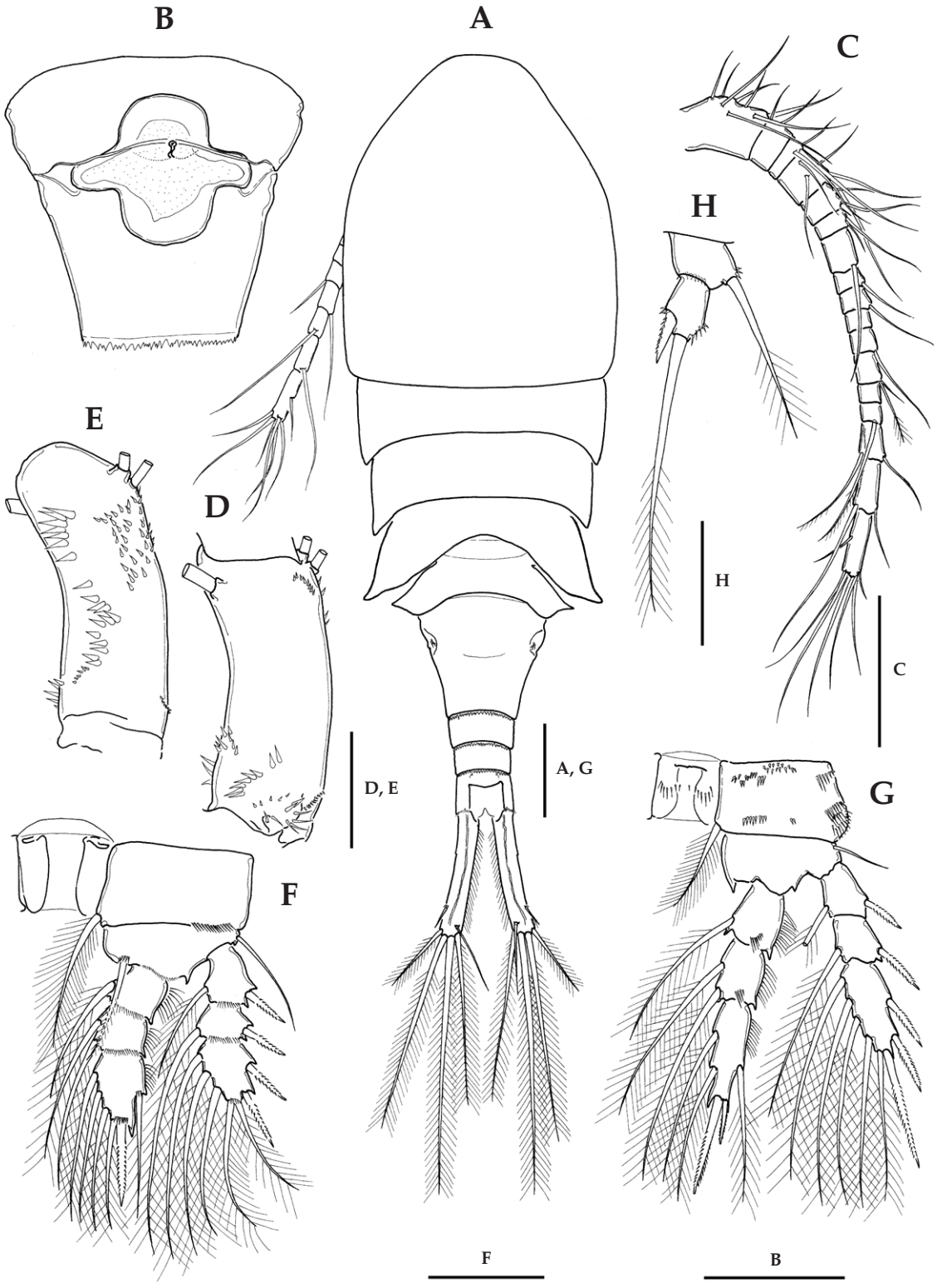


Fig. 1. *Cyclops vicinus*, female. A. habitus, dorsal; B. genital double-somite, ventral; C. A1; D. A2 basis, frontal; E. A2 basis, caudal; F. P1; G. P4. Scales: A–C=100 μm, D, E, H=20 μm, F, G=50 μm (cited from Chang and Min, 2005).

surface, 1 oblique row of minute spinules on inner distal corner.

P1–P4 biramous, both rami 3-segmented. Spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; I-1; II,1,4	enp 0-1; 0-2; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; I-1; III,1,4	enp 0-1; 0-2; 1,I,4
P3	coxa 0-1	basis 1-0	exp I-1; I-1; III,1,4	enp 0-1; 0-2; 1,I,4
P4	coxa 0-1	basis 1-0	exp I-1; I-1; III,1,4	enp 0-1; 0-2; 1,II,2

P1, inner distal seta on basis slightly exceeding posterior end of enp2. P4 intercoxal sclerite (coupler) with 1 transverse setule row in middle of caudal face; posterior margin of intercoxal sclerite and both lateral lobes smooth. P4 enp3 about 3 times longer than wide; inner apical spine strong, nearly as long as enp3, and about 2.3 times as long as outer apical spine.

P5 2-segmented; basis distinctly divided from fifth pedigerous somite, not expanded laterally; exopod about 1.3–1.5 times longer than wide; outer distal margin slightly swollen, ornamented with spinules; armed with 1 inner apical spine and 1 apcial plumose seta.

Distribution: Korea, Japan, China, Russia, Europe.

Korea: All provinces.

Specimen examined: GB: (Chunghyo Reservoir: 26.v.2012; rice paddies, Sangrim-ri, Gyeongsan: 6.vi.2012).

Ecology: Dominant in the reservoirs and lakes of South Korea as plankters from autumn (October) to spring (May); often found in brackish waters; in warm water season (from June to early September in South Korea), usually existing as copepodites only.

Remarks: This species sometimes co-occurs with *Cyclops kikuchii*, which is distinguished from *C. vicinus* by the spinule arrangement on the A2 basis (cf. Figs. 1D, E and 2D, E).

2. *Cyclops kikuchii* Smirnov, 1932 (Fig. 2)

Eo-ri-cham-geom-mul-byeo-ruk (어리참검물벼룩)

Cyclops kikuchii Smirnov, 1932, p. 283, figs. 1–5; Kim and Chang, 1989 (part.), p. 239; Einsle, 1996, p. 28, fig. 17; Ishida, 2002, p. 52, fig. 19; Chang and Min, 2005, p. 67, fig. 34G, H; Chang, 2009, p. 438, fig. 237.

Female: Similar in shape to preceding species. Body large, 1.4–2.1 mm long. Cephalothorax slightly protruding anteriorly; much longer than next prosomites combined. Fourth and fifth pedigerous somites typically with wing-shaped protrusion. Anal operculum convex, with smooth posterior margin.

Fu elongate, about 6–8 times longer than wide; nearly parallel to each other; with longitudinal ridge dorsally and pilose inner face. Lateral caudal seta arising from about distal fifth of lateral margin of ramus. Inner caudal seta nearly as long as ramus, about 2.1 times as long as outer caudal seta. Dorsal caudal seta arising slightly proximal to basis of inner caudal seta, slightly longer than outer caudal seta.

A1 17-segmented, its tip slightly extending over second pedigerous somite. Last 3 segments elongated, without conspicuous hyaline membrane along anterior margin. A2 3-segmented, comprising

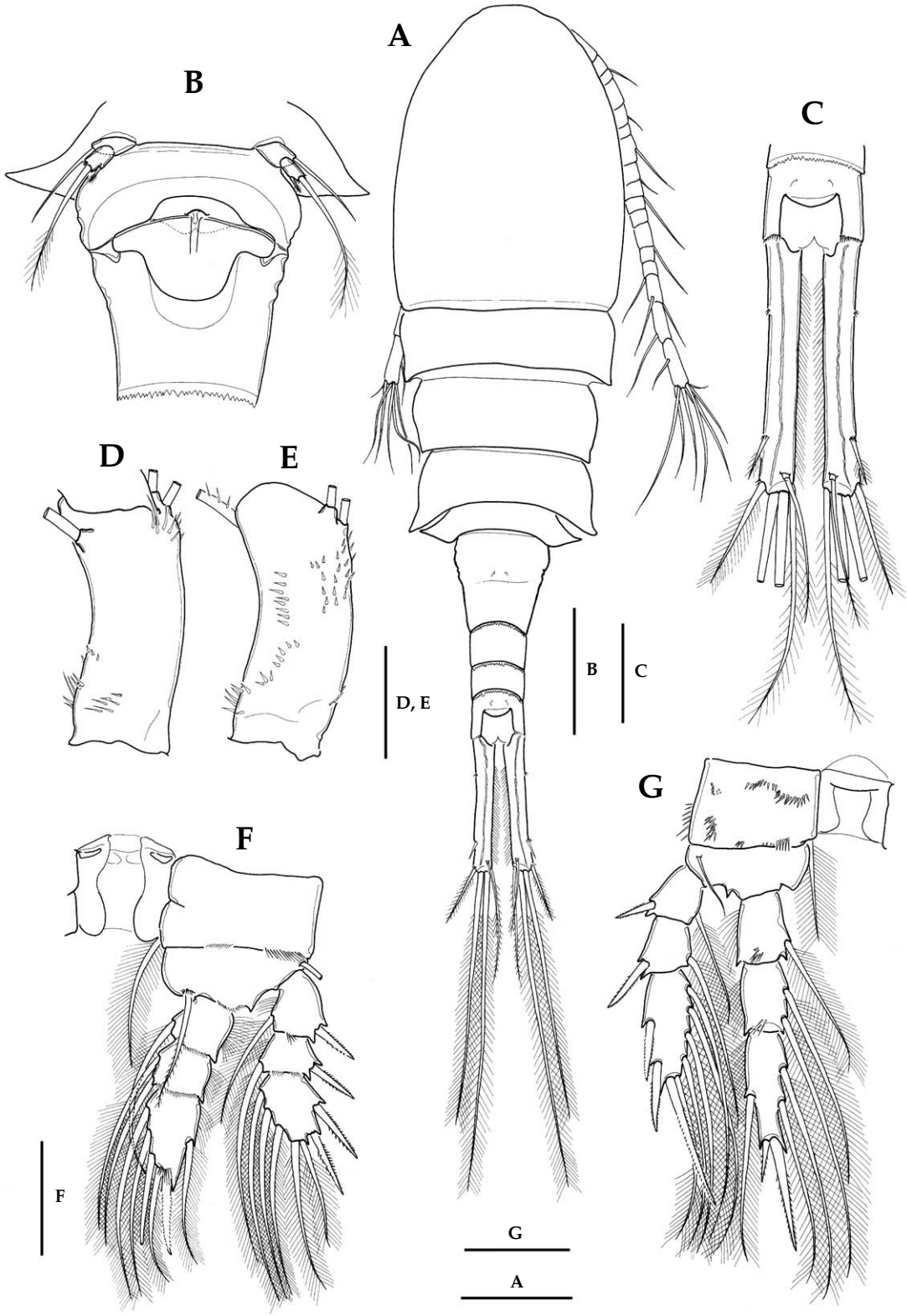


Fig. 2. *Cyclops kikuchii*, female. A. habitus; B. fifth pedigerous somite and genital double-somite, ventral; C. anal somite and Fu, dorsal; D. A2 basis, frontal; E. A2 basis, caudal; F. P1; G. P4. Scales: A=200 μm, B, C, F, G=100 μm, D, E=50 μm (cited from Chang and Min, 2005).

coxobasis and 2-segmented endopod. Coxobasis armed with 2 inner distal setae, and 1 outer distal seta representing exopod; on caudal surface, about 15 spinules aligned along lateral margin, not conspicuously increasing in size distally, distalmost spinule not reaching to distal quarter of outer margin; on frontal surface, spinules on inner distal corner well developed, acute, extending slightly over posterior margin of A2 basis.

P1–P4 biramous, both rami 3-segmented. Spine formula 2,3,3,3. Seta/spine armature of P1–P4 identical to that of preceding species.

P5 2-segmented; basis distinctly divided from fifth pedigerous somite, not expanded laterally; exopod about 1.3–1.5 times longer than wide; outer distal margin slightly swollen, ornamented with spinules; armed with 1 inner apical spine and 1 apical plumose seta.

Distribution: Korea, Japan, Russia, eastern Europe, Germany.

Korea: All provinces.

Specimen examined: GB: (Muncheon Reservoir, Gyeongsan: 23.v.2012; lotus swamp, Pyeongsa-ri, Gyeongsan: 24.iii.2012).

Ecology: Occurring in lakes, reservoirs, marshes and streams, especially abundant in the cold-water season, between late autumn and early spring in Korea; found also in brackish waters.

Remarks: This species is rarer than *Cyclops vicinus* in Korea, and often co-occurs with *C. vicinus*.

Genus *Megacyclops* Kiefer, 1927

Ko-kki-ri-geom-mul-byeo-ruk-sok (코끼리검물벼룩속)

Body very large, about 1.7–2.3 mm long. Fu about 3.5–4.0 times longer than wide, with hairs along inner margin. A1 17-segmented; distal end not reaching posterior margin of cephalothorax. P5 2-segmented; basal segment expanded laterally, with 1 long lateral seta; free exopod bearing 1 inner spinule and 1 long apical seta.

Type species: *Megacyclops viridis* (Jurine, 1820).

Species 12 (2 in Korea).

Key to the species of genus *Megacyclops*

1. Fu pilose with 4 bundles of hairs along inner margin; P4 enp3 with inner spine longer than outer spine; P4 intercoxal sclerite (coupler) with 1 transverse row of 8–14 setules loosely arrayed ····· ····· *M. viridis*
− Fu hirsute on inner face; P4 enp3 with inner spine shorter than outer spine; P4 intercoxal sclerite (coupler) with 1 transverse row of 14–18 dentate spinules densely arranged ····· *M. magnus*

3. *Megacyclops viridis* (Jurine, 1820) (Fig. 3)

Ko-kki-ri-geom-mul-byeo-ruk (코끼리검물벼룩)

Monoculus quadricornis viridis Jurine, 1820, pl. 3, fig. 1.
Cyclops viridis: Fischer, 1851, p. 412, pl. 9, figs. 1–11.
Cyclops (*Megacyclops*) *viridis*: Kiefer, 1929, p. 53, fig. 17(a–b).
Cyclops (*Acanthocyclops*) *viridis*: Gurney, 1933, p. 185, figs. 1563–1582.
Acanthocyclops viridis: Rylov, 1948, p. 215, fig. 45(1–7).
Acanthocyclops (*Megacyclops*) *viridis viridis*: Dussart, 1969, p. 138, fig. 63.
Acanthocyclops (*Megacyclops*) *viridis*: Tai and Chen, 1979, p. 364, fig. 121.
Megacyclops viridis: Mizuno and Miura, 1984, p. 606, fig. 343(1–8); Kim and Chang, 1989, p. 239, fig. 7c–h; Einsle, 1996, p. 46, fig. 28; Ishida, 2002, p. 54, fig. 23a–g; Chang and Min, 2005, p. 68, fig. 35A–D; Chang, 2009, p. 440, fig. 239.

Female: Body largest among freshwater cyclopoid species from Korea, about 1.5–2.3 mm long; generally colored brown, often entire body daubed with mud. Prosome ovoid, comprising more than two-thirds of entire body; maximum width at posterior end of cephalothorax. Cephalothorax slightly protruding anteriorly; more than 2 times longer as long as next prosomites combined. Urosomites with serrated hyaline frill along posterior margin. Genital double-somite slightly longer than wide; sclerotized wrinkles apparent dorsolaterally, armed with 3 elements, representing P6. Anal operculum rounded, with smooth posterior margin.

Fu elongate but stout, about 3.5–4.0 times longer than wide; slightly divergent posteriorly. Inner margin ornamented with 4 bundles of hairs; proximal 1/4 of lateral margin interrupted by minute spinules. Lateral caudal seta arising from distal quarter of lateral margin of ramus. Inner caudal seta about 3 times longer than outer caudal seta. Outer caudal seta slightly shorter than ramus. Dorsal caudal seta short, slightly longer than half length of ramus.

A1 not reaching to posterior margin of cephalothorax; 17-segmented.

P1–P4, both endopods and exopods 3-segmented. Spine formula 2,3,3,3. Inner distal seta on P1 basis nearly reaching to posterior end of enp2. P4 enp3 about 2.5 times as long as wide; inner apical spine nearly as long as enp3 or slightly shorter, about 1.1–1.2 times longer than outer apical spine. P4 intercoxal sclerite (coupler) with 1 transverse row of 8–14 setules along midline of coupler. Seta/spine armature of P1–P4 as follows:

P1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I,4
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I,4
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I,4
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,II,2

P5, basal segment strikingly enlarged laterally, with a basal seta poking out of lateral side of fifth pedigerous somite, in dorsal view. Exopod relatively small, about 1.5 times as long as wide; medial spine minute, issuing from nearly middle of inner margin of exopod.

Distribution: Cosmopolitan.
Korea: All provinces.
Specimen examined: GB: (Yeonji pond, Gyeongsan: 28.iii.2012; rice paddies, Daebo, Pohang: 20.vi.2012); GN (Upo-nup Swamp, Changnyeong: 22.vii.2012; Jinnal-nup Swamp: 29.iv.2011); JJ: (man-made cave, Suwolbong, Gosan, Jeju Island: 13.v.2012).

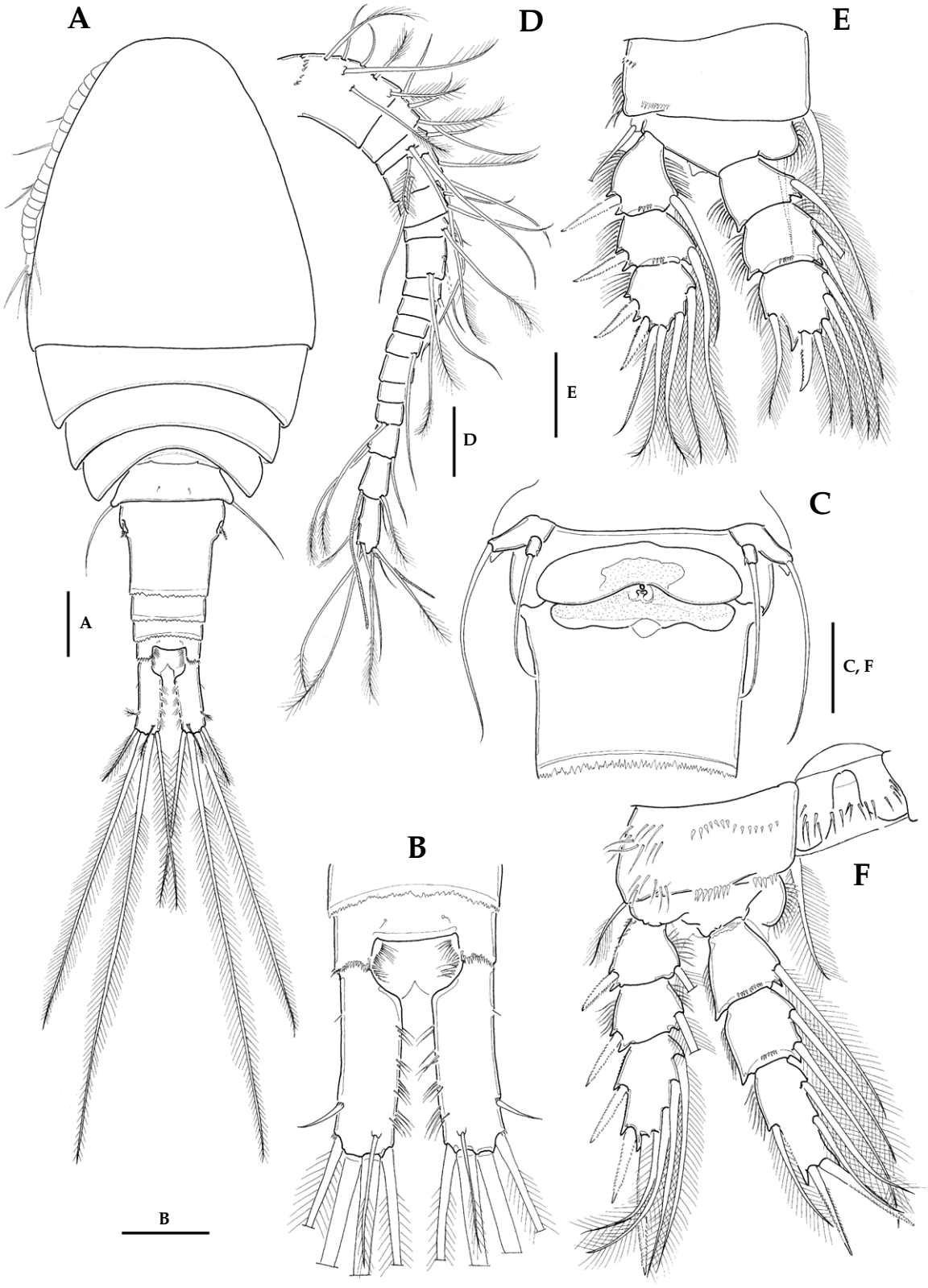


Fig. 3. *Megacyclops viridis*, female. A. habitus; B. anal somite and Fu, dorsal; C. P5 and genital double-somite, ventral; D. A1; E. P1; F. P4. Scales: A=50 μm, B–F=50 μm (cited from Chang and Min, 2005).

Ecology: Although it occurs year-round in Korea, this species seems to favor the small, stagnant, warm waters such as ricefields, bogs, and marshes, especially in summer. Sometines this species is also found in semi-subterranean waters such as springs and wells, and in salt marshes in South Korea.

4. *Megacyclops magnus* (Marsh, 1920) (Figs. 4, 5)

Deong-chi-geom-mul-byeo-ruk (덩치검물벼룩)

Cyclops magnus Marsh, 1920, p. 8, pl. 3, figs. 11, 12, 14, pl. 4, figs. 1, 5.
Megacyclops magnus: Einsle, 1996, p. 51, fig. 31; Ishida, 2002, p. 54, fig. 23h–k; Lee, Kim, Choi and Chang, 2007, p. 155, figs. 2, 3; Chang, 2009, p. 442, figs. 240, 241.

Female: Body slightly smaller than that of *M. viridis*, 1.1–1.7 mm long; tinged milky white. Prosome ovoid; maximum width at posterior end of cephalothorax. Cephalothorax about 1.3 times longer as long as next prosomites combined. Urosomites with serrated hyaline frill along posterior margin. Genital double-somite nearly as long as wide. Anal operculum rounded, with smooth posterior margin.

Fu about 4 times as long as wide. Inner (medial) margin pilose, with irregularly arranged hairs; dorsal surface of rami rough. Lateral seta inserted at about distal 1/4 of lateral margin of ramus; proximal 1/4 of lateral margin interrupted by minute spinules; outer caudal seta nearly 2/3 times as long as Fu, and slightly more than half length of inner caudal seta; dorsal caudal seta nearly as long as outer caudal seta.

A1 nearly reaching posterior margin of cephalothorax, consisting of 17 segments. A2 basis ornamented with 7–8 slender spinules near middle of outer margin of frontal face; with 8–9 spinules along outer margin of caudal face; smooth on outer and inner distal corners of both faces.

P1–P4, both exopods and endopods 3-segmented; spine formula 2,3,3,3. All intercoxal sclerites (couplers) each with 2 naked lateral lobes, without particular setule/spinule ornamentation on distal margin of caudal face. P4 coupler with 1 row of 12–17 spinules along middle of caudal face, both ends of spinule row pointing proximally; enp3 about 2.2 times longer than wide, nearly as long as outer spine or slightly longer; outer spine 1.1–1.2 times longer than inner spine; plumose setae of enp3 not transformed into spiniform setae, not exceeding end of outer spine.

P5 composed of 2 free segments; basal segment enlarged laterally, about 1.8 times longer than wide; distal segment with 1 minute spine medially and 1 long plumose seta apically.

Male: Body about 0.8 mm long; more slender than female. P5 small, slightly longer than wide. P6 comrising 1 inner spine, 1 medial seta, and 1 long outer seta.

Distribution: Korea, Japan (northern Honshu, Hokkaido), Russia (Kamchatka and Okhotsk), Alaska.

Korea: GW, GB.

Specimen examined: GB: (Jangsacheon Stream, Yeongdeok: 28.vii.2012).

Ecology: This species is known as a boreal species, restricted to the Far East (Hokkaido, northern Honshu, Kamchatka, and Okhotsk) and Alaska, so this record from the caves in southern Gangwon-do Province is tentatively the southern limit of the geographical distribution of this species (Lee,

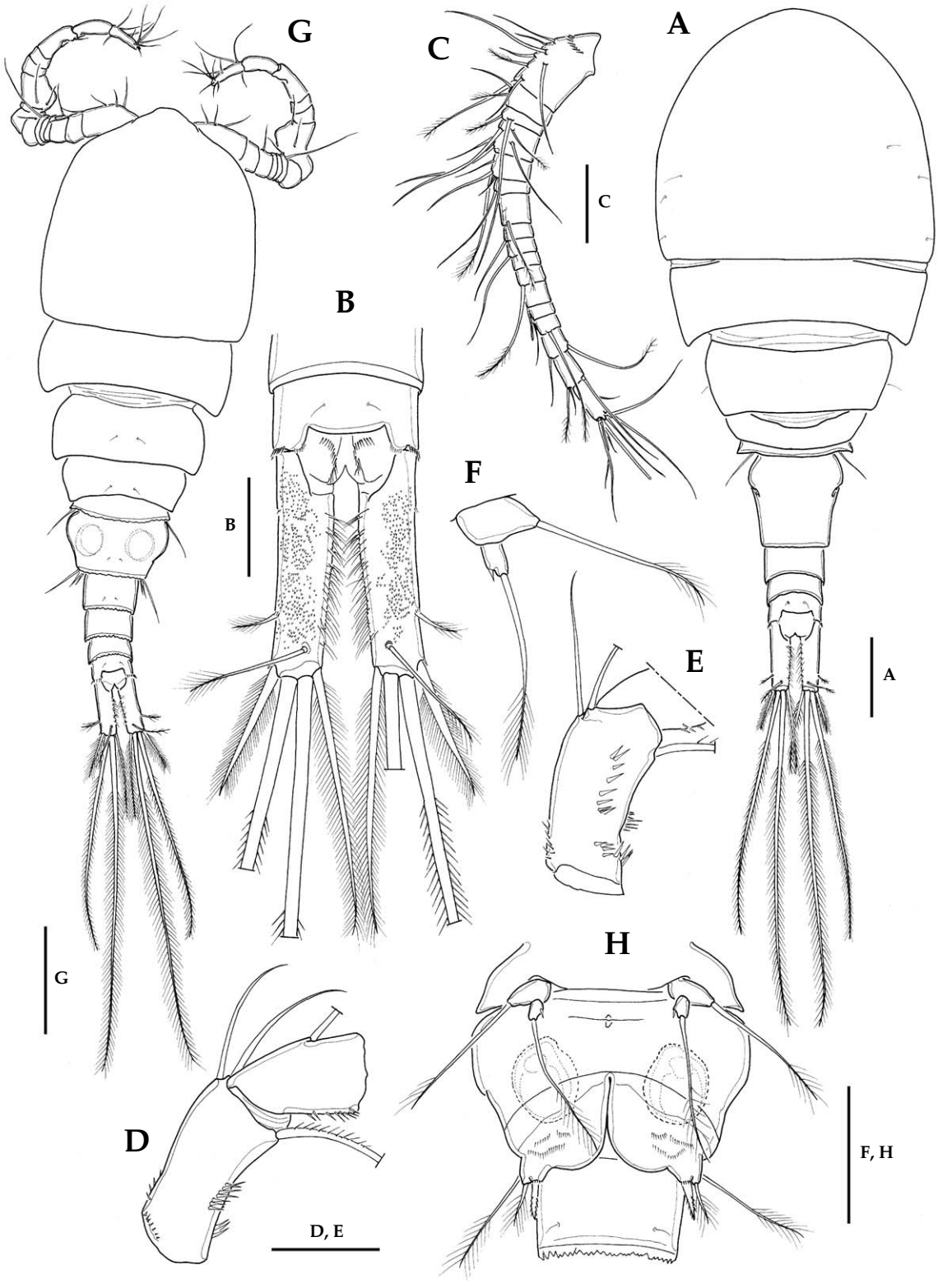


Fig. 4. *Megacyclops magnus*. Female: A. habitus; B. anal somite and Fu, dorsal; C. A1; D. A2 basis, frontal; E. A2 basis, caudal; F. P5. Male: G. habitus; H. P5, P6 and genital somite, ventral. Scales: A=100 μm, B–H=50 μm (cited from Lee, Kim, Choi and Chang, 2007).

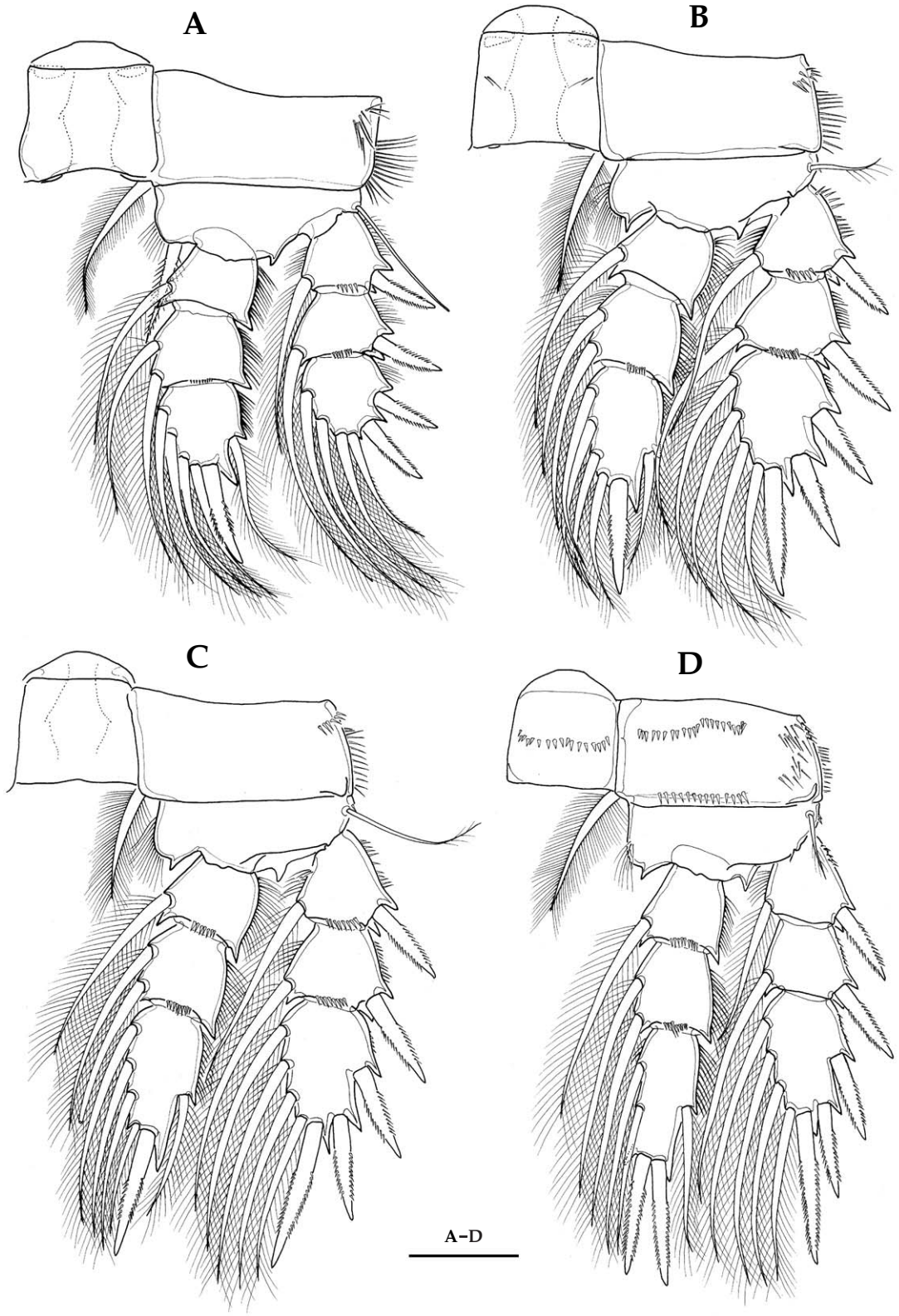


Fig. 5. *Megacyclops magnus*, female. A–D. P1–P4. Scale: 50 μm (cited from Lee, Kim, Choi and Chang, 2007).

Kim, Choi, and Chang, 2007). In Korea, this species occurs in caves and streams.

Remarks: This species differs from *Megacyclops viridis* by the following characteristics: outer spine on P4 enp3 longer than inner spine (versus inner spine longer in *M. viridis*); 14–18 spinules densely arranged in the middle of caudal face of intercoxal sclerite (coupler) of P4 (versus 6–8 slender spinules rather sparsely arranged in *M. viridis*); the inner caudal seta slightly (about 1.1–1.2 times) longer than Fu (versus more than 1.5 times, and nearly 2 times longer in *M. viridis*).

Korean specimens coincide well with Japanese specimens except for a minor discrepancy of the spinule row on the coupler of P4 (the spinule row consisting of 16–18 spinules without a gap in the middle of the row, versus about 12 spinules with a gap in Japanese specimens) (Lee, Kim, Choi, and Chang, 2007).

Genus *Acanthocyclops* Kiefer, 1927

Ga-si-geom-mul-byeo-ruk-sok (가시검물벼룩속)

Body relatively large, 1.0–1.5 mm long. Posterolateral corners of fourth pedigerous somite slightly protruding. Fu 4–5 times longer than wide, generally without hairs along inner margin. A1 basically 17-segmented. P5 2-segmented; basis not broadened laterally; exopod armed with 1 short inner spine and 1 long outer seta apically.

Type species: *Acanthocyclops vernalis* (Fischer, 1853).

Species 63 (6 in Korea).

Key to the species of genus *Acanthocyclops*

1. P5 exopod with 1 spine; P4 enp3 with 2 spines distally ····· 2
– P5 exopod with 2 spines; P4 enp3 with 1 spine distally ····· *A. fonticulus*
2. Fu pilose along inner margin ····· *A. tokchokensis*
– Fu bare along inner margin ····· 3
3. Fu 2.5–3.0 times longer than wide; inner spine on P4 enp3 more than 1.5 times as long as outer spine ····· *A. sensitivus*
– Fu 4–6 times longer than wide; inner spine on P4 enp3 nearly as long as outer spine ····· 4
4. Setae on P4 enp3 and exp3 not modified; outer terminal caudal seta normally plumose ····· 5
– Setae on P4 enp3 and exp3 spiniform; outer terminal caudal seta pectinate ····· *A. robustus*
5. Outer spine on P4 enp3 longer than inner spine; spinule row on P4 intercoxal sclerite (coupler) discontinuous medially ····· *A. vernalis*
– Outer spine on P4 enp3 shorter than inner spine; spinule row on P4 intercoxal sclerite (coupler) continuous, without gap medially ····· *A. orientalis*

5. *Acanthocyclops vernalis* (Fischer, 1853) (Fig. 6)

Ga-si-geom-mul-byeo-ruk (가시검물벼룩)

Cyclops vernalis Fischer, 1853, p. 90, pl. 3, figs. 1–5.
Cyclops (*Acanthocyclops*) *vernalis*: Kiefer, 1929, p. 54, fig. 18(a–b); Gurney, 1933, p. 198.
Acanthocyclops vernalis: Rylov, 1948, p. 223, fig. 47(1–4); Mizuno and Miura, 1984, p. 591(1–8); Ishida, 2002, p. 54, fig. 24a–i; Chang and Min, 2005, p. 70, fig. 35E, F; Chang, 2009, p. 446, fig. 243.
Acanthocyclops (*Acanthocyclops*) *vernalis*: Dussart, 1969, p. 125; Tai and Chen, 1979, p. 363, fig. 211.

Female: Body relatively small, about 1.1−1.5 mm long, excluding caudal setae. Prosome comprising cephalothorax incorporating first pedigerous somite and 3 free pedigerous somites. Posterolateral corners of fourth and fifth pedigerous somites slightly protruding. Genital double-somite about 1.2–1.3 times longer than wide, anterior part laterally swollen. Genital double-somite and next two urosomites with serrated hyaline fringe along posterior margin. Anal operculum gently rounded, with smooth posterior margin.

Fu elongate, about 4–5 times longer than wide; divergent posteriorly. Inner margin not haired; lateral margin interrupted at proximal 1/4–1/5 by minute spinules. Lateral caudal seta situated at distal quarter of lateral margin of ramus. Inner caudal seta naked, slightly shorter than ramus, about 1.3 times longer than outer caudal seta. Dorsal caudal seta 0.9 times as long as inner caudal seta, slightly longer than outer caudal seta. Outer terminal caudal seta not pinnate, normal plumose seta.

A1 slightly exceeding posterior margin of cephalothorax; 17-segmented; segments 12 and 17 each armed with aesthetasc. A2 basis ornamented with 5–6 spinules near middle of outer margin of frontal face; with 7–8 spinules along outer margin of caudal face; smooth on outer and inner distal corners of both faces.

P1–P4, both exopods and endopods 3-segmented; spine formula 2,3,3,3 (or 3,4,4,4). Seta/spine armature of P1–P4 as follows:

P1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I,4
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I,4
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,II,2

P4 coupler ornamented with 1 transverse row of 10–12 spinules on caudal face, with a gap in the middle; enp3 about 2.5–3.0 times longer than wide, about 1.5–1.8 times as long as outer spine; outer spine slightly longer than inner spine; plumose setae of exp3 and enp3 not transformed into spiniform setae; outer seta on enp3 not exceeding end of outer spine.

P5 composed of 2 free segments; basal segment not enlarged laterally; free exopod armed with 1 short inner spine and 1 long outer seta apically.

Male: Body about 0.8–0.9 mm long; more slender than female. P5 small, about 1.2 times longer than wide. P6 comrising 1 inner spine, 1 medial seta, and 1 long outer seta.

Distribution: Korea, Japan, China, Russia, Europe, North America.
Korea: GW, GN, GB, JJ.
Specimen examined: GW: (Chodang cave, Samcheok: 12.v.1994); GN: (estuary of Nakdong River, Busan: 12.v.2005).
Ecology: Mostly occurring in mountain streams and springs in Korea.

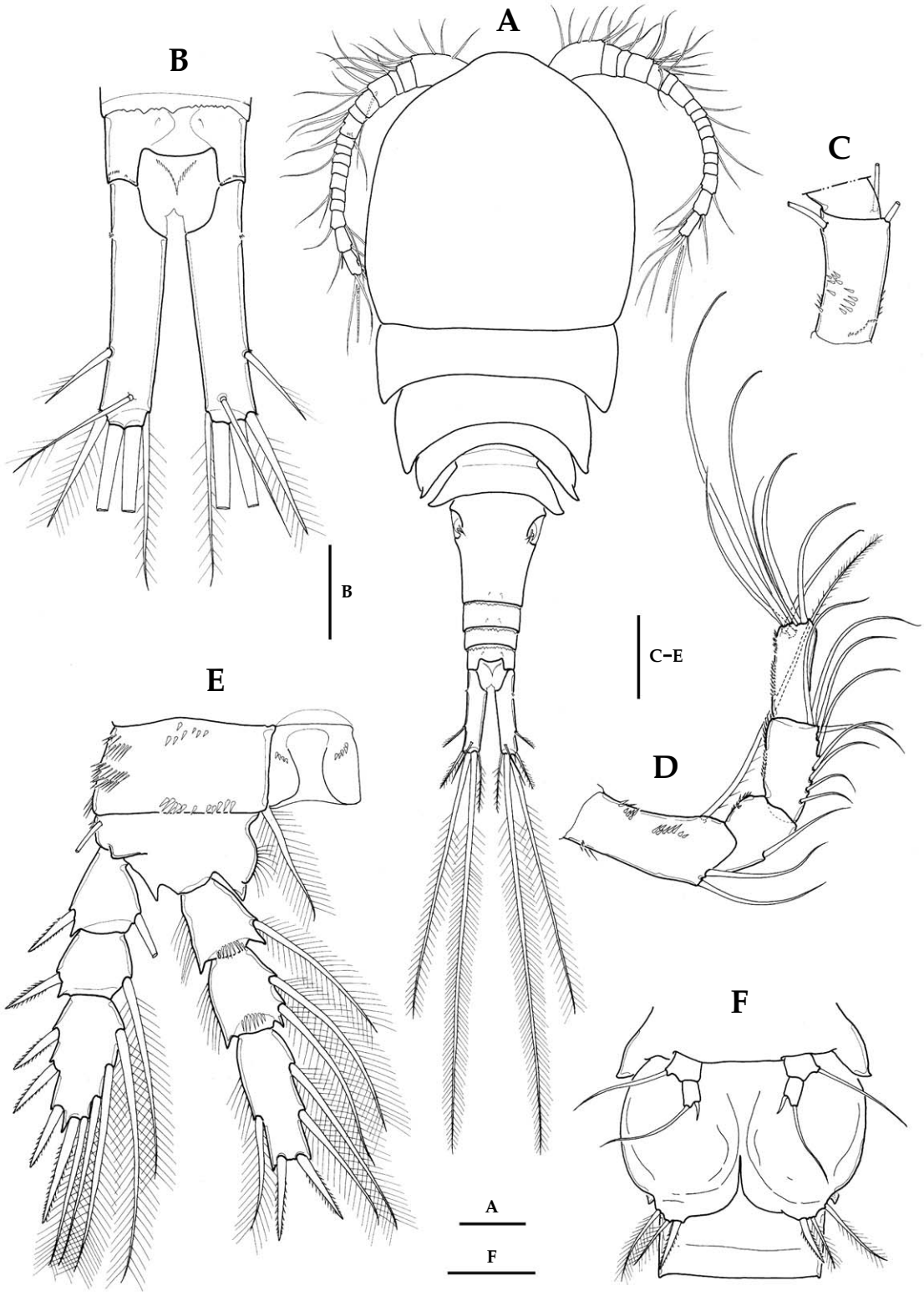


Fig. 6. *Acanthocyclops vernalis*. Female: A. habitus; B. anal somite and Fu, dorsal; C. A2 basis, frontal; D. A2, caudal; E. P4. Male: F. P5 and genital somite, ventral. Scales: A=100 μm, B–F=50 μm (cited from Chang, 2009).

6. *Acanthocyclops orientalis* Borutzky, 1966 (Figs. 7, 8)

Dong-bang-ga-si-geom-mul-byeo-ruk (동방가시검물벼룩)

Acanthocyclops vernalis orientalis Borutzky, 1966, p. 772, fig. 2.
Acanthocyclops orientalis: Dussant and Defaye, 1985, p. 80; Reid et al., 1991, p. 145; Lee, Kim, Choi and Chang, 2007, p. 159, figs. 4, 5; Chang, 2009, p. 449, figs. 244, 245.

