

REVISION OF THE AUSTRALASIAN SPECIES OF THE GENUS *MESOCYCLOPS* SARS, 1914 (COPEPODA: CYCLOPIDAE)

MARIA HOLYŃSKA

Museum and Institute of Zoology PAS, 00-950 Warszawa, Wilcza 64, Poland, e-mail: mariahol@robal.miiz.waw.pl

Abstract.— Using new material and museum collections, a taxonomic and zoogeographical overview of the Australasian *Mesocyclops* is provided. The detailed morphological descriptions are supplemented with critical reassessment of the published records, a key to the Australasian and Oriental representatives of the genus (30 spp.) and distribution maps of the Australasian species and their extralimital relatives. The paper reports on the occurrence of sixteen species, 11 of them endemic, in Australasia: *M. dayakorum* sp. nov., *M. darwini* Dussart et Fernando 1988, *M. pseudoannae* Van de Velde, 1987, *M. cf. genae*, *M. yesoensis* Ishida 1999, *M. papuensis* Van de Velde, 1987, *M. aspericornis* (Daday, 1906), *M. ogunnus* Onabamiro, 1957, *M. affinis* Van de Velde, 1987, *M. tobae* Kiefer, 1933, *M. francisci* sp. nov., *M. woutersi* Van de Velde, 1987, *M. friendorum* sp. nov., *M. microlasius* Kiefer, 1981, *M. geminus* sp. nov., *M. thermocyclopoides* Harada, 1931. **New synonymy:** *M. papuensis* (*M. borneoensis* Dussart et Fernando, 1988). Closely related species pairs/groups seem to indicate some repeating pattern of relationships: 1. Palaeotropical; 2. Oriental; 3. Australasia/Africa disjunction; 4. Speciation within Australasia.



Key words.— Cyclopidae, *Mesocyclops*, Australasia, taxonomy, zoogeography.

INTRODUCTION

Species of the genus *Mesocyclops* are medium-sized cyclopids of 0.5 [*M. intermedius* Pesce, 1985] to 2 mm [*M. annulatus* (Wierzejski, 1892)] in length, known as predators feeding on all smaller freshwater organisms (cladocerans, rotifers, copepods, young mosquito larvae, etc). Most of them are eurytopic, yet some species seem to be confined to special habitats like large lakes (*M. aequatorialis* s. str. Kiefer, 1929 in Tanganyika and Kivu; *M. tobae* Kiefer, 1933 in Lake Toba), cave of constant high temperature (*M. cuttaccuttiae* Dumont et Maas, 1985), large hypogean waterbodies (*M. yutsil* Reid, 1996 in "cenote"), hypogean karstic crevices (*M. chaci* Fiers, 1996) or ground waters (*M. intermedius*, *M. pescei* Petkovski, 1986, *M. genae* Holyńska, 1998). With the exception of a few representatives living in the northern temperate zone [*M. leuckarti* (Claus, 1857), *M. edax* (Forbes, 1890)] or in large lakes intensively studied by limnologists [*M. ogunnus* Onabamiro, 1957 – L. Kinneret; *M. dissimilis* Defaye et Kawabata, 1993 – L. Biwa], information available on the biology of the species is still very fragmentary. Contrary to Santer's suggestion (1998), that cyclopids show no dormancy under tropical conditions, experiments of Zhen et al. (1994) provide indirect evidences of that all the four tropical/subtropical species they investigated [*M. aspericornis* (Daday, 1906), *M. woutersi* Van de Velde, 1987, *M. darwini* Dussart et Fernando, 1988 and *M. australiensis* (Sars, 1908)] survive desiccation by entering dormancy.

The presence of dormant stages, likely facilitating long-distance dispersal, may have significant consequences on the distribution of *Mesocyclops* species.

The genus, as currently known, contains 68 nominal (sub)species, whose distribution among zoogeographic regions is shown in Fig. 1. The overwhelming majority inhabits tropical and subtropical waters, only few enter the temperate zone. Until the 1980's the taxonomy of the genus remained poorly understood, with prevailing assumption of cosmopolitan distribution of some "standard" species. The break-through was Van de Velde's (1984) revision of the African fauna, which demonstrated the diagnostic significance of several "microcharacters" and paved the way for further taxonomic and zoogeographical improvements. Comprehensive phylogenetic analysis has never been attempted, but several presumably ancestral characters (Fig. 2) present in majority of the American species sharply distinguish the New World fauna.

Australasia is here defined as a region extending from the Isthmus of Kra (the narrowest part of Malay Peninsula) through the Malay Archipelago, Philippines, New Guinea to North (tropical) Australia. The Isthmus of Kra is a climatic demarcation dividing Southeast Asia into a northern region with more pronounced seasonality and monsoon forest vegetation (Indochina, Thailand, Burma, India, and Sri Lanka), and a southern with slight seasons and evergreen rainforest. In Australia, the aridity of the central and western part, and the temperate climate in south constitute a severe barrier for species preferring warm and

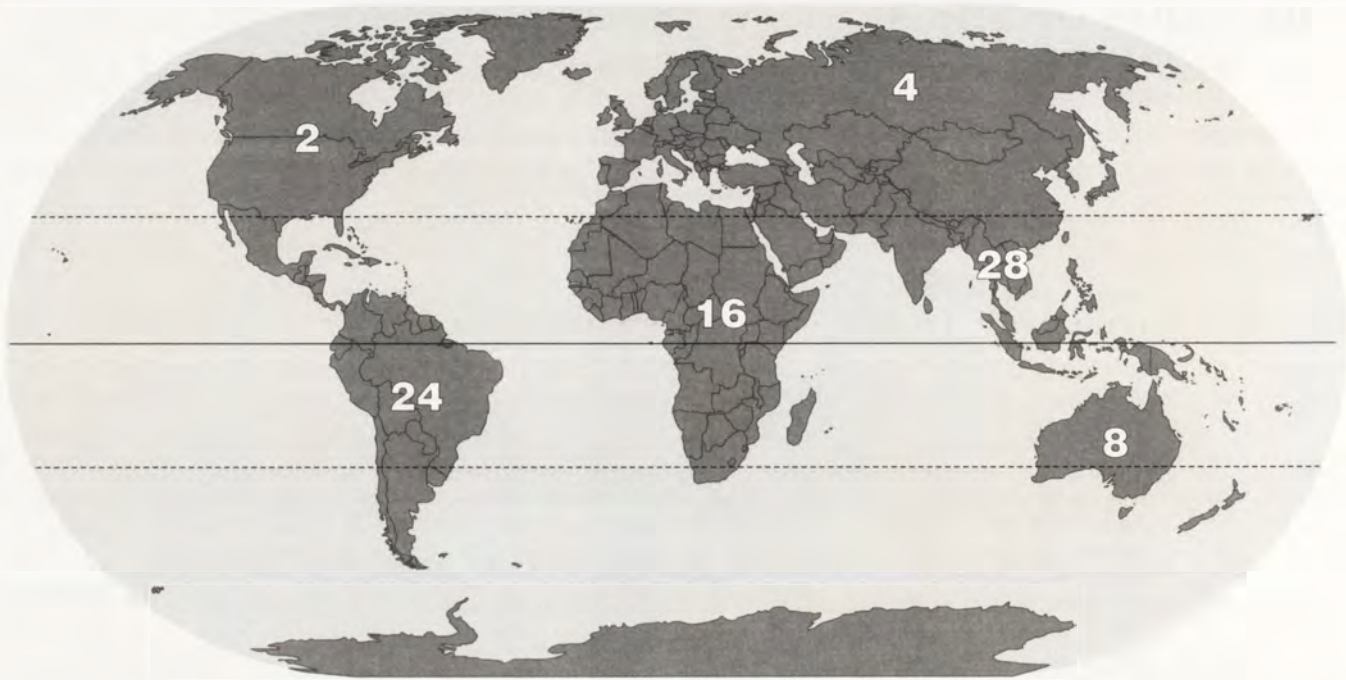


Figure 1. Number of known *Mesocyclops* (sub)species reported from different zoogeographical regions.

humid conditions. The huge island system between Malaysia and New Guinea, developed by the interaction of three major lithospheric plates (Eurasia, India-Australia and Pacific), is a result of extremely complex geological history (Boer 1995, Hall 1998, Metcalf 1998). Two, from biogeographical point of view, highly important elements of these intricate processes can be stressed: the development of volcanic island arcs from the Eocene to Pliocene, creating new dispersal routes for the Asian, Melanesian and Australian biota; and the "reticulate evolution" of most islands by the coalescence of several terranes of different age and origin. The present configuration of the region came into existence in the Pliocene (2–5 Mya). However, the drastic sea level and climate fluctuations in the last two million years, may have had a more significant influence on the distribution pattern of the lower rank taxa in particular, than the preceding geological events. The most recent lowest sea level was –112 m at 21000 yr BP (Hope 1996), hence, in the near past, Australia and New Guinea were several times broadly connected across Torres Strait and shallow Arafura Sea. An even more spectacular example of inter-island connections is the Sunda Shelf, which was dry land during last sea regression. The paths of drowned river basins in the shallow sea floor in Gulf of Siam, Strait of Malacca and Java Sea indicate that drainages of East Sumatra, North Java, West and South Borneo, the Malay Peninsula, and South Indochina joined in large river systems in the Pleistocene, which is clearly reflected by close affinity of their fish fauna (Bănărescu 1991, Rainboth 1996). As to the Pleistocene climatic changes in Australasia, the temperature was about 6–7 °C cooler in high altitude at last glaciation (New Guinea and

Borneo), but the extent of thermal lowering at sea level remains controversial (Hope 1996). Yet results of the pollen and sediments analyses made at several sites in Australasia unambiguously indicate, that times of maximum glaciation were also times of minimum rainfall (Hope 1996). All these processes resulted in a zoogeographical demarcation along Makassar and Lombok Straits, Wallace's Line, to the west of which (Sumatra, Java, Bali, Borneo and the Philippines) the fauna consists almost exclusively of Asian elements, while to the east (Lesser Sundas, Moluccas, New Guinea) species with Australian affinities increasingly dominate. This border between the Asian and Australian biotas is sharp indeed concerning the vertebrates. For good dispersers (cyclopids?), however, deep sea is not an unsurmountable barrier, and in many groups of insects and plants for instance, although there is a gradual attenuation of the Oriental elements from west to east, they still constitute the major part in the New Guinean fauna/flora (Keast 1996).

First studies on the cyclopids of Australasia date back to the turn of the 20th century (Table 1.).

Major contributions to the understanding of zoogeography and ecology of the freshwater biota in this region were made by three ambitious German limnological expeditions: The Sunda-Expedition to the Lesser Sundas organized by B. Rensch in 1927; "Deutsche Limnologische Sunda-Expedition" to Sumatra, Java, and Bali organized by A. Thienemann in 1928–29; and "Wallacea-Expedition", visiting the Philippines, Talaud-Sangihe Is., Sulawesi, the Lesser Sundas, and Java organized by R. Woltereck in 1931–32. Results concerning the cyclopids collected during

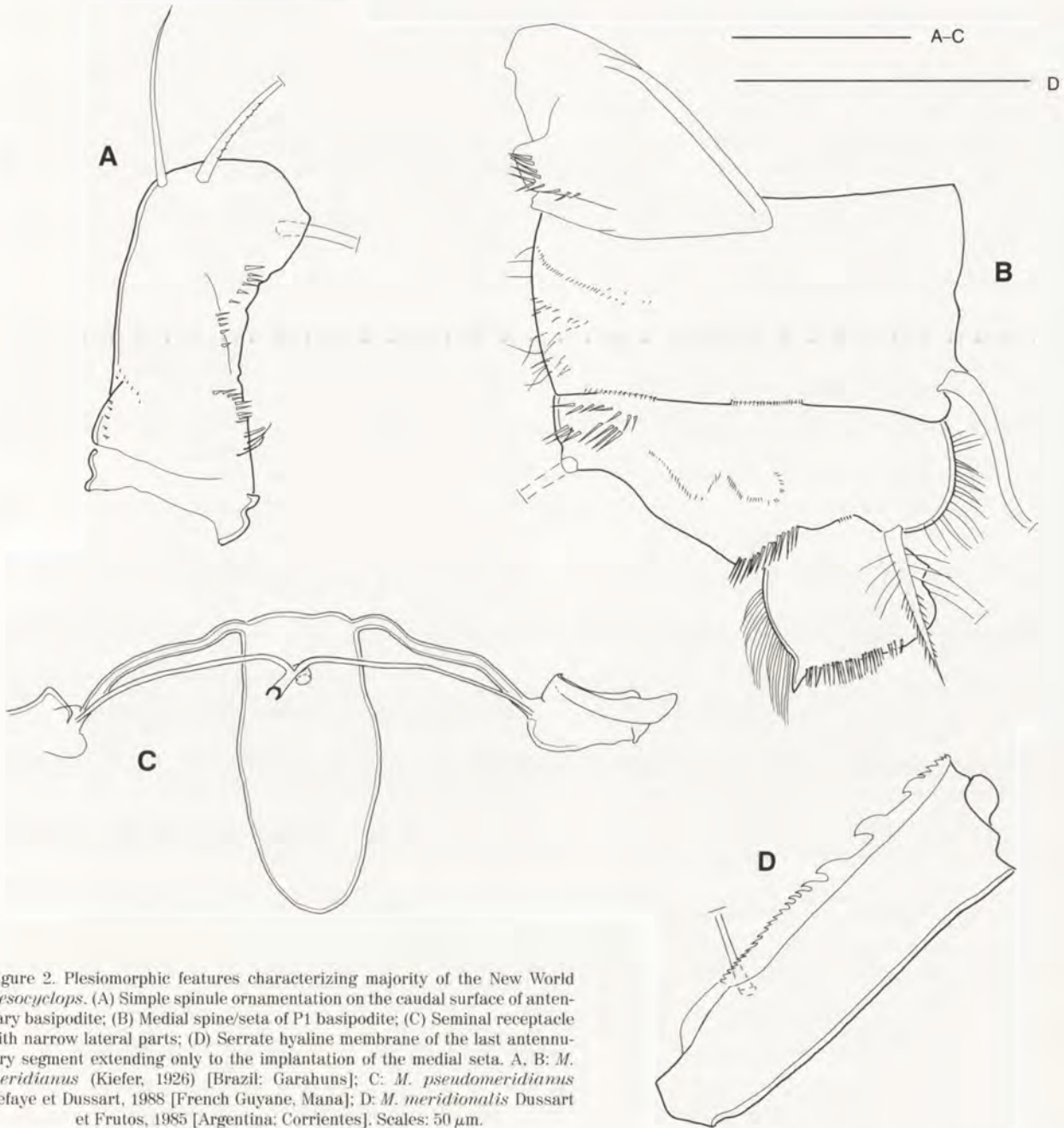


Figure 2. Plesiomorphic features characterizing majority of the New World *Mesocyclops*. (A) Simple spinule ornamentation on the caudal surface of antenary basipodite; (B) Medial spine/seta of P1 basipodite; (C) Seminal receptacle with narrow lateral parts; (D) Serrate hyaline membrane of the last antennular segment extending only to the implantation of the medial seta. A, B: *M. meridianus* (Kiefer, 1926) [Brazil: Garahun]; C: *M. pseudomeridianus* Defaye et Dussart, 1988 [French Guyane, Mana]; D: *M. meridionalis* Dussart et Frutos, 1985 [Argentina: Corrientes]. Scales: 50 μm .

these trips are summarized in the publications of Heberer and Kiefer (1932) and Kiefer (1933, 1938).

In the present paper, based partly on the material collected during a private trip to SE Asia and New Guinea in 1988–89, I give a critical overview of the Australasian *Mesocyclops*. Interpretation of the distribution patterns is hampered by the fact, that phylogenetical analysis of the genus has not yet been undertaken. Nevertheless in many cases the morphological grounds are sufficient to infer close relatedness of some taxa, which will be therefore treated together in the zoogeographical discussions.

MATERIAL AND METHODS

The observations and measurements were made on all specimens listed in the species descriptions. Drawings were made using a drawing tube attached to an Olympus BX 50 microscope. Unless otherwise stated, allowance for telescoping of body somites has been made in the measurements. All linear dimensions, with the exception of the length of the body, urosome, and terminal caudal setae, where an accuracy of 5 μm was used, were measured to the nearest 1 μm . Since neither the types (Canadian

***M. affinis* Van de Velde, 1987**

Van de Velde 1987 (Papua New Guinea); Holyńska 1997a (New Guinea, Malay Archipelago), 2000 (Papua New Guinea, Sulawesi, Sumatra, Java, Bali, Borneo)

M. annae* Kiefer, 1930

Dussart and Fernando 1986 (Australia: Northern Territory, Queensland)

***M. aspericornis* (Daday, 1906)**

Daday 1906 (Singapore, Sumatra); Grochmalicki 1915 (Java); Kiefer 1981 (Singapore, The Philippines); Lim and Fernando 1985 (Malaysia); Dussart and Fernando 1986 (Borneo, Sulawesi); Van de Velde 1987 (Papua New Guinea)

***M. borneoensis* Dussart et Fernando, 1988**

Dussart and Fernando 1988 (Borneo)

***M. brevisetosus* Dussart et Sarnita, 1987**

Dussart and Sarnita 1987 (Borneo)

***M. darwini* Dussart et Fernando, 1988**

Dussart and Fernando 1988 (Australia: Northern Territory); Brown et al. 1991 (Australia: N Queensland); Zhen et al. 1994 (Australia: N Queensland); Jennings et al. 1994 (Australia: N Queensland)

M. leuckarti* (Claus, 1857)

Richard 1889 (Sumatra, Sulawesi), 1894 (Sumatra: L. Toba); Stingelin 1900 (Sulawesi); Sars 1903 (Sumatra); Daday 1906 (Sumatra, Java, Singapore); Heberer and Kiefer 1932 (Sumatra, Mentawai Is., Java, Lombok, Sumbawa, Flores, Wetar); Kiefer 1933 (Sumatra, Java, Bali)

M. l. aequatorialis* Kiefer, 1929

Kiefer 1929 (Sumatra), 1933 (Sumatra, Java); Heberer and Kiefer 1932 (Sumatra, Java, Wetar)

M. l. f. pilosa* Kiefer, 1930

Heberer and Kiefer 1932 (Lombok)

***M. microlasius* Kiefer, 1981**

Kiefer 1981 (The Philippines: Luzon)

***M. notius* Kiefer, 1981**

Dussart and Fernando 1986 (Australia: South Australia, Northern Territory, Queensland); Dussart and Sarnita 1987 (Indonesia); Dussart and Fernando 1988 (Australia: Northern Territory, Queensland); Brown et al. 1991 (N Australia: Horn Is.)

***M. ogunnus* Onabamiro, 1957**

Dussart and Sarnita 1987 (Indonesia); Dussart and Fernando 1988 (Java?)

***M. papuensis* Van de Velde, 1987**

Van de Velde 1987 (Papua New Guinea); Holyńska 2000 (New Guinea, Java, Borneo)

***M. pehpeiensis* Hu, 1943**

Dussart and Fernando 1985 (Malaysia); Lim and Fernando 1985 (Malaysia); Dussart and Fernando 1986 (Malaysia, Australia: Northern Territory)

***M. pseudoannae* Van de Velde, 1987**

Van de Velde 1987 (Papua New Guinea); Holyńska 2000 (New Guinea, Australia?)

***M. pseudospinosus* Dussart et Fernando, 1988**

Dussart and Fernando 1988 (Java)

M. rarus* Kiefer, 1981

Dussart and Fernando 1986 (Australia: Northern Territory)

***M. thermocyclopoidea* Harada, 1931**

Kiefer 1981 (Sumatra, Java, Bali, Lombok, Flores); Lim and Fernando 1985 (Malaysia); Dussart and Fernando 1986 (Kalimantan; Sulawesi; Australia: Northern Territory, West Australia, South Australia, Queensland); Holyński 1994a (Malaysia); Holyńska 2000 (Java, Malaysia)

***M. t. acutus* Dussart et Fernando, 1988**

Dussart and Fernando 1988 (Borneo: Kalimantan)

***M. tobae* Kiefer, 1933**

Kiefer 1933 (Sumatra, Java), 1981 (Sumatra); Dussart and Fernando 1988 (Sumatra); Holyńska 2000 (Sumatra)

***M. woutersi* Van de Velde, 1987**

Van de Velde 1987 (Papua New Guinea); Holyńska 1997b (Papua New Guinea)

Species marked with asterisks do not occur in Australasia: *M. aequatorialis* inhabits Africa, West and Central Asia; *M. annae* is known only from Madagascar; *M. leuckarti* is restricted to Palaearctic; *M. pilosus* occurs in Madagascar and Aldabra Is.; *M. rarus* lives in Africa.

Table 1. Summary of the published records of Mesocyclops in Australasia.

Museum of Nature, Ottawa), nor any other material of *M. brevisetosus* Dussart et Sarnita 1987, and *M. pseudospinosus* Dussart et Fernando, 1988 have not been available for me, no redescriptions of these species are provided here, but both species are included in the key.

Those specimens for which no institution as place of the deposition is given, are in the Author's collection deposited in the Museum and Institute of Zoology, Warsaw.

Abbreviations used in the text: Coll. Dadayana=Collection of J. Daday, Hungarian Museum of Natural History, Budapest; KBIN=Koninklijk Belgisch Instituut voor Natuurwetenschappen, Brussel; MNHN=Muséum National d'Histoire Naturelle, Paris; SMNK=Staatliches Museum für Naturkunde, Karlsruhe; ZMA=Zoölogisch Museum, Amsterdam; USNM=National Museum of Natural History, Smithsonian Institution, Washington.

P1–P4=leg 1–leg 4; enp=endopodite; exp=exopodite; P4enp3= third segment of leg 4; CV=copepodid V.

TAXONOMY

Mesocyclops dayakorum sp. nov.

Types. Female holotype and one female paratype (Indonesia, East Kalimantan, Mahakam Valley, Muara Muntai, 0°23'S–116°22' E, ca. 30 m a.s.l.; swamp, depth ca. 1 m; leg. M. & R. Holyński, 28 May 1989) are dissected and mounted on two slides each. Types are deposited at Museum and Institute of Zoology PAS, Warsaw.

Etymology. This species is named after the Dayaks, the original people of Borneo.

Description (female). Body length: 1300 µm; prosome/urosome: 2.02; cephalothorax, length/width: 1.14; cephalothorax width/genital double-somite width: 2.94 (all data refer to holotype).

Pediger 5 (Fig. 5A) without hairs, two medial and two laterodistal sensilla on dorsal surface of somite. Genital double-somite (Fig. 5A) relatively wide (length/width: 1.12) and naked, group of six pores posteriorly to P6. Seminal receptacle with narrow lateral arms and large distal part. Transverse ducts (Fig. 5B) curve deeply backwards to copulatory pore in paratype specimen, in which the urosome was compressed by cover glass, yet in intact structure (holotype) this curvature seems to be very slight. Proximal part of seminal receptacle weakly developed, anterior margin arcuate in the middle. Posteriorly to horseshoe-shaped copulatory pore one circular pore (Fig. 5B). Copulatory duct short. Posterior margin of anal somite (Figs 5E,F) with small ventral and large dorsal spinules, no spinules laterally. Caudal rami (Figs 5D,E,F) short (length/width: 2.33 in holotype, and 2.26 in paratype), without medial hairs, dorsal and ventral surfaces adorned with tiny spinules in random pattern. No spinules at implantation of lateral caudal, and lateralmost terminal setae. Dorsal and lateralmost terminal setae subequal. Length of terminal setae from medialmost to lateralmost: 355 µm, 650 µm, 475 µm, 135 µm in holotype, and 360 µm,

660 µm, 460 µm, 130 µm in paratype. Longest terminal seta/length of urosome: 1.51 (holotype), 1.55 (paratype).

Armature formula of 17-segmented antennule: 8, 4, 2, 6, 4, 1+1sp, 2, 1, 1, 0, 1, 1+1ae, 0, 1, 2, 2+ae, 7+ae, typical for genus (Fig. 49A). Serrate hyaline membrane on last antennular segment, extending to implantation of medial seta of segment only, with two (holotype) or one (paratype) small notch (Fig. 3C). Ventral spinules present on segment 1 only, dorsal surface of segment 1, 2, 11, 14–16 adorned with scattered shallow pits in holotype.

Antenna armed with 3 setae on basipodite, and 1, 7, 7, setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of basipodite (Fig. 3B) composed of: long proximal spinules on lateral rim; tiny spinules on medial rim near base; oblique row of spinules (6, 7) next to proximal row on lateral rim; longitudinal row of spinules (8) along lateral rim. Frontal spinule pattern of antennary basipodite (Fig. 3A) consisting of longitudinal row (11–14 spinules) along lateral rim and group of spinules (6–9) next to implantation of exopodite seta.

Except for fringe hairs overhanging toothed distal rim, no other hairs on ventral surface of labrum (Fig. 3E). Vertical cleft separating epistoma from rostrum with elongate strong hairs.

Mandibular palp bears two long and one short setae. Gnathobase ornamented with three groups of spinules of relatively large and about equal size near palp (Fig. 4C). Row of elongate spinules ventrally, at base of three middle gnathobasic teeth.

Maxillulary arthrite (Fig. 4D) with three distal claws, one ventral seta at their base; four paired setae (one pair of longer claw-like, and one pair of smaller setae), one small naked and one long feathered setae on medial rim, and small spine near base of arthrite. Maxillulary palp bearing one spine and two setae apically, one lateral seta proximally and three setae on lateral (outer) lobe, without spinules. Lateralmost seta of lateral lobe without long setules.

Maxilla (Fig. 4A) with syncoxopodite, basipodite and one-segmented endopodite. Praecoaxal-coxal suture present on caudal surface only. Praecoaxa bearing one endite with two setae, coxa bearing one endite distally and one endite at distal third with two and one setae respectively. No spinules on frontal surface of coxopodite. Basipodite with two setae, shorter seta inserted caudally, longer inserted in front of claw-like endite which armed with many teeth. Basipodite seta in front of endite with few caudal spinules near its articulation, and two longer setules at proximal third, which followed by fine teeth on posterior edge only. One-segmented endopodite bear five setae. Two small setae (broken off in holotype) inserted on caudal surface of lateralmost spiniform seta very near its articulation with free endopodal segment.

Maxilliped (Fig. 4B) with syncoxopodite, basipodite and two-segmented endopodite. Syncoxopodite bear three setae; group of large spinules on frontal surface present. Basipodite with one medial seta at distal third and one spiniform seta on frontal surface; spinules on lateral rim and caudal surface arranged in two groups. Enp1 with one

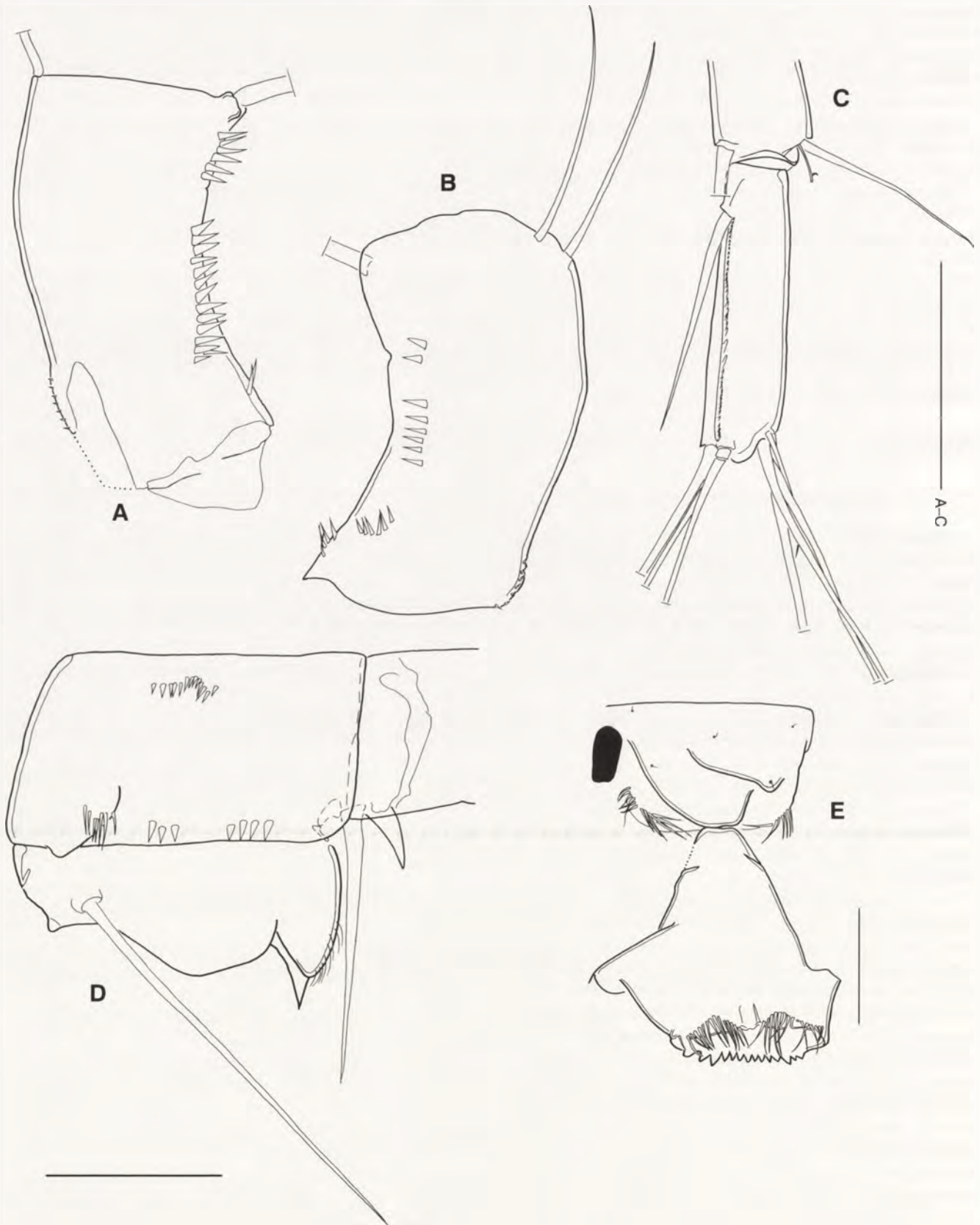


Figure 3. *Mesocyclops dayakorum* sp. nov. (A) Antennary basipodite, frontal; (B) Antennary basipodite, caudal; (C) Last antennary segment; (D) P4 protopodite, caudal; (E) Labrum, epistoma, rostrum. A-D: holotype; E: paratype. Scales: 50 μ m.

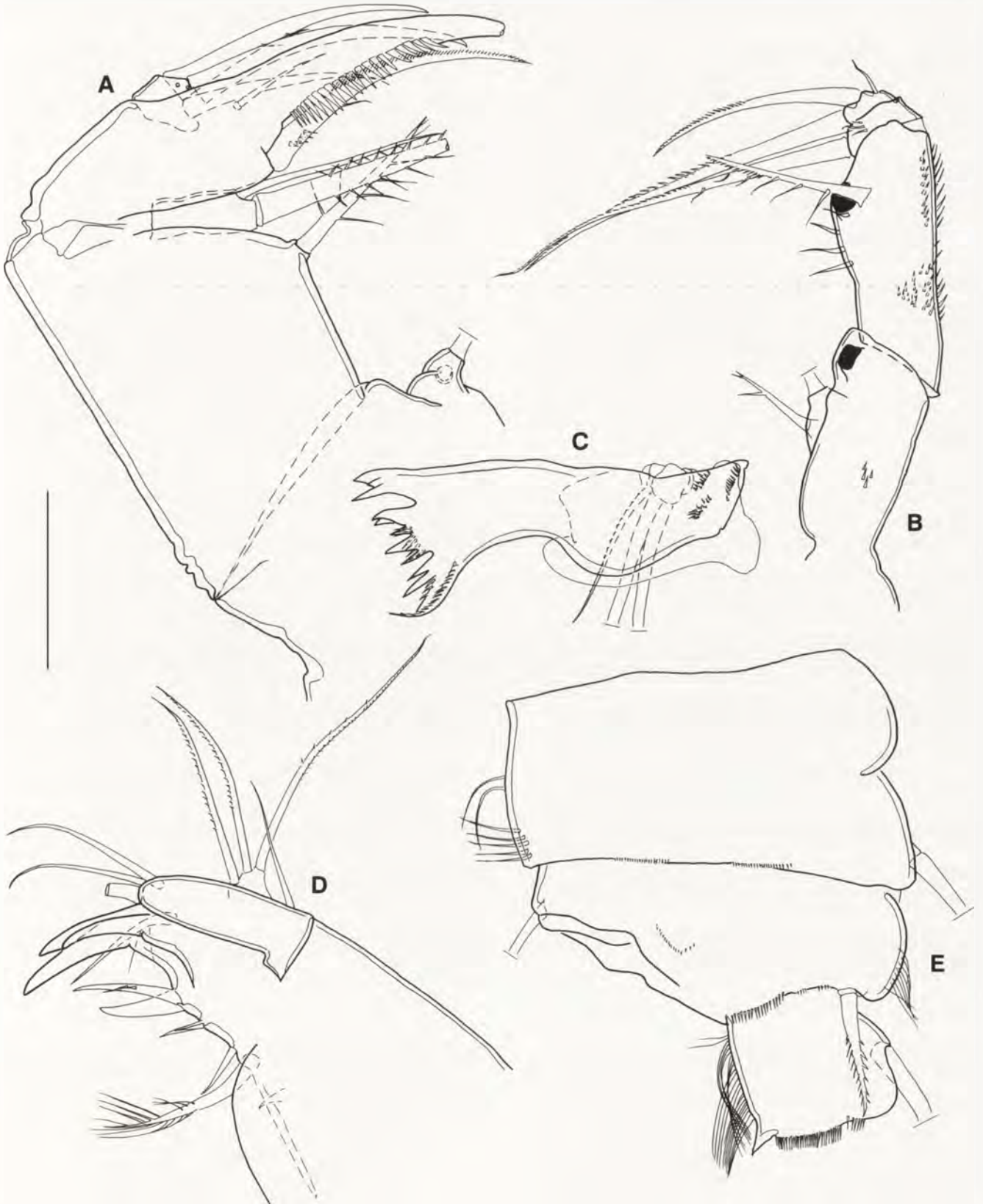


Figure 4. *Mesocyclops dayakorum* sp. nov. (A) Maxilla, frontal; (B) Maxilliped, frontal; (C) Mandible, frontal; (D) Maxillule, frontal; (E) P1 protopodite, frontal. A-D: holotype; E: paratype. Scale: 50 μ m.

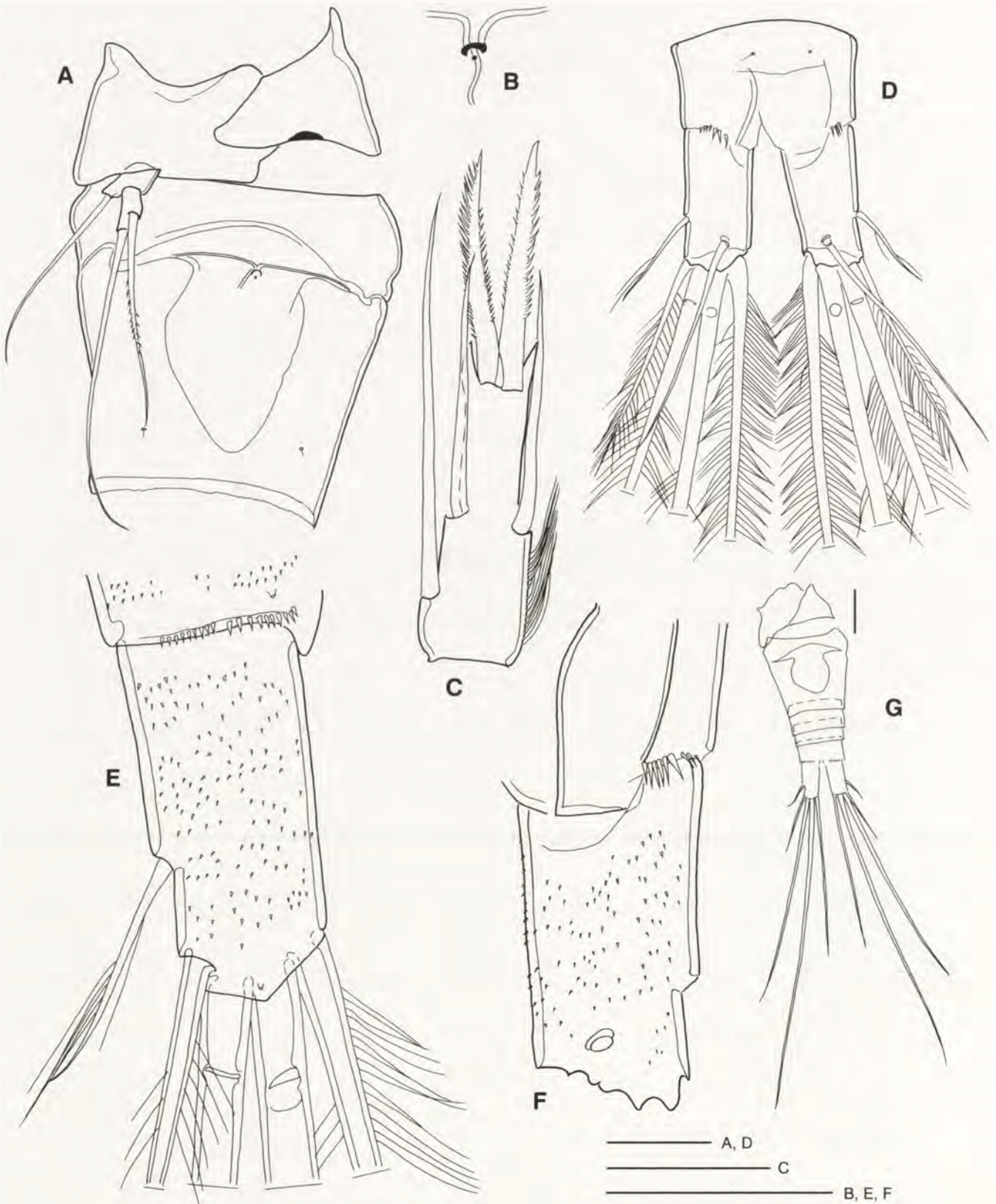


Figure 5. *Mesocyclops dayakorum* sp. nov. (A) Pediger 5 and genital double-somite, ventral; (B) Copulatory pore, copulatory duct, and the medial section of the transverse ducts; (C) P4enp3; (D) Anal somite and the caudal rami, dorsal – spinule ornamentation is not shown; (E) Caudal ramus, spinule ornamentation, ventral; (F) Caudal ramus, spinule ornamentation, dorsal; (G) Urosome, ventral. A, C, D, F, G: holotype; B and E: paratype. Scales: 50 μ m.

stout seta and few spinules on frontal surface, Enp2 with three setae of medially increasing length.

Armature of legs 1–4 (Table 2)

	Coxa	Basis	Exopodite	Endopodite
Leg 1	0-1	1-1	1-1; 1-1; 1-II,1-2	0-1; 0-2; 1-1,1-3
Leg 2	0-1	1-0	1-1; 1-1; 1-II,1-3	0-1; 0-2; 1-1,1-3
Leg 3	0-1	1-0	1-1; 1-1; 1-II,1-3	0-1; 0-2; 1-1,1-3
Leg 4	0-1	1-0	1-1; 1-1; 1-II,1-3	0-1; 0-2; 1-II-2

Table 2. Armature of leg 1–4 in *Mesocyclops dayakorum* sp. nov. (Spines are denoted by Roman, setae by Arabic numerals. The armature on the outer margin of any segment is given first, followed by the elements on the apical and inner margins.)

Couplers naked on frontal and caudal surfaces, distal margin of leg 4 coupler with two large outgrowths (Fig. 3D). Medial expansion of P1 basipodite with spine; tiny spinules arranged in arch on frontal surface of segment (Fig. 4E). Medial expansion of basipodite of P1–P4 with apical hairs. Caudal spinule ornamentation of P4 coxopodite consists of (Fig. 3D): intermittent row of few spinules (5, 7) along distal rim; few (7, 9), relatively short spinules arranged in one or two rows at laterodistal angle; many (10–14) large spinules along proximal rim; lateral rim bare. P4 coxopodite seta conspicuously longer (1.53× in holotype; 1.65× in paratype) than height of medial expansion of P4 basipodite. P4enp3 (Fig. 5C) length/width: 2.50 (holotype), 2.73 (paratype). Apical spines subequal, length ratio of longer apical spine and P4enp3 0.91 in holotype and 0.87 in paratype. Lateral edge of medial apical spine with many teeth.

Segmentation and setation of P5 typical of genus, setae relatively long. P6 with one long (123 µm) medial seta and two small lateral spines (7 µm, 5 µm) – data refer to paratype.

Male unknown.

Diagnosis. *Mesocyclops dayakorum* can be distinguished from its congeners by the following combination of characters: pediger 5 and genital double-somite without hairs; seminal receptacle with narrow lateral arms, anterior margin of proximal part arcuate, copulatory duct short; posterior margin of anal somite with small spinules ventrally, large spinules dorsally and bare laterally; caudal rami short, adorned with tiny spinules in random pattern, no hairs; spinules at implantation of lateralmost terminal, and lateral caudal setae absent; serrate hyaline membrane of the last antennular segment extending to implantation of medial seta of segment; ventral spinules present only on first antennular segment; second endopodal segment of antennae armed with 7 setae; spinule ornamentation of antennary basipodite (caudal pattern simple, few medium-sized spinules in longitudinal row along lateral rim; group of spinules next to implantation of exopodite seta present on frontal surface); with exception of distal fringe hairs no other hairs on ventral surface of labrum, epistoma bare, row of strong hairs in vertical cleft; maxillulary palp naked; P1 basipodite with medial spine, frontal surface of segment with tiny spinules arranged in arch; P4 coupler

with large outgrowths, naked; caudal spinule ornamentation of P4 coxopodite (few spinules in intermittent row along distal margin; many spinules along proximal rim, lateral rim bare); medial expansion of P4 basipodite with apical hairs; lateral margin of medial apical spine of P4 endopodite with many teeth; P5 bearing conspicuously long apical and lateral setae.

Distribution. Known only from the type locality.

Remarks. See *Mesocyclops darwini*.

Mesocyclops darwini Dussart et Fernando, 1988

Mesocyclops darwini Dussart et Fernando, 1988: 259, Figs 71–78.
Mesocyclops rarus: Dussart and Fernando 1986: 291.

Types. *Mesocyclops darwini*: 2 paratypes, ♀♀, (MNHN: Cp 935) – Beatrice Lagoon (inundation area of Adelaide River), near Darwin, Australia, leg. Tann, 7 Sep 1981.

Other material examined. PAPUA NEW GUINEA: 2♀♀ on two slides (SMNK: 10419, 10420) – 10419: “*Mesocyclops* 2♀♀, Abd.+P5, Kiefer 17.10.78; Neu Guinea Augustafluß, 397”; 10420: “*Mesocyclops* ♀, A1-P4, Kiefer 17.10.78; Neu Guinea Augustafluß, 397”. 4♀♀ – Lagoon, shore, 9°02'S–146°45'E, 20 km E Obo Mission, 70 km NW Port Moresby, Central Prov. [135/b], leg. M. & R. Holyński, 22 Apr 1989.

“*Mesocyclops rarus orientalis*” [unpublished name]: “holotype”, ♀, (KBIN: 26528/A, 3275) and two “paratypes”, ♀♀, (KBIN: 26528/B,C, 3275) – Nubia village (bombhole), Madang Prov., Papua New Guinea, leg. K. Wouters, 29 May 1982, det. I. Van de Velde.

INDONESIA. **Irian Jaya:** 1♀ – Shallow pool under rainforest canopy or house-hold wells, Transmigration settlement Number IX, Timika, 04°30'S–136°46'E, leg. E. P. Ebsworth, 20 Jul 1999.

Comparative material. *Mesocyclops rarus*: 2 syntypes (SMNK: 10939, 10940) – 10939: “*Mesocyclops rarus* n. sp. 2♀♀, A1–P4, Kiefer 24.4.80; Kongo, Ondosee 1214 H. Damas (285), 29.7.1935; 10940: “*Mesocyclops rarus* n. sp. 2♀♀, A1–P4, Kiefer 24.4.80; Kongo, Ondosee 1214 H. Damas (285), 29.7.1935. *Mesocyclops rarus*: 1♀ (KBIN) – “*Mesocyclops rarus* Kiefer, 1981, Lac Mugesera Kiss coll. 50555”, 2°06'S–30°20'E, Ruanda, 6.6.1958., det. I. Van de Velde; 1♀ (KBIN) – “*Mesocyclops rarus* Kiefer, 1981, Lac Mugesera Kiss coll. 50586”, 2°06'S–30°20'E, Ruanda, 7.6.1958., det. I. Van de Velde.

Description (female). Body length: 950–1230 µm; prosome ca. 1.6–1.9 times as long as urosome; cephalothorax nearly as long as wide.

Pediger 5 (Fig. 7B) without hairs, bending over genital double-somite. Genital double-somite 1.0–1.4 times as long as wide, no hairs on somite. Seminal receptacle (Figs 7B, 8E) with narrow lateral arms, large sac-like distal part, and proximal part of variable but smaller size; anterior margin of proximal part arcuate in middle; transverse ducts curve deeply backwards, forming conspicuous V-shape, to copulatory pore; copulatory pore horseshoe-shaped; copulatory duct long. Posterior margin of anal somite (Figs 7F,G) bearing ventral spinules only. Caudal rami (Figs 7F,G, 9G) 2.7–3.7 times as long as wide, without medial hairs, dorsal surface adorned with tiny spinules in random pattern (no data on ventral spinule ornamentation). Spinules at implantation of lateral caudal, and lateralmost terminal setae, absent. Dorsal caudal seta 0.7–1.2 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.2–2.8, 3.7–5.2, [value 5.8 given by Dussart and Fernando (1988)], 3.1–3.9, 1. Longest terminal seta 0.9–1.2 times as long as urosome.

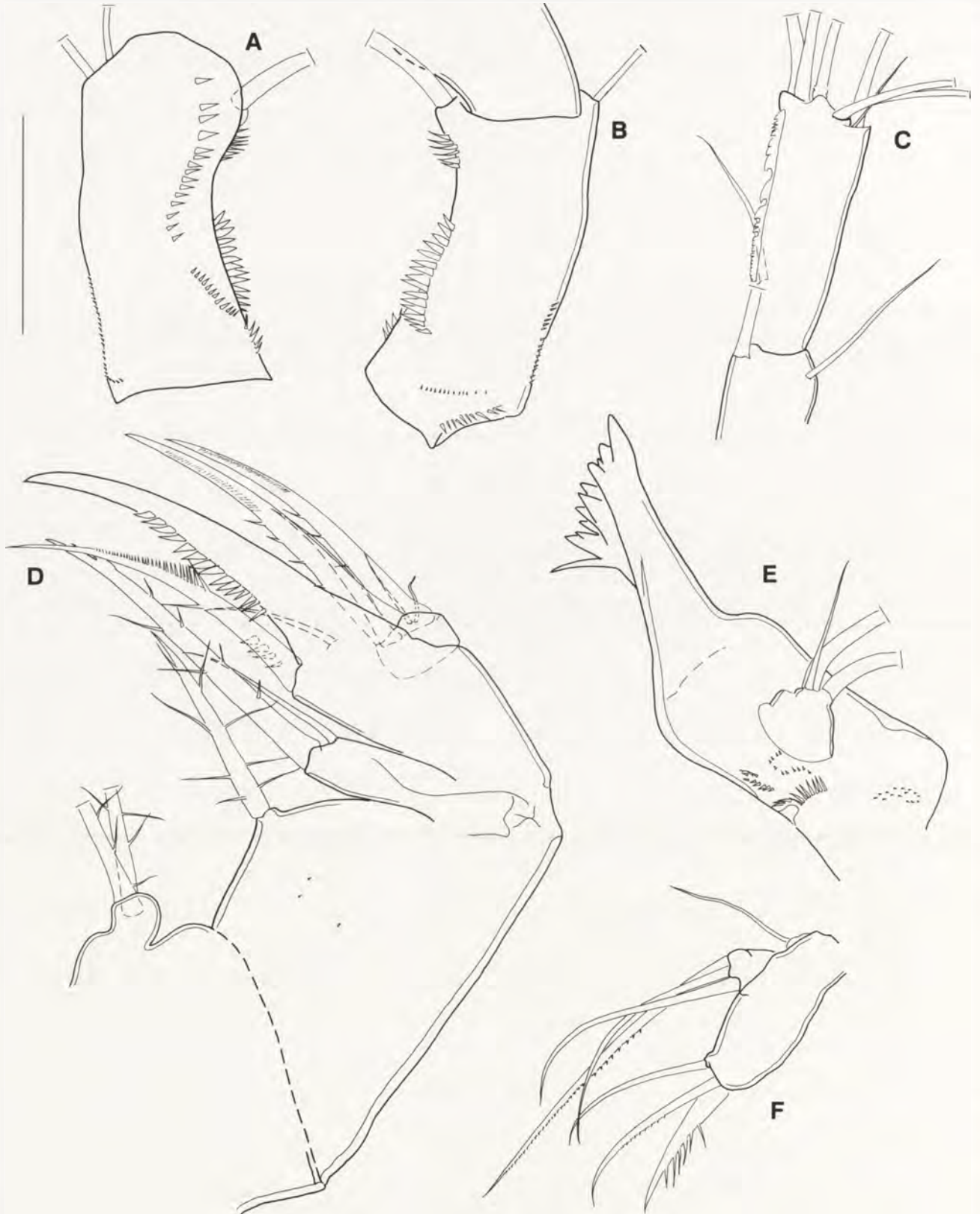


Figure 6. *Mesocyclops darwini* Dussart et Fernando, 1988. (A) Antennary basipodite, caudal; (B) Antennary basipodite, frontal; (C) Last antennular segment; (D) Maxilla, frontal; (E) Mandible; (F) Maxillular palp. All the drawings show the paratypes [Australia: Darwin]. Scale: 50 μ m.