Female: Body relatively large, about 7.2–0.9 mm long excluding caudal seta. Tinged with milky gray. Prosome oval, 1.1 times longer than urosome. Rostrum reduced. Cephalothorax somewhat protruding anteriorly, about 1.5 times longer than next three thoracic somites combined. Nauplius eye not observed. Genital double-somite 1.2 times longer than wide, anterior half moderately swollen laterally. Pedigers 4 and 5 moderately protruding posterolaterally. Posterior margins of all urosomites with hyaline fringes weakly crenulated; posterior margin of anal somite with 15–20 fine spinules ventrally. Anal operculum slightly convex, smooth on posterior margin.

Fu about 4.0–5.5 times as long as wide, without hairs along inner (medial) margin. Lateral margin smooth without interruption at proximal quarter; lateral seta inserted at about posterior quarter of lateral margin of ramus. Outer caudal seta about 1/2 times as long as Fu, and slightly less than 2/3 times length of inner caudal seta. Dorsal caudal seta slightly shorter than inner caudal seta, and about 3/4 times as long as Fu.

A1 17-segmented, slightly shorter than posterior margin of cephalothorax; 12th segment bearing 1 aesthetasc on lateral margin, its tip extending well beyond posterior margin of 14th segment. A2, both frontal and caudal face of basis smooth distally; caudal face of basis ornamented with 5–6 long setules near middle of outer margin.

P1–P4, all exopods and endopods 3-segmented. Spine formula 2,3,3,3. Seta formula (number of setae on exp3 of P1–P4) 4,4,4,4. Spine/seta armature of P1–P4 same as in preceding species. Intercoxal sclerites (couplers) of P1–P3 each with 2 lateral lobes, each ornamented with 1 curved row of hairs distally and medially. Distomedial corner of basis of P1 with 1 long seta, exceeding enp2. P4, lateral lobes of coupler not protruding; posterior margin smooth; 19–20 slender spinules densely arranged in 1 row in middle of caudal face, both lateral ends curved proximally; spinule row present along posterior margin of coxa, with a gap between two groups of spinules with different sizes and shapes; enp3 about 2.5–3.0 times as long as wide; inner apical spine about 1.2 times as long as outer apical spine, about 3/4 times as long as enp3; setae of enp3 not transformed into spiniform seta; inner setae extending well beyond tip of inner spine, while outer seta nearly reaching or only slightly exceeding it.

P5 2-segmented; basal segment slightly enlarged laterally, about 1.5 times wider than long, with 1 seta distolaterally. Exopod about 2 times longer than wide, with 1 inner spine and 1 long plumose apical seta; inner spine rather short (less than half length of distal segment). P6 represented by 2 strong conical projections and 1 long plumose seta, located on dorsolateral part of genital double-somite.

Male: P5, exopod about 1.5 times as long as wide, slightly swollen medially, with 1 very short inner spine, located subdistally. P6 armed with innermost spine, median seta (nearly as long as inner spine), and outer seta (about 2 times longer than inner spine).

Distribution: Korea, Russia (Maritime Territory, the Far East).
Korea: GW, CB, GB.

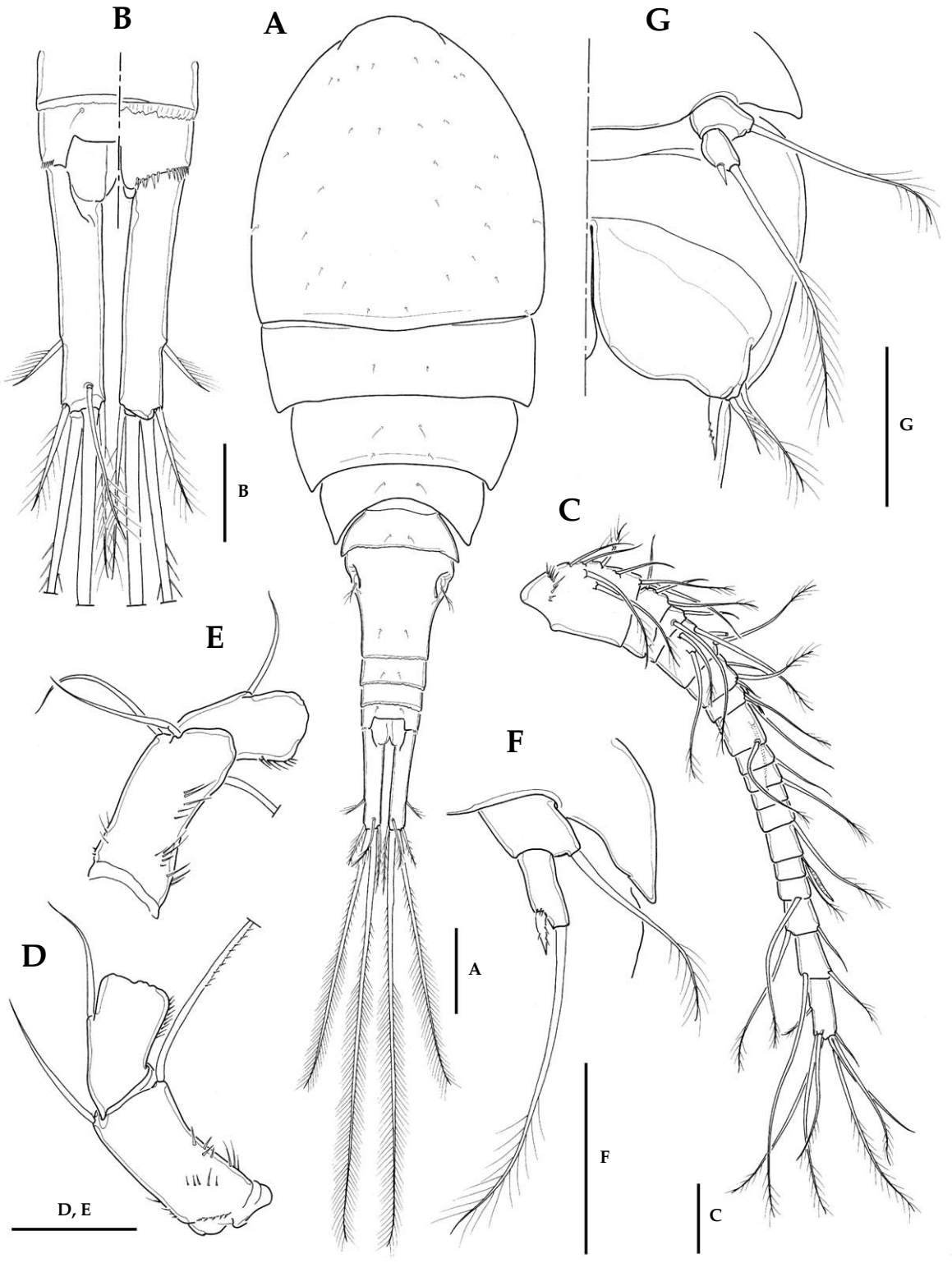


Fig. 7. *Acanthocyclops orientalis*. Female. A. habitus; B. anal somite and Fu, dorsal (left) and ventral (right); C. A1; D. A2 basis, frontal; E. A2 basis, caudal; F. P5. Male: G. fifth pedigerous somite and genital somite, ventral. Scales: A=100 μm, B–G=50 μm (cited from Lee, Kim, Choi and Chang, 2007).

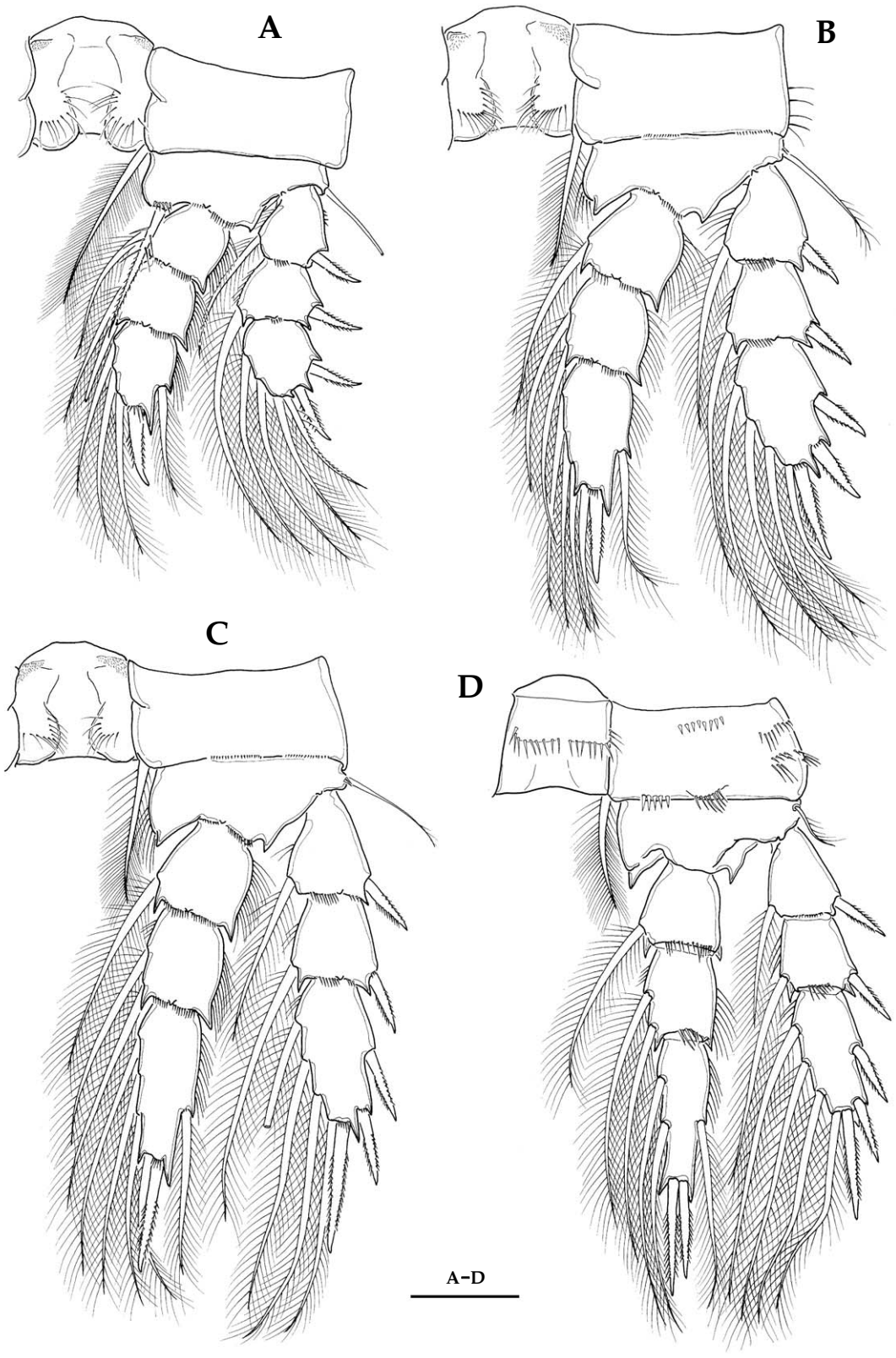


Fig. 8. *Acanthocyclops orientalis*, female. A–D. P1–P4. Scale: 50 μm (cited from Lee, Kim, Choi and Chang, 2007).

Specimen examined: GB: (Seongryu Cave, Uljin: 2.viii.2010, 10.v.2012).

Ecology: Found in limestone caves and nearby springs in South Korea.

Remarks: This species was described from a cave in the Maritime Territory (Primorsky Krai) of Russia by Borutzky (1966), as a subspecies of *Acanthocyclops vernalis*. In spite of his insufficient and inadequate figures and brief discussion in Russian without description, *A. orientalis* can be recognized as a valid species distinguished from *A. vernalis* as Petkovski (1975) mentioned, and identified with Korean specimens in having the longer inner spine on P4 enp3 (versus outer spine usually longer in *A. vernalis*) and the elongate setae on P4 enp3 (much exceeding the spines on enp3 in *A. orientalis*, versus usually not reaching the tip of outer spine in *A. vernalis*). Moreover, based on Korean specimens, *A. orientalis* shows some consistent discrepancies from *A. vernalis*, as follows: (1) small body (0.8–0.9 mm), versus usually much more than 1 mm in *A. vernalis*; (2) posterolateral edges of pedigerous somites 4 and 5 not strongly protruded; (3) the lateral margin of Fu without interruption at proximal quarter; (4) a row of 18–19 spinules on the caudal face of coupler of P4 densely arranged and not interrupted in the middle of the spinule row, versus 8–9 spinules sparsely arranged, sometimes with a gap in the middle of the row in *A. vernalis*; (5) spinule row along the posterior margin of the coxa shows a gap between two groups of spinules with different sizes and shapes, versus the spinule row consisting of similar spinules without a gap in the middle in *A. vernalis*; (6) dorsal caudal seta about 1.5 times longer than outer caudal seta (versus nearly equal in length or less than 1.2 times longer in *A. vernalis*). "*Acanthocyclops* cf. *orientalis*" *sensu* Petkovski (1975) from Jugoslavia differs from Borutzky's figure as well as from Korean specimens in having the dorsal caudal seta shorter than the outer caudal seta and the presence of an interruption on the lateral margin of the Fu. Because Borutzky did not describe the intercoxal sclerite (coupler) and coxa of P4, we cannot confirm the spinule arrangement, which is highly consistent in Korean specimens.

The Korean specimens, found in five limestone caves, show the above characteristics rather consistently. In Hwaam-gul Cave, Jeongseon, this species co-occurred with *A. vernalis*, where the two species showed character displacement, that is, emphasizing their morphological discrepancies for sexual isolation between the two species. This species frequently co-occurs with *Attheyella coreana* Miura, 1969 (Lee, Kim, Choi and Chang, 2007).

7. *Acanthocyclops robustus* (Sars, 1863) (Fig. 9)

Teun-teun-ga-si-geom-mul-byeo-ruk (튼튼가시검물벼룩)

Cyclops robustus Sars, 1863, p. 245; Sars, 1914, p. 45.
Cyclops (*Acanthocyclops*) *robustus*: Kiefer, 1929, p. 55.
Cyclops vernalis var. *robustus*: Gurney, 1933, p. 201, fig. 1612.
Acanthocyclops vernalis var. *robustus*: Rylov, 1948, p. 226, fig. 47.
Acanthocyclops (*Acanthocyclops*) *robustus*: Dussart, 1969, p. 126, fig. 56.
Acanthocyclops robustus: Petkovski, 1975, p. 107, figs. 21–41; Reid et al., 1991, p. 145; Ishida, 2002, p. 55, fig. 24j–n; Lee, Kim, Choi and Chang, 2007, p. 162, fig. 6; Chang, 2009, p. 453, fig. 246.

Female: Body relatively small, about 1,100–1,300 μm long. Pedigers 4 and 5 protruding posterolaterally. Anterior part of genital double-somite swollen laterally. Seminal receptacle lip-shaped, both upper and lower parts narrow.

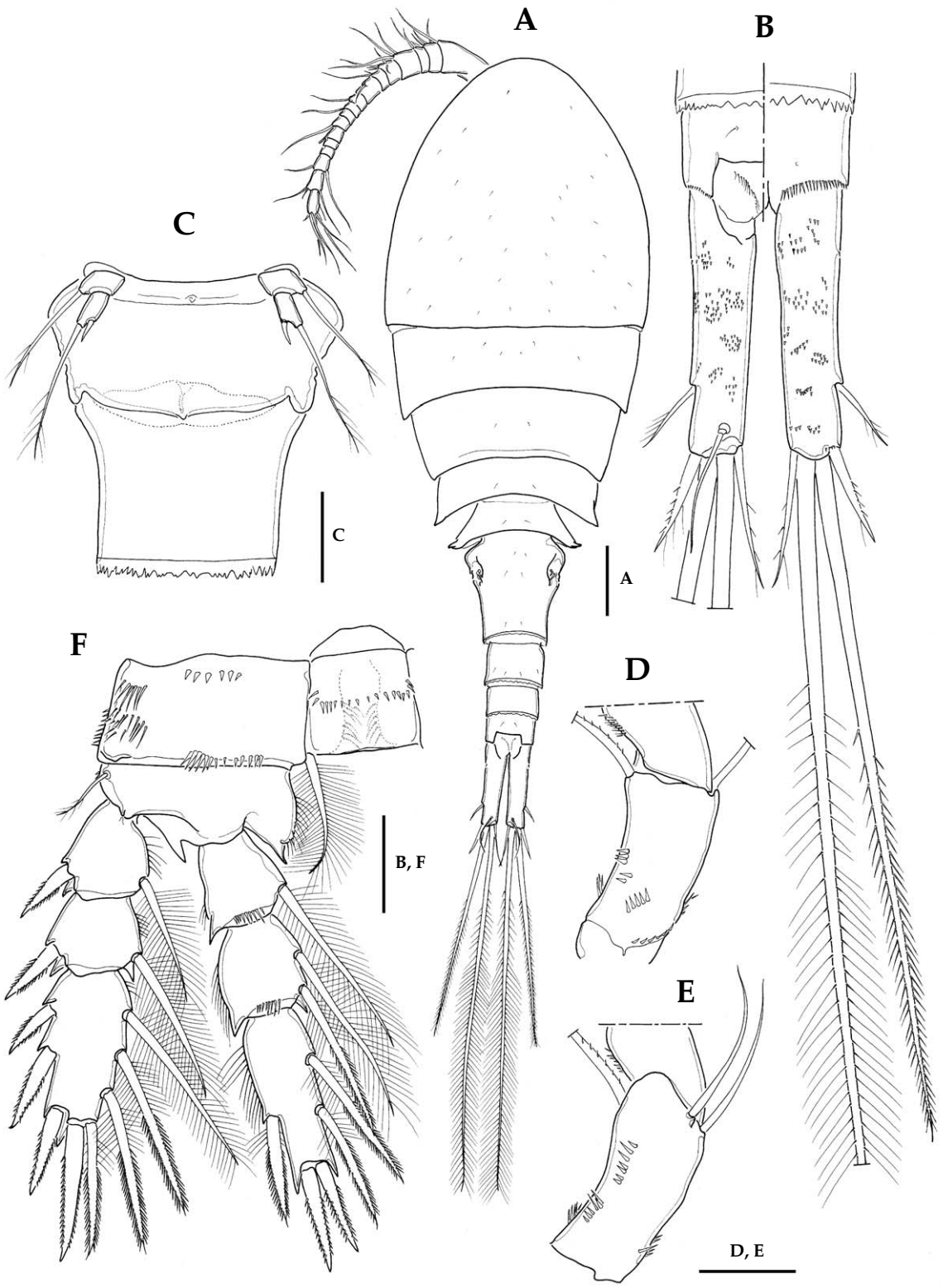


Fig. 9. *Acanthocyclops robustus*, female. A. habitus; B. anal somite and Fu, dorsal; C. P5 and genital somite, ventral; D. A2 basis, frontal; E. A2 basis, caudal; F. P4. Scales: A=100 μm, B–F=50 μm (cited from Lee, Kim, Choi and Chang, 2007).

Fu 4.0–4.5 times as long as wide, with 4–6 bands of minute spinules on both dorsal and ventral surfaces; inner (medial) margin smooth; lateral seta inserted at about posterior 1/4 of lateral margin of ramus; outer caudal seta slightly less than 3/4 times as long as inner caudal seta; dorsal caudal seta slightly longer than outer caudal seta, but shorter than inner caudal seta; outer terminal caudal seta stout, pinnate with spinules along distal 2/3 of seta.

A1 17-segmented, not reaching posterior margin of cephalothorax. Antennary basis smooth at distal part of both frontal and caudal faces, with 7–8 spinules along middle of outer margin of caudal face.

P1–P4, both exopods and endopods 3-segmented; spine formula 3,4,4,4. P4, enp3 about 2.3 times as long as wide, about 1.5 times longer than outer spine; outer spine slightly (1.1 times) longer than inner spine; outer seta modified into spiniform, nearly as long as outer spine; inner setae also transformed into spiniform setae, not reaching tip of spines; exp3 with 4 inner setae, distal three of which modified into spiniform.

P5, proximal segment slightly enlarged laterally, about 1.5 times wider than long; distal segment about 1.5–2 times longer than wide, with 1 short inner distal spine and 1 long apical seta. P6 represented by 3 conical projections on wrinkled genital operculum, located dorsally on both sides of anterior part of genital double-somite.

Distribution: Korea, Japan, Russia, Europe, North America.
Korea: GW.
Specimen examined: GW: (Sohan-gul Cave, Samcheok: 12.v.1994).
Ecology: Found in a mountain bog, flowing from a limestone cave in Korea.
Remarks: This species is closely allied with *Acanthocyclops vernalis* and *A. orientalis*. This species resembles *A. vernalis* in general appearance (especially the produced distolateral margins of pedigers 4 and 5), the shape of Fu with the relative length ratios among caudal setae, the shape of P4 enp3 and the relative length between its two apical spines, and the spinulation on the basis of the antennal exopod. However, *A. robustus* differs from *A. vernalis* by the transformed spiniform setae on P4 enp3 and exp3, the pinnate outer terminal caudal seta, the spine formula (usually 3,4,4,4 in *A. robustus*, against 2,3,3,3 in *A. vernalis*), and anterior part of the genital double-somite with a rounded lateral margin (Lee, Kim, Choi and Chang, 2007).

8. *Acanthocyclops sensitivus* (Graeter and Chappuis, 1914) (Fig. 10)

Mong-dang-ga-si-geom-mul-byeo-ruk (몽당가시검물벼룩)

Cyclops sensitivus Graeter and Chappuis, 1914, p. 507.
Cyclops (*Acanthocyclops*) *sensitivus*: Kiefer, 1929, p. 58.
Acanthocyclops sensitivus: Rylov, 1948, p. 238, fig. 52(1–2); Einsle, 1996, p. 68, fig. 48; Chang and Min, 2005, p. 72, fig. 36; Chang, 2009, p. 455, fig. 248.
Acanthocyclops (*Acanthocyclops*) *sensitivus*: Dussart, 1969, p. 133, fig. 61.

Female: Body relatively small, 720–830 μm long; tinged milky white. Prosome suboval. Cephalothorax protruding anteriorly, much longer than next 3 prosomites combined, widest at posterior margin; posterolateral corner of each prosomites not protruding. Urosomites except anal somite with

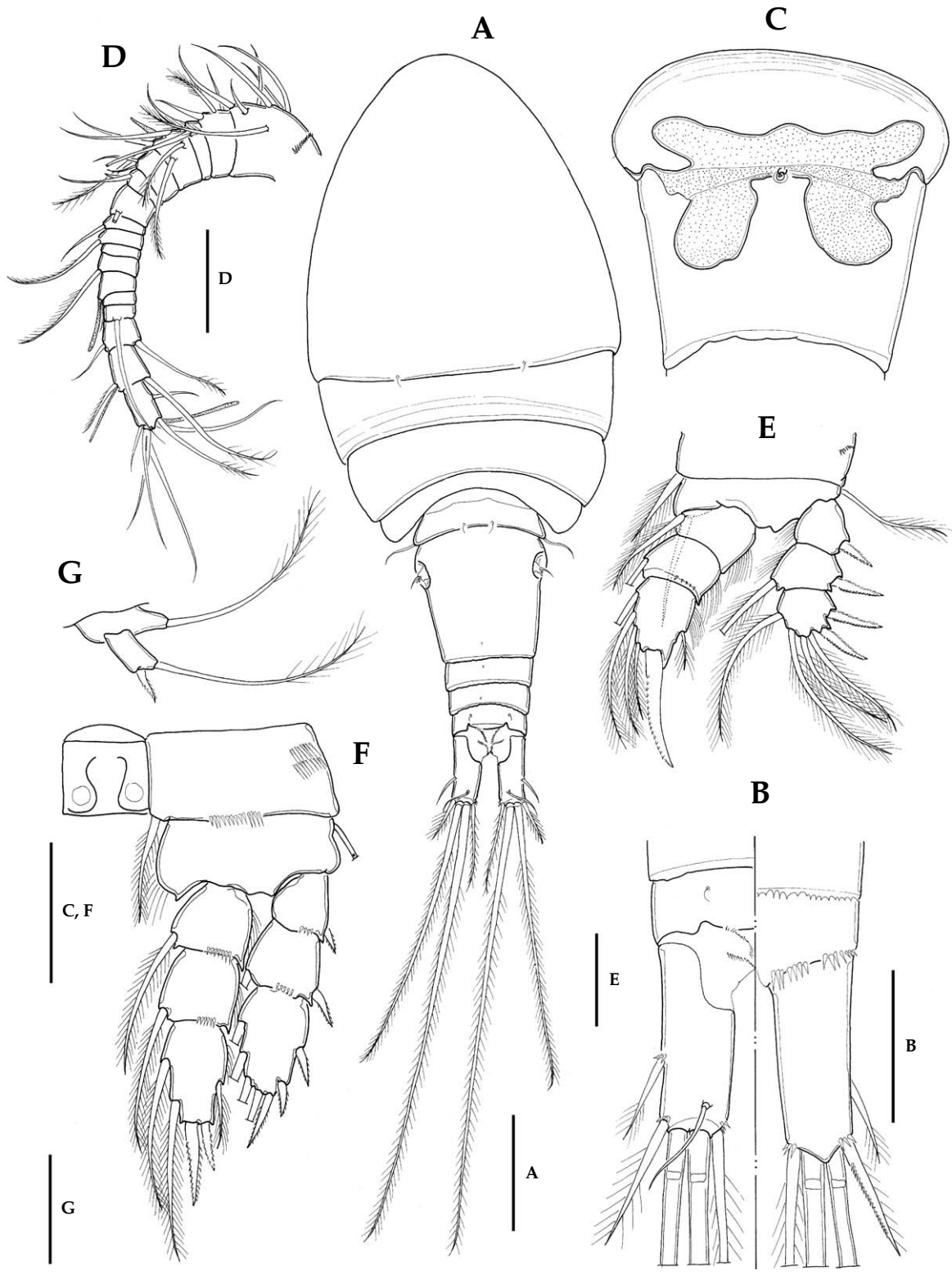


Fig. 10. *Acanthocyclops sensitivus*, female. A. habitus, dorsal; B. anal somite, dorsal (left) and ventral (right); C. genital double-somite; D. A1; E. P1; F. P4; G. P5. Scales: A=100 μm, B–G=50 μm (cited from Chang and Min, 2005).

serrated hyaline fringe along posterior margin. Genital double-somite slightly longer than wide, with anterior part slightly swollen laterally. Seminal receptacle butterfly-shaped, posterior part well developed. Anal operculum convex, with smooth posterior margin.

Fu stout, about 2.5–3.0 times longer than wide; slightly divergent posteriorly; medial face not hairy; lateral margin smooth without notch and spinules except a few spinules at base of outer caudal seta. Lateral caudal seta lying at about distal third. Inner caudal seta about 1.3 times as long as Fu, 2.1–2.3 times as long as outer caudal seta. Outer caudal seta normally plumose, not modified, about 1/2 times longer than Fu. Dorsal caudal seta slightly shorter than outer caudal seta.

A1 nearly reaching to posterior margin of cephalothorax; 17-segmented, with aesthetasc on segment 12 and last segment.

P1–P4 biramous, both rami 3-segmented. Spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-0; I-1; II,1,3	enp 0-1; 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-0; I-1; III,1,3	enp 0-1; 0-1; 1,I,4
P3	coxa 0-1	basis 1-0	exp I-0; I-1; III,1,3	enp 0-1; 0-1; 1,I,4
P4	coxa 0-1	basis 1-0	exp I-0; I-1; III,1,3	enp 0-1; 0-1; 1,II,2

P1, inner distal seta on basis extending slightly beyond middle of enp3. Intercoxal sclerites of P1–P4 with lateral expansions not produced, with smooth posterior margin, lacking transverse spinule row in middle of caudal surface. P4 enp3 about 1.6 times longer than wide; inner apical spine curved inward, much shorter (0.8 times) than enp3, about 1.7 times longer than inner apical spine; both inner setae normal, not deformed.

P5 2-segmented; basal segment slightly expanded laterally, about 2.5 times as broad as long; exopod small, about 1.5 times as long as wide, armed with 1 short subapical spine and 1 apical seta.

Distribution: Korea, Europe.
Korea: CB, GB, JB.
Specimen examined: GB: (well, Gyeongsan: 12.vi.2009).
Ecology: Subterranean species, usually occurring in wells and springs.

9. *Acanthocyclops tokchokensis* Kim and Chang, 1991 (Figs. 11, 12)

Deok-jeok-ga-si-geom-mul-byeo-ruk (덕적가시검물벼룩)

Acanthocyclops tokchokensis Kim and Chang, 1991, p. 300, figs. 1–3; Chang and Min, 2005, p. 72, fig. 37; Chang, 2009, p. 457, figs. 249, 250.

Female: Body about 930 μm long, excluding caudal seta. Prosome oblong-oval, much longer than urosome (1.45 times); widest at posterior margin of cephalothorax, gradually tapering behind. Cephalothorax somewhat protruding anteriorly, more than 2 times longer than next 3 thoracic somites combined. Posterior corners of thoracic somites slightly projected. Genital double-somite as long as wide, or slightly wider than long; both sides of dorsal surface near proximal quarter of genital double-somite with a few sclerotized folds and wrinkles with 2 strong conical projections and 1 spine. Seminal receptacle not well defined. Posterior margins of all abdominal segments coarsely fringed. Anal operculum slightly convex and smooth on its posterior margin.

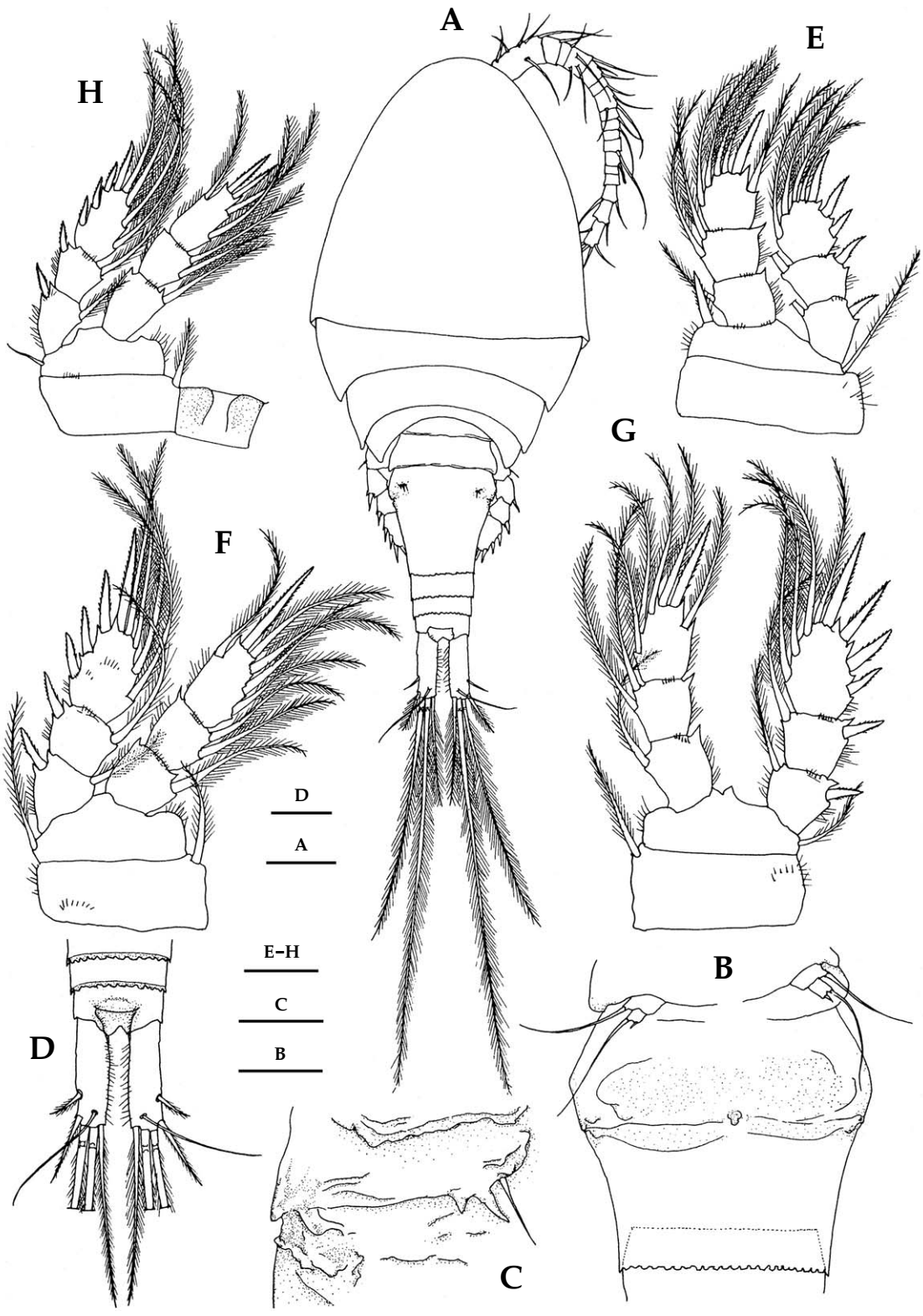


Fig. 11. *Acanthocyclops tokchokensis*, female. A. habitus, dorsal; B. P5 and genital somite; C. P6; D. anal somite and Fu, dorsal; E. P1; F. P2; G. P3; H. P4. Scales: A=100 μm, B, D–H=50 μm, C=20 μm (cited from Kim and Chang, 1991).

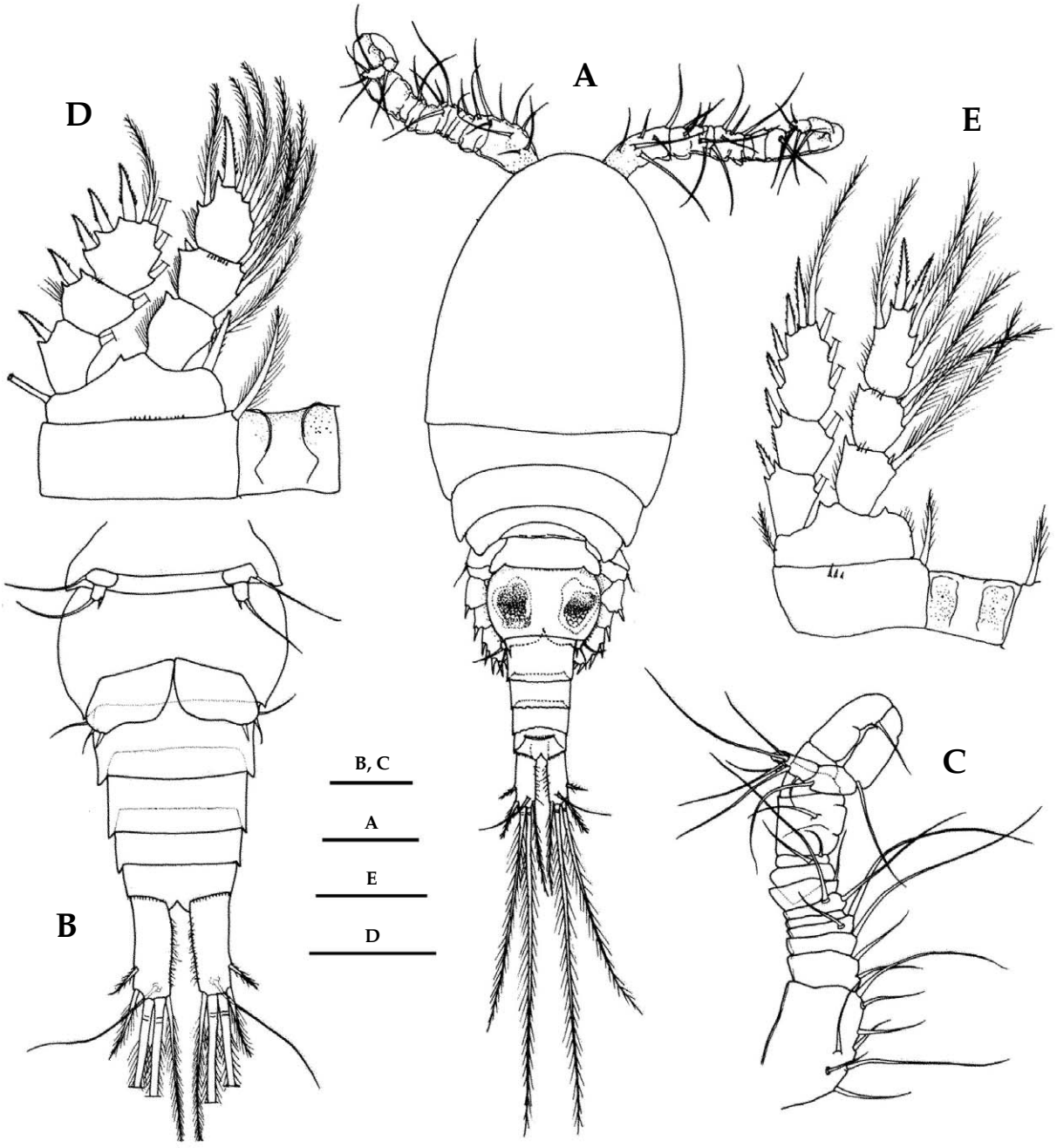


Fig. 12. *Acanthocyclops tokchokensis*, male. A. habitus, dorsal; B. P5 and urosome; C. A1; D. P1; E. P4. Scales: A=100 μm, B–E=50 μm (cited from Kim and Chang, 1991).

Fu nearly parallel, 3.25 times as long as wide, with fine hairs along inner lateral margin. Lateral caudal seta inserted at a distance from base of ramus, equal to about 71% of length of ramus; slightly longer than width of ramus itself. Inner caudal seta 2.32 times longer than outer caudal seta. Dorsal caudal seta about 1.8 times longer than outer apical seta. Inner terminal caudal seta about 1.7 times longer than outer seta, and nearly 2/3 times as long as length of entire body.

A1 slightly longer than cephalothorax when reflexed, 17-segmented; last segment with no distinguishable hyaline lamella, much longer than penultimate and antepenultimate segments; segment 12 with slender asthetasc not reaching distal margin of segment 14. A2 consisting of 4 segments; coxobasis bearing a long seta on inner distal corner, with a few groups of spinules on both surfaces; last endopodal segment with 7 curved setae of varying lengths. Mandible, maxillule, maxilla, and maxilliped as illustrated.

P1–P4 3-segmented. Spine formula 3,4,4,4. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; I-1; II,1,4	enp 0-1; 0-2; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; I-1; III,I,4	enp 0-1; 0-2; 1,I,4
P3	coxa 0-1	basis 1-0	exp I-1; I-1; III,I,4	enp 0-1; 0-2; 1,I,4
P4	coxa 0-1	basis 1-0	exp I-0; I-1; III,I,4	enp 0-1; 0-2; 1,II,2

Intercoxal sclerite (coupler) of P1 with 2 naked lateral lobes; stout seta on inner corner of basis reaching middle of enp2. P4 enp3 somewhat elongated, about 1.8 times as long as wide; apical spines of enp3 nearly equal in length (or outer spine slightly longer than inner one), about 3/4 times as long as the segment; coupler without tubercles, spinules or hairs.

P5 basis not enlarged, about 2 times broader than exopod; exopod 1.46 times longer than wide. Inner spine rather short (less than half length of distal segment), located nearly on distal end.

Male: Body length 720 μm. Prosome much more slender than in female. Genital somite 1.3 times wider than long. Fu somewhat shorter than in female, about 2.9 times as long as wide, and inner margin with short hairs. P4 enp3 1.9 times longer than wide; outer apical spine slightly longer than inner one (1.1 times), but shorter than enp3 (0.81 times). P6 with 1 innermost spine and 2 outer setae, of which inner seta markedly shorter than outermost seta.

Distribution: Korea.

Korea: GG, GB.

Specimen examined: GB: (spring, Gyeongju: 18.viii.2011).

Ecology: Inhabiting wells not far from seashore in South Korea.

Remarks: This species has a 17-segmented A1, which distinguishes it from the other troglobiotic or highly differentiated subterranean congeneric species with 11- or 12-articulated A1 such as *Acanthocyclops kieferi* (Chappuis, 1925), *A. venustus* (Norman and Scott, 1906), *A. miurai* (Ito, 1957), *A. morimotoi* (Ito, 1952), etc.

Among the other species with 17-segmented A1, *A. tokchokensis*, *A. gordani* Petkovski, 1971, and *A. cephallenus* Pesce, 1978/1979 are quite characteristic in possessing the intermediate features of *Acanthocyclops* and *Megacyclops*, for instance, the relatively short Fu with its inner margin sparsely haired, suggesting that the above three species are closely related to the genus *Megacyclops*, as Petkovski (1971) and Pesce (1978–1979) appropriately pointed out. Although *A. tokchokensis* resembles especially *M. viridis* in many aspects such as the 17-segmented A1, shape of the Fu, and shape of the P4 enp3 including the apical spines on it, it is discernable from *M. viridis* by the spine formula as well as the non-enlarged proximal segment of P5 and the inner spine located nearly on the distal end of the distal segment of P5, which confirms the former as a member of the genus *Acanthocyclops*. *Acanthocyclops tokchokensis* is distinguished from *A. gordani* Petkovski by the spine formula and the P4 enp3 that is longer than its apical spines; and from *A. cephallenus* Pesce by the spine formula, somewhat more slender Fu, and P4 enp3 with the outer apical spine longer than its bearing segment (Kim and Chang, 1991).

10. *Acanthocyclops fonticulus* Lee and Chang, 2007 (Figs. 13–15)

Ong-dal-saem-ga-si-geom-mul-byeo-ruk (옹달샘가시검물벼룩)

Acanthocyclops fonticulus Lee and Chang, 2007a, p. 62, figs. 2–5; Chang, 2009, p. 460, figs. 251–253.

Female: Body large, 1.2–1.5 mm long, excluding caudal seta. Tinged milky white. Prosome oval, 1.3 times longer than urosome; widest at posterior margin of cephalothorax, and gradually tapering behind. Cephalothorax somewhat protruding anteriorly, about 2 times longer than next three prosomites combined. Genital double-somite 1.1 times longer than wide, anterior half somewhat swollen laterally. Upper part of seminal receptacle semicircular; lower part with 2 narrow wings. Posterior margins of all urosomites with weakly crenate hyaline fringes; posterolateral margin of anal somite with 15–18 fine spinules. Anal operculum weakly convex, its posterior margin smooth.

Fu parallel, 2.9–3.2 times as long as wide; medial margin not hairy; lateral margin with notch between proximal third and quarter. Lateral seta inserted at distal third. Outer caudal seta slightly shorter than Fu, slightly less than half length of inner caudal seta. Dorsal caudal seta about 0.8 times as long as outer caudal seta, about 0.75 times shorter than Fu.

A1 short, extending slightly past midlength of cephalothorax, 11-segmented. Eighth segment bearing 1 short asthetasc near middle of anterior margin. A2 4-segmented, coxobasis 3-segmented; coxobasis bearing 4 setule rows along outer margin on caudal surface; 4–5 spinules present in middle of frontal surface, along lateral margin.

P1–P4 3-segmented. Spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,I+1,3
P3	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,I+1,3
P4	coxa 0-1	basis 1-0	exp I-0; I-1; II,I,4	enp 0-1; 0-2; 1,II,2

P1, intercoxal sclerite with 2 naked lateral expansions; basal seta extending slightly over enp2. P4, intercoxal sclerite smooth on posterior margin and in middle of caudal surface; enp3 about 1.4 times as long as wide; single apical spine slightly longer than enp3; inner seta on exp1 absent.

P5 basis not enlarged, about 2 times broader than exopod; exopod about 1.5 times longer than wide, armed with 2 subapical spines and 1 apical plumose seta; inner spine rather short (less than half length of exopod), outer spine about 2 times longer than inner spine.

Male: Body length about 680–730 μm. A1 14-segmented, geniculate between 12th and 13th segments; 1st, 9th and 14th segments each with 1 aesthetasc. P6 represented by indistinctly separated plate with innermost spine, median seta (nearly as long as inner spine), and outer (subdorsal) seta (its tip extending slightly beyond posterior margin of succeeding somite).

Distribution: Korea.

Korea: GW, CB, GN, JB, JN.

Specimen examined: GW: (streamlet, Mt. Guhak, Wonju: 25.ii.2009).

Ecology: Collected from small mountain springs in Korea.

Remarks: This subterranean *Acanthocyclops* species described from several mountain springs in South Korea is allied to the *A. kieferi* species group in sharing the 11-segmented A1. However, it is clearly distinguished from them by the single apical spine and long plumose apical seta on P4 enp3 (versus 2 apical spines) and an extra spine on the exopod of P5 in both sexes (see Lee and Chang, 2007a for details).

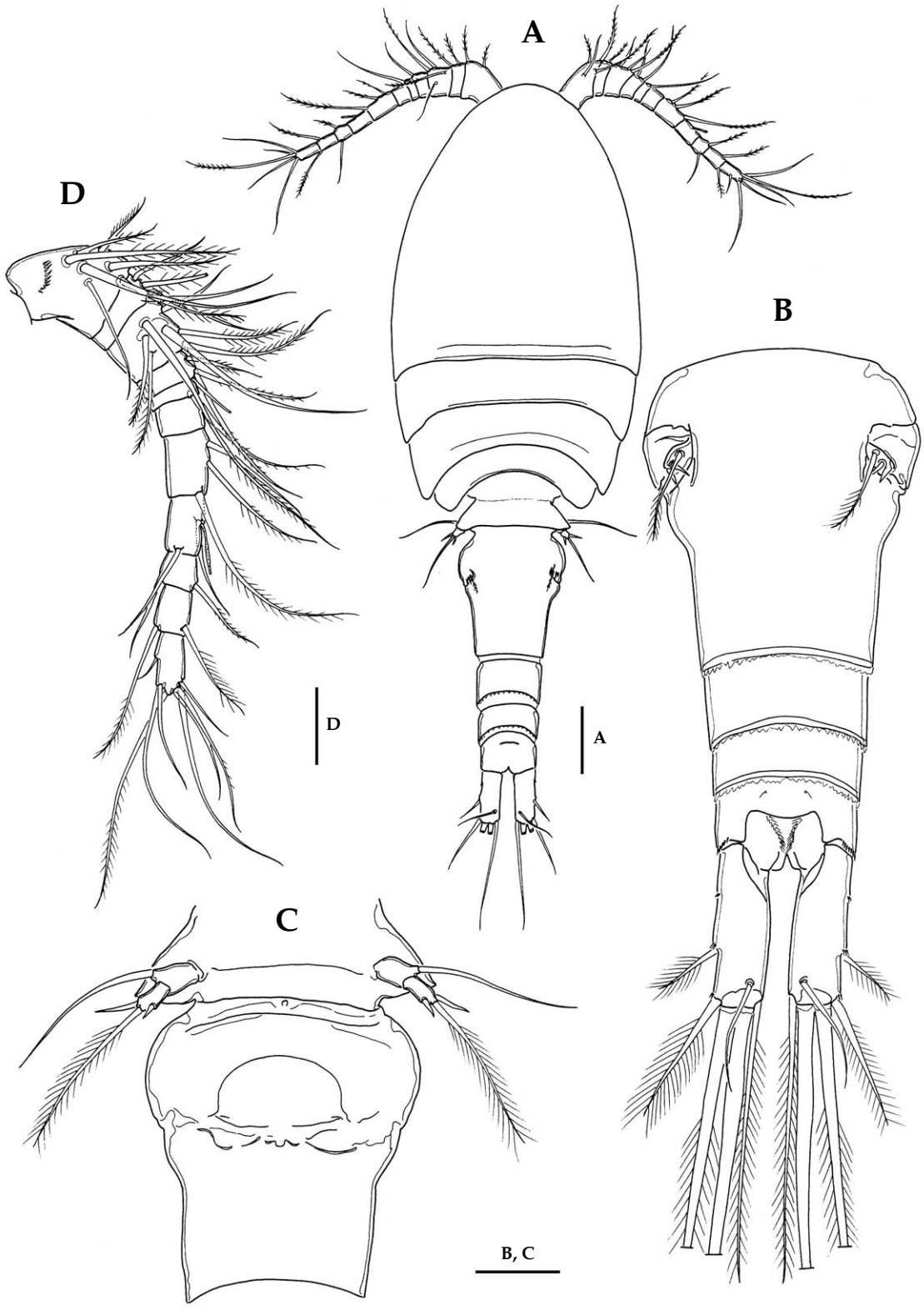


Fig. 13. *Acanthocyclops fonticulus*, female. A. habitus; B. urosome, dorsal; C. P5 and genital somite, ventral; D. A1. Scales: A=100 μm, B–D=50 μm (cited from Lee and Chang, 2007a).

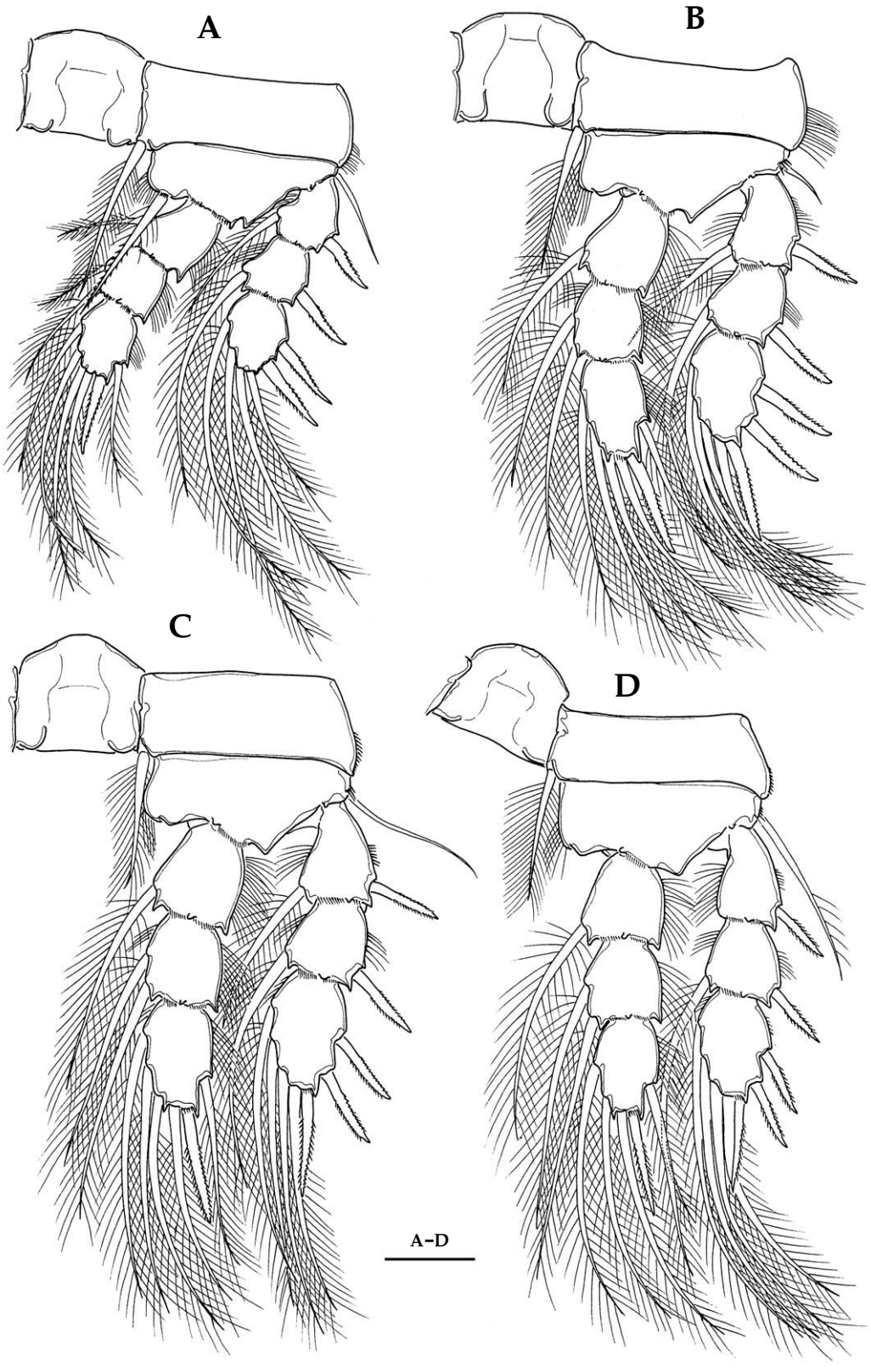


Fig. 14. *Acanthocyclops fonticulus*, female. A–D. P1–P4. Scales: 50 μm (cited from Lee and Chang, 2007a).

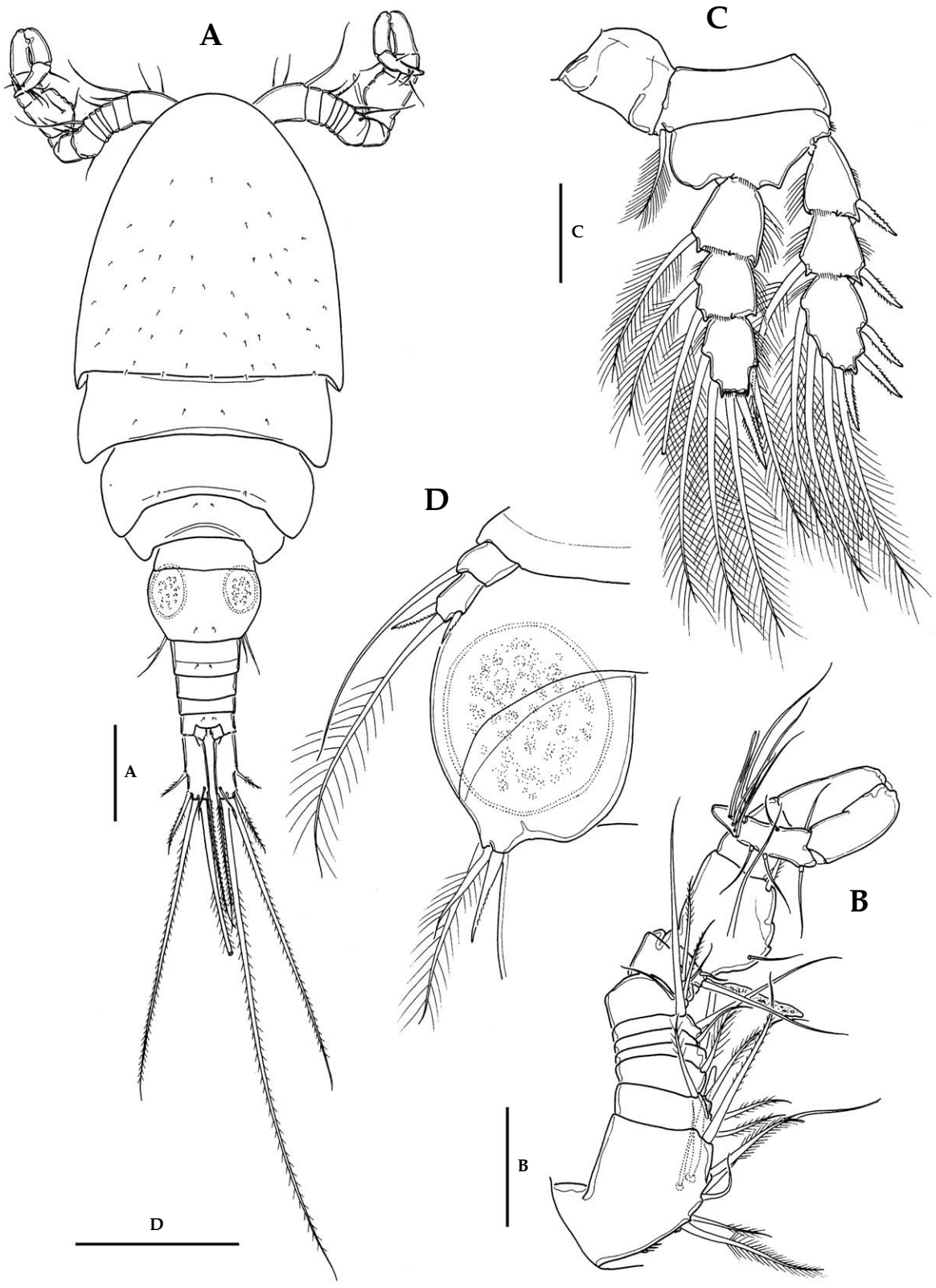


Fig. 15. *Acanthocyclops fonticulus*, male. A. habitus; B. A1; C. P4; D. P5, P6 and genital somite, ventral. Scales: A=100 μm, B–D=50 μm (cited from Lee and Chang, 2007a).

Genus *Diacyclops* Kiefer, 1927

Maep-si-geom-mul-byeo-ruk-sok (맵시검물벼룩속)

Fu elongate, generally 4–8 times longer than wide. A1 of 11–17 segments. P5 2-segmented; exopod bearing 1 inner subapical spine and 1 apical seta, spine much longer than width of exopod.

Type species: *Diacyclops bicuspidatus* (Claus, 1857).

Species 111 (8 in Korea).

Key to the species of genus *Diacyclops*

1. A1 17-segmented ····· *D. bicuspidatus*
– A1 16-segmented ····· *D. disjunctus*
– A1 12-segmented ····· *D. crassicaudis*
– A1 11-segmented ····· 2
2. Lateral caudal seta situated near middle of Fu ····· *D. nanus*
– Lateral caudal seta situated at distal 1/3 of Fu ····· 3
3. Antenna with exopodal seta ····· 4
– Antenna without exopodal seta ····· 5
4. Fu more than 4 times as long as wide ····· *D. languidoides*
– Fu about 3 times as long as wide ····· *D. leeae*
5. Fu 1.6–2 times as long as wide; basis of antenna with single seta ····· *D. hanguk*
– Fu about 2.9 times as long as wide; basis of antenna with 2 setae ····· *D. parasuoensis*

11. *Diacyclops bicuspidatus* (Claus, 1857) (Figs. 16, 17)

Ga-si-kko-ri-maep-si-geom-mul-byeo-ruk (가시꼬리맵시검물벼룩)

Cyclops bicuspidatus Claus, 1857b, p. 209, pl. 11, figs. 6, 7; Schmeil, 1892, p. 75, pl. 2, figs. 1–3.
Cyclops (*Diacyclops*) *bicuspidatus*: Kiefer, 1929, p. 58, fig. 19(a–b).
Cyclops (*Acanthocyclops*) *bicuspidatus*: Gurney, 1933, p. 219, figs. 1655–1671.
Acanthocyclops bicuspidatus: Rylov, 1948, p. 238, fig. 53.
Diacyclops bicuspidatus: Dussart, 1969, p. 145, fig. 67; Mizuno and Miura, 1984, p. 597, fig. 338: 1–5; Kim and Chang, 1989, p. 241, fig. 8; Ishida, 2002, p. 55, fig. 25a–e; Chang and Min, 2005, p. 74, fig. 38D, E; Chang, 2009, p. 446, figs. 255, 256.
Acanthocyclops (*Diacyclops*) *bicuspidatus*: Tai and Chen, 1979, p. 366, fig. 214.

Female: Body large, about 1.6 mm long, excluding caudal setae. Prosome comprising cephalothorax incorporating first pedigerous somite and 3 free pedigerous somites; posterior margins of prosomites slightly protruding posterolaterally; sensilla scattered on dorsal surface. Anal operculum gently convex, without spinules or hairs along its posterior margin.

Fu slender and elongate, about 5–7 times longer than wide; parallel to each other; medial margin not haired; lateral margin with minute notch at proximal one-fifth. Lateral caudal seta situated at about distal one-third. Inner caudal seta 1.1–1.3 times longer than outer caudal seta. Dorsal caudal

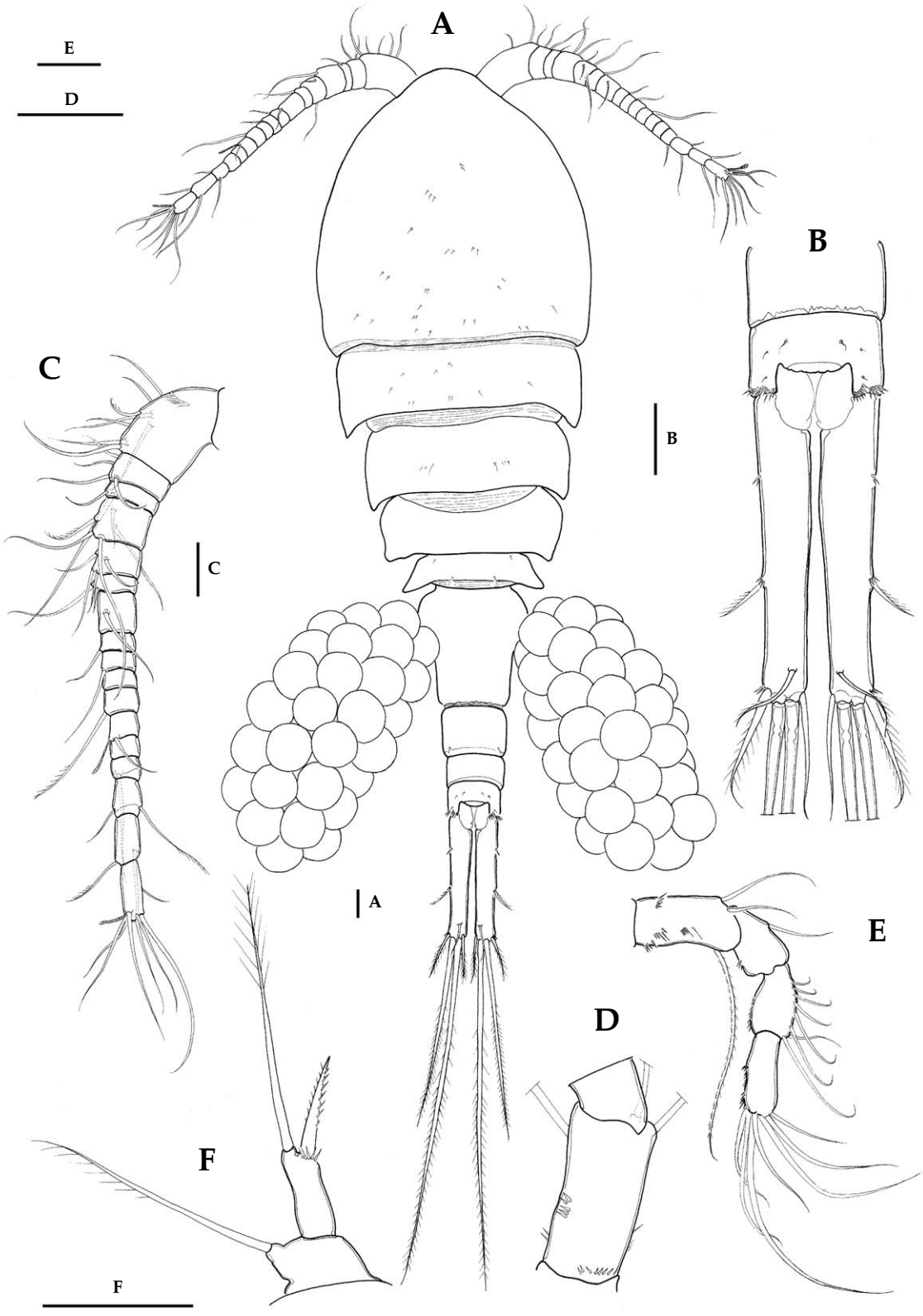


Fig. 16. *Diacyclops bicuspidatus*, female. A. habitus; B. anal somite and Fu, dorsal; C. A1; D. A2 basis, frontal; E. A2, caudal; F. P5. Scales: 50 μm (cited from Chang, 2009).

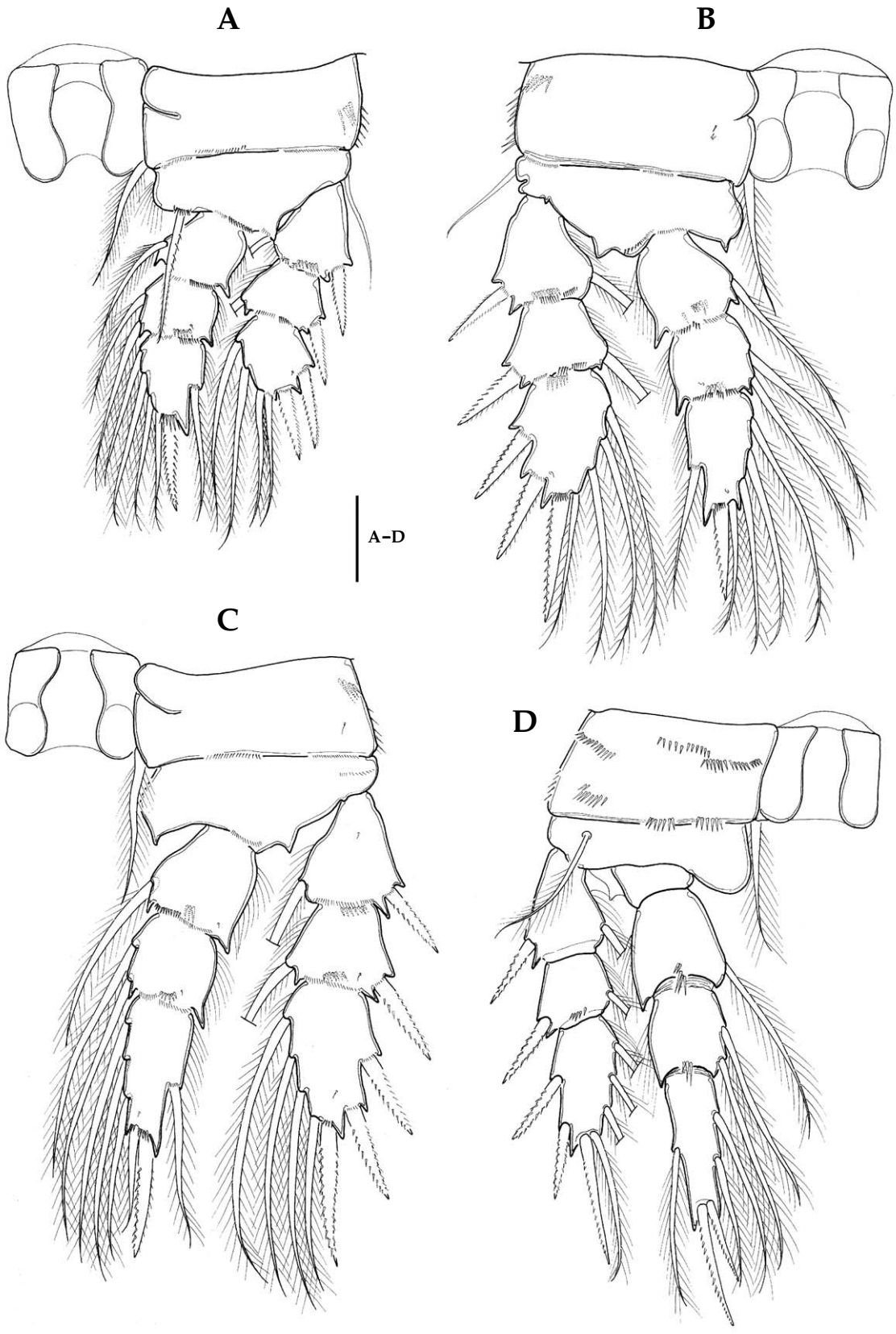


Fig. 17. *Diacyclops bicuspidatus*, female. A–D. P1–P4. Scale: 50 μm (cited from Chang, 2009).

seta much shorter than both inner and outer caudal setae.

A1 reaching almost to posterior margin of cephalothorax; 17-segmented. Short aesthetasc present on each of segments 12, 16, and 17. A2 basis armed with 1 outer distal seta representing exopod; inner distal corner of frontal surface and outer distal edge of caudal surface naked, lacking spinules.

P1–P4 biramous, both rami 3-segmented. Spine formula 2,3,3,3; seta formula 5,5,5,5. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1, I+1,3
P3	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,I+1,3
P4	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,II,2

Basal seta of P1 slightly exceeding enp2. Intercoxal sclerites with smooth posterior margin, lacking transverse spinule row in middle of plate. P4 enp3 about 2.5–3 times longer than wide; outer apical spine much longer than inner spine, but shorter than enp3.

P5 2-segmented; exopod about 2.5 times as long as wide, armed with 1 inner apical spine and 1 apical plumose seta.

Male: About 1 mm long. Fu 5–6 times as long as wide. P6 armed with 1 innermost spine, 1 median seta and 1 long outer seta.

Distribution: Korea, Japan, China, Europe, North America, North Africa, New Zealand.

Korea: GG, CN, GB, GN, JN, JB.

Specimen examined: GB: (Muncheon Reservoir, Gyeongsan: 22.iv.2012); GN: (Upo Swamp, Changnyeong: 11.iii.2013).

Ecology: Occurring in various freshwater bodies, including polysaprobic waters; known as eurythermic, but frequently found at streamsides and littoral zones of reservoirs in early spring in Korea.

Remarks: Kim and Chang (1989a) and Chang and Min (2005) reported "*Diacyclops thomasi*", considering that specimens have the inner spine longer than P4 enp3. However, detailed reexamination of all the Korean specimens of "*D. thomasi*" revealed that the length ratio of the P4 enp3 and the inner spine varied continuously in different specimens. Furthermore, in other important characters, such as the spinule arrangement on the antennary basis, intercoxal sclerites of P2–P4, relative setal lengths of P4 enp3, and relative lengths of the caudal setae, no significant discrepancies could be found. Accordingly, the "*D. thomasi*" mentioned in Kim and Chang (1989) and Chang and Min (2005) are treated as erroneous identifications of *D. bicuspidatus* (see Chang, 2009).

12. *Diacyclops crassicaudis* (Sars, 1863) (Fig. 18)

Yeol-du-ma-di-maep-si-geom-mul-byeo-ruk (열두마디맵시검물벼룩)

Cyclops crassicaudis Sars, 1863, p. 249.
Cyclops (*Diacyclops*) *crassicaudis*: Kiefer, 1929, p. 60.
Cyclops (*Acanthocyclops*) *crassicaudis*: Gurney, 1933, p. 233.
Cyclops crassicaudis: Dussart, 1969, p. 152, fig. 70; Ishida, 2002, p. 57, fig. 26j–q; Chang, 2009, p. 469, fig. 257.

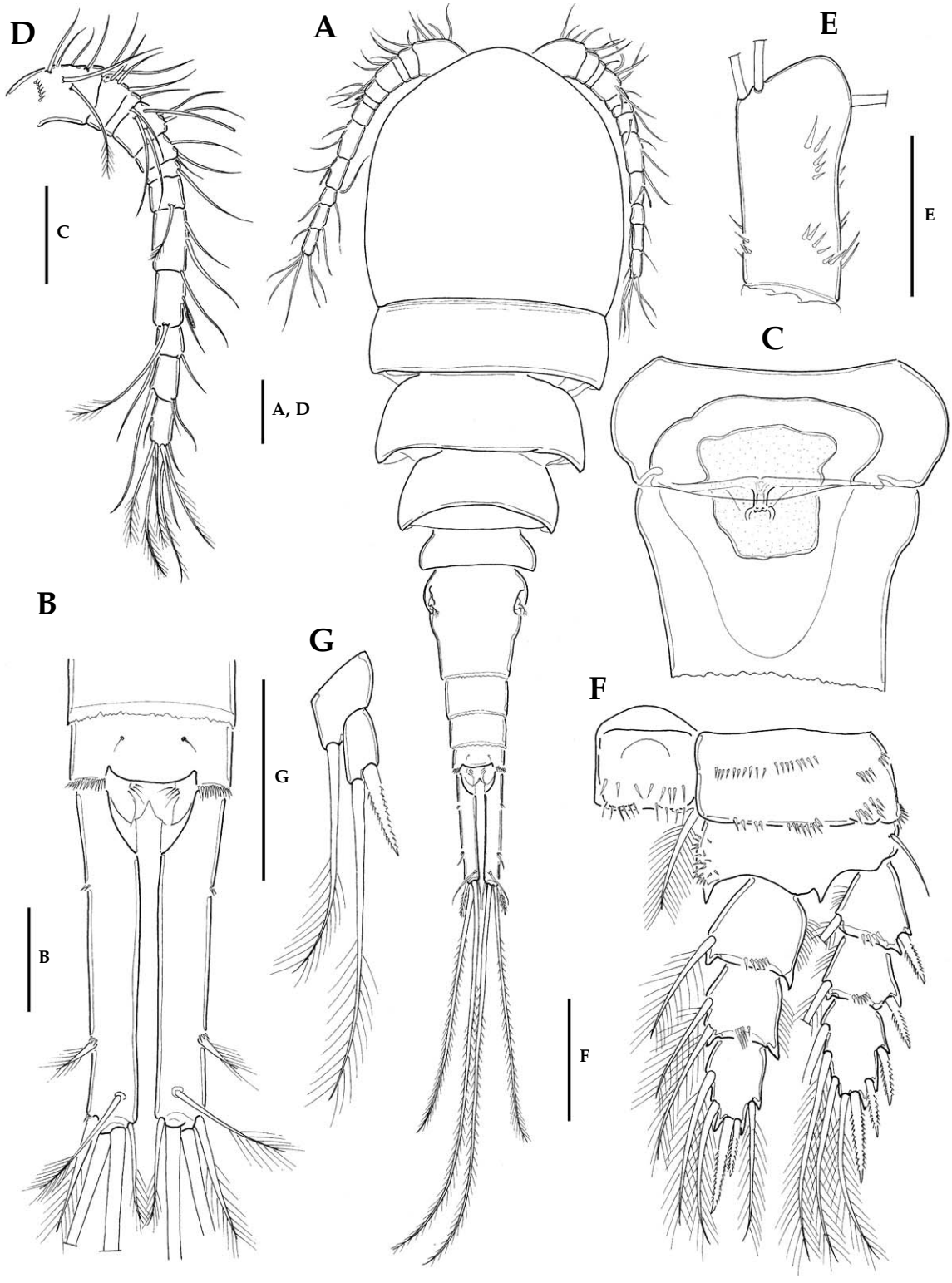


Fig. 18. *Diacyclops crassicaudis*, female. A. habitus; B. anal somite and Fu, dorsal; C. genital somite; D. A1; E. A2 basis, caudal; F. P4; G. P5. Scales: A=100 μm, B–G=50 μm (B, D, F and G cited from Chang and Min, 2005; A, C and E cited from Chang, 2009).

Diacyclops crassicaudis cretensis: Kim and Chang, 1989 (part.), p. 242, fig. 9a–e; Chang and Min, 2005, p. 76, fig. 39A–D.

Female: Body slender, narrowing posteriorly, about 1.2 mm long, excluding caudal setae; maximum width at middle of cephalothorax. Cephalothorax bell-shaped. Rostral expansion rarely visible in dorsal view. Posterior margins of prosomites nearly smooth; posterolateral edges of third and fourth prosomites slightly produced. Genital double-somite about 1.2 times longer than wide, with anterior part slightly expanded laterally; seminal receptacle as shown in Fig. 18C. Anal somite armed with 16–20 sharp spinules along posterior margin dorsally. Anal operculum gently rounded, with smooth posterior margin.

Fu slender and elongate, about 5–6 times as long as wide; nearly parallel; lateral margin with a notch and 2–3 spinules at proximal quarter; medial margin smooth. Lateral caudal seta situated at distal 1/4–1/5 of lateral margin of Fu. Outer caudal seta plumose, not pinnate, slightly less than 1/3 times as long as Fu, 1.2 times longer than inner caudal seta. Dorsal caudal seta slightly shorter than outer caudal seta.

A1 reaching almost to posterior margin of cephalothorax; 12-segmented. Segment 9 elongate, with short aesthetasc in middle of anterior margin. A2 basis armed with 2 inner distal setae and 1 outer distal seta representing exopod; 5–6 spinules present along lateral margin of caudal surface, enlarged distally; outer distal edge smooth.

P1–P4 biramous, both rami 3-segmented. Spine formula 2,3,3,3; seta formula 5,5,5,5. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,I+1,3
P3	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,I+1,3
P4	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,II,2

P1, inner distal seta on basis extending slightly over enp2. P4, intercoxal sclerite with 4–5 setules on posterior margin of each lateral expansion, with transverse row of 8–9 spinules in middle of caudal surface; enp3 about 1.4 times as long as wide; inner apical spine very long, more than 1.3 times as long as enp3, about 2 times longer than outer apical spine.

P5 2-segmented; basal segment not expanded laterally; exopod about 1.7 times longer than wide, armed with 1 inner apical spine and 1 apical plumose seta.

Distribution: Korea, Japan, China, Europe, North Africa, North America.

Korea: GG, GB, GN, JN.

Specimen examined: GB: (Aejiho pond, Gyeongsan: 28.vi.2012); GN: (Upo Swamp, Changnyeong: 11.iii.2013).

Ecology: Occurring in bottom debris or among littoral plants of relatively small, lentic waters such as bogs, swamps, reservoirs, etc. (Chang, 2009). Sometimes co-occurring with the preceding species, *Diacyclops bicuspidatus*.

13. *Diacyclops nanus* (Sars, 1863) (Fig. 19)

Jung-gan-kko-ri-teol-maep-si-geom-mul-byeo-ruk (중간꼬리털맵시검물벼룩)

Cyclops nanus Sars, 1863, p. 251.
Cyclops (*Diacyclops*) *nanus*: Kiefer, 1929, p. 63.
Cyclops (*Acanthocyclops*) *nanus*: Gurney, 1933, p. 248, figs. 1736–1746.
Acanthocyclops nanus: Rylov, 1948, p. 258, fig. 60, 1–7.
Diacyclops nanus: Dussart, 1969, p. 158, fig. 74; Monchenko, 1974, p. 321, fig. 144; Chang et al., 1998, p. 299; Mizuno and Miura, 1984, p. 600, fig. 340: 8–12; Ishida, 2002, p. 57, fig. 27h–n; Chang and Min, 2005, p. 79, fig. 40D, E; Chang, 2009, p. 471, fig. 258.

Female: Body relatively small for a *Diacyclops* species, as suggested in the specific name, about 600–650 μm long, excluding caudal setae. Prosome elliptical, comprising cephalothorax incorporating first pedigerous somite and 3 free pedigerous somites. Cephalothorax strongly protruding anteriorly; posterior margins of prosomites nearly smooth. Genital double-somite slightly longer than wide, with anterior part slightly expanded laterally. Urosomites ornamented with hyaline fringe along posterior margin. Anal operculum slightly convex, not protruding posteriorly, with smooth posterior margin.

Fu elongate, 4–5 times longer than wide; slightly divergent from each other posteriorly; medial margin not hairy; lateral margin smooth, without notch. Lateral caudal seta situated just posterior to middle of lateral margin. Outer caudal seta nearly 1/2 as long as Fu, slightly longer than inner caudal seta. Dorsal caudal seta about 1.5–2.0 times as long as inner caudal seta.

A1 reaching almost to posterior margin of cephalothorax; 11-segmented. A2 basis armed with 5–6 spinules along lateral margin of caudal surface; outer distal edge smooth.

P1–P4 biramous; segmentation (enp/exp) 2/2, 2/3, 3/3, 3/3; spine formula 3,3,3,3; seta formula 5,5,5,5. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-1; 1,I,4
P4	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,II,2

P1, inner distal seta on basis nearly reaching to posterior end of enp2. P4, intercoxal sclerites with 5–6 spinules on posterior margin of each lateral expansion, with transverse row of 12–14 spinules in middle of caudal surface; inner apical spine on enp3 slightly longer than enp3, about 1.3 times longer than outer apical spine.

P5 2-segmented; basal segment slightly expanded laterally; exopod about 2.3 times as long as wide, armed with 1 inner subapical spine and 1 apical plumose seta.

Distribution: Korea, Japan, China, Thailand, Europe, North America.
Korea: CB, GB, GN, JB, JN.
Specimen examined: GB: (well, Hwajin-ri, Pohang: 28.vii.2011).
Ecology: Inhabiting various mountain waters such as alpine bogs and puddles, or sometimes springs and wells.

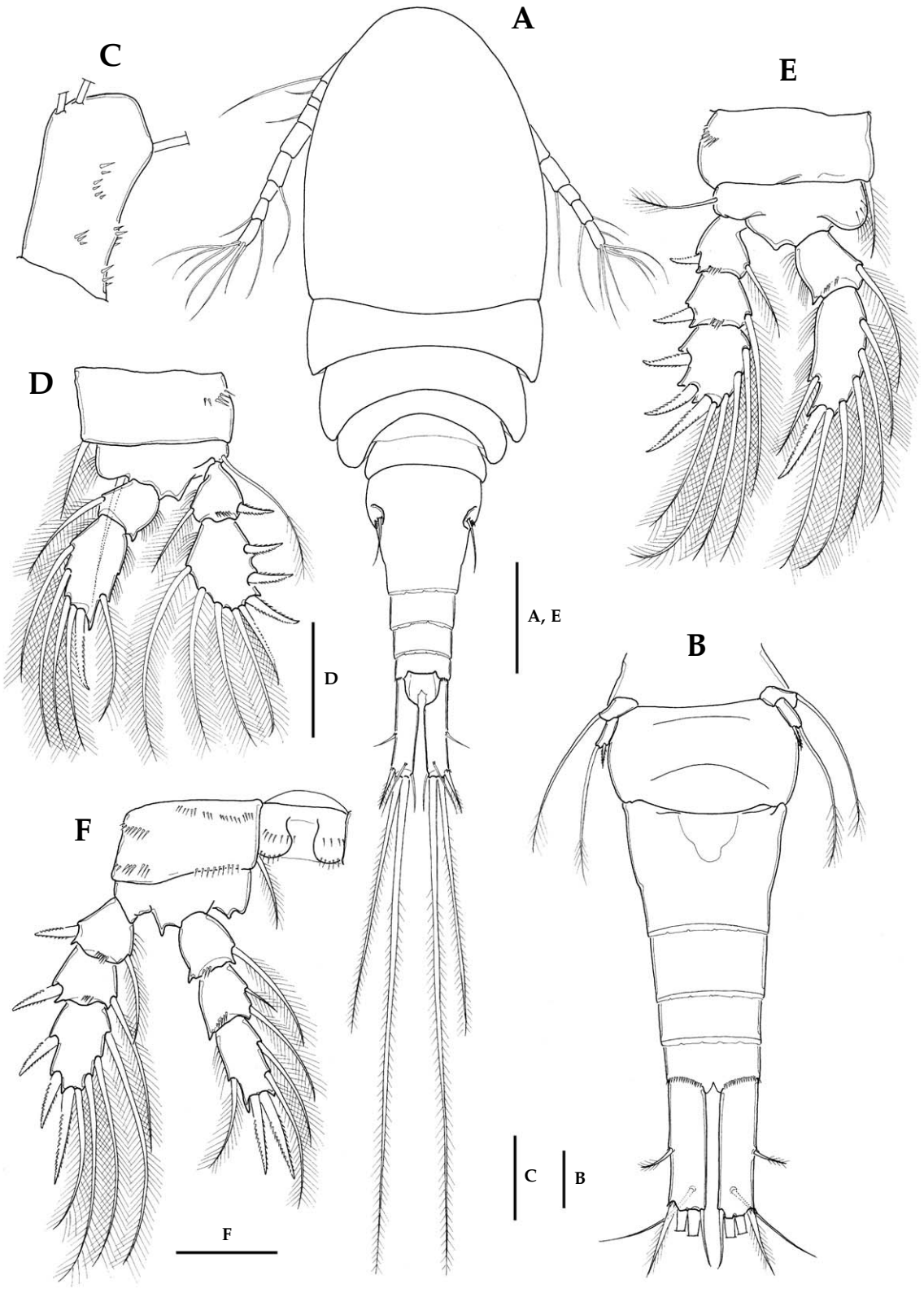


Fig. 19. *Diacyclops nanus*, female. A. habitus; B. P5 and urosome, ventral; C. A2 basis, caudal; D, E. P1–P2; F. P4. Scales: A=100 μm, B, D–F=50 μm, C=30 μm (cited from Chang, 2009).

14. *Diacyclops disjunctus* (Thallwitz, 1927) (Figs. 20, 21)

U-mul-maep-si-geom-mul-byeo-ruk (우물맵시검물벼룩)

Cyclops languidus var. *disjunctus* Thallwitz, 1927, p. 59, figs. 1, 2.
Acanthocyclops languidus disjunctus: Dussart, 1969, p. 156, fig. 72.
Diacyclops disjunctus: Ito, 1952, p. 1115; Mizuno and Miura, 1984, p. 597, fig. 338: 12–17; Chang et al., 1998, p. 299; Ishida, 2002, p. 56, fig. 26h, i; Chang and Min, 2005, p. 78, fig. 39E–G; Chang, 2009, p. 473, figs. 260, 261.

Female: Body relatively small, 640–780 μm long, excluding caudal setae; generally milky white. Prosome suboval and slightly flattened dorsoventrally, comprising cephalothorax incorporating first pedigerous somite and 3 free pedigerous somites. Posterior margins of prosomites nearly smooth; posterolateral edges of third to fourth prosomites acute. Genital double-somite slightly longer than wide, with anterior part slightly expanded laterally. Seminal receptacle consisting of broad anterior lobe and narrow posterior lobe. Posterior margins of urosomites, except for anal somite, with serrated hyaline fringe. Anal somite armed with 10–16 sharp spinules both dorsally and ventrally. Anal operculum not protruding posteriorly, with smooth posterior margin.

Fu elongate, 3–4 times longer than wide; nearly parallel, or slightly divergent posteriorly, curved outward after about distal third of rami; medial margin not hairy; lateral margin smooth, without notch. Lateral caudal seta situated at about distal quarter of ramus. Outer caudal seta stout, slightly longer than inner caudal seta. Dorsal caudal seta about 2–3 times as long as inner caudal seta.

A1 reaching almost to posterior end of cephalothorax; 16-segmented. A2 basis armed with 2 inner distal setae and 1 outer distal seta representing exopod; distal corners of both frontal and caudal surfaces smooth, without hairs and spinules; oblique row of 5–6 spinules present along medial margin.

P1–P4 biramous; segmentation (enp/exp) 2/2, 2/3, 3/3, 3/3; spine formula 3,3,3,3; seta formula 5,5,5,5. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-1; 1,I,4
P4	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,II,2

P1, inner distal seta on basis reaching almost to middle of enp2. P4, intercoxal sclerite with 2 oblique rows of 4–5 spinules on caudal surface; posterior margin smooth, without setule or hair row; enp3 short, about 1.2–1.3 times as long as wide; inner apical spine about 1.4 times longer than enp3 and outer apical spine.