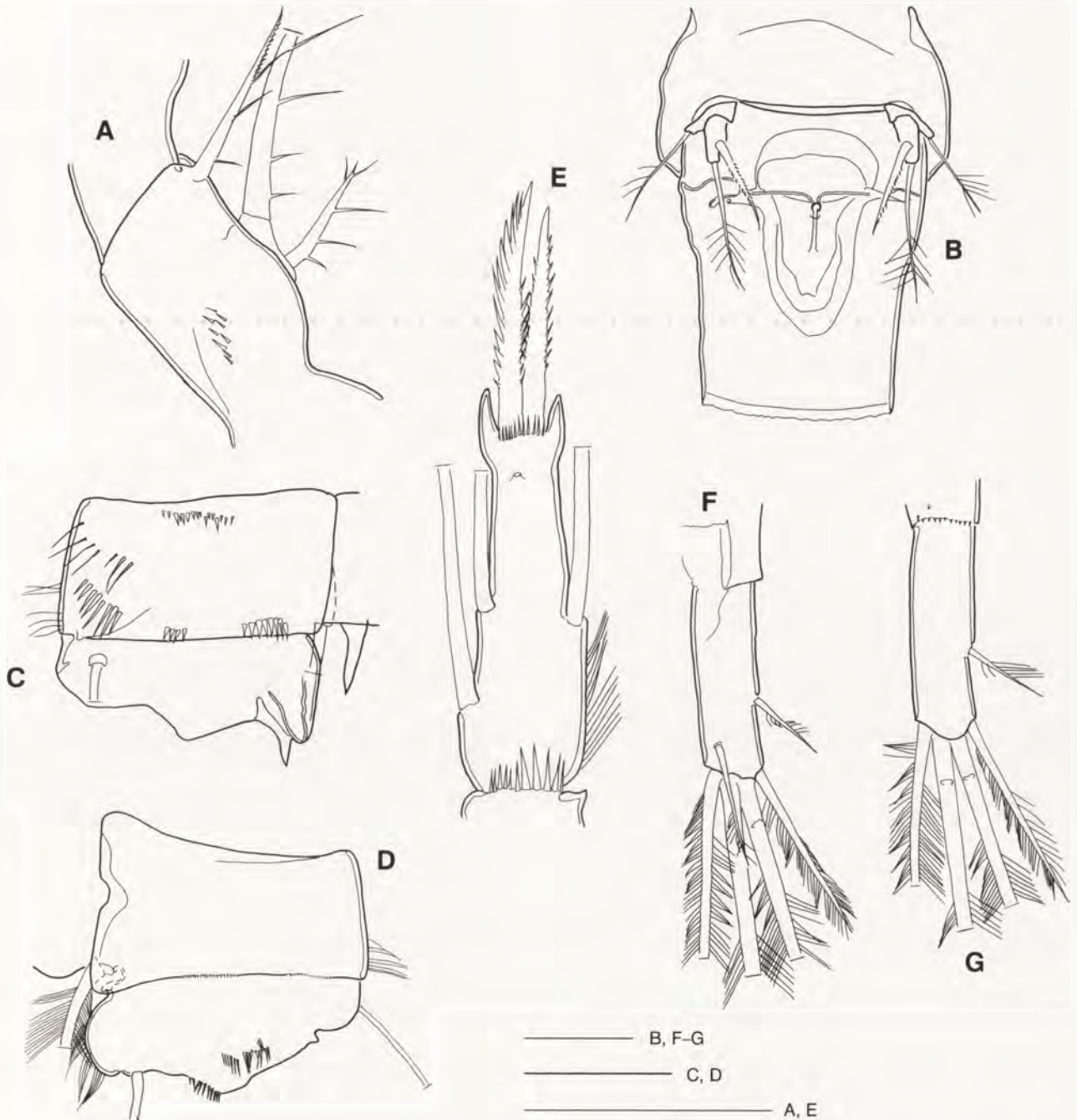


Figure 7. *Mesocyclops darwini* Dussart et Fernando, 1988. (A) Maxilliped syncopodite, frontal; (B) Pediger 5, and genital double-somite, ventral; (C) P4 protopodite, caudal; (D) P1 protopodite, frontal; (E) P4enp3; (F) Caudal ramus, dorsal; (G) Caudal ramus, ventral. All the drawings show the paratypes [Australia: Darwin]. Scales: 50 μ m.

Armature formula of 17-segmented antennule, like in *M. dayakorum*, typical for genus (Fig. 49A). Hyaline membrane on last antennular segment (Fig. 6C), serrate to implantation of medial seta of segment only and smooth beyond it, with two or more small notches. Ventral spinules present on segment 1 only, dorsal surface of antennular segments sometimes adorned with scattered shallow pits.

Antenna armed with 3 setae on basipodite and 1, 8, 7, setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of basipodite, simple (Figs 6A, 8A): long proximal spinules on lateral rim; tiny spinules on medial rim in proximal third; many spinules (8–14) in oblique row next to spinules on lateral rim; longitudinal row (12–21 spinules) along lateral rim. Frontal spinule pat-

tern of antennary basipodite (Figs 6B, 8B) composed of longitudinal row (12–20 spinules) along lateral rim, group of spinules (6–10) next to implantation of exopodite seta, large spinules along proximal rim, and transverse spinule row near base of segment.

Segmentation and setation of mouthparts, like in *M. dayakorum*, typical for genus. Besides ventral fringe hairs overhanging the relatively few teeth (9/10) on distal rim, fine hairs in belt under epistoma; vertical cleft and epistoma with fine hairs. Gnathobase (Figs 6E, 8C) bearing three groups of spinules near palp (those forming transverse row conspicuously larger than others) and one spinule group proximally to this triplet. Maxillulary palp (Fig. 6F) without spinules; lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite (Fig. 6D) with tiny, hardly visible spinules at most. Basipodite seta in front of claw-like basal endite with few caudal spinules near its articulation, and two longer setules ca. at proximal two-fifth, which followed by fine teeth on posterior edge only. Maxilliped syncopodite (Figs 7A, 8D) adorned with oblique row of large spinules on frontal surface; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of legs 1–4 as in *M. dayakorum* (Table 2).

Couplers naked on frontal and caudal surfaces, distal margin of leg 4 coupler with two very large outgrowths reaching ca half height of medial expansion of P4 basipodite (Figs 7C, 9C). Medial expansion of P1 basipodite with spine extending from third to half of second endopodal segment; on frontal surface of basipodite conspicuously large spinules arranged in group (Figs 7D, 9F). Apical hairs on medial expansion of basipodite present in P1–P3, absent in P4. Caudal spinule ornamentation of P4 coxopodite (Figs 7C, 9C) composed of: intermittent or continuous row (11–16 spinules) along distal rim; 9–13 spinules arranged in one row at laterodistal angle; many (8–16) large spinules along proximal rim; distinct row of strong hairs proximally to row at laterodistal angle; and long hairs on lateral rim. P4 coxopodite seta 1.3–1.6 times longer than height of medial expansion of P4 basipodite. P4enp3 (Fig. 7E) 2.6–2.9 times as long as wide. Of apical spines medial one 0.9–1.2 times as long as lateral; length ratio of longer apical spine and P4enp3, 0.7–0.9. Lateral edge of medial apical spine with many teeth.

P5 (Fig. 7B) medial spine short, 0.5–0.6 times as long as genital double-somite, apical seta 1.0–1.3 times as long, lateral seta 0.7–0.9 times as long as medial spine.

Distribution. Northern Australia (Northern Territory, Queensland), and New Guinea.

Biology. Recorded from ephemeral waterbodies in inundation areas, lagoons, ponds.

Remarks. *Mesocyclops darwini* has several features supposed here to be plesiomorphic [taxa used as outgroups: *Diacyclops bernardi* (Petkovski, 1986), *Thermocyclops oithonoides* (Sars, 1863), *T. crassus* (Fischer, 1853), *Acanthocyclops smithae* Reid, 1999; *Acanthocyclops vernalis* (Fischer, 1853); *Megacyclops viridis* (Jurine, 1820)]:

1. medial spine on basipodite of P1, present;
2. only the first antennular segment adorned with ventral spinules;
3. serrate hyaline membrane of last antennular segment not extending beyond implantation of medial seta of segment;
4. caudal spinule pattern of antennary basipodite simple.
5. seminal receptacle with narrow lateral arms: light microscopic observations made on South American taxa [*M. pseudomeridianus* Defaye et Dussart, 1988 (Fig. 2D); *M. intermedius*; *M. ellipticus* Kiefer, 1936, *M. meridianus* (Kiefer, 1926), and *M. varius*, Dussart 1987) seem to suggest that “narrow lateral arms” of the seminal receptacle in these species and in *M. darwini* also, are actually canals ending in genital antra rather than lateral protrusions of a closed sac (seminal receptacle), in which case might be homologous with the ancestral receptacle ducts.

The character states mentioned above, while often occurring in the Neotropical representatives of the genus, in this combination are retained only in four other out of 47 Palaeotropical species: *Mesocyclops paludosus* Lindberg, 1956 [character 3 is unknown] – restricted to the East African Lake District; *Mesocyclops rarus* Kiefer, 1981 – distributed from the Tibesti Mountains to Mozambique in Africa, westernmost record from Nigeria (Jeje 1988), the record from the Northern Territory in Australia (Dussart and Fernando 1986) actually refers to *M. darwini*; *M. tenuisaccus* (Sars, 1927) [serrate hyaline membrane on the last antennular segment extending beyond the implantation of the medial seta (Van de Velde 1984)] – known only from South Africa; and *M. dayakorum* – eastern Borneo. The symplesiomorphies listed above, however, could define only a paraphyletic group. Close kinship of any pair of these taxa should be indicated by shared derived features. A priori polarization in majority of the characters used in the descriptions seems to be very problematic because of the highly mosaic distribution of the character states in *Mesocyclops* species. Yet out-group comparisons with the genus *Diacyclops* and association of the character state with other presumably plesiomorphic features suggest, that the short copulatory duct in *M. tenuisaccus*, *M. paludosus*, and *M. dayakorum* is an ancestral state, while the long copulatory duct supposedly is a synapomorphy of *M. rarus* and *M. darwini*. The very close relationship between *M. rarus* and *M. darwini* was already recognized by Van de Velde, who identified the specimens from Papua New Guinea (Madang Prov.) as a subspecies of *M. rarus*, and Dussart and Fernando (1986) reporting *M. rarus* (*M. darwini* in fact) from the Northern Territory, Australia. *Mesocyclops darwini* can be distinguished from *M. rarus* by having large spinules arranged in group on the frontal surface of P1 basipodite (Fig. 9F) [no spinules in *M. rarus* (Fig. 9E)], the caudal spinule pattern of P4 coxopodite [many large spinules along proximal rim in *M. darwini* (Fig. 9C), vs. few large in *M. rarus* (Fig. 9A)], caudal spinule ornamentation of antennary basipodite [longitudinal row of 12–21 spinules along later-

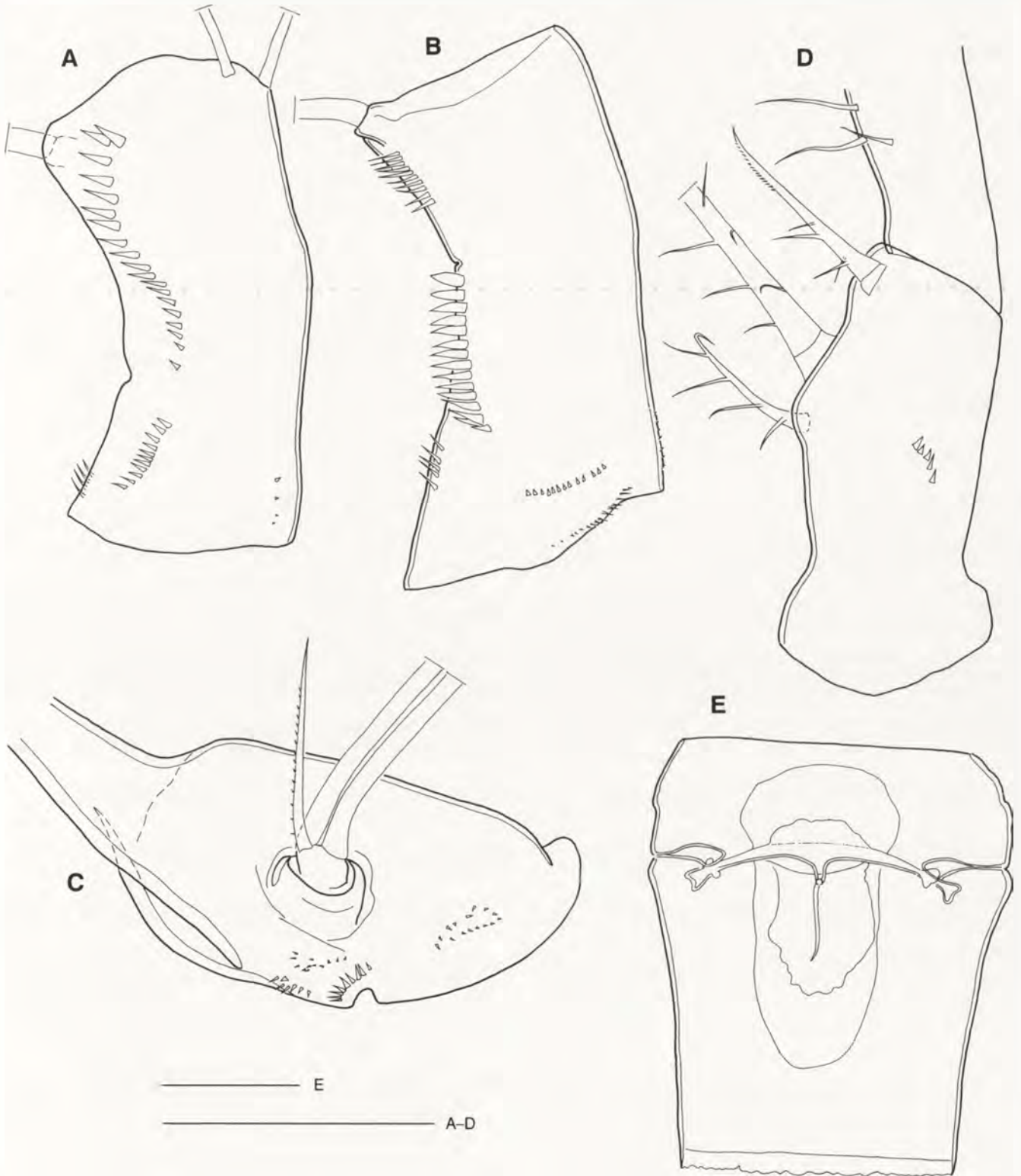


Figure 8. *Mesocyclops darwini* Dussart et Fernando, 1988, female. (A) Antennary basipodite, caudal; (B) Antennary basipodite, frontal; (C) Spinule ornamentation next to the mandibular palp; (D) Maxilliped syncopodite, frontal; (E) Genital double-somite, ventral. All the figures show "*M. rarus orientalis*" [Papua New Guinea: Nubia]. Scales: 50 μ m.

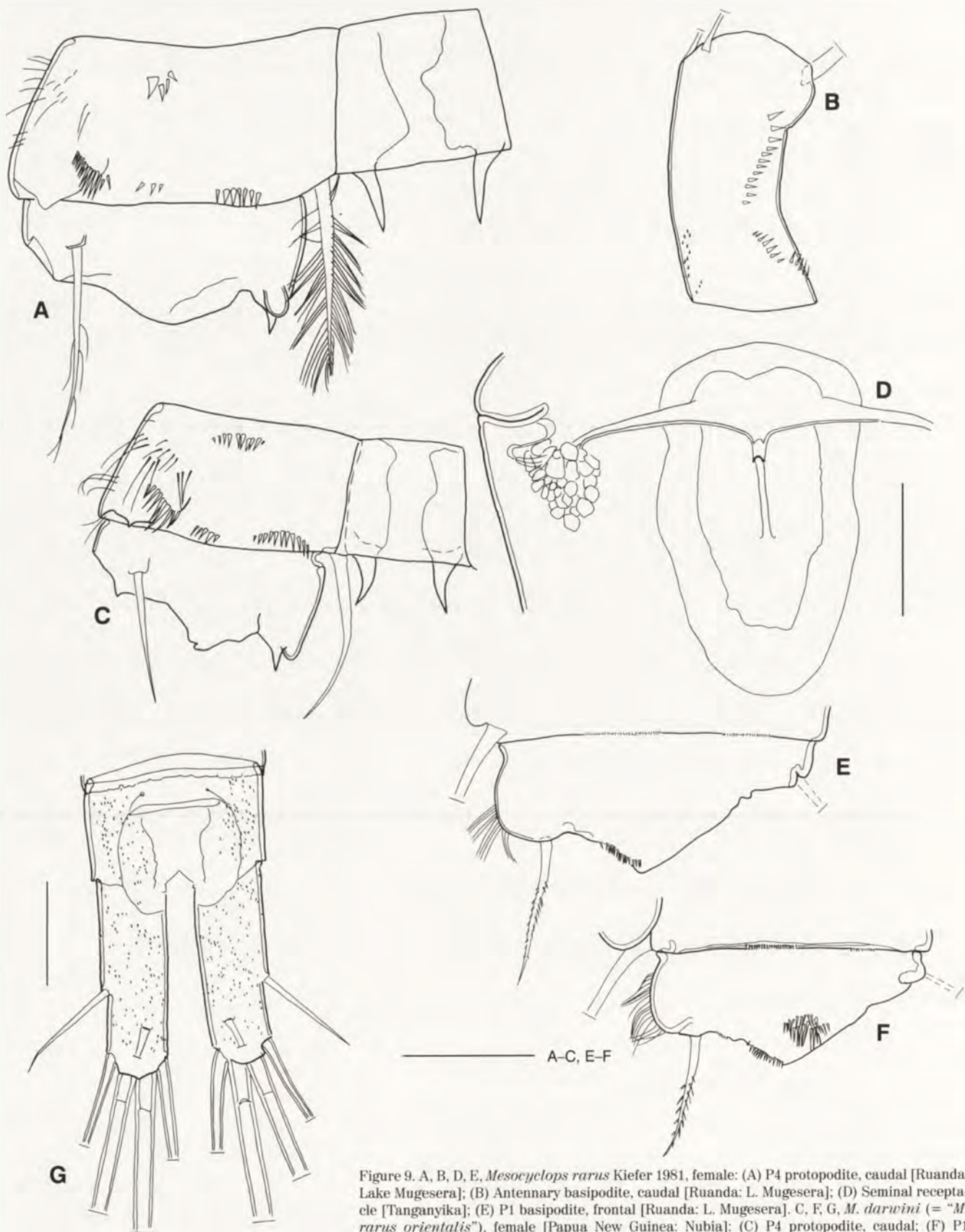


Figure 9. A, B, D, E, *Mesocyclops rarus* Kiefer 1981, female: (A) P4 protopodite, caudal [Ruanda: Lake Mugesera]; (B) Antennary basipodite, caudal [Ruanda: L. Mugesera]; (D) Seminal receptacle [Tanganyika]; (E) P1 basipodite, frontal [Ruanda: L. Mugesera]. C, F, G, *M. darwini* (= "*M. rarus orientalis*"), female [Papua New Guinea: Nubia]: (C) P4 protopodite, caudal; (F) P1 basipodite, frontal; (G) Anal somite, and caudal rami, dorsal. Scales: 50 μm .

al rim extending beyond implantation of exopodite seta in *M. darwini* (Figs 6A, 8A), vs. 10–14 spinules not reaching the height of exopodite seta in *M. rarus* (Fig. 9B).]

	Australia (Darwin)	PNG (Madang, Sepik)
Body length (µm):	(950)–1135, 1145	–
Cephthx l/w:	0.97, 1.03	–
Gen dos l/w:	1.25	1.13, 1.40
Pros/Uros:	1.56, 1.57	–
P4enp3		
l/w:	2.62, 2.89	2.65–2.95: 2.80
ap sp med/lat:	1.14, 1.20	0.86–1.04: 0.95
ap sp/enp3 l:	0.73, 0.85	0.74–0.91: 0.82
P5		
ap s/med sp:	–	1.08, 1.28
lat s/med sp:	0.75	0.77–0.82: 0.79
Caudal ramus, l/w:	3.05, 3.26 (3.7)	2.73–3.33: 3.03
Caudal setae		
term s ₁ /s ₄	2.40, 2.79 (2.4)	2.20–2.40: 2.32
term s ₂ /s ₄	3.67, 4.36 (5.8)	4.33–5.20: 5.00
term s ₃ /s ₄	3.14, 3.50 (3.9)	3.09–3.70: 3.46
dors s/s ₄	0.69 (1.0)	0.78–1.20: 0.94
term s ₂ /Uros	0.92	1.05, 1.12

Table 3. Morphometric comparison of *M. darwini* (types) and "*M. rarus orientalis*" ["types" + specimens from Augustafluß (=Sepik River)]. Values in bold are measurements of Dussart and Fernando (1988). Mean values are counted from the author's data and given only, if more than two specimens were measured.

Abbreviations:

Cephthx l/w: cephalothorax, length/width; Gen dos l/w: genital double-somite, length/width; Pros/Uros: Prosome length/Urosome length; ap sp med/lat: apical spines of P4enp3, medial/lateral; ap sp/enp3 l: length of longer apical spine/length of P4enp3; ap s/med sp: P5, apical seta/medial spine; lat s/med sp: P5, lateral seta/medial spine; term s₁, term s₂, term s₃, term s₄: caudal terminal setae from medialmost to lateralmost; dors s/s₄: caudal setae, dorsal/lateralmost terminal setae; term s₂/Uros: longest terminal seta/length of urosome.

Mesocyclops pseudoannae Van de Velde, 1987

Mesocyclops pseudoannae Van de Velde, 1987: 150–151, Figs 2–14.
? *Mesocyclops annae*: Dussart and Fernando 1986: 291.

Types. *Mesocyclops pseudoannae*: Holotype, ♀, (KBIN: 26528/B, 3283) 2 paratypes, ♀♀, (KBIN: 26528/A, D, 3283), and 1 allotype, ♂, (KBIN: 26528/E, 3283) – Swamp, Hansa Point, 4°11'S–144°54'E, Papua New Guinea leg. K. Wouters, 31 May 1982.

Other material examined. PAPUA NEW GUINEA: 6♀♀, 1♂ – Swamp, Riwo village, 9 km N Madang, 5°09'S–145°48'E, Madang Prov., [57] leg. R. & M. Holyński, 02 Mar 1989.

Comparative material. *Mesocyclops splendidus*: SRI LANKA: 2♀♀ (Coll. Dadayana: III, 253) – "*Cyclops leuckarti* 1070, 1896 Madarász". INDIA. Kerala: 2♀♀ – Paddy fields, near Guruwayoor Temple, Trichur District, leg. S. George, 03 Jan 1992; 1♀ – marshy area adjacent to Chalakudy railway station, 10°18'N–76°22'E, leg. S. George, 02 Sep 1992.

Mesocyclops annae Kiefer 1930: neotype, ♀, on two slides (SMNK: 10381, 10382) – 10381: "*Mesocyclops annae* n. sp. ♀, Abd+P5, neotypus, Kiefer 21.8.78; Madagascar, Tananarivo V. aus 1363, Waterlot leg. 1924; 10382: "*Mesocyclops annae* n. sp. ♀, A1–P4, neotypus, Kiefer 21.8.78; Madagascar, Tananarivo V. aus 1363, Waterlot leg. 1924.

Description (female). Body length: 915–1080 µm. Pediger 5 without lateral hairs. Genital double-somite (Fig.

10E) adorned with shallow pits, no hairs on somite. Posteriorly to P6 six pores in group. Seminal receptacle (Fig. 10E) with slender lateral arms curved backward, anterior and posterior margin of proximal part parallel, anterior margin sinuate in middle. Transverse ducts run more or less along posterior margin and directed to each other at obtuse or shallow acute angle before connection with copulatory duct. Copulatory duct nearly straight or slightly curved, part connecting copulatory pore with transverse ducts is not discernible [„jointed canal” (Van de Velde 1987) absent]. Spinules along posterior margin of anal somite absent laterally, small dorsally, and medium-sized ventrally. Caudal rami short (Fig. 12G), 2.1–2.5 times as long as wide, without hairs. Spinules at implantation of lateralmost terminal and lateral caudal setae absent. Dorsal caudal seta 1.0–1.1 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.4–2.9, 4.6–5.6, 3.2–4.0, 1.0. Longest terminal seta 1.6–1.7 times as long as urosome.

Armature formula of 17-segmented antennule, like in *M. dayakorum*, typical for genus (Fig. 49A). Serrate hyaline membrane on last antennular segment (Fig. 10C), extending only to implantation of medial seta of segment, with two or more small notches. None of antennular segments ornamented with ventral spinules, yet dorsally adorned (most often on article 1 and 4) with scattered shallow pits.

Antenna armed with 3 setae on basipodite and 1, 9, 7, setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of basipodite (Fig. 10B) consisted of: spinules on lateral and medial rim, near base; few (3–7) large spinules in oblique row next to spinules on lateral rim; longitudinal row of small spinules (10–14) of equal size along lateral rim. Frontal spinule pattern of antennary basipodite (Fig. 10A) composed of longitudinal row of large spinules (13–18) along lateral rim, and group of spinules (7–9) next to implantation of exopodite seta.

Segmentation and setation of mouthparts, like in *M. dayakorum*, typical for genus. Except distal fringe hairs no other hairs on labrum, epistoma and vertical cleft also naked. Gnathobase adorned with additional rows/groups of spinules (Fig. 10F), proximally to three groups near mandibular palp. Spinules near palp large and of similar size. Maxillary palp (Fig. 11C) without spinules; lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite without spinules; basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only (Fig. 11A). Maxilliped syncopodite adorned with few large spinules on frontal surface (Fig. 11D); spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 as in *M. dayakorum* (Table 2), medial spine of P1 basipodite reaching proximal quarter to half of second endopodal segment. Frontal surface of P1 basipodite ornamented with tiny spinules arranged in arch (Fig. 11E); medial expansion of basipodite of P1–P4 with apical hairs. Couplers naked on frontal and caudal surfaces in all legs, distal margin of P4 coupler bearing two

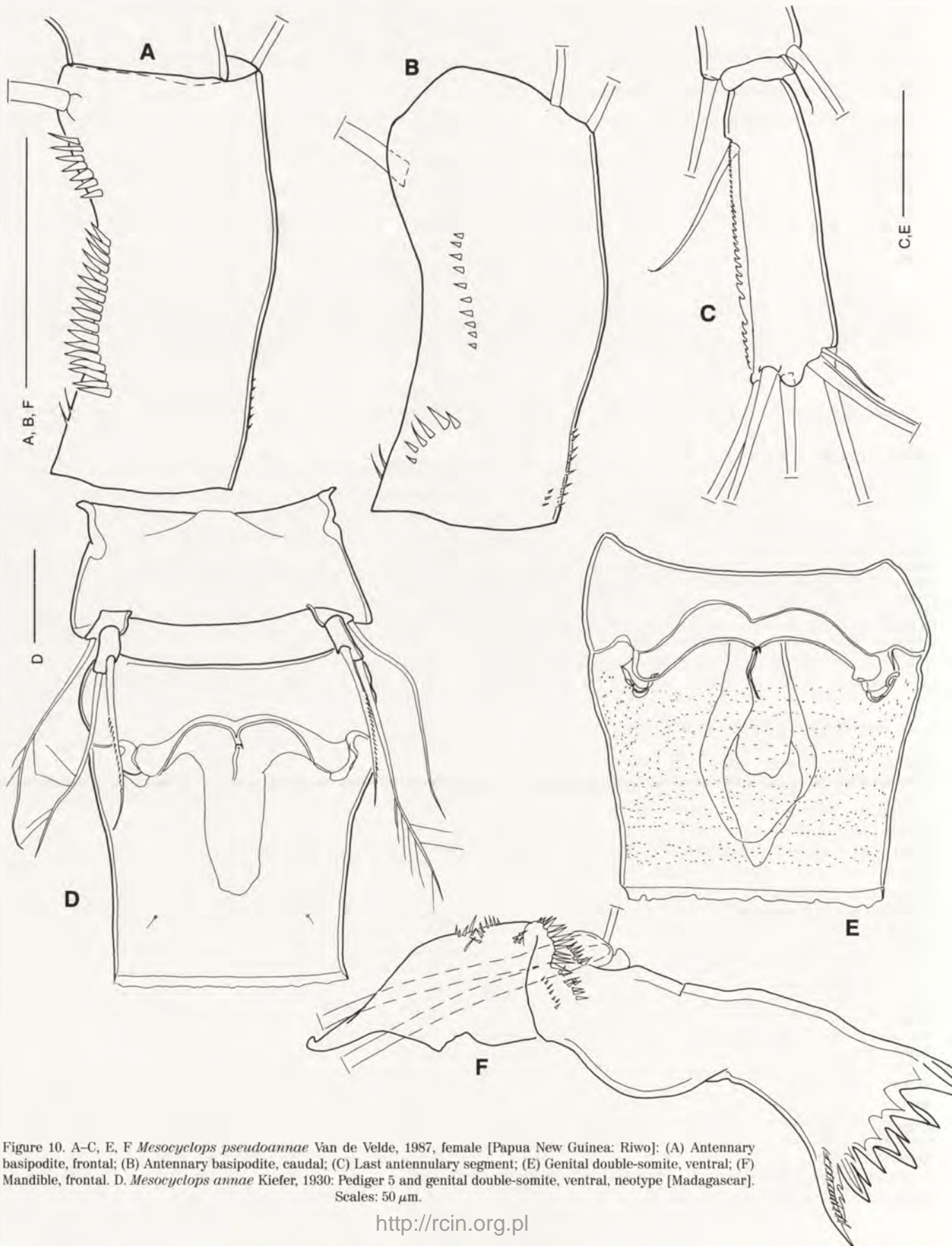


Figure 10. A–C, E, F *Mesocyclops pseudoannae* Van de Velde, 1987, female [Papua New Guinea: Riwo]: (A) Antennary basipodite, frontal; (B) Antennary basipodite, caudal; (C) Last antennular segment; (E) Genital double-somite, ventral; (F) Mandible, frontal. D. *Mesocyclops annae* Kiefer, 1930: Pediger 5 and genital double-somite, ventral, neotype [Madagascar]. Scales: 50 μm .

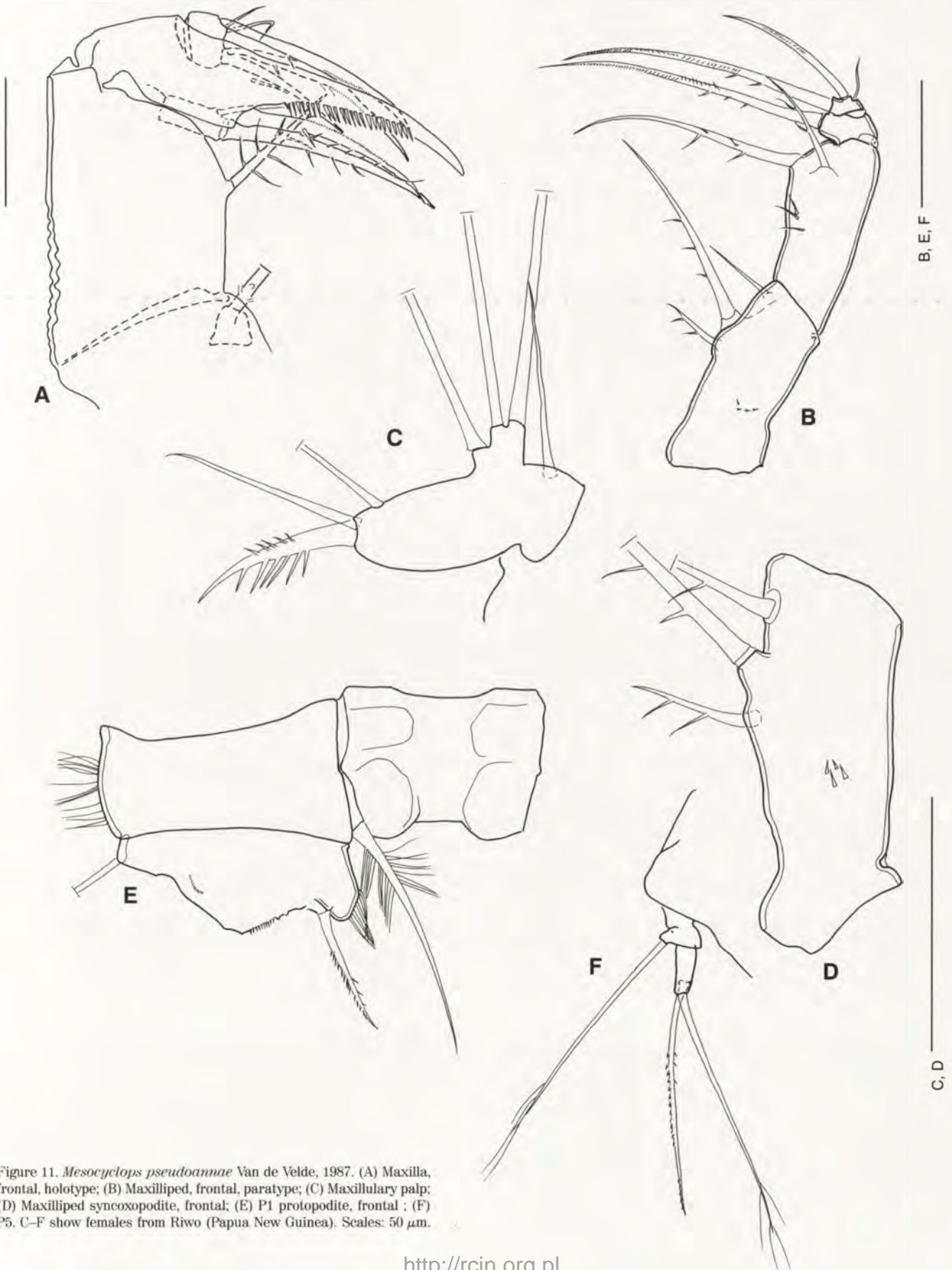


Figure 11. *Mesocyclops pseudoannae* Van de Velde, 1987. (A) Maxilla, frontal, holotype; (B) Maxilliped, frontal, paratype; (C) Maxillulary palp; (D) Maxilliped syncoxopodite, frontal; (E) P1 protopodite, frontal; (F) P5. C-F show females from Riwo (Papua New Guinea). Scales: 50 μ m.

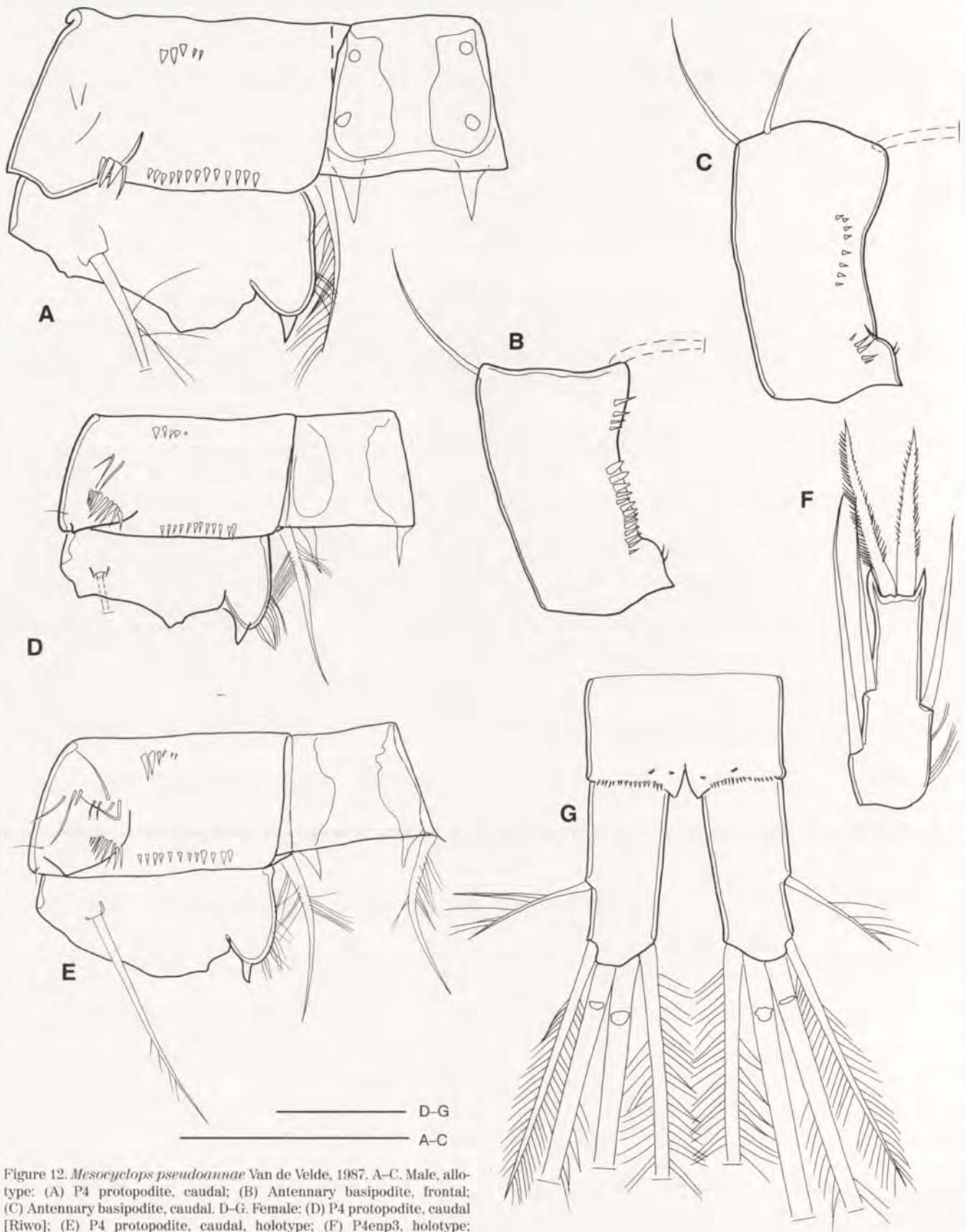


Figure 12. *Mesocyclops pseudoannae* Van de Velde, 1987. A–C. Male, allotype: (A) P4 protopodite, caudal; (B) Antennary basipodite, frontal; (C) Antennary basipodite, caudal. D–G. Female: (D) P4 protopodite, caudal [Riwo]; (E) P4 protopodite, caudal, holotype; (F) P4enp3, holotype; (G) Anal somite and caudal rami, ventral [Riwo]. Scales: 50 μ m.

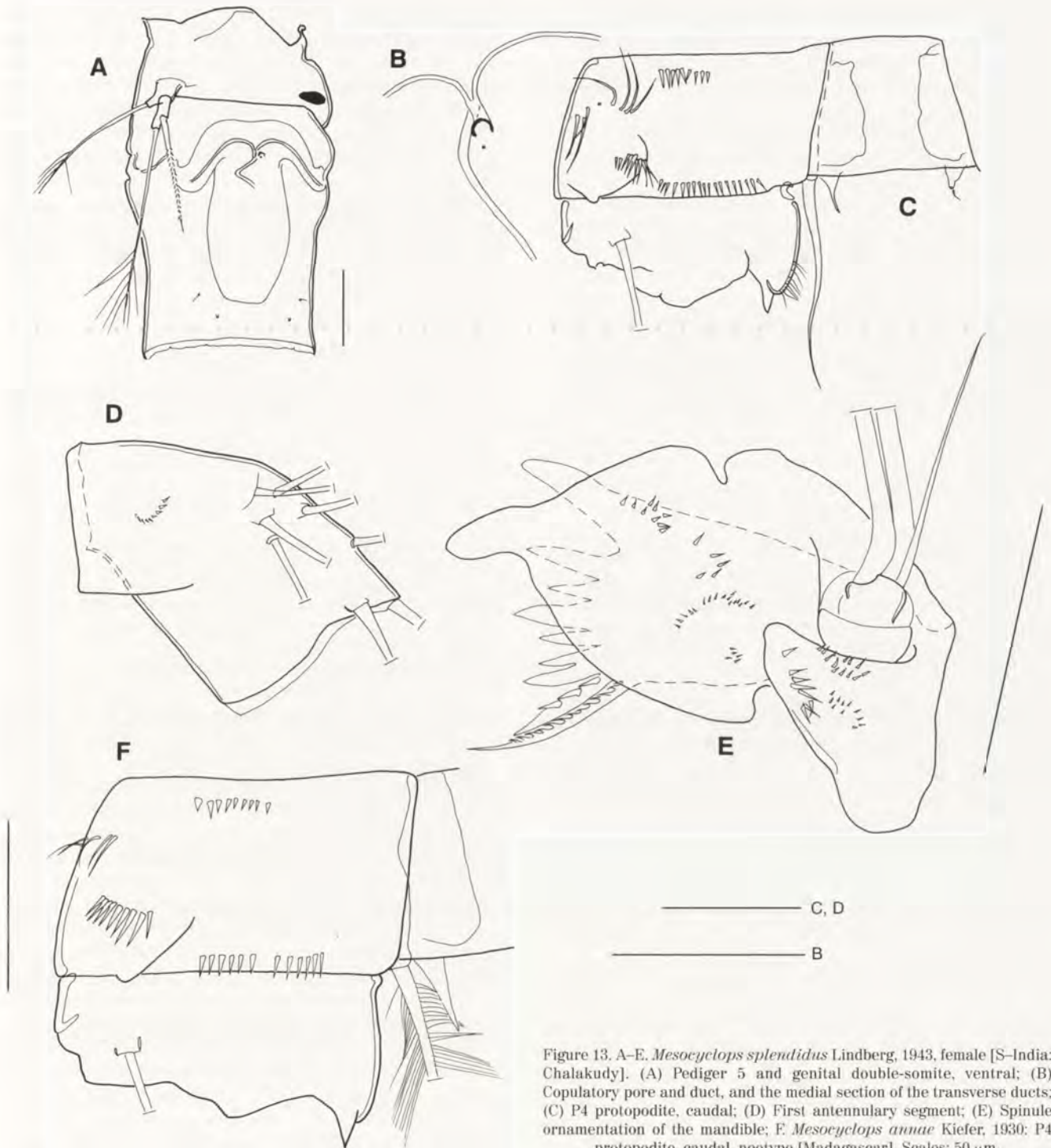


Figure 13. A–E. *Mesocyclops splendidus* Lindberg, 1943, female [S-India: Chalakudy]. (A) Pediger 5 and genital double-somite, ventral; (B) Copulatory pore and duct, and the medial section of the transverse ducts; (C) P4 protopodite, caudal; (D) First antennular segment; (E) Spinule ornamentation of the mandible; F. *Mesocyclops annae* Kiefer, 1930: P4 protopodite, caudal, neotype [Madagascar]. Scales: 50 μ m.

large and acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Figs 12D,E) composed of: 10–13 spinules in continuous row along distal rim; relatively short spinules arranged in one row at laterodistal angle; row of 4–9 spinules along proximal rim, lateral ones may be conspicuously large; distinct row of strong hairs at midlength of segment. P4 coxopodite seta 1.4–1.9 times longer than height of medial expansion of P4 basipodite. P4enp3 (Fig.

12F) 2.0–2.9 times as long as wide; of apical spines medial one 1.0–1.1 times as long as lateral. Lateral edge of medial apical spine with many teeth.

Male. Body length: 692 μ m (Van de Velde, 1987). No lateral hairs on pediger 5. P6 flaps without spinule ornamentation. Anal somite bearing spinules along entire posterior margin. Caudal rami 1.9–2.0 times as long as wide. Spinules at implantation of lateralmost terminal setae and

lateral caudal setae present. Dorsal caudal seta 0.84 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.3–2.5, 3.9–4.2, 3.0–3.1, 1.0. Longest terminal seta 1.3 times as long as urosome.

Antennule 16-segmented, but with incomplete subdivision of compound apical segment. Armature formula: 8+3ae, 4, 2, 2+ae, 2, 2, 2, 2, 1+ae+sp, 2, 2, 2, 2+ae, 2, 1+ae, [5, 7+ae]. At distal geniculation plate-like structures (one on segment 14 and two on segment 15) with striated surface and single pore, and short conical element on segment 14 and 15 each (Fig. 49B,C). First antennular segment ornamented with row of spinules on ventral surface.

Second endopodal segment of antenna bearing 6 setae. Caudal spinule pattern of antennary basipodite like in female (Fig. 12C). Spinules (8) in longitudinal row along lateral rim very small, of equal size. Frontal spinule ornamentation of antennary basipodite (Fig. 12B) composed of longitudinal row of 12, 13 large spinules along lateral rim, and group of spinules (7) next to implantation of exopodite seta. No spinules on maxillary palp and maxillary coxopodite.

P1 basipodite with medial spine. Frontal surface of P1 basipodite ornamented with tiny spinules arranged in arch; medial expansion of basipodite of P1–P4 with apical hairs. P4 coupler naked, bearing two large and acute outgrowths on distal margin. Caudal spinule ornamentation of P4 coxopodite like in female, except that strong hairs at midlength of segment absent (Fig. 12A). P4 coxopodite seta 1.4–1.5 times longer than height of medial expansion of P4 basipodite. P4enp3 2.7–2.9 times as long as wide; of apical spines medial one 1.2 times as long as lateral. Lateral edge of medial apical spine with many teeth. P6 armed with medial spine and two lateral setae. In contrast to figure of allotype (Van de Velde, 1987), seta next to medial spine conspicuously (1.6 times) longer than former element in male from Riwo.

Distribution. The species is known so far only from few marshy areas in Madang Province, (Papua New Guinea), yet record of „*Mesocyclops annae*” from Northern Territory and Queensland in Australia (Dussart and Fernando 1986) supposedly also refers to *M. pseudoannae*.

Remarks. *Mesocyclops pseudoannae* also displays some of the ancestral features (characters 1, 3, 4) listed in the description of *M. darwini*. Yet, the lateral part of the seminal receptacle are wide sacs and not canal-like, and none of the antennular segments is adorned with ventral spinules. The latter feature is considered here as an autapomorphy of *M. pseudoannae*. The wide and elongate lateral arms of the seminal receptacle, anterior and posterior margin of which are nearly parallel and curved strongly backward, are also shared by *M. annae* Kiefer, 1930 (Fig. 10D) (Madagascar) and *M. splendidus* Lindberg 1943 (Fig. 13A) (South India, Sri Lanka, and Bangladesh). The three species showing highly disjunct distribution pattern can be distinguished from each other by only few “microcharacters”: 1. apical hairs on medial expansion of P4 basipodite absent in *M. annae* (Fig. 13F), present in *M. splendidus* (Fig. 13C) and *M. pseudoannae* (Figs 12 D,E);

2. row of spinules on ventral surface of the first antennular segment present in *M. annae*, and *M. splendidus* (Fig. 13D), absent in *M. pseudoannae*; 3. transverse ducts (female genital system) shifted forwards near anterior margin of proximal part of seminal receptacle in *M. annae* (Fig. 10D), but running in parallel with posterior margin of proximal part of seminal receptacle in *M. splendidus* (Fig. 13A) and *M. pseudoannae* (Fig. 10E); transverse ducts directed to each other at deep acute angle before connection with copulatory duct, and “jointed canal” present in *M. annae* (Fig. 10D) and *M. splendidus* (Fig. 13B), vs. transverse ducts meet obtuse, or shallow acute angle, and “jointed canal” absent in *M. pseudoannae* (Fig. 10E).

Mesocyclops cf. yena

Types. *Mesocyclops yena* Holyńska, 1998: Holotype (♀) and 17 paratypes (♀♀) (MIZ) – Hue, 16°30'N–107°30'E, Vietnam, leg Dr. Hue, 28 May 1996.

Other material examined. 2 ♀♀ (KBIN: COP3742A,B; COP3744A,B) – COP3742A: “*M. brevisetosus* Dussart & Sarnita, det. V. d. Velde 1989, 1A, Abdomen ♀; I. G. 27362, st. 7025, Awar Point, Papua N. G. Sago put”; COP3742B: “*M. brevisetosus* Dussart & Sarnita, 1987 det. V. d. Velde 1989; I. G. 27362 st. 7025, Awar Point, Papua N. G. Sago put, 1B, A1–P4 ♀”; COP3744A: “*M. brevisetosus* Dussart & Sarnita, 1987, det. V. d. Velde 1989; I. G. 27362 st. 7025, Awar Point, Papua N. G. Sago put, 3A, A1–P4 ♀”; COP3744B: “*M. brevisetosus* Dussart & Sarnita, 1987 det. V. d. Velde 1989; I. G. 27362 st. 7025, Awar Point, Papua N. G. Sago put, 3B, Abdomen, ♀”.

Description. Pediger 5 without hairs, two medial and two laterodistal sensilla present on dorsal surface of somite. No pseudosomite between pediger 5 and genital double-somite (Fig. 15F). Genital double-somite (Fig. 15F) 1.0–1.2 times as long as wide, without hairs, six hair sensilla present on dorsal surface and two sensilla laterodorsally. Posteriorly to P6 six pores in group. Lateral arms of seminal receptacle elongate and curved backward, anterior margin of proximal part sinuate in middle. Posteriorly to horseshoe-shaped copulatory pore one circular pore. Transverse ducts meeting straight copulatory duct at right angle. Strong spinules along posterior margin of anal somite. Caudal rami (Fig. 15E) 3.2–3.3 times as long as wide, without hairs; dorsal surface with tiny spinules arranged in distinct group. Spinules present at implantation of lateralmost terminal, lateral caudal setae and on lateral margin in proximal third. Dorsal caudal seta as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 1.3–1.4, 5.0, 3.5, 1.0. Longest terminal seta as long as urosome (Fig. 15D).

Armature formula of 17-segmented antennule same as in *M. dayakorum*. Last two antennular segments in one female (COP3744) little bit shortened (Fig. 14D), but in other specimen (COP3742) proportions of segments as in holotype of *M. yena* (Fig. 14C). Serrate hyaline membrane on last antennular segment, extending beyond implantation of medial seta of segment, but not reaching proximal margin of segment, with one large notch (Fig. 14D). Ventral spinules present on antennular segments 1, 4, 5, 7–10, 12, and 13, no pits on dorsal surface. Antenna



Figure 14. A, B, D–F *Mesocyclops cf. yeneae*, COP 3744 [Papua New Guinea: Awar Point]. (A) Maxilla, frontal; (B) Maxillule, caudal; (D) 16. and 17. antennary segments; (E) Antennary basipodite, caudal; (F) Antennary basipodite, and first endopodal segment, frontal. C. *Mesocyclops yeneae* Holyńska, 1998: 16. and 17. antennary segments, holotype. Scales: 50 μm .

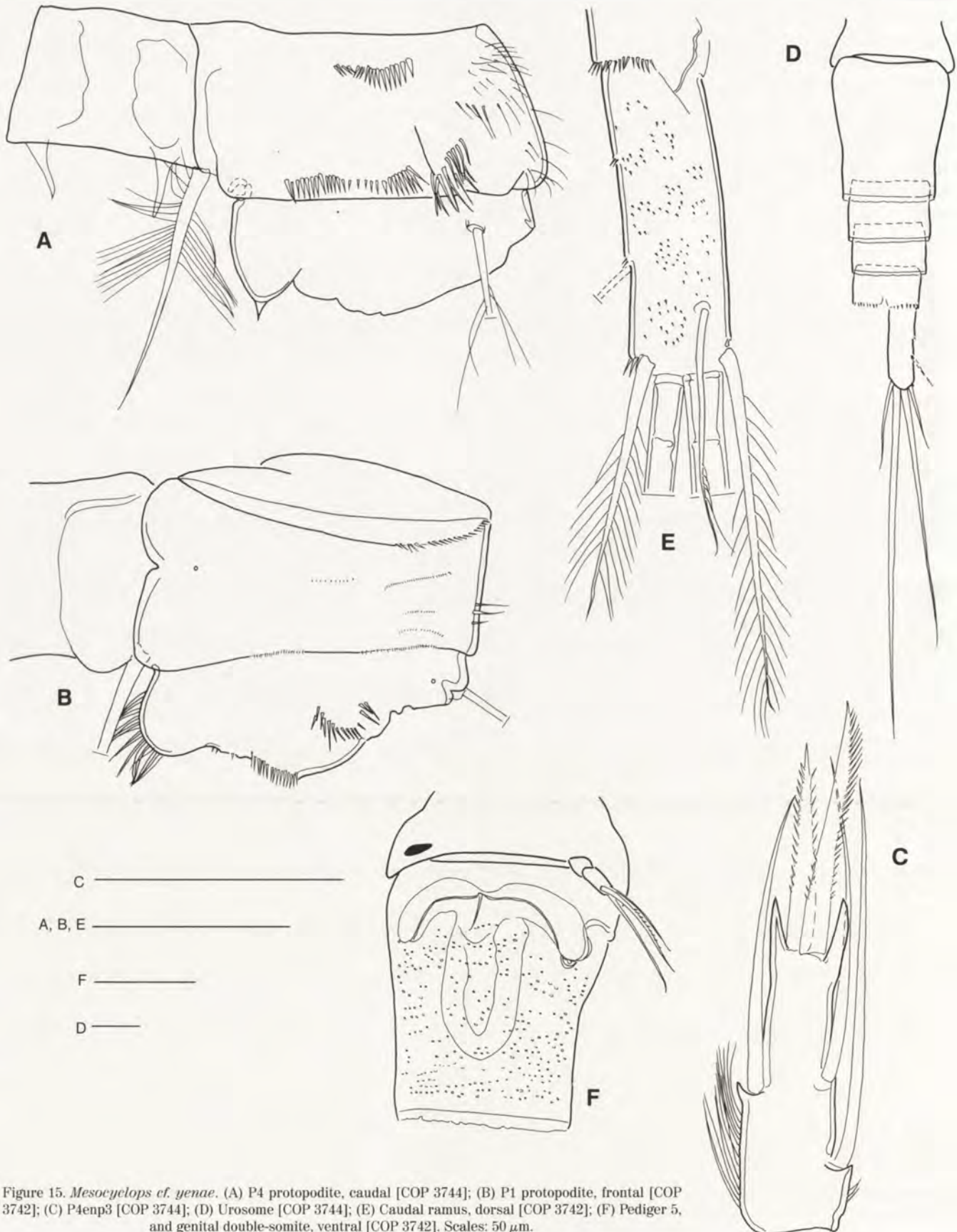


Figure 15. *Mesocyclops cf. yensei*. (A) P4 protopodite, caudal [COP 3744]; (B) P1 protopodite, frontal [COP 3742]; (C) P4enp3 [COP 3744]; (D) Urosome [COP 3744]; (E) Caudal ramus, dorsal [COP 3742]; (F) Pediger 5, and genital double-somite, ventral [COP 3742]. Scales: 50 μ m.

bearing 3 setae on basipodite and 1, 9, and 7 setae on endopodal segments 1–3, respectively. Caudal surface of antennary basipodite displaying the basic pattern (see *M. dayakorum*) (Fig. 14E); 14–16 spinules in curved longitudinal row along lateral rim. Frontal spinule ornamentation of antennary basipodite (Fig. 14F) composed of 17–20 spinules arranged in longitudinal row, and transverse row of elongate spinules distally to spinules along proximal rim; group of tiny spinules proximally to exopodal seta, present in *M. yenaie*, absent in New Guinean females.

Segmentation and setation of mouthparts as in *M. dayakorum*. With exception of distal fringe hairs no other hairs on ventral surface of labrum, epistoma and vertical cleft bare. Maxillulary palp naked, lateralmost (longest) seta of lateral lobe with long setules (Fig. 14B). No spinules on frontal surface of maxillary coxopodite. Basipodite seta in front of claw-like basal endite with two longer setules, followed by fine teeth on posterior and anterior edges; teeth on anterior edge reach about distal third of seta (Fig. 14A). Maxilliped syncoxopodite adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

P1 basipodite without medial spine; frontal surface with large spinules arranged in semicircular arch (Fig. 15B). Medial expansion of basipodite of P1–P3 with apical hairs. Medial expansion of P4 basipodite relatively wide, bare (Fig. 15A). Couplers of P1–P4 naked on frontal and caudal surfaces, P4 coupler with two large acute outgrowths on distal margin. Caudal spinule ornamentation of P4 coxopodite (Fig. 15A) composed of: 22–27 large spinules along distal rim, those in the middle smaller; 15–17 elongate spinules in two rows at laterodistal angle; 14–20 spinules in one row along proximal rim, those in lateral section conspicuously large; and dense, short lateral hairs. P4 coxopodite seta 1.8 times as long as height of medial expansion of P4 basipodite. P4enp3 (Fig. 15C) 2.5 times as long as wide; of apical spines medial one 1.2–1.3 times as long as lateral one, and 0.9 times as long as segment. Lateral edge of medial apical spine with five teeth in proximal half. Apical seta of P5 0.9 times as long, lateral seta 0.7 times as long as medial spine. Medial spine of P5 about half as long as genital double-somite (Fig. 15F).

Remarks. The two females from northern Papua New Guinea (Madang Pr., 04°09'S–44°51') differ from *M. yenaie* Holyńska, 1998 (Central Vietnam) only in two characters: they do not have pseudosomite, which is hoop-like but open dorsally in adult females of *M. yenaie*, and the group of tiny spinules inserted proximally to the exopodite seta on the frontal surface of the antennary basipodite, present in *M. yenaie*, is also missing. It is possible, that the occurrence of incomplete pseudosomite in *M. yenaie* is an environment (interstitial)-dependent rather than a species-specific character. Since the species has apparently been described from single population, this question can not be answered without the comparison of *M. yenaie* populations living in different habitats.

On the other hand, the New Guinean specimens differ also from *M. brevisetosus* Dussart et Sarnita, 1987, a species which is very closely related to *M. yenaie*, and known only from two females found in West Kalimantan (Sebangkau). The types of *M. brevisetosus* (Canadian Museum of Nature, Ottawa) were not accessible for me, but, the observations kindly made by Ms. Judith Price (CMN, Ottawa) on the holotype, and the original description (Dussart and Sarnita 1987) show a slight morphological divergence between the New Guinean forms and *M. brevisetosus*: the longest terminal caudal seta is 3.5–3.7 times as long as the medial terminal seta in females from P.N.G. (4.4 times in *M. brevisetosus*); P4 coxopodite seta 1.7–1.8 times as long as height of medial expansion of P4 basipodite (1.3 times in *M. brevisetosus*); medial expansion of P4 basipodite bare (with apical hairs in *M. brevisetosus*). Since no data are available on intraspecific variability of *M. brevisetosus*, and *M. yenaie* is a much better known species, the New Guinean females provisionally are identified as *M. cf. yenaie*.

Mesocyclops yesoensis Ishida, 1999

Mesocyclops yesoensis Ishida, 1999: 81–83, Figs 1–2.

Material examined. MALAYSIA: 1 ♀ – Desaru Beach, leg. T. Ishida, 14 Feb 1987. JAPAN (Hokkaido): 3 ♀ ♀, 2 ♂ ♂ – Yoichimachi, leg. T. Ishida, 24 Apr 1991; 1 ♀ – Asahicho, Yoichimachi, leg. T. Ishida, 21 Apr 1997.

Description (female from Malaysia). Body length: 1545 µm; prosome/urosoma: 1.61; cephalothorax, length/width: 1.24; cephalothorax width/genital double-somite width: 3.17.

Pediger 5 without hairs, two medial and two laterodistal sensilla on dorsal surface of somite. Genital double-somite (Fig. 17A) 1.29 times as long as wide, without hairs. Lateral arms of seminal receptacle wide and long, anterior and posterior margin near parallel. Anterior margin of proximal part of seminal receptacle sinuate in middle. Copulatory pore horseshoe-shaped; transverse ducts (Fig. 17B) directed to each other at straight angle (not V-shaped) before connection with copulatory duct; copulatory duct slightly curved. Strong spinules along entire posterior margin of anal somite (Figs 17C,D). Caudal rami (Figs 17C,D) elongate, 4.7 times as long as wide, without medial hairs. Spinules at implantation of lateral caudal and lateralmost terminal setae, present. Dorsal caudal seta 0.74 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.7, 6.3, 4.7, 1. Longest terminal seta 1.1 times as long as urosome.

Armature formula of 17-segmented antennule like that in *M. dayakorum*. Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch. Ventral spinules present on segments 1–4, 5, 7–10, 12–13, dorsal surface of antennular segments 1, 2, 4, 5, 7, 9 adorned with shallow pits.

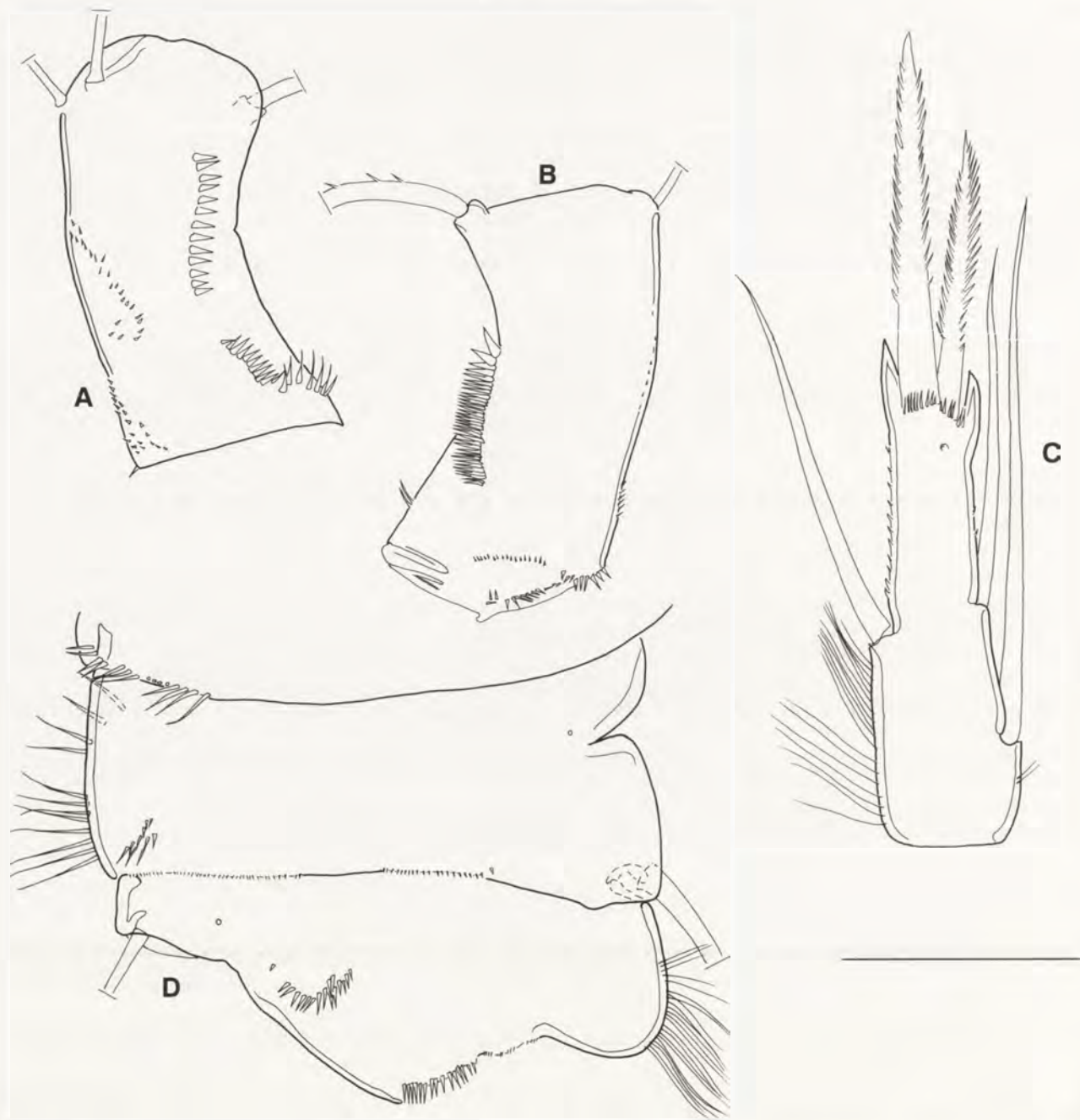


Figure 16. *Mesocyclops yesoensis* Ishida, 1999 [Malaysia?]. (A) Antennary basipodite, caudal; (B) Antennary basipodite frontal; (C) P4enp3; (D) P1 propodite, frontal. Scale: 50 μ m.

Antenna bearing 3 setae on basipodite and 1, 7, 7 setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of antennary basipodite (Fig. 16A): long proximal spinules on lateral rim; tiny spinules on medial rim in proximal fourth; 11 spinules in oblique row next to spinules on lateral rim; longitudinal row of spinules (13) near lateral rim; oblique row of fine spinules starting in distal half of medial rim. Frontal spinule ornamentation of antennary basipodite (Fig. 16B) composed of longitudinal

row of spinules (33) and transverse row of spinules distally to spinules along proximal rim.

Segmentation and setation of mouthparts typical for genus (for detailed characterization see the description of *M. dayakorum*). Mandible bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillary palp without spinules; lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite naked. Basipodite

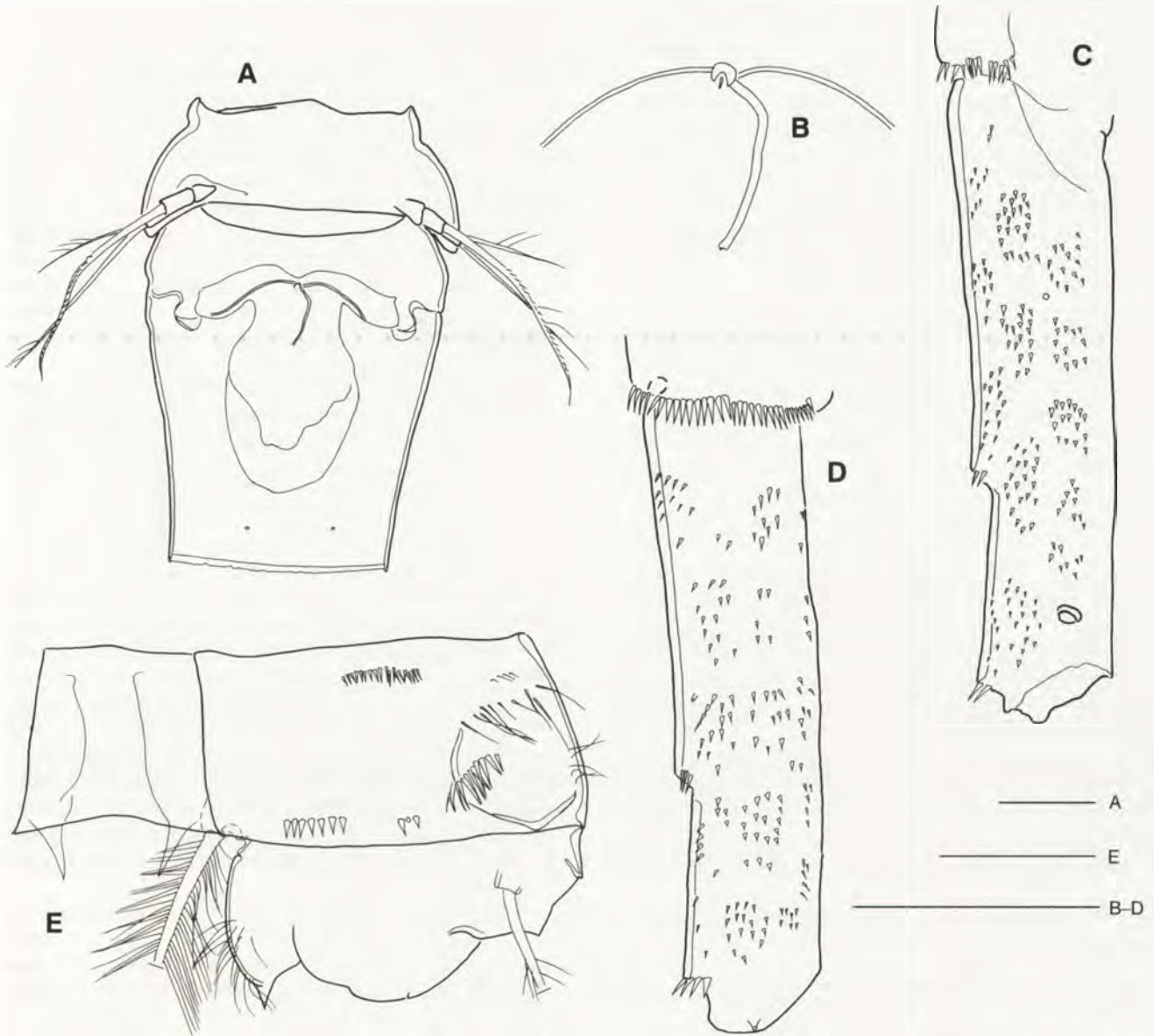


Figure 17. *Mesocyclops yesoensis* Ishida, 1999 [Malaysia?]. (A) Pediger 5 and genital double-somite, ventral; (B) Copulatory pore and duct, and the median section of the transverse ducts; (C) Caudal ramus, dorsal; (D) Caudal ramus, ventral; (E) P4 protopodite, caudal. Scales: 50 μ m.

seta in front of claw-like basal endite with fine teeth on posterior edge only. Maxilliped syncoxopodite adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 as in *M. dayakorum* (Table 2) except P1 basipodite without medial spine. Frontal surface of P1 basipodite with large spinules arranged in semicircular arch (Fig. 16D); medial expansion of basipodite of P1–P4 with apical hairs. Couplers naked on frontal and caudal surfaces, distal margin of P4 coupler bearing two large outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 17E) composed of: intermittent row of spinules (6+1, 7+2) along distal rim; 14/12 elongate spinules

arranged in one row at laterodistal angle; many (18) large spinules along proximal rim; distinct row of strong hairs proximally to row at laterodistal angle; long and fine hairs on lateral rim, and short hairs lateroproximally. P4 coxopodite seta 1.7 times longer than height of medial expansion of P4 basipodite. P4enp3 (Fig. 16C) 3 times longer than wide; of apical spines medial one 0.83 times as long as lateral. Lateral edge of medial apical spine with many teeth. Apical seta of P5 0.92 times as long, lateral seta 0.64 times as long as medial spine (Fig. 17A).

Male (Hokkaido). Body length: 1090–1145 μ m. Pediger 5 without hairs. Posterior margin of anal somite with strong spinules. Caudal rami 3.5–3.8 times as long as wide, without medial hairs. Spinules at implantation of lateral

caudal, and lateralmost terminal setae present. Dorsal caudal seta 0.78–0.85 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.5–2.7, 5.7–6.0, 4.1–4.3, 1.0. Longest terminal seta 1.1–1.2 times as long as urosome. Ventral spinules present on first antennular segment only. Second endopodal segment of antenna with 6 setae. Caudal and frontal spinule ornamentation of antennary basipodite similar to those in female, only number of spinules in particular groups less. Armature of labrum, mandible, maxillary palp, syncopodite of maxilla and maxilliped as in female. Couplers naked, distal margin of P4 coupler with two large outgrowths. Caudal spinule ornamentation of P4 coxopodite similar to that in female, only number of spinules in particular groups less; spinules along distal rim in continuous or intermittent row; and lateral hairs reduced. Medial expansion of P4 basipodite bearing apical hairs. P4 coxopodite seta 1.7–1.9 times as long as height of medial expansion of P4 basipodite. P4enp3 3.1–3.2 times as long as wide; of apical spines medial one 0.8 times as long as lateral. Lateral edge of medial apical spine with many teeth. P5: apical seta 0.9 times as long, lateral seta ca. 0.6 times as long as medial spine. P6 composed of stout medial spine, slender seta of about equal length, and 2.5 times longer lateral seta.

Distribution. Known from Hokkaido and Malaysia(?). Comparison of the *M. yesoensis* females collected in the type locality (Yoichimachi, Hokkaido) with the single Malaysian specimen leaves no doubt of its identity. However, since mistakes during the sorting or preparation procedures can not be completely excluded, the Malaysian occurrence of *M. yesoensis* still remains to be verified.

Mesocyclops papuensis Van de Velde, 1987

Mesocyclops papuensis Van de Velde, 1987: 157–160, Figs 45–59.

Mesocyclops borneoensis Dussart et Fernando, 1988: 254, Figs 51–56.

Syn. nov.

Types. *Mesocyclops papuensis*: Holotype, ♀, (KBIN: 26528/A, 3279) 1 paratype, ♀, (KBIN: 26528/C, 3279) and 1 allotype, ♂, (KBIN: 26528/B, 3279) – Swamp, Hansa Point, 04°11'S–144°54'E, Madang Prov., Papua New Guinea, leg. K. Wouters, 31 May 1982.

Other material examined. PAPUA NEW GUINEA: 5 ♀♀, 1 ♂ – Swamp, Ríwo village, 9 km N Madang, 5°09'S–145°48'E, Madang Prov., [57] leg. R. & M. Holyński, 02 Mar 1989; 3 ♀♀ – Lagoon, shore, 9°02'S–146°45'E, 20 km E Obo Mission, 70 km NW Port Moresby, Central Prov. [135/b], leg. M. & R. Holyński, 22 Apr 1989.

INDONESIA: Java: 1 ♀ – Pening Lake, Rawa, Semarang Regency [9], leg. G. Marten, 1994. Borneo: 1 ♀, shallow, slow-current stream, [3]; 1 ♀, 1 ♂, ricefield, depth 5–10 cm, [5/b] – Long Iram, 0°00'N/S–115°35'E, 180 km WNW Samarinda, Mahakam Riv. Valley, 80 m, leg. M. & R. Holyński, 24 May 1989.

Description (female). Body length: 1375–1645 µm; prosome/urossome: 1.8–1.9; cephalothorax, length/width: 1.0–1.1; cephalothorax width/genital double-somite width: 3.0–3.1 (Fig. 18A).

Pediger 5 without hairs, two medial and two laterodistal sensilla present on dorsal surface of somite. Genital double-

somite 1.1–1.2 times as long as wide, naked. Posteriorly to P6 six pores in group. Seminal receptacle (Figs 18B,E) with very broad lateral arms, anterior margin of proximal part arcuate in middle. Posteriorly to horseshoe-shaped copulatory pore two circular pores present. Transverse ducts directed to each other at acute angle (V-shaped) before connection with copulatory duct; curvature of copulatory duct varies from nearly straight to strong. Anal somite with spinules along posterior margin. Caudal rami 3.0–3.6 times as long as wide, without hairs. Spinules at implantation of lateralmost terminal setae and lateral caudal setae, present. Dorsal caudal seta 0.9–1.1 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.7–3.1, 5.7–7.1, 4.0–4.7, 1.0. Longest terminal seta 1.2–1.4 times as long as urosome.

Armature formula of 17-segmented antennule, as in *M. dayakorum*. Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch (Fig. 19B). Ventral spinules present on antennular segments 1, 4–5, 7–13, dorsal surface of antennule adorned with shallow pits. Antenna (Fig. 19A) bearing 3 setae on basipodite and 1, 7, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of antennary basipodite (Fig. 18D): the basic pattern (see in *M. dayakorum*) supplemented with oblique row of fine spinules starting in distal half of medial rim, field of tiny spinules near implantation of medial setae, and spinules near distal rim. This latter element absent in one specimen from Aroa Lagoon (P. N. G.). Number of spinules in longitudinal row along lateral rim highly variable from extreme 0 (Java) to 13 (holotype, P. N. G.). Frontal spinule ornamentation of antennary basipodite composed of 23–31 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

Except distal fringe hairs no other hairs on ventral surface of labrum, epistoma and vertical cleft also bare. Mandible (Fig. 19E) bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillary palp naked. Frontal surface of maxillary coxopodite with very tiny spinules arranged in rows or field. Basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only. Maxilliped syncopodite adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 like that in *M. dayakorum* (Table 2) except P1 basipodite without medial spine. Frontal surface of P1 basipodite (Fig. 19F) with large spinules arranged in semicircular arch; apical hairs of medial expansion of basipodite present on P1–P3, absent on P4. Couplers naked on frontal and caudal surfaces, distal margin of P4 coupler bearing two large and acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 19C) composed of: 6–11 spinules in intermittent or continuous row along distal rim; relatively thick and short spinules arranged in one row at laterodistal angle; spinule row along proximal rim comb-like, consisting of numerous fine

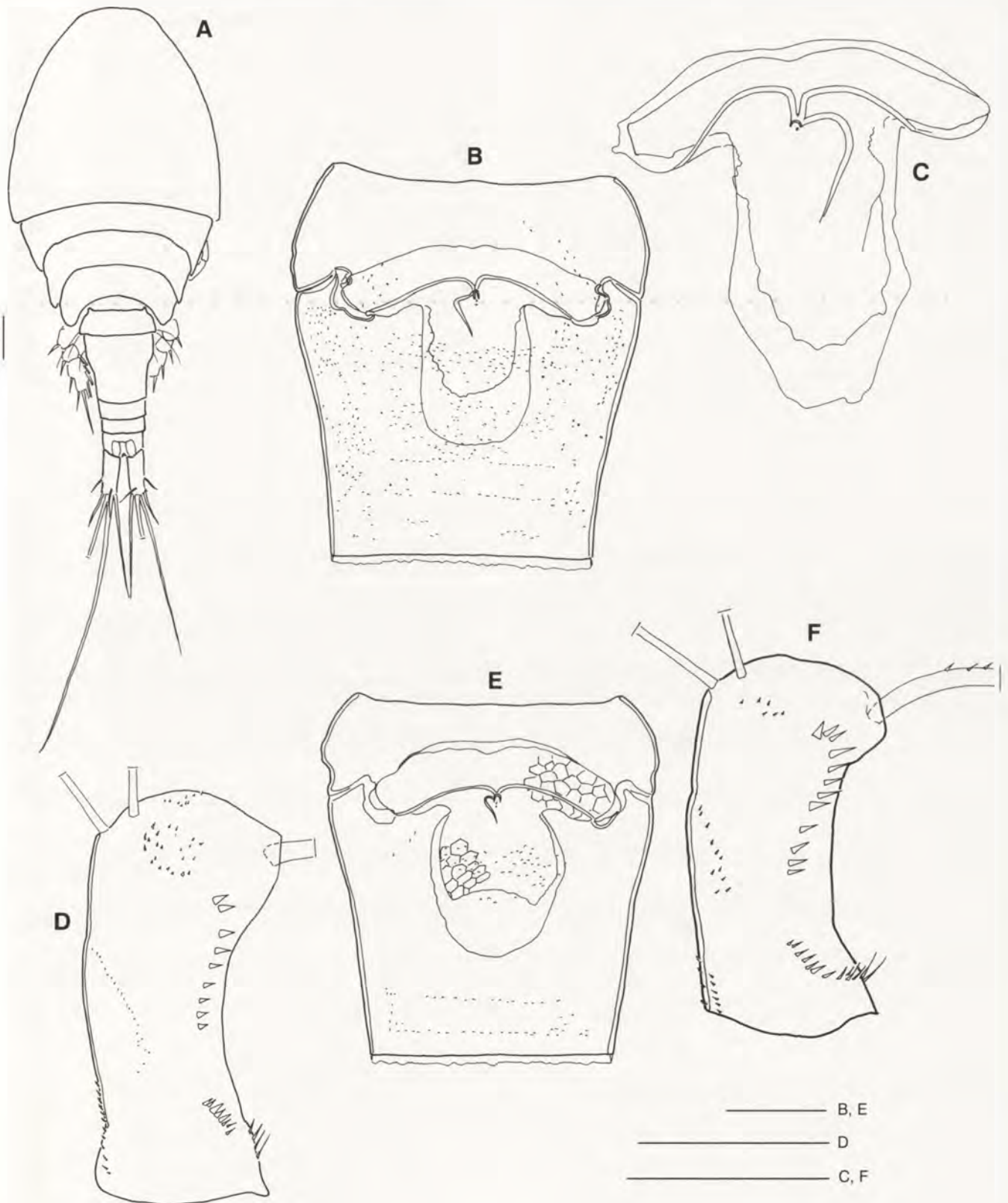


Figure 18. A, B, D, E. *Mesocyclops papuensis* Van de Velde, 1987: (A) Habitus [Riwo]; (B) Genital double-somite, ventral, holotype; (D) Antennary basipodite, caudal [Riwo]; (E) Genital double-somite, ventral [Riwo]; C, F. *Mesocyclops rutneri* Kiefer, 1981: (C) Seminal receptacle [syntype, SMNK: 10510]; (F) Antennary basipodite, caudal [syntype, SMNK: 10511]. Scales: A: 100 μ m; B–F: 50 μ m.

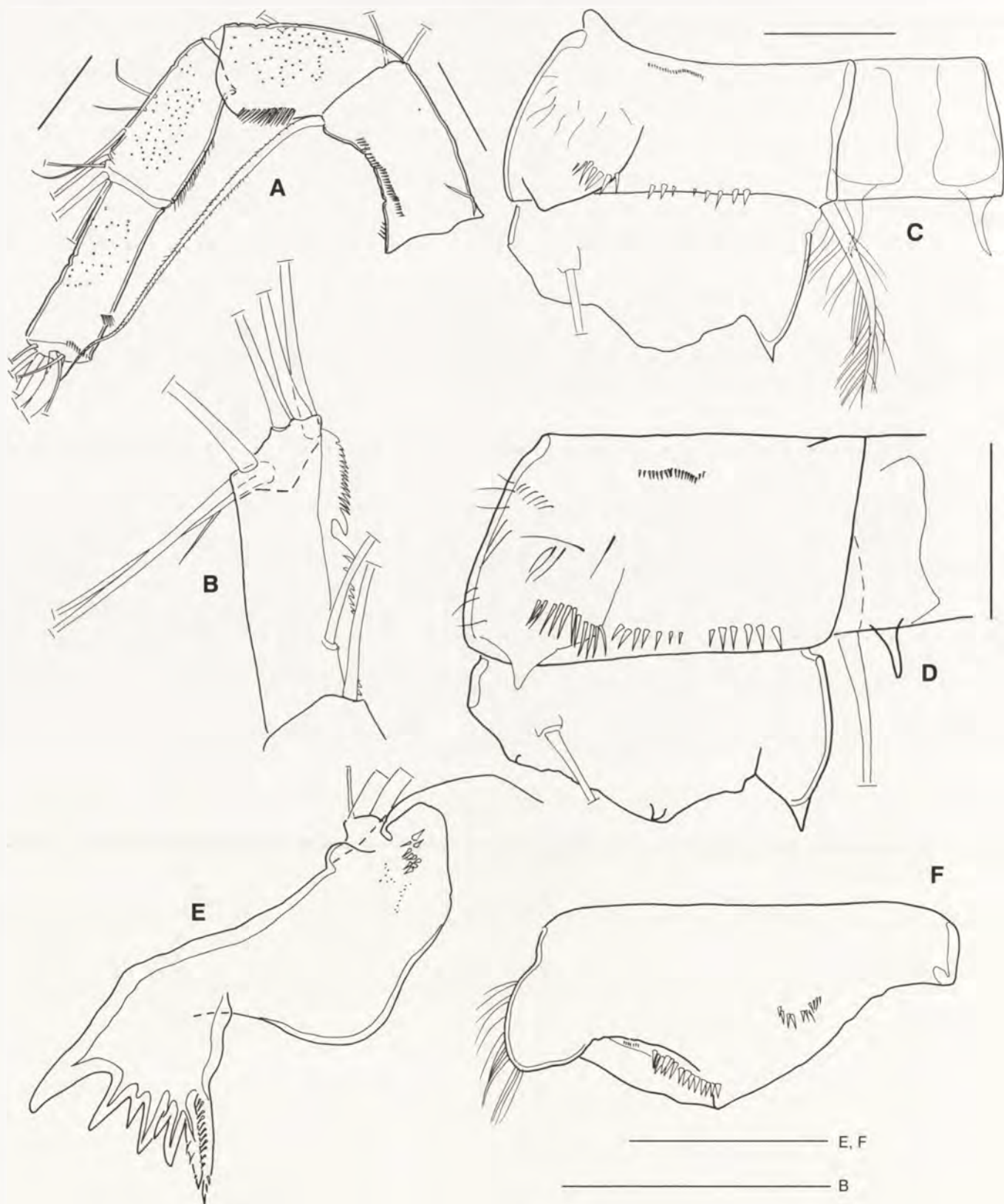


Figure 19. A–C, E, F. *Mesocyclops papuensis* Van de Velde, 1987: (A) Antenna, frontal [holotype]; (B) Last antennular segment [Riwo]; (C) P4 protopodite, caudal [holotype]; (E) Mandible [paratype, 26528/C]; (F) P1 basipodite, frontal. [Riwo]. D. *Mesocyclops ruttneri* Kiefer, 1981: P4 protopodite, caudal [Sri Lanka, Coll. Dadayana III.253]. Scales: 50 μ m.

spinules of equal length; row of hairs at midlength of segment, and reduced lateral hairs. P4 coxopodite seta 1.4–1.8 times longer than height of medial expansion of P4 basipodite. P4enp3 2.5–3.1 times as long as wide; of apical spines medial one 1.0–1.2 times as long as lateral. Lateral edge of medial apical spine with 0–9 teeth. Apical seta of P5 1.0–1.2 times as long, lateral seta 0.5–1.0 times as long as medial spine.

Male. Body length: 820 (Long Iram), 944 (allotype) μm . Pediger 5 without hairs, two medial and two laterodistal sensilla present on dorsal surface of somite. Very fine spinules on P6 flaps. Anal somite with spinules along posterior margin. Caudal rami 2.65 (allotype), 2.67 (Long Iram) times as long as wide, without hairs. Spinules at implantation of lateralmost terminal and lateral caudal setae, present. Dorsal caudal seta 1.0 (Long Iram), 1.1 (allotype) times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.8 (Long Iram), 3.1 (allotype); 6.3 (allotype) 6.7 (Long Iram); 4.1 (allotype), 4.4 (Long Iram); 1.0.

Antennule 16-segmented, but with incomplete subdivision of compound apical segment. Armature formula: S+3ae, 4, 2, 2+ae, 2, 2, 2, 1+ae+sp, 2, 2, 2, 2+ae, 2, 1+ae, [5, 7+ae]. At distal geniculation plate-like structures (one on segment 14 and two on segment 15) with striated surface and single pore, and short conical element on segment 14 and 15 each (Fig. 49B,C). First antennular segment adorned with row of spinules on ventral and scattered shallow pits on dorsal surface. Pits present on articles 14 and 15 also in male from Long Iram. Second endopodal segment of antenna bearing 6 setae. Spinule ornamentation of antennary basipodite like in female, except caudal spinules near distal rim absent. Number of spinules in longitudinal row along lateral rim 9 caudally, and 21 (Long Iram), 26 (allotype) frontally.

P1 basipodite without medial spine; medial expansion of basipodite of P1–P4 with apical hairs. P4 coupler naked on frontal and caudal surfaces, distal margin bearing two large and acute outgrowths. Caudal spinule ornamentation of coxopodite similar to that in female: 5–8 spinules in intermittent row along distal rim, 6 relative thick and short spinules at laterodistal angle arranged in one row; spinule row along proximal rim „comb-like”, consisting of many (14, 16) fine spinules of equal size; row of hairs at midlength of segment, and reduced lateral hairs. P4 coxopodite seta 1.4–1.6 times as long as height of medial expansion of P4 basipodite. P4enp3 3.3–3.5 times as long as wide; of apical spines medial one 1.1–1.2 times longer than lateral one. Lateral edge of medial apical spine with many teeth. Lateral seta of P5 0.7 (allotype), 1.0 (Long Iram) times as long as medial spine. P6 armed with medial spine, 0.7–0.8 times as long slender seta, and 2.4 times as long lateral seta.

Distribution. *Mesocyclops papuensis* is known so far from New Guinea (P. N. G.), Java, and Borneo. It occurs in ponds, swamps, pools, shallow ditches, slow-current streams and littoral region of lakes.

Remarks. Although the type of *M. borneoensis* collected in the surroundings of Pontianak (West Borneo) was not accessible for study, comparison of the two females from Long Iram (Mahakam River Valley, East Borneo) with the types of *M. papuensis*, supports the synonymy of these taxa. In the illustration of the antennary basipodite, Dussart and Fernando (1988, Fig. 52) showed the caudal pattern without the oblique row starting in distal half of medial rim, and the field of tiny spinules near implantation of medial setae, present in *M. papuensis*, but these fine structures are easily overlooked especially when the surface of the basipodite is contaminated with sediments or microorganisms.

Mesocyclops papuensis shows strong morphological affinity to two mainland Asian species, *M. pehpeiensis* Hu, 1943 [*M. ruttneri* Kiefer, 1981 is considered here as synonym of *M. pehpeiensis* – Guo 2000] and *M. ferjemurami* described from Sri Lanka, northern India, and Vietnam (Holyńska and Nam 2000). The close relationship of *M. ruttneri* (= *M. pehpeiensis*) and *M. papuensis* was already referred to by Van de Velde (1987) and Reid (1993). The characters, which the three species share, include: relatively large size; medial spine of P1 basipodite absent; ventral surface of the antennule adorned with spinules on segment 1, 4, 5, 7–13; hyaline membrane of the last antennular segment extending far beyond implantation of the medial seta of the segment, with one large notch; second endopodal segment of the antenna bearing 7 setae, the caudal spinule ornamentation of the antennary basipodite more complex than in *M. dayakorum*; outgrowths of P4 coupler large; no proximal hairs on the caudal surface of medial expansion of P4 basipodite; pediger 5 and the genital double-somite without hair ornamentation, seminal receptacle with wide and elongate lateral arms, transverse ducts directed to each other at acute angle before connection with copulatory duct; entire posterior margin of anal somite with strong spinules; spinules at implantation of lateralmost terminal and lateral caudal setae present. *M. pehpeiensis* differs from *M. papuensis* in having: usually only one (sometimes no) circular pore (Fig. 18C) posteriorly to the horseshoe-shaped copulatory pore; few, sometimes no spinules near implantation of the medial setae on the caudal surface of the antennary basipodite (Fig. 18F); and the anterior margin of the proximal part of the seminal receptacle sinuate in the middle (Fig. 18C). *Mesocyclops ferjemurami* differs from *M. pehpeiensis* and *M. papuensis* in having distal hairs on the medial expansion of P4 basipodite, and the antennary basipodite caudally ornamented with a triangular field of spinules proximally to the spinule group at height of the medial setae. The range of *M. pehpeiensis* extends from Central Asia (South Kazakhstan, Uzbekistan) through India, Sri Lanka, Indochina, China as far as Hokkaido (Ishida 1999). Records of *M. ruttneri* from the United States refer to supposedly introduced populations of *M. pehpeiensis*. Australian occurrence of the species (Dussart and Fernando 1986) needs to be confirmed. The same holds for the Malaysian record because some of the characters

[dense apical pilosity of the medial expansion of P4 basipodite, the caudal spinule ornamentation of the antennary basipodite, the conspicuously large outgrowths of the P4 coupler, and lack of teeth on the lateral edge of the medial apical spine of P4 endopodite (Lim and Fernando 1985)] do not match the genuine *M. pephpeiensis* (Guo 2000, Holyńska and Nam 2000).

Mesocyclops aspericornis (Daday, 1906)

Cyclops aspericornis Daday, 1906: 181–184, Pl. 14, Figs 1–6; *Mesocyclops aspericornis*: Kiefer 1981: 172–173, Pl. 10; Van de Velde 1984: 42–45, Figs 28–29; Lim and Fernando 1985: 83, Table 3–4, Figs 54–56.

Mesocyclops iranicus Lindberg, 1936: 12–16, Figs 17–21. Synonymized by Ghenne and Fiers 2000.

Material examined. PHILIPPINES: 4 ♀♀ on one slide (SMNK: 4020) – “*Mesocyclops aspericornis* 4 ♀♀, Kiefer, 13.5.38; Philippinen, Woltereck, Wallacea Phil 85”. **South Luzon:** 3 ♀♀ on two slides (SMNK: 10483, 10484) – 10483: “*Mesocyclops aspericornis* 3 ♀♀, Abd+P5, Kiefer, 17.11.78; Insel Luzon, Teich bei Bato, 1313, R. Woltereck, Phil 85”; 10484: “*Mesocyclops aspericornis* 3 ♀♀, A1-P4, Kiefer, 17.11.78; Insel Luzon, Teich bei Bato, 1313, R. Woltereck, Phil 85”. **Mindanao (Camiguin I.):** 2 ♀♀ on two slides (SMNK: 10889, 10890) – 10889: “*Mesocyclops aspericornis* 2 ♀♀, Abd+P5, Kiefer, 31.3.80; Philippinen, Mindanao Camaguin[sic], Teich, 1327, Wallacea-Exp. P.121”; 10890: “*Mesocyclops aspericornis* 2 ♀♀, A1-P4, Kiefer, 31.3.80; Philippinen, Mindanao Camaguin, Teich, 1327, Wallacea-Exp. P.121”

INDONESIA. **Irian Jaya:** 1 ♀, 1 ♂ – Shallow pool under rainforest canopy or house-hold wells, Transmigration settlement Number IX, Timika, 04°30'S–136°46'E leg. E. P Ebsworth, 20 Jul 1999. **Sulawesi:** 2 ♀♀, 2 ♂♂, roadside shallow ditch; 1 ♀, shallow puddles – Saha, 1°21'S–119°57'E, 45 km SSE Palu, 200 m, leg. M. & R. Holyńska, 15 May 1989. 1 ♀, ditch draining a paddyfield; 2 ♀♀, paddyfield, actually resting – Tuwa, 1°19'S–119°57'E, 45 km SSE Palu, 200 m, leg. M. & R. Holyńska, 15 May 1989. 1 ♀ – Drain between two paddyfields, ca 1 km E Palatokke, Tana Toraja, 2°58'S–119°57'E, 800 m, leg. R. & M. Holyńska, 11 Oct 1988; 1 ♀ – Small pool in forest, Barana, 4 km NW Rantepao, 2°54'S–119°54'E, 900 m, leg. R. & M. Holyńska, 14 Oct 1988; 2 ♀♀ – Roadside puddle, Sadan, 13 km N Rantepao, 2°49'S–119°57'E, 900 m, leg. R. & M. Holyńska, 15 Oct 1988; 1 ♀ – Pool on meadow, 3 km S Pangli, 5 km N Tallunglipu, 2°54'S–119°56'E, 850 m, leg. R. & M. Holyńska, 10 Oct 1988; 4 ♀♀ – Ricefield, Tambolang, 1 km W Rantepao, 2°56'S–119°54'E, 850 m, leg. R. & M. Holyńska, 8 Oct 1988. **Borneo:** 3 ♀♀, draining ditch, 23 May 1989; 1 ♀, shallow pool in stream bed, 23 May 1989; 3 ♀♀, shallow, slow-current stream, [3], 24 May 1989; 1 ♀, swamp in sand dune area, dense vegetation, water brownish-red, [7], 25 May 1989 – Long Iram, 0°00'N/S–115°35'E, 180 km WNW Samarinda, Mahakam Riv. Valley, 80 m, leg. M. & R. Holyńska. 1 ♀ – Swamp [4/b] Muara Muntai, 0°23'S–116°22'E, 100 km W Samarinda, Mahakam Riv. Valley, 30 m leg. M. & R. Holyńska, 28 May 1989. **Java:** 2 ♀♀ – from colony, Jakarta, Aug. 1988, B. H. Kay. **Sumatra:** 8 ♀♀ (Coll. Dadayana: III 282) – “*Cyclops leuckarti*, Sumatra”.

MALAYSIA: 1 ♀, 1 ♂ – Roadside puddle, Ayer Keroh, 12 km N Malacca, 2°19'N–102°16'E, 20 m, leg. M. & R. Holyńska, 19 Sep 1988; 1 ♀ – Desaru Beach, southernmost East coast of Malay Pen., leg. T. Ishida, 14 Feb 1987.

THAILAND. 1 ♀ – Ditch with dense vegetation of *Polygonum* (?), [B], Koh Samui (Ban Lamai), 9°26'N–100°03'E, 0–30 m, leg. R. & M. Holyńska, 3 Sep 1988.

BAHAMAS. **Caicos Is.:** 1 ♀ (ZMA: 102730) – “*Mesocyclops aspericornis* 79-153” (collection data in Pesce 1985)

NETHERLAND ANTILLES. **Curacao:** 1 ♀ (ZMA) “*Mesocyclops aspericornis* 74-57” (collection data in Pesce 1985).

BRAZIL. **Ceará.** 3 ♀♀ – Maracanaú, 16 Jul. 1990, C. E. F. da Rocha.

EAST AFRICA: 3 ♀♀ (Coll. Dadayana: III/P-377) – “*Cyclops aspericornis*, Africa orient”

Description (female). Body length: 1115–1600 µm; prosome/urosome: 1.5–1.9; cephalothorax, length/width: 0.9–1.2; cephalothorax width/genital double-somite width: 2.6–3.1.