P5 2-segmented; exopod armed with 1 inner subapical spine and 1 apical plumose seta.

Distribution: Korea, Japan, Europe.
Korea: GG, CN, GB, GN, JB.
Specimen examined: GN: (streamside puddle, Gucheoncheon Stream, Geoje: 5.ix.2011).
Ecology: Often occurring in interstitial waters of streams, and sometimes found in wells or springs.
Remarks: This species was once regarded as a subspecies of *Diacyclops languidus* (Sars, 1863). *D. languidus* is distinguished from *D. disjunctus* by the short inner spine on P4 enp3, which is shorter than the segment and only slightly longer than outer spine. *D. languidus* mostly inhabits small

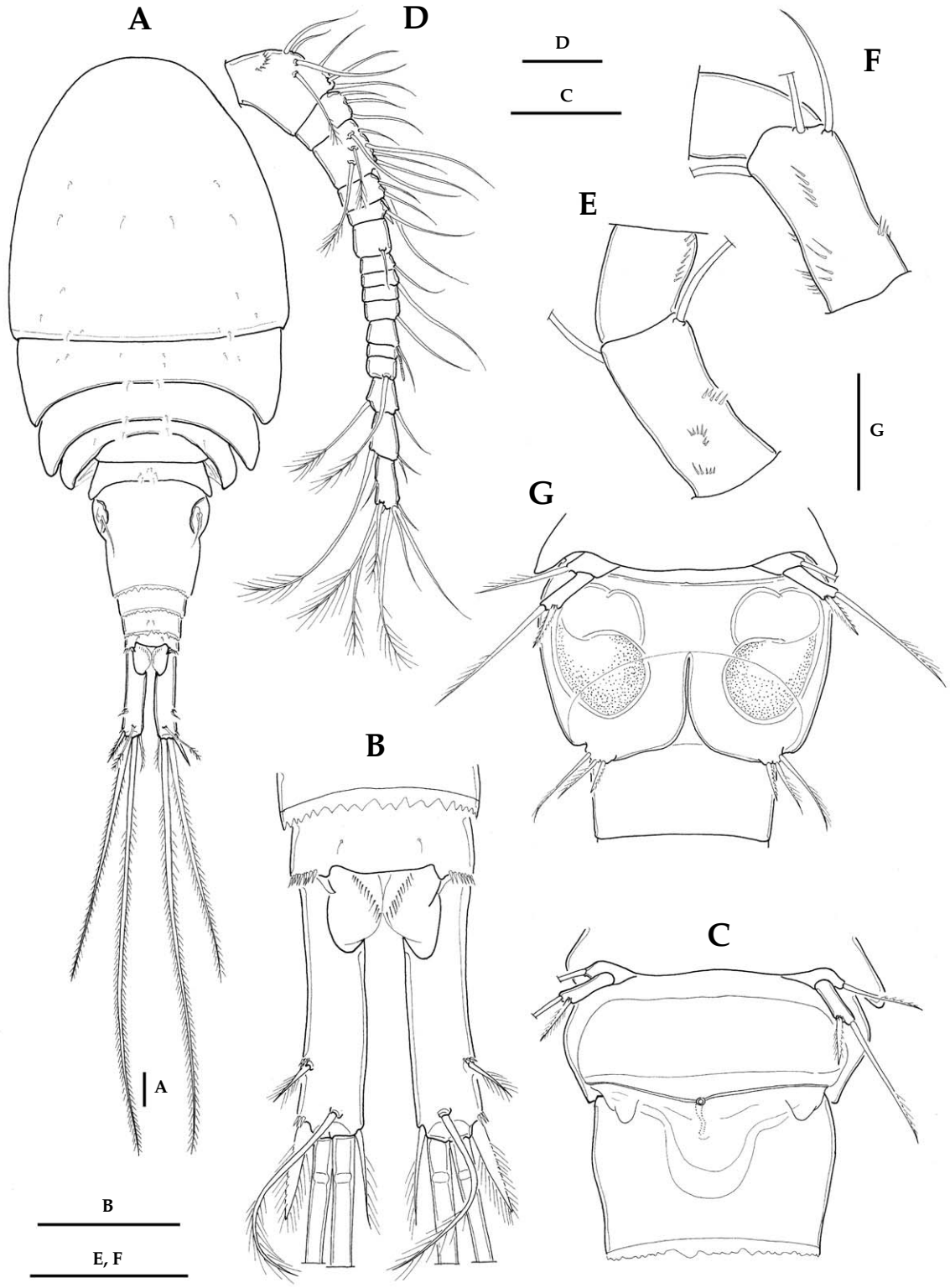


Fig. 20. *Diacyclops disjunctus*. Female: A. habitus; B. anal somite and Fu, dorsal; C. P5 and genital somite; D. A1; E. A2 basis, frontal; F. A2 basis, caudal. Male: G. fifth pedigerous somite and genital somite, ventral. Scales: 50 μm (cited from Chang, 2009).

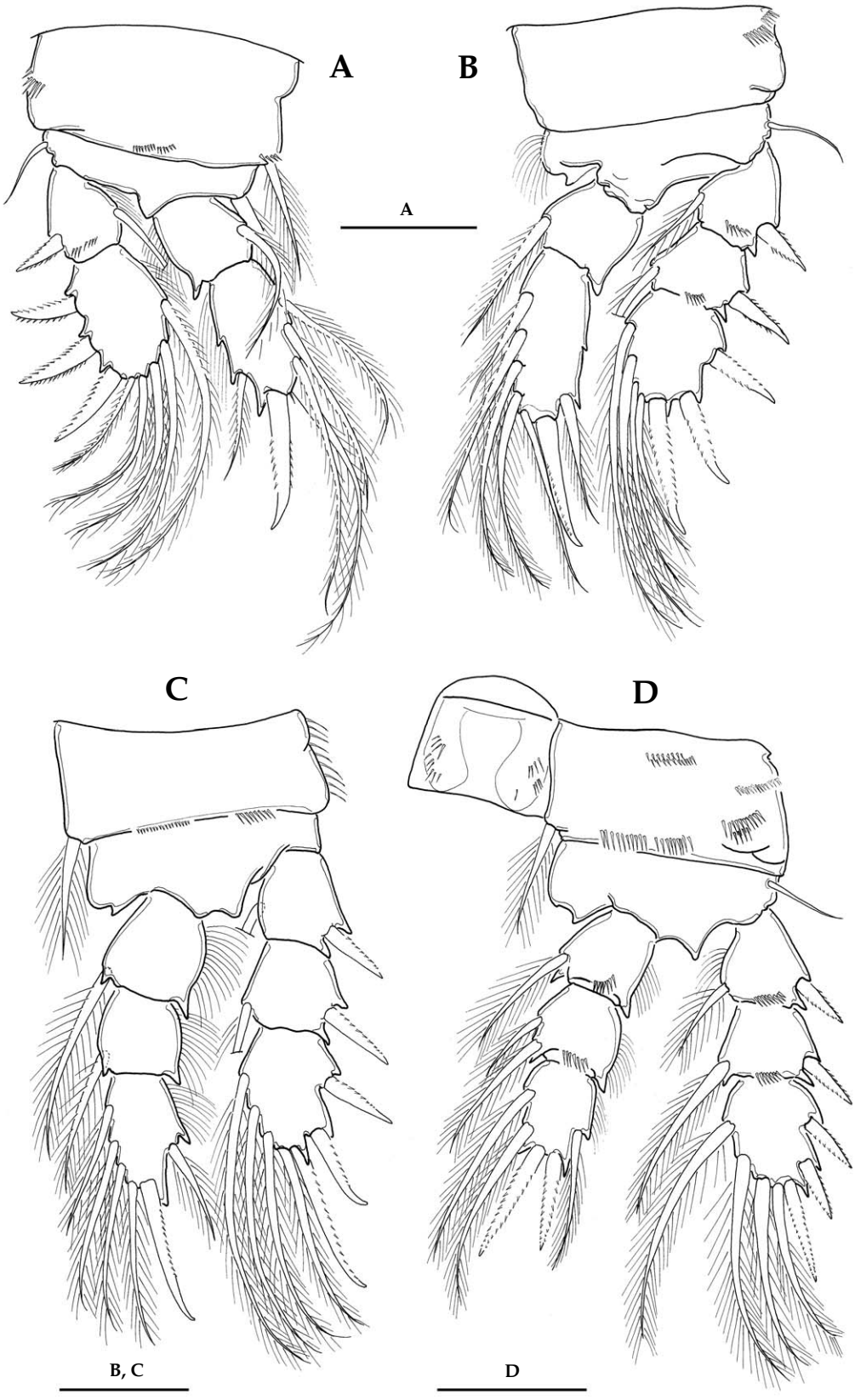


Fig. 21. *Diacyclops disjunctus*, female. A–D. P1–P4. Scales: 50 μm (cited from Chang, 2009).

stagnant pools, bogs, marshes and humid mosses in Europe and Japan (Dussart, 1969; Ishida, 2002), whereas *D. disjunctus* is collected mostly from underground waters, including wells, springs and interstitial waters (Chang, 2009).

15. *Diacyclops languidoides* (Lilljeborg, 1901) (Fig. 22)

Yak-gol-maep-si-geom-mul-byeo-ruk (약골맵시검물벼룩)

Cyclops languidoides Lilljeborg, 1901, p. 61, pl. 4, figs. 10–12.
Cyclops (*Diacyclops*) *languidoides*: Kiefer, 1929, p. 62.
Cyclops (*Acanthocyclops*) *languidoides*: Gurney, 1933, p. 241.
Acanthocyclops languidoides: Rylov, 1948, p. 250, fig. 57, 1–5.
Diacyclops languidoides: Dussart, 1969, p. 160; Mizuno and Miura, 1984, p. 602, fig. 340: 13–19; Chang et al., 1998, p. 299; Ishida, 2002, p. 57, fig. 27a–g; Chang and Min, 2005, p. 79, fig. 40 A–C; Chang, 2009, p. 476, fig. 262.

Female: Body small, 580–640 μm long, excluding caudal setae; slightly flattened dorsoventrally. Milky white when preserved in ethanol or formalin. Cephalothorax not protruding anteriorly, nearly as long as wide. Posterior margins of prosomites nearly smooth. Genital double-somite slightly longer than wide, with anterior part slightly expanded laterally. Seminal receptacle with anterior lobe expanding laterally. Posterior margins of urosomites with crenated hyaline frills both dorsally and ventrally, except for anal somite armed with 10–14 sharp spinules both dorsally and ventrally. Anal operculum slightly convex, with smooth posterior margin.

Fu elongate, 4–5 times longer than wide; both medial and lateral margins smooth, without hairs or spinules. Lateral caudal seta located at distal third of ramus. Inner caudal seta short, less than half length of Fu, slightly shorter than outer caudal seta. Dorsal caudal seta more than 2 times as long as inner caudal seta.

A1 reaching almost to posterior end of cephalothorax; 11-segmented. A2 basis armed with row of 4–5 spinules along lateral margin of caudal surface.

P1–P4 biramous; segmentation (enp/exp) 2/2, 2/3, 3/3, 3/3; spine formula 3,3,3,3; seta formula 5,5,5,5. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-1; 1,I,4
P4	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,II,2

P4, intercoxal sclerite with 2 transverse rows of spinules on caudal surface; posterior margin smooth, without setule or hair row; enp3 about 1.6 times as long as wide, slightly longer than apical spines; inner apical spine slightly longer (about 1.1 times) than outer apical spine; distal setae on enp3 far exceeding tips of apical spines.

P5 2-segmented; basal segment slightly expanded laterally; exopod about 2.3 times as long as wide, armed with 1 inner subapical spine and 1 apical plumose seta.

Distribution: Korea, Japan, Europe.
Korea: GW, GB.

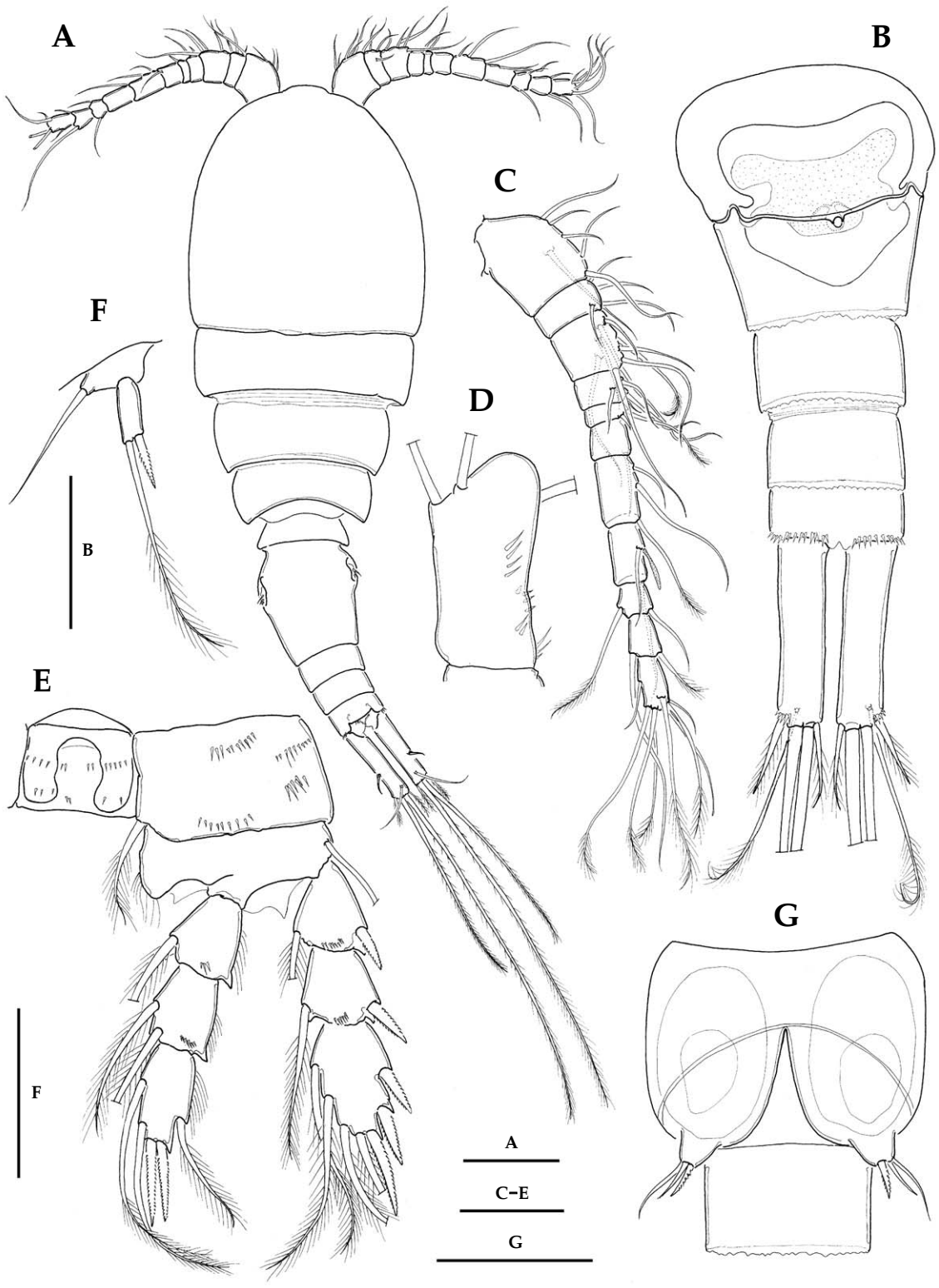


Fig. 22. *Diacyclops languidoides*. Female: A. habitus; B. urosome, ventral; C. A1; D. A2 basis, caudal; E. P4; F. P5. Male: G. genital somite, ventral. Scales: A–C, E–G=50 μm, D=20 μm (cited from Chang, 2009).

Specimen examined: GB: (well, Gyeongsan: 17.v.2007).
Ecology: Basically subterranean species, inhabiting wells, springs, and related mountain steamlets.

16. *Diacyclops leeae* Karanovic, Grygier and Lee, 2013 (Figs. 23, 24)
Na-bi-maep-si-geom-mul-byeo-ruk (나비맵시검물벼룩)

Diacyclops leeae Karanovic, Grygier and Lee, 2013, p. 48.
Diacyclops suoensis: Lee, Kim, Choi and Chang, 2007, p. 162, figs. 7, 8; Chang, 2009, p. 478, figs. 263, 264.

Female: Body small and somewhat slender, 600–700 μm long; tinged milky white. Seminal receptacle butterfly-shaped, both sides of anterior half deeply concave. Anal operculum not strongly convex, smooth on its posterior margin.

Fu about 3 times as long as wide, without hairs along inner (medial) margin; lateral seta inserted at about posterior 1/3 of lateral margin of ramus; outer caudal seta slightly less than 2/3 times as long as Fu, slightly longer than inner caudal seta; dorsal caudal seta long, nearly 2 times longer than inner caudal seta.

A1 11-segmented, slightly exceeding posterior margin of cephalothorax; 8th and last segments each bearing 1 asthetasc. A2, caudal face of basis ornamented with 4–5 spinules near middle of outer margin; a long seta on outer distal corner of basis representing exopod.

P1–P4, segmentation of exopod/endopod 2/2, 3/2, 3/3, 3/3. Spine formula 3,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-1; 1,I,4
P4	coxa 0-1	basis 1-0	exp I-1; I-1; II,I,4	enp 0-1; 0-2; 1,II,2

P4, lateral lobes of coupler not produced, with smooth posterior margin; caudal face of coupler armed with 2 spinule rows, each consisting of about 16 spinules in the middle and 20 in the posterior part, respectively; enp3 about 1.2 times as long as wide, about 3/4 times as long as inner spine; inner spine about 1.4 times longer than outer spine; 2 inner setae extending far beyond inner apical spine, while outer seta not reaching end of inner apical spine.

P5 composed of 2 free segments; basal segment slightly enlarged distolaterally, about 1.5 times wider than long; exopod about 2 times longer than wide, with 1 distomedial spine and 1 long plumose apical seta. P6 represented by 2 strong conical projections and 1 long plumose seta, located at both sides of dorso-anterior part of genital double-somite.

Ovigerous females generally bearing 5–6 eggs in each egg sac.

Distribution: Korea.
Korea: CB, GB.
Specimen examined: GB: (Naeseongcheon Stream, Yecheon: 18.viii.2011).
Ecology: This species was found in cavern puddles and interstitial waters of streambanks.
Remarks: This species has been reported from cavern puddles, springs and wells in South Korea

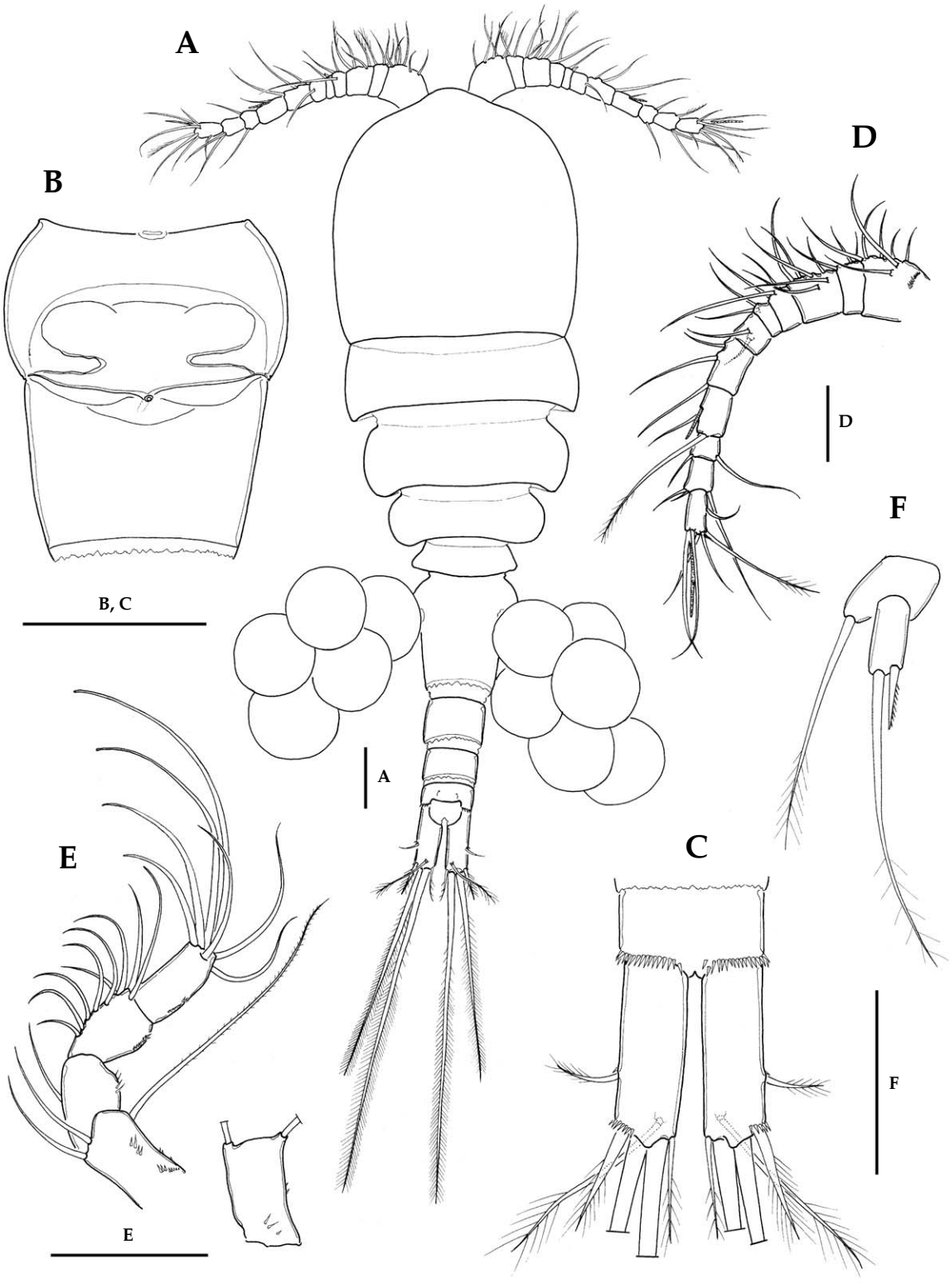


Fig. 23. *Diacyclops leeae*, female. A. habitus; B. genital double-somite; C. anal somite and Fu, ventral; D. A1; E. A2, caudal and basis, frontal; F. P5. Scales: A–E=50 μm, F=20 μm (cited from Lee, Kim, Choi and Chang, 2007).

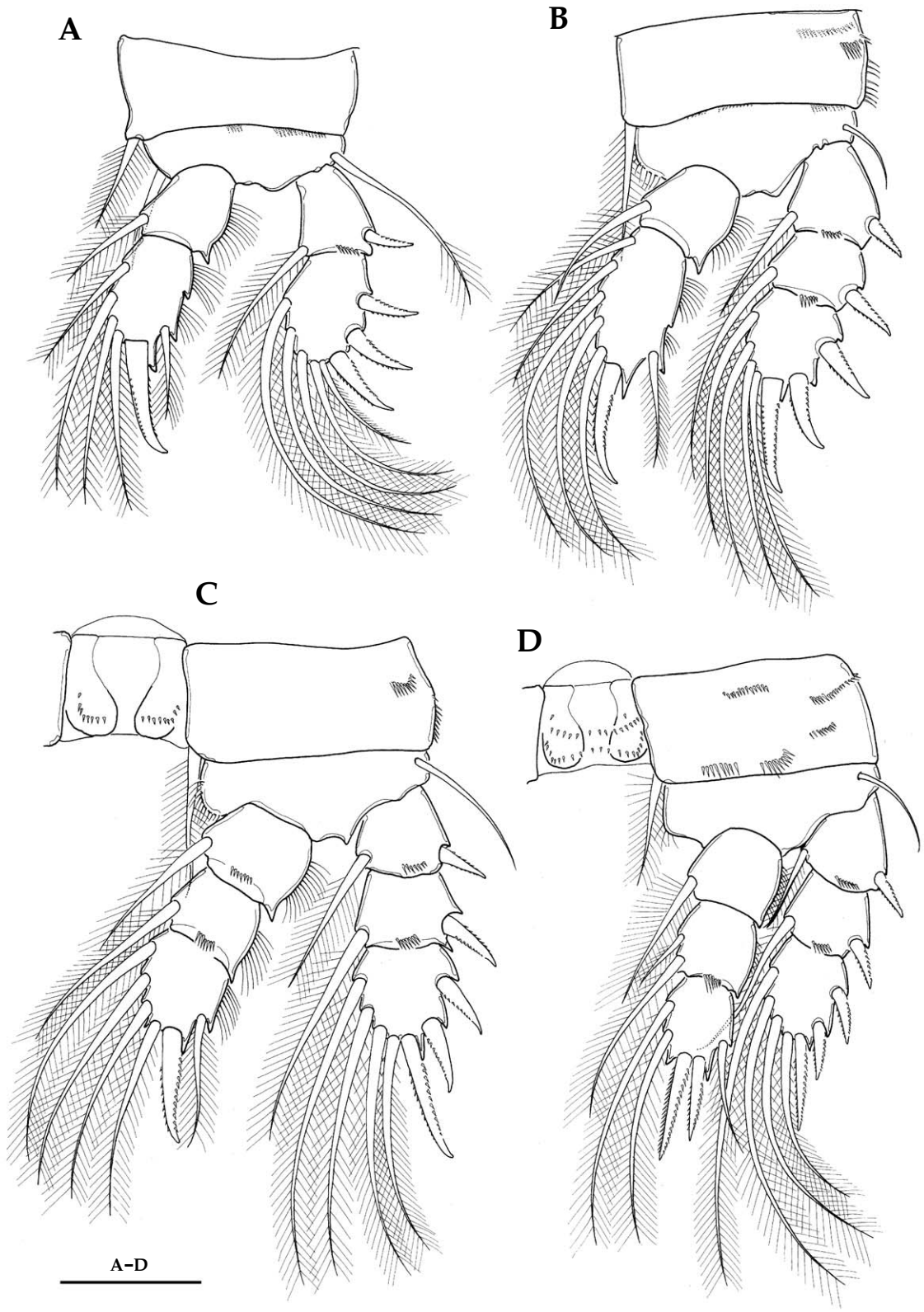


Fig. 24. *Diacyclops leeae*, female. A–D. P1–P4. Scale: 50 μm (cited from Lee, Kim, Choi and Chang, 2007).

under the name of '*Diacyclops suoensis* Ito' by Lee, Kim, Choi and Chang (2007) and Chang (2009). Recently, Karanovic et al. (2013) have made a revision on the subterranean *Diacyclops* from Korea and Japan, and described seven new species of *languidoides*-group, including two new Korean endemic species, *D. parasuoensis* and *D. hanguk*. Furthermore, they redescribed *D. suoensis* Ito, based upon the newly collected specimens from Japan, and treated the Korean '*D. suoensis*' as a distinct new species, *D. leeae*. According to their redescription of *D. suoensis* Ito, *D. leeae* evidently differs from *D. suoensis* Ito by the exopodal seta of antenna. This species is closely related with *D. languidoides*, but can be distinguished from it by relatively shorter Fu (about 3 times as long as wide, against more than 4 times as long as wide in *D. languidoides*).

Genus *Itocyclops* Ishida and Reid, 2000

Saem-geom-mul-byeo-ruk-sok (샘검물벼룩속)

Fu minute, 400–500 μm; slightly depressed dorsoventrally. A1 11- or 12-segmented. Anal operculum triangular, protruding posteriorly. Fu stumpy, less than 2 times longer than wide. P1 and P2 with 2-segmented exopod and endopod; P3 and P4 with 3-segmented exopod and 2-segmented endopod. P5 2-segmented; endopod partially incorporated into fifth pedigerous somite.

Type species: *Itocyclops yezoensis* (Ito, 1954).

Species 1 (1 in Korea).

17. *Itocyclops yezoensis* (Ito, 1953) (Figs. 25, 26)

Saem-geom-mul-byeo-ruk (샘검물벼룩)

Speocyclops yezoensis Ito, 1953, p. 406, figs. 175–182; Ishida, 1992b, p. 249, figs. 3–8.
Diacyclops yezoensis: Monchenko, 1974, p. 331.
Itocyclops yezoensis: Reid and Ishida, 2000, p. 589, figs. 1–3; Ishida, 2002, p. 58, fig. 28k–o; Lee et al., 2004. p. 151, figs. 5, 6; Chang and Min, 2005, p. 87, fig. 43; Chang, 2009, p. 482, figs. 266, 267.

Female: Body small, less than 500 μm long; habitus dorsoventrally flattened. Genital double-somite much swollen laterally, and 1.3 times wider than long. Seminal receptacle rather complex, with paired lateral wings.

Anal operculum triangular, its tip extending slightly beyond middle of Fu or just reaching it in lateral view, with lateral margins irregularly crenate.

Fu slightly divergent, 1.69 times as long as wide; lateral caudal seta inserted at midlength of ramus, with row of spinules anteriorly; outer caudal seta swollen at its base, about 2.5 times longer than inner caudal seta; dorsal caudal seta about 2 times longer than outer terminal seta; inner caudal seta about 1.8 times longer than outer terminal seta, and about 60% of entire body length.

A1 11-segmented, its tip not reaching to posterior margin of cephalothorax.

P1–P4, exopods composed of 2,2,3,3 segments respectively, endopods all 2-segmented; spine

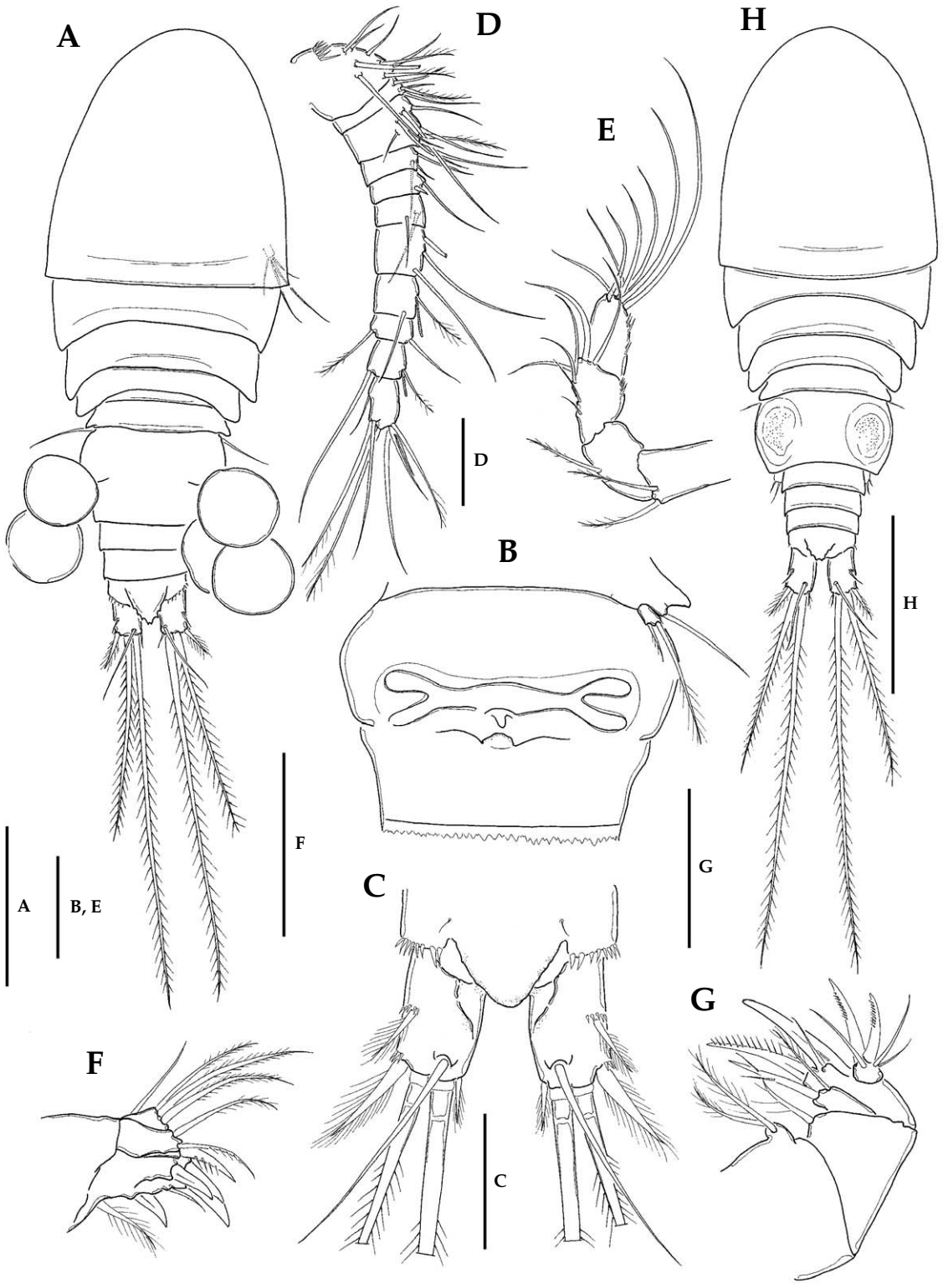


Fig. 25. *Itocyclops yezoensis*. Female: A. habitus; B. P5 and genital somite; C. anal somite and Fu, dorsal; D. A1; E. A2; F. maxillule; G. maxilla. Male: H. habitus. Scales: A, H=50 μm, B–G=30 μm (cited from Lee et al., 2004).

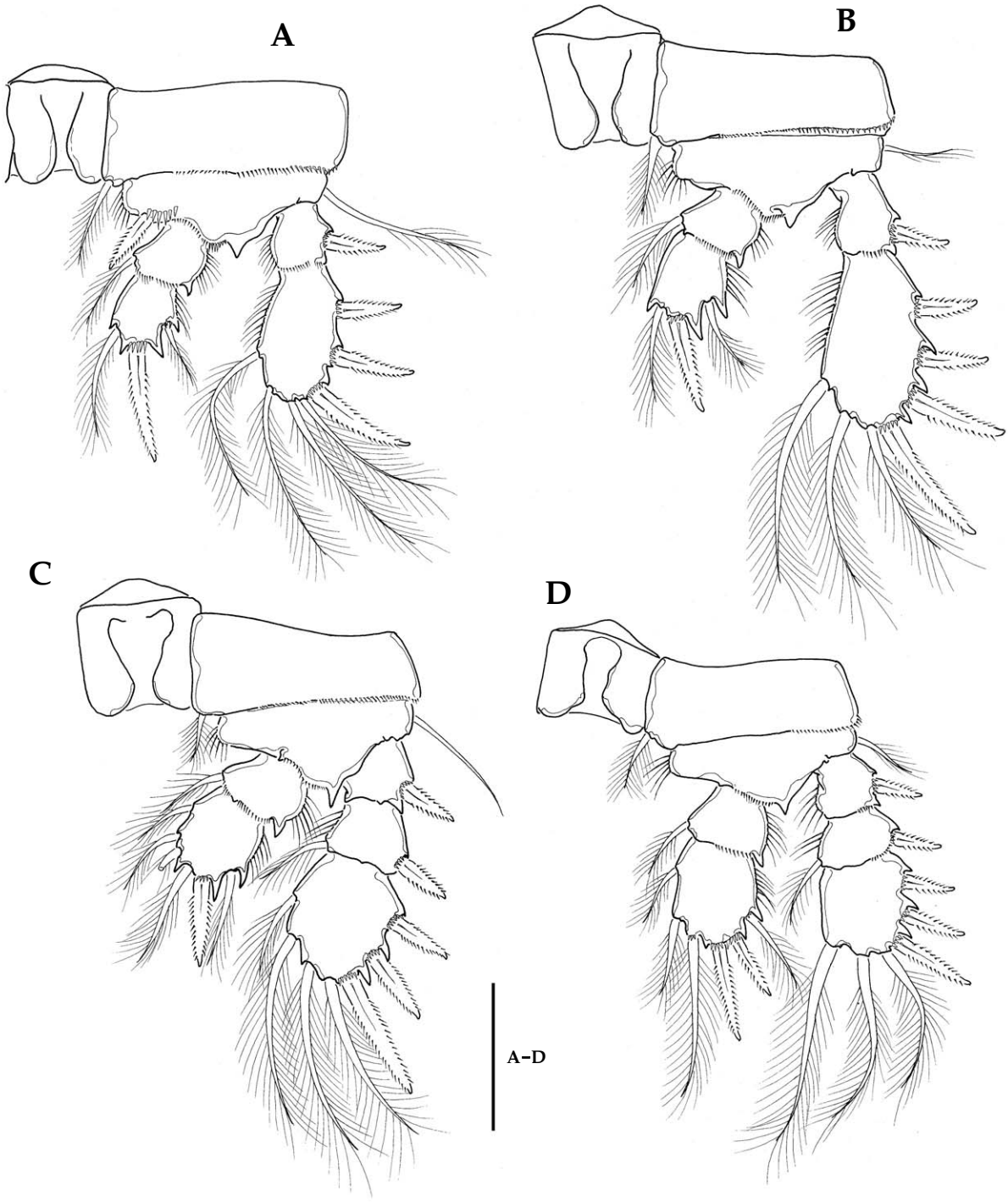


Fig. 26. *Itocyclops yezoensis*, female. A–D. P1–P4. Scale: 50 μm (cited from Lee et al., 2004).

formula 3,4,3,3. P4 enp2 oval, about 1.25 times as long as wide, inner apical spine nearly equal in length to enp2, and 1.67 times longer than outer spine. Setal and spinous ornamentation on exo- and endopods of legs 1–4 as follows:

P1	coxa 0-1	basis 1-I	exp I-0; II,I,4(3)	enp 0-1; 1,I,1(2)
P2	coxa 0-1	basis 1-0	exp I-0; III,I,3(4)	enp 0-1; 1,I,1(2 or 3)
P3	coxa 0-1	basis 1-0	exp I-0; I-1; II,I,4(3)	enp 0-1; 1,I,4(2)
P4	coxa 0-1	Basis 1-0	exp I-1; I-1; II,I,3	enp 0-1; 1,II,3

P5, basal segment partly fused with fifth pedigerous somite, much enlarged, about 3 times broader than exopod; exopod with 2 setae on its tip, inner seta rather short, less than half of outer seta.

Distribution: Korea, Japan, North America (Alaska and Mississippi River drainage basin).
Korea: GW, GB, GN, JJ.
Specimen examined: GB: (well, Suryeom-ri, Gyeongju: 5.v.2009).
Ecology: Subterranean species, occurring mostly in springs, well and cave waters, especially not far from seashore in Korea.
Remarks: Reid and Isida (2000) established the genus *Itocyclops* to accommodate this species, which showed evidently generic differences of the segmentation of legs, from the genera *Speocyclops*, *Diacyclops*, *Metacyclops*, and so on (cf. Reid and Ishida, 2000: 293–595). *Itocyclops yezoensis* still remains as the monotypic species of the genus.

Specimens from Korea well coincide with the original description and Reid and Ishida's (2000) redescription, except for the relatively longer Fu (more than 1.6 times as long as wide, versus 1.4 times in Japanese specimens). Shape of anal operculum (its length and number of teeth on lateral margins) shows a rather wide range of variation, that is, it passes over middle of rami in about 60% of individuals examined, while it nearly reaches middle of Fu in a lateral view in others, and the lateral margins of anal operculum vary in the shape from heavily crenate to weakly undulate. Setal armature is also variable in the distal segment of both endopods and exopods of P1–P3 (see Lee et al., 2004).

Genus *Psammophilocyclops* Fryer, 1956

Mo-rae-mu-ji-geom-mul-byeo-ruk-sok (모래무지검물벼룩속)

Body minute, 300–450 μm long, excluding caudal seta; somewhat flattened dorsoventrally, with distinct demarcation between prosome and urosome. Cephalothorax incorporating first pedigerous somite. Anal operculum convex, generally with smooth posterior margin, but sometimes semicircular in some species, rarely with serrated posterior margin. Fu truncate and not elongate, 2–3 times as long as wide, armed with 6 caudal setae. A1 10- or 11-segmented. A2 4-segmented; coxobasis lacks outer distal seta representing exopod. Maxilliped fundamentally comprising syncoxa, basis and 2-segmented endopod, with 2,1,2,3 setation, but often segmentation and setation reduced. P1–P4, both endopods and exopods 2-segmented, with spine formula 3,3,3,3 or 2,2,2,2 and seta formula 5,5,5,4. Basis of P1 bearing inner distal spiniform seta. P4 enp2 typically with 1,I,2 formula. P5 completely incorporated into fifth pedigerous somite, represented by 1 lateral seta and 2 inner apical setae in both sexes. Free-living. Found in streamside sand beach.

Type species: *Psammophilocyclops boccaroi* Fryer, 1956.

Species 4 (1 in Korea).

18. *Psammophilocyclops paucisetosus* Lee and Chang, 2011 (Figs. 27–31)

Mo-rae-mu-ji-geom-mul-byeo-ruk (모래무지검물벼룩)

Psammophilocyclops paucisetosus Lee and Chang, 2011, p. 2, figs. 1–5.

Female: Body minute, 412 μm long, excluding caudal setae, greatest width 138 μm at middle of cephalothorax; somewhat flattened dorsoventrally. Prosome oblong-oval, much longer than urosome (1.42 times). Cephalothorax protruding anteriorly, about 1.7 times longer than next three prosomites combined; chitinous lines present on dorsal and lateral surface, running transversely along posterior margin of cephalothorax and extending up to lateral margin; numerous pits and 20–24 sensilla scattered on entire dorsal and lateral surfaces. Second prosomite with 1 longitudinal cuticular ridge laterally, with paired sensilla dorsolaterally. Third prosomite with rough and rugged posterior margin. Posterolateral corners of third and fourth prosomites slightly produced posterolaterally. First urosomite (fifth pedigerous somite) with ventrolateral corner strongly produced.

Genital somite and first abdominal somite fused to form genital double-somite, chitinous suture line persisting laterally; somewhat flattened dorsoventrally; much (about 1.5 times) wider than long (58.6 μm long, 87.5 μm wide); both sides swollen laterally, but lateral margin rather smooth without chitinous projection; dorsolateral surface depressed widely and heavily sclerotized, with wrinkles, and a slender plumose seta and a small conical projection representing P6; 2 pairs of cuticle furrows, each engraved to form a groove, in hind region of mid-dorsal surface. Seminal receptacle comsisting of two wide lobes in the shape of a pot with lid, posterior lobe well developed, nearly semicircular with slight posteromedial depression. Third and fourth urosomites ornamented with row of 8 cuticle furrows dorsally. Posterior margins of abdominal somites strongly crenated, except anal somite bearing spinule row on both dorsal and ventral sides. Anal operculum slightly convex; posterior margin round and smooth, except with a notch on each side.

Fu nearly parallel or slightly divergent, 1.91 times as long as wide; a weak dorsal rib curving inward, extending to dorsal caudal seta; lateral margins smooth. Lateral caudal seta located at almost midlength of lateral margin of ramus, inserted slightly dorsolaterally, without spinules around its base. Outer caudal seta plumose, flanking 1 spinule just ahead of its base; nearly as long as Fu, 1.9 times as long as inner caudal seta. Inner terminal caudal seta not swollen at its base, with fracture plane, about 1.9 times longer than outer seta, and 0.42 times as long as entire body length. Dorsal caudal seta slightly longer than Fu, about 1.2 times longer than outer caudal seta.