Pediger 5 (Figs 20H, 22A) with strong spine-like hairs laterally, and fine hairs on laterodorsal surface; hairs on dorsum usually absent, but distinct rows of fine hairs observed also on dorsal surface in one Bornean (Long Iram) specimen. Genital double-somite 1.1–1.3 times as long as wide, without hairs. Posteriorly to P6 six pores in group. Lateral arms of seminal receptacle (Fig. 20F) wide and elongate, anterior margin of proximal part sinuate in middle. Circular pore posteriorly to horseshoe-shaped copulatory pore usually absent. Transverse ducts (Fig. 20G) directed to each other at acute angle (V-shaped) before connection with copulatory duct; copulatory duct usually strongly curved. Anal somite with spinules along posterior margin. Caudal rami (Fig. 22D) 2.7–3.6 times as long as wide, with medial hairs at whole length. Spinules at implantation of lateral caudal and lateralmost terminal setae present. Dorsal caudal seta 0.8–1.3 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.6–3.4, 5.5–6.8, 3.9–5.0, 1.0. Longest terminal seta 1.0–1.4 times as long as urosome. Antennule, antenna maxilla, and body somites, with exception of anal somite, very often adorned with shallow pits.

Armature formula of 17-segmented antennule, as in *M. dayakorum*. Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch (Fig. 20A). Ventral spinules present on antennular segments 1, 4–5, 7–13. Antenna bearing 3 setae on basipodite and 1, 8 or 9, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule pattern of antennary basipodite complex (Fig. 20C): basic pattern (see in *M. dayakorum*) supplemented with oblique row of fine spinules starting at distal third of medial rim, wide field of tiny spinules near implantation of medial setae (laterodistal angle of field rectangular), and group of spinules between proximal oblique and longitudinal spinule rows. Spinules next to distal rim, present in single specimen found in Sulawesi (Tambolang, Tana Toraja), absent in all other females. Number of spinules in longitudinal row varies from 9 to 17. Frontal spinule ornamentation of antennary basipodite (Fig. 20B) composed of 17–34 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

Proximally to distal fringe hairs, belt of spinules present on ventral surface of labrum, epistoma pilose, fine hairs laterally to epistoma arranged in row (Fig. 21B). Mandible (Fig. 21D) bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillary palp (Fig. 21E) naked, lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite usually bearing distinct row of hair-like spinules (Fig. 21A), but in few specimens [2 females from Sulawesi (Tana Toraja) and 3 from Sumatra] coxopodite bare. Basipodite seta in front of claw-

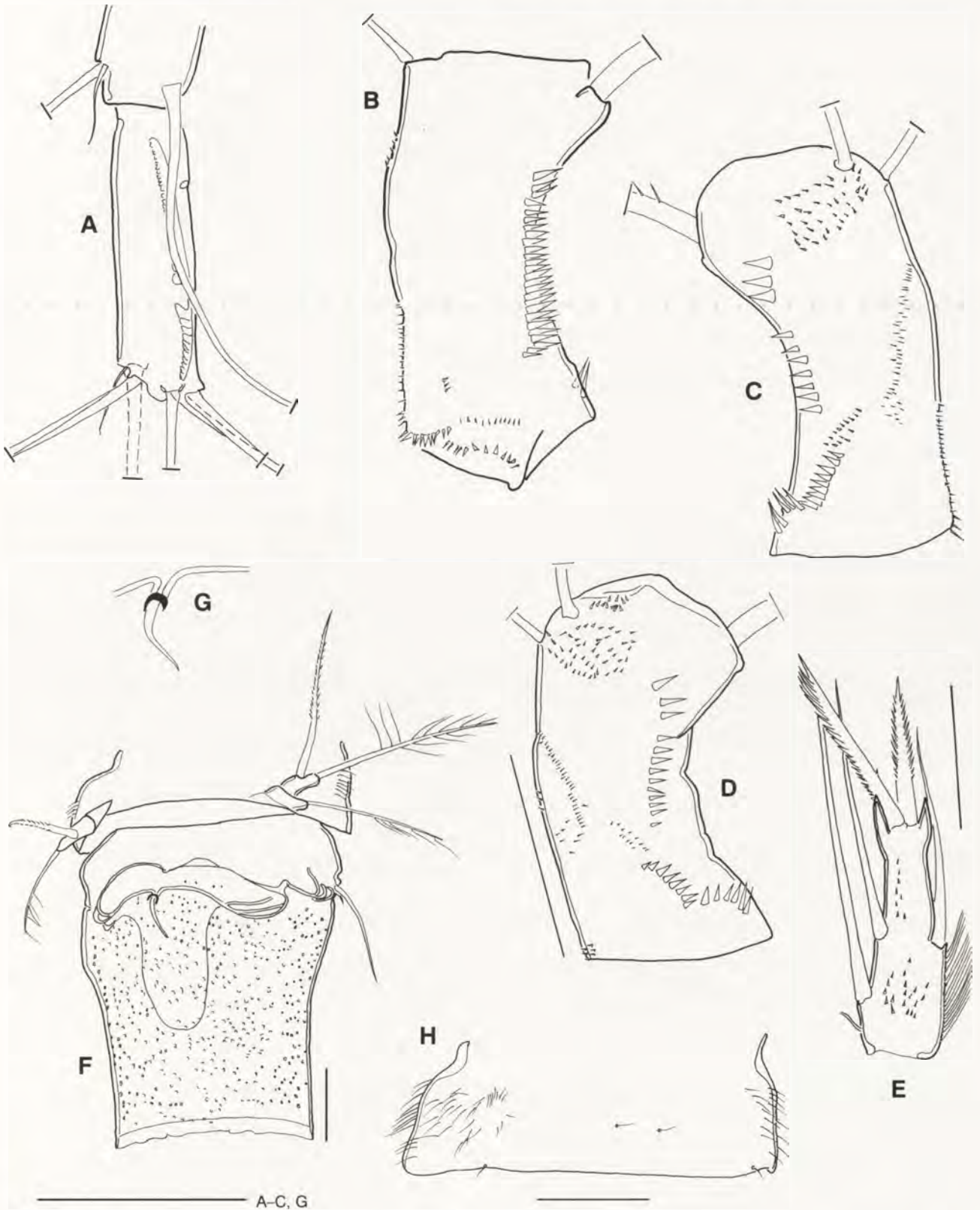


Figure 20. *Mesocyclops aspericornis* (Daday, 1906), female. (A) Last antennular segment; (B) Antennary basipodite, frontal; (C, D) Antennary basipodite, caudal: (C) Salua [Indonesia]; (D) Maracanaú [Brazil]; (E) P4enp3; (F) Pediger 5, and genital double-somite, ventral; (G) Copulatory pore and duct, and the medial section of the transverse ducts; (H) Pediger 5, dorsal. Except for (D) all the figures show specimens from Salua [Sulawesi]. Scales: 50 μ m.

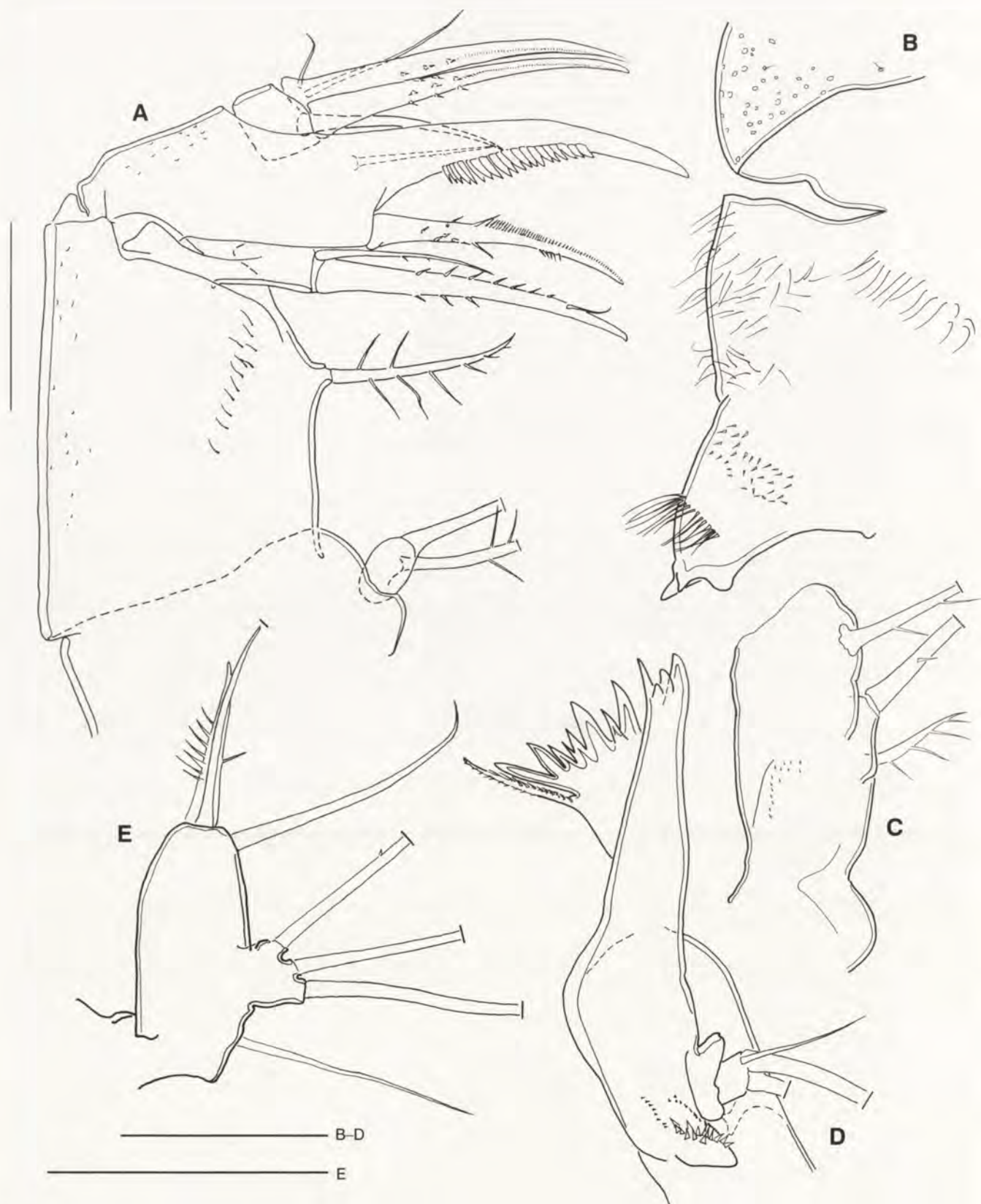


Figure 21. *Mesocyclops aspericornis* (Daday, 1906), female. (A) Maxilla, frontal; (B) Labrum, epistoma, and rostrum [Sumatra, Coll. Dadayana; III-282]; (C) Maxilliped syncopodite, frontal; (D) Mandible, frontal; (E) Maxillulary palp. Except for (B) all the figures show specimens from Salua [Sulawesi]. Scales: 50 μm .

like basal endite with fine teeth usually on posterior edge only. Maxilliped syncoxopodite (Fig. 21C) adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 like that in *M. dayakorum* (Table 2), except P1 basipodite without medial spine. Frontal surface of P1 basipodite with large spinules arranged in semicircular arch (Fig. 22E); medial expansion of basipodite of P1–P4 with apical hairs. Apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface. Couplers naked on frontal and caudal surfaces in P1–P4, distal margin of P4 coupler bearing two small, acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 22B) composed of: 4–9 spinules in intermittent row along distal rim; 4–11 thick spinules at laterodistal angle arranged usually in one row; 4–11 relatively large spinules in one row along proximal rim; and dense lateral hairs. P4 coxopodite seta 1.5–1.9 times longer than height of medial expansion of P4 basipodite. P4enp3 (Fig. 20E) 2.4–3.0 times as long as wide; of apical spines medial one 1.1–1.5 times as long as lateral; longer (medial) spine 0.8–0.9 times as long as segment. Lateral edge of medial apical spine with no or few teeth only. Apical seta of P5 1.1–1.6 times as long, lateral seta 0.7–1.1 times as long as medial spine.

Male. Body length: 720–865 μm ; prosome/urosome: 1.7–2.0; cephalothorax, length/width: 1.2. Pediger 5 (Fig. 23D) with lateral hairs. P6 flaps (Fig. 23D) adorned with complex pattern of tiny spinules. Anal somite with spinules along entire posterior margin. Caudal rami (Fig. 23E) 2.6–3.0 times as long as wide. Spinules at implantation of lateralmost terminal setae and lateral caudal setae present. Dorsal caudal seta 0.9–1.2 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.7–3.2, 5.6–6.3, 3.8–4.4, 1.0. Longest terminal seta 1.2–1.5 times as long as urosome.

Antennule 16-segmented, but with incomplete subdivision of compound apical segment. Armature formula: 8+3ae, 4, 2, 2+ae, 2, 2, 2, 2, 1+ae+sp, 2, 2, 2, 2+ae, 2, 1+ae, [5, 7+ae]. At distal geniculation plate-like structures (one on segment 14 and two on segment 15) with striated surface and single pore, and one short conical element on segment 14 and 15 each (Fig. 49B,C). First antennular segment ornamented with row of spinules on ventral surface.

Antenna armed with three setae on basipodite, and 1, 6, and 7 setae on endopodal segments 1–3, respectively – as an abnormality an extra eighth seta appeared on medial surface of endopodite 3, near tip of segment (Fig. 23C), in one antenna of the male collected in Ayer Keroh (Malaysia). Caudal spinule pattern of antennary basipodite (Figs 23A,B) like in female. Number of spinules in longitudinal rows along lateral rim on caudal and frontal surfaces 10–11 and 17–20 respectively. In contrast to rich hair and spinule ornamentation present in female, labrum bearing distal fringe hairs only, epistoma bare. Armature of mandible, maxillule, and maxilliped the same as in female. Setation of maxilla like in female, but frontal surface of syncoxopodite adorned with tiny spinules only.

P1 basipodite without medial spine; frontal surface of basipodite with large spinules arranged in semicircular arch. Apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface. P4 coupler with two small acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 22C) composed of: 5–7 spinules in continuous or intermittent row along distal rim; spinules (6–8) at laterodistal angle arranged in row; 10–12 robust spinules in one/two rows along proximal rim; and reduced lateral hairs. P4 coxopodite seta 1.7–1.8 times longer than height of medial expansion of P4 basipodite. P4enp3 2.6–3.0 times as long as wide; of apical spines medial one 1.1–1.3 times as long as lateral; longer spine (medial) 0.9–1.0 times as long as segment. Lateral edge of medial apical spine with 5–7 teeth. Apical seta of P5 1.4–1.5 times as long, lateral seta 0.8–0.9 times as long as medial spine. P6 armed with medial spine, ca. 1.1 times as long slender seta, and 2.5–3.2 as long lateral seta.

Distribution. Pantropical. Within Australasia and Oceania *M. aspericornis* has been found in South Thailand, Malay Peninsula (see also Lim and Fernando 1985), Sumatra, Java, Sabah and Sarawak (Dussart and Fernando 1986), Kalimantan, Sulawesi, Philippines, Irian Jaya, Papua New Guinea (Van de Velde 1987) northeastern Australia (Brown et al. 1991), Mariana, Marshall, Hawai'i Islands (Kiefer 1981), and French Polynesia (Rivière et al. 1987).

Biology. *Mesocyclops aspericornis* has been usually encountered in low density, but in an extremely wide variety of the habitats [lake/pond, river, ricefield, swamp, well, groundwaters, small ephemeral waterbodies, phytotelmata, water storage containers, discards^f (a world-wide overview of the collection data is given by Reid and Saunders 1986)], which suggests great ecological flexibility. This relatively large-sized and widely distributed cyclopoid is a highly effective predator of *Aedes* species, and has been the focus of mosquito control researches, especially in the Old World tropics, since the eighties (Rivière et al. 1987). The studies comparing temperature, pH, salinity, food level, chlorine and desiccation tolerances of different *Mesocyclops* species (Marten et al. 1994, Jennings et al. 1994, Brown et al. 1994, Zhen et al. 1994) luckily provide some information on ecological requirements. The laboratory and field investigations revealed order of magnitude differences in salinity tolerance between *aspericornis* populations (land crab burrows, French Polynesia vs. lake, Queensland, Australia), a slower population growth in comparison with *M. darwini* on the same alga-Protozoa medium, and the ability of the adults and larvae of *M. aspericornis* to survive the disappearance of free water in moist sediment. These results are in accord with the hypothesis of Reid and Saunders (1986) that *M. aspericornis* is a „fugitive species“ characterized by good dispersal power (desiccation resistance, ecological flexibility) but poor competitive abilities (slower growth in comparison with the congeners).

Remarks. Daday (1906) described the species from a material collected by Walter Volz in Singapore, Sumatra [a Javanese record from Buitenzorg (=Bogor) is also men-

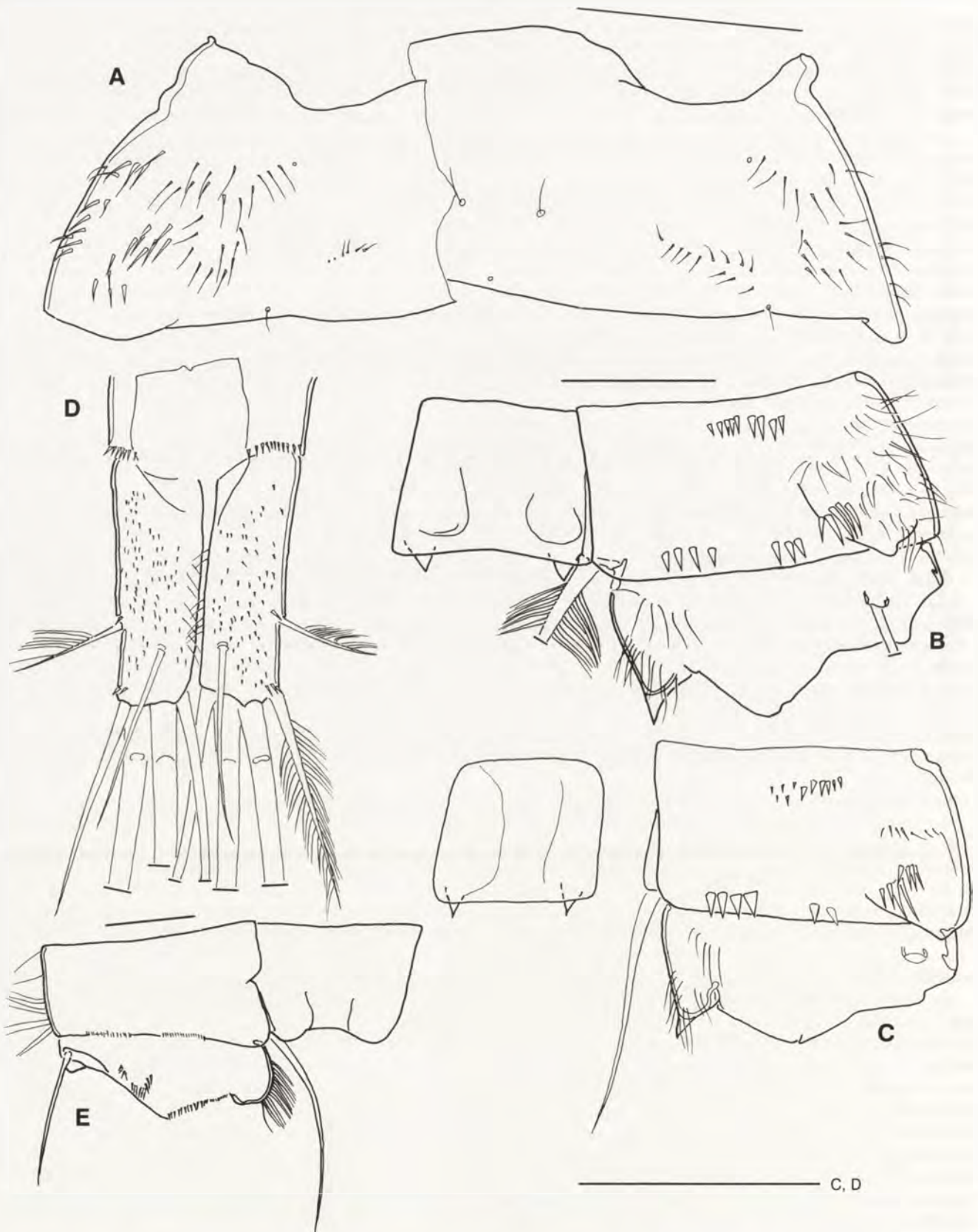


Figure 22. *Mesocyclops aspericornis* (Daday, 1906). (A) Pediger 5, dorsal, female [Borneo: Long Iram]; B, C. P4 protopodite, caudal: (B) female; (C) male; (D) Caudal rami, dorsal, female; (E) P1 protopodite, frontal, female. Except for (A) all the figures show specimens from Salua [Sulawesi]. Scales: 50 μm .

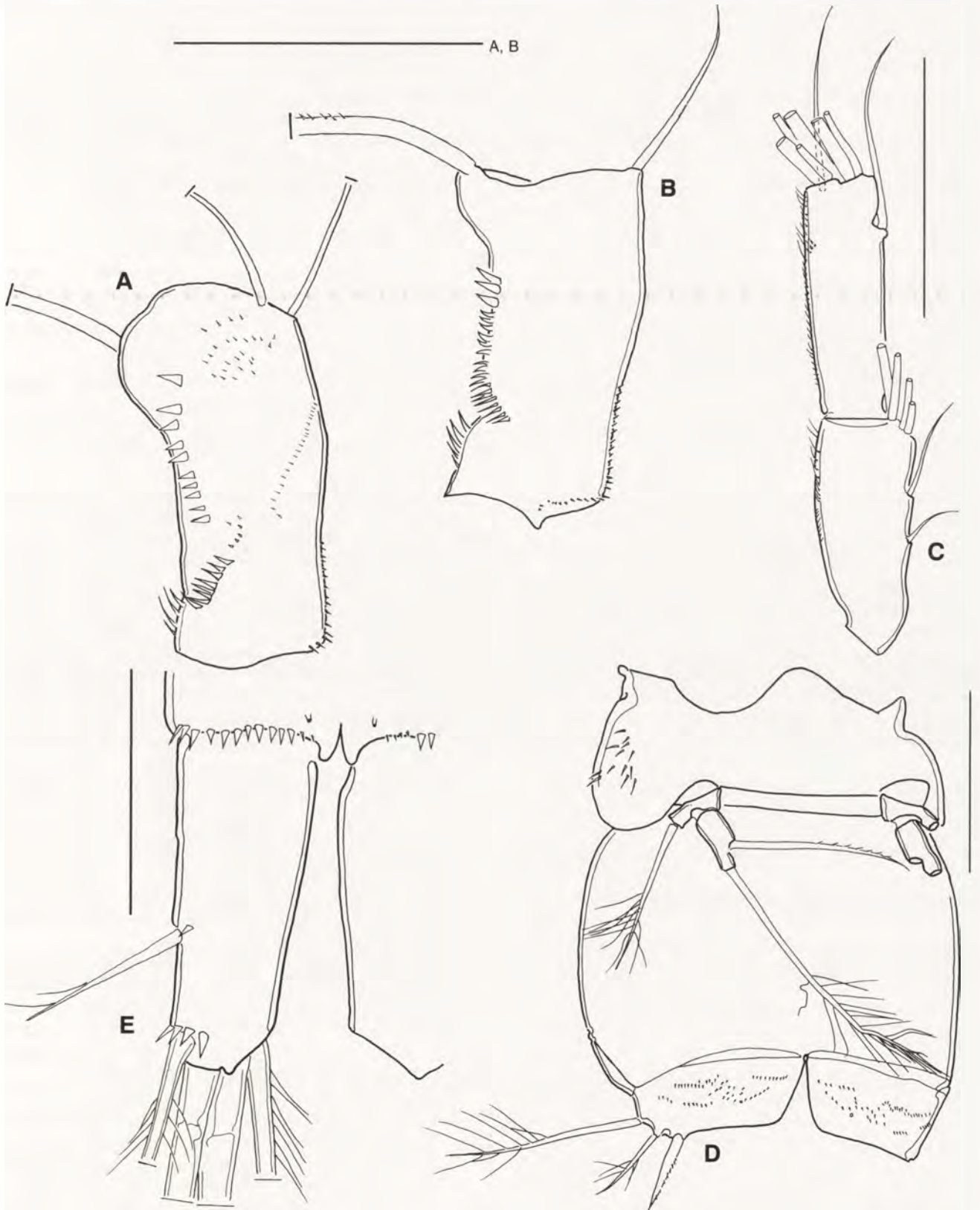


Figure 23. *Mesocyclops aspericornis* (Daday, 1906), male. (A) Antennary basipodite, caudal; (B) Antennary basipodite, frontal; (C) Aberrant setation of the third endopodal segment of the antenna [Malaysia: Ayer Keroh]; (D) Pediger 5, and genital segment, ventral [Irian Jaya: Timika]; (E) Caudal ramus, ventral. Except for (C) and (D), all the figures show specimens from Salua [Sulawesi]. Scales: 50 μ m.

tioned in the description part, but missing from the list of Javanese copepods in which Daday summarized his identification results (p.178)], and Hawai'i (Oahu). Unfortunately I failed to find any trace of the type material in the Collection of Daday (Budapest, Natural History Museum). The Sumatran *M. aspericornis* specimens in vial III-282 studied here, were labelled as „*Cyclops leuckarti*” without any reference to the name of the collector, locality, or date of the collection. No other material under the name „*Cyclops leuckarti*” or „*Cyclops aspericornis*” collected in Singapore or Hawaii is deposited in Budapest (Fórró and Dussart 1985) either. The single slide labelled as *Cyclops aspericornis* actually contained three females of *Mesocyclops aequatorialis* from East Africa. Van de Velde noticed (1984), that Kiefer had made a redescription (1981) based on the type material, yet Kiefer himself did not mention that he had seen Daday's material, moreover all *M. aspericornis* specimens from Sumatra, Singapore or Hawai'i deposited in the Kiefer Collection (Karlsruhe), were either collected after appearance of the original description, or there is no indication of origin of the specimens.

The exceptionally wide occurrence of *M. aspericornis* poses several intriguing questions as to the morphological uniformity/variability, yet nobody has thoroughly compared populations throughout the geographic range of the species. Van de Velde (1984) reported a slight morphological difference between the Sumatran, East African and West African populations in the caudal spinule ornamentation of the antennary basipodite: a distal row of spinules present in the specimens from West Africa is absent in the eastern African and Sumatran populations. The sporadic observations made on females from Uzbekistan (Mirabdullayev 1996), Malaysia (Lim and Fernando, 1985), Indochina, and Australasia show the Asian populations to agree in this respect with the East African ones. Surprisingly, Ghene and Fiers (2000) found the spinules typical of West African specimens also in two females collected in SW Iran (Laristan), but to estimate the frequency of this feature in Iranian populations, an investigation based on much larger sample would be necessary. I have also examined the spinule ornamentation in some females from the Neotropics [Brazil, 3♀♀; Curaçao, 1♀; Caicos Is., 1♀]. The spinule pattern (Fig. 20D) in all of them agreed with the West African one. Another feature in which these specimens also seem to differ from the Oriental populations, is that three (Caicos, Curaçao, Brazil) of the five females were armed with seven setae on the second endopodal segment of the antenna, and the remaining two Brazilian specimens had eight setae. The literature data (Daday 1906, Mirabdullayev 1996) and all observations made on Australasian specimens concordantly show, that the females from Uzbekistan to New Guinea bear eight or nine setae on the second endopodal segment of the antenna, while the seven setae-state has never been reported so far. Unfortunately it is not clear, which character state is present in the African and Iranian populations. Van de Velde's formulation in the redescription (1984) based on specimens from Ghana „Structure of endopodite as in *M.*

leuckarti.” might suggest that the West African females also bear seven setae on the second endopodal segment of the antenna. This, however, is a presumption only, which needs further verification. The slight differences in the two characters mentioned above may indicate a subspecies-level divergence of the eastern and western populations of *M. aspericornis*. To confirm this hypothesis, it is necessary to compare a large set of samples, representing the whole zoogeographical area of *M. aspericornis*.

Mesocyclops ogunnus Onabamiro, 1957

Mesocyclops ogunnus Onabamiro, 1957: 125–127, Figs 7–12; Van de Velde 1984: 31–36, Figs 19–22; Dussart and Fernando 1988: 250–251, Figs 28–30; Reid and Kay 1992: 338–339, Figs 3d–f; Holyński and Fiers 1994: 41–54, Fig. 4e; Mirabdullayev 1996: 96, Figs 12–17; Holyńska 1997a: 27–30, Fig. 4G.

Material examined. MALAYSIA: 2♀♀ – Desaru Beach, leg T. Ishida, 14 Feb 1987. PAPUA NEW GUINEA: 1♀ – Lagoon, shore, 9°02'S–146°45'E, 20 km E Obo Mission, 70 km NW Port Moresby, Central Prov. [135/b], leg. M. & R. Holyński, 22 Apr 1989.

Description (female). Body length: 1000–1120 µm; prosome/urosome: 1.7–1.9; cephalothorax, length/width: 1.1–1.2; cephalothorax width/genital double-somite width: 2.8–3.2.

Pediger 5 (Fig. 24C) laterally and dorsally pilose, two medial and two laterodistal sensilla on dorsal surface of somite. Genital double-somite 1.2–1.3 times as long as wide, without hairs. Lateral arms of seminal receptacle (Fig. 24E) wide and short, anterior margin of proximal part sinuate in middle. Posteriorly to horseshoe-shaped copulatory pore one circular pore. Transverse ducts directed to each other at obtuse angle (not V-shaped) before connection with copulatory duct; copulatory duct slightly or strongly curved. Strong spinules along entire posterior margin of anal somite. Caudal rami 2.7–2.9 times as long as wide, without medial hairs. Spinules at implantation of lateralmost terminal setae always present, at implantation of lateral caudal setae present or absent. Dorsal caudal seta slightly shorter or longer than lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.6–2.8, 6.1–6.7, 3.9–4.2, 1.0. Longest terminal seta ca. 1.3 times as long as urosome.

Armature formula of 17-segmented antennule, as in *M. dayakorum*. Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch. Ventral spinules present on segments 1–4, 5, 7–13, dorsal surface of antennular segments sometimes adorned with shallow pits.

Antenna armed with 3 setae on basipodite and 1, 8 or 9, and 7 setae on endopodal segments 1–3 respectively. Caudal spinule ornamentation of basipodite (Fig. 24A) composed of: long spinules on lateral, and tiny spinules on medial rim near base of segment; 6 (Malaysia) or 13 (PNG) spinules in oblique row next to long lateral spinules near base; 10–12 (Malaysia) or 16 (PNG) spinules in longitudinal row near lateral rim; oblique row of fine spinules starting at distal third of medial rim, diffuse patch of spinules under this row; row

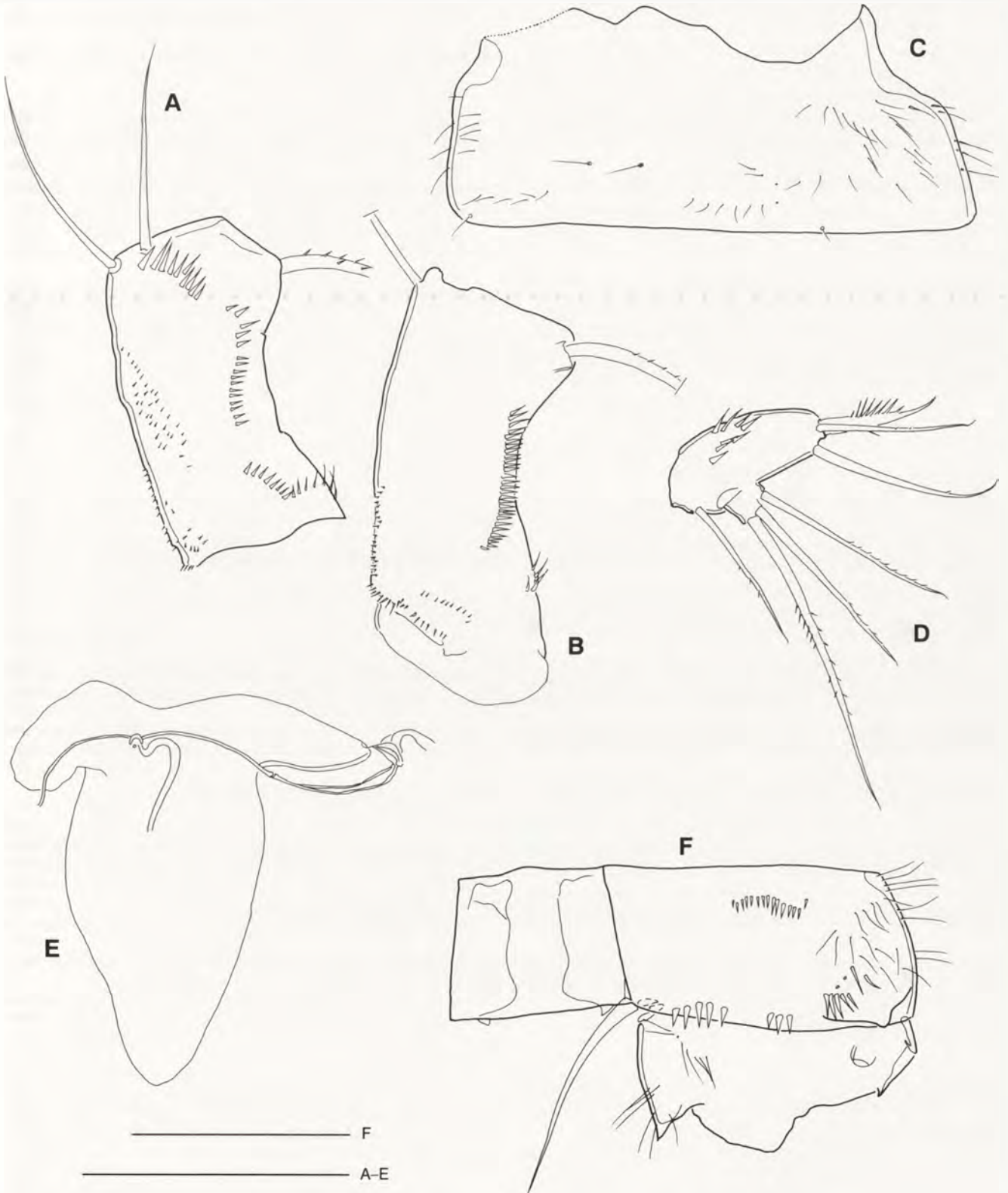


Figure 24. *Mesocyclops ogunnus* Onabamiro, 1957, female [Papua New Guinea: Obo Mission]. (A) Antennary basipodite, caudal; (B) Antennary basipodite, frontal; (C) Pediger 5, dorsal; (D) Maxillular palp; (E) Seminal receptacle; (F) P4 protopodite, caudal. Scales: 50 μ m.

of large spinules (7–10) near implantation of medial setae. Frontal spinule ornamentation of antennary basipodite (Fig. 24B) composed of 18–25 (Malaysia) or 29 (PNG) spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

Segmentation and setation of mouthparts typical for genus (for detailed characterization see the description of *M. dayakorun*). Distal fringe hairs on ventral surface of labrum, fine hairs on epistoma and in vertical cleft. Mandible bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillary palp (Fig. 24D) bearing group of large spinules, lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite with distinct row of spinules. Basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only. Maxilliped syncoxopodite adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 as in *M. dayakorun* (Table 2) except P1 basipodite without medial spine. Frontal surface of P1 basipodite with large spinules arranged in semicircular arch; medial expansion of P1–P4 basipodite with apical hairs. Medial expansion of P4 basipodite bearing long proximal hairs on caudal surface. Couplers naked on frontal and caudal surfaces, distal margin of P4 coupler with two small, obtuse or acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 24F) composed of: 7–10 spinules in intermittent row along distal rim; 10–16 elongate spinules arranged in group at laterodistal angle; many (11–18), large spinules along proximal rim; dense lateral hairs. P4 coxopodite seta 1.6–1.9 times longer than height of medial expansion of P4 basipodite. P4enp3 2.5–2.9 times as long as wide; of apical spines medial one 0.9–1.2 times as long as lateral. Lateral edge of medial apical spine with many teeth. Apical seta of P5 1.2–1.3 times as long, lateral seta 0.8–0.9 times as long as medial spine.

Distribution. Afro-Asian species: its range extends from West Africa as far as Kyushu Island (Japan). Northernmost records from Northeast Algeria in Africa (Samraoui et al. 1998), and from Uzbekistan in Asia (Mirabdullayev 1996); southernmost record from Natal in Africa (Van de Velde 1984). The southern limit of Asian distribution is still questionable. Dussart and Fernando (1988) made a short mention of a *Mesocyclops* (single female) „très proche de *M. ogunnus*” from East Java. The unexpected finding of a single female of *M. ogunnus* in Papua New Guinea (Central Prov.), does not necessarily indicate a natural distribution in Australasia. The species has also been recorded from Brazil (Reid and Pinto-Coelho 1994) and the Caribbean Cayman Islands (Suárez-Morales et al. 1998), where its restricted distribution suggests recent introduction.

***Mesocyclops affinis* Van de Velde, 1987**

Mesocyclops affinis Van de Velde, 1987: 151–156, Figs 15–27.

Mesocyclops thermocyclopoides acutus Dussart et Fernando, 1988: 254, 255, Figs 43–50; Reid and Kay 1992: 340–341, Figs 4a–d – synonymized by Holyński 1994a.

Mesocyclops thermocyclopoides: Dussart and Fernando 1988 [partim]: 245–246, Figs 8–10.

Types. *Mesocyclops affinis*: Holotype, ♀, (KBIN: 26528/A, 3196), 3 paratypes, ♀♀, (KBIN: 26528/B–D, 3196), 1 allotype, ♂, (KBIN: 26528/E, 3196) – Pool in bombhole, between Awar and Awar airfield, 04°09'S–44°51'E, Madang Prov., Papua New Guinea, leg. K. Wouters, 24 May 1982.

Other material examined. PAPUA NEW GUINEA: 3♀♀ – Swamp, Riwo village, 9 km N Madang, 5°09'S–145°48'E, Madang Prov., [57] leg. R. & M. Holyński, 02 Mar 1989.

INDONESIA. **Lombok:** 1♀ (SMNK: 10525) – „*Mesocyclops* ♀ zerlegt. Kiefer 1.2.79; Lombok, Segare Anak (11) G. Heberer 6.4.1927. **Bali:** 2♀♀ on two slides (SMNK: 10461, 10462) – 10461: „*Mesocyclops* 2♀♀, Abd+P5, Kiefer 11.11.78; Bali, Danu Batur, Plankton (114), 878, D. L. Sunda-Exp., 21.6.1929”; 10462: „*Mesocyclops* 2♀♀, A1-P4, Kiefer 11.11.78; Bali, Danu Batur, Plankton 878, D. L. Sunda-Exp. (114), 21.6.1929”. **Java:** 2♀♀, 1♂ – Lake in Botanical Garden, Bogor, 6°37'S–106°48'E, 200 m, leg. R. & M. Holyński, 30 Sep 1988; 3♀♀ – Ricefield, Pabelan village, Semarang Regency, leg. G. Marten, Nov 1994. **Sumatra:** 2♀♀ together with one unidentified *Mesocyclops* ♀ on one slide (SMNK: 10481) – „*Mesocyclops* 3♀♀, zerlegt Kiefer 16.11.78; Sumatra, Toba-Meer (1c) 883, D. L. Sunda Exp., 15.4.1929”; 1♂ – Lake Toba, St. 5., leg. C. H. Fernando, 7 Jul 1977; 3♀♀ (Coll. Dadayana, III 282) – „*Cyclops leuckarti*, Sumatra”. **Sulawesi:** 1♀ – drain-ditch between two paddyfields, ca 1 km E Palatokke, Tana Toraja, 2°58'S–119°57'E, 800 m, leg. R. & M. Holyński, 11 Oct 1988. 1♀, paddyfield; 4♀♀ marsh with Sago – Tuwa, 1°19'S–119°57'E, 45km SSE Palu, 200 m, leg. M. & R. Holyński, 15 May 1989. **Borneo:** 1♀, 2♂♂, swamp, [4b]; 1♀, 2♂♂, 1CV, swamp, depth ca. 1 m, [3]; 3♀♀, ditch, ca. 0.5 m deep, dense vascular plant vegetation, [1/b] – Muara Muntai, 0°23'S–116°22'E, 100 km W Samarinda, Mahakam Riv. Valley, 30 m leg. M. & R Holyński, 28 May 1989.

MALAYSIA: 2♀♀ – Desaru Beach, southernmost East coast of Malay Pen., leg. T. Ishida, 14 Feb 1987; 1♀ – Swampy meadow, Malacca, 2°12'N–102°15'E, 0–50 m, leg. R. & M. Holyński, 15 Sep 1988; 2♀♀, 1♂ – Lake in recreational park, shore, Ayer Keroh, 12 km N Malacca, 2°19'N–102°16'E, 20 m, leg. R. & M. Holyński, 19 Sep 1988; 1♀ – 10 mi Raub, leg. R. P. Lim, 25 May 83.

Comparative material. *Mesocyclops aequatorialis* s. str.: 4♀♀ on two slides (SMNK: 10391, 10392) – 10391: „*Mesocyclops aequatorialis* Neotypus 4♀♀, A1–P4, Kiefer 23.8.78; Zaire Kivu-Seq, Ngoma 1726, Damas coll., 12.4.35”; 10392: „*Mesocyclops aequatorialis* Neotypus 4♀♀, Abd–P5, Kiefer 23.8.78; Zaire Kivu-See, Ngoma 1726, Damas coll., 12.4.35”. 1♀ (KBIN) – „*Mesocyclops aequatorialis* (Kiefer) Tanganika 50611a”, 03°20'S–29°10'E, leg. L. Symoens, Aug 1955–Nov 1955, det. I. Van de Velde; 1♀ (KBIN) – „*Mesocyclops aequatorialis* (Kiefer) Tanganika 50611b”, 03°20'S–29°10'E, leg. L. Symoens, Aug 1955–Nov 1955, det. I. Van de Velde.

Mesocyclops aequatorialis similis: 1♀ (KBIN) – „*Mesocyclops aequatorialis similis* Lake Tana Ethiopie 5-82, 60/a” det. I Van de Velde; 1♀ (KBIN) – „*Mesocyclops aequatorialis similis* Wamba Bangwe, 93 Zaire” 02°03'N–28°00'E, leg. P. van Oye, 21 Nov 1957, det. I. Van de Velde; 1♀ (KBIN) – „*Mesocyclops aequatorialis similis* Lake Awassa, Ethiopie 37” 07°02'N–38°20'E, leg. H. Dumont & H. Verheye, 18 May 1982, det. I. Van de Velde; 1♀ (KBIN) – „*Mesocyclops aequatorialis similis* Lake Awassa, Ethiopie 37c” 07°02'N–38°20'E, leg. H. Dumont & H. Verheye, 18 May 1982, det. I. Van de Velde; 1♀ (KBIN) – „*Mesocyclops aequatorialis similis* Debre Marcos, Ethiopie 65” 10°11'N–38°10', det. I. Van de Velde; 1♀ (KBIN) – „*Mesocyclops aequatorialis similis* Debre Marcos, 40 km S, Ethiopie 65” 10°11'N–38°10'E, det. I. Van de Velde; 1♀ (KBIN) – „*Mesocyclops aequatorialis similis* Debre Marcos, 40 km S, Ethiopie 64.” 10°11'N–38°10'E, leg. H. Dumont & H. Verheye, 23 May 1982; det. I. Van de Velde.

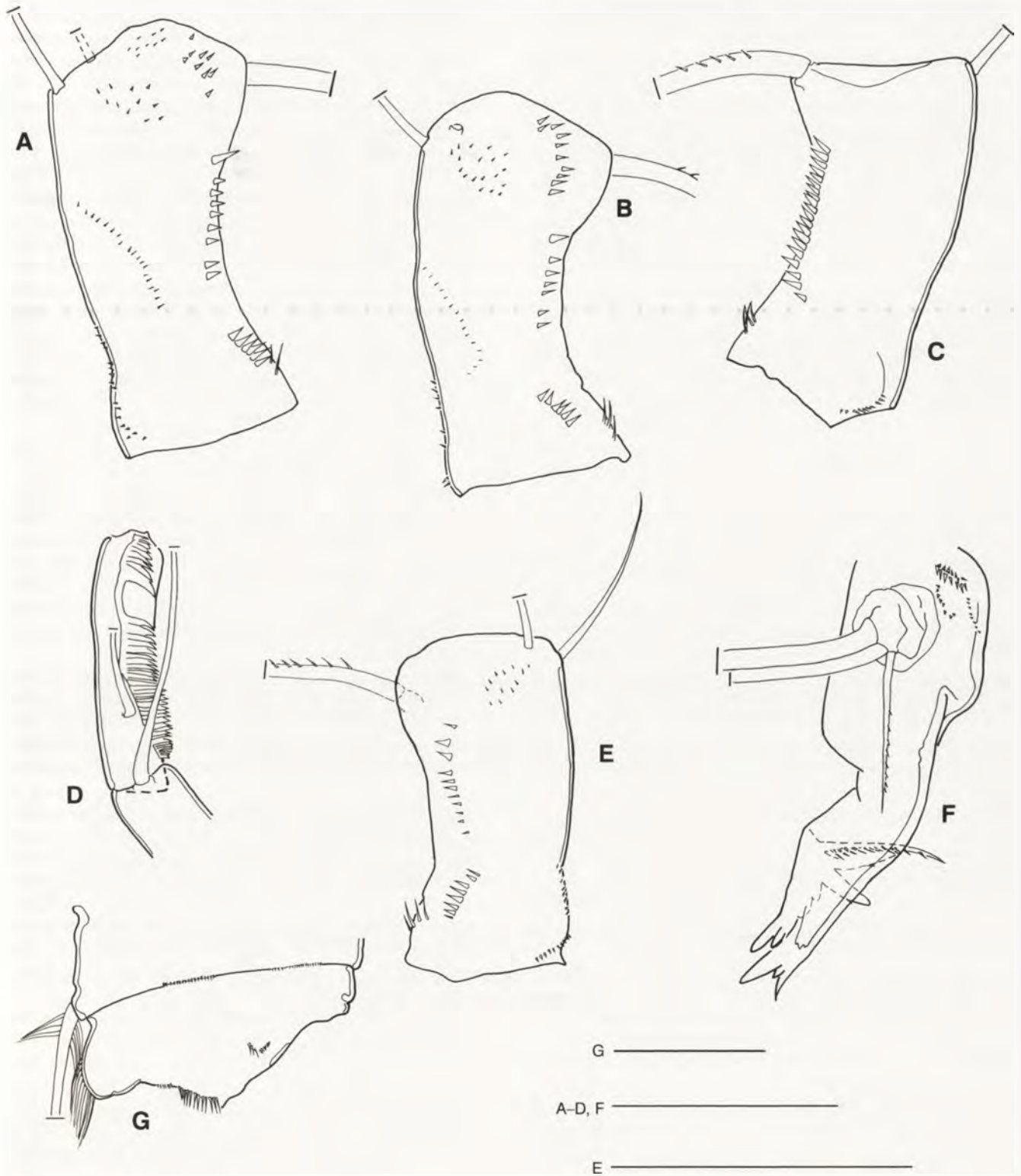


Figure 25. *Mesocyclops affinis* Van de Velde, 1987. A, B. Intraspecific variability of the caudal spinule ornamentation of the antennary basipodite [Borneo: Muara Muntai]; (C) Antennary basipodite, frontal [Borneo: Muara Muntai]; (D) Last antennular segment [Papua New Guinea: Riwo]; (E) Antennary basipodite, caudal [male allotype]; (F) Mandible [paratype]; (G) P1 basipodite, frontal [Borneo: Muara Muntai]. Except for (E), all the figures show females. Scales: 50 μ m.

Description (female). Body length: 860–1285 μm ; prosome/urosome: 1.6–1.9; cephalothorax, length/width: 1.0–1.2; cephalothorax width/genital double-somite width: 2.8–3.3.

Pediger 5 with lateral hairs only, two medial and two laterodistal sensilla present on dorsal surface of somite. Genital double-somite (Figs 26C,D) 1.2–1.3 times as long as wide, without hairs. Posteriorly to P6 six pores in group. Lateral arms of seminal receptacle (Figs 26C,D) wide and short, anterior margin of proximal part sinuate in middle, horseshoe-shaped copulatory pore often near anterior margin. Posteriorly to copulatory pore one circular pore present. Transverse ducts directed to each other at straight or nearly straight angle (not V-shaped) before connection with copulatory duct; copulatory duct straight or slightly curved. Anal somite with spinules along posterior margin. Caudal rami (Fig. 27E) short, 2.3–3.2, times as long as wide, without hairs. Spinules at implantation of lateralmost terminal setae always present, at implantation of lateral caudal setae spinules present, or absent. Dorsal caudal seta 0.8–1.2 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.5–3.5, 5.4–7.4, 3.6–5.2, 1.0. Longest terminal seta 1.2–1.5 times as long as urosome.

Serrate hyaline membrane on last antennary segment, extending far beyond implantation of medial seta of segment, with one, very large notch (Fig. 25D). Ventral spinules present on antennary segments 1 4–5, 7–13, (in one of two specimens from Bali spinules also present on segment 14), dorsal surface of antennule (most often segments 1, and 4) sometimes adorned with shallow pits. Antenna bearing 3 setae on basipodite and 1, 7, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule pattern of antennary basipodite complex and variable (Figs 25A,B): basic pattern (see in *M. dayakorum*) supplemented with oblique row of fine spinules starting at half or distal third of medial rim, field of tiny spinules near implantation of medial setae, group of relatively large spinules at laterodistal angle, and few tiny spinules near distal rim. Groups of spinules at laterodistal angle and next to distal rim sometimes absent. Spinules (7–16) in longitudinal row along lateral rim of similar size, largest max. twice as long as smallest. Frontal spinule ornamentation of antennary basipodite (Fig. 25C) composed of 20–40 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

Proximally to distal fringe hairs belt of fine hairs present on ventral surface of labrum, epistoma and vertical cleft also pilose. Mandible (Fig. 25F) bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillulary palp (Fig. 26B) naked, lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite with distinct row of spinules (Fig. 26A). Basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only. Maxilliped syncopodite adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 as in *M. dayakorum* (Table 2) except P1 basipodite lacking medial spine. Frontal surface of P1 basipodite with large spinules arranged in semicircular arch (Fig. 25G); medial expansion of basipodite of P1–P4 with apical hairs. Medial expansion of P4 basipodite bearing long proximal hairs on caudal surface. Couplers of P1–P4 naked on frontal and caudal surfaces, distal margin of P4 coupler with two small, obtuse or acute outgrowths (Figs 27B–D). Caudal spinule ornamentation of P4 coxopodite (Figs 27A–C) composed of: 9–14 spinules in continuous or intermittent row along distal rim; spinules at laterodistal angle arranged in row or group; 13–20 relatively large spinules in one or two rows along proximal rim; and dense lateral hairs. P4 coxopodite seta 1.6–2.1 times longer than height of medial expansion of P4 basipodite. P4enp3 2.4–3.2 times as long as wide; of apical spines medial one 1.0–1.2 times as long as lateral. Lateral edge of medial apical spine with few teeth usually. Apical seta of P5 1.1–1.6 times as long, lateral seta 0.5–1.1 times as long as medial spine.

Male. Body length: 645–980 μm ; prosome/urosome: 1.4–1.9; cephalothorax length/width: 1.0–1.3. Pediger 5 without lateral hairs. Anal somite with spinules along posterior margin. Caudal rami 2.2–2.8 times as long as wide, without hairs. Spinules at implantation of lateral caudal, and lateralmost terminal setae present. Dorsal caudal seta 0.8–1.0 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.4–2.6; 5.0–6.1; 3.7–4.2; 1.0. Longest terminal seta 1.1–1.5 times as long as urosome.

Antenna armed with 3 setae on basipodite and 1, 6, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of antennary basipodite (Fig. 25E) similar to that in female. Basic pattern (see in *M. dayakorum*) can be supplemented in variable combinations of following elements: oblique row of fine spinules starting at half or distal third of medial rim, field of tiny spinules near implantation of medial setae and group of relatively large spinules at laterodistal angle. Spinules (7–11) in longitudinal row along lateral rim, of similar size. Frontal spinule ornamentation of antennary basipodite composed of 22–31 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim. Armature of mandible, maxillulary palp, syncopodite of maxilla and maxilliped like in female.

P1 basipodite without medial spine; medial expansion of basipodite of P1–P4 with apical hairs. Apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface. P4 coupler with two small, acute or obtuse outgrowths. Caudal spinule ornamentation of P4 coxopodite composed of 9–14 spinules in continuous or intermittent row along distal rim, spinules at laterodistal angle arranged in row or group, 13–19 relatively large spinules in one row along proximal rim, and reduced lateral hairs. P4 coxopodite seta 1.5–1.6 times longer than height of medial expansion of P4 basipodite. P4enp3 2.6–3.3 times as long as wide; of apical spines medial one 0.9–1.3 times as long as lateral. Lateral edge of medial apical spine with many teeth. Apical seta of P5 1.6–1.9 times

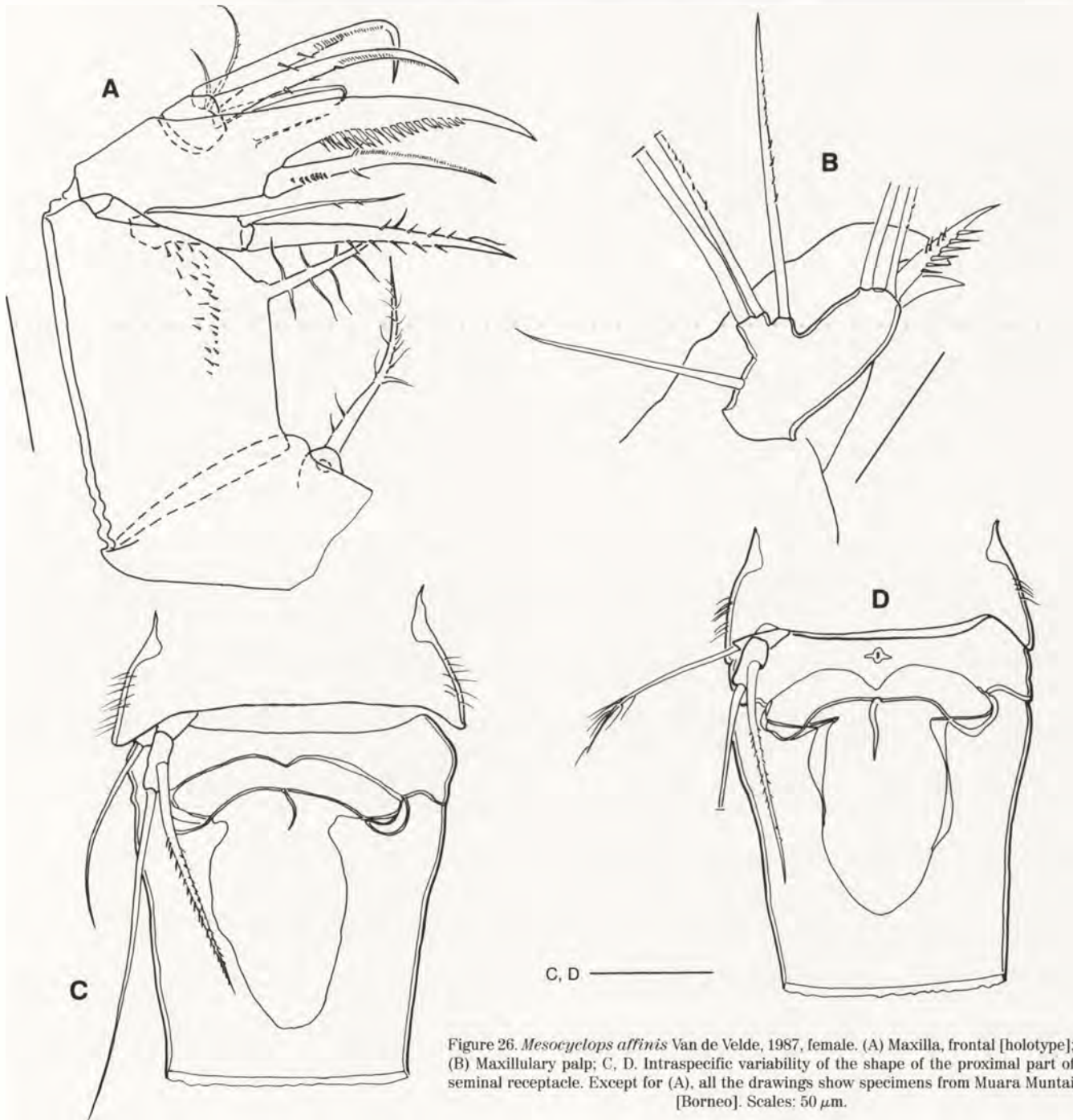


Figure 26. *Mesocyclops affinis* Van de Velde, 1987, female. (A) Maxilla, frontal [holotype]; (B) Maxillulary palp; C, D. Intraspecific variability of the shape of the proximal part of seminal receptacle. Except for (A), all the drawings show specimens from Muara Muntai [Borneo]. Scales: 50 μ m.

as long, lateral seta 1.2–1.3 times as long as medial spine. P6 armed with medial spine, ca. 1.4 times as long slender seta, and twice as long lateral seta.

Distribution. Range extends at least from New Guinea through Indonesia, Malaysia as far as Indochina.

Biology. *Mesocyclops affinis* lives in various kinds of waterbodies like shallow ditches, swamps, lake shore, ponds, rainwater tanks, jars, ricefields, and also in plankton of large deep lakes (e.g. Pangururan Bay in L. Toba,

Sumatra, depth. 97 m, and L. Batur, Bali, depth 88 m – characteristics of collecting sites of *Mesocyclops* specimens deposited in Kiefer's Collection based on information provided in Kiefer 1933, and Ruttner 1952). In the four females collected in the plankton of deep lakes, the length to width ratio of P4enp3 shows higher values (3.0 and 3.1–3.2 in L. Toba and L. Batur, respectively), than ever observed in other populations. I have not found similar shifts in the relative length of P5 setae and dorsal caudal

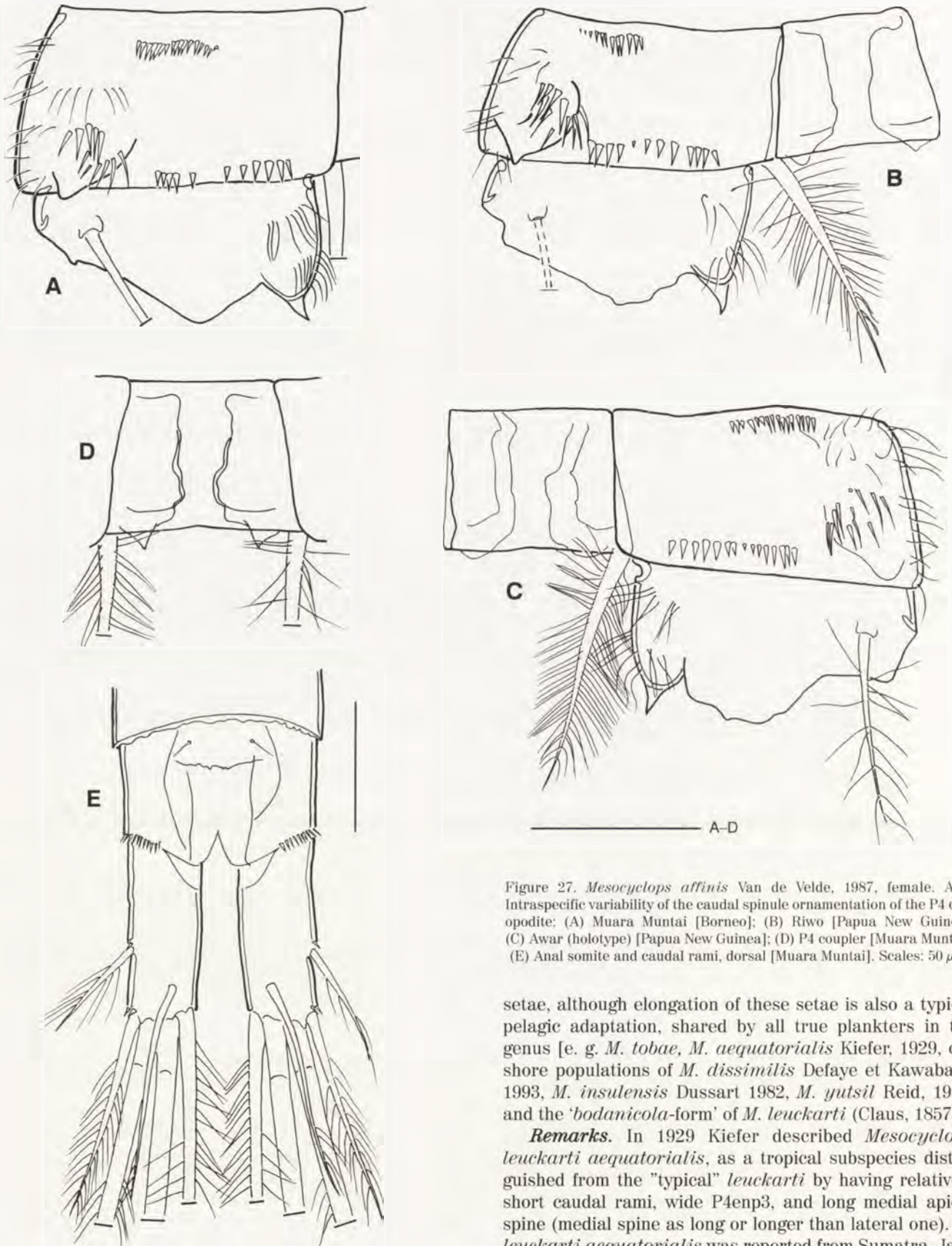


Figure 27. *Mesocyclops affinis* Van de Velde, 1987, female. A–C. Intraspecific variability of the caudal spinule ornamentation of the P4 exopodite: (A) Muara Muntai [Borneo]; (B) Riwo [Papua New Guinea]; (C) Awar (holotype) [Papua New Guinea]; (D) P4 coupler [Muara Muntai]; (E) Anal somite and caudal rami, dorsal [Muara Muntai]. Scales: 50 μm .

setae, although elongation of these setae is also a typical pelagic adaptation, shared by all true plankters in the genus [e. g. *M. tobae*, *M. aequatorialis* Kiefer, 1929, offshore populations of *M. dissimilis* Defaye et Kawabata, 1993, *M. insulensis* Dussart 1982, *M. yutsil* Reid, 1996, and the 'bodanicola-form' of *M. leuckarti* (Claus, 1857)].

Remarks. In 1929 Kiefer described *Mesocyclops leuckarti aequatorialis*, as a tropical subspecies distinguished from the "typical" *leuckarti* by having relatively short caudal rami, wide P4enp3, and long medial apical spine (medial spine as long or longer than lateral one). *M. leuckarti aequatorialis* was reported from Sumatra, Java

and Wetar (Kiefer 1929, 1933; Heberer and Kiefer, 1932). In 1981 Kiefer revised all his previous *M. leuckarti* records, and established that range of *M. leuckarti* was restricted to Europe and the western part of northern Asia. In this same paper *M. l. aequatorialis* was raised to specific rank and redescribed from specimens collected in Lake Kivu. In the revision of the African fauna Van de Velde (1984) described *Mesocyclops aequatorialis similis*, a subspecies that – in contrast to *M. aequatorialis* s. str. restricted to the Lake Tanganyika and Kivu – is widely distributed in Africa and also recorded from Israel (Defaye 1995) and Uzbekistan (Mirabdullayev 1996). In the paper on the *Mesocyclops* fauna of Uzbekistan Mirabdullayev (1996) synonymized *M. aequatorialis similis* Van de Velde, 1984 with *Mesocyclops thermocyclopoides acutus* Dussart et Fernando, 1988 described from West Kalimantan and also reported from Laos (Reid and Kay 1992). "*M. thermocyclopoides acutus*" displays clear-cut differences from *M. thermocyclopoides* s. str. in several characters [caudal spinule ornamentation of the antennary basipodite; presence of spinules at the implantation of the lateralmost terminal caudal setae; outgrowth of P4 coupler acute; posterior margin of anal somite with spinules also on the lateral surface; and only few spinules present on the lateral edge of the medial apical spine of P4enp3] indeed, yet all the characters of this form are fully congruent with those in *M. affinis*, therefore *M. thermocyclopoides acutus* is considered here to be a junior synonym of *M. affinis*. Comparison of the Australasian material examined with both subspecies of *M. aequatorialis*, shows that these specimens are not conspecific with *M. aequatorialis*. Probably neither the nominative subspecies nor *M. a. similis* occurs in this region, and the records of *M. leuckarti aequatorialis* are supposed here to refer to *M. affinis*. Both subspecies of *M. aequatorialis*, although morphologically very closely related to *M. affinis* differ in the following „microcharacters“: transverse ducts (female genital system) having conspicuously wide lumen; the part of copulatory duct connecting the copulatory pore with the transverse duct is often discernible; spinules at the implantation of the lateral caudal setae always present; posteriorly to P6 instead of six, often eight pores appear. In contrast, *M. affinis* have transverse ducts with narrow lumen, the part of copulatory duct connecting the copulatory pore with the transverse ducts is not discernible, spinules at the implantation of the lateral caudal setae are often absent, and posteriorly to P6 six pores present.

In the description of *M. thermocyclopoides* s. str. Dussart and Fernando (1988) show the antennary basipodite in caudal view, with a spinule ornamentation characteristic of *M. affinis* (and also *M. aequatorialis similis*), but obviously different from that in the genuine *M. thermocyclopoides* (Van de Velde 1987, Holynski 1994a). Yet other features they mention and illustrate, like pilose P4 coupler and long dorsal caudal seta, do not agree with any observation made so far on *M. affinis*, moreover the combination of the characters presented there does not match any known Asian *Mesocyclops*. Unfortunately

Dussart and Fernando did not specify the origin of the material upon which their description was based.

Mesocyclops tobae Kiefer, 1933

Mesocyclops Tobae Kiefer, 1933: 577. Figs 137–142, Table P; *Mesocyclops tobae*: Kiefer 1981: 170–171, Pl. 9; Dussart and Fernando 1988: 254–256, Figs 57–63.

Type. Two paratypes (♀♀) on two slides (SMNK: 10893, 10894) – 10893: "*Mesocyclops tobae* n. sp. 2♀♀, Abd+P5, Kiefer 2.4.80.; Sumatra Tobameer, Südbecken, 862, D.L.S. Exp., 10.4.1929"; 10894: "*Mesocyclops tobae* n. sp. 2♀♀, A1-P4, Kiefer 2.4.80; Sumatra, Tobameer, Südbecken, 862, D.L.S. Exp., 10.4.1929".

Other material examined. INDONESIA (Sumatra, Lake Toba): 4♀♀ and 1♂ – St. 5, leg. C. H. Fernando, 7 Jul 1977; 2♀♀ – southern part, leg. A. S. Sarnita, 6 Sep 1984.

Description (female). Body length: 690–750 µm; prosome/urosome: 1.5–1.8; cephalothorax, length/width: 1.1–1.4; cephalothorax width/genital double-somite width: 2.5–2.8.

Pediger 5 (Fig. 30D,H) without hairs, two medial and two laterodistal sensilla present on dorsal surface of somite. Genital double-somite 1.2–1.3 as long as wide, without hairs. Lateral arms of seminal receptacle (Fig. 30D) wide and short, anterior margin of proximal part sinuate in middle. Posteriorly to horseshoe-shaped copulatory pore one circular pore. Transverse ducts (Fig. 30E) directed to each other at straight angle before connection with straight or slightly curved copulatory duct. Posterior margin of anal somite (Figs 30F,G) with ventral and conspicuously large dorsal spinules, but lateral ones sometimes reduced. Caudal rami (Figs 30F,G) short, 2.7–2.9 times as long as wide, without hairs. Spinules at implantation of lateralmost terminal setae always present, at implantation of lateral caudal setae spinules very small, or absent. Dorsal caudal seta long, 2.0–2.5 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.1–2.9, 7.3–8.4, 3.9–5.0, 1.0. Longest terminal seta 1.4–1.6 times as long as urosome.

Armature formula of 17-segmented antennule, as in *M. dayakorum*. Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large or two small notches (Figs 28D,E). Ventral spinules present on antennular segments 1, 4–5, 7–13.

Antenna bearing 3 setae on basipodite and 1, 7 or 8, and 7 setae on endopodal segments 1–3 respectively. Caudal spinule pattern of antennary basipodite (Fig. 28B) highly reduced: lateral spinules near base and tiny spinules on medial rim in proximal third; 4–5 spinules in oblique row next to lateral spinules near base; 2–7 spinules in longitudinal row near lateral rim; few spinules near implantation of medial setae present or absent. On frontal surface of basipodite 9–17 spinules in longitudinal row; transverse row, distally to spinules along proximal rim, present or absent (Fig. 28C).

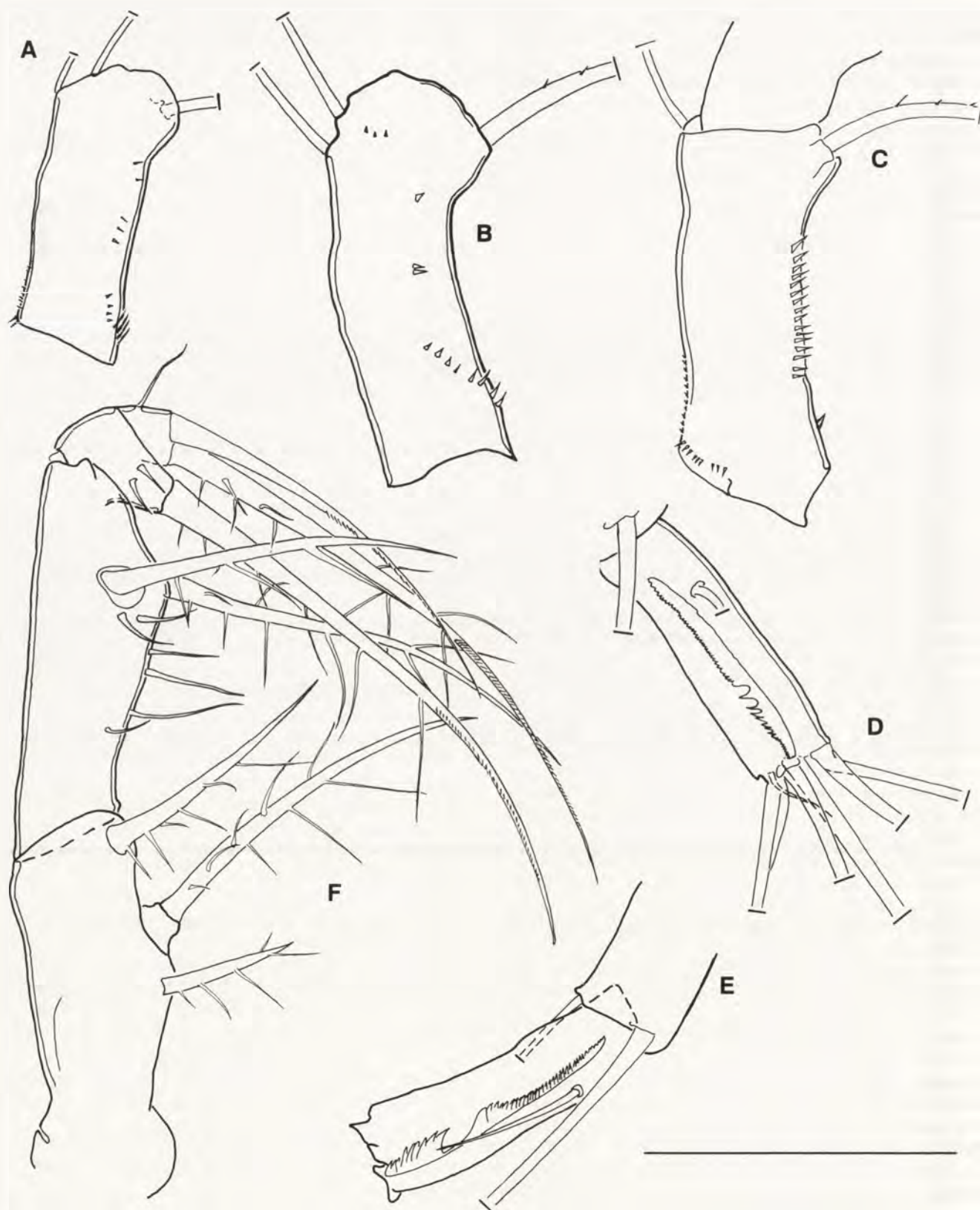


Figure 28. *Mesocyclops tobae* Kiefer, 1933. [Sumatra: Lake Toba]. A–C Antennary basipodite: (A) Caudal, male; (B) Caudal, female; (C) Frontal, female. D, E. Last antennular segment. (F) Maxilliped, frontal. Except for (A) all the drawings show female. Scale: 50 μ m.

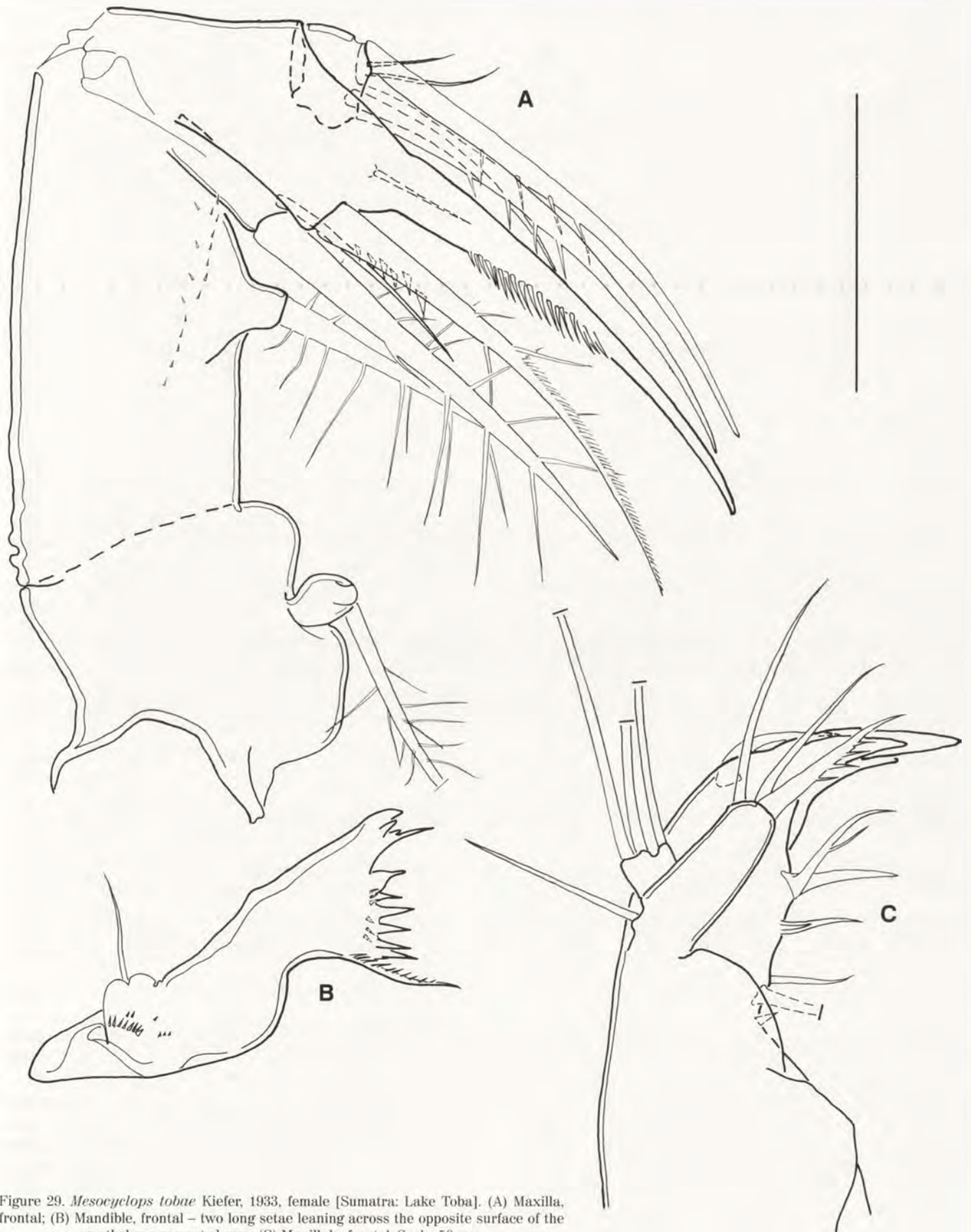


Figure 29. *Mesocyclops tobae* Kiefer, 1933, female [Sumatra: Lake Toba]. (A) Maxilla, frontal; (B) Mandible, frontal – two long setae leaning across the opposite surface of the gnathobase are not shown; (C) Maxillule, frontal. Scale: 50 μ m.

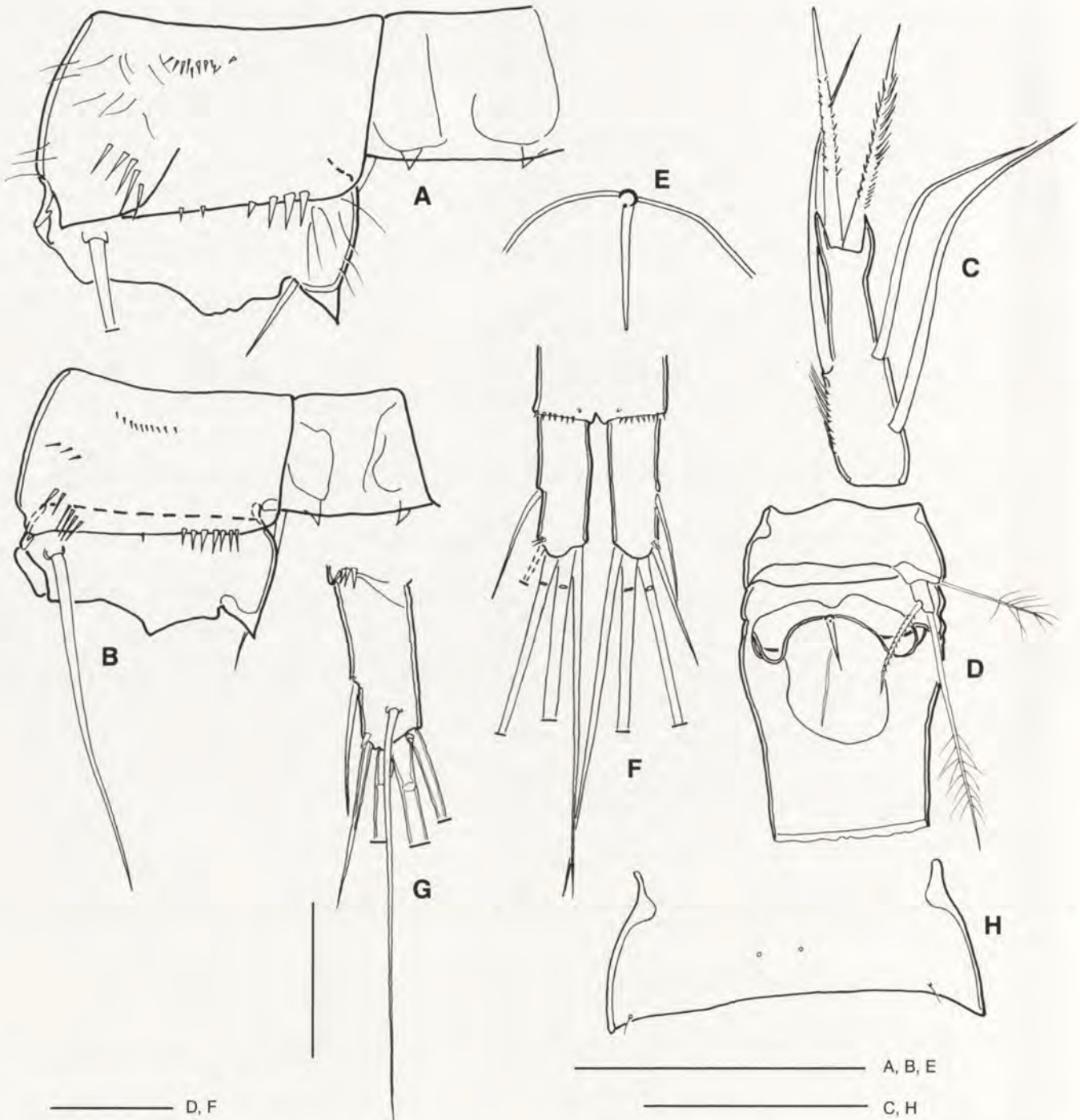


Figure 30. *Mesocyclops tobae* Kiefer, 1933 [Sumatra: Lake Toba]. A, B. P4 protopodite, caudal: (A) Female; (B) Male. (C) P4enp3; (D) Pediger 5, and genital double-somite, ventral; (E) Copulatory pore and duct, and transverse ducts. F, G. Caudal rami: (F) Ventral; (G) Dorsal. (H) Pediger 5, dorsal. Scales: 50 μm .

Segmentation and setation of mouthparts like in *M. dayakorum*. Except fringe hairs overhanging toothed distal rim, no other hairs on ventral surface of labrum. Vertical cleft separating epistoma from rostrum with fine hairs. Mandible (Fig. 29B) bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillulary palp naked, lateralmost (longest)

seta of lateral lobe without long setules (Fig. 29C). Frontal surface of maxillary coxopodite with distinct row of spinules; basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only (Fig. 29A). Oblique row of fine spinules on frontal surface of maxilliped syncoxopodite usually absent (Fig. 28F); spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 like that in *M. dayakorum* (Table 2) except P1 basipodite lacking medial spine. P1 exopodite spines with flagellum-like tip, spines on P2–P4 exopodite normal robust. Frontal surface of P1 basipodite with large spinules arranged in arch; medial expansion of basipodite of P1–P3 with apical hairs. Medial expansion of P4 basipodite usually bearing proximal row of hairs on caudal surface of segment, and apical hairs. Couplers naked on frontal and caudal surfaces, distal margin of P4 coupler with two small, acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 30A): enlarged spinules (4–8) in intermittent row along distal rim; few (5–8) elongate spinules arranged in one row at laterodistal angle; row of fine spinules (7–13) along proximal rim; sparse lateral hairs. P4 coxopodite seta 1.3–1.7 times longer than height of medial expansion of basipodite. P4enp3 (Fig. 30C) 2.7–3.5 times as long as wide; of apical spines medial one slightly shorter than lateral. Lateral edge of medial apical spine with many teeth. Apical seta of P5 more than twice as long, lateral seta 0.9–2.0 times as long as medial spine (Fig. 30D).

Male. Body length: 480 μm ; prosome/urosome: 1.3; cephalothorax, length/width: 1.1. Pediger 5 without hairs. Anal somite with spinules along posterior margin. Caudal rami 2.7 times as long as wide, without hairs. Spinules at implantation of lateral caudal, and lateralmost terminal setae present. Dorsal caudal seta twice as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.2, no data (longest terminal seta broken off), 4.1, 1.0.

Antennule 16-segmented, but with incomplete subdivision of compound apical segment. Antenna armed with 3 setae on basipodite and 1, 6, and 7 setae on endopodal segments 1–3, respectively. Spinule ornamentation of antennary basipodite like in female, highly reduced (Fig. 28A). Armature of maxillulary palp and maxilliped like in female, but frontal surface of maxillary coxopodite without row of spinules. Segmentation and setation of legs the same as in female. P1 exopodite spines with flagellum-like tip, spines on P2–P4 exopodite normal robust. P4 coupler with two small acute outgrowths, naked. P4 coxopodite devoid of lateral hairs, caudal spinule ornamentation otherwise like in female (Fig. 30B). No hairs on medial expansion of P4 basipodite. Coxopodite seta of P4 1.4 times as long as height of medial expansion of basipodite. P4enp3 2.9 times as long as wide; of apical spines medial one slightly longer than lateral. Apical seta of P5 more than twice as long as medial spine. P6 armed with medial spine, slender seta of about equal length and ca. 2.5 times as long lateral seta.

Distribution. Species endemic to Lake Toba (Sumatra). In the original description Kiefer (1933) reported *M. tobae* from East Java (Ranu Lamongan) too, yet in the later redescription (Kiefer 1981) he did not confirm the Javanese record.

Remarks. The body length and proportions, the conspicuously long P5 and caudal setae, flagellum-like tips of P1 exopodite spines, and reduced spinule and hair orna-

mentation of the limbs and pediger 5 unambiguously indicate that *M. tobae* is adapted to the pelagic life conditions in the large, deep [1300 km³, 400 to 500 m (Rainboth 1996)] caldera-lake. Apart from the features mentioned above, there is conspicuous congruence in all other characters between *M. tobae* and *M. affinis*, which suggests that the former is a pelagic offshoot of the latter. The Lake Toba is situated in a resurgent caldera, where the most recent, extremely large eruption, depositing 3000 km³ volcanic ash on surrounding land, happened 75,000 years ago (Rainboth 1996). As a consequence, the time of *M. tobae*–*M. affinis* divergence might be less than 75,000 years.

Mesocyclops francisci sp. nov.

Types. Holotype and one female paratype from Malaysia (Ayer Keroh, 12 km N Malacca, 2°19'N–102°16'E, 20 m, lake in recreational park, shore, leg. M. & R. Holyński, 19 Sep 1988) and one female paratype from Sumatra (Coll. Dadayana: III. 282 – “*Cyclops leuckarti*”) are dissected and mounted in glycerin on two slides each. Types are deposited at Museum and Institute of Zoology PAS, Warsaw.

Etymology. The species is named for Dr. Frank Fiers, in grateful recognition of the invaluable help he provided during my stay in the Koninklijk Belgisch Instituut voor Natuurwetenschappen (Brussel), in 1992–93.

Description (female). Body length: 965–1060 μm (980 μm in holotype); prosome/urosome: 1.8–2.0 (2.0 in holotype); cephalothorax, length/width: 1.0–1.2 (paratypes); cephalothorax width/genital double-somite width: 2.9–3.1 (paratypes).

Pediger 5 (Figs 34B,D) with lateral and dorsal hairs, two medial (broken off in holotype) and two laterodistal sensilla on dorsal surface of somite. Genital double-somite (Figs 32C, 34C) 1.1–1.3 (1.3 in holotype) times as long as wide, without hairs, group of six pores posteriorly to P6 (Fig. 33D). Seminal receptacle (Fig. 32C) with wide and short lateral arms; anterior margin of proximal part deeply sinuate in middle. Posteriorly to horseshoe-shaped copulatory pore, one circular pore present. Transverse ducts directed to each other at acute angle (V-shaped) before connection with copulatory duct; copulatory duct strongly curved. Anal somite with spinules along posterior margin (Figs 33E,F). Caudal rami (Figs 33E,F) 2.8–2.9 (2.8 in holotype) times as long as wide, ventral surface adorned with row of long spinules in distal quarter, next to medial rim. Spinules present at implantation of lateralmost terminal seta, but absent at implantation of lateral caudal seta. Dorsal caudal seta 1.1–1.3 (1.1 in holotype) times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost 3.2–3.3, 7.4–7.9 (7.9 in holotype), 4.3–5.2 (5.1 in holotype), 1.0. Longest terminal seta 1.5–1.6 (1.5 in holotype) times as long as urosome (Fig. 34A).

Armature formula of 17-segmented antennule like in *M. dayakorum*. Serrate hyaline membrane on last antennulary segment, extending far beyond implantation of medial seta of segment, with one large notch (Fig. 31A). Ventral

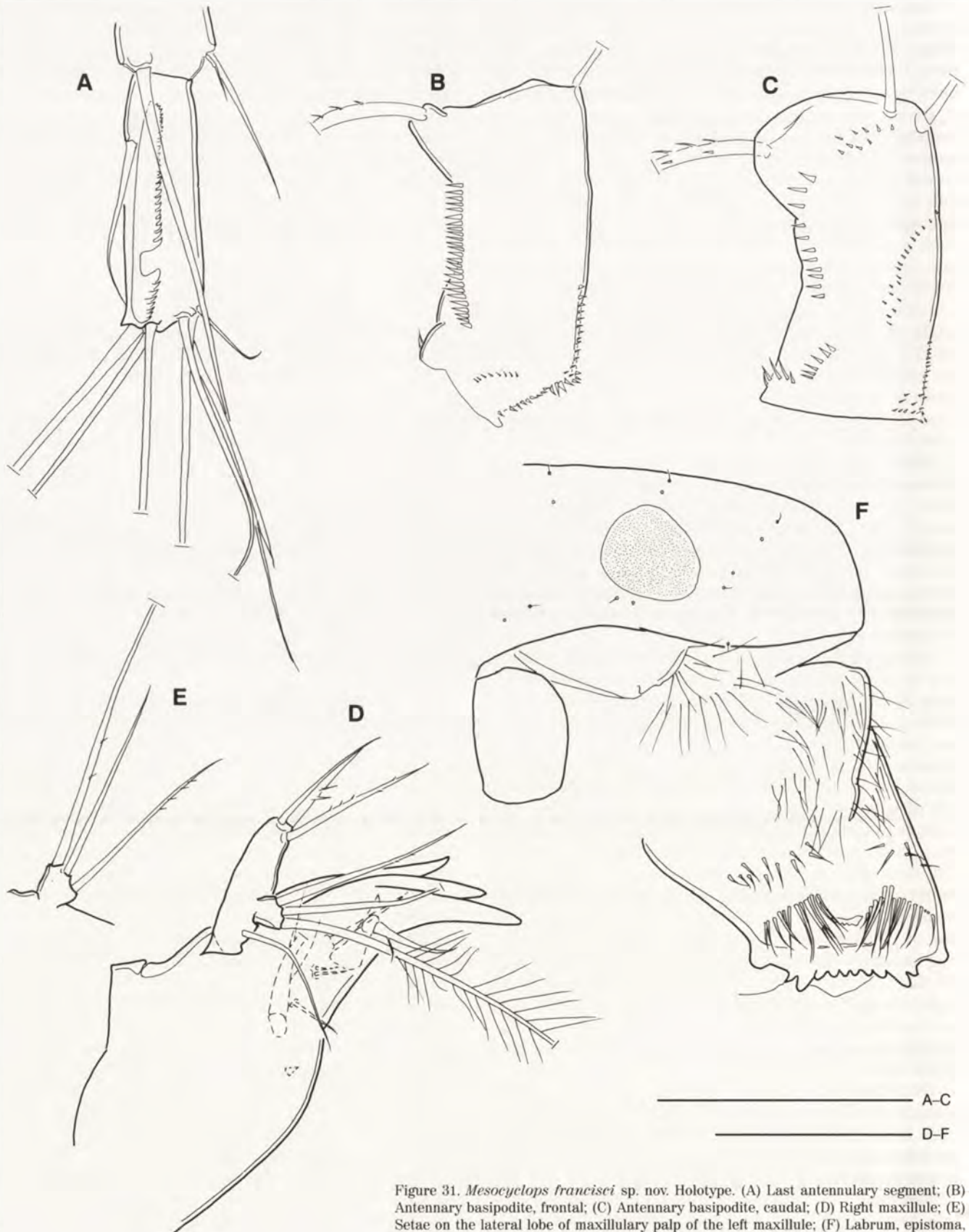


Figure 31. *Mesocyclops francisci* sp. nov. Holotype. (A) Last antennary segment; (B) Antennary basipodite, frontal; (C) Antennary basipodite, caudal; (D) Right maxillule; (E) Setae on the lateral lobe of maxillary palp of the left maxillule; (F) Labrum, epistoma, and rostrum. Scales: 50 μ m.

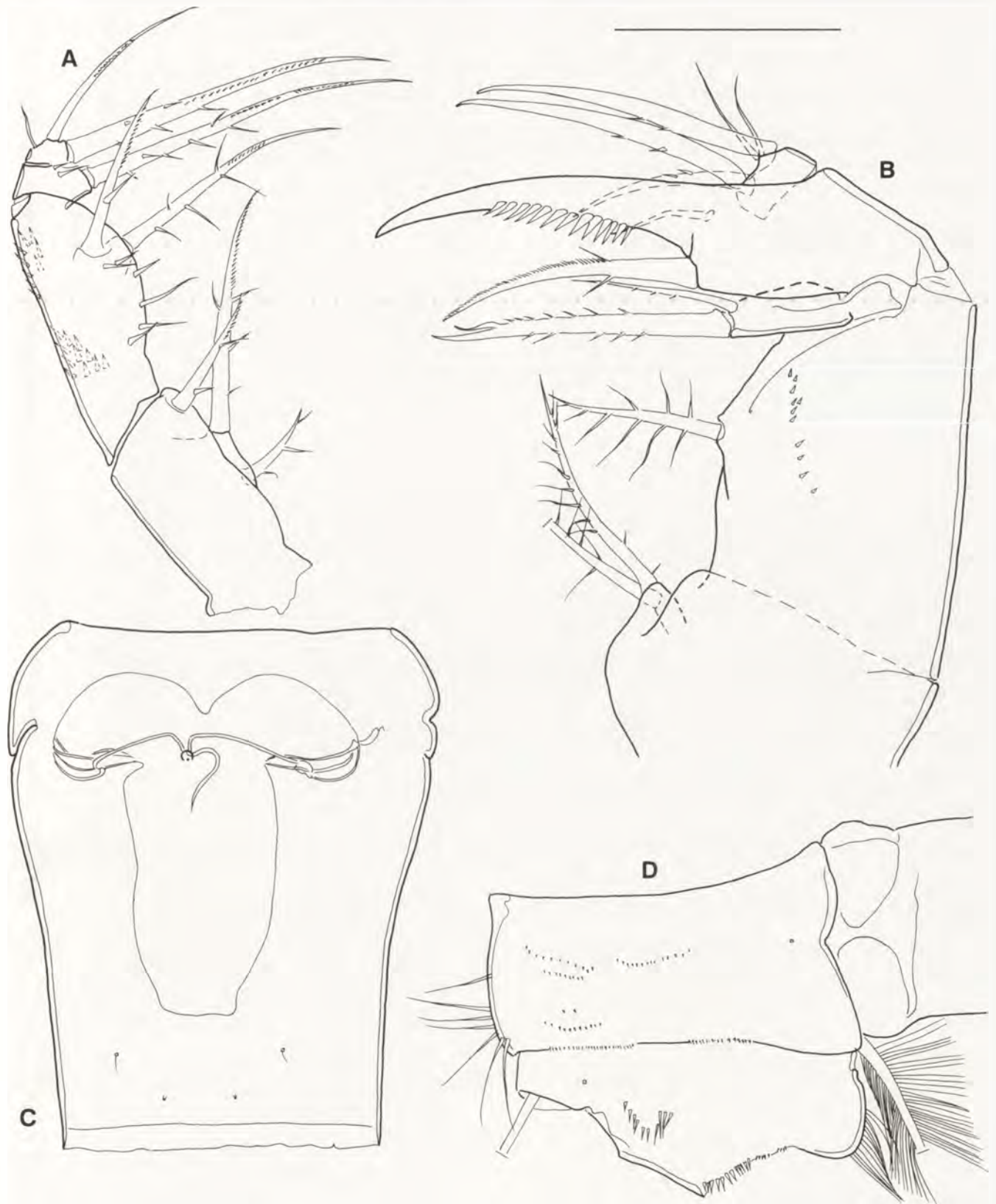


Figure 32. *Mesocyclops francisci* sp. nov. Holotype. (A) Maxilliped, frontal; (B) Maxilla, frontal; (C) Genital double-somite, ventral; (D) P1 protopodite, frontal. Scale: 50 μ m.