A1 11-segmented, its tip extending slightly over middle of cephalothorax. Segments 2, 4 and 5 relatively short; segments 1, 3, 7 and 8 stout and long. Anterodistal seta on segment 5 completely lacking. Segments 7 and 11 each with 1 aesthetasc. Last segment without distinguishable hyaline lamella, about 1.5 times longer than penultimate segment. Setal formula: 6, 2, 5, 2, 0, 2, 3, 2+1 aesthetasc, 2, 3, 7+1 aesthetasc.

A2 4-segmented, comprising coxobasis and 3-segmented endopod. Coxobasis bearing 1 inner distal seta, lacking outer distal seta representing exopod. First endopodal segment bearing 1 inner seta with 1 spinule row at outer distal corner. Second endopodal segment with total of 5 setae along inner distal margin. Third endopodal segment armed with 7 setae around distal area.

Maxilliped 4-segmented. Syncoxa with 2 setae representing endite. Basis ornamented with 3 setules along outer margin, bearing 1 long pinnate seta. First endopodal segment armed with 1 strong pinnate seta; second endopodal segment with 2 naked setae.

P1–P4, both endopods and exopods 2-segmented. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-0; III,5	enp 0-1; 1,I,2
P2	coxa 0-0	basis 1-0	exp I-0; III,5	enp 0-1; 1,I,2
P3	coxa 0-0	basis 1-0	exp I-0; III,5	enp 0-1; 1,I,4
P4	coxa 0-0	basis 1-0	exp I-0; III,4	enp 0-1; 1,I,2

Intercoxal sclerites of P1–P4 each with paired lateral lobes strongly produced distally and smooth distal margin; both anterior and posterior surfaces smooth, without transverse spinule or setule row. Inner coxal seta present in P1, absent in P2–P4. Bases of P1–P4 produced inner distally, with setule row along inner distal margin. Basis of P1 bearing 1 short stout spiniform inner distal seta, not reaching to middle of P1 enp2. Enp1 of P1–P4 each with 1 inner seta. Exp2 of P1–P4 strikingly enlarged, each armed with 3 spines (spine formula 3,3,3,3), and with 5 setae on legs 1–3 and 4 setae on P4 (setal formula 5,5,5,4). Enp2 of P1–P4 with 3,3,5,3 setae. P4 enp2 relatively small, about 0.9 times as long as wide, bearing only 1 spine, nearly as long as enp2.

P5 completely incorporated into fifth pedigerous somite, represented by 1 lateral seta and 2 inner apical setae; two inner setae inserted close together, innermost one nearly 3 times longer than the outer one. P6 represented by 1 plumose seta and 1 minute spinule on small cuticular projection in dorsolateral part of genital double-somite.

Male: Sexual dimorphism in genital somite, anal operculum, A1, P3 enp2, and P6. Genital somite swollen laterally, about 1.6 times wider than long, posterior margin serrated dorsally; in ventral view, paired genital opercular plates oblong, each with 3 setae in total (2 plumose setae posterolaterally and 1 minute vestigial seta posterodorsally), representing P6. Next three urosomites with posterior margins serrated both dorsally and ventrally. Anal somite with spinules along posterior margin, 5–7 spinules dorsally, 9–10 spinules ventrally.

Anal operculum nearly semicircular, with posterior margin strongly serrated. Fu 2.15 times as long as wide, slightly longer than in female; relative lengths of caudal setae similar to those in female. A1 geniculate, indistinctly 14-segmented; articulation between segments 12 and 13; segments 1, 4, 8, 12 each bearing 1 aesthetasc. P1 similar to that of female, including inner seta on basis. P3 enp2, bearing 1 short, slender seta issuing from base of distal spine; distal spine modified with hooked tip and swollen mid-lateral margin, armed with spinules along outer margin.

Distribution: Korea.

Korea: GB.

Specimen examined: GB: (sand basin, Yecheon: 23.v.2008).

Ecology: Streamside sand beach.

Remarks: Since Fryer (1956) established a new genus *Psammophilocyclops* for a new species, *P. boccaroi*, from sandy beaches of Lake Nyasa (now called Lake Malawi), southeastern Africa, only two species have been added to the genus: *P. trispinosus* Shen and Tai, 1964 and *P. bispinosus* Shen and Tai, 1964, both from riverside beaches at Kwangtung, southern China. Shen and Tai (1964) regarded *Psammophilocyclops* as being allied to the genera *Goniocyclops* Kiefer, 1955, *Psammocyclops* Kiefer, 1955 and *Cochlocyclops* Kiefer, 1955 in sharing the character combination of 11- or 10-segmented A1, semicircular (or triangular) shape of anal operculum, 2-segmented endopods and exopods of P1–P4, and P5 completely incorporated into fifth pedigerous somite with 2 apical setal elements (see Shen and Tai, 1964: 376, Table 7; Tai and Chen, 1979: 402). The present species apparently does not belong to the allied genera above but to *Psammophilocyclops* in showing the spine formula of 3,3,3,3 (versus 2,3,3,2 in *Goniocyclops*, and 3,3,3,2 in *Psammocyclops* and *Cochlocyclops*).

The reduction in the setal and/or spine armature of the legs and in the segmentation and setation of the maxilliped occurs widely in the members of the genus *Psammophilocyclops*, supposedly result-

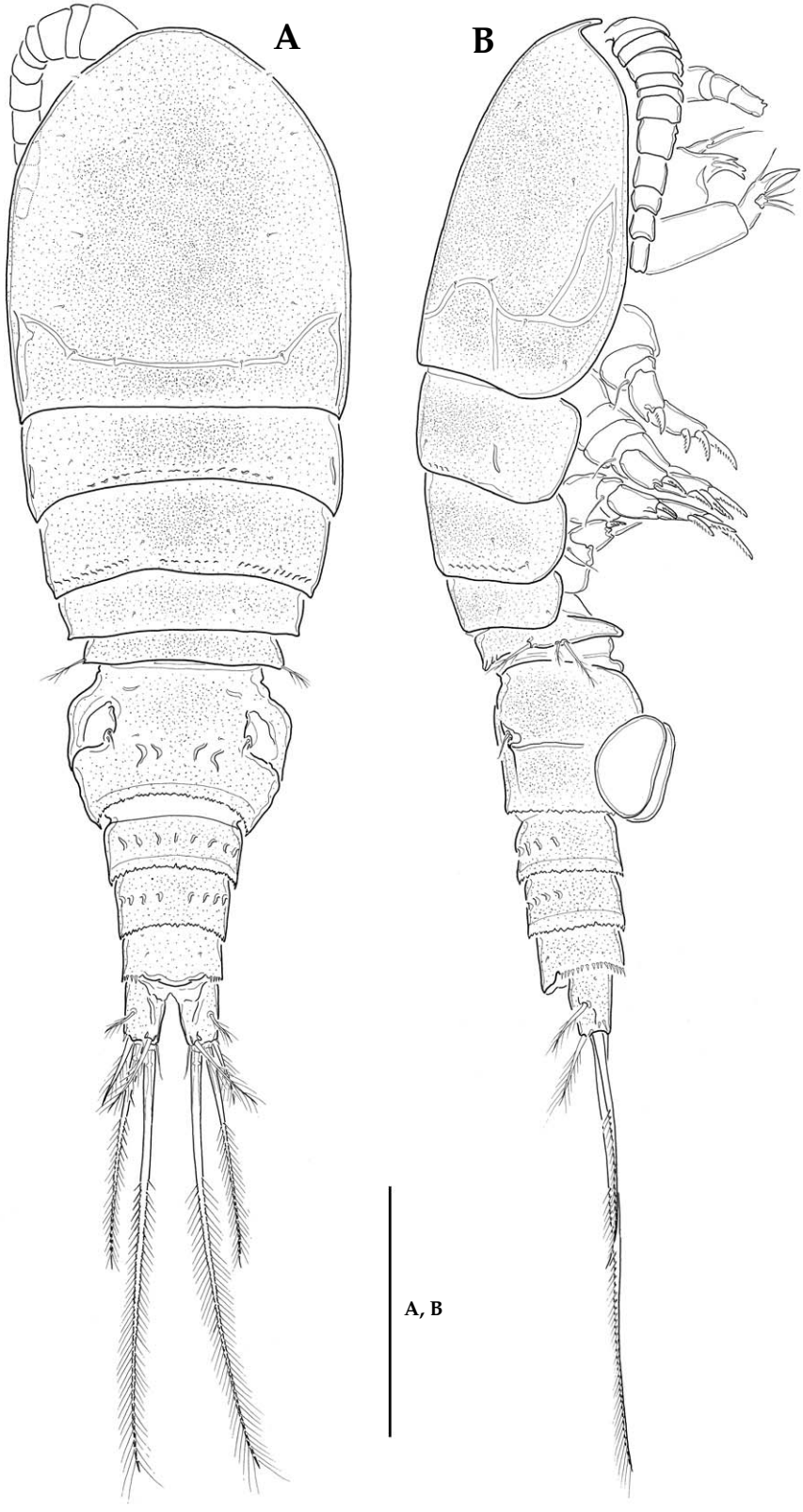


Fig. 27. *Psammophilocyclops paucisetosus*, female. A. habitus, dorsal; B. habitus, lateral (with paired spermatophores attached). Scale: 100 μm (cited from Lee and Chang, 2011).

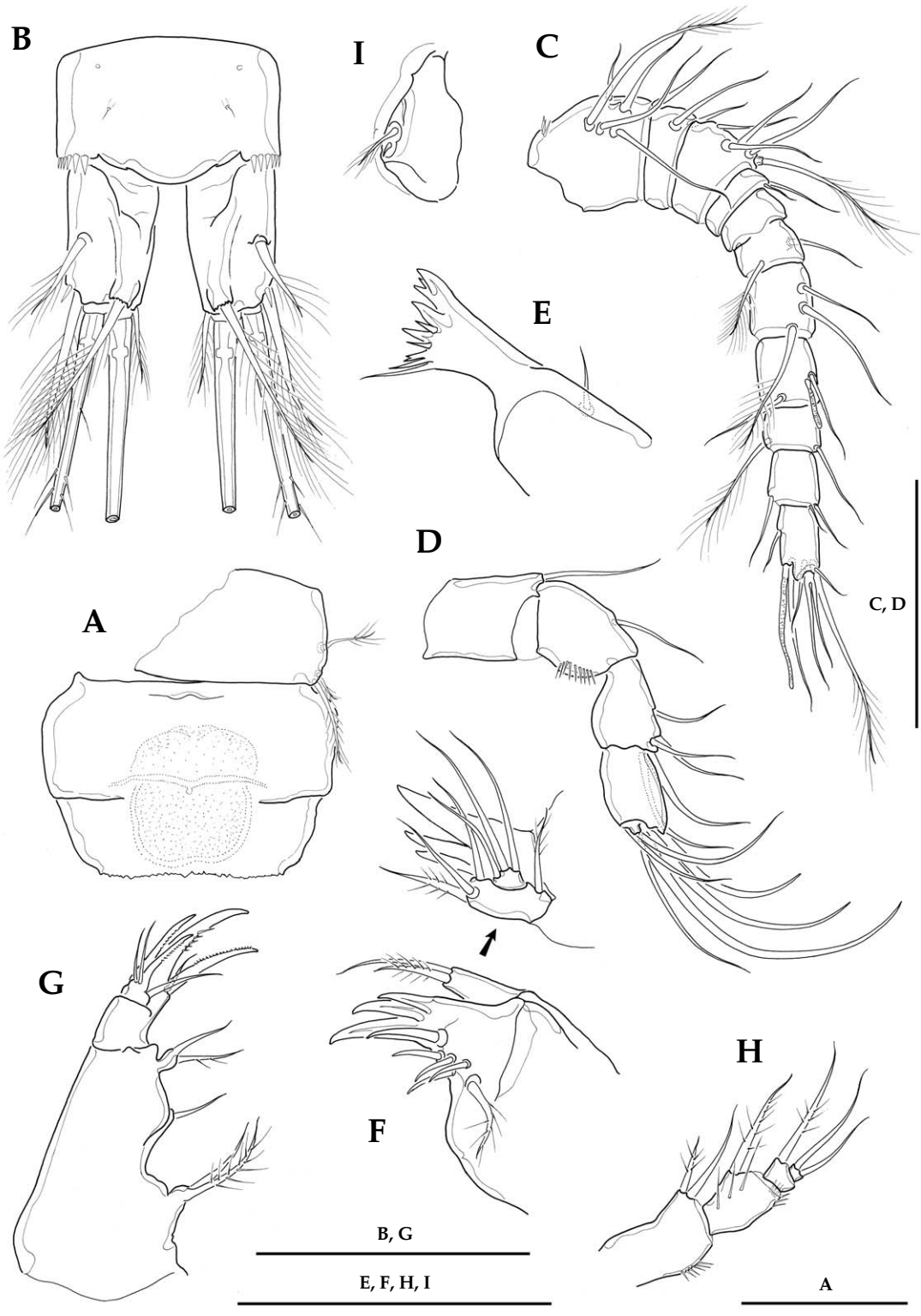


Fig. 28. *Psammophilocyclops paucisetosus*, female. A. genital double-somite and P5, ventral; B. anal somite and Fu, dorsal; C. A1; D. A2, caudal; E. mandible; F. maxillule, posterior (with palp in anterior view); G. maxilla; H. maxilliped; I. P6. Scales: A, H=50 μm, B–G, I=30 μm (cited from Lee and Chang, 2011).

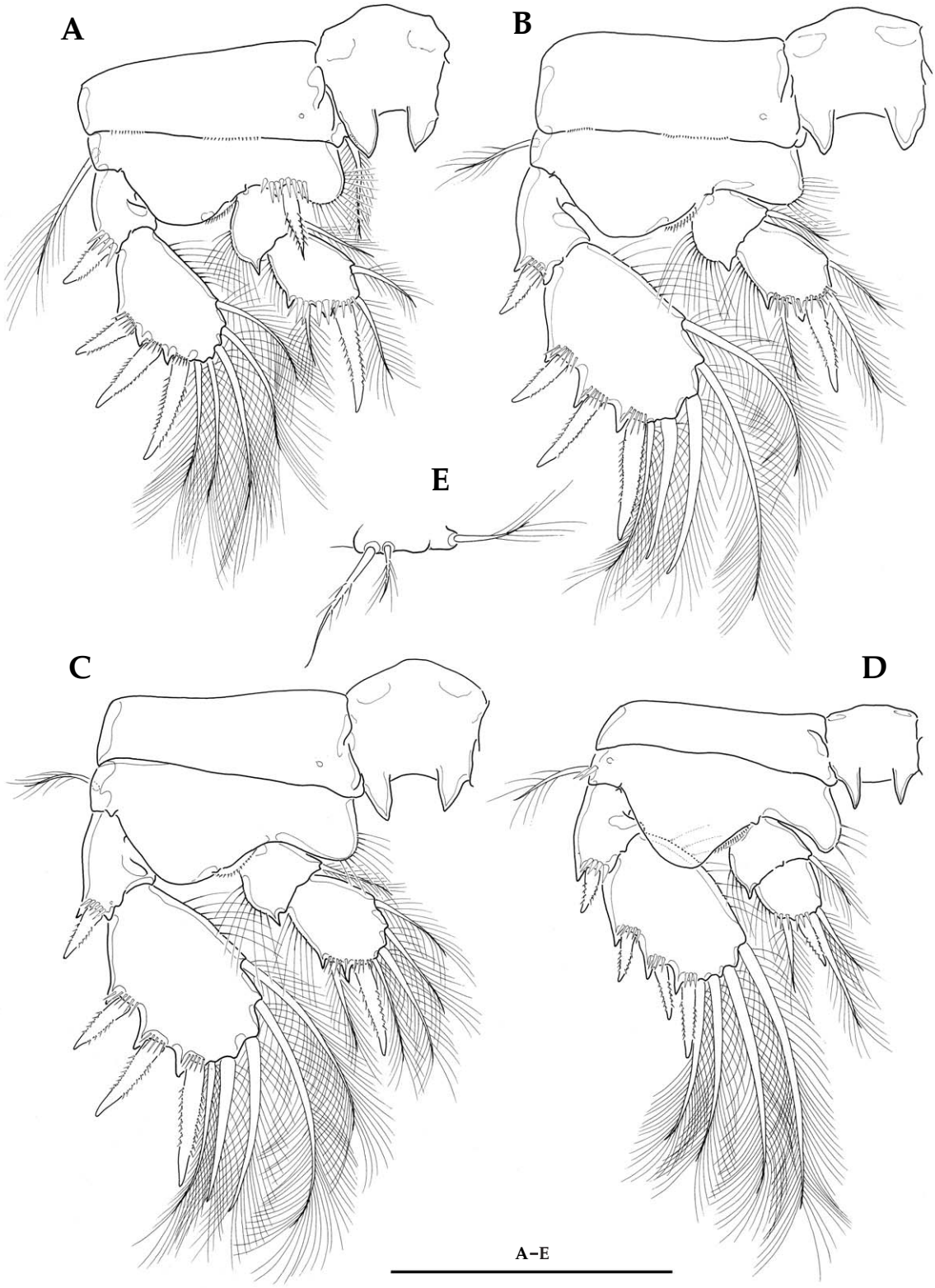


Fig. 29. *Psammophilocyclops paucisetosus*, female. A–D. P1–P4, caudal; E. P5, ventrolateral. Scale: 50 μm (cited from Lee and Chang, 2011).

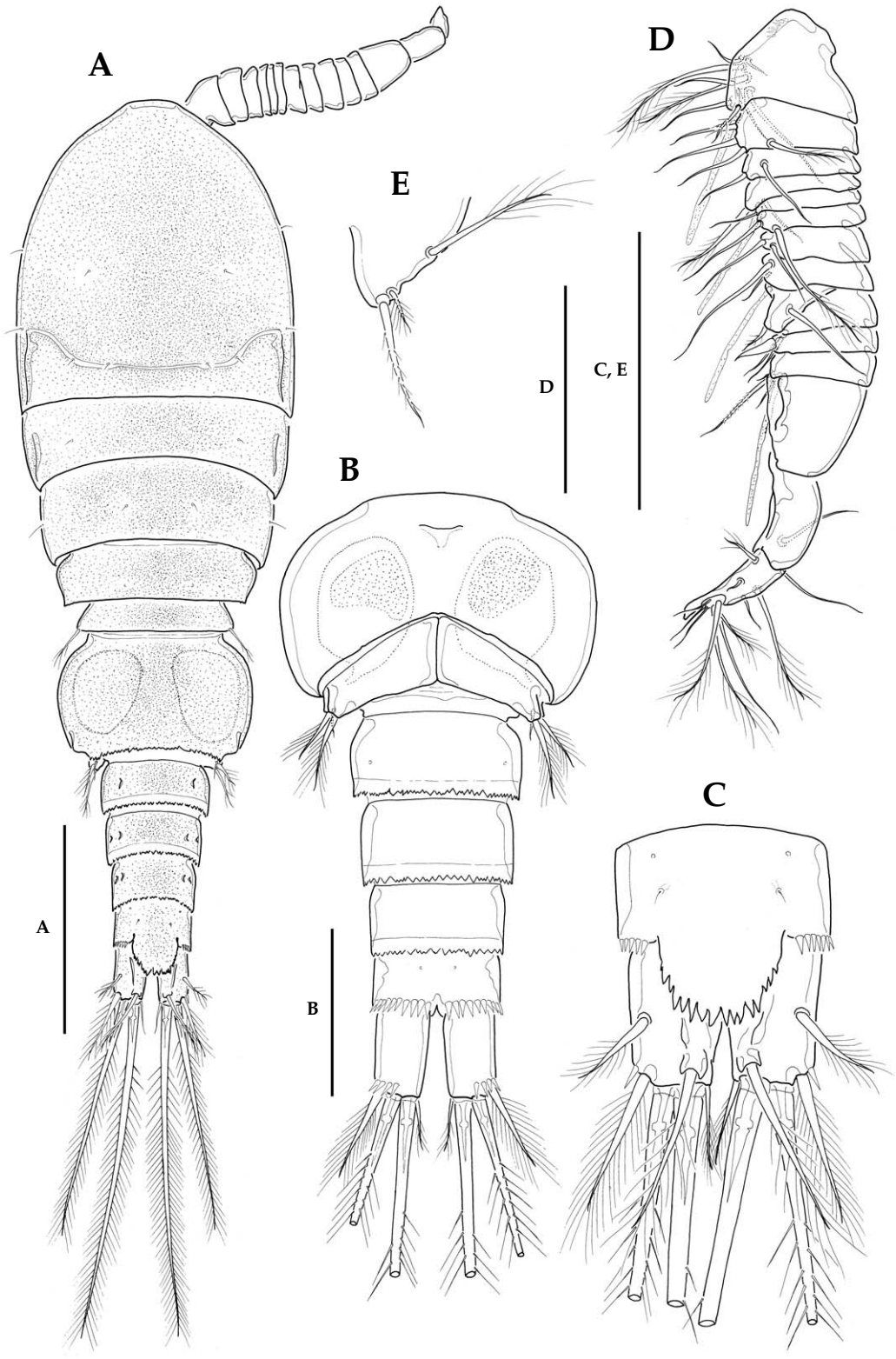


Fig. 30. *Psammophilocyclops paucisetosus*, male. A. habitus, dorsal; B. urosome with P6, ventral; C. anal somite and Fu, dorsal; D. A1; E. P5, ventrolateral. Scales: A=50 μm, B–E=30 μm (cited from Lee and Chang, 2011).

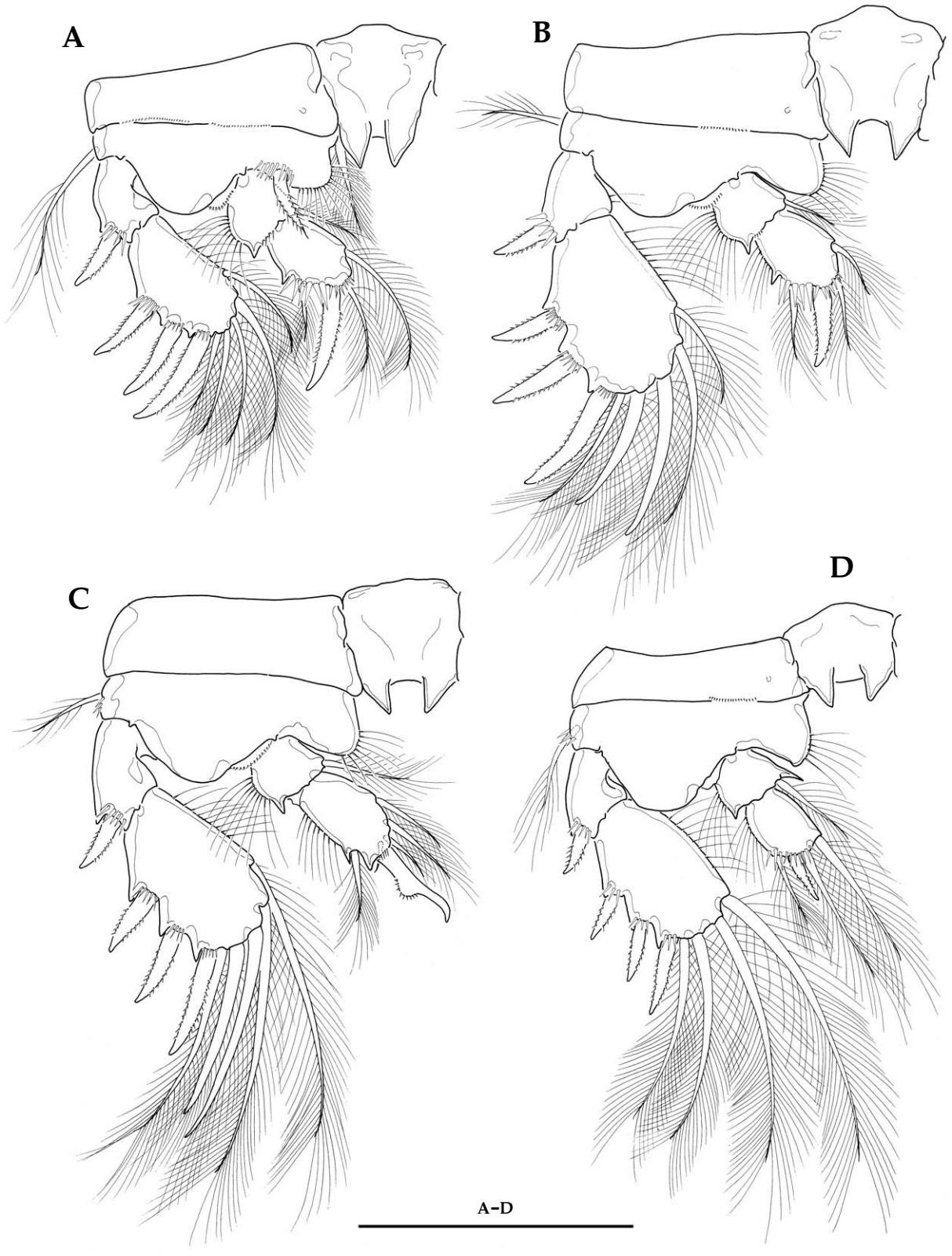


Fig. 31. *Psammophilocyclops paucisetosus*, male. A–D. P1–P4, caudal. Scale: 50 μm (cited from Lee and Chang, 2011).

ing from the interstitial or hypogean habit. Especially, the tendency of reduction appears evident in the number of setae on the distal endopodal segment of legs 1–2 and the inner coxal seta of P2–P4, as well as the segmentation and setation of the maxilliped. *Psammophilocyclops paucisetosus* n. sp., as suggested in the specific name, is most characteristic in showing the reduction in the setal armature, that is, only 3 setae on legs 1–2 enp2 and the absence of inner coxal seta on P2–P4.

Psammophilocyclops paucisetosus shares the combination of characters of 11-segmented A1, spine formula (3,3,3,3) and relatively shorter Fu (around 2 times as long as wide) with *P. boccaroi*. However, *P. boccaroi* differs from *P. paucisetosus* by the 3-segmented maxilliped and the angular shape of the anal operculum with a straight posterior margin (vs. round in the female and crescentic in the male of the latter).

Psammophilocyclops trispinosus is allied with *P. paucisetosus* in sharing the same spine formula and 4-segmented maxilliped; however, the former differs from the latter by the setation of 2,1,2,3 on the maxilliped (vs. 2,1,2,2), 10-segmented A1 and relatively elongate Fu.

The other Chinese congener, *P. bispinosus*, apparently differs from the new species by the spine formula of 2,2,2,2, 10-segmented A1, 3-segmented maxilliped and elongate Fu.

In *P. boccaroi*, the arrangement of two exopodal setae of P5 was described as the inner seta being short and the outer one long, in contrast with the long inner seta and short outer seta in the three Asian species, including *P. paucisetosus*. If this difference is not caused by a simple inadequate observation under improper positioning of the minute specimen of *P. boccaroi*, it may be a genuine interspecific discrepancy between the species groups from two continents.

Another remarkable characteristic of *P. paucisetosus* is the semicircular anal operculum with serrated posterior margin, shown only in male specimens. The feature is strongly reminiscent of the triangular anal operculum with serrated lateral margins of *Itocyclops yezoensis* Reid and Ishida, 2000, which has been reported from cave waters, springs and driven wells in Japan, Alaska and Korea (Ito, 1953, 1954; Ishida, 1992, 2002; Reid and Ishida, 2000; Lee et al., 2004), and still remains as the monotypic species of the genus. In *I. yezoensis*, the shape of the anal operculum is known as rather variable in the length and in shape of the lateral margins, from heavily crenate to weakly undulate (Lee et al., 2004). As this study is based on only two female specimens including a juvenile and several males, it cannot be fully ascertained whether the characteristic is a real sexual dimorphic character or not, and whether it might be variable or consistent, especially in the female (Lee and Chang, 2011).

Genus *Microcyclops* Claus, 1893

Kko-ma-geom-mul-byeo-ruk-sok (꼬마검물벼룩속)

Body small, 500–700 μm long. Fu generally about 3–4 times as long as wide. A1 11- or 12-segmented; its tip not reaching posterior end of cephalothorax. P1–P4, both endopods and exopods 2-segmented; P4 intercoxal sclerite (coupler) normal, not narrower or smaller than other couplers. P5 cylindrical, with a minute inner distal spine.

Type species: *Microcyclops varicans* (Sars, 1863).

Species 65 (3 in Korea).

Key to the species of genus *Microcyclops*

1. Fu 3–4 times longer than wide; A1 12-segmented ····· 2
– Fu more than 4 times as long as wide; A1 11-segmented ····· *M. longiramus*
2. Outer terminal spine on P4 enp2 swollen, more than 2 times as long as inner terminal spine ····· *M. varicans*
– Outer terminal spine on P4 enp2 not swollen, about 1.5 times longer than inner terminal spine ·· ····· *M. rubellus*

19. *Microcyclops varicans* (Sars, 1863) (Fig. 32)

Kko-ma-geom-mul-byeo-ruk (꼬마검물벼룩)

Cyclops varicans Sars, 1863, p. 252.
Cyclops (*Microcyclops*) *varicans*: Kiefer, 1929, p. 66, fig. 24; Gurney, 1933, p. 255, figs. 1747–1764.
Microcyclops varicans: Rylov, 1948, p. 267, fig. 62, 1–7; Dussart, 1969, p. 180, fig. 89; Kim and Chang, 1989, p. 244, fig. 10a–e; Ishida, 2002, p. 58, fig. 29f–l; Chang, 2009, p. 486, fig. 269.
Microcyclops (*Microcyclops*) *varicans*: Tai and Chen, 1979, p. 375, fig. 221; Chang and Min, 2005, p. 81, fig. 41A, B.

Female: Body small and somewhat slender, 640–720 μm long; live specimens tinged with pale yellow, and preserved specimens always milky white. P5 incorporated into fifth pedigerous somite; basal seta extending laterally from outer distal corner of the somite in dorsal view. Genital double-somite much longer than wide, with anterior part slightly swollen laterally. Anal somite with transverse row of 9–12 spinules along posterior margin both dorsally and ventrally. Anal operculum slightly convex, with smooth posterior margin.

Fu 3.5–4 times as long as wide, nearly parallel; medial margin not hairy; lateral margin smooth without notch. Lateral seta inserted at about posterior 1/4 of lateral margin of ramus; outer caudal seta about 0.7–0.8 times shorter than inner caudal seta, slightly longer than dorsal caudal seta.

A1 12-segmented, not reaching to posterior margin of cephalothorax; 1st, 8th and 9th segments elongate; 9th segment bearing 2 asthetascs. A2, caudal face of basis ornamented with 7–9 spinules curving inward near middle of outer margin.

P1–P4, both exopod and endopod 2-segmented. Spine formula 3,4,4,3. Seta/spine armature of P1–P4 as follows.

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P4	coxa 0-1	basis 1-0	exp I-1; III,1,4	enp 0-1; 1,II,3

P1, medial seta on basis extending over middle of enp2. P4, intercoxal sclerite not much smaller than those of P1–P3; lateral lobes of coupler not produced, with smooth posterior margin; enp2 relatively large, about 2.5–2.8 times as long as wide, with 3–4 spinules in the middle; inner apical spine stout, slightly swollen, more than 2 times as long as outer spine, slightly longer than enp2.

P5, basis completely incorporating into pedigerous somite, represented by 1 free exopod; exopod cylindrical, armed with 1 minute medial spinule and 1 long apical seta.

Male: Body 530–600 μm long. Fu about 3 times longer than wide. Lateral caudal seta locating

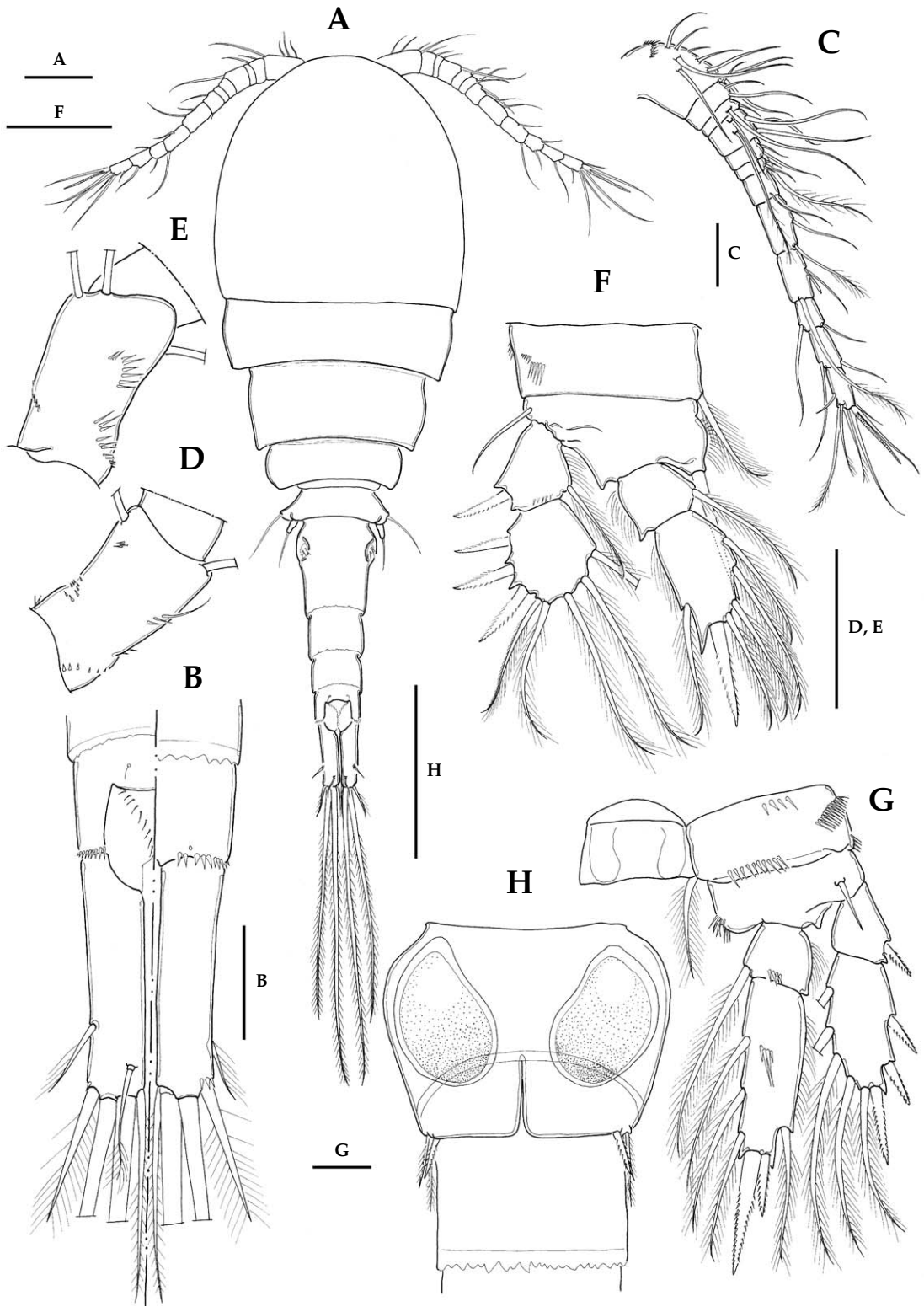


Fig. 32. *Microcyclops varicans*. Female: A. habitus; B. anal somite and Fu, dorsal (left) and ventral (right); C. A1; D. A2 basis, frontal; E. A2 basis, caudal; F. P1; G. P4. Male: H. genital somite and first abdominal somite, ventral. Scales: 50 μm (cited from Chang, 2009).

slightly dorsally at distal third of Fu. P6 armed with 1 short innermost spine, 1 apical plumose seta, and 1 longest outer seta somewhat dorsolaterally.

Distribution: Cosmopolitan.
Korea: All provinces.
Specimen examined: GG: (ditch, Ganghwa Island: 17.x.2012); GB: (lower stream of Hyeongsan River, Angang: 19.v.2012); GN: (Upo Swamp, Changnyeong: 22.vi.2012); JN: (puddle, Paengmok tidal embankment, Jindo: 19.x.2004).
Ecology: Occurring in various freshwaters, especially abundant in the littoral zone of rivers, streams, reservois and ponds, sometimes found in wells.

20. *Microcyclops rubellus* (Lilljeborg, 1901) (Fig. 33)
Eo-ri-kko-ma-geom-mul-byeo-ruk (어리꼬마검물벼룩)

Cyclops rubellus Lilljeborg, 1901, p. 4, figs. 25, 26.
Cyclops (*Microcyclops*) *rubellus*: Kiefer, 1929, p. 67, fig. 25.
Cyclops (*Microcyclops*) *varicans rubellus:* Gurney, 1933, p. 260, figs. 1765–1770.
Microcyclops varicans rubellus: Rylov, 1948, p. 269, fig. 63, 3–10; Kim and Chang, 1989, p. 245, fig. 10f–i.
Microcyclops rubellus: Dussart, 1969, p. 182, fig. 90; Ishida, 2002, p. 59, fig. 30a–g; Chang and Min, 2005, p. 83, fig. 41C; Chang, 2009, p. 486, fig. 269.
Microcyclops (*Microcyclops*) *rubellus*: Tai and Chen, 1979, p. 377, fig. 223.

Female: Body small and slender, 520–630 μm long. Prosome slightly flattened dorsoventrally; posterior margins of second and third pedigerous somites with undulating fringe. P5 incorporating into fifth pedigerous somite; basal seta extending laterally from outer distal corner of the somite in dorsal view. Genital double-somite much longer than wide, with anterior part slightly swollen laterally. Anal somite with transverse row of 12–18 sharp spinules along posterior margin both dorsally and ventrally. Anal operculum slightly convex, with posterior margin truncated.

Fu about 3 times as long as wide, nearly parallel; medial margin not hairy; lateral margin smooth without notch. Lateral seta inserted at about posterior 1/4 of lateral margin of ramus; outer caudal seta about 0.8–0.9 times shorter than inner caudal seta, slightly longer than dorsal caudal seta.

A1 12-segmented, not reaching to posterior margin of cephalothorax; 1st, 8th and 9th segments elongate; 9th segment bearing 2 asthetascs. A2, caudal face of basis ornamented with 5–7 long setules curving inward near middle of outer margin.

P1–P4, both exopod and endopod 2-segmented. Spine formula 3,4,4,3. Seta/spine armature of P1–P4 as follows.

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P4	coxa 0-1	basis 1-0	exp I-1; III,I,4	enp 0-1; 1,II,3

P1, medial seta on basis extending over middle of enp2. P4, intercoxal sclerite not much smaller than those of P1–P3; lateral lobes of coupler not produced, with smooth posterior margin; enp2

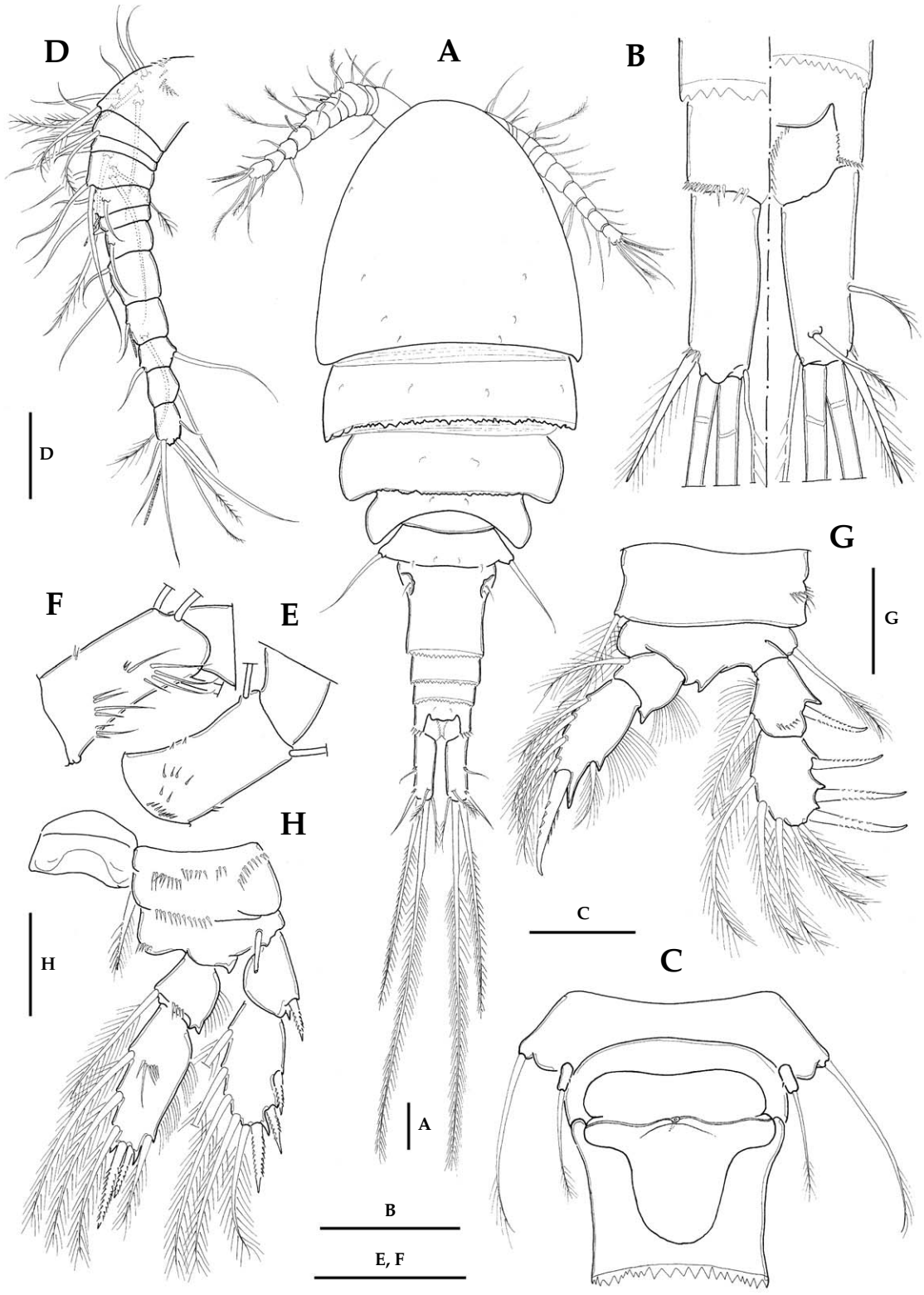


Fig. 33. *Microcyclops rubellus*, female. A. habitus; B. anal somite and Fu, ventral (left) and dorsal (right); C. P5 and genital double-somite, ventral; D. A1; E. A2 basis, frontal; F. A2 basis, caudal; G. P1; H. P4. Scales: 50 μm (cited from Chang, 2009).

relatively large, about 2.3–2.5 times as long as wide, with 4–5 spinules in the middle; inner apical spine normal, not swollen, about 1.8 times as long as outer spine, about 2/3 times as long as enp2.

P5, basis completely incorporating into pedigerous somite, represented by 1 free exopod; exopod cylindrical, armed with 1 minute medial spinule and 1 long apical seta.