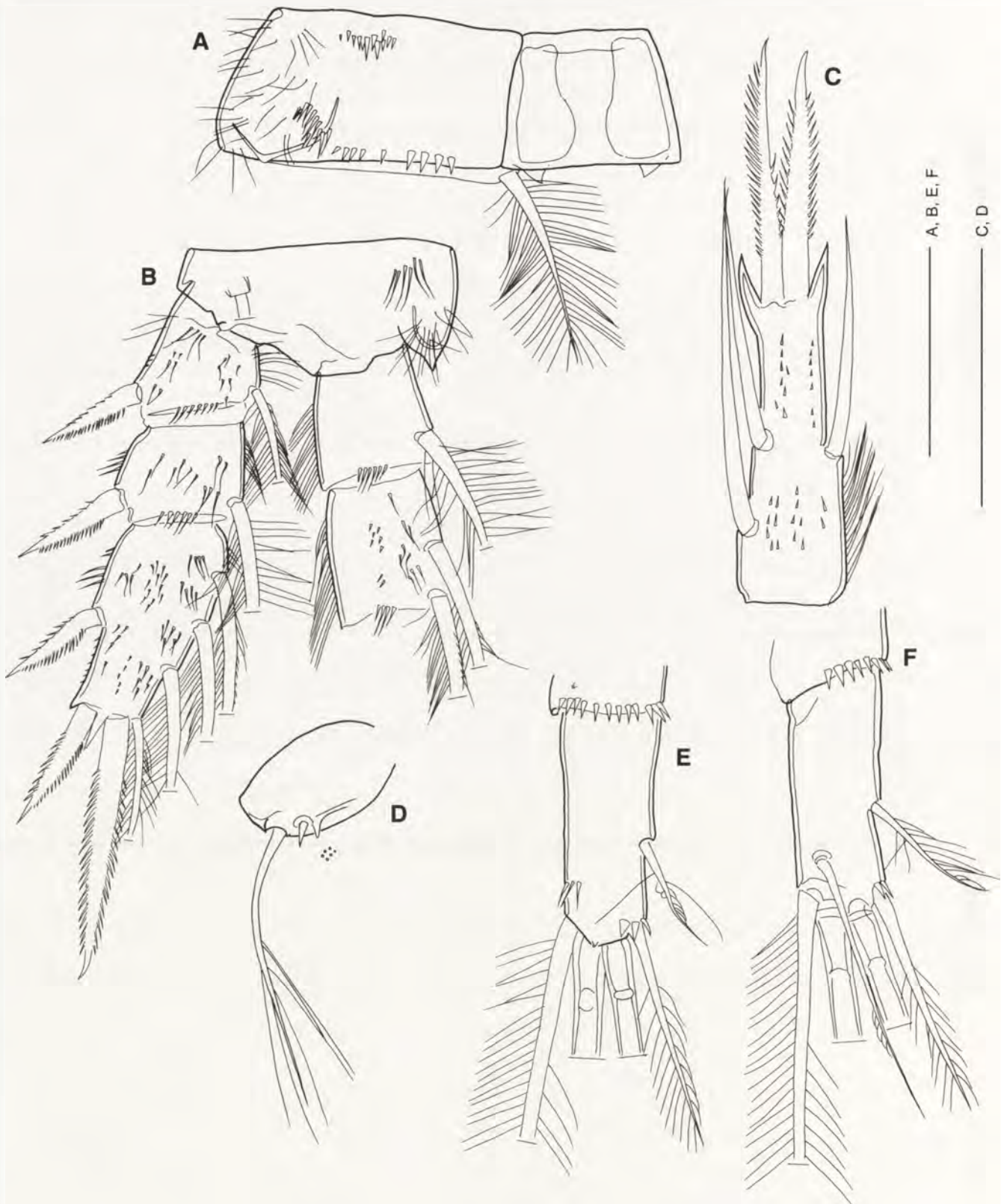


Figure 33. *Mesocyclops francisci* sp. nov. (A) P4 coupler and coxopodite, caudal; (B) P4 basipodite and rami, caudal; (C) P4enp3; (D) P6 [paratype, Malaysia]; (E) Caudal ramus, ventral; (F) Caudal ramus, dorsal. Except for (D) all the drawings show the holotype. Scales: 50 μ m.

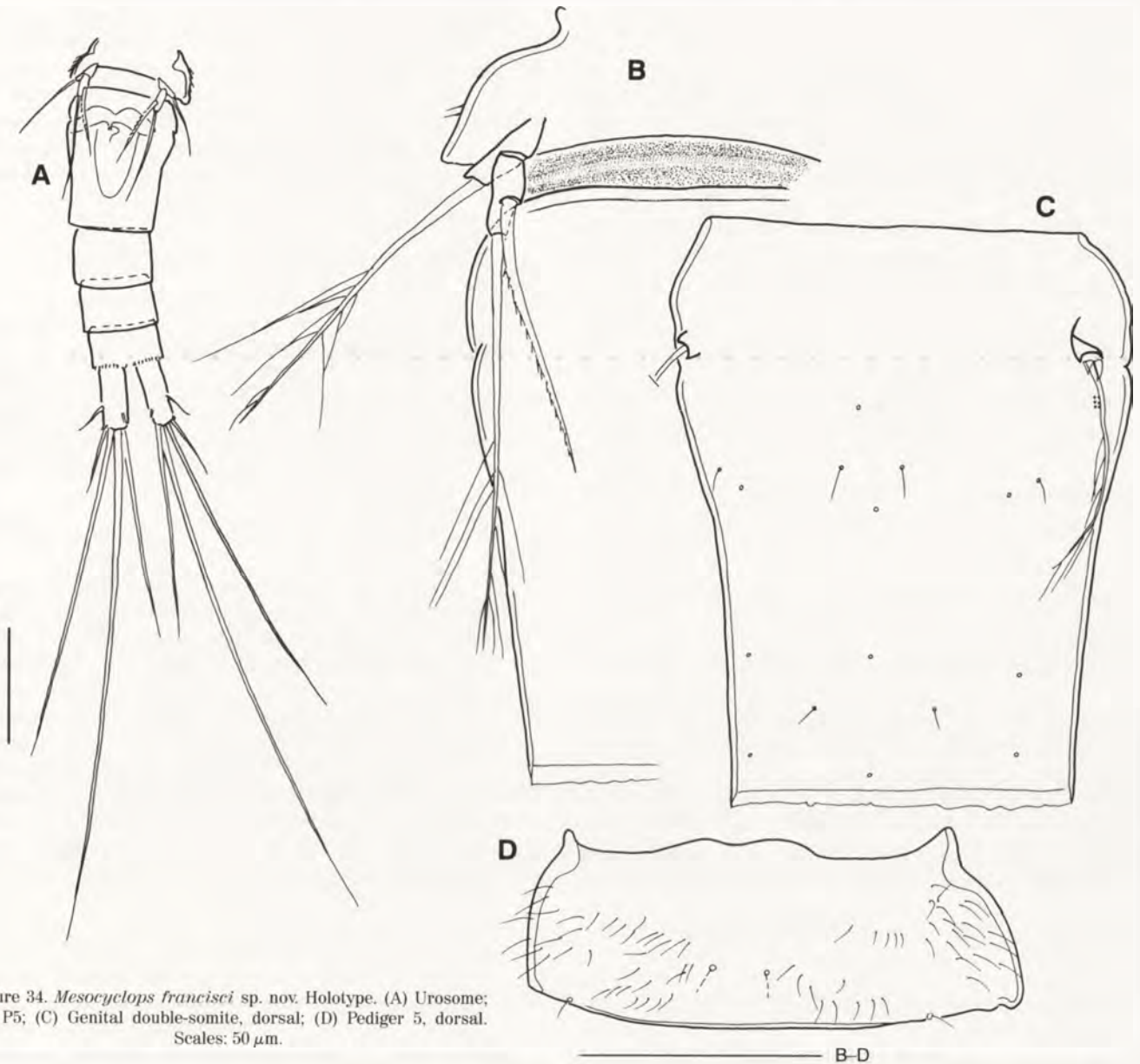


Figure 34. *Mesocyclops francisci* sp. nov. Holotype. (A) Urosome; (B) P5; (C) Genital double-somite, dorsal; (D) Pediger 5, dorsal. Scales: 50 μ m.

spinules present on antennular segments 1, 4–5, 7–13. Antenna bearing 3 setae on basipodite and 1, 8, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule pattern of antennary basipodite complex (Fig. 31C), basic pattern (see in *M. dayakorum*) supplemented with: oblique row of spinules starting in distal half of medial rim and ending in diffuse patch proximally; two/three rows of small spinules near implantation of medial setae. Spinules (11) in longitudinal row along lateral rim, of similar size (longest/shortest ≤ 1.5). Frontal spinule ornamentation of antennary basipodite (Fig. 31B) composed of 24–27 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

Proximally to distal fringe hairs, elongate spinules arranged in belt present on ventral surface of labrum, epistoma pilose, fine hairs laterally to epistoma arranged in

group (Fig. 31F). Segmentation and setation of mandible, maxillule, maxilla and maxilliped like in *M. dayakorum*. Mandible bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillulary palp naked; lateralmost (longest) seta of lateral lobe with long setules in right maxillule of holotype, but setules absent in paratypes and left maxillule of holotype (Figs 31D,E). Frontal surface of maxillary coxopodite bearing distinct row of spinules; basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only (Fig. 32B). Spinules in oblique row on frontal surface of maxilliped syncopodite, very tiny or absent; spinules on lateral rim and caudal surface of basipodite arranged in two groups (Fig 32A).

Armature of P1–P4 like in *M. dayakorum* (Table 2), except P1 basipodite lacking medial spine. Frontal surface

of P1 basipodite with large spinules arranged in semicircular arch (Fig. 32D); medial expansion of basipodite of P1–P4 with apical hairs. Apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface (Fig. 33B). Couplers naked on frontal and caudal surfaces in P1–P4, distal margin of P4 coupler bearing two small acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 33A) composed of: 7–12 spinules in continuous or intermittent row along distal rim; 10–12 elongate spinules at laterodistal angle arranged in group or row; 11–15 spinules of different size in one or two rows along proximal rim; dense lateral hairs. P4 coxopodite seta 1.7–1.8 times longer than height of medial expansion of P4 basipodite. Caudal surface of P4 rami, with exception of enp1, adorned with hair-like and short spinules (Fig. 33B). Similar, but less expressed ornamentation present on caudal surface of P2–P3 rami, and absent on P1. P4enp3 (Fig. 33C) 2.9–3.2 times as long as wide; of apical spines medial one 1.0–1.1 times as long as lateral; longer (medial) spine 0.8–0.9 times as long as segment. Lateral edge of medial apical spine with 4–15 teeth. Apical seta of P5 1.4–1.6 times as long, lateral seta 1.0–1.1 times as long as medial spine (Fig. 34B). P6 (Malaysian paratype) (Fig. 33D) with one long medial seta and two small lateral spines.

No male found.

Diagnosis. *Mesocyclops francisci* can be distinguished from its congeners by the following combination of characters: length of the body relatively small (ca 1000 µm); pediger 5 laterally and dorsally pilose, genital double-somite bare; seminal receptacle with short and wide lateral arms, anterior margin of proximal part deeply sinuate in the middle; transverse ducts directed to each other at acute angle (V-shaped) before connection with copulatory duct; entire posterior margin of anal somite with spinules; spinules at implantation of lateralmost terminal seta present, but absent at implantation of lateral caudal seta; ventral surface of caudal rami adorned with group of long spinules in distal quarter, next to medial rim; longest terminal seta 1.5–1.6 times as long as urosome; hyaline membrane on last antennular segment with one large notch, ventral spinules present on antennular segments 1, 4–5, 7–13; second endopodal segment of antenna armed with 8 setae; caudal spinule ornamentation of antennary basipodite (oblique row of spinules starting in distal half of medial rim ends in diffuse patch proximally; spinules near implantation of medial setae arranged in 2/3 rows); proximally to distal fringe hairs, belt of elongate spinules present on ventral surface of labrum, epistoma pilose, fine hairs laterally to epistoma arranged in group; maxillary palp naked; P1 basipodite without medial spine; apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface; P4 coupler with two small acute outgrowths, naked; caudal spinule ornamentation of P4 coxopodite (spinules along proximal rim of conspicuously different size, and arranged in one or two rows).

Distribution. Known from SW Malaysia and Sumatra (precise locality data for the Sumatran specimen found in the Collection of Daday are unknown to me).

Remarks. *Mesocyclops francisci* is morphologically closely allied to members of the *woutersi*-superspecies [*M. woutersi* Van de Velde, 1987, *M. parentium* Holyńska, 1997, *M. dissimilis* Defaye et Kawabata, 1993 and *M. friendorum* sp. nov.] (Holyńska, 1997b), it differs, however, from all of them in having 8 (instead of 7) setae on the second endopodal segment of antenna, and a row of long ventral spinules in distal quarter of the caudal rami.

Mesocyclops woutersi Van de Velde, 1987

Mesocyclops woutersi Van de Velde, 1987: 156–157, Figs 31–44.

Mesocyclops guangxiensis Reid et Kay, 1992: 332–338, Figs 1a–f, 2a–i, 3a–c. Synonymized by Holyńska 1997b.

Types. *Mesocyclops woutersi*: Holotype, ♀, (KBIN: 26528/A, 3291), 2 paratypes, ♀♀, (KBIN: 26528/B–C, 3291), and 1 allotype, ♂, (KBIN: 26528/D, 3291) – Coral gravel pit, Warawaranga, 04°14'S–144°56'E, Madang Prov., Papua New Guinea, leg. K. Wouters, 2 Jun 1982.

Other material examined. PAPUA NEW GUINEA: 7 ♀♀ – Pond in bombhole, „Japanese airstrip”, 04°47'S–145°40'E, Madang Prov., leg. R. & M. Holyński, 04 Mar 1989.

Description (female, Papua New Guinea). Body length: 810–990 µm – no allowance for telescoping of body somites has been made; Holotype 1016 µm (Van de Velde 1987). Pediger 5 pilose laterally, dorsum without hairs (Figs 35D,E). Genital double-somite bare; group of six pores on laterodorsal surface, posteriorly to P6. Seminal receptacle (Fig. 35E) with wide and short lateral arms; anterior margin of proximal part sinuate in middle. Transverse ducts (Fig. 35F) directed to each other at acute angle (V-shaped) before connection with copulatory duct; copulatory duct strongly curved; part of copulatory duct connecting copulatory pore and transverse ducts [„jointed canal” in Van de Velde 1987] usually discernible. Posterior margin of anal somite with large spinules ventrally, small spinules dorsally, naked laterally (Fig. 37C). Caudal rami (Fig. 37C) 2.5–3.1 times as long as wide, without special hair or spinule ornamentation. No spinules at implantation of lateralmost terminal, and lateral caudal setae. Dorsal caudal seta 0.9–1.1 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.8–3.3, 5.9–7.2, 4.1–4.8, 1.0. Longest terminal seta 1.4 (three specimens) times as long as urosome.

Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch (Fig. 35C). Ventral spinules present on antennular segments 1, 4–5, 7–13, and also on segment 14 in five of nine New Guinean females. Antenna armed with 3 setae on basipodite and 1, 7, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule pattern of antennary basipodite complex (Fig. 35B): basic pattern (see in *M. dayakorum*) supplemented with: oblique row of spinules starting in distal half of medial rim and diffuse patch of spinules medially to this row; field of small spinules near implantation of medial setae; and group of spinules next to distal rim (present in eight of nine females). Spinules (13–19) in longitudinal row along later-

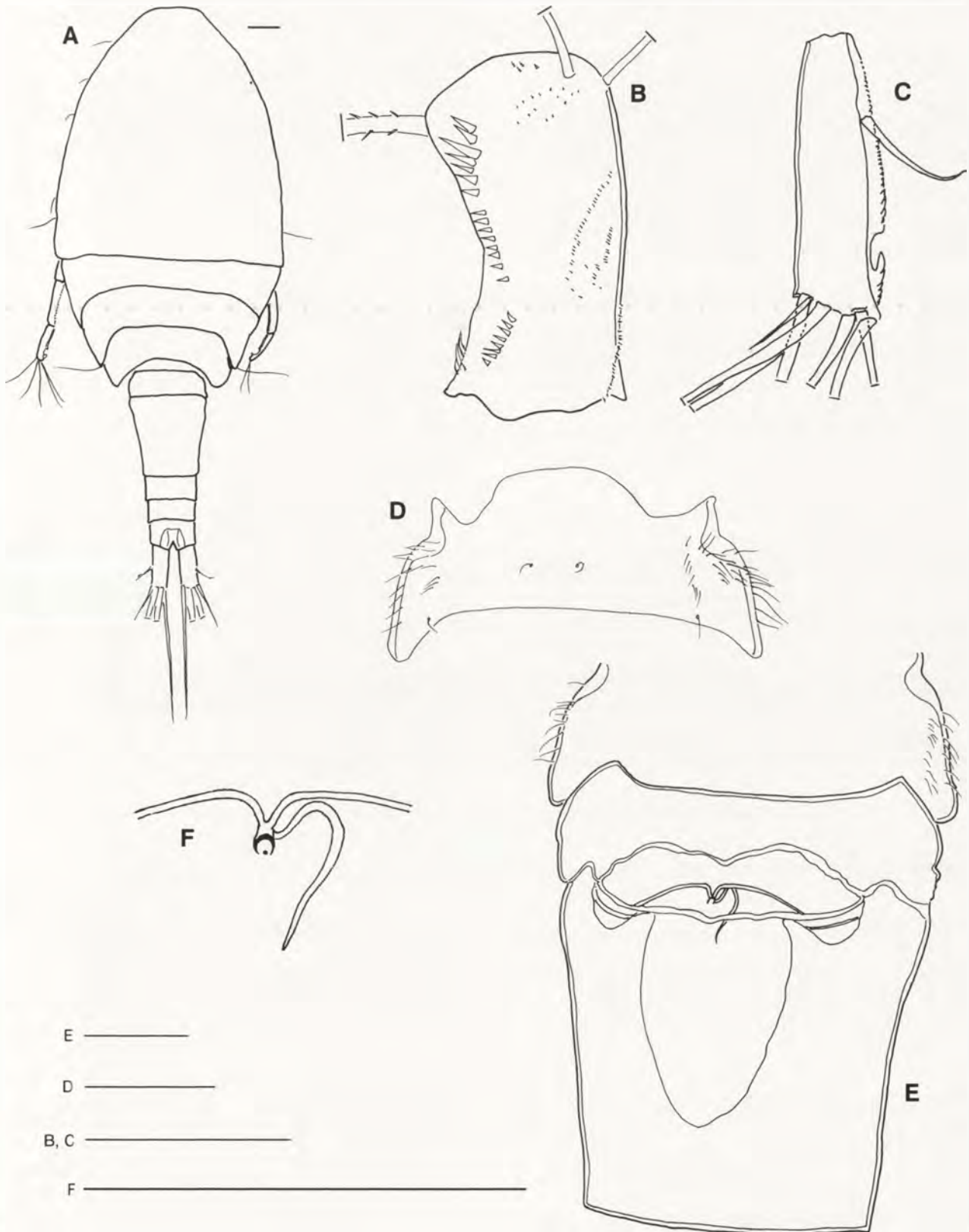


Figure 35. *Mesocyclops woutersi* Van de Velde, 1987, female. (A) Habitus; (B) Antennary basipodite, caudal [paratype]; (C) Last antennular segment; (D) Pediger 5, dorsal; (E) Pediger 5 and genital double-somite, ventral; (F) Copulatory pore and duct, and transverse ducts. Except for (B) all the drawings show specimens from the "Japanese airstrip" [Papua New Guinea]. Scales: 50 μ m.

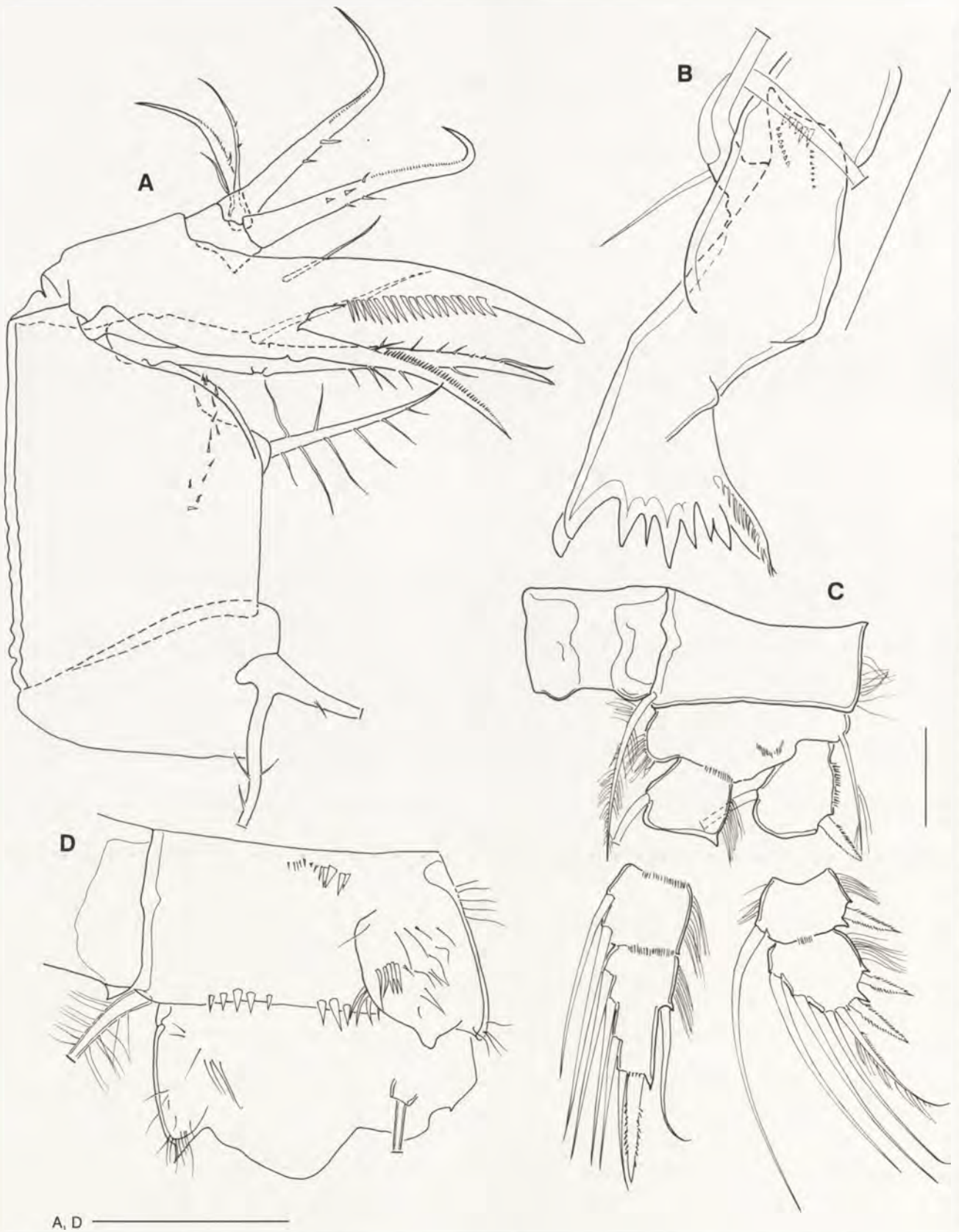


Figure 36. *Mesocyclops woutersi* Van de Velde, 1987, female. (A) Maxilla, frontal; (B) Mandible, caudal; (C) P1, frontal [Papua New Guinea: "Japanese airstrip"]; (D) P4 protopodite, caudal. Except for (C), all the drawings show the paratype 26528/C. Scales: 50 μ m.

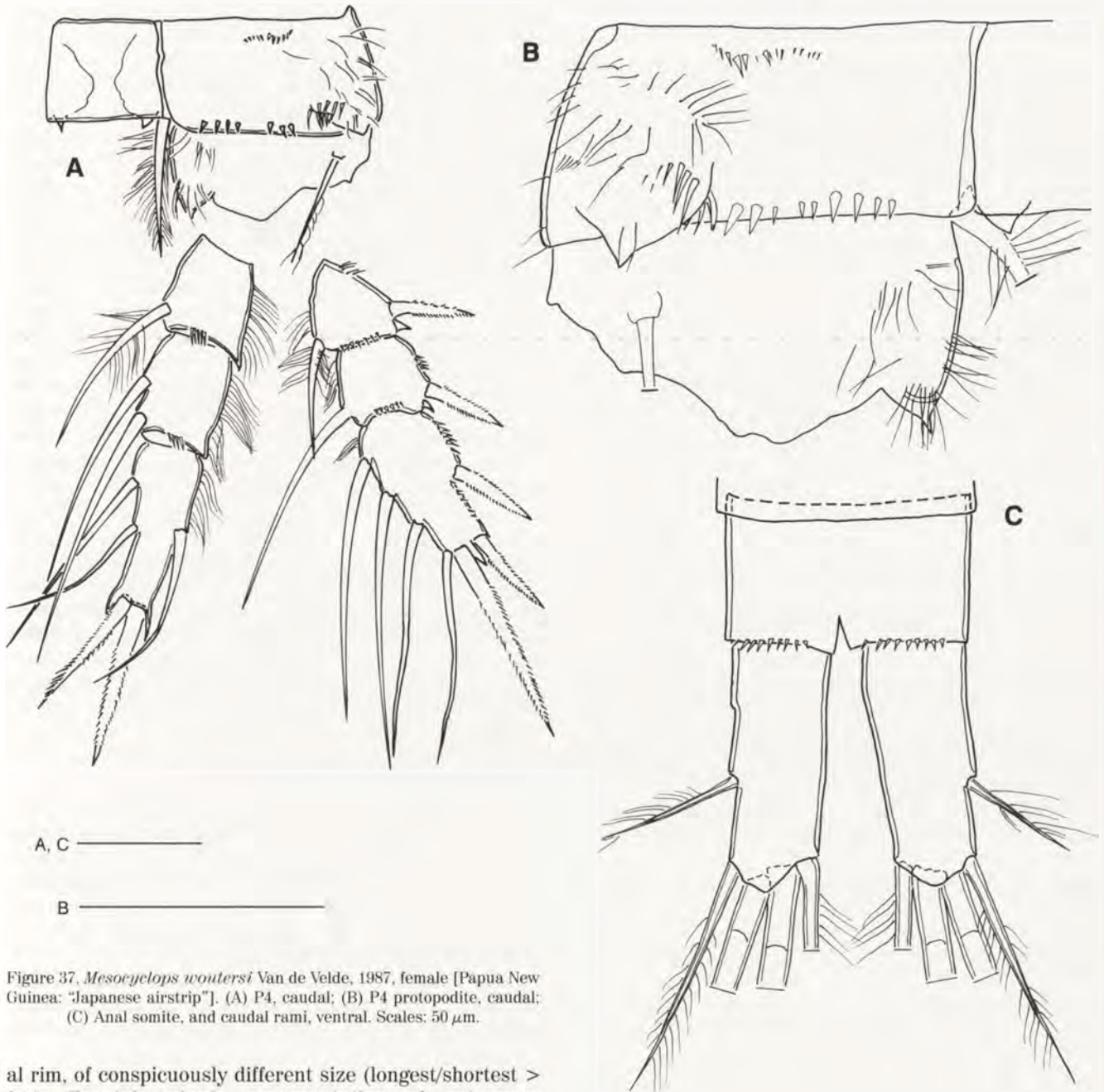


Figure 37. *Mesocyclops woutersi* Van de Velde, 1987, female [Papua New Guinea: "Japanese airstrip"]. (A) P4, caudal; (B) P4 protopodite, caudal; (C) Anal somite, and caudal rami, ventral. Scales: 50 μ m.

al rim, of conspicuously different size (longest/shortest > 2.5). Frontal spinule ornamentation of antennary basipodite composed of 25–31 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

Proximally to distal fringe hairs, fine hairs arranged in belt present on ventral surface of labrum, epistoma and vertical cleft pilose (Fig. 38F). Segmentation and setation of mandible, maxillule, maxilla and maxilliped like in *M. dayakorum*. Mandible (Fig. 36B) bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillulary palp naked; lateral-most (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite bearing distinct row of spinules; basipodite seta in front of claw-like basal

endite with fine teeth on posterior edge only (Figs 36A). Spinules in oblique row on frontal surface of maxilliped syncopodite, very tiny or absent; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 as in *M. dayakorum* (Table 2), except P1 basipodite lacking medial spine. Frontal surface of P1 basipodite with large spinules arranged in semicircular arch (Fig. 36C); medial expansion of P1–P4 with apical hairs. Apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface. Couplers naked on frontal and caudal surfaces in P1–P4, distal margin of P4 coupler bearing two small acute or obtuse outgrowths. Caudal spinule ornamentation of P4

coxopodite (Figs 36D, 37B) composed of: 6–11 spinules in continuous or intermittent row along distal rim; 7–12 elongate spinules at laterodistal angle arranged in group or row; many (10–14 spinules of different size in one or two rows along proximal rim; dense lateral hairs. P4 coxopodite seta 1.5–1.9 times longer than height of medial expansion of P4 basipodite. Caudal surface of P4 exopodite segments, and enp3 adorned with hair-like and short spinules (not shown in figure). P4enp3 2.4–2.9 times as long as wide; of apical spines medial one 0.9–1.0 times as long as lateral; longer spine 0.8–1.0 times as long as segment. Lateral edge of medial apical spine with 2–10 teeth. Apical seta of P5 1.1–1.5 times as long, lateral seta 0.5–0.8 times as long as medial spine.

Male (Allotype). Body length 620 μm (Van de Velde 1987). Pediger 5 laterally pilose. Caudal rami without special hair or spinule ornamentation, 2.3 times as long as wide (Van de Velde, 1987). Spinules present at implantation of lateralmost terminal, and lateral caudal setae. Dorsal caudal seta as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.9, 6.8, broken off, 1.0. Caudal spinule pattern of antennary basipodite similar to that in female, but diffuse patch, medially to oblique row starting in distal half of medial rim, absent. Number of spinules in longitudinal rows on caudal and frontal surfaces 12 and 23, respectively. P1 basipodite without medial spine, frontally adorned with large spinules arranged in semicircular arch. Apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface. P4 coupler with two small acute outgrowths. Caudal spinule ornamentation of P4 coxopodite composed of: 7, 10 spinules in continuous/intermittent row along distal rim; elongate spinules at laterodistal angle; many (12) small spinules along proximal rim, and lateral hairs. P4 coxopodite seta ca. 1.7 times as long as height of medial expansion of P4 basipodite. P4enp3 2.7 times as long as wide; apical spines of equal length, 0.9 times as long as segment. Lateral edge of medial apical spine with 11 teeth.

Distribution. *Mesocyclops woutersi* seems to display a curious disjunction: outside the numerous localities in northern Papua New Guinea (Madang Prov. – Van de Velde 1987), it has been also found in Laos, Vietnam, China (Guangxi Province), the Ryukyus (Holyńska 1987, 2000) and Honshu (Ishida, in litt.). However the examined samples (46) from South Thailand, Malaysia, and Indonesia did not contain a single specimen of *M. woutersi*, nor is there any literature record of this species from Indonesia and peninsular Malaysia. This is all the more strange, because *M. woutersi* is relatively common in Indochina, encountered in a wide variety of natural habitats (lakes, ponds, ricefields, ditch, small stream), and it is also very frequent inhabitant of the peridomestic water containers and wells in Vietnam (Nam et al. 2000). Connection between the Chinese and New Guinean populations might be through Taiwan, Philippines and Moluccas, the *Mesocyclops* fauna of which is almost completely unknown. We can have also in mind the possibility of recent introduction to Papua New

Guinea, but occurrence of a *Mesocyclops* very closely related to, or conspecific with *M. woutersi* [it was recorded by Brown (1995) as *Mesocyclops* *nr. isabellae*, but all the characters in the description and illustration, which Dr. Brown kindly sent to me, match *M. woutersi*] in a reservoir on Palm Island (North Queensland, Australia) suggests, that it is indigenous species there. *Mesocyclops woutersi* along with other three allopatric representatives of the *M. thermocyclopoides*-group (Holynski and Fiers 1994) [*M. parentium* – southern India, Sri Lanka; *M. friendorum* – Sulawesi; and *M. dissimilis* – from Honshu (Japan) through China to Vietnam] constitute the *woutersi*-superpecies (Holyńska 1997), members of which display a very slight degree of the morphological divergence. They can be distinguished from other species belonging to the *thermocyclopoides*-group by having: 1. seven setae on the second endopodal segment of the antenna; 2. V-shaped connection of the transverse ducts (female genital system); 3. complex spinule ornamentation on the caudal surface of the antennary basipodite (the basic pattern supplemented with an oblique row of spinules starting in distal half of medial rim, and field of small spinules near the implantation of the medial setae); 4. characteristic caudal ornamentation of the P4 coxopodite (spinules along proximal rim of conspicuously different size; elongate spinules at laterodistal angle arranged usually in group; few spinules along distal rim, in intermittent row). *Mesocyclops francisci* known only from southwest Malaysia and Sumatra, is supposed here to be the closest relative of the *woutersi*-superspecies.

Mesocyclops friendorum sp. nov.

Types. Holotype and one female paratype [Indonesia, S-Sulawesi, Tana Toraja, Tambolang, 1 km W Rantepao, 2°56'S–119°54'E, 850 m, ricefield, leg. R. & M. Holyński, 8 Oct 1988] are dissected and mounted in glycerin on two slides each. Types are deposited at Museum and Institute of Zoology PAS, Warsaw.

Etymology. The species is named for my friends Maria and Tony Friend, whose generous invitation and „private grant” made my collecting trip to South East Asia and New Guinea possible.

Description (female). Body length 1080–1130 μm ; prosome/urosome: 1.8–2.0 (1.8 in holotype); cephalothorax, length/width: 1.2 (holotype); cephalothorax width/genital double-somite width: 3.0 (holotype).

Pediger 5 (Fig. 39D) with lateral and dorsal hairs, two medial and two laterodistal sensilla on dorsal surface of somite. Genital double-somite (Fig. 40B) 1.2 times as long as wide, without hairs, on laterodorsal surface group of six pores posteriorly to P6. Seminal receptacle (Fig. 40A) with wide and short lateral arms; anterior margin of proximal part deeply sinuate in middle. Posteriorly to horseshoe-shaped copulatory pore, one circular pore present. Transverse ducts directed to each other at acute angle (V-shaped) before connection with copulatory duct; copulatory duct strongly curved. Anal somite (Figs 40C,D) with strong

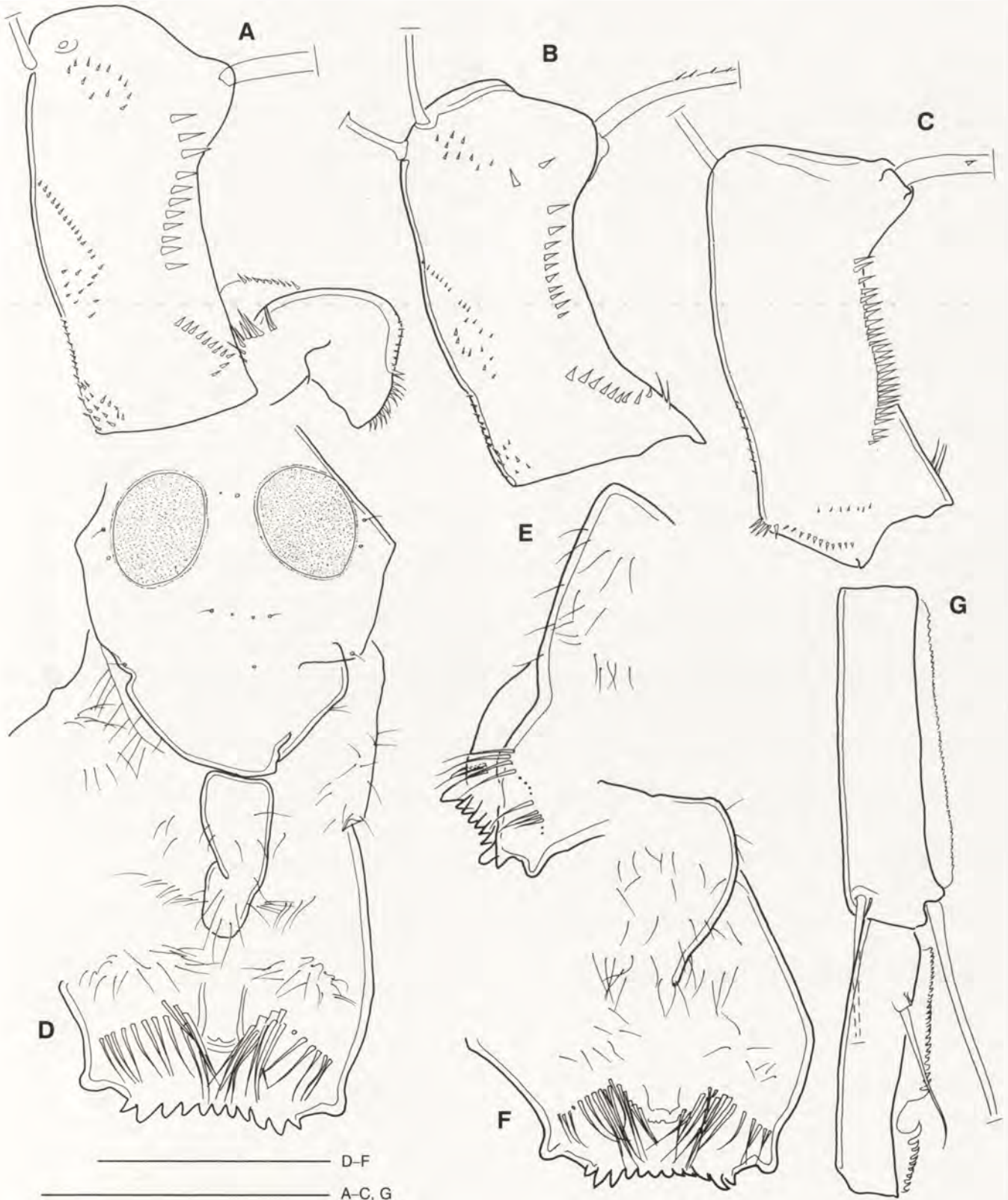


Figure 38. A-C, E, G. *Mesocyclops friendorum* sp. nov., female: (A) Antennary basipodite, caudal [paratype]; (B) Antennary basipodite, caudal [holotype]; (C) Antennary basipodite, frontal [paratype]; (E) Labrum and epistoma [Holotype]; (G) 16. and 17. antennary segments [holotype]. D. *Mesocyclops dissimilis* Defaye et Kawabata, 1993, female: Labrum, epistoma, and rostrum [Japan: L. Biwa]. F. *Mesocyclops woutersi* Van de Velde, 1987, female: Labrum and epistoma [P.N.G.: "Japanese airstrip"]. Scales: 50 μ m.

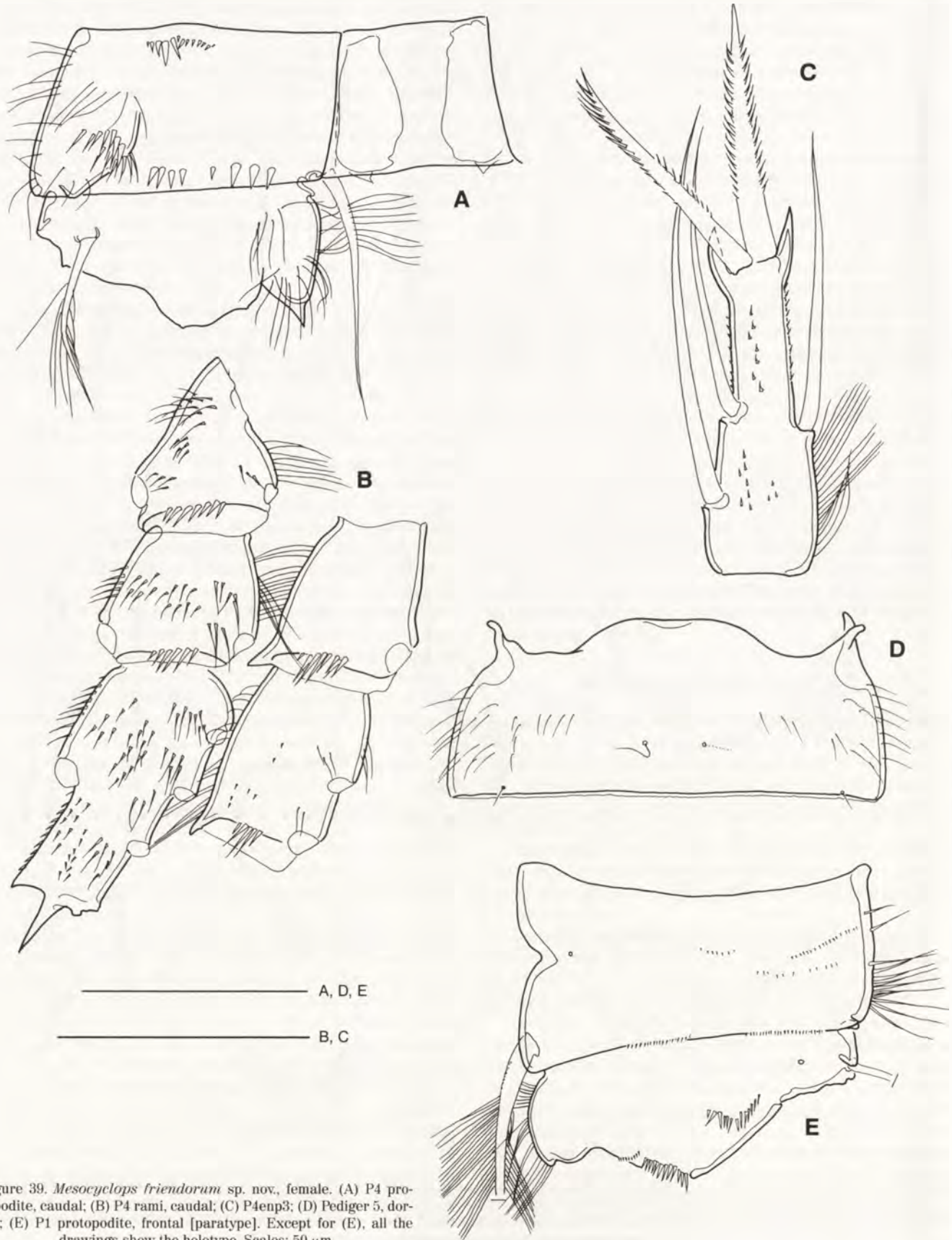


Figure 39. *Mesocyclops friendorum* sp. nov., female. (A) P4 propodite, caudal; (B) P4 rami, caudal; (C) P4enp3; (D) Pediger 5, dorsal; (E) P1 propodite, frontal [paratype]. Except for (E), all the drawings show the holotype. Scales: 50 μ m.

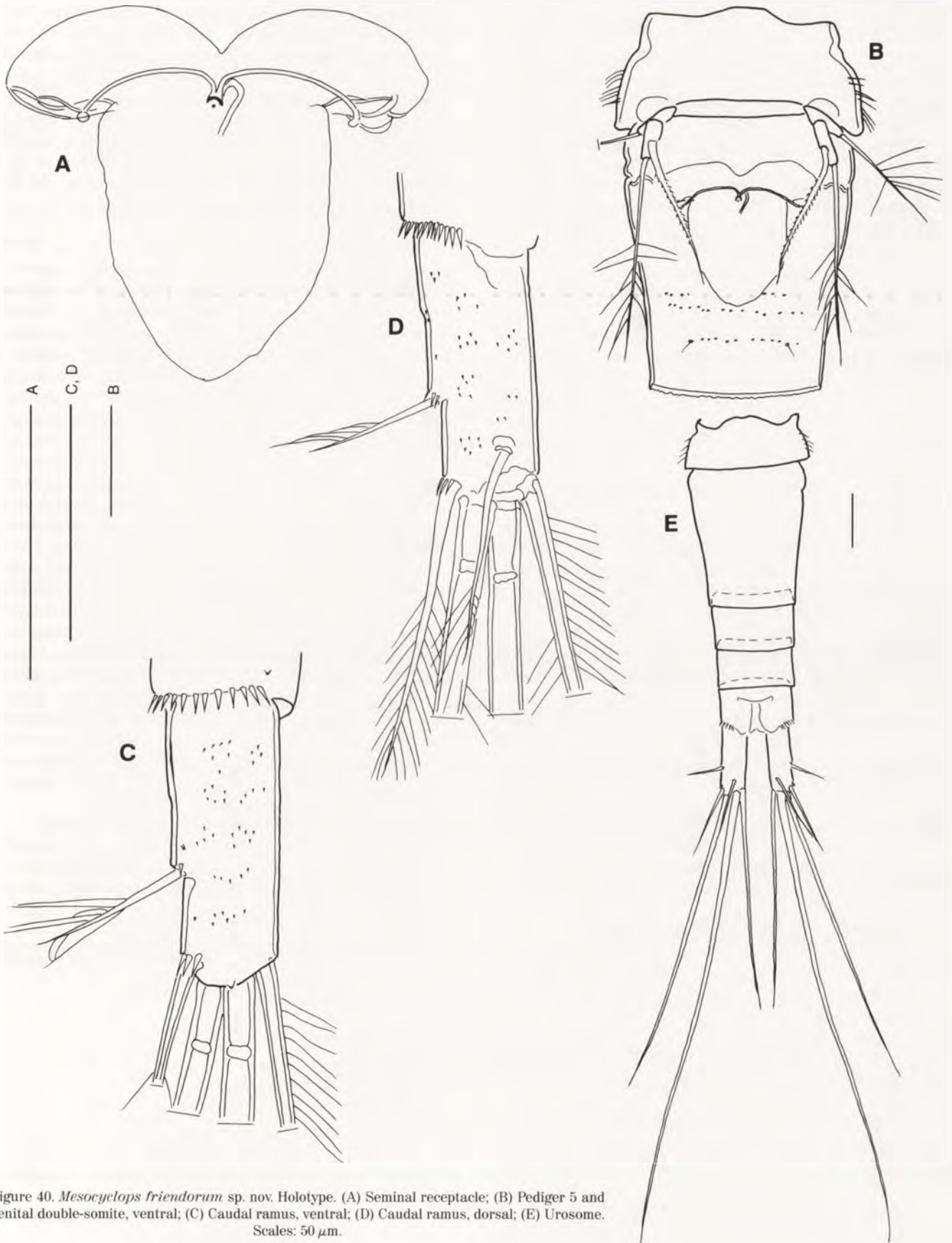


Figure 40. *Mesocyclops friendorum* sp. nov. Holotype. (A) Seminal receptacle; (B) Pediger 5 and genital double-somite, ventral; (C) Caudal ramus, ventral; (D) Caudal ramus, dorsal; (E) Urosome. Scales: 50 μ m.

spinules along entire posterior margin. Caudal rami (Figs 40C,D) 2.6 times as long as wide, without hairs, dorsal and ventral surfaces covered with tiny spinules arranged in distinct groups. Spinules present at implantation of lateral-most terminal and lateral caudal setae. Dorsal caudal seta 1.1 (holotype) times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.8–3.1; 5.9–6.1; 3.9(holotype)–4.6; 1.0. Longest terminal seta 1.3 times as long as urosome (Fig. 40E).

Armature formula of 17-segmented antennule as in *M. dayakorum*. Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch (Fig. 38G). Ventral spinules present on antennular segments 1, 4–5, 7–13. Antenna bearing 3 setae on basipodite and 1, 7, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule pattern of antennary basipodite complex (Figs 38A,B), basic pattern (see in *M. dayakorum*) supplemented with: oblique row of spinules starting in distal half of medial rim and ending in diffuse patch of spinules proximally; one/two rows of small spinules near implantation of medial setae. Spinules (11, 12) in longitudinal row along lateral rim, of similar size (longest/shortest ≤ 1.7). Frontal spinule ornamentation of antennary basipodite (Fig. 38C) composed of 28 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

With exception of distal fringe hairs no other hairs on ventral surface of labrum, epistoma pilose (hair ornamentation of vertical cleft was not verifiable) (Fig. 38E). Segmentation and setation of mandible, maxillule, maxilla and maxilliped as in *M. dayakorum*. Spinule ornamentation of mouthparts like in *M. woutersi*: mandible bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others; maxillary palp naked, lateralmost (longest) seta of lateral lobe without long setules; frontal surface of maxillary coxopodite bearing distinct row of spinules, basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only; spinules in oblique row on frontal surface of maxilliped syncopodite very tiny, spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 like in *M. dayakorum* (Table 2), except P1 basipodite lacking medial spine. Frontal surface of P1 basipodite with large spinules arranged in semicircular arch (Fig. 39E); medial expansion of basipodite of P1–P4 with apical hairs. Long apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface (Fig. 39A). Couplers naked on frontal and caudal surfaces in P1–P4, distal margin of P4 coupler bearing two small acute outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 39A) composed of: 7, 8 spinules in intermittent row along distal rim; many (16, 18) elongate spinules at laterodistal angle arranged in group; many (10–14) spinules of conspicuously different size in one row along proximal rim; dense lateral hairs. P4 coxopodite seta 1.7–1.8 times longer than height of medial expansion of P4 basipodite. Caudal

surface of P4 rami, with exception of *enp1*, adorned with hair-like and short spinules (Fig. 39B). Similar, but less expressed ornamentation present on caudal surface of P2–P3 rami, and absent in P1. P4*enp3* (Fig. 39C) 2.6–2.9 times as long as wide; of apical spines medial one 0.9–1.0 times as long as lateral; longer(lateral) spine 0.9 times as long as segment. Lateral edge of medial apical spine with 7(holotype), 16 teeth. Apical seta of P5 1.2 times as long, lateral seta 0.7–0.8 times as long as medial spine. P6 with one long medial seta and two small lateral spines.

No male found.

Diagnosis. *Mesocyclops friendorum* can be distinguished from its congeners by the following combination of characters: length of the body relatively small (ca 1100 μm); pediger 5 laterally and dorsally pilose; genital double-somite bare; seminal receptacle with short and wide lateral arms, anterior margin of proximal part deeply sinuate in the middle; transverse ducts directed to each other at acute angle (V-shaped) before connection with copulatory duct; entire posterior margin of anal somite with spinules; spinules present at implantation of lateralmost terminal and lateral caudal setae; caudal rami adorned with tiny spinules arranged in distinct groups, but no hairs; longest terminal seta ca. 1.3 times as long as urosome; hyaline membrane on last antennular segment with one large notch, ventral spinules present on antennular segments 1, 4–5, 7–13; second endopodal segment of antenna armed with 7 setae; caudal spinule ornamentation of antennary basipodite (oblique row of spinules starting in distal half of medial rim ends in diffuse patch proximally; spinules near implantation of medial setae arranged in 1/2 rows); labrum ventrally bearing distal fringe hairs only, epistoma pilose; maxillary palp naked; P1 basipodite without medial spine; apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface; P4 coupler with small acute outgrowths, naked; spinule ornamentation of P4 coxopodite (spinules along proximal rim of conspicuously different size, and arranged in row).

Distribution. Known only from the type locality.

Remarks. *Mesocyclops friendorum* is a member of the *M. woutersi*-superspecies (see also description of *M. woutersi*). Differences in the fixed (non-variable) characters between members of the complex are shown in Table 4.

	PA	FR	WO	DI
A2 basipodite, caudal, diffuse patch of spinules medially/proximally to medial oblique row:	+	+	+	–
Pores posteriorly to P6:	6	6	6	8
Pediger 5, dorsal hairs:	+	+	–	–
Spinules at base of lateral caudal seta:	–	+	–	+
Spinules at base of lateralmost terminal setae	+	+	–	+
Labrum, hairs, proximally to distal fringe hairs	+	–	+	+

Table 4. Fixed characters showing differentiation in *Mesocyclops woutersi*-superspecies.

Abbreviations: PA: *M. parentium*; FR: *M. friendorum*; WO: *M. woutersi*; DI: *M. dissimilis*; +: present; –: absent.

Mesocyclops microlasius Kiefer, 1981

Mesocyclops microlasius Kiefer, 1981: 173–175, Pl. 11, Figs 7–12.

Type. Holotype together with four *Thermocyclops* females on two slides (SMNK: 2892, 2893) – 2892: “*Mesocyclops microlasius* n. sp. Typus, 5 *Thermocyclops*, A1–P4, Kiefer 21.1.36; Philippinen, Manila, Zementteiche, 1345, Wallacea Exp. P.220”; 2893: “*Mesocyclops microlasius* Typus, 5 *Thermocyclops*, Abd+P5, Kiefer M. 21.1.36; Philippinen, Manila, Zementteiche, Wallacea P. 220, 1345”, leg. R. Woltereck.

Other material examined. PHILIPPINES: 1♀ on one slide (SMNK: 4032) – “*Mesocyclops microlasius* 1♀, Kiefer 13.5.38; Philippinen, Luzon, Laguna-See, Wallacea-Exp., 15.4.32”, leg. R. Woltereck. 2♀♀ on two slides (SMNK: 10485, 10486) – 10485: “*Mesocyclops* 2♀♀, Abd+P5, Kiefer 17.11.78; Insel Luzon, Teich bei I. Manila, 1321, R. Woltereck, Phil. 103”; 10486: “*Mesocyclops* 2♀♀, A1–P4, Kiefer 17.11.78; Insel Luzon, Teich I. bei Manila, 1321, R. Woltereck Phil.103”, leg. R. Woltereck. 1♀ on two slides (SMNK: 10887, 10888) – 10887: “*Mesocyclops*” ♀, Abd+P5, Kiefer 29.3.80; Wallacea-Exp. P.255”; 10888: “*Mesocyclops* ♀, A1–P4, Kiefer 29.3.80; Wallacea-Exp. P.255. Antennule and antenna only (♀) (SMNK: 11283) – “*Mesocyclops microlasius* ♀, A1+A2, Kiefer 12.11.82; Philippinen, Luzon, Manila, Teiche, Woltereck P220”, leg. R. Woltereck.

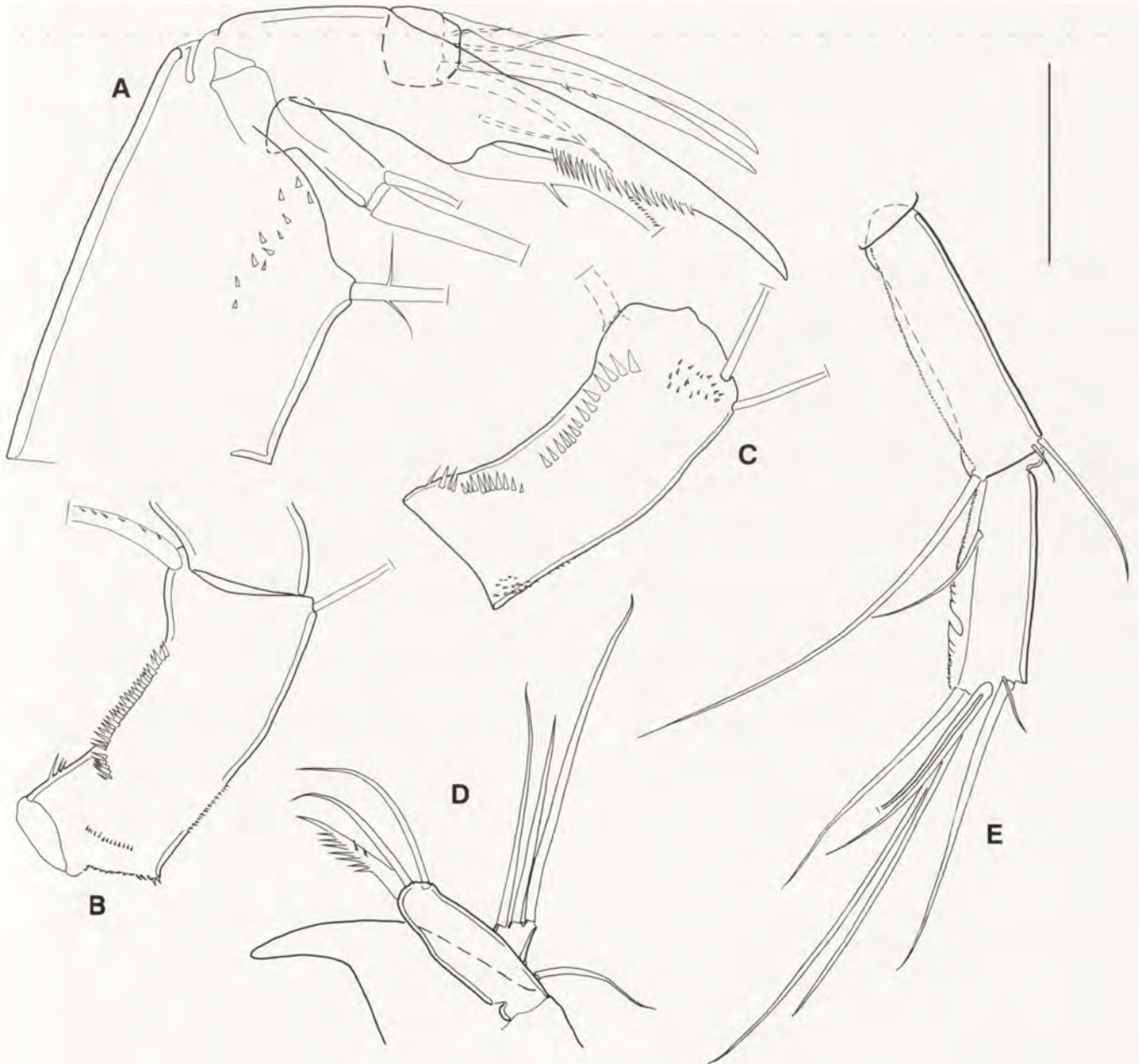


Figure 41. *Mesocyclops microlasius* Kiefer, 1981. Holotype. (A) Maxilla, frontal; (B) Antennary basipodite, frontal; (C) Antennary basipodite, caudal; (D) Maxillary palp; (E) 16. and 17. antennular segment. Scale: 50 μ m.

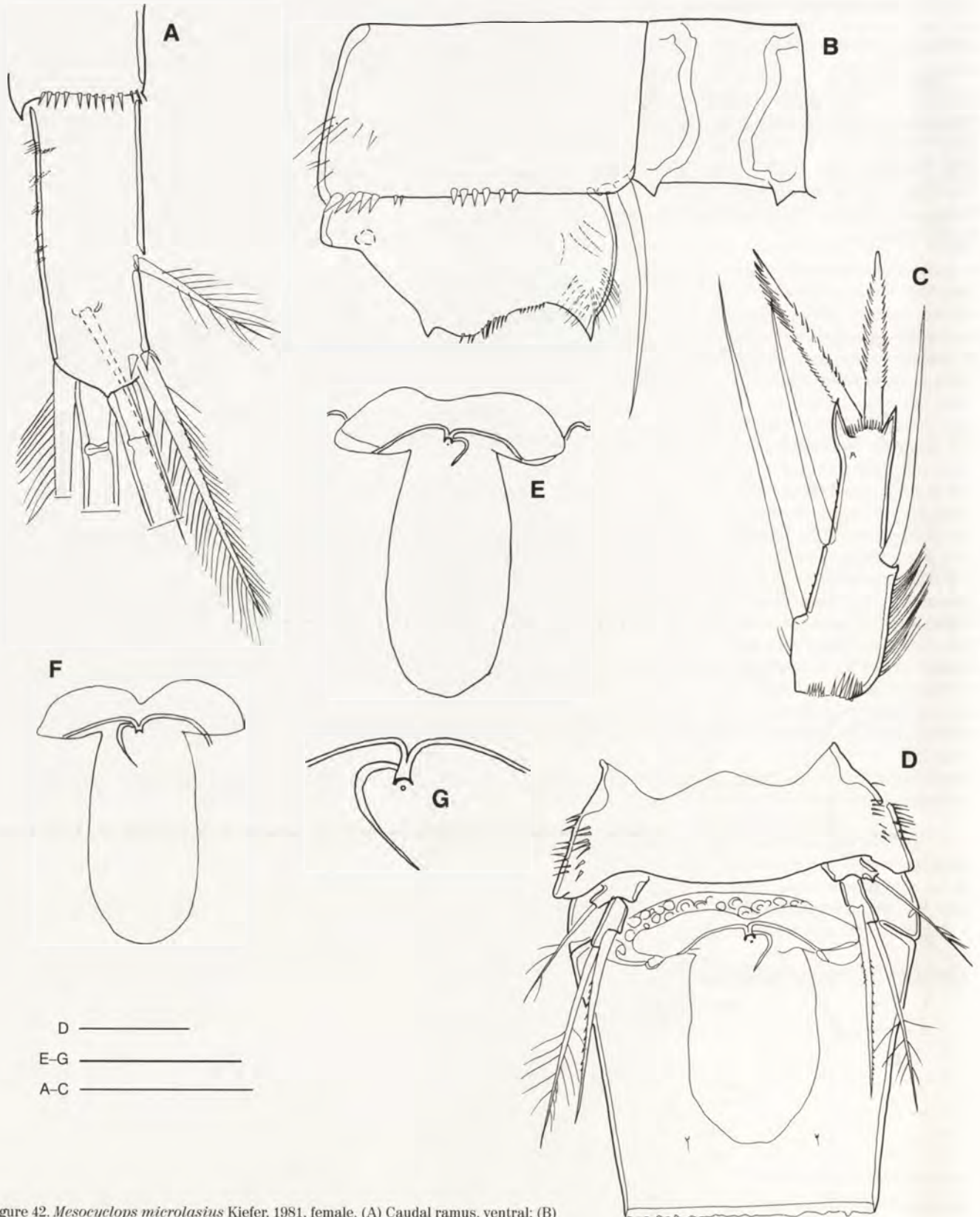


Figure 42. *Mesocyclops microlasius* Kiefer, 1981, female. (A) Caudal ramus, ventral; (B) P4 protopodite, frontal; (C) P4enp3; (D) Pediger 5 and genital double-somite, ventral; (E) and (F) Seminal receptacle [SMNK:10485]; (G) Copulatory pore and duct, and transverse ducts. Except for (E) and (F) all the drawings show the holotype. Scales: 50 μ m.

Description (female). Body length: 1005 μm ; prosome 1.75 times as long as urosome (both data refer to SMNK, 4032).

Pediger 5 (Fig. 42D) with strong lateral hairs; no observation made on ornamentation of dorsal surface (position of urosomes in all preparations ventral up). Genital double-somite 1.2–1.4 times as long as wide, without hairs on ventral surface. Lateral arms of seminal receptacle (Figs 42D–F) wide, anterior margin of proximal part sinuate in middle. Posteriorly to horseshoe-shaped copulatory pore one circular pore. Transverse ducts (Figs 42D–G) directed to each other at acute angle (V-shaped) before connection with copulatory duct; copulatory duct strongly curved, the section connecting copulatory pore and transverse ducts usually well visible. Posterior margin of anal somite with spinules, those on lateral surface sometimes reduced (SMNK: 10485). Caudal rami (Fig. 42A) 2.8–2.9 times as long as wide; medial rim, anteriorly to implantation of lateral caudal setae, with hairs arranged in distinct rows. Spinules at implantation of lateralmost terminal setae always present, at implantation of lateral caudal setae spinules present or absent. Dorsal caudal seta 0.94 (holotype) times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.6–2.7, 5.6–6.0, 3.9–4.1, 1.0. Longest terminal seta 1.1–1.2 times as long as urosome.

Armature formula of 17-segmented antennule, as in *M. dayakorum*. Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch (Fig. 41E). Ventral spinules present on segments 1, 4–5, 7–13, dorsal surface of antennule (segments 1, 4, in SMNK 11283) adorned with shallow pits.

Antenna bearing 3 setae on basipodite and 1, 7, 7 setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of antennary basipodite (Fig. 41C): long lateral spinules near base; tiny spinules on medial rim in proximal quarter/third, and few at medioproximal angle; 8–10 spinules in oblique row next to long lateral spinules near base; 13–15 spinules in longitudinal row near lateral rim; oblique row of fine spinules starting at ca. distal third of medial rim, absent in holotype, but present in other specimens; field of tiny spinules near implantation of medial setae. Frontal spinule pattern of antennary basipodite (Fig. 41B) composed of longitudinal row of spinules (18–31), and transverse spinule row distally to spinules along proximal rim.

Distal fringe hairs on ventral surface of labrum, episoma pilose. Mandible bearing three groups of spinules near palp. Maxillary palp (Fig. 41D) naked, lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite with distinct row of spinules (Fig. 41A); basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only. Maxilliped syncoxopodite adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 as in *M. dayakorum* (Table 2) except P1 basipodite lacking medial spine. Frontal surface of P1 basipodite with spinules arranged in semicircular

arch; medial expansion of basipodite of P1–P4 with apical hairs. Apical hairs on medial expansion of P4 basipodite supplemented with long proximal hairs on caudal surface (Fig. 42B). Couplers naked on frontal and caudal surfaces in P1–P4, distal margin of P4 coupler bearing two small, acute outgrowths. Caudal spinule ornamentation of P4 coxopodite was not verifiable. P4 coxopodite seta 1.6 (holotype) times as long as height of medial expansion of P4 basipodite. P4enp3 (Fig. 42C) 2.9–3.7 times as long as wide; of apical spines medial one 1.1–1.2 times as long as lateral. Lateral edge of medial apical spine with 4–11 teeth in middle two quarters. Apical seta of P5 1.0–1.2 times as long, lateral seta 0.63–0.90 times as long as medial spine.

Male unknown.

Distribution. Known only from Luzon.

Mesocyclops geminus sp. nov.

Mesocyclops cf. *microlasius*: Holyński 1994b: 47–53, Figs 22–24.

Types. Holotype (adult female) and four paratypes (one adult male, and three copepodids V, females) from Borneo, Long Iram, 0°00'N/S–115°35'E, 180 km WNW Samarinda, Mahakam Riv. Valley, 80 m., shallow pool in stream bed, leg. M. & R. Holyński, 23 May 1989.

Etymology. The specific name derived from the Latin word “geminus” for “twin”, and refer to the very close morphological relationship with *M. microlasius*.

Description (holotype). Body length: 970 μm (no allowance for telescoping of body somites has been made). Pediger 5 (Fig. 44F, 45A) with lateral hairs only, dorsally two medial and two laterodistal hair sensilla present. Genital double-somite as long as wide, no hairs, whole surface adorned with shallow pits; six sensilla (two medial, two lateral, and two distal) on dorsal surface, and two distal sensilla on ventral surface; posteriorly to P6 six pores in group (Fig. 45E). Shape of seminal receptacle distorted, yet wide lateral arms discernible. Posteriorly to horseshoe-shaped copulatory pore one circular pore present. Transverse ducts (Fig. 44E) directed to each other at acute angle (V-shaped) before connection with copulatory duct; copulatory duct strongly curved, the part connecting copulatory pore and transverse ducts well visible. Anal somite (Fig. 45D,G) with strong spinules along entire posterior margin. Caudal rami (Fig. 45D,G) 2.8 times as long as wide, adorned with tiny spinules; in proximal half of medial rim rows of hairs extending also to dorsal surface. Spinules present at implantation of lateralmost terminal and lateral caudal setae. Dorsal caudal seta 1.1 times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost (Fig. 45F): 2.6, 5.8, 3.6, 1.0. Longest terminal seta ca. 1.2 times as long as urosome.

Armature formula of 17-segmented antennule, as in *M. dayakorum*, typical for genus (Fig. 49A). Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch (Fig. 43F). Ventral spinules present on seg-

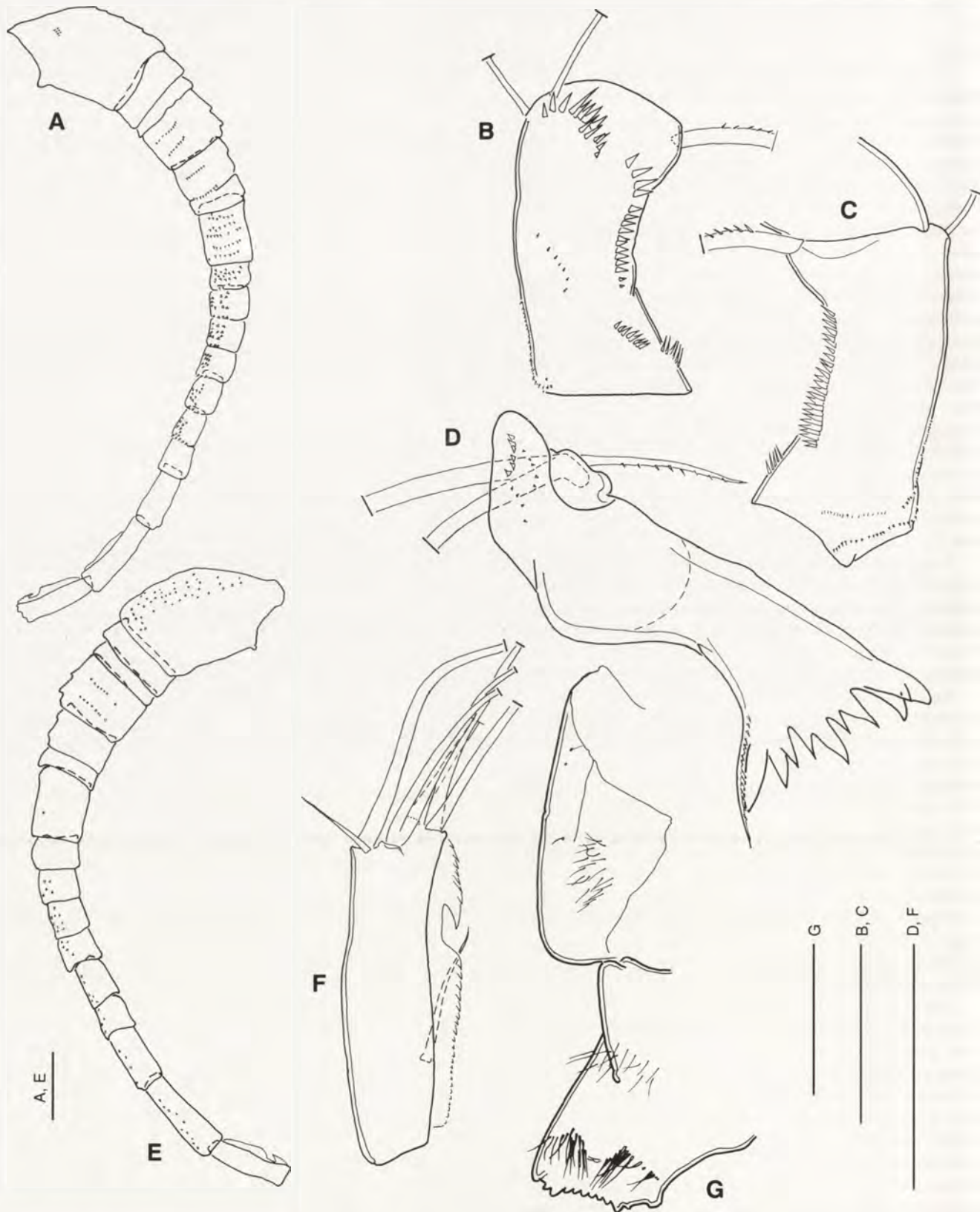


Figure 43. *Mesocyclops geminus* sp. nov. Holotype. A, E. Antennule: (A) Anterior view; (E) Posterior view. B, C. Antennary basipodite: (B) Caudal view; (C) Frontal view. (D) Mandible; (F) Last antennary segment; (G) Labrum, epistoma, and vertical cleft. Scales: 50 μ m.

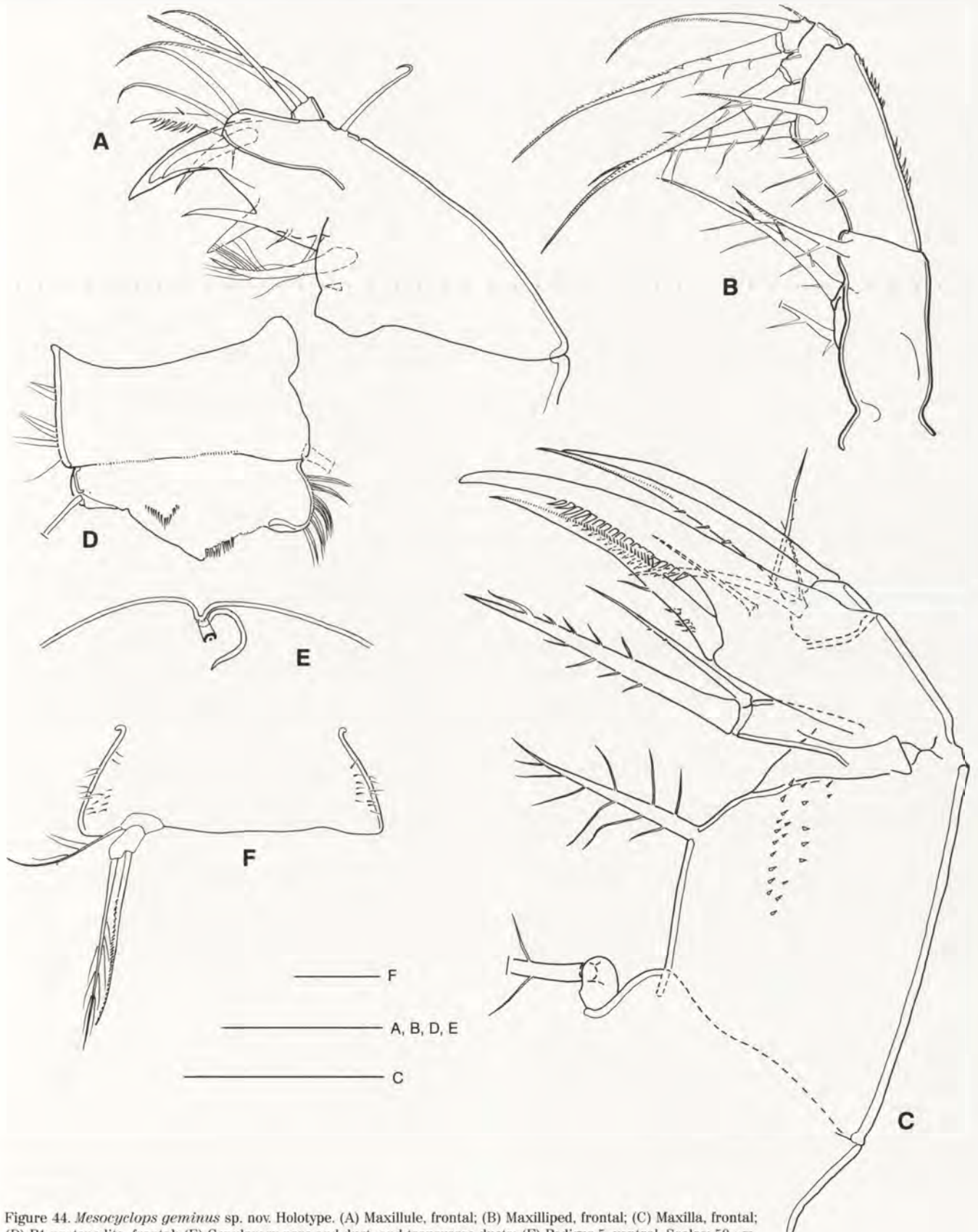


Figure 44. *Mesocyclops geminus* sp. nov. Holotype. (A) Maxillule, frontal; (B) Maxilliped, frontal; (C) Maxilla, frontal; (D) P1 protopodite, frontal; (E) Copulatory pore and duct, and transverse ducts; (F) Pediger 5, ventral. Scales: 50 μ m.

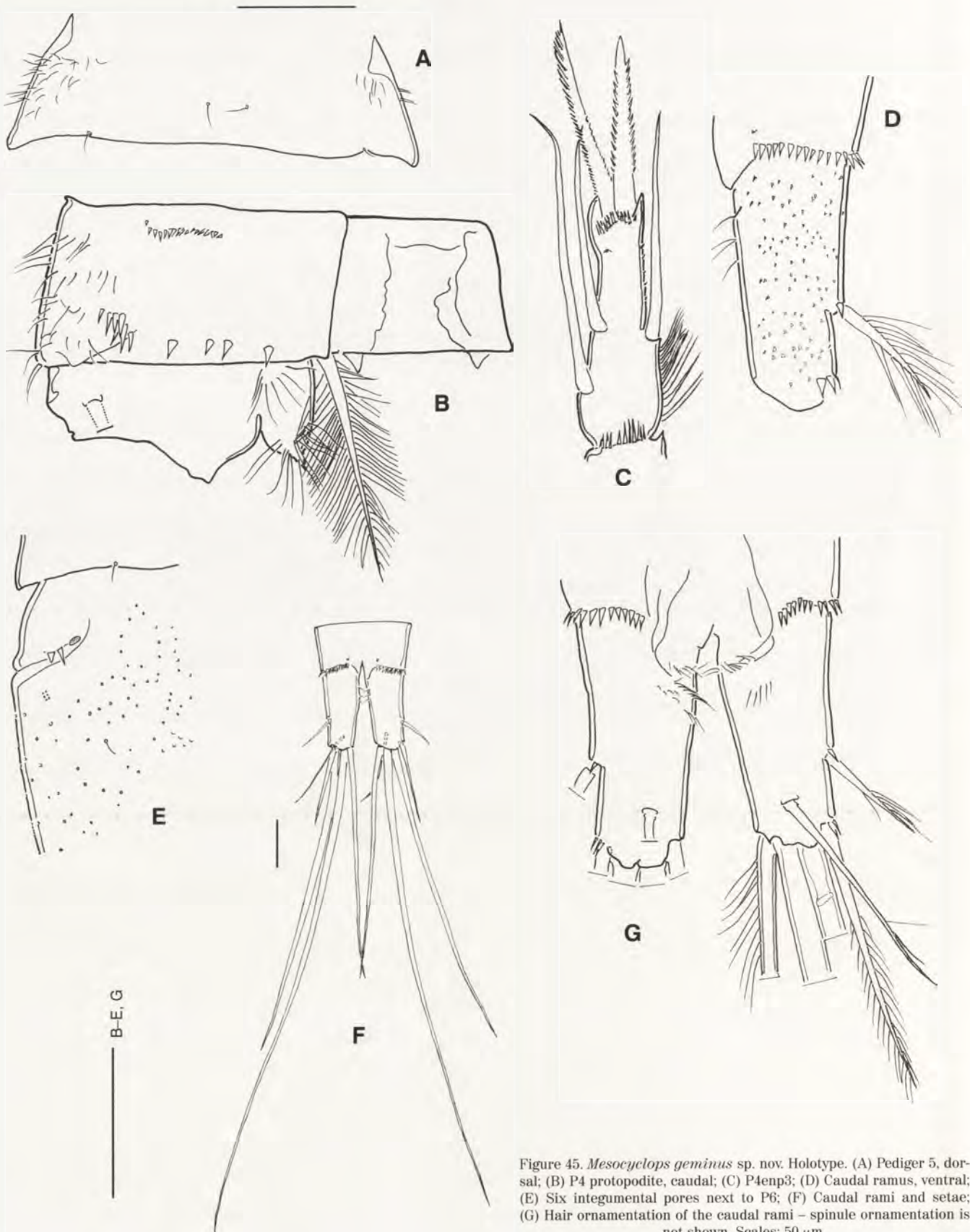


Figure 45. *Mesocyclops geminus* sp. nov. Holotype. (A) Pediger 5, dorsal; (B) P4 protopodite, caudal; (C) P4enp3; (D) Caudal ramus, ventral; (E) Six integumental pores next to P6; (F) Caudal rami and setae; (G) Hair ornamentation of the caudal rami – spinule ornamentation is not shown. Scales: 50 μ m.

ments 1, 4–5, 7–13 (Fig. 43A), dorsal surface of antennule adorned with shallow pits (Fig. 43E).

Antenna bearing 3 setae on basipodite and 1, 7, 7 setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of antennary basipodite (Fig. 43B): basic pattern (see in *M. dayakorum*) supplemented with oblique row of spinules starting at mid of medial rim; one/two rows of large spinules near implantation of medial setae. Spinules (14, 16) in longitudinal row along lateral rim distally increasing. Frontal spinule pattern of antennary basipodite (Fig. 43C) composed of longitudinal row of spinules (26), and transverse row distally to spinules along proximal rim.

With exception of distal fringe hairs no other hairs on ventral surface of labrum, epistoma and vertical cleft pilose (Fig. 43G). Segmentation and setation of mandible, maxillule, maxilla and maxilliped as in *M. dayakorum*. Mandible (Fig. 43D) bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillary palp naked; lateralmost (longest) seta of lateral lobe without long setules (Fig. 44A). Frontal surface of maxillary coxopodite bearing triangular field of spinules; basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only (Fig. 44C). Group of large spinules on frontal surface of maxilliped syncoxopodite absent, spinules on lateral rim and caudal surface of basipodite arranged in two groups (Fig. 44B).

Armature of P1–P4 as in *M. dayakorum* (Table 2) except P1 basipodite lacking medial spine. Frontal surface of P1 basipodite with spinules arranged in semicircular arch (Fig. 44D); medial expansion of basipodite of P1–P4 with apical hairs. Apical hairs on medial expansion of P4 basipodite supplemented with long proximal hairs on caudal surface (Fig. 45B). Couplers of P1–P4 naked on frontal and caudal surfaces, P4 coupler with two small, acute outgrowths on distal margin. Caudal spinule ornamentation of P4 coxopodite (Fig. 45B) composed of: few (3+1; 4) large spinules along distal rim; elongate spinules in one row at laterodistal angle; many (16) spinules in one row along proximal rim; and dense lateral hairs. P4 coxopodite seta 1.8 times as long as height of medial expansion of P4 basipodite. P4enp3 (Fig. 45C) 2.6 times as long as wide; of apical spines medial one 1.1 times as long as lateral. Lateral edge of medial apical spine with many teeth. Lateral seta of P5 0.71 times as long as medial spine.

Male. Body length: 800 μm ; prosome/urosome: 1.9; cephalothorax, length/width: 1.2. Pediger 5 with lateral hairs. No spinule ornamentation on P6 flaps. Anal somite with spinules along entire posterior margin. Caudal rami 2.3 times as long as wide, without hairs. Spinules at implantation of lateralmost terminal setae and lateral caudal setae present. Dorsal caudal seta as long as lateralmost terminal seta. Relative length of terminal setae from medialmost most to lateralmost: 2.8, 6.4, 4.3, 1.0. Longest terminal seta 1.4 times as long as urosome.

Antennule 16-segmented but with incomplete subdivision of compound apical segment. Armature formula: 8+3ae, 4, 2, 2+ae, 2, 2, 2, 1+ae+sp, 2, 2, 2, 2+ae, 2, 1+ae,

[5, 7+ae]. At distal geniculation plate-like structures (one on segment 14 and two on segment 15) with striated surface, and one short conical element on segment 14 and 15 each. First antennular segment ornamented with row of spinules on ventral surface, and pits dorsally. Antenna armed with 3 setae on basipodite, and 1, 6, and 7 setae on endopodal segments 1–3, respectively. Spinule pattern of antennary basipodite (Figs 46C–E) like in female. Number of spinules in longitudinal rows along lateral rim on caudal and frontal surfaces 14, 15, and 22, respectively. 7, 9 spinules arranged in row near implantation of medial setae on caudal surface. Labrum bearing distal fringe hairs only, epistoma bare. Armature of mandible, maxillule, and maxilliped the same as in female. Setation of maxilla like in female, but spinules on frontal surface of syncoxopodite, absent.

P1 basipodite without medial spine; frontal surface of basipodite with large spinules arranged in semicircular arch. Apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface (Fig. 46F). Outgrowths of P4 coupler little bit larger than those of female. Caudal spinule ornamentation of P4 coxopodite (Fig. 46F) composed of: 6 spinules in intermittent row along distal rim; spinules at laterodistal angle arranged in row; 16 spinules in one row along proximal rim; and reduced lateral hairs. P4 coxopodite seta 1.9 times longer than height of medial expansion of P4 basipodite. P4enp3 3.1 times as long as wide; of apical spines medial one 1.2 times as long as lateral; longer spine (medial) 0.9 times as long as segment. Lateral edge of medial apical spine with many teeth. Lateral seta of P5 0.65 times as long as medial spine. P6 composed of medial spine, slender seta of same length, and long (2,3 \times ?) lateral seta.

Copepodid V (females). Body length: 940–1000 μm ; prosome/urosome: 1.7–1.9; cephalothorax, length/width: 1.0–1.2. Pediger 5 with lateral hairs. In one specimen the copulatory pore with one circular pore, copulatory duct, and the medial section of transverse ducts discernible on ventral surface of genital segment (Fig. 46B), but no trace of these structures in other copepodid females. Anal somite with spinules along entire posterior margin. Caudal rami ca. 2.4 times as long as wide, without hairs. Spinules at implantation of lateralmost terminal setae and lateral caudal setae present. Dorsal caudal seta as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.5, 7.0, 4.5, 1.0 (one specimen). Longest terminal seta 1.2–1.4 times as long as urosome.

Armature formula of 11-segmented antennule: 7, 4, 8, 4, 1+sp, 2, 3, 2+ae, 2, 2+ae, 7+ae. Serrate hyaline membrane on last antennular segment extending beyond implantation of medial seta of segment, but shorter, than that in adult female, with one small or large notch. Transverse rows of spinules present on compound antennular segments homologous with those on adult female segments 1, 4, 5, 7–13. Antenna bearing 7 setae on second endopodal segment. Spinule ornamentation of antennary basipodite (Fig. 46A) like in adult female, except caudal spinules near implantation of medial setae smaller, and spinules in particular group less (caudally 10–14 spinules

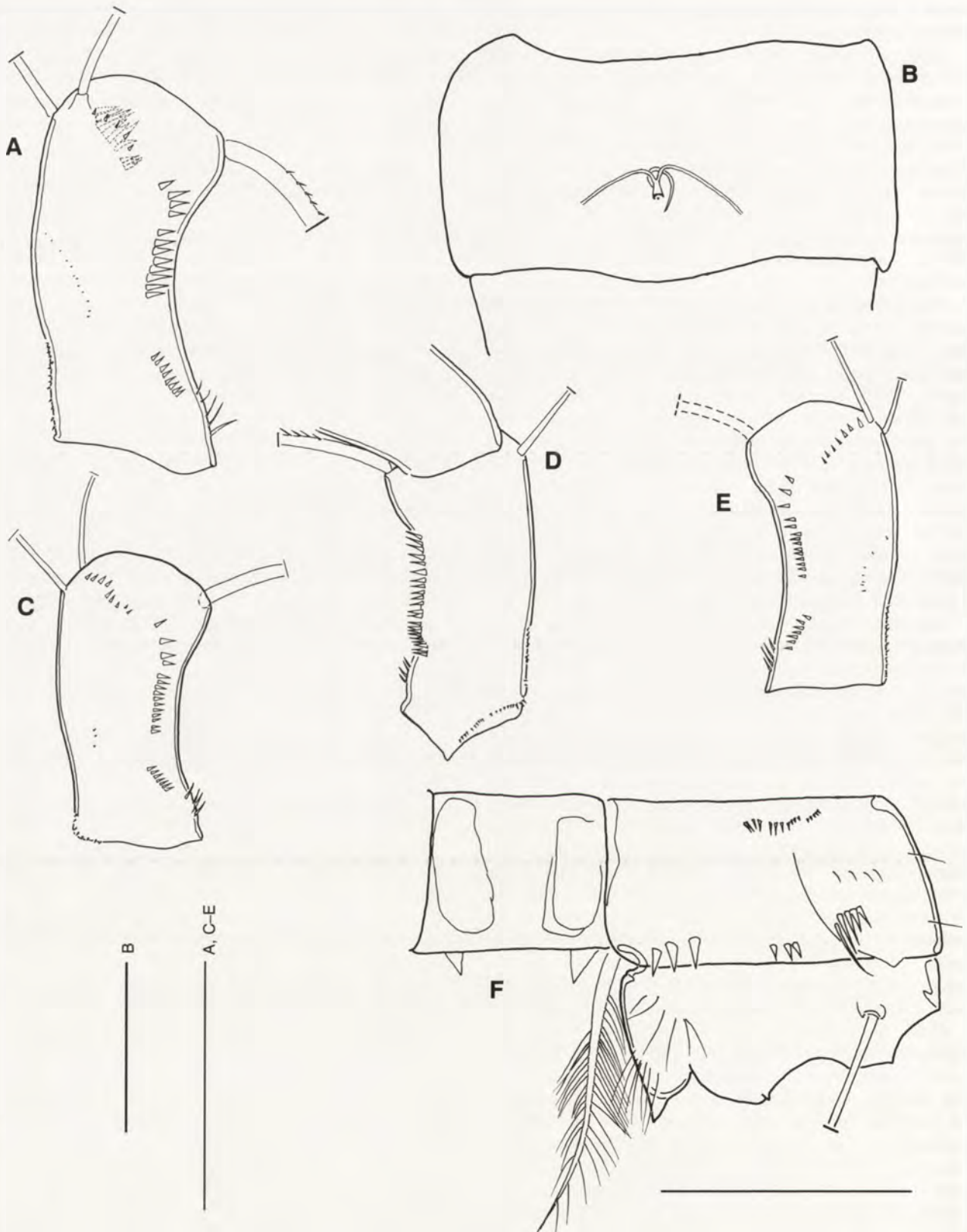


Figure 46. *Mesocyclops geminus* sp. nov. Paratypes. A. B. Copepodid V: (A) Antennary basipodite, caudal; (B) Genital segment – Transverse and copulatory ducts are beginning to take shape. C–F. Male: (C) Antennary basipodite (right), caudal; (D) Antennary basipodite, frontal; (E) Antennary basipodite (left), caudal; (F) P4 protopodite, caudal. Scales: 50 μ m.

in longitudinal row along lateral rim). Segmentation and setation of mouthparts identical to those in adults. With exception of distal fringe hairs no other hairs on ventral surface of labrum, epistoma and vertical cleft naked. Maxillary palp naked. Frontal surface of maxillary coxopodite adorned with rows of tiny spinules.

P1–P4 with two-segmented rami, number of setae and spines the same as in adult. Medial expansion of basipodite of P1–P4 with apical hairs. Caudal proximal hairs on medial expansion of P4 basipodite present on one side in one copepodid, otherwise absent. Caudal spinule ornamentation of P4 coxopodite composed of: 4–7 spinules in intermittent row along distal rim, 6–11 spinules at laterodistal angle arranged in one row, 11–15 spinules in one row along proximal rim, and lateral hairs. P4 coxopodite seta 1.5 (one specimen) times longer than height of medial expansion of P4 basipodite. P4enp3 2.9 times as long as wide (one specimen); apical spines of equal length. Lateral edge of medial apical spine with many teeth. Apical seta of P5 1.3 times (one specimen), lateral seta 0.75–0.95 times as long as medial spine. P6 composed of one long seta and two small spines located on laterodorsal surface of genital segment.

Diagnosis. *Mesocyclops geminus* differs from its congeners in having the following combination of characters: pediger 5 pilose laterally; genital double-somite bare; transverse ducts directed to each other at acute angle (V-shaped) before connection with copulatory duct; part of copulatory duct connecting copulatory pore and transverse duct discernible; entire posterior margin of anal somite with spinules; spinules present at implantation of lateralmost terminal and lateral caudal setae; caudal rami short, in proximal half of medial rim rows of hairs extending to dorsal surface; hyaline membrane on last antennular segment with one large notch, ventral spinules present on antennular segments 1, 4–5, 7–13; second endopodal segment of antenna armed with 7 setae; caudal spinule ornamentation of antennary basipodite (row of large spinules near implantation of medial setae); ventral surface of labrum adorned with distal fringe hairs only, epistoma and vertical cleft pilose; maxillary palp naked; P1 basipodite without medial spine; apical hairs on medial expansion of P4 basipodite supplemented with long hairs on caudal surface; P4 coupler with small acute outgrowths, naked; spinule ornamentation of P4 coxopodite (few robust spinules along distal margin; many spinules arranged in one row along proximal rim).

Distribution. Known only from the type locality.

Remarks. The closest relative of *M. geminus* is *M. microlasius*. Both species belong to the *thermocycloides*-group (Holynski and Fiers 1994). The only difference between them is, that the large spinules arranged in row at height of medial setae on caudal surface of antennary basipodite, present in *M. geminus*, are replaced by a field of fine spinules in *M. microlasius*. The couple can be distinguished from almost all *Mesocyclops* living in Australasia by the distinct hair rows in proximal half of the medial rim of the caudal rami. *Mesocyclops pseudospinosus* Dussart et Fernando, 1988, a species known

only from Java, has the same hair ornamentation on the caudal rami, but differs from *M. microlasius* and *M. geminus* in other characters [pediger 5 without lateral hairs; medial expansion of P4 basipodite bearing only proximal hairs on caudal surface of segment, no hairs apically; two (instead of one) rows of spinules along proximal rim on caudal surface of P4 coxopodite (Dussart and Fernando 1988, Reid in litt.)]. Outside Australasia, among the 47 Old World species recognized so far, *M. spinosus* Van de Velde 1984 (West Africa), *M. pilosus* Kiefer, 1930 (Madagascar), and *M. insulensis* Dussart, 1982 (Madagascar) possess proximal hairs on the caudal rami. *Mesocyclops pilosus* and *M. insulensis* are very closely related to one another (Holyńska 2000), but have highly diverged from *Mesocyclops spinosus*, *M. microlasius*, *M. geminus*, and *M. pseudospinosus*. No opinion can be formed of the significance of the proximal pilosity of the caudal rami in these species without phylogenetic analysis including at least all the Old World species.

Mesocyclops thermocycloides Harada, 1931

Mesocyclops thermocycloides Harada, 1931: 161–162, Figs 23–25; Kiefer 1981: 153, 162–165, Fig. 2(3), Fig. 5; Van de Velde 1987: 156, Figs 28–30; Holynski 1994a: 100–109, Figs 1–5; Ueda and Ishida 1997: 46–48, Fig. 4–5.

Non: *Mesocyclops thermocycloides*: Van de Velde 1984: 31, Fig. 18; Lim and Fernando 1985: 82–83, Figs 51–53; Kawabata 1989: 9–13; Dussart and Fernando 1988: 245–246, Figs 8–11.

Mesocyclops cf. *thermocycloides*: Dahms and Fernando 1993: 9–18, Figs 5–6.

Mesocyclops thermocycloides acutus Dussart et Fernando, 1988: 254, Figs 43–50; Reid and Kay 1992: 340–341, Fig. 4.

Material examined: TAIWAN (Topotypes): 1♀, undissected (SMNK: 11448) – “*Mesocyclops thermocycloides* ♀, Lectotypus [sic], Kiefer 27.4.84; Taiwan, See Candidius 5770, M. Ueno coll. 14.7.1935”; 3♀♀, 1♂ – Sun Moon Lake (=L. Candidius, =L. Zitugetan), 23°51'N–120°55'E, horizontal trawl, leg. Mr. Chao, Oct 1993.

MALAYSIA: 2♀♀ – Fishpond, 2.5ml Chemor, 4°43'N–101°07'E, leg. R. P. Lim, 25 May 1981.

INDONESIA. Java: 3♀♀, 1♂, lake; 1♀, pond – Botanical Garden, Bogor, 6°37'S–106°48'E, 200 m, leg. R. & M. Holyński, 30 Sep 1988; 3♀♀ on two slides (SMNK 10417, 10418) – 10417: “*Mesocyclops thermocycloides* 3♀♀, Abd+P5, 16.10.1978; Jawa, Tjibodas 354, R. Menzel”; 10418: “*Mesocyclops thermocycloides* 3♀♀, A1–P4, 16.10.1978; Jawa, Tjibodas 354, R. Menzel”; 3♀♀ on two slides (SMNK: 10463, 10464) – 10463: “*Mesocyclops* 3♀♀, Abd+P5, Kiefer, 11.11.78; Jawa, Telaga Warna, Plankton 868, D. L. Sunda Exp. (52) 21.7.1928”; 10464: “*Mesocyclops* 3♀♀, A1–P4, Kiefer, 11.11.78; Jawa, Telaga Warna, Plankton 868, D. L. Sunda Exp. (52) 21.7.1928”. Flores: 2♀♀ on two slides (SMNK: 11085, 11086) – 11085: “*Mesocyclops thermocycloides* 2♀♀ Abd., Kiefer 18.8.80; ?Flores? Rana Mesé 658, Heberer coll. 1927; 11086: “*Mesocyclops thermocycloides* 2♀♀ A1–P4, Kiefer 18.8.80; ?Flores? Rana Mesé 658, Heberer coll. 1927.