Distribution: Korea, Japan, China, Europe, North America.

Korea: GW, CN, GB, GN, JN.

Specimen examined: GW: (streamside, Jusu-ri, Okgye, Gangreung: 13.x.2011); GB: (Hugok Reservoir, Yeongcheon: 3.x.2012); JJ: (puddle, Yongdang-ri, Jeju Is.: 21.iii.2003).

Ecology: Occurring in mostly small lentic fresh waters, such as swamps or temporay bogs, especially abundant among aquatic macrophytes.

21. *Microcyclops longiramus* Shen and Sung, 1965 (Fig. 34)

Gin-kko-ri-kko-ma-geom-mul-byeo-ruk (긴꼬리꼬마검물벼룩)

Microcyclops (*Microcyclops*) *longiramus* Shen and Sung, 1965a, p. 173, figs. 19–26; Tai and Chen, 1979, p. 381, fig. 266.

Microcyclops longiranus: Kim and Chang, 1989, p. 245, fig. 10f–I; Chang and Min, 2005, p. 83, fig. 41D–G; Chang, 2009, p. 491, fig. 271.

Female: Body small and slender, 580–630 μm long. Prosome slightly flattened dorsoventrally. P5 incorporated into fifth pedigerous somite; basal seta extending laterally from outer distal corner of the somite in dorsal view. Genital double-somite much longer than wide, with anterior part slightly swollen laterally. Seminal receptacle with narrow, ellipsoidal anterior lobe. Anal somite with 13–18 sharp spinules along posterior margin both dorsally and ventrally. Anal operculum with middle of posterior margin slightly concave.

Fu about 4.0–4.5 times as long as wide, nearly parallel; medial margin not hairy; lateral margin smooth without notch. Lateral seta inserted at about posterior 1/3–1/4 of lateral margin of ramus; inner caudal seta about 1.2–1.3 times longer than outer caudal seta; dorsal caudal seta slightly shorter than outer caudal seta.

A1 11-segmented, not reaching posterior margin of cephalothorax; 8th segment bearing 2 asthetascs. A2, caudal face of basis with 6 spinules near middle of outer margin.

P1–P4, both exopod and endopod 2-segmented. Spine formula 3,4,4,3. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P4	coxa 0-1	basis 1-0	exp I-1; III,I,4	enp 0-1; 1,II,3

P1, medial seta on basis not reaching to middle of enp2. P4, intercoxal sclerite not much smaller than those of P1–P3; lateral lobes little produced, with smooth posterior margin; enp2 relatively large, about 2.3–2.5 times as long as wide, with 4–5 setules in the middle; inner apical spine normal, not swollen, about 1.3–1.4 times as long as outer spine, about 2/3 times as long as enp2.

P5, basis completely incorporated into pedigerous somite, represented by 1 free exopod; exopod

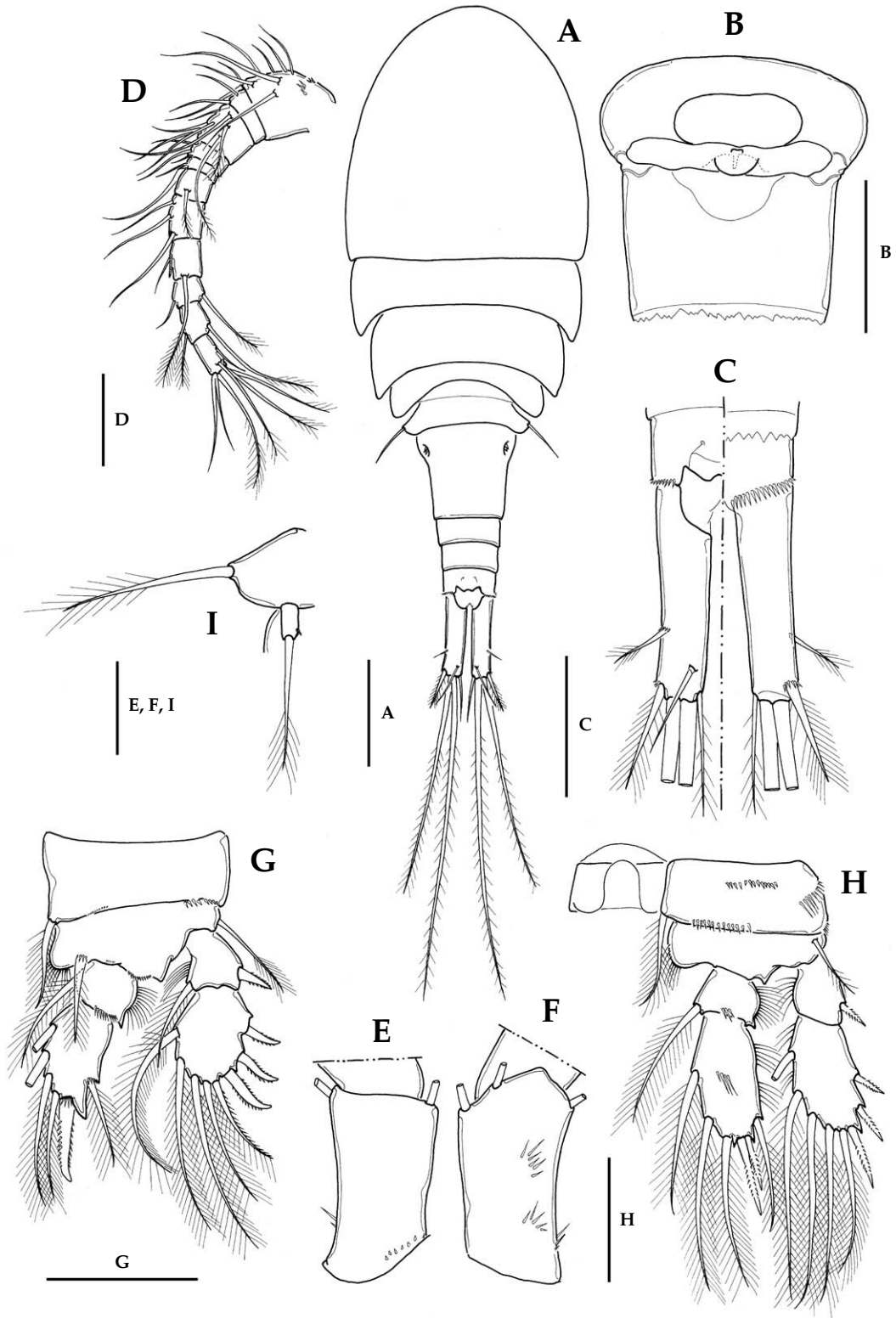


Fig. 34. *Microcyclops longiramus*, female. A. habitus; B. genital double-somite; C. anal somite and Fu, dorsal (left) and ventral (right); D. A1; E. A2 basis, frontal; F. A2 basis, caudal; G. P1; H. P4; I. P5. Scales: A=100 μm, B–I=50 μm (cited from Chang, 2009).

cylindrical, armed with 1 minute medial spinule and 1 long apical seta.

Distribution: Korea, China.
Korea: GB.
Specimen examined: GB: (streamside bog, Wolpo, Pohang: 10.v.2010).
Ecology: Usually occurring in small lentic waters, such as streamside bogs or puddles.

Genus *Cryptocyclops* Sars, 1927

Yu-ryeong-geom-mul-byeo-ruk-sok (유령검물벼룩속)

Body small, 500–700 μm long. A1 11-segmented; its tip not reaching to posterior end of cephalothorax. P1–P4, both endopods and exopods 2-segmented; P4 coupler much narrower and smaller than other couplers. P5 incorporated into fifth pedigerous somite; exopod cylindrical, with minute spine near midlength of inner margin.
Type species: *Cryptocyclops bicolor* (Sars, 1863).

Species 21 (2 in Korea).

Key to the species of genus *Cryptocyclops*

1. Inner terminal spine on P4 enp2 about 4 times as long as outer terminal spine ····· *C. bicolor*
– Inner terminal spine on P4 enp2 about 1.4–1.8 times as long as outer terminal spine ····· *C. javanus*

22. *Cryptocyclops bicolor* (Sars, 1863) (Fig. 35)

Yu-ryeong-geom-mul-byeo-ruk (유령검물벼룩)

Cyclops bicolor Sars, 1863, p. 253.
Cyclops (*Microcyclops*) *bicolor*: Kiefer, 1929, p. 70, fig. 26a; Gurney, 1933, p. 262, figs. 1771–1784.
Microcyclops bicolor: Rylov, 1948, p. 271, fig. 64, 1–5.
Microcyclops (*Cryptocyclops*) *bicolor*: Tai and Chen, 1979, p. 390, fig. 233.
Cryptocyclops bicolor: Dussart, 1969, p. 178, fig. 88; Kim and Chang, 1989, p. 246, fig. 12; Ishida, 2002, p. 59, fig. 30h–n; Chang and Min, 2005, p. 85, fig. 42A–D; Chang, 2009, p. 493, fig. 273.

Female: Body small and somewhat slender, about 600 μm long; live specimens tinged with pale yellow, and preserved specimens usually milky white. Cephalothorax protruding anteriorly. P5 incorporated into fifth pedigerous somite; basal seta extending laterally from outer distal corner of the somite in dorsal view. Genital double-somite much longer than wide, with anterior part slightly swollen laterally. Seminal receptacle with posterior lobe concave in middle of posterior margin. Anal somite with 9–10 spinules along posterior margin both dorsally and ventrally. Anal operculum slightly convex, with smooth posterior margin.
Fu 3.5–4 times as long as wide, nearly parallel; medial margin not hairy; lateral margin smooth,

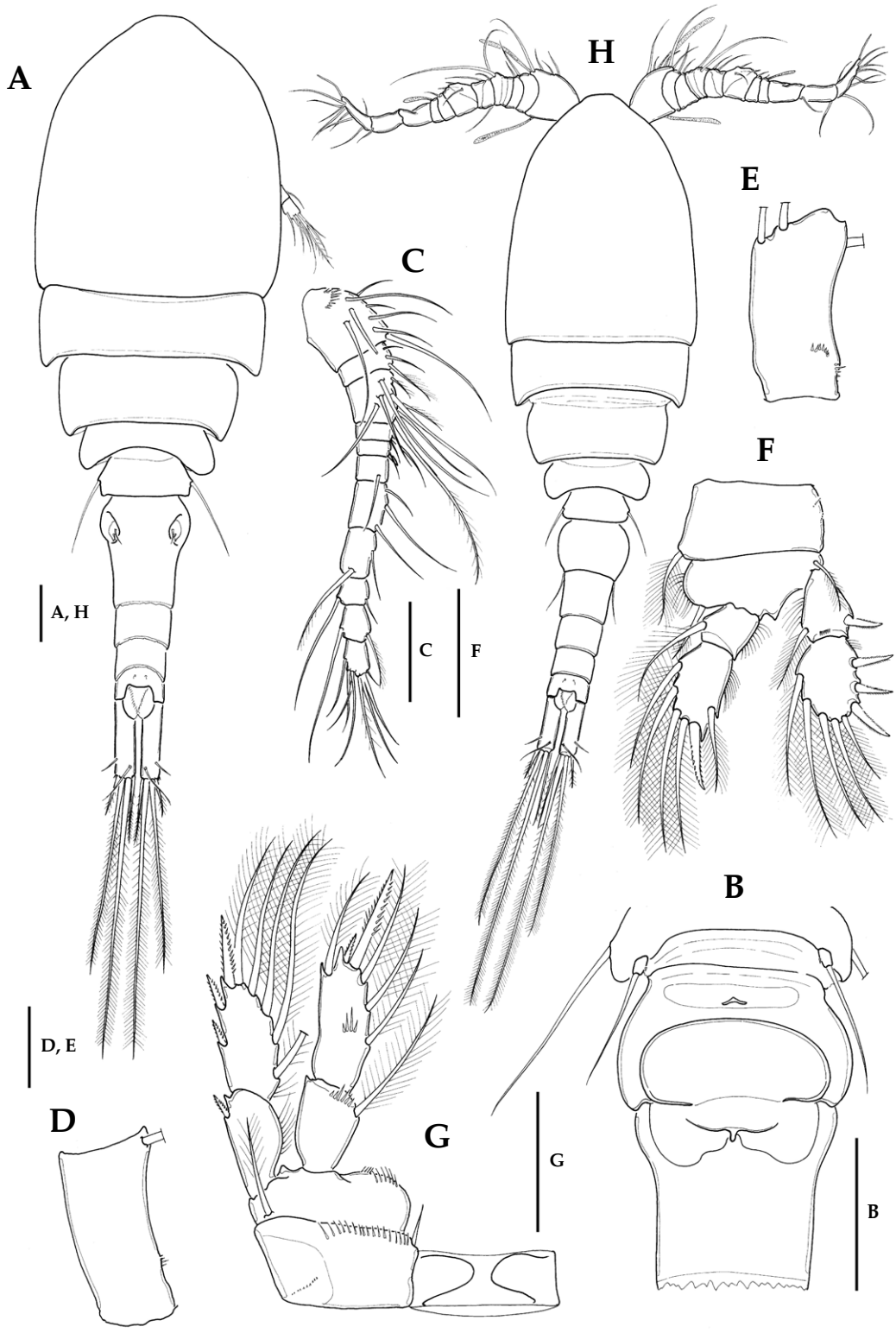


Fig. 35. *Cryptocyclops bicolor*. Female: A. habitus; B. fifth pedigerous somite and genital double-somite, ventral; C. A1; D. A2 basis, frontal; E. A2 basis, caudal; F. P1; G. P4. Male: H. habitus, dorsal. Scales: A–C, F–H=50 μm, D, E=20 μm (cited from Chang, 2009).

without notch. Lateral seta inserted at about distal quarter of ramus, slightly dorsally; inner caudal seta about 2 times longer than outer caudal seta, slightly shorter than Fu; dorsal caudal seta slightly longer than outer caudal seta.

A1 11-segmented, not reaching posterior margin of cephalothorax; 1st, 3rd, 7th and 8th segments elongate. A2, basis smooth, without spinules or hairs in middle and distal part of both frontal and caudal surfaces.

P1–P4, both exopod and endopod 2-segmented. Spine formula 3,4,4,3. Seta/spine armature of P1–P4 as follows:

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P4	coxa 0-1	basis 1-0	exp I-1; III,I,4	enp 0-1; 1,II,3

P1, medial seta on basis not reaching middle of enp2. P4 much smaller than P1–P3; intercoxal sclerite markedly short and somewhat broad with lateral lobes not protruding, posterior margin smooth; distomedial part of basis enlarged, with 2 spinule rows; outer spines on exopods relatively small; enp2 elongate, about 2.5–3.0 times as long as wide, with 3–4 spinules in the middle; inner apical spine stout, lanceolate, about 4 times longer than outer spine, slightly shorter (80–90%) than enp2.

P5, basis completely incorporated into pedigerous somite, represented by 1 free exopod; exopod cylindrical, armed with 1 minute medial spinule and 1 long apical seta.

Male: Body about 500 μm long. Fu about 3 times longer than wide. Lateral caudal seta located slightly dorsally at distal quarter of Fu. P6 armed with 1 short innermost spine, 1 apical plumose seta, and 1 long outer seta; outer seta situated somewhat dorsolaterally, very long, nearly reaching posterior margin of first abdominal somite.

Distribution: Korea, Japan, China, Russia, Europe, Alaska.

Korea: GW, GB, GN.

Specimen examined: GW: (streamside, Jusu-ri, Okgye, Gangreung: 13.x.2011); GB: (lower reach of Hyeongsan River, Pohang: 15.x.2012).

Ecology: Often collected from small lentic waters such as swamps or temporary bogs with abundant macrophytes. Known as a stenothermal species favoring warm waters, with its population size increasing in summer (Chang, 2009).

23. *Cryptocyclops javanus* (Kiefer, 1930) (Fig. 36)

Ja-ba-yu-ryeong-geom-mul-byeo-ruk (자바유령검물벼룩)

Cyclops (*Microcyclops*) *javanus* Kiefer, 1930, p. 187, fig. 5.
Microcyclops (*Cryptocyclops*) *javanus*: Tai and Chen, 1979, p. 384, fig. 228.
Cryptocyclops javanus: Kim and Chang, 1989, p. 247, fig. 13; Chang and Min, 2005, p. 87, fig. 42E, F; Chang, 2009, p. 496, fig. 274.

Female: Body small and slender, 560 μm long. Prosome ovoid, slightly flattened dorsoventrally; posterolateral corners of prosomites not produced. P5 incorporated into fifth pedigerous somite; basal seta extending laterally from outer distal corner of the somite in dorsal view. Anal somite

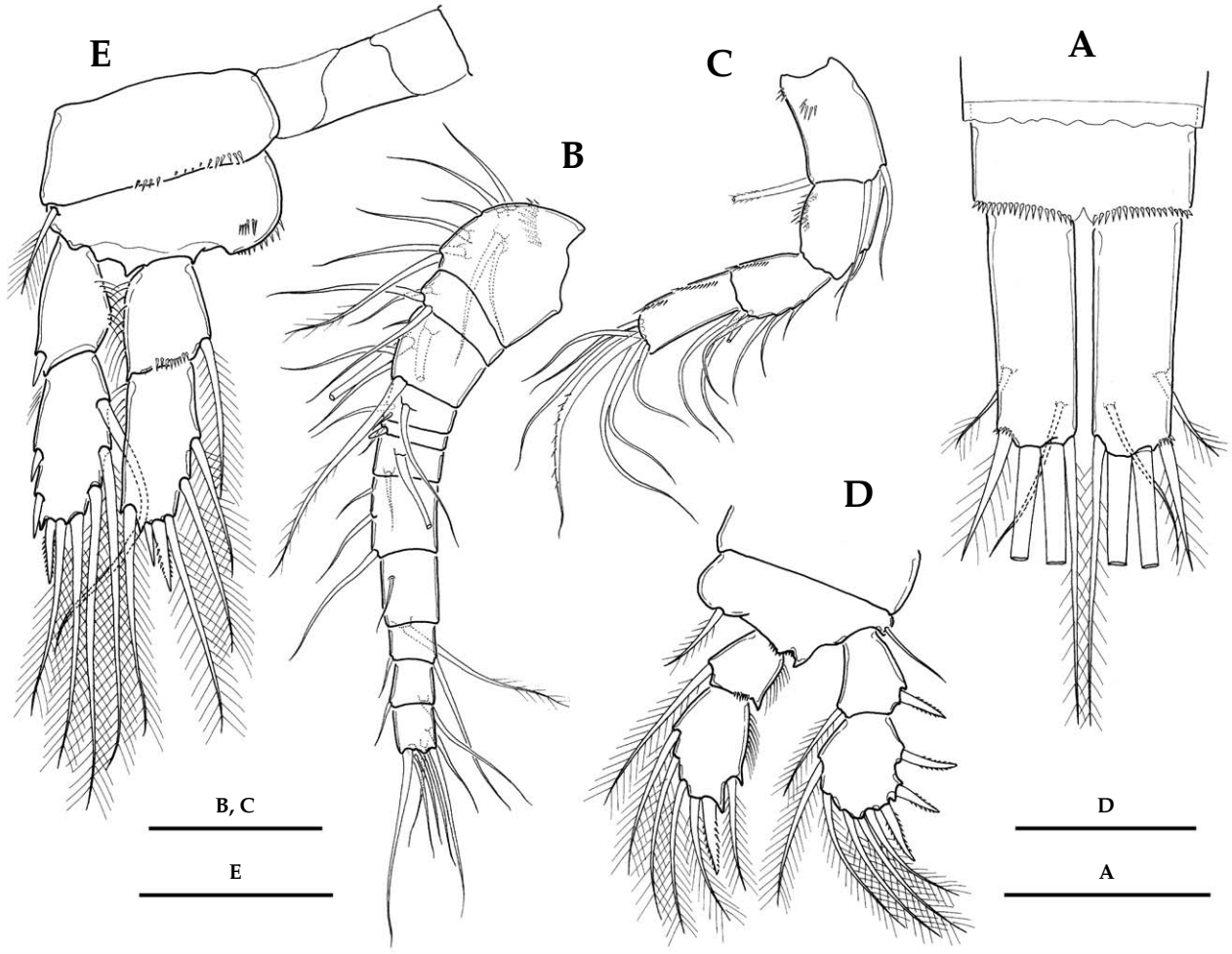


Fig. 36. *Cryptocyclops javanus*, female. A. anal somite and Fu, ventral; B. A1; C. A2; D. P1; E. P4. Scales: 50 μm (cited from Chang, 2009).

with 12–18 spinules along posterior margin both dorsally and ventrally. Anal operculum slightly convex, with smooth posterior margin.

Fu about 3 times as long as wide, nearly parallel; medial margin not hairy; lateral margin smooth, without notch. Lateral seta inserted at about posterior 1/3–1/4 of lateral margin of ramus; outer caudal seta about 1/2 times longer than inner caudal seta, slightly shorter than dorsal caudal seta.

A1 11-segmented, not reaching posterior margin of cephalothorax; 1st, 3rd, 7th and 8th segments elongate. A2, basis smooth, without spinules or hairs in middle and distal part of both frontal and caudal surfaces.

P1–P4, both exopod and endopod 2-segmented. Spine formula 3,4,4,3. Seta/spine armature of P1–P4 as follows.

P1	coxa 0-1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I,4
P2	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P3	coxa 0-1	basis 1-0	exp I-1; III,I,5	enp 0-1; 1,I,5
P4	coxa 0-1	basis 1-0	exp I-1; III,I,4	enp 0-1; 1,II,3

P1, medial seta on basis not reaching middle of enp2. P4 much smaller than P1–P3; intercoxal sclerite markedly broad, with lateral lobes not protruding, posterior margin smooth; distomedial part of basis enlarged, with 2 spinule rows along posterior margin; outer spines on exp1 and exp2 relatively small; enp2 about 2.3–2.7 times as long as wide, with 3–4 spinules in the middle; inner apical spine small, about 1.4–1.6 times longer than outer spine, about 1/3 times as long as enp2.

P5, basis completely incorporated into pedigerous somite, represented by 1 free exopod; exopod cylindrical, armed with 1 minute medial spinule and 1 long apical seta.

Distribution: Korea, China, Indonesia.
Korea: GW, GB, GN.
Specimen examined: GB: (rice paddies, Chuksan, Yeongdeok: 2011.vii.15).
Ecology: In South Korea, this species occurs in eutrophic bogs or marshes near the seacoast in summer; known as a warm water (tropical) species; a rare species in Korea (Chang, 2009).

Genus *Apocyclops* Lindberg, 1942

Ya-reut-geom-mul-byeo-ruk-sok (야릇검물벼룩속)

Body slender, about 1 mm long. Fu strikingly elongated, 6–10 times as long as wide; rami parallel to each other. A1 11-segmented. P1–P4 with 2-segmented exopod and endopod. P5 basal segment completely incorporated into fifth pedigerous somite; free exopod armed with 1 short spine and 1 long seta. Typically brackish, tropical species.

Type species: *Apocyclops dengizicus* (Lepechkine, 1900).

Species 11 (1 in Korea).

24. *Apocyclops borneoensis* Lindberg, 1954 (Fig. 37)

Ya-reut-geom-mul-byeo-ruk (야릇검물벼룩)

Apocyclops borneoensis Lindberg, 1954, p. 168, fig. 3; Ishida, 2002, p. 59, fig. 31; Yoon and Chang, 2008, p. 244, fig. 5; Chang, 2009, p. 497, fig. 276.
Apocyclops japonensis Ito, 1957, p. 463, figs. 1–22; Mizuno and Miura, 1984, p. 589.

Female: Body about 970 μm long, excluding caudal seta; somewhat slender, greatest width about 31% of body length at posterior margin of cephalothorax; tinged with pale brown. Prosome ellipsoidal, slightly longer than urosome; widest at posterior margin of cephalothorax, and gradually tapering behind. Rostrum reduced. Cephalothorax somewhat protruding anteriorly, about 2 times longer than next three thoracic somites combined. Fourth pedigerous somite produced posterolaterally. First urosomite (fifth pedigerous somite) broadened posteriorly; basal segment of P5 fully fused into the somite, lateral basal seta issuing from dorsal side of the somite; exopodal segment with 1 inner spine and 1 distal seta visible in dorsal view. Fifth pedigerous somite without patch of hairs dorsolaterally.

Genital double-somite 1.1 times longer than wide, anterior part slightly swollen laterally, nearly as long as next three urosomites combined, and gradually tapering behind. Seminal receptacle "T"-shaped in general appearance; anterior part forming lateral wings, their lateral tips not bent posteriorly; posterior part ellipsoidal, much narrower than anterior part. Posterolateral margin of anal somite with 7–8 spinules dorsally. Anal operculum gently convex, smooth on its posterior margin.

Fu strikingly elongate, about 8 times (ranging 7.6–8.9) as long as wide, nearly parallel to each other; with 1 oblique row of minute spinules proximal to dorsal seta, without hairs along inner (medial) margin. Lateral caudal seta inserted at about distal third of lateral margin of ramus; lateral margin not interrupted by minute spinules. Outer caudal seta 1.2–1.3 times longer than inner caudal seta. Inner caudal seta about 1.5 times longer than outer terminal caudal seta, 1.8–1.9 times as long as Fu. Dorsal caudal seta long, plumose, 2.3–2.5 times longer than outer caudal seta, and about half the length of Fu.

A1 slightly exceeding posterior margin of third prosomite, consisting of 11 segments, without hyaline membrane on distal 3 segments; segments 7 and 8 elongate, segment 7 slightly (1.04 times) longer than segment 8. Setal formula: 1-[9], 2-[4], 3-[6], 4-[1], 5-[1 (spiniform)], 6-[2], 7-[3], 8-[2+1 aesthetasc], 9-[2], 10-[2], 11-[7+1 aesthetasc]. A2 3-segmented, consisting of basis (fused with first endopodal segment) and 2 free endopodal segments; exopod represented by 1 long seta at outer distal corner of basis; basis with 3 setae along medial margin; first free endopodal segment with 9 setae, distal endopodal segment with 7 setae. Mandible, maxilla and maxilliped typical for the genus *Apocyclops*.

P1–P4, biramous, both exopods and endopods 2-segmented. Spine formula 3,4,4,3. Seta formula 5,5,5,5. Spine/seta armature of P1–P4 as follows:

P1	basis 1-1	exp I-1; III,1,4	enp 0-1; 1,I+1,3
P2	basis 1-0	exp I-1; III,I+1,4	enp 0-1; 1,I+1,4
P3	basis 1-0	exp I-1; III,I+1,4	enp 0-1; 1,I+1,4
P4	basis 1-0	exp I-0; II,I+1,4	enp 0-1; 1,I,4

P1, basis with 1 inner seta exceeding middle of enp2; coupler with 2 lateral lobes, bearing 2–3 spinules on posterior margin; frontal face with 5–6 spinules laterally; caudal face with 1 row of 18–21 spinules near posterior margin. P2 coupler with 1 transverse row of minute spinules on posterior part of caudal face; lateral lobe ornamented with 2–3 spinules on posterior margin. P3 with same setae/spine armature as P2; lateral lobes of coupler each with 4 spinules on posterior margin; caudal face with 2 spinule rows. P4 coupler armed with 1 transverse row of about 20 spinules in the middle of caudal face and 4 spinules at each side; lateral lobes naked on posterior margin; coxa armed with 1 transverse row of 18–21 spinules, without interruption or gap, along posterior margin of caudal face; exp1 lacking inner seta; enp2 about 2.1–2.2 times as long as wide, about 1.7 times longer than apical spine.

P5, basal segment fully fused into 5th pedigerous somite, lateral seta issuing from dorsal side of the somite; exopodal (distal) segment trapezoidal, about 1.4 times wider than long, narrowing distally, with 1 inner spine and 1 lateral seta; inner surface hirsute, densely furnished with minute spinules; bearing 1 innermost spine and 2 setae, inner seta about 1.7 times longer than P5 segment (ranging from 1.54–1.80), and nearly as long as outermost seta.

Distribution: Korea, Japan (Iriomote Is., Okinawa; Mie, Honshu), Indonesia (Borneo).
Korea: JN, JJ.
Specimen examined: JJ: (Saeseom Islet, Jeju Island: 20.v.2009).

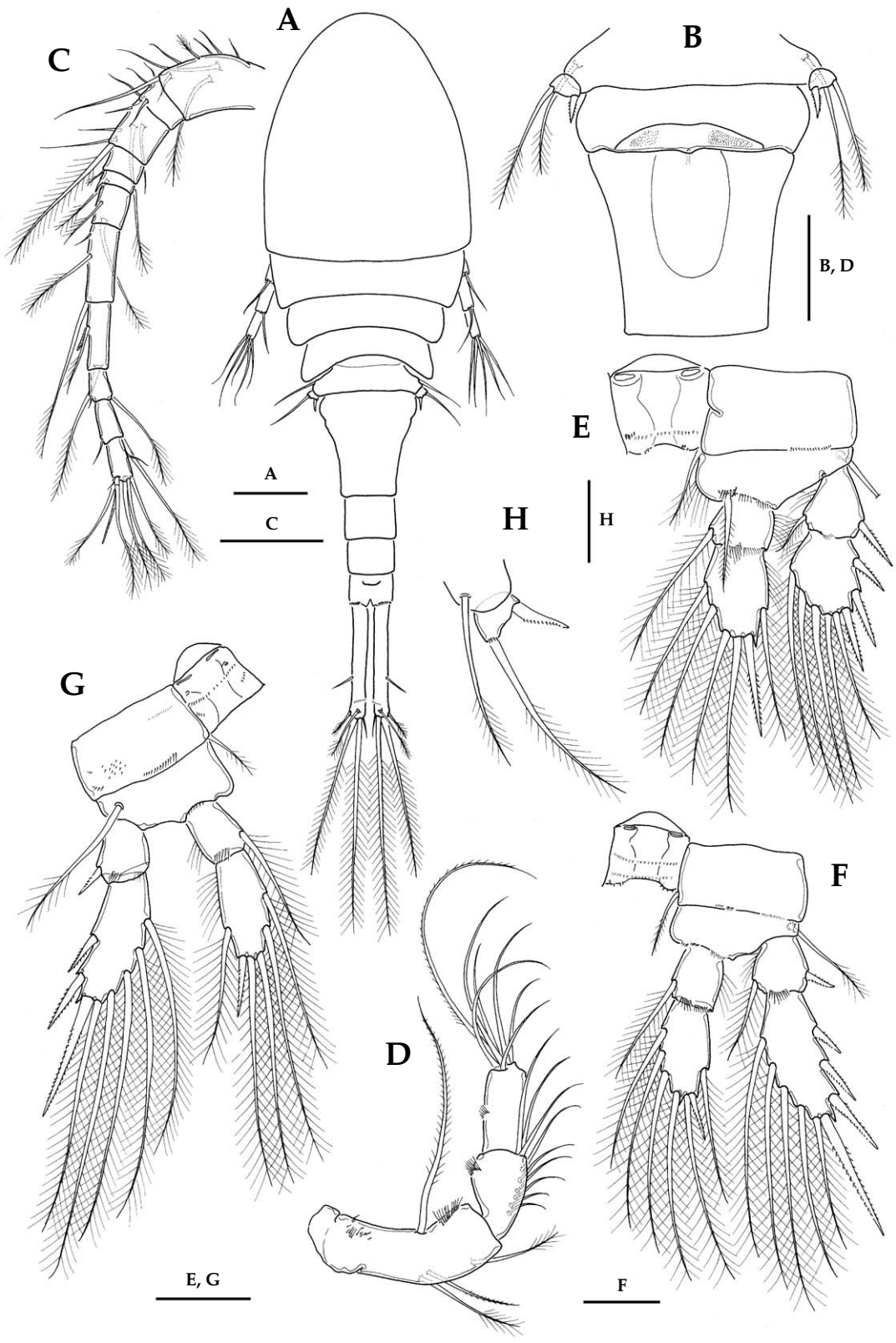


Fig. 37. *Apocyclops borneoensis*, female. A. habitus; B. P5 and genital somite, ventral; C. A1; D. A2; E. P1; F. P3; G. P4; H. P5. Scales: 50 μm (cited from Chang, 2009).

Ecology: This species was described from a coastal salt marsh in Borneo, Indonesia, and reported from saline waters in Kwangtung, southern China, and a coastal rice paddy in Iriomote Is., Okinawa, Japan. In Korea, it was found in the salt marsh on Saeseom islet, adjacent to the breakwater of Swegwipo Port, Jeju Is., southernmost part of Korea.

This must be a tropical species, and apparently favors shallow coastal salt marshes with high organic matter content, especially in the summer (Yoon and Chang, 2008).

Remarks: Ito (1957) described *Apocyclops japonensis* from eel-culture ponds near the seashore of Mie prefecture, southern Honshu, Japan, and differentiated it from *A. borneoensis* Lindberg by the more elongated Fu (slightly more than 10 times longer than wide, versus 7–9 times in *A. borneoensis*), and a slightly larger body (slightly more than 1 mm long, 1,004–1,079 μm in Chinese specimens, and 962–983 μm in Korean specimens). Ishida (2002) identified specimens found in a rice paddy on Iriomote Is., Okinawa as *A. borneoensis*, and he regarded *A. japonensis* as a junior synonym of *A. borneoensis*. Considering our specimens of *A. borneoensis*, we think that the relatively longer dorsal caudal seta of *A. japonensis* (2.6–3.0 times as long as the outer caudal seta in *A. japonensis*, against 2.2–2.4 times in Borneo specimens, and 2.3–2.5 times in Korean specimens of *A. borneoensis*) should be treated as a more significant taxonomic character than the above characters (Yoon and Chang, 2008; Chang, 2009).

Genus *Mesocyclops* Sars, 1914

Bo-tong-geom-mul-byeo-ruk-sok (보통검물벼룩속)

Fu stout, 3–4 times as long as wide, with 1 lateral caudal seta at about distal 1/3 of lateral margin of ramus. A1 17-segmented; last segment ornamented with hyaline membrane. P1–P4 with 3-segmented exopods and endopods. P5 with 2 free segments; exopod armed with 1 long inner spine and 1 long apical seta.

Type species: *Mesocyclops leuckarti* (Claus, 1857).

Species 90 (5 in Korea).

Key to the species of genus *Mesocyclops*

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

25. *Mesocyclops leuckarti* (Claus, 1857) (Fig. 38)

Bo-tong-geom-mul-byeo-ruk (보통검물벼룩)

Cyclops Leuckarti Claus, 1857a, p. 35, pl. I, fig. 4, pl. II, figs. 1–14.

Mesocyclops leuckarti: Kiefer, 1981, p. 158, pl. III, figs. 1–9; Van de Velde, 1984, p. 13, figs. 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; Lee, Jeon and Chang, 2005, p. 94, fig. 1; Chang and Mins, 2005, p. 89, fig. 44; Chang, 2009, p. 500, fig. 278.

Female: Body length 1.0–1.2 mm. Fifth pedigerous somite not pilose laterally. Genital double-somite about 1.2 times longer than wide; seminal receptacle with relatively short lateral arms; large slit pore present posterior to horseshoe-shaped copulatory pore; copulatory duct very wide and sinuously curved inward, not laterally.

Fu about 3.3–3.6 times longer than wide, without special ornamentation on both lateral and medial faces, except spinules at implantations of lateral and lateralmost terminal caudal setae. Outer caudal seta less than 1/3 length of inner caudal seta, nearly as long as dorsal caudal seta.

A1 furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on segments 4–5, 7–10 and 12–13, spinule arrangement as in figure. A2, frontal surface of basis with longitudinal row of 18–23 spinules along proximal half of lateral margin; caudal surface of A2 basis ornamented with oblique spinule row around middle of medial margin, longitudinal row of about 8 spinules along lateral margin rather sparsely, while nearly regular around implantation of distomedial setae; enp2 with 7 setae.

P1–P4 biramous, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-0	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1 basis without distomedial seta. P4, intercoxal sclerite smooth on both posterior and anterior surface, with pair of large acute outgrowths on distal margin; P4 coxa with about 8–9 spinules along distal margin; outer spine of P4 enp3 about 1.1 times longer than inner spine, apical spines much shorter than P4 enp3, lateral edge of inner spine with many spinules.

P5 2-segmented, medial spine located just distal to midlength of medial margin of last segment, medial spine shorter than apical seta.

Distribution: Korea, Japan, China, Europe.

Korea: GG, GW, JN.

Specimen examined: GW: (Hajodae, Yangyang: 2.iii.2010).

Ecology: In Korea, this species is found rarely in salt marshes, reservoirs, bogs, streams and irrigation ditches near the coast.

Remarks: This species is relatively rare among the congeneric species from Korea. This species has been collected usually from the eutrophic littoral zones of both lentic and lotic waters, frequently from streams or irrigation ditches (sometimes from oligohaline streams) near the southwest coast of South Korea. This species is a "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). This

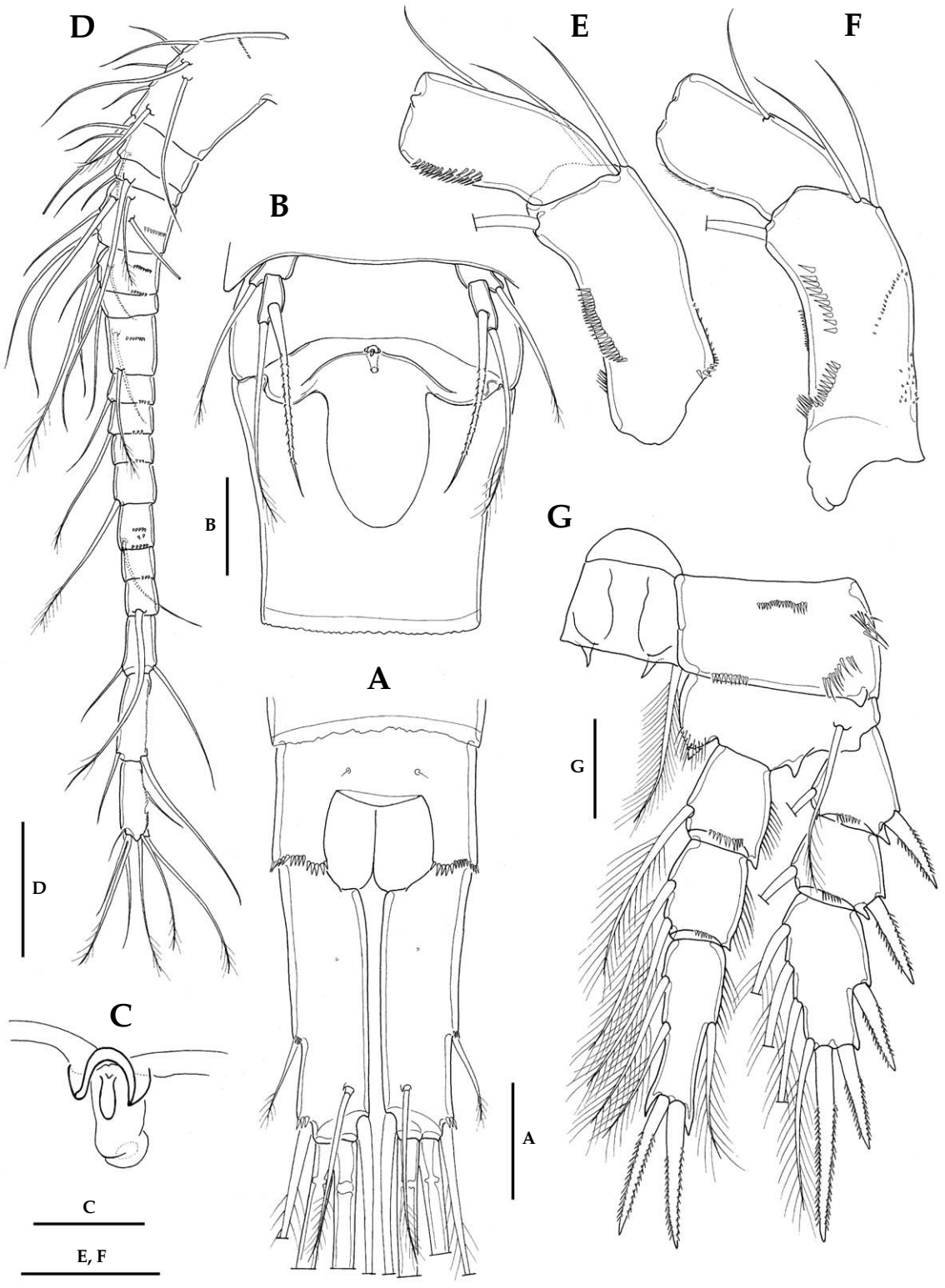


Fig. 38. *Mesocyclops leuckarti*, female. A. anal somite and Fu, dorsal; B. P5 and genital somite, ventral; C. copulatory duct; D. A1; E. A2 basis, frontal; F. A2 basis, caudal; G. P4. Scales: A, B, E–G=50 μm, C=10 μm, D=100 μm (cited from Lee, Jeon and Chang, 2005).

species has the character combination of the basic pattern of spinule ornamentation on the A2 basis (simple oblique row of spinules along the medial margin and longitudinal spinules along the lateral margin, with a smooth field around the distal margin and implantation of the distomedial setae), acute outgrowths on the distal margin of the P4 coupler, and a very wide copulatory duct that is not curved laterally. The shape of the outgrowths on the distal margin of the P4 coupler is slightly variable, from fully hooked to simple acute triangular (Lee, Jeon and Chang, 2005).

26. *Mesocyclops pehpeiensis* Hu, 1943 (Fig. 39)

Gal-go-ri-bo-tong-geom-mul-byeo-ruk (갈고리보통검물벼룩)

Mesocyclops leuckarti pehpeiensis Hu, 1943, p. 124, figs. 1–6.

Mesocyclops pehpeiensis: Tai and Chen, 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; Lee, Jeon and Chang, 2005, p. 97, fig. 2; Chang and Min 2005, p. 91, fig. 45; Chang, 2009, p. 503, fig. 279.

Female: Body large and stout, 1.3–1.6 mm long; live specimens usually tinged with dark yellow or brown. Prosome oval, widest at posterior margin of cephalothorax. Fifth pedigerous somite without hairs laterally. Genital double-somite slightly longer than wide. Seminal receptacle with long wide lateral arms. Copulatory duct widely curved laterally. Anal operculum convex, with smooth posterior margin.

Fu 3.6–3.9 times as long as wide; without special spinule or setule ornamentation on both lateral and medial faces, except spinules at implantations of lateral and lateralmost terminal caudal setae. Lateral caudal seta located at distal third. Outer caudal seta less than 1/3 times as long as inner caudal seta, nearly as long as dorsal caudal seta.

A1 furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennulary segments 4–5 and 7–13, with spinule arrangement as in figure. Anterior surface of A2 basis with longitudinal row of 28–30 spinules along lateral margin; caudal surface of A2 basis ornamented with oblique spinule row around middle of medial margin, 2 longitudinal rows with about 15–18 and 6–8 spinules along lateral margin, and a few spinules near distal margin and implantation of distomedial setae.

P1–P4 biramous, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-0	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1 basis lacking distomedial seta. P4, intercoxal sclerite smooth on both posterior and anterior surface, with pair of acute hook-shaped outgrowths on distal margin; P4 coxa with 8–10 spinules along distal margin; apical spines of P4 enp3 nearly subequal, slightly shorter than P4 enp3, inner apical spine with more than 10 spinules on lateral edge.

P5 2-segmented, medial spine located near middle of medial margin of exopod, apical seta slightly longer than inner spine.

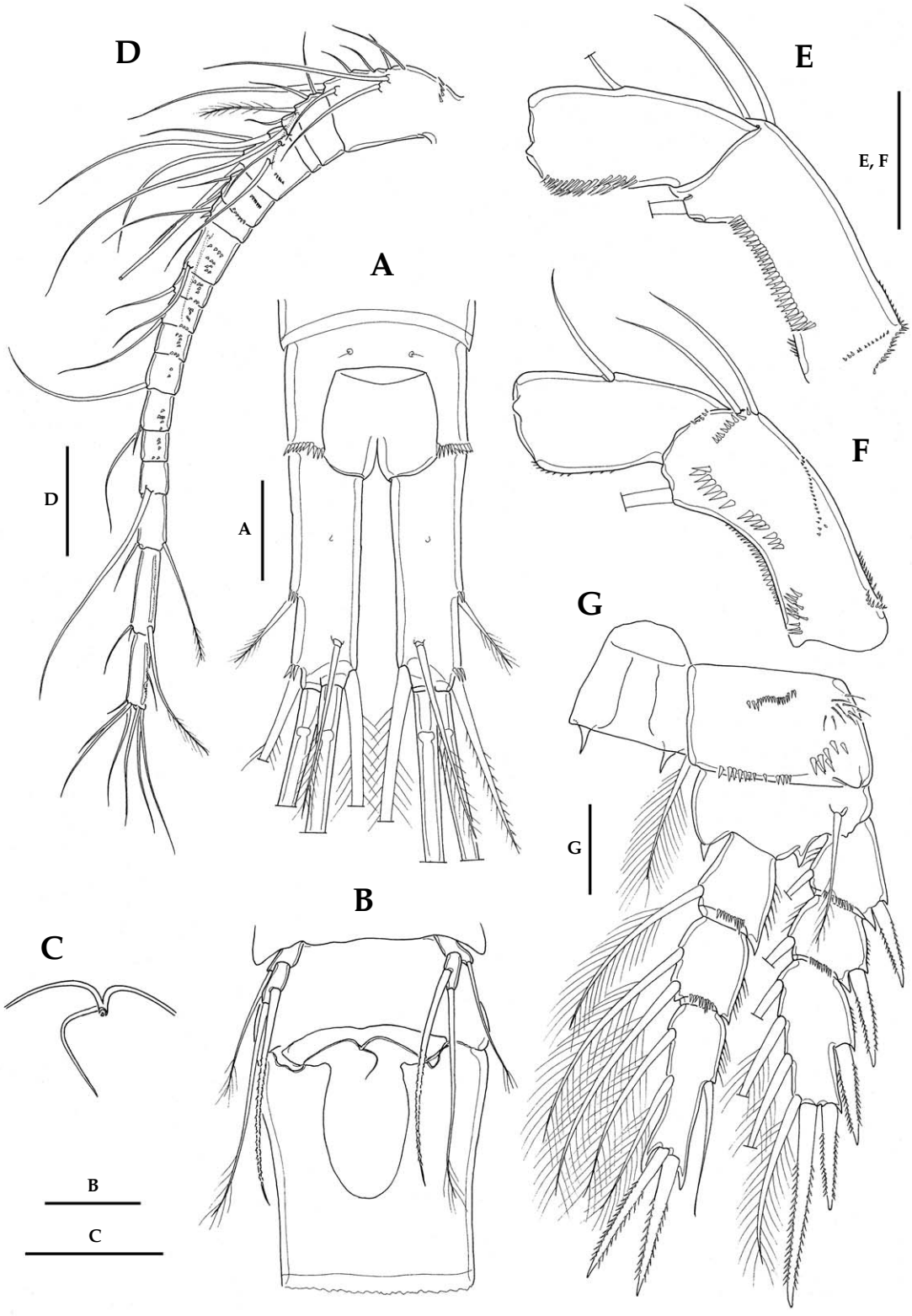


Fig. 39. *Mesocyclops pehpeiensis*, female. A. anal somite and Fu, dorsal; B. P5 and genital somite, ventral; C. copulatory duct; D. A1; E. A2 basis, frontal; F. A2 basis, caudal; G. P4. Scales: A, C, E–G=50 μm, B, D=100 μm (cited from Lee, Jeon and Chang, 2005).

Distribution: Korea, Japan, China, Central Asia, Indochina, India, introduced in Mexico, USA.
Korea: All provinces.
Specimen examined: CN: (Duung Pond, Taean: 22.viii.2012); GB: (rice paddies, Sangrim-ri, Gyeongsan: 6.vi.2012; Aejiho Pond, Daegu University, Gyeongsan: 17.vi.2012; Saemot Reservoir, Yeongcheon: 2.x.2012); GN: (Upo Swmap, Changnyeong: 29.v.2012; Samrak swamp, Busan: 3.vi.2011).
Ecology: In Korea, this species occurs frequently in various freshwaters, especially favoring eutrophic water bodies with abundant aquatic vegetation. It is also found in brackish waters.
Remarks: This species, which together with *Mesocyclops dissimilis* are the most common members of the genus in Korea, seems to favor the detritus-rich littoral zone of various habitats, including lotic waters such as streams and irrigation ditches.

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, all the records above, including the original description, were based on the traditional "macrocharacters", resulting in long-lasting controversies on the identity of this species. 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: a much larger 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 the posterior margin of the P4 coupler; copulatory duct widely curved laterally; and spinules present near the distal margin and implantation of the distomedial setae of the A2 basis. The Korean specimens coincide well with the descriptions of Guo (2000b) and Ishida (2002), except the slightly stronger spinule ornamentation near the distal margin of the A2 basis and along the distal margin of the P4 coxopodite than in the Chinese and Japanese specimens (Lee, Jeon and Chang, 2005).

27. *Mesocyclops dissimilis* Defaye and Kawabata, 1993 (Figs. 40, 41)

Kkok-ji-bo-tong-geom-mul-byeo-ruk (꼭지보통검물벼룩)

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; Lee, Jeon and Chang, 2005, p. 99, figs. 3–5; Chang and Min, 2005, p. 93, figs. 46, 49A, B; Chang, 2009, p. 506, fig. 281, 282.

Female: Body 0.8–1.0 mm long. Fifth pedigerous somite with hairs laterally, but bare dorsally; genital double-somite slightly longer than wide; seminal receptacle with short wide lateral arms; copulatory pore horseshoe-shaped; copulatory duct conspicuous, strongly curved as in figure.

Fu about 3.1–3.6 times longer than wide, with spinules at implantation of lateral and lateralmost terminal caudal setae. Outer caudal seta about 1/4 times as long as inner caudal seta, nearly as long as dorsal caudal seta.

A1 furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennulary segments 4–5 and 7–13, arranges as in figure. A2 basis with longitudinal row of 23–30 spinules along lateral margin of anterior face; caudal surface of basis ornamented with oblique spinule row around middle of medial margin, patch of minute spinules proximal to implantation of distomedial setae and distal margin, a few minute spinules

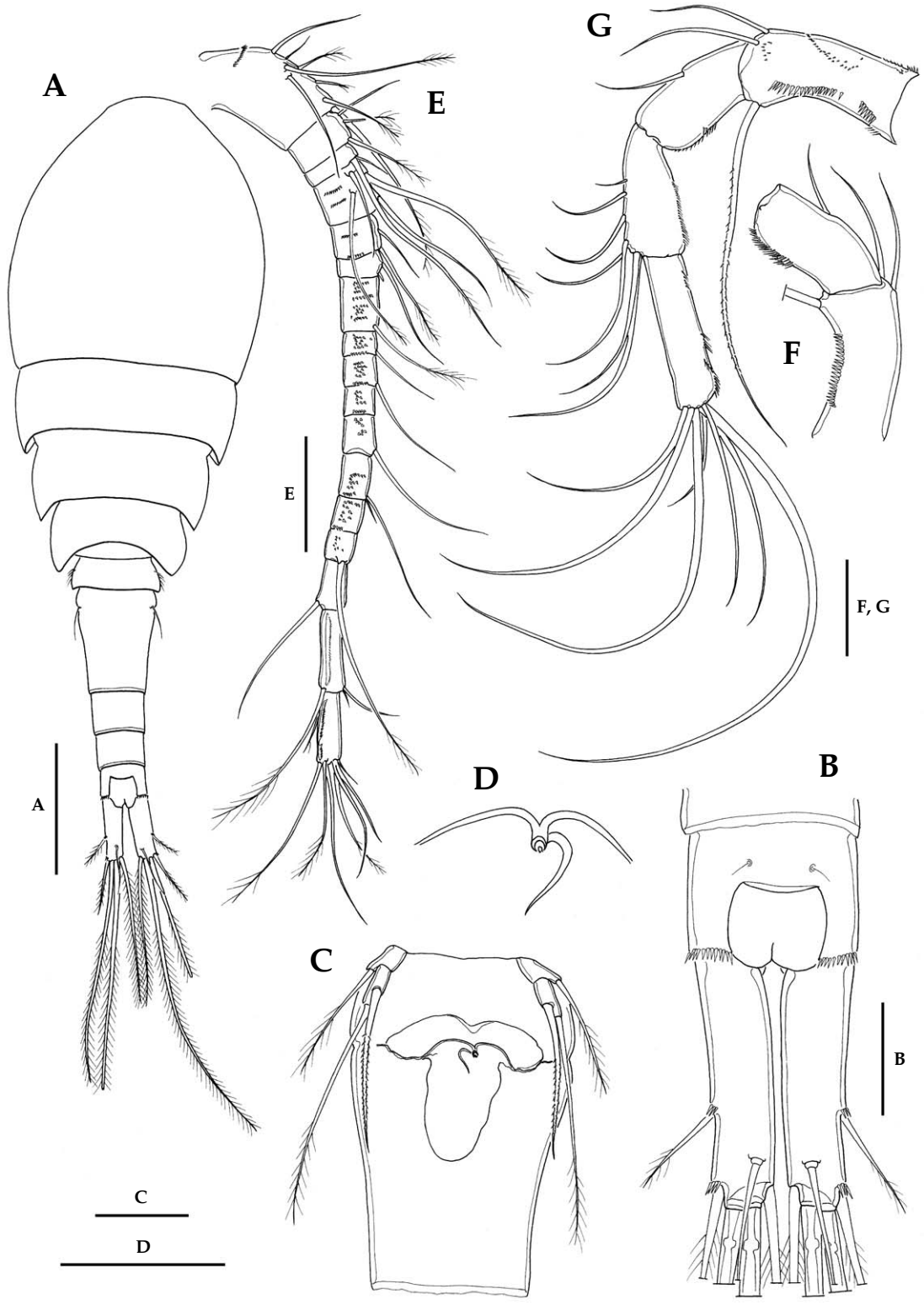


Fig. 40. *Mesocyclops dissimilis*, female. A. habitus; B. anal somite and Fu, dorsal; C. P5 and genital double-somite, ventral; D. copulatory duct; E. A1; F. A2 basis, frontal; G. A2, caudal. Scales: 50 μm (cited from Lee, Jeon and Chang, 2005).

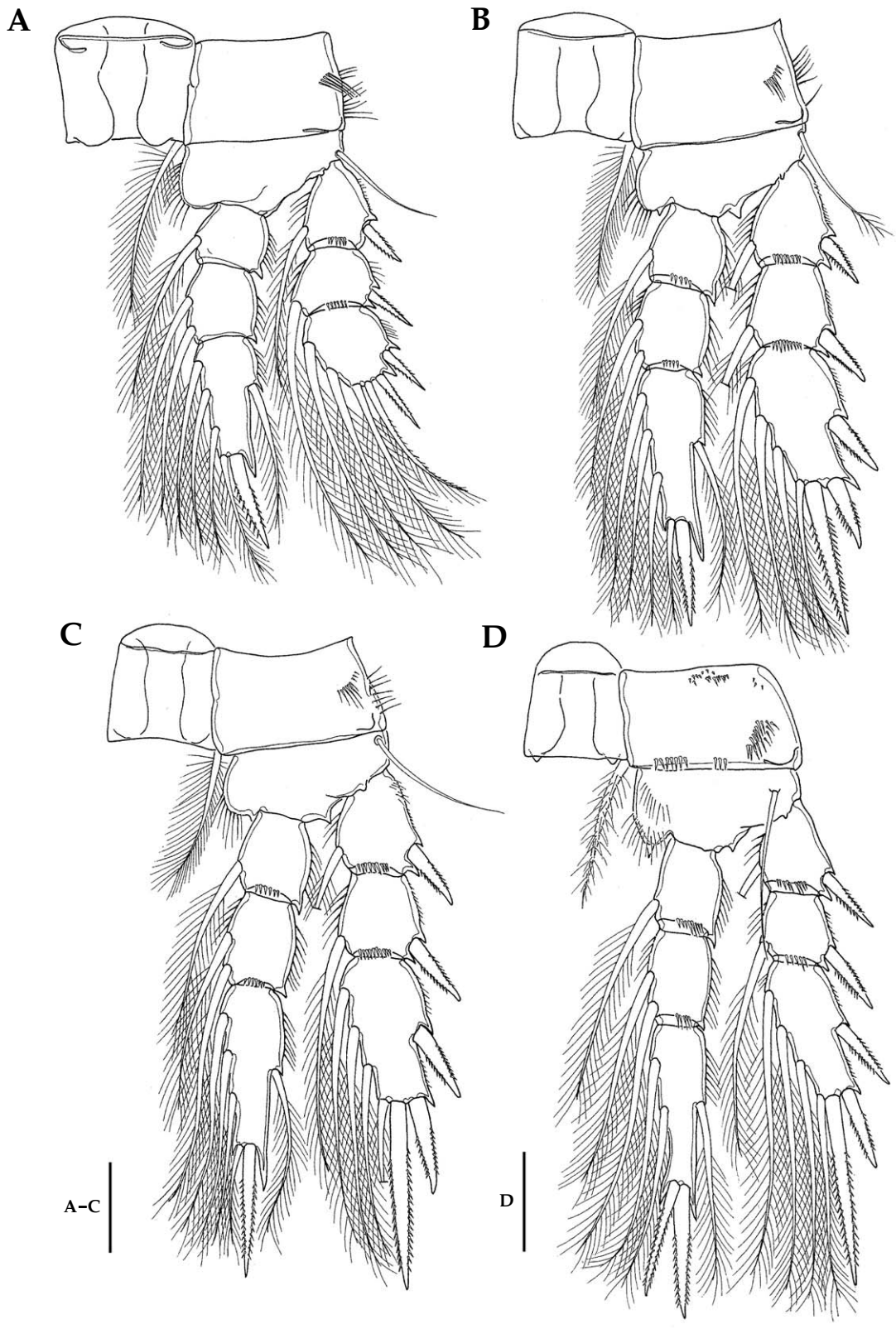


Fig. 41. *Mesocyclops dissimilis*, female. A–D. P1–P4. Scales: 50 μm (cited from Lee, Jeon and Chang, 2005).

beside distal margin and longitudinal row of 13–20 spinules along lateral margin; enp2 armed with 7 setae.

P1–P4 biramous, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-0	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1 basis lacking distomedial seta. P4, intercoxal sclerite smooth on both posterior and anterior surface, with pair of obtuse triangular outgrowths on distal margin; P4 coxa with 7–12 spinules arranged intermittently along distal margin; apical spines of P4 enp3 nearly subequal (inner spine generally slightly shorter than outer one), both spines slightly shorter than P4 enp3, inner apical spine with more than 15 spinules on lateral edge.

P5 2-segmented, medial spine located on middle of medial margin of distal segment, apical seta much longer than medial spine, outer seta of proximal segment slightly shorter than medial spine.

Distribution: Korea, Japan, China, Vietnam, Russian Far East.

Korea: All provinces.

Specimen examined: CN: (Duung Pond, Taean: 22.viii.2012); GB: (Saemot Reservoir, Yeongcheon: 2.x.2012; Ahwa Reservoir, Gyeongju: 20.vi.2012).

Ecology: This species generally occurs in large lentic waters, such as reservoirs, lakes and dams, as a pelagic plankter, but is sometimes found also in the relatively cold and oligosaprobic waters. Pelagic planktonic individuals show a tendency toward a relatively smaller body than the "near-shore" ecotype, as mentioned in Ueda and Reid (2003). In the "cold-water" season (usually from November to March in Korea), *Mesocyclops dissimilis* diapauses in the copepodid IV or V stages (Lee, Jeon and Chang, 2005).

Remarks: "*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 the distal margin of the P4 coupler and the presence of spinules at the implantations of the lateral and lateralmost terminal caudal setae, although these were illustrated rather insufficiently or inadequately. Likewise, most of the previous records reported as "*M. leuckart*" in limnological studies in Korea might be misidentifications of this species, for the samples were usually composed of pelagic plankters, and generally of the more common species studied only for limnological purposes, living in the large reservoirs or main channels of large rivers (Lee, Jeon and Chang, 2005).

28. *Mesocyclops woutersi* Van de Velde, 1987 (Fig. 42)

Min-ga-si-bo-tong-geom-mul-byeo-ruk (민가시보통검물벼룩)

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; Lee, Jeon and Chang, 2005, p. 103, fig. 6; Chang and Min, 2005, p. 95, fig. 47; Chang, 2009, p. 510, fig. 283.

Female: Body 0.9–1.1 mm long. Fifth pedigerous somite with hairs laterally, but bare dorsally; genital double-somite slightly longer than wide. Seminal receptacle with short wide lateral arms;

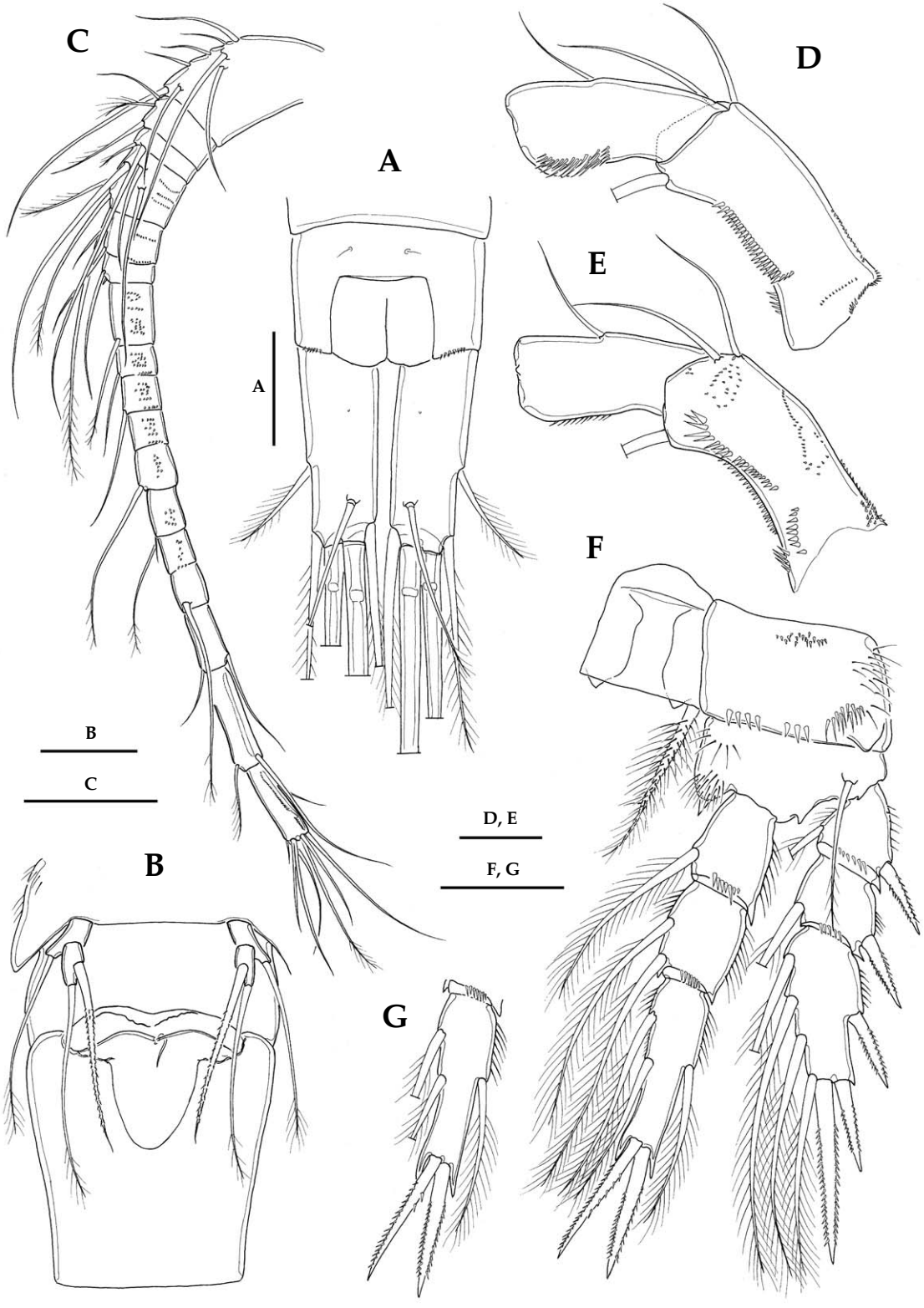


Fig. 42. *Mesocyclops woutersi*, female. A. anal somite and Fu, dorsal; B. P5 and genital somite; C. A1; D. A2 basis, frontal; E. A2 basis, caudal; F. P4; G. P4 enp3. Scales: A, C–G=50 μm, B=100 μm (cited from Lee, Jeon and Chang, 2005).

copulatory duct strongly curved.

Fu about 3–3.5 times longer than wide, without special spinule or setule ornamentation on both lateral and medial faces, lacking spinules at implantations of lateral and lateralmost terminal caudal setae.

A1 furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennulary segments 4–5 and 7–13, arranged as in figure. A2 basis with longitudinal row of 25–30 spinules along lateral margin of anterior face; caudal surface ornamented with oblique spinule row around middle of medial margin, ellipsoidal patch 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; enp2 armed with 7 setae.

P1–P4, both exopods and endopods composed of 3 segments; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-0	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1 basipodite without distomedial seta. P4, intercoxal sclerite smooth on both posterior and anterior surface, with pair of obtuse triangular outgrowths on distal margin. P4 coxa with 7–9 spinules along distal margin; apical spines of P4 enp3 nearly equal in length, slightly shorter than P4 enp3, inner apical spine with 5–7 spinules on lateral edge.

P5 2-segmented, medial spine located on middle of medial margin of distal segment, apical seta slightly longer than medial spine, lateral seta of proximal segment slightly shorter than medial spine.

Distribution: Korea, Japan, China, Indochina, Papua New Guinea, Australia.

Korea: GW, CN, GB, GN, JB, JN, JJ.

Specimen examined: GB: (Oksancheon, Gyeongju: 23.vi.2011); JJ: (marshes, Sumeunmulbengdwi, Halla Mt.: 11.ix.2010).

Ecology: Occurring in littoral zone of various freshwater bodies. In Korea, this species is abundant in eutrophic lentic waters, especially in summer.

Remarks: This species constitutes the *woutersi*-superspecies together with *Mesocyclops dissimilis*, and they are distinguished from the other three congeners from Korea by having the small triangular protrusion on the posterior margin of the P4 coupler and the patch of minute spinules on the distomedial corner of the A2 basis. *Mesocyclops woutersi* differs from *M. dissimilis* by the absence of spinules at the implantations of the lateral and outer caudal setae, and the sparsely spinulose lateral blade of the medial apical spine of P4 enp3. This last characteristic is slightly variable in the Korean populations, that is, generally with 5–7 spinules sparsely, but rarely with only 2–3 spinules or even bare in some variations (Lee, Jeon and Chang, 2005).

29. *Mesocyclops mariae* Guo, 2000 (Fig. 43)

Teol-jul-bo-tong-geom-mul-byeo-ruk (털줄보통검물벼룩)

Mesocyclops mariae Guo, 2000b, p. 116, figs. 1–4; Ueda and Reid, 2003, p. 98, figs. 38, 39; Lee, Jeon and Chang, 2005, p. 107, fig. 7; Chang and Min, 2005, p. 97, figs. 48, 49C–F; Chang, 2009, p. 512, fig. 284.

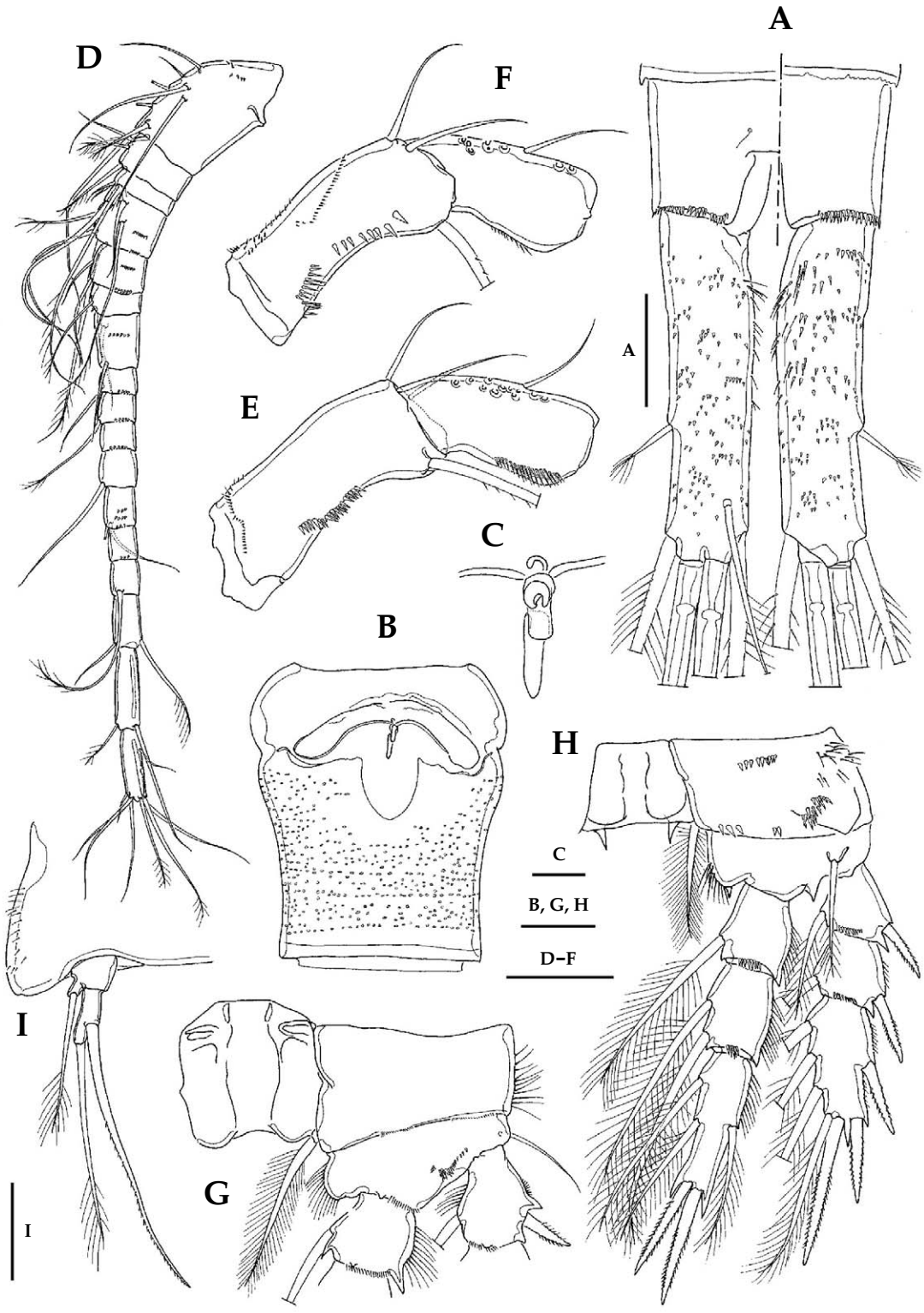


Fig. 43. *Mesocyclops mariae*, female. A. anal somite and Fu, dorsal (left) and ventral (right); B. genital somite, ventral; C. copulatory duct; D. A1; E. A2 basis, frontal; F. A2 basis,caudal; G. P1, intercoxal sclerite and basal part; H. P4; I. Posterolateral corner of fifth pedigerous somite and P5, ventral. Scales: A, B, E–I=50 μm, C=10 μm, D=100 μm (cited from Lee, Jeon and Chang, 2005).

Female: Body about 1.1 mm long. Fifth pedigerous somite pilose laterally; genital double-somite slightly longer than wide; seminal receptacle with long wide lateral arms; transverse ducts meeting at straight or concave angle anteriorly to horseshoe-shaped copulatory pore. Copulatory duct wide and sinuously curved, or appearing folded in overview.

Fu 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.

A1 furnished with serrate hyaline membrane with large notch on last segment, ventral spinule ornamentation present on antennulary segments 4–5, 7–10 and 12–13, spinule arrangement as in figure. A2 basis with longitudinal row of 18–20 spinules along proximal half of lateral margin of anterior face; caudal surface 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.

P1–P4, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-0	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1 basipodite lacking distomedial seta. P4, intercoxal sclerite smooth on both posterior and anterior surface, with pair of large, acute hook-shaped outgrowths on distal margin. P4 coxopodite with about 5 spinules sparsely along distal margin; apical spines of P4 enp3 nearly subequal (outer spine about 1.1 times longer than inner spine), apical spines much shorter than P4 enp3, lateral edge of inner spine with many spinules.

P5 2-segmented, medial spine located just anterior to midlength of medial margin of distal segment, lateral seta of proximal segment much shorter than medial spine and apical seta.

Distribution: Korea, China.

Korea: GG.

Specimen examined: GG: (Seokmodo Island, Ganghwa Island: 29.v.2005).

Ecology: Occurring in coastal swamp or ditches (Chang, 2009).

Remarks: This species was originally described from a pool in southern China (Guangxi Province) by Guo (2000b). In Korea, only one female was found in a small ditch flowing into the Yellow Sea, near the westernmost mud flat of Ganghwa Is., about 50 km west of Seoul. The Korean specimen fits well with the original description, except the relative length of apical spines on P4 enp3 (the medial spine is shorter than the lateral one in the Korean specimen, while vice versa in the original description), the size arrangement of the setae/spine armature on P5 (the medial spine is longest in the Korean specimen, while the apical seta is slightly longer than the medial spine in the original description), and the spinule ornamentation on the ventral surface of the first segment of the A1 (simple in Korean specimens, versus with 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 following important characteristics: wide and sinuously folded copulatory duct, basic ornamentation pattern on the A2 basis, and possession of large and acute hook-shaped outgrowths on the distal margin of the P4 coupler. However, *M. mariae* is easily distinguished from *M. leuckarti* by the medial hairs on the Fu, absence of spinules at the implantations of the lateral and lateralmost terminal caudal setae, and the pilose pediger 5 (Lee, Jeon and Chang, 2005).

Genus *Thermocyclops* Kiefer, 1927

On-nan-geom-mul-byeo-ruk-sok (온난검물벼룩속)

Body relatively small, 0.6–1.0 mm long in female. Fu 2–3 times as long as wide. A1 17-segmented. P1–P4 with 3-segmented exopod and endopod. P4 enp3 with 2 apical spines. P5 of 2 free segments; exopod with 1 long spine and 1 long seta apically.

Type species: *Thermocyclops oithonoides* (Sars, 1863).

Species 65 (4 in Korea).

Key to the species of genus *Thermocyclops*

1. Fu not hairy along inner margin ····· 2
– Fu pilose along inner margin ····· *T. uenoi*
2. Inner spine on P4 enp3 more than 2.5 times as long as outer spine ····· 3
– Outer spine on P4 enp3 about 1.2 times as long as inner spine ····· *T. dybowskii*
3. Fu 2.2–2.5 times as long as wide; inner spine on P4 enp3 about 2.7 times as long as outer spine; seminal receptacle "T"-shaped ····· *T. crassus*
– Fu 2.7–3.0 times as long as wide; inner spine on P4 enp3 more than 4 times as long as outer spine; lateral wings of seminal receptacle bent posteriorly ····· *T. taihokuensis*

30. *Thermocyclops crassus* (Fischer, 1853) (Fig. 44)

Yu-ri-on-nan-geom-mul-byeo-ruk (유리온난검물벼룩)

Cyclops crassus Fischer, 1853, p. 92.
Cyclops hyalinus Rehberg, 1880, p. 542, pl. 6, figs. 1, 2; Lilljeborg, 1901, p. 40.
Mesocyclops (*Thermocyclops*) *hyalinus*: Kiefer, 1929, p. 83.
Cyclops (*Mesocyclops*) *hyalinus*: Gurney, 1933, p. 295, figs. 1880–1896.
Mesocyclops (*Thermocyclops*) *crassus*: Rylov, 1948, p. 305, figs. 77, 1–4.
Thermocyclops hyalinus: Tai and Chen, 1979, p. 416, fig. 253; Mizuno and Miura, 1984, p. 614, fig. 347, 1–6; Yoo and Lim, 1989, p. 135, pl. 9, figs. 1–4.
Thermocyclops crassus: Dussart, 1969, p. 210, fig. 108; Kim and Chang, 1989, p. 250, fig. 14; Ishida, 2002, p. 62, fig. 36a–h; Ueda and Reid, 2003, p. 265, fig. 125; Chang and Min, 2005, p. 97, fig. 50A–D; Chang, 2009, p. 515, fig. 286.

Female: Body length 680–780 μm. Live specimens tinged with pale yellow or pale brown. Prosome suboval. Fifth pedigerous somite not pilose laterally. Genital double-somite about 1.2 times longer than wide; seminal receptacle "T"-shaped, with long, transverse lateral arms, distal ends not bent posteriorly. Posterior margins of urosomites with crenate hyaline frill. Anal operculum convex, with smooth posterior margin.

Fu relatively short, 2.2–2.5 times longer than wide, slightly divergent posteriorly, without special ornamentation on lateral and medial margins. Lateral margin straight, not curved outward. Lateral caudal seta inserted at about distal third of lateral margin of ramus. Inner caudal seta about 3 times

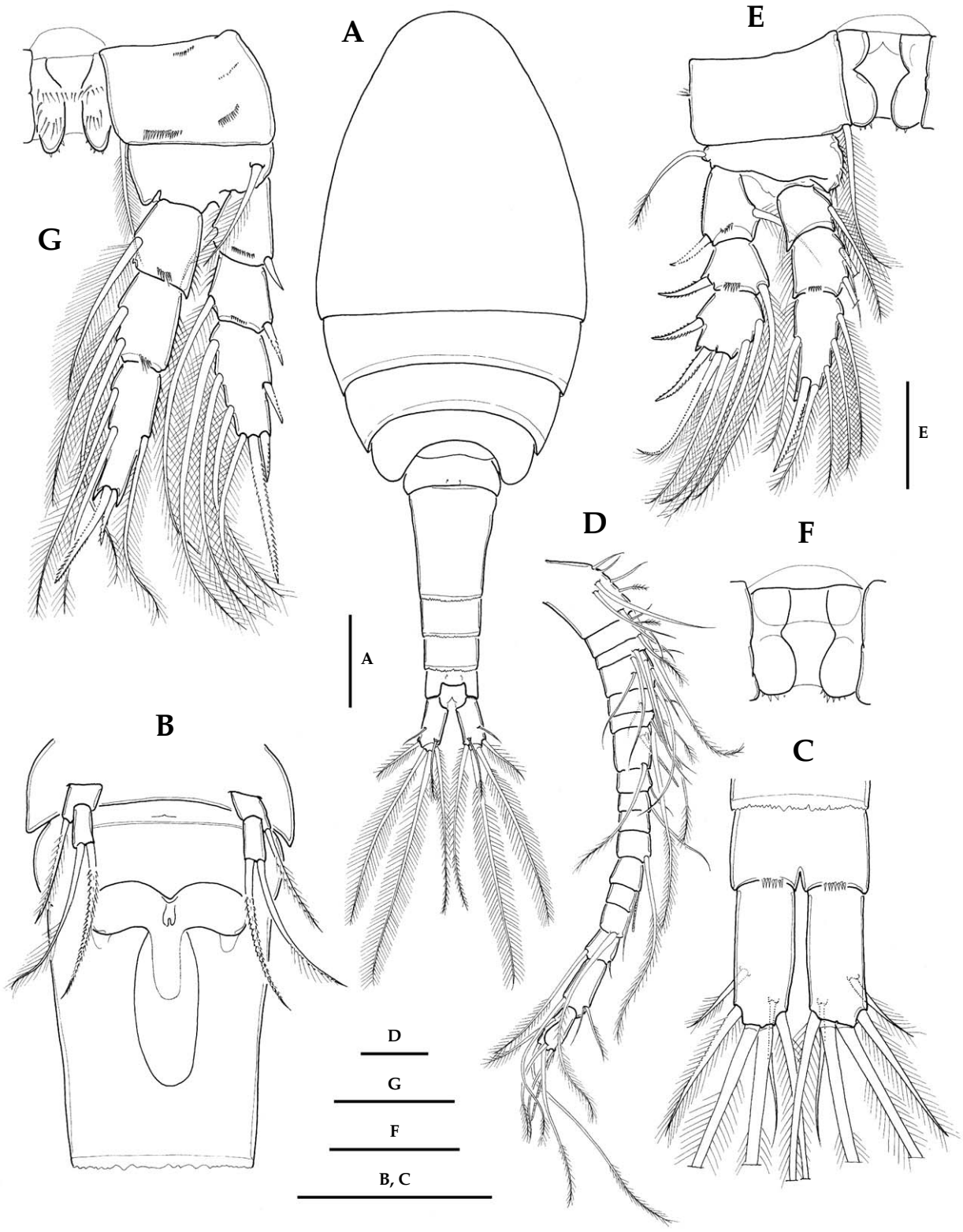


Fig. 44. *Thermocyclops crassus*, female. A. habitus; B. P5 and genital double-somite, ventral; C. Fu, ventral; D. A1; E. P1; F. P3, intercoxal sclerite; G. P4. Scales: A=100 μm, B–G=50 μm (cited from Chang, 2009).

longer than outer caudal seta. Dorsal caudal seta slightly shorter than outer caudal seta, and slightly longer than Fu.

A1 17-segmented, reaching posterior end of second pedigerous somite.

P1–P4 biramous, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1, distomedial seta on basis extending slightly past posterior margin of enp2. P4, intercoxal sclerite with lateral expansions protruding, armed with 4–5 acute spinules along inner posterior margin; posterior surface of intercoxal sclerite with 2 setule rows. P4 coxa with about 12–14 spinules along posterior margin. P4 enp3, inner apical spine curved, about 0.8–0.9 times as long as enp3, about 2.7 times longer than outer spine.

P5 2-segmented; exopod oblong, armed with 1 long inner apical spine and 1 apical plumose seta, subequal in length.

Distribution: Cosmopolitan.

Korea: All provinces.

Specimen examined: CN: (pond, Chungnam National University, Daejeon: 17.viii.2012); GB: (Yetjinmot Reservoir, Gyeongsan: 28.vi.2012; rice paddies, Sangrim-ri, Gyeongsan: 6.vi.2012; Saemot Reservoir, Yeongcheon: 2.x.2012); GN: (Upo Swamp, Changnyeong: 22.vi.2012).

Ecology: Occurring in various freshwater bodies; often co-occurring with *Thermocyclops taihokuensis*, but more abundant in relatively large water bodies (dams, lakes and rivers) and oligosaprobic waters, especially in spring and autumn (Chang, 2009).

31. *Thermocyclops taihokuensis* (Harada, 1931) (Fig. 45)

On-nan-geom-mul-byeo-ruk (온난검물벼룩)

Mesocyclops (*Thermocyclops*) *taihokuensis* Harada, 1931, p. 163, figs. 26, 27; Kikuchi, 1940, p. 295, fig. 12.

Mesocyclops (*Thermocyclops*) *asiaticus*: Rylov, 1948, p. 303, fig. 76.

Thermocyclops taihokuensis: Kiefer, 1938, p. 67; Shen and Sung, 1962, p. 45; Shen and Sung, 1965a, p. 175, figs. 27, 28; Tai and Chen, 1979, p. 411, fig. 347, 7–12; Ueda and Reid, 2003, p. 282, fig. 135; Chang and Min, 2005, p. 101, fig. 50E–H; Chang, 2009, p. 518, fig. 288.

Female: Body length 720–840 μm; slenderer than that of preceding species; broadest at posterior margin of cephalothorax; urosome sharply narrowing posteriorly. Live specimens tinged with pale yellow or pale brown. Prosome ellipsoidal, protruding anteriorly. Postrolateral edges of prosomites not produced. Genital double-somite about 1.4 times longer than wide; seminal receptacle "T"-shaped, with paired long lateral arms, distal ends strongly bent posteriorly. Posterior margins of urosomites with crenate hyaline frill. Anal operculum convex, with smooth posterior margin.

Fu relatively long, 2.7–3.0 times longer than wide, usually strongly divergent posteriorly, with posterior half of ramus curved outward, without special ornamentation on both lateral and medial

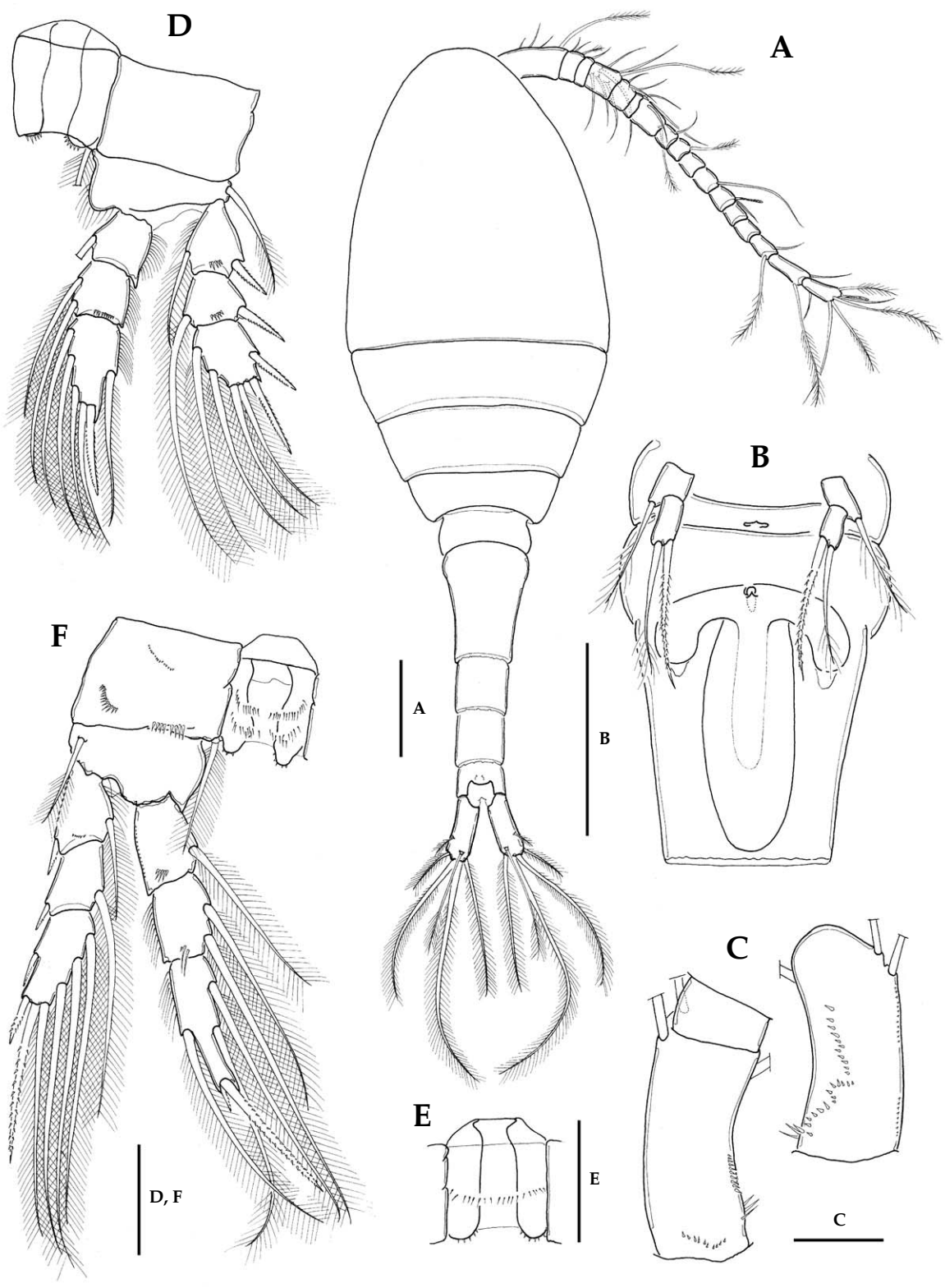


Fig. 45. *Thermocyclops taihokuensis*, female. A. habitus; B. P5 and genital double-somite, ventral; C. A2 basis, frontal (left) and caudal (right); D. P1; E. P3, intercoxal sclerite; F. P4. Scales: A=100 μm, B–F=50 μm (cited from Chang, 2009).

margins. Lateral caudal seta inserted at about distal quarter of lateral margin of ramus. Inner caudal seta about 2.7 times longer than outer caudal seta. Dorsal caudal seta about 2 times longer than outer caudal seta, and about 1.7 times longer than Fu.

A1 17-segmented, reaching almost to posterior end of second pedigerous somite. A2 basis, row of 9–11 spinules along proximal part of lateral margin of frontal surface; longitudinal row of 10–12 spinules near middle of caudal surface; distal parts of both frontal and caudal surfaces bare, lacking hairs or spinules.

P1–P4 biramous, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1, distomedial seta on basis extending slightly over posterior margin of enp2. P4, intercoxal sclerite with lateral expansions strongly protruding, armed with 4–5 acute spinules on apex and inner posterior margin; posterior surface of intercoxal sclerite with 2 setule rows. P4 coxa with about 8–10 sharp spinules along posterior margin. P4 enp3, inner apical spine straight, about 1.2 times longer than enp3, about 3.7–4.0 times longer than outer spine.

P5 2-segmented; exopod oblong, armed with 1 long inner apical spine and 1 apical plumose seta, subequal in length.

Distribution: Korea, Japan, China, Taiwan, Vietnam, Russian Far East, Central Asia.

Korea: All provinces.

Specimen examined: CN: (Duung marsh, Sindu-ri, Taean: 22.viii.2012); GB: (Aejiho Pond, Daegu University, Gyeongsan: 17.vi.2012).

Ecology: Occurring in littoral zone of various freshwater bodies; abundant in eutrophic ponds, reservoirs and ricefields, especially in summer (Chang, 2009).

32. *Thermocyclops dybowskii* (Landé, 1890) (Fig. 46)

Han-cheol-on-nan-geom-mul-byeo-ruk (한철온난검물벼룩)

Cyclops dybowskii Landé, 1890, p. 363, pl. 7, figs. 60–68.

Mesocyclops (*Thermocyclops*) *dybowskii*: Kiefer, 1929, p. 84; Gurney, 1933, p. 302, figs. 1901–1951; Rylov, 1948, p. 310, fig. 79.

Thermocyclops dybowskii: Shen and Sung, 1965b, p. 390; Dussart, 1969, p. 213, fig. 109; Tai and Chen, 1979, p. 417, fig. 254; Ishida, 2002, p. 63, fig. 37g–m; Ueda and Reid, 2003, p. 257, fig. 120; Chang and Min, 2005, p. 103, fig. 51A–E; Chang, 2009, p. 521, fig. 290.

Female: Body length 740–930 μm; broadest at posterior margin of cephalothorax; urosome sharply narrowing posteriorly. Live specimens tinged with pale yellow or pale brown. Prosome ellipsoidal, protruding anteriorly. Postrolateral edges of prosomites not produced. Cephalothorax longer than next prosomites combined. Genital double-somite about 1.2 times longer than wide; seminal receptacle "T"-shaped, with paired oblique lateral arms. Posterior margins of urosomites with crenate hyaline frill. Anal operculum convex, with smooth posterior margin.

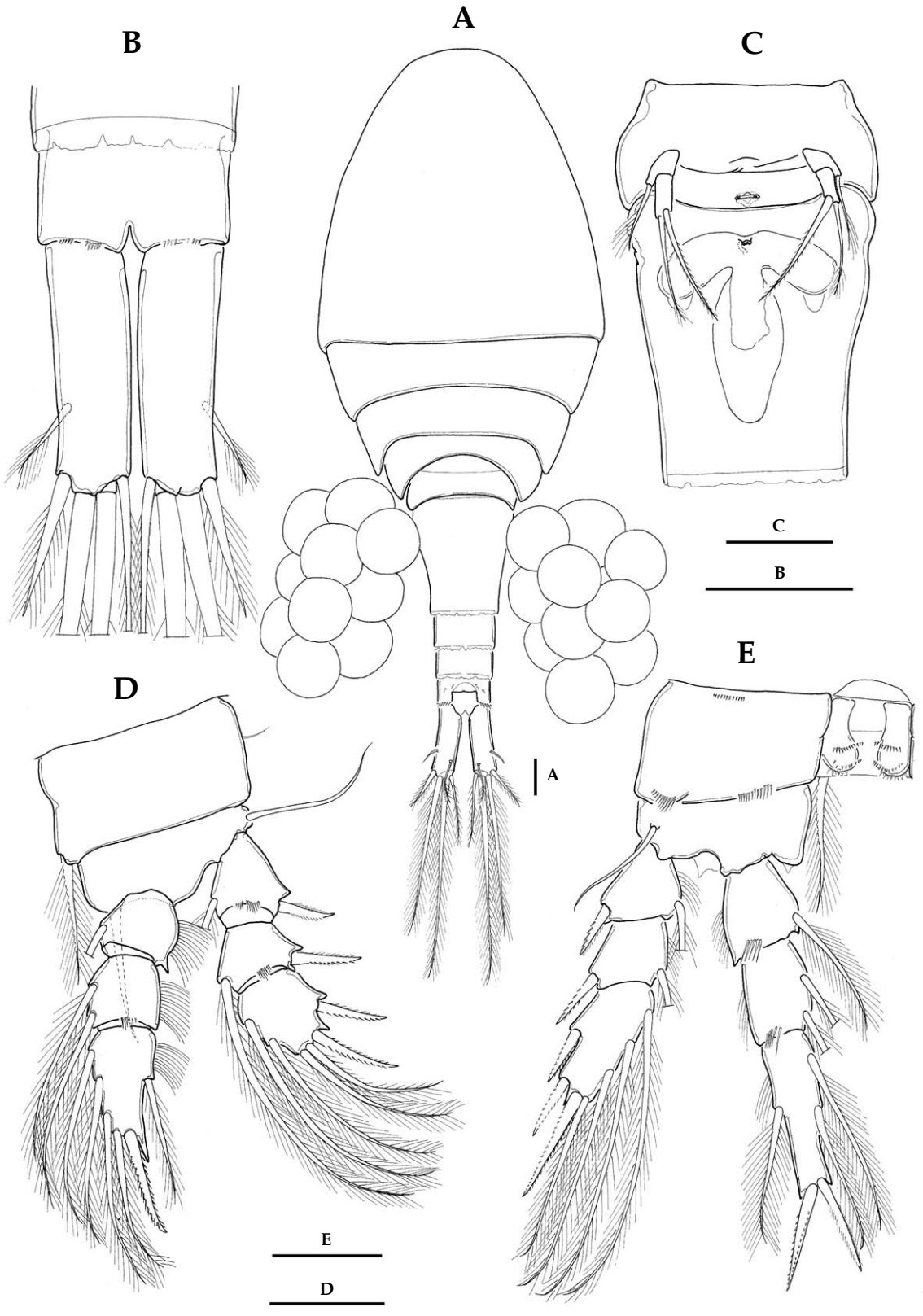


Fig. 46. *Thermocyclops dybowskii*, female. A. habitus; B. anal somite and Fu, ventral; C. P5 and genital double-somite, ventral; D. P1; E. P4. Scales: 50 μm (cited from Chang, 2009).

Fu relatively long, 2.7–3.3 times longer than wide, usually strongly divergent posteriorly, with posterior half of ramus curved outward, without special ornamentation on both lateral and medial margins. Lateral caudal seta inserted at about distal third of lateral margin of ramus. Inner caudal seta slightly longer than Fu, about 1.5 times longer than outer caudal seta. Dorsal caudal seta slightly shorter than outer caudal seta.

A1 17-segmented, reaching almost to posterior end of second pedigerous somite. A2 basis, row of 9–11 spinules along proximal part of lateral margin of frontal surface; longitudinal row of 10–12 spinules near middle of caudal surface; distal parts of both frontal and caudal surfaces bare, lacking hairs or spinules.

P1–P4 biramous, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1, distomedial seta on basis extending slightly over posterior margin of enp2. P4, intercoxal sclerite with lateral expansions strongly protruding, armed with 5–7 acute spinules along posterior margin; posterior surface with paired spinule rows, each consisting of 12–15 spinules in middle of intercoxal sclerite. P4 coxa with about 14–16 sharp spinules along posterior margin. P4 enp3 long, 2.9–3.4 times as long as wide, about 1.4–1.5 times longer than outer apical spine; outer apical spine about 1.1–1.2 times longer than inner spine.

P5 2-segmented; exopod oblong, armed with 1 long inner apical spine and 1 apical plumose seta, subequal in length.

Distribution: Korea, Japan, China, Russia, Pakistan, Algeria, Iran, Egypt, Europe.

Korea: GW, CN, GB, CB, CN, JJ.

Specimen examined: GB: (well, Gameunsaji, Gyeongju: 26.v.2007).

Ecology: Occurring in small freshwater bodies such as ponds or bogs, especially in summer (Chang, 2009).

33. *Thermocyclops uenoi* Ito, 1952 (Fig. 47)

Ba-dat-ga-on-nan-geom-mul-byeo-ruk (바닷가온난검물벼룩)

Thermocyclops uenoi Ito, 1952, p. 119, figs. 22–25; Ito, 1954, p. 405, figs. 169–174; Ishida, 2002, p. 63, fig. 38; Ueda and Reid, 2003, p. 222, fig. 96; Chang and Min, 2005, p. 103, fig. 51F–I; Chang, 2009, p. 523, fig. 291.

Female: Body relatively large for a *Thermocyclops* species, 0.9–1.1 mm long; more slender than that of preceding species; broadest at posterior margin of cephalothorax; urosome sharply narrowing posteriorly. Live specimens tinged with pale yellow or pale brown. Prosome ellipsoidal, protruding anteriorly. Postrolateral edges of prosomites not produced. Posterior margins of prosomites and urosomites with finely serrated hyaline frill. Genital double-somite about 1.1 times longer than wide; transverse rows of minute spinules present on ventral and ventrolateral surfaces. Seminal receptacle "T"-shaped, with long lateral arms, distal ends strongly bent posteriorly. Poste-

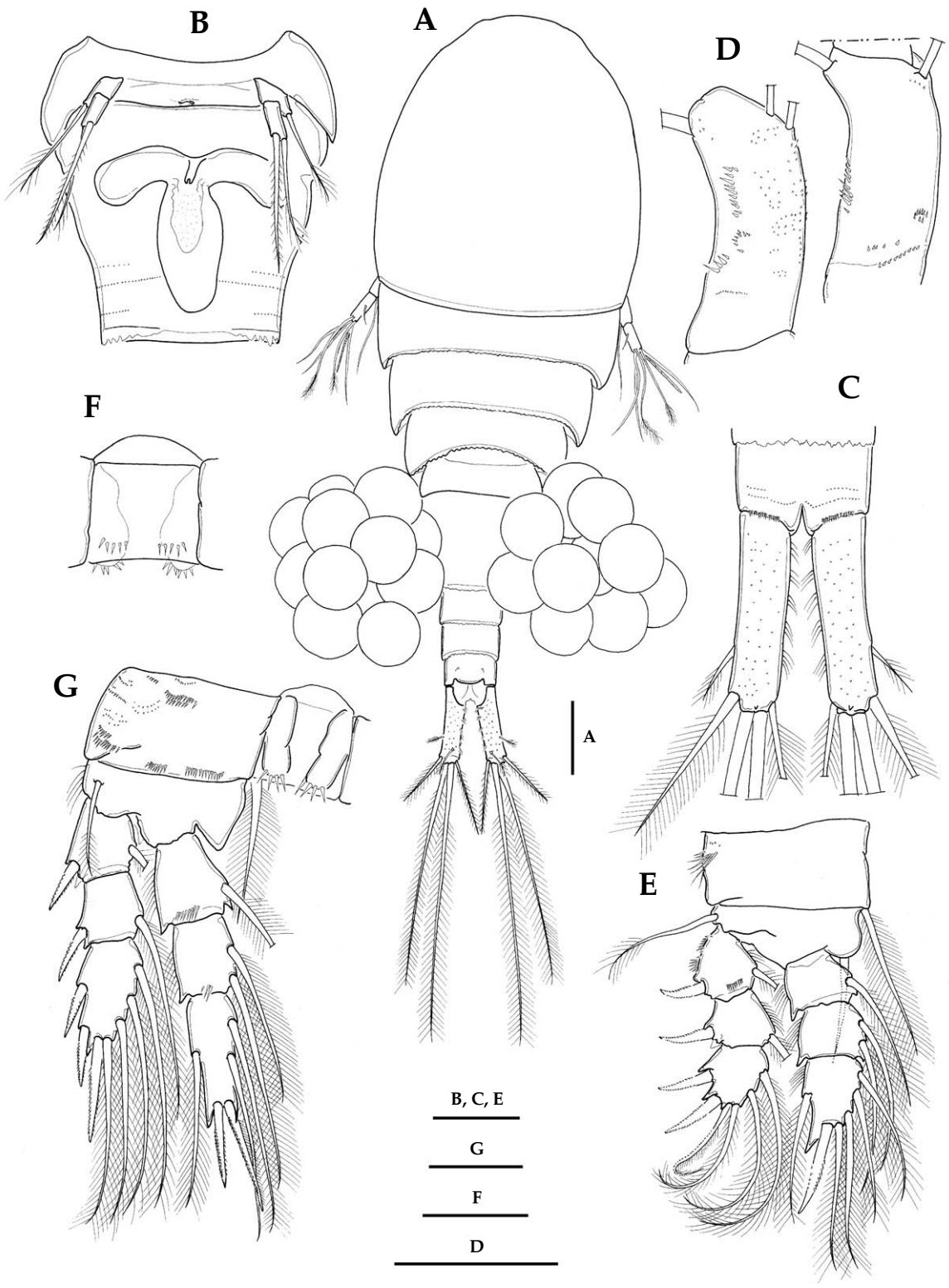


Fig. 47. *Thermocyclops uenoi*, female. A. habitus; B. P5 and genital somite, ventral; C. anal somite and Fu, ventral; D. A2 basis, caudal (left) and frontal (right); E. P1; F. P3, intercoxal sclerite; G. P4. Scales: A=100 μm, B–G=50 μm (cited from Chang, 2009).

rior margins of urosomites with crenate hyaline frill. Anal operculum slightly convex, with smooth posterior margin.

Fu elongate, 3.7–4.0 times longer than wide, usually strongly divergent posteriorly, with posterior half of ramus curved outward, ornamented with 4–5 groups of hairs along medial margin; lateral margin smooth, without notch. Lateral caudal seta inserted at about distal third of lateral margin of ramus. Inner caudal seta slightly shorter than Fu, about 1.3–1.5 times longet than outer caudal seta. Dorsal caudal seta about 2 times longer than outer caudal seta, and about 1.7 times longer than Fu.

A1 17-segmented, reaching nearly to middle of second pedigerous somite. A2 basis with 10 or more spinules along proximal part of lateral margin of frontal surface; longitudinal row of 10–12 spinules near middle of caudal surface; distal parts of both frontal and caudal surfaces ornamented with numerous minute spinules.

P1–P4 biramous, both exopods and endopods 3-segmented; spine formula 2,3,3,3. Seta/spine armature of P1–P4 as follows:

P1	basis 1-1	exp I-1; I-1; II,1,3	enp 0-1; 0-2; 1,I+1,3
P2	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P3	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2; 1,I+1,3
P4	basis 1-0	exp I-1; I-1; III,1,3	enp 0-1; 0-2, 1,II,2

P1, distomedial seta on basis extending slightly over posterior margin of enp2. P4, intercoxal sclerite with lateral expansions strongly protruding, armed with 4–5 acute spinules along posterior margin; posterior surface of intercoxal sclerite bare, without spinule row in middle. P4 coxa with about 14–16 spinules along posterior margin. P4 enp3 about 2.5 times as long as wide, slightly longer than inner apical spine; inner spine about 1.4–1.5 times longer than outer spine.

P5 2-segmented; exopod oblong, armed with 1 long inner apical spine and 1 apical plumose seta (spine 1.2–1.3 times longer than seta).

Distribution: Korea, Japan.

Korea: JN.

Specimen examined: JN: (well, Yeosu: 24.viii.2004).

Ecology: Inhabiting coastal wells and springs in Japan and Korea (Chang, 2009).

Remarks: This species was described from coastal wells on the western coast of Japan, and later found in a pond in a park near Tokyo (Ishida, 2002). In summer 2004, the author collected many specimens from a spring in a fishing village on Tsushima Island, Japan.

Literature Cited

Borutzky, E.V., 1966. Copepoda of the caves of the marine territory (Primorsky Krai). Zool. Zh., 45(5): 770–772 (Russian with English summary).

Boxshall, G.O. and S.H. Halsey, 2004. An Introduction to Copepod Diversity, Vols. I, II. The Ray Society, London, pp. 1–966.

Brady, G.S., 1878. A Monograph of the Free and Semi-parasitic Copepoda of the British Islands, Vol. 1. The Ray Society, London, pp. 1–148.

Burckhardt, G., 1913. Zooplankton aus ost-und südasiatischen Binnengewässern. Zool. Jahrb., Syst., 34: 341–472.

Chang, C.Y., 2009. Illustrated Encyclopedia of Fauna & Flora of Korea. Vol. 42. Inland-water Copepoda. Ministry of Education, Science & Engineering, Republic of Korea (Jeonghaeng-sa Publ. Co., Seoul), pp. 1–687.

Chang, C.Y., 2012. Invertebrate Fauna of Korea, vol. 21, no. 19. Continental cyclopoids (Halicyclopinae & Eucyclopinae). National Institute of Biological Resources, Ministry of Environment, pp. 1–92.

Chang, C.Y. and G.-s. Min, 2005. Key to the Korean freshwater cyclopoid copepods and their DNA taxonomy. Junghaeng-Sa Publ. Co., Seoul, pp. 1–153 (in Korean).

Chang, C.Y., S.M. Yoon, S.K. Lee and W. Kim, 1998. Distribution of mountain cyclopoids in Korea. Korean J. Environ. Biol., 16(4): 299–304 (in Korean).

Claus, C., 1857a. Das Genus *Cyclops* und seine einheimischen Arten. Arch. Naturgesch., 23: 1–40.

Claus, C., 1857b. Weitere Mittheilungen über die einheimischen Cyclopiden. Arch. Naturgesch., 23: 205–211.

Claus, C., 1893. über die Antennen der Cyclopiden und die Auflösung der Gattung *Cyclops* in Gattungen und Untergattungen. Anz. Akad. Wiss. Wien, 30(9): 79–83.

Defaye, D. and K. Kawabata, 1993. *Mesocyclops dissimilis* n. sp. from Lake Biwa, Japan (Copepoda, Cyclopoida). Hydrobiologia, 257: 121–126.

Dussart, B., 1969. Les Copépodes des Eaux Continentales d' Europe Occidentale. Tôme II: Cyclopoïdes et Biologie. N. Boubée et Cie, Paris, pp. 1–292.

Dussart, B. and D. Defaye, 1985. Répertoire mondial des Copépodes Cyclopoïdes. CNRS. Paris, 236 pp.

Ferrari, F.D. and J. Orsi, 1984. *Oithona davisae*, new species and *Limnoithona sinensis* (Burckhardt, 1912) (Copepoda: Oithonidae) from the Sacramento-San Joaquin Estuary, California. J. Crust. Biol., 4: 106–126.

Fischer, S., 1851. Beiträge zur Kenntnis der in der Umgegend von St. Petersburg sich findenden Cyclopiden. Bull. Soc. Imp. natur. Moscou, 24(3): 409–438, pls. 9–10.

Fischer, S., 1853. Beiträge zur Kenntnis der in der Umgegend von St. Petersburg sich findenden Cyclopiden (Fortsetzung). Bull. Soc. Imp. natur. Moscou, 26: 74–100, pls. 2–3.

Fischer, S., 1860. Beiträge zur Kenntnis der Entomostraken. Abh. K. Bayer Akad. Wiss., 8(3): 645–680.

Flössner, D., 1984. Two new species of the genera *Acanthocyclops* and *Diacyclops* (Crustacea, Copepoda) from Lake Baikal. Limnologica, 15: 149–156.

Graeter, A., 1903. Die Copepoda der Umgebung Basels. Rev. suisse Zool., 11: 419–541.

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.

Gurney, R., 1933. The British Fresh-water Copepoda. Vol. 3, Cyclopoida, Caligoida. The Ray Society, London,

pp. 1–334.

Hołyńska, M., 1997. Tracing the routes of speciation in *Mesocyclops woutersi*-superspecies (Copepoda: Cyclopoida). Ann. Zool., 47(3/4): 321–336.

Hołyńska, 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.

Huys, R. and G.A. Boxshall, 1991. Copepod Evolution. The Ray Society, London, pp. 1–468.

Huys, R., J.M. Gee, C.G. Moore and R. Hamond, 1996. Marine and brackish water harpacticoid copepods. Part. 1. In: Synopses of the British Fauna (New Series), No. 51. The Linnean Society of London and The Estuarine and Coastal Sciences Association, pp. i–vii, 1–352.

Ishida, T., 1984. On the newly discovered three species of copepod *Halicyclops* sp., *Acanthocyclops venustoides bispinosus* (Yeatman) and *Attheyella dentata* (Poggenpol) from freshwaters of Hokkaido, Japan. Sci. Rep. Hokkaido Salmon Hatchery, 38: 51–56.

Ishida, T., 1994. Copepods in the upper reaches of the Tama River, Tokyo, Japan. Japan. J. Limnol., 55: 125–129.

Ishida, T., 1999. *Mesocyclops yesoensis* sp. nov., *M. leuckarti* and *M. pehpeiensis* (Crustacea: Copepoda) from Hokkaido, northern Japan. Biogeography, 1: 81–85.

Ishida, T., 2000. *Eucyclops pacificus* and *E. ohtakai*, two new cyclopoid copepods (Crustacea) from Japan. Biogeography, 2: 21–28.

Ishida, T., 2001. *Eucyclops borealis* sp. nov. from Alaska, and *E. tsushimensis* sp. nov. from Tsushima Island, Japan (Crustacea, Copepoda, Cyclopoida). Biogeography, 3: 51–57.

Ishida, T., 2002. Illustrated fauna of the freshwater cyclopoid copepods of Japan. Bull. Biogeogr. Soc. Japan, 575: 37–106 (in Japanese).

Ishida, T., 2003. Description of *Eucyclops serrulatus* (Fischer, 1851) (Copepoda, Cyclopoida) from Japan, with reference to the degree of difference from specimens from the type locality. Biogeography, 5: 1–7.

Ishida, T. and S. Hiruta, 1999. *Eucyclops speratus* from Japan (Crustacea, Copepoda, Cyclopoida). Biogeography, 1: 87–91.

Ito, T., 1952. Four new Copepoda from subterranean waters. Rep. Fac. Fish. Prefect. Univ Mie, 1: 115–120.

Ito, T., 1954. Cyclopoid copepods of Japanese subterranean waters. Rep. Fac. Fish., Pref. Mie Univ., 1(3): 372–417.

Ito, T., 1956. Three new copepods from brackish-water lakes of Japan. Pacif. Sci., 10: 468–473.

Ito, T., 1957. Groundwater copepods from South-Western Japan. Hydrobiologia, 11: 1–28.

Ito, T., 1964. Groundwater copepod from the middle and western parts of Japan. Jap. J. Zool., 14: 119–132.

Jurine, L., 1820. Histoire des Monocles, qui se trouvent aux environs de Genève. J.J. Paschoud, Imprimeur-Libraire, Geneva. 43–48.

Karanovic, T., 2006. Subterranean copepods (Crustacea, Copepoda) from the Pilbara region in Western Australia. Rec. W. Austr. Mus., supplement 70, pp. 1–239.

Karanovic, T., M.J. Grygier and W. Lee, 2013. Endemism of subterranean *Diacyclops* in Korea and Japan, with descriptions of seven new species of the *languidoides*-group and redescriptions of *D. brevifurcus* Ishida, 2006 and *D. suoensis* Ito, 1954 (Crustacea, Copepoda, Cyclopoida). Zookeys, 267: 1–76.

Karanovic, T., H. Yoo and W. Lee, 2012. A new cyclopoid copepod from Korean subterranean waters reveals an interesting connection with the Central Asian fauna (Crustacea: Copepoda: Cyclopoida). J. Species Res., 1(2): 155–173.

Karaytug, S., 1999. Copepoda: Cyclopoida. Genera *Paracyclops, Ochridacyclops* and Key to the Eucyclopinae. In: H.J.F. Dumont (ed.), Guides to the Identification of the Microinvertebrates of the Continental Waters

of the World, 14, Backhuys Publishers, Leiden, pp. 1–217.

Karaytug, S. and G.A. Boxshall, 1998. Partial revision of *Paracyclops* Claus, 1893 (Copepoda, Cyclopoida, Cyclopidae) with descriptions of four new species. Bull. nat. Hist. Mus. Lond. (Zool.), 64(2): 111–205.

Kawabata, K. and D. Defaye, 1994. Description of planktonic copepods from Lake Kahoku-gata, Japan. Japan. J. Limnol., 55: 143–158.

Kiefer, F., 1929. Crustacea Copepoda. 2. Cyclopoda Gnathostoma. Das Tierreich, Berlin and Leipzig, 53: 1–102.

Kiefer, F., 1935. Zur Kenntnis der Halicyclopiden (Crustacea Copepoda). Zool. Anz., 110(1–2): 10–13.

Kiefer, F., 1937. Eine neuer Cyclopide (Crust. Copepoda) aus dem Ochridasee. Zool. Anz., 120: 133–143.

Kiefer, F., 1981. Beitrag zur Kenntnis von Morphologie, Taxonomie und geographischer Verbreitung von *Mesocyclops leuckarti* auctorum. Arch. Hydrobiol., Suppl. 62(1): 148–190.

Kim, C.K., 1978. Distribution and seasonal variations of the copepods and branchiopods in the Myeongam Lake. Korean J. Zool., 21 (2): 67–75 (in Korean).

Kim, H.S. and C.Y. Chang, 1989. Freshwater cyclopoid copepods (Cyclopoida, Cyclopidae) of Korea. Korean J. Syst. Zool., 5(2): 225–256.

Kim, H.S. and C.Y. Chang, 1991. *Acanthocyclops tokchokensis*, a new cyclopoid copepod species from wells in Tokchok Island of Korea. Korean J. Zool., 34: 300–306.

Kim, H.S. and K.S. Lee, 1978. A study on the zooplankton (Copepoda and Branchiopoda) in the Han River. Rep. Inst. Natur. Sci., SNU: 57–69 (in Korean).

Kim, H.S. and K.B. Park, 1969. A study on the copepods and branchiopods from Han-River, Korea. I. Kwangnaru and Bokwang Dong regions. Zoologica, 8: 1–17 (in Korean).

Koch, C.L., 1838. Deutschlands Crustaceen, Myriapoden und Arachniden. Ein Beitrag zur deutschen Fauna, 1/40, Regensburg.

Lee, J.M. and C.Y. Chang, 2007a. *Acanthocyclops fonticulus* (Cyclopoida, Cyclopidae), a new species of cyclopoid copepods from mountain springs in Korea. Integr. Biosci., 11(1): 61–68.

Lee, J.M. and C.Y. Chang, 2007b. Two new species of *Tropocyclops prasinus* group (Copepoda: Cyclopidae) from South Korea. Integr. Biosc., 11(2): 255–263.

Lee, J.M. and C.Y. Chang, 2011. Discovery of the rarely known genus *Psammophilocyclops* (Cyclopidae Cyclopinae) from a water purification plant in South Korea. Anim. Cells Syst., 2011 (online ed.), pp. 1–9. http://dx.doi.org/10.1080/19768354.2011.637578.

Lee, J.M., J.M. Jeon and C.Y. Chang, 2004. Two semi-subterranean copepods from Korea. Korean J. Biol. Sci., 8: 145–154.

Lee, J.M., J.M. Jeon and C.Y. Chang, 2005. Taxonomy on genus *Mesocyclops* (Copepoda: Cyclopoida: Cyclopidae) from South Korea. Korean J. Syst. Zool., 21(1): 93–110.

Lee, J.M., W.-R. Kim, Y.-G. Choi and C.Y. Chang, 2007. Four cyclopoid copepods from limestone caves and lava tube in South Korea. Korean J. Syst. Zool., 23(2): 155–167.

Lee, J.M., G.-S. Min and C.Y. Chang, 2005. Taxonomy on *Eucyclops serrulatus* species group (Copepoda: Cyclopoida: Cyclopidae) from South Korea. Korean J. Syst. Zool., 21(2): 137–156.

Lee, J.M., H.J. Yoon and C.Y. Chang, 2007. A faunistic study on the brackish-water calanoid copepods from South Korea. Korean J. Syst. Zool., 23(2): 135–154.

Lilljeborg, W., 1901. Synopsis specierum huc usque in Suecia observatorum generis *Cyclops*. K. Svenska Vetensk. Acad. Handl., n. ser., 35: 1–118.

Lindberg, K., 1954. Cyclopides (Crustacés Copépodes) d'îles du Pacifique Sud (Mélanésie et Micronésie) et de Borneo. Kungl. Fysiogr. Sällsk. Lund Förhandl., 24(18): 1–14.

Marsh, C.D., 1920. Freshwater Copepoda. Report of the Canadian Arctic Expedition 1913–1918, 7(J): 1–25.

Miura, Y., 1969. Results of the speleological survey in South Korea 1966 XIV. Subterranean harpacticoid cope-

pods of South Korea. Bull. Nat. Sci. Mus. Tokyo, 12: 241–254.

Mizuno, T., S.W. Kang and K.S. Cho, 1980. Summary of research on inland water plankton in Korea. Overseas Scientific Research on "History of Environmental Changes in Korea," Ministry of Education, Japan, interim report for 1978, pp. 63–88 (in Japanese).

Mizuno, T. and Y. Miura, 1984. Nihon no rikusuisan kaiashi-rui (Inland-water Copepoda of Japan). In: T. Mizuno and Y. Miura (eds.), Freshwater Copepoda. Tatara Shobo, Tokyo, pp. 471–650 (in Japanese).

Pesce, G.L., 1978/79. A new cyclopid from subterranean phreatic waters of Greece *Acanthocyclops* (*Acanthocyclops*) *cephallenus*, n. sp. (Crustacea, Copepoda). Vie et Milieu, 28–29: 77–82.

Pesce, G.L., 2011. Cyclopoida: Halicyclopinae Kiefer, 1927: *Halicyclops* A.M. Norman, 1903. Accessed through: Copepod Web Portal at http://www.luciopesce.net/ copepods/halicyc.htm on 2011-10-21.

Pesce, G.L., 2012. Cyclopoida: Halicyclopinae Kiefer, 1927: *Halicyclops* A.M. Norman, 1903. Accessed through: Copepod Web Portal at http://www.luciopesce.net/ copepods/halicyc.htm on 2012-08-21.

Pesce, G. and R. Lattinger, 1983. A new cyclopoid copepod from hyporheic subterranean waters of Yugoslavia: *Acanthocyclops* (*Acanthocyclops*) *petkovskii* n. sp. (Crustacea: Copepoda). Riv. Idrobiol., 22: 59–65.

Petkovski, T.K., 1971. Einige neue und seltene subterrane Cyclopiden (Crustacea, Copepoda) aus Jugoslawien. Acta Mus. Maced Sci. nat., Skopje, 12: 74–144.

Petkovski, T.K., 1975. Revision von *Acanthocyclops*-Formen der *vernalis*-Gruppe aus Jugoslawien (Crustacea, Copepoda). Acta Mus. Maced. Sci. nat., Skopje, 2: 1–31.

Reid, J.W. and T. Ishida, 2000. *Itocyclops*, a new genus proposed for *Speocyclops yezoensis* (Copepoda: Cyclopoida: Cyclopidae). J. Crustacean Biol., 20: 589–596.

Reid, J.W., E.B. Reed, J.V. Ward, N.J. Voelz and J.A. Stanford, 1991. *Diacyclops languidoides* (Lilljeborg, 1901) s.l. and *Acanthocyclops montana*, new speceids (Copepoda, Cyclopoida), from groundwater in Montana, USA. Hydrobiologia, 218: 133–149.

Richard P.J., 1887. Liste des cladocères et des Copa. podes d'eau douce observés en France. Bull. Soc. Zool. France, 12: 156–164.

Rylov, V.M., 1948. Freshwater Cyclopoida. Fauna of U.S.S.R., Crustacea. Zool. Inst. Acad. Sci. U.S.S.R., n. ser. 35, pp. 1–318. [English translation, 1963, Israel Program for Scientific Translations, Jerusalem, Fauna of U.S.S.R., 3(3): 1–314]

Sars, G.O., 1863. Oversigt af de indenlandske Ferskvandscopepoder. Forhandl. Vidensk.-Selskab. Christiania, Aar 1862: 212–262.

Sars, G.O., 1914. Copepoda Cyclopoida. Parts V and VI. Cyclopidae (continued). An Account of the Crustacea of Norway, with short descriptions and figures of all the species. Bergen Museum, Bergen, 6: 57–80, pls. 33–48.

Schmeil, O., 1892. Deutschlands freilebende Süsswasser-Copepoden. I. Cyclopidea. Bibl. Zool. Stuttg., 11: 1–191.

Shen, C.J. and T.H. Sung, 1965a. The freshwater copepods of the Bai-Yang-Dien Lake, Hopen Province. Acta Zool. Sinica, 17(2): 167–183.

Shen, C.J. and T.H. Sung, 1965b. Notes on freshwater Copepoda of Sinkiang, northwestern China. Acta Zool. Sinica, 17(4): 383–400.

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-slide. Benthos Res., 44: 41–44.

Soh, H.Y., H.-L. Suh, O.H. Yu and S. Ohtsuka, 2001. The first record of two demersal calanoid copepods, *Pseudodiaptomus poplesia* and *P. nihonkaiensis* in Korea, with remarks on morphology of the genital

area. Hydrobiologia, 448: 203–215.

Tai, A.Y. and G.X. Chen, 1979. Cyclopoida Sars, 1886. In: C.J. Shen (ed.), Fauna Sinica, Crustacea, Freshwater Copepoda. Science Press, Beijing, pp. 301–420.

Thallwitz, J., 1927. *Cyclops languidus* var. *disjuncta*, eine neue Form der *languidus*-Gruppe. Zool. Anz., 71: 56–63.

Thomson, G.M., 1882. On the New Zealand Copepoda. Trans. Proc. N.Z. Inst., 15: 93–116.

Ueda, H. and H. Nagai, 2009. Three new species of the brackish-water copepod *Halicyclops* (Crustacea, Cyclopoida) from Ariake Bay, Japan. J. Nat. Hist., 43: 287–307.

Ueda, H. and H. Nagai, 2012. Two new species of *Halicyclops* (Crustacea: Copepoda: Cyclopidae) from Honshu with a key to the species of the genus in Japan. Species Diversity, 17: 97–107.

Ueda, H., S. Ohtsuka and T. Kuramoto, 1996. Cyclopoid copepods from a stream in the limestone cave Akiyoshido. Japan. J. Zool., 57(4): 305–312.

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.

Walter, T.C. and G. Boxshall (Eds.), 2013. World Copepoda database. http://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=106413.

Yamamoto, K., 1941. The plankton of Lake Husenko of northern Korea. Japan. J. Limnol., 11(3): 108–116 (in Japanese).

Yoo, K.-I. and B.J. Lim, 1989. Systematic studies on the freshwater Copepoda (Crustacea) in Lake Yongsan, Korea. Korean J. Limnol., 22: 127–146.

Yoon, H.J. and C.Y. Chang, 2008. Two brackish cyclopoid copepods from southern coast of Korea. Korean J. Syst. Zool., 24: 241–250.

Index to Korean Names

ㄱ

가시검물벼룩 19
가시검물벼룩속 18
가시꼬리맵시검물벼룩 36
갈고리검물벼룩 80
검물벼룩과 7
검물벼룩아과 7
긴꼬리꼬마검물벼룩 68
꼬마검물벼룩 64
꼬마검물벼룩속 63
꼭지보통검물벼룩 82

ㄴ

나비맵시검물벼룩 49

ㄷ

덕적가시검물벼룩 28
덩치검물벼룩 15
동방가시검물벼룩 21

ㅁ

맵시검물벼룩속 36
모래무지검물벼룩 56
모래무지검물벼룩속 55
몽당가시검물벼룩 26
민가시보통검물벼룩 85

ㅂ

바닷가온난검물벼룩 96
보통검물벼룩 78
보통검물벼룩속 77

ㅅ

샘검물벼룩 52
샘검물벼룩속 52

ㅇ

야릇검물벼룩 74
야릇검물벼룩속 74
약골맵시검물벼룩 47
어리꼬마검물벼룩 66
어리참검물벼룩 10
열두마디맵시검물벼룩 39
온난검물벼룩 92
온난검물벼룩속 90
옹달샘가시검물벼룩 32
우물맵시검물벼룩 44
유령검물벼룩 70
유령검물벼룩속 70
유리온난검물벼룩 90

ㅈ

자바유령검물벼룩 72
중간꼬리털맵시검물벼룩 42

ㅊ

참검물벼룩 8
참검물벼룩속 8

ㅋ

코끼리검물벼룩 13
코끼리검물벼룩속 12

ㅌ

털줄보통검물벼룩 87
튼튼가시검물벼룩 24

ㅎ

한철온난검물벼룩 94

Index to Korean Names as Pronounced

B

Ba-dat-ga-on-nan-geom-mul-byeo-ruk 96
Bo-tong-geom-mul-byeo-ruk 78
Bo-tong-geom-mul-byeo-ruk-sok 77

C

Cham-geom-mul-byeo-ruk 8
Cham-geom-mul-byeo-ruk-sok 8

D

Deok-jeok-ga-si-geom-mul-byeo-ruk 28
Deong-chi-geom-mul-byeo-ruk 15
Dong-bang-ga-si-geom-mul-byeo-ruk 21

E

Eo-ri-cham-geom-mul-byeo-ruk 10
Eo-ri-kko-ma-geom-mul-byeo-ruk 66

G

Gal-go-ri-bo-tong-geom-mul-byeo-ruk 80
Ga-si-geom-mul-byeo-ruk 19
Ga-si-geom-mul-byeo-ruk-sok 18
Ga-si-kko-ri-maep-si-geom-mul-byeo-ruk 36
Geom-mul-byeo-ruk-a-gwa 7
Geom-mul-byeo-ruk-gwa 7
Gin-kko-ri-kko-ma-geom-mul-byeo-ruk 68

H

Han-cheol-on-nan-geom-mul-byeo-ruk 94

J

Ja-ba-yu-ryeong-geom-mul-byeo-ruk 72
Jung-gan-kko-ri-teol-maep-si-geom-mul-byeo-ruk 42

K

Kkok-ji-bo-tong-geom-mul-byeo-ruk 82
Kko-ma-geom-mul-byeo-ruk 64
Kko-ma-geom-mul-byeo-ruk-sok 63
Ko-kki-ri-geom-mul-byeo-ruk 13
Ko-kki-ri-geom-mul-byeo-ruk-sok 12

M

Maep-si-geom-mul-byeo-ruk-sok 36
Min-ga-si-bo-tong-geom-mul-byeo-ruk 85
Mong-dang-ga-si-geom-mul-byeo-ruk 26
Mo-rae-mu-ji-geom-mul-byeo-ruk 56
Mo-rae-mu-ji-geom-mul-byeo-ruk-sok 55

N

Na-bi-maep-si-geom-mul-byeo-ruk 49

O

Ong-dal-saem-ga-si-geom-mul-byeo-ruk 32
On-nan-geom-mul-byeo-ruk 92
On-nan-geom-mul-byeo-ruk-sok 90

S

Saem-geom-mul-byeo-ruk 52
Saem-geom-mul-byeo-ruk-sok 52

T

Teol-jul-bo-tong-geom-mul-byeo-ruk 87
Teun-teun-ga-si-geom-mul-byeo-ruk 24

U

U-mul-maep-si-geom-mul-byeo-ruk 44

Y

Yak-gol-maep-si-geom-mul-byeo-ruk 47
Ya-reut-geom-mul-byeo-ruk 74
Ya-reut-geom-mul-byeo-ruk-sok 74
Yeol-du-ma-di-maep-si-geom-mul-byeo-ruk 39
Yu-ri-on-nan-geom-mul-byeo-ruk 90
Yu-ryeong-geom-mul-byeo-ruk 70
Yu-ryeong-geom-mul-byeo-ruk-sok 70

Index to Scientific Names

A

Acanthocyclops 18
vernalis 19
orientalis 21
robustus 24
sensitivus 26
tokchokensis 28
fonticulus 32
Apocyclops 74
borneoensis 74

C

Cryptocyclops 70
bicolor 70
javanus 72
Cyclopidae 7
Cyclopinae 7
Cyclops 8
vicinus 8
kikuchii 10

D

Diacyclops 36
bicuspidatus 36
crassicaudis 39
nanus 42
disjunctus 44
languidoides 47
leeae 49

I

Itocyclops 52
paucisetosus 56

M

Megacyclops 12
viridis 13
magnus 15
Mesocyclops 77
leuckarti 78
pehpeiensis 80
dissimilis 82
woutersi 85
mariae 87
Microcyclops 63
varicans 64
rubellus 66
longiramus 68

P

Psammophilocyclops 55
yezoensis 52

T

Thermocyclops 90
crassus 90
taihokuensis 92
dybowskii 94
uenoi 96

National Institute of Biological Resources
Ministry of Environment

ISBN 978-89-6811-068-9