Description (female). (Values given in parentheses have been measured on the topotypes) Body length: 830–1040 µm (870–895 µm); prosome/urosome: 1.4–1.7 (1.3–1.7); cephalothorax, length/width: 1.1–1.3 (1.1–1.3); cephalothorax width/genital double-somite width: 2.7–3.1 (3.0–3.2)

Pediger 5 (Fig. 47C) with dorsal and lateral hairs, two medial and two laterodistal sensilla present on dorsal sur-

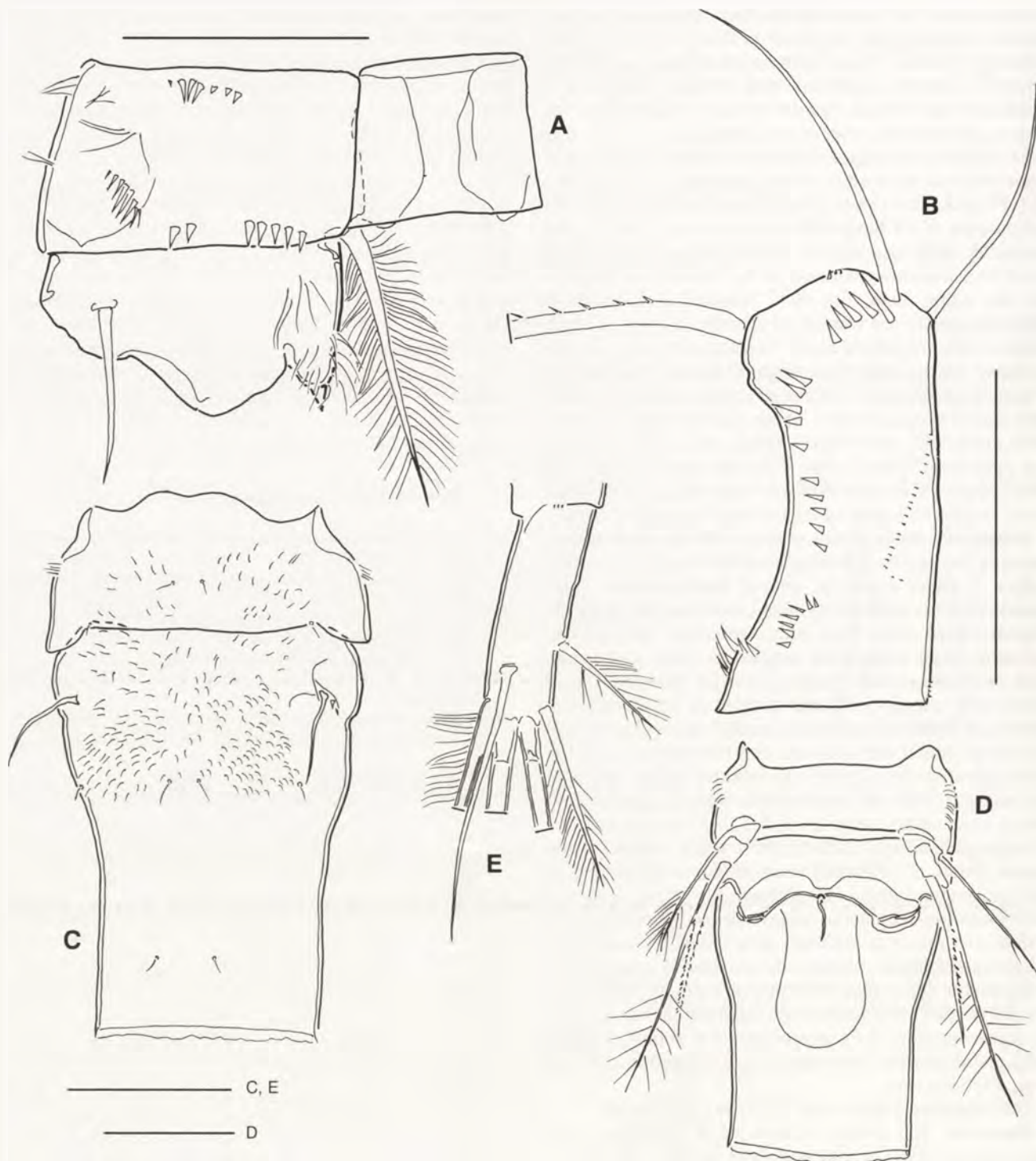


Figure 47. *Mesocyclops thermocyclopoides* Harada, 1931. Female [Taiwan: Sun Moon Lake]. (A) P4 protopodite, caudal; (B) Antennary basipodite, caudal; (C) Pediger 5 and genital double-somite, dorsal; (D) Pediger 5 and genital double-somite, ventral; (E) Caudal ramus, dorsal. Scales: 50 μm .

face of somite. Genital double-somite 1.3–1.5 (1.3–1.5) times as long as wide, with dorsal hairs in anterior half (Fig. 47C). Posteriorly to P6 six pores in group (topotypes). Lateral arms of seminal receptacle (Fig. 47D) wide and short, anterior margin of proximal part sinuate in middle. Posteriorly

to horseshoe-shaped copulatory pore one circular pore. Transverse ducts (Fig. 47D) directed to each other at straight or nearly straight angle (not V-shaped) before connection with copulatory duct; curvature of copulatory duct varies from straight to strong. Spinules along posterior

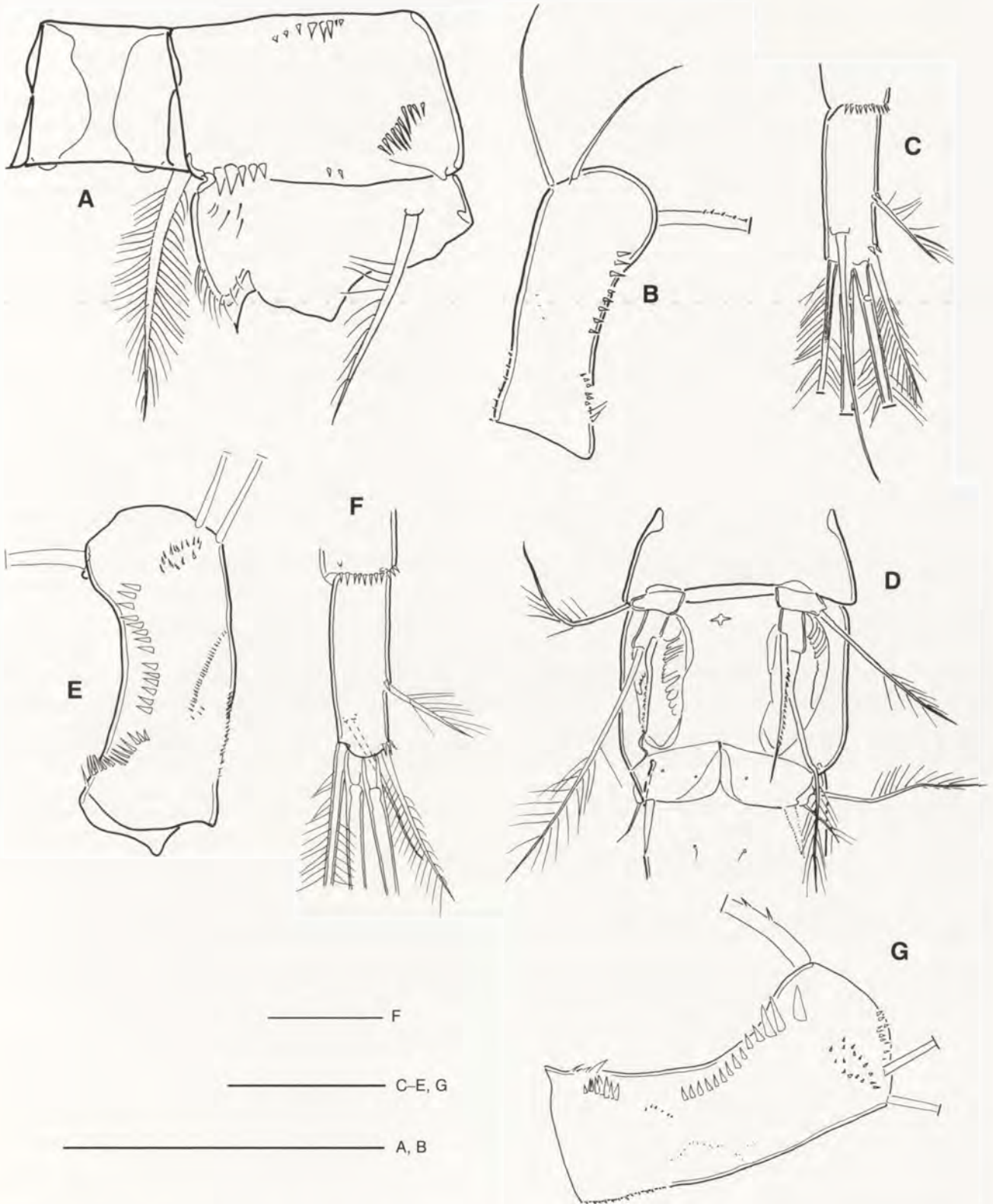


Figure 48. A–D. *Mesocyclops thermocyclopoides* Harada, 1931. Male [Taiwan: Sun Moon Lake]: (A) P4 protopodite, caudal; (B) Antennary basipodite, caudal; (C) Caudal ramus, dorsal; (D) Pediger 5 and genital segment, ventral. E, F. *Mesocyclops australiensis* (Sars, 1908) [Australia, NSW]: (E) Antennary basipodite, caudal – SMNK: 10664; (F) Caudal ramus ventral – SMNK: 10656. G. *Mesocyclops isabellae* Dussart et Fernando, 1958 [India: Jabalpur]: Antennary basipodite, caudal – paratype. Scales: 50 μ m.

margin of anal somite strong ventrally, tiny or absent dorsally, absent laterally (Fig. 47E). Caudal rami (Fig. 47E) 2.9–3.4 (3.2–3.6), times as long as wide, without hairs. Spinules at implantation of lateralmost terminal and lateral caudal setae absent. Dorsal caudal seta 1.1–1.5 (1.5–1.9) times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.6–4.0, 4.9–7.1, 3.5–4.9, 1.0 (2.9–3.3, 5.3–6.9, 3.8–4.8, 1.0). Longest terminal seta 0.9–1.2 (0.8–1.2) times as long as urosome.

Armature formula of 17-segmented antennule as in *M. dayakorum* typical for genus (Fig. 49A). Serrate hyaline membrane on last antennular segment, extending far beyond implantation of medial seta of segment, with one large notch. Ventral spinules present on antennular segments 1, 4–5, 7–13, dorsal surface without pits usually. Antenna bearing 3 setae on basipodite and 1, 7, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of antennary basipodite (Fig. 47B): basic pattern (see in *M. dayakorum*) supplemented with oblique row of fine spinules starting in distal half of medial rim, and row of large spinules (7–10, Australasia; 5–8, topotypes) near implantation of medial setae. Number of spinules in longitudinal row along lateral rim varies from 9 to 12. Frontal spinule ornamentation of antennary basipodite composed of 20–23 spinules arranged in longitudinal row, and transverse row of spinules distally to spinules along proximal rim.

Segmentation and setation of mouthparts as in *M. dayakorum*. With exception of distal fringe hairs no other hairs/spinules on ventral surface of labrum, yet epistoma pilose, and rows of hairs present also laterally to epistoma near vertical cleft. Mandible bearing three groups of spinules near palp, those forming transverse row conspicuously larger than others. Maxillular palp naked, lateralmost (longest) seta of lateral lobe without long setules. Frontal surface of maxillary coxopodite with distinct row of spinules; basipodite seta in front of claw-like basal endite with fine teeth on posterior edge only. Maxilliped syncopodite adorned with oblique row of fine spinules on frontal surface in proximal half; spinules on lateral rim and caudal surface of basipodite arranged in two groups.

Armature of P1–P4 as in *M. dayakorum* (Table 2) except P1 basipodite lacking medial spine. Frontal surface of P1 basipodite with large spinules arranged in semicircular arch; medial expansion of basipodite of P1–P4 with apical hairs. Apical hairs on medial expansion of P4 basipodite supplemented with long proximal hairs on caudal surface (Fig. 47A). Couplers of P1–P4 naked on frontal and caudal surfaces, distal margin of P4 coupler bearing two small, obtuse outgrowths. Caudal spinule ornamentation of P4 coxopodite (Fig. 47A) composed of: 6–8 (7–8) spinules in intermittent row along distal rim; 8–14 (8–9) relatively short spinules at laterodistal angle arranged in row; 5–8 (6–7) large spinules in one row along proximal rim; and lateral hairs. P4 coxopodite seta 1.6–1.9 (1.8–2.0) times longer than height of medial expansion of P4 basipodite. P4enp3 2.7–3.3 (2.8–3.6) times as long as wide; of apical spines medial one 0.9–1.1 (0.9–1.0) times as long

as lateral; longer spine 0.8–1.0 (0.9–1.0) times as long as segment. Lateral edge of medial apical spine with many teeth. Apical seta of P5 1.3–1.6 times as long, lateral seta 0.8–0.9 (0.8–1.2) times as long as medial spine.

Male. (Values given in parentheses have been measured on the topotype) Body length: 810 (620) μm ; prosome/urosome: 1.7 (1.6); cephalothorax length/width: 1.4 (1.3).

Pediger 5 (Fig. 48D) without lateral and dorsal hairs. Anal somite with strong spinules along entire posterior margin. Caudal rami (Fig. 48C) 3.0 (3.1) times as long as wide, without hairs. Spinules at implantation of lateral caudal, and lateralmost terminal setae present. Dorsal caudal seta 1.1 (1.7) times as long as lateralmost terminal seta. Relative length of terminal setae from medialmost to lateralmost: 2.2 (2.4); 4.5 (5.4); 3.3 (4.1); 1.0. Longest terminal seta 1.0 (1.0) times as long as urosome.

Armature formula of antennule as in males of all other species here described (topotype). Antenna bearing 3 setae on basipodite and 1, 6, and 7 setae on endopodal segments 1–3, respectively. Caudal spinule ornamentation of antennary basipodite (Fig. 48B): row of large spinules at height of medial setae absent, otherwise like in female. Number of spinules in longitudinal row along lateral rim 6–8 caudally 14–17 frontally (topotype). Armature of mandible, maxillule, and maxilliped as in female. Setation of maxilla as in female, but spinules on frontal surface of coxopodite reduced or absent.

P1 basipodite without medial spine; frontal surface of basipodite with large spinules arranged in semicircular arch. Apical hairs on medial expansion of P4 basipodite supplemented with hairs on caudal surface (topotype) (Fig. 48A). Outgrowths of P4 coupler small, obtuse. Caudal spinule ornamentation of P4 coxopodite (Fig. 48A) composed of (topotype): 4, 5 spinules in intermittent row along distal rim; 8, 10 spinules at laterodistal angle arranged in row; 7, 8 spinules in one row along proximal rim; and highly reduced lateral hairs. P4 coxopodite seta 1.7 (topotype) times longer than height of medial expansion of P4 basipodite. P4enp3 3.3 (topotype) times as long as wide; of apical spines medial one 0.9–1.0 times as long as lateral; longer spine 0.9 times as long as segment. Lateral edge of medial apical spine with many fine teeth. Apical seta of P5 1.6 times as long, lateral seta 0.9–1.0 times as long as medial spine (Fig. 48D). P6 armed with stout medial spine, slender seta of equal length, and long lateral seta.

Distribution. *Mesocyclops thermocyclopoides* probably occurs from Flores through Java Malaysia, Burma, Indochina, China [Guo, in press(a)], Taiwan to the Ryukyus (Okinawa). On the slide SMNK: 11085, and 11086 Kiefer himself referred to Flores with question marks, indicating some doubt about the origin of the specimens, yet all other collecting data perfectly agree with those from Flores cited in Heberer and Kiefer's paper (1932) on the copepods of the Lesser Sundas. A form apparently closely related to (con-specific?) *M. thermocyclopoides* lives in Central America [Costa Rica (Collado et al. 1984) and Honduras (Reid in litt.)], identity of which still remains to be verified.

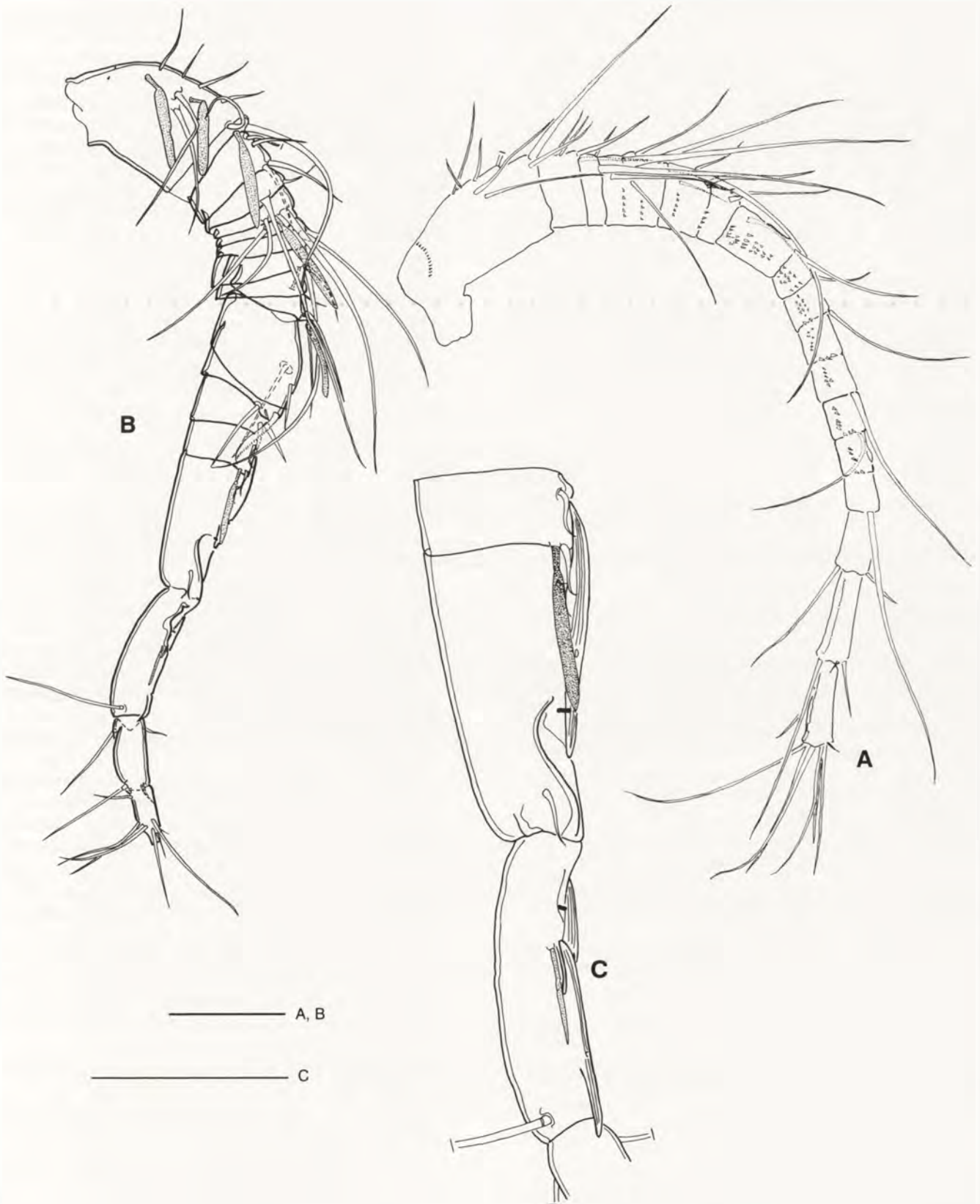


Figure 49. Armature of the antennule in the genus *Mesocyclops*. A. Female – *M. thermocyclopoides* Harada, 1931 [Taiwan: Sun Moon Lake]. B, C. Male – *M. yeneae* Holyńska, 1998 [Vietnam:Hue]: (B) Whole armature; (C) Distal geniculation with plate-like structures. Scales: 50 μm .

Mesocyclops thermocyclopoides prefers large ponds and lakes.

Remarks. Within the speciose *thermocyclopoides* -group as defined by Holynski and Fiers 1994, *Mesocyclops thermocyclopoides* along with *M. australiensis* (Sars, 1908) [Australia: Tasmania, Victoria, NSW, Queensland, West. Austr.], *M. isabellae* Dussart et Fernando, 1988 [Indian subcontinent, Sri Lanka], *M. dadayi* Holyńska, 1997 [India: Calcutta] and *M. dussarti* Van de Velde, 1984 [West-Africa] are distinguished by a combination of characters [the genital double-somite and pediger 5 dorsally pilose; transverse ducts directed to each other at straight angle before connection with copulatory duct - female genital system; longest terminal seta short - ca. as long as urosome], which occur individually in other species. Morphologically *M. isabellae* seems the closest to *M. thermocyclopoides*: it differs from the latter species only in the caudal spinule ornamentation of the antennary basipodite (Fig. 48G) [field of small spinules at height of medial setae; group of tiny spinules between the longitudinal and proximal oblique rows; and spinules next to distal margin (usually absent in *M. thermocyclopoides*)] and the presence of ventral spinules on the 14. antennular segment.

KEY TO THE ORIENTAL AND AUSTRALASIAN SPECIES OF MESOCYCLOPS:

1. Medial expansion of P1 basipodite with spine (Fig. 4E); group of spinules next to implantation of exopodite seta present on frontal surface of antennary basipodite (Fig. 3A) **2**
 - Medial expansion of P1 basipodite without spine; group of spinules next to implantation of exopodite seta absent from frontal surface of antennary basipodite **5**
2. Lateral parts of seminal receptacle narrow (Fig. 8E) **3**
 - Lateral parts of seminal receptacle wide (Fig. 10E) ... **4**
3. Pediger 5 not bending over genital double-somite; copulatory duct short (Fig. 5A); large dorsal spinules on posterior margin of anal somite; longest terminal caudal seta ca. 1.5 times as long as urosome; longitudinal spinule row on caudal surface of antennary basipodite, not reaching level of implantation of exopodite seta, with few spinules (Fig. 3B); spinules on frontal surface of P1 basipodite very small, arranged in arc (Fig. 4E) *M. dayakorum* sp. nov.
 - Pediger 5 bending over genital double somite; copulatory duct long (Fig. 7B); no dorsal spinules on posterior margin of anal somite; longest terminal caudal seta 0.9-1.2 times as long as urosome; longitudinal spinule row on caudal surface of antennary basipodite, extending beyond implantation of exopodite seta, with many spinules (Fig. 6A); many large spinules on frontal surface of P1 basipodite, arranged in group (Fig. 7D, 9F) *M. darwini* Dussart et Fernando, 1988
4. Transverse ducts (female genital system) directed to each other at deep acute angle before connection with copulatory duct; part of copulatory duct connecting copulatory pore and transverse ducts ["jointed canal"] visible (Fig. 13B); first segment of antennule with spinules on ventral surface (Fig. 13D) *M. splendidus* Lindberg, 1943
 - Transverse ducts directed to each other at obtuse or shallow acute angle before connection with copulatory duct; part of copulatory duct connecting copulatory pore and transverse ducts ["jointed canal"] not visible (Fig. 10E); first segment of antennule without spinules on ventral surface *M. pseudoannae* Van de Velde, 1987
5. Medialmost terminal caudal setae at most 1.5 as long as lateralmost terminal caudal setae (Fig. 15E) **6**
 - Medialmost terminal caudal setae more than twice as long as lateralmost terminal caudal setae **7**
6. Medial expansion of P4 basipodite without apical hairs; longest terminal caudal setae at most 3.9 times as long as medialmost terminal setae; hoop-like but dorsally open pseudosomite between pediger 5 and genital double-somite present *M. yenaе* Holyńska, 1998
 - Medial expansion of P4 basipodite with apical hairs; longest terminal caudal setae ca. 4.4 times as long as medialmost terminal setae; pseudosomite between pediger 5 and genital double-somite absent *M. brevisetosus* Dussart et Sarnita, 1987
7. P4 coxopodite seta shorter than height of medial expansion of P4 basipodite *M. restrictus* Dussart et Fernando, 1985
 - P4 coxopodite seta conspicuously longer than height of medial expansion of P4 basipodite **8**
8. P4 coupler with large (length/width > 1) outgrowths (Fig. 17E) **9**
 - P4 coupler with small (length/width ≤ 1) outgrowths (Fig. 22B) **12**
9. Transverse ducts directed to each other at straight angle before connection with copulatory duct (Fig. 17B); antennular segments 1, 4-5, 7-10, and 12-13 adorned with ventral spinules; no spinules near implantation of medial setae on caudal surface of antennary basipodite (Fig. 16A) *M. yesoensis* Ishida, 1999
 - Transverse ducts directed to each other at acute angle before connection with copulatory duct (Fig. 18B,C); antennular segments 1, 4-5, 7-13 usually adorned with ventral spinules; spinules near implantation of medial setae on caudal surface of antennary basipodite (Fig. 18F), usually present **10**
10. Medial expansion of P4 basipodite with apical hairs; caudal surface of antennary basipodite adorned with triangular field of spinules between group near implantation of medial setae, and oblique row of fine spinules starting in distal half of medial rim *M. ferjemurami* Holyńska et Nam, 2000
 - Medial expansion of P4 basipodite bare; triangular field of spinules between group near implantation of medial setae, and oblique row of fine spinules starting in distal half of medial rim, absent **11**
11. Anterior margin of proximal part of seminal receptacle arcuate in middle; posteriorly to horseshoe-shaped copulatory pore two circular pores (Fig. 18B,E); many

- spinules near implantation of medial setae on caudal surface of antennary basipodite (Fig. 18D) *M. papuensis* Van de Velde, 1987
- Anterior margin of proximal part of seminal receptacle sinuate in middle; posteriorly to horseshoe-shaped copulatory pore usually one (sometimes no) circular pore (Fig. 18C); few (sometimes no) spinules near implantation of medial setae on caudal surface of antennary basipodite (Fig. 18F) *M. pehpeiensis* Hu, 1943
12. Pediger 5 bare (Fig. 30H) 13
- Pediger 5 laterally pilose 15
13. Caudal rami with hairs/hair-like spinules in proximal half of medial rim *M. pseudospinosus* Dussart et Fernando, 1988
- Caudal rami without hairs 14
14. Dorsal caudal seta shorter than or a little longer than lateralmost terminal caudal seta; caudal surface of medial expansion of P4 basipodite distally adorned with minute spinules *M. kieferi* Van de Velde, 1984
- Dorsal caudal seta at least twice as long as lateralmost terminal caudal seta (Fig. 30G); medial expansion of P4 basipodite if distally adorned, only with hairs (Fig. 30A) *M. tobae* Kiefer 1933
15. Caudal rami with medial hairs 16
- Caudal rami without hairs 19
16. Medial hairs confined to proximal half of caudal rami (Fig. 45G) 17
- Medial hairs present at whole length of caudal rami (Fig. 22D) 18
17. Caudal surface of antennary basipodite adorned with field of tiny spinules near implantation of medial setae (Fig. 41C) *M. microlastus* Kiefer, 1981
- Caudal surface of antennary basipodite adorned with row of large spinules near implantation of medial setae (Fig. 43B) *M. geminus* sp. nov.
18. Genital double-somite bare, transverse ducts directed to each other at acute angle before connection with copulatory duct (Fig. 20G); P4 coupler bare on caudal and frontal surfaces; antennulary segments 1, 4–5, 7–13 adorned with ventral spinules, group of tiny spinules between proximal oblique and longitudinal spinule rows present on caudal surface of antennary basipodite (Figs 20C, D) *M. aspericornis* (Daday, 1906)
- Genital double-somite with dorsal hairs in anterior half, transverse ducts directed to each other at straight angle before connection with copulatory duct; P4 coupler hairy on caudal surface; antennulary segments 1, 4–5, 7–14 adorned with ventral spinules, group of tiny spinules between proximal oblique and longitudinal spinule rows absent on caudal surface of antennary basipodite *M. dadayi* Holyńska 1997
19. Maxillillary palp with row of large spinules (Fig. 24D) *M. ogunnus* Onabamiro, 1957
- Maxillillary palp without spinules 20
20. Genital double-somite with dorsal hairs 21
- Genital double-somite bare 24
21. Transverse ducts directed to each other at acute angle (V-shaped) before connection with copulatory duct; serrate hyaline membrane on last antennulary segment usually with two or more small notches *M. notius* Kiefer, 1981
- Transverse ducts directed to each other at straight angle before connection with copulatory duct (Fig. 47D); serrate hyaline membrane on last antennulary segment with one large notch 22
22. Caudal surface of antennary basipodite adorned with row of large spinules near implantation of medial setae (Fig. 47B); ventral spinules present on antennulary segments 1, 4–5, 7–13 (Fig. 49A) *M. thermocyclopoides* Harada, 1931
- Caudal surface of antennary basipodite adorned with field of tiny spinules near implantation of medial setae (Fig. 48E, G) 23
23. Group of tiny spinules between proximal oblique and longitudinal spinule rows on caudal surface of antennary basipodite, present (Fig. 48G); ventral spinules present on antennulary segments 1, 4–5, 7–14; spinules at implantation of lateralmost terminal caudal setae absent *M. isabellae* Dussart et Fernando, 1988
- Group of tiny spinules between proximal oblique and longitudinal spinule rows on caudal surface of antennary basipodite, absent (Fig. 48E); ventral spinules present on antennulary segments 1, 4–5, 7–13; spinules at implantation of lateralmost terminal caudal setae present (Fig. 48F) *M. australiensis* (Sars, 1908)
24. Medial expansion of P4 basipodite with apical hairs only; copulatory duct with granules; hyaline membrane of last antennulary segment with two or more small notches, or without notch; second endopodal segment of antenna armed with 9 setae *M. granulatus* Dussart et Fernando, 1988
- Medial expansion of P4 basipodite adorned with group of hairs apically, and row of proximal hairs on caudal surface (Fig. 27A); no granules along copulatory duct; hyaline membrane of last antennulary segment with one large notch (Fig. 25D); second endopodal segment of antenna armed with 7 or 8 setae 25
25. Transverse ducts directed to each other at straight or obtuse angle before connection with copulatory duct; curvature of copulatory duct varies from straight to moderate (Figs. 26C, D); spinules at implantation of lateralmost terminal caudal setae always present, at implantation of lateral caudal setae spinules present or absent (Fig. 27E) 26
- Transverse duct usually directed to each other at acute angle (V-shaped) before connection with copulatory duct, and curvature of copulatory duct varies from moderate to strong (Fig. 35F); if transverse ducts meet at obtuse angle, and/or curvature of copulatory duct slight or straight, spinules at implantation of lateral caudal and lateralmost terminal setae absent (Fig. 37C) ... 27
26. Transverse ducts with wide lumen, part of copulatory duct connecting copulatory pore with transverse ducts visible *M. aequatorialis* Kiefer, 1929

- . Transverse ducts with narrow lumen, part of copulatory duct connecting copulatory pore with transverse ducts not visible (Fig. 26C) . . . *M. affinis* Van de Velde, 1987
27. Second endopodal segment of antenna armed with 8 setae; ventral surface of caudal rami adorned with row of long spinules in distal quarter, next to medial rim (Fig. 33E) *M. francisci* sp. nov.
- . Second endopodal segment of antenna armed with 7 setae; long ventral spinules in distal quarter of caudal rami absent 28
28. Pediger 5 dorsally pilose (Fig. 39D) 29
- . No hairs on dorsal surface of pediger 5 30
29. Spinules at implantation of lateral caudal setae present (Figs 40C, D) *M. friendorum* sp. nov.
- . Spinules at implantation of lateral caudal setae absent *M. parentium* Holyńska 1997
30. Spinules at implantation of lateral caudal and lateral-most terminal setae absent (Fig. 37C); on laterodorsal surface of genital double-somite six pores in group posteriorly to P6; on caudal surface of antennary basipodite diffuse patch of spinules, proximally/medially to oblique row starting from medial rim, present (Fig. 35B) *M. woutersi* Van de Velde, 1987
- . Spinules at implantation of lateral caudal and lateral-most terminal setae present; on laterodorsal surface of genital double-somite eight pores in group posteriorly to P6; on caudal surface of antennary basipodite dif-

fuse patch of spinules, proximally/medially to oblique row starting from medial rim, absent
 *M. dissimilis* Defaye et Kawabata 1993

ZOOGEOGRAPHICAL REMARKS

Since this study is only a part of the ongoing project on the world revision of the genus *Mesocyclops*, a hypothesis of the phylogenetic relationships, the necessary frame to evaluate the distributional patterns, is still missing. The other limiting factor is the scarcity and uneven (strongly biased in favour of the Greater Sundas) representation of exact data. Great caution is necessary in the interpretation of the observed distributions.

Disregarding species apparently misidentified (Table 1.), of the 20 *Mesocyclops* species reported from Australasia *M. notius* from Indonesia and *M. pehpeiensis* from Malaysia and Australia (NT) are dubious as to their identity, and there are some doubts about the presence of *M. yesoensis* in Malaysia (Fig. 50) and the natural occurrence of *M. ogunnus* in the insular part of Australasia (Fig. 51). Eleven species are endemic to Australasia. Species most often encountered in the sampled waterbodies were *M. affinis* and *M. aspericornis*, a circumtropical representative of the genus (Fig. 52). Known *Mesocyclops* fauna of different parts of Australasia is given in Table. 5.

	Mal	Sum	Jav	Bal	Bor	Sul	Luz	Min	Lom	Flo	Gui	Aus
<i>dayakorum</i>					+							
<i>darwini</i>											+	+
<i>pseudoannae</i>											+	+?
<i>brevisetosus</i>					+							
<i>cf. yena</i>											+	
<i>yesoensis</i>	+?											
<i>papuensis</i>			+		+						+	
<i>aspericornis</i>	+	+	+		+	+	+	+			+	+
<i>ogunnus</i>	+		+?								+?	
<i>pseudospinosus</i>			+									
<i>affinis</i>	+	+	+	+	+	+			+		+	
<i>tobae</i>		+										
<i>francisci</i>	+	+										
<i>woutersi</i>											+	+?
<i>friendorum</i>						+						
<i>microlasius</i>							+					
<i>geminus</i>					+							
<i>thermocyclopoides</i>	+		+							+		

Table. 5. Occurrence of *Mesocyclops* species in Australasia.

Abbreviations: Mal=Malaysia+ southern Thailand; Sum=Sumatra; Jav=Java; Bal=Bali; Bor=Borneo; Sul=Sulawesi; Luz=Luzon; Min=Mindanao; Lom=Lombok; Flo=Flores; Gui=New Guinea; Aus=northern Australia.



Figure 50. Records of *Mesocyclops yesoensis*. ⊙: literature data; ★: own records.

Figure 51. Distribution of *Mesocyclops ogunius*. ⊙: records from Australasia. Dotted line denotes especially uncertain sections.





Figure 52. Distribution of *Mesocyclops aspericornis* in Australasia. \diamond : literature data; \blacklozenge : substantiated records. Solid line approximately shows the the northern limit of the range. Dotted line denotes especially uncertain sections.

The morphologically closely related species pairs/groups seem to indicate some repeating patterns of relationships.

I. Palaeotropical affinities

M. annae/*M. splendidus*/*M. pseudoannae* (Fig. 53): this group differs from the other two groups below in its highly disjunct distribution: Madagascar/Sri Lanka–southern India–Bangladesh/ New Guinea–northern Australia(?). Pattern of the disjunction might suggest a Gondwanian origin, however, the slight degree of morphological divergence points to rather recent separation of the species. The occurrence data indicate that all the three species prefer humid climate. Whether their speciation is a result of the Pleistocene–Holocene disappearance of wet areas between Africa and India, or overseas dispersal, or both, can not be reliably answered.

M. aequatorialis s. str. – *M. a. similis*/*M. affinis* (Fig. 54): *M. aequatorialis similis* is considered here as the western sister of *M. affinis*. Both eurytopic forms gave a pelagic offshoot, *M. aequatorialis* s. str. (L. Tanganyika, Kivu) and *M. tobae* (L. Toba, Sumatra). While intermediate forms indicating the hybridization of the two subspecies of *M. aequatorialis* were reported from several places in the East African Lake District (Van de Velde 1984), the difference between *M. affinis* and *M. tobae* is clear-cut.

M. dussarti/*M. dadayi*/*M. isabellae*/*M. thermocyclopoides*/*M. australiensis* (Fig. 55): Although there are

reports of the occurrence of *M. thermocyclopoides* (or cf. *thermocyclopoides*) in Central America, all the other members of this group, and species supposedly related to them (*M. thermocyclopoides*-group sensu Holyński and Fiers 1994) live in the Palaeotropics.

II. Asian continental affinities

All the groups listed below show a **very slight** degree of the in-group divergence, indicating an ongoing speciation in these groups.

M. woutersi-superspecies [*M. dissimilis*, *M. woutersi*, *M. parentium*, *M. friendorum*]/*M. francisci* (Fig. 56): except for some overlapping in the areas of *M. dissimilis* and *M. woutersi* in North Vietnam, South China (unpublished data of Mr. Guo Xiaoming; Holyńska 2000) and probably in Honshu (Ishida in litt.), all other species occur in allopatry. *Mesocyclops francisci*, a species morphologically closely allied to the *woutersi*-superspecies, displays characters, which are probably plesiomorphic for this group [pediger 5 dorsally pilose; spinules at implantation of lateral caudal, and lateralmost terminal caudal setae absent and present, respectively] (Holyńska 1997). While all representatives of the *woutersi*-superspecies bear 7 setae on the second endopodal segment of the antenna, in *M. francisci* the more ancestral 8 setae state is present. These observations suggest that *M. francisci* is not the actual ancestor of the superspecies but close to it. From the



Figure 53. Distribution of *Mesocyclops pseudoannae* and its close relatives. ▲: *M. pseudoannae*; △?: records of *M. annae*, supposedly referring to *M. pseudoannae*; ★: *M. annae*; — ··· : *M. splendidus*. Dotted line denotes especially uncertain sections.

Figure 54. Distribution of *Mesocyclops affinis* and its close relatives. ◆: records of *M. affinis* in Australasia; — ··· : range of *M. affinis* outside Australasia; ●: *M. tobae*; ▤: *M. aequatorialis* s. str.; - - ··· : *M. a. similis*. Dotted line denotes especially uncertain sections.





Figure 55. Distribution of *Mesocyclops thermocyclopoides* and its close relatives. ◆: substantiated records of *M. thermocyclopoides* from Australasia and Taiwan; — ···· : range of *M. thermocyclopoides* outside Australasia; ▲: *M. isabellae*; ★: *M. dadayi*; - · - · : *M. dussarti*; ····· : *M. australiensis*. Dotted line denotes especially uncertain sections.

Figure 56. Distribution of *Mesocyclops woutersi* and its close relatives. ⊕: records of *M. woutersi* from Australasia; — ···· : range of *M. woutersi* outside of Australasia; - - ···· : *M. dissimilis*; ····· : *M. parentium*; ⊙: *M. friendorum*; ⊕: *M. francisci*. Dotted line denotes especially uncertain sections.





Figure 57. Distribution of *Mesocyclops papuensis* and its close relatives. ♦: *M. papuensis*; ■: *M. ferjemurami*; — ··· : *M. pehpeiensis*. Dotted line denotes especially uncertain sections.

occurrence of *M. francisci* in Malaysia and Sumatra, and the distribution of the members of *woutersi*-superspecies, a Southeast Asian origin of the group might be inferred.

M. pehpeiensis/*M. ferjemurami*/*M. papuensis* (Fig. 57): while the two former taxa are mainland species, *M. papuensis* seems to be an insular form. Range of genuine *M. pehpeiensis* probably includes Central, South, and East Asia as far as Hokkaido. *Mesocyclops ferjemurami* Holyńska and Nam, 2000 known from Sri Lanka, Siliguri in northern India, and southern Vietnam (Khanh Hoa).

M. yенаe/*M. brevisetosus*/*M. cf. yенаe* (Fig. 58): There is no doubt of the very close affinity of these forms, but the particularly meagre material does not allow full resolution of the taxonomic relationships between them or evaluation of their distributions.

III. Disjunct African affinities

M. darwini/*M. rarus* (Fig. 59); ?*M. dayakorum*/*M. paludosus* (Fig. 60): Except for the southern African *M. tenuisaccus*, the supposed closest relatives of which live in the Neotropics (Van de Velde 1984), there are only four Palaeotropical species having retained a set of ancestral features (see "Remarks" at *M. darwini*) common in American *Mesocyclops*. Sister group relationship between *M. darwini* and *M. rarus* is indicated by a shared (here supposed to be derived) character, the long copulatory

duct. Monophyly of *M. dayakorum* and *M. paludosus* remains controversial, because the shared features are presumably plesiomorphic.

IV. Speciation within Australasia

M. microlasius/*M. geminus* (Fig. 61): the two species, known from Luzon and eastern Borneo respectively, differ only in a single character, the caudal spinule ornamentation of the antennary basipodite.

M. affinis/*M. tobae* (Fig. 54): *Mesocyclops affinis* is considered here as a paraphyletic species, from pelagic populations of which in Lake Toba evolved *M. tobae*, a form highly adapted to the pelagic way of life in the large deep lake. From the date of the most recent eruption in the caldera of the Lake Toba it can be inferred, that the age of the *M. affinis*-*M. tobae* separation is less than 75,000 years (Rainboth 1996).

Distributions and affinities of the taxa support an [Afro]asian origin of at least half of the Australasian species. Further analysis of the phylogenetical relationships is expected to reveal even larger impact of these regions on the Australasian fauna. On the other hand, looking for Australian elements is hampered by the fact, that distinctness and origin of the Australian *Mesocyclops* fauna have not yet been analyzed. The rather trivial (and frustrating) statement holds true: we can not understand a part before understanding the whole.



Figure 58. Records of *Mesocyclops cf. yeneae* and its close relatives. ◆: *M. cf. yeneae*; ★: *M. brevisetosus*; ▲: *M. yeneae*.

Figure 59. Distribution of *Mesocyclops darwini* (▲) and *M. rarus* (— ···). Dotted line denotes especially uncertain sections.





Figure 60. Record of *Mesocyclops dayakorum* (★) and the range of *M. patudosus* (—).

Figure 61. Records of *Mesocyclops microtasius* (⊕) and *M. geminus* (⊙).



ACKNOWLEDGEMENTS

My researches on Australasian *Mesocyclops* would have perhaps never been started without our fascinating travel sponsored by our idealist friends Maryla and Tony Friend (Townsville, Australia) to Indonesia and Papua New Guinea in 1988–89.

I am grateful for the help of all curators and private persons who made the types or other materials used in this study available to me. A part of my samples have been collected during the one month fellowship provided by the Christensen Research Institute in Madang (Papua New Guinea) in 1989. My studies were funded by the State Committee for Scientific Research (Komitet Badań Naukowych), Poland (Project Nr 6 P04C 095 12).

REFERENCES

- Bănărescu, P. 1991. Zoogeography of Fresh Waters. Vol. 2. Distribution and Dispersal of Freshwater Animals in North America and Eurasia pp. 519–1091. AULA-Verlag Wiesbaden.
- Boer, A. J. de. 1995. Islands and cicadas adrift in the West-Pacific. Biogeographic patterns related to plate tectonics. Tijdschrift voor Entomologie, 138: 169–244.
- Brown, M. 1995. Evaluation of *Mesocyclops* (Copepoda: Cyclopoida) for the biological control of mosquitoes in north-eastern Australia. Ph. D. thesis, The University of Queensland, St Lucia, Brisbane, Australia, 223 pp.
- Brown, M. D., B. H. Kay, and J. G. Greenwood. 1991. The predation efficiency of north-eastern Australian *Mesocyclops* (Copepoda: Cyclopoida) on mosquito larvae. Proceedings of the Fourth International Conference on Copepoda. Bulletin of Plankton Society of Japan, Spec. vol.: 329–338.
- Brown, M. D., D. O. Walker, J. K. Hendrikz, C. P. Cabral, D. B. Araujo, Z. M. Ribeiro, and B. H. Kay. 1994. Chlorine tolerance of *Mesocyclops* (Cyclopoda: Cyclopidae) copepods and three container-breeding species of mosquitoes. Environmental Entomology, 23(5): 1245–1249.
- Collado, C., D. Defaye, B. H. Dussart and C. H. Fernando. 1984. The freshwater Copepoda (Crustacea) of Costa Rica with notes on some species. Hydrobiologia, 119: 89–99.
- Daday, E. von. 1901. Mikroskopische Süßwasserthiere aus Deutsch-Neu-Guinea. Természettudományi Füzetek, 24: 1–56.
- Daday, E. von. 1906. Untersuchungen über die Copepodenfauna von Hinterindien, Sumatra und Java, nebst einem Beitrag zur Copepodenkenntnis der Hawaii-Inseln. (Reise von Dr. Walter Volz.) Zoologische Jahrbücher (Syst.) 24: 175–206 + Taf. 14–16.
- Dahms, H.-U and C. H. Fernando. 1993. Naupliar development of *Mesocyclops cf. thermocyclopoides* Harada, 1931 and *Thermocyclops decipiens* (Kiefer, 1929) (Copepoda: Cyclopoida) from Beira Lake, Sri Lanka. Journal of Plankton Research, 15(1): 9–26.
- Defaye, D. 1995. The cyclopid (Crustacea, Copepoda) fauna of the inland waters of Israel 2. Preliminary note on the genus *Mesocyclops* (Cyclopoida, Cyclopidae), with description of a new species. Hydrobiologia, 310: 11–18.
- Dussart, B. and C. H. Fernando. 1985. Tropical freshwater Copepoda from Papua, New Guinea, Burma, and Costa Rica, including a new species of *Mesocyclops* from Burma. Canadian Journal of Zoology, 63: 202–206.
- Dussart, B. H. and C. H. Fernando. 1986. The *Mesocyclops* problem today. Syllogeus, 58: 288–293.
- Dussart, B. H. and C. H. Fernando. 1988. Sur quelques *Mesocyclops* (Crustacea, Copepoda). Hydrobiologia, 157: 241–264.
- Dussart, B. H. and A. S. Sarnita. 1987. A new freshwater copepod, *Mesocyclops brevisetosus* sp. nov. (Crustacea, Cyclopoida) from Kalimantan, Indonesia. Canadian Journal of Zoology, 65: 2731–2733.
- Fórró, L. and B. Dussart. 1985. Copepoda taxa described by E. Daday, together with a catalogue of pertinent material in the Hungarian Natural History Museum. Miscellanea Zoologica Hungarica, 3: 45–64.
- Franke, U. 1989. Katalog zur Sammlung limnischer Copepoden von Prof. Dr. Friedrich Kiefer. Carologica, 5: 433 pp.
- Ghenne, V. and F. Fiers. 2000. On *Mesocyclops iranicus* Lindberg, 1936 (Copepoda: Cyclopoida) and the cyclopid collection made by Knut Lindberg during his 1935 visit to Iran. Annales Zoologici, 50(1): 93–98.
- Guo, X. 2000. A redescription of *Mesocyclops pelpiensis* Hu, 1943, and notes on *Mesocyclops ruttneri* Kiefer, 1981 (Copepoda, Cyclopidae). Hydrobiologia, 418: 33–43.
- Guo, X. in press(a). Two new species of *Mesocyclops* from southern China and notes on the genus *Mesocyclops* in China. Hydrobiologia.
- Grochmalicki, J. 1915. Przyczynki do znajomości słodkowodnej fauny Jawy. Skorupiaki Widłonogie, Liścionogie i Malżoraczkki. – Beiträge zur Kenntnis der Süßwasserfauna Javas. Phyllopoda, Copepoda und Ostracoda. Bulletin international de l'Académie des Sciences naturelles de Cracovie, Serie B, III: 216–242.
- Hall, R. 1998. The plate tectonics of Cenozoic SE Asia and distribution of land and sea. pp. 99–131. In: R. Hall and J. D. Holloway (eds), Biogeography and Geological Evolution of SE Asia, Backhuys Publishers, Leiden.
- Harada, I. 1931. Studien über die Süßwasserfauna Formosas, IV. Süßwasser-Cyclopiden aus Formosa. Annotationes Zoologicae Japonenses, 13: 149–168.
- Heberer, G. and F. Kiefer. 1932. Zur Kenntnis der Copepodenfauna der Sunda-Inseln. Archiv für Naturgeschichte, 1(2): 225–274.
- Holynski, M. 1994a. A redescription of *Mesocyclops thermocyclopoides* Harada, 1931 (Copepoda, Cyclopidae). Bulletin de l'Institut royal des Sciences naturelles de Belgique, Biologie, 64: 99–110.
- Holynski, M. 1994b. Taxonómiai és állatföldrajzi kapcsolatok az orientális *Mesocyclops* Sars, 1918 (Copepoda: Cyclopoida) fajok között. I. *Thermocyclopoides*-kör. [Taxonomical and zoogeographical relationships between the Oriental representatives of the genus *Mesocyclops* Sars, 1918 (Copepoda: Cyclopoida), *Thermocyclopoides*-circle.]. Doctorate dissertation, Kossuth Lajos University, Debrecen, Hungary, 92 pp. + 44Pls.
- Holyńska, M. 1997a. A new representative of *Mesocyclops thermocyclopoides*-circle (Copepoda: Cyclopoida) from India. Miscellanea Zoologica Hungarica, 11: 15–31.
- Holyńska, M. 1997b. Tracing the routes of speciation in *Mesocyclops woutersi*-superspecies (Copepoda: Cyclopoida). Annales Zoologici, 47(3/4): 321–336.
- Holyńska, M. 2000. Is the spinule pattern on the leg 4 coxopodite a tactile signal in the specific mate recognition system of *Mesocyclops* (Copepoda, Cyclopidae)? Hydrobiologia, 417: 11–24.
- Holynski, M. and F. Fiers. 1994. *Mesocyclops thermocyclopoides* species-group: redefinition and content. Hydrobiologia, 292/293: 41–51.
- Holyńska, M. and V. S. Nam. 2000. A new Oriental species of *Mesocyclops* (Copepoda: Cyclopidae). Hydrobiologia, 429: 197–206.
- Hope, G. 1996. Quaternary change and historical biogeography of Pacific islands. pp.165–190. In: A. Keast and S. Miller (eds). The origin and evolution of Pacific Island biotas, New Guinea to Eastern Polynesia: patterns and processes. SPB Academic Publishing, Amsterdam.
- Ishida, T. 1999. *Mesocyclops yesoensis* sp. nov., *M. leuckarti*, and *M. pelpiensis* (Crustacea: Copepoda: Cyclopoida) from Hokkaido, Northern Japan. Biogeography, 1: 81–85.
- Jeje, C. Y. 1988. A revision of the Nigerian species of the genera *Mesocyclops* Sars, 1914 and *Thermocyclops* Kiefer, 1927 (Copepoda: Cyclopidae). Hydrobiologia 164: 171–184.
- Jennings, C. D., J. G. Greenwood, and B. H. Kay. 1994. Response of *Mesocyclops* (Cyclopoida: Copepoda) to biological physicochemical

- attributes of rainwater tanks. *Environmental Entomology*, 23(2): 479–486.
- Kawabata, K. 1989. Seasonal changes in abundance and vertical distribution of *Mesocyclops thermocyclopoides*, *Cyclops vicinus* and *Daphnia longispina* in Lake Biwa. *Japanese Journal of Limnology*, 50(1): 9–13.
- Keast, A. 1996. Pacific biogeography: Patterns and processes. pp. 477–512. In: A. Keast and S. Miller (eds). *The origin and evolution of Pacific Island biotas, New Guinea to Eastern Polynesia: patterns and processes*, SPB Academic Publishing, Amsterdam.
- Kiefer, F. 1929. Zur Kenntnis einiger Artengruppen der Süßwasser-Cyclopiden. *Zeitschrift für wissenschaftliche Zoologie*, 133: 1–56.
- Kiefer, F. 1933. Die freilebenden Copepoden der Binnengewässer von Insulinde. *Archiv für Hydrobiologie Suppl.* 12(3): 519–621.
- Kiefer, F. 1938. Die von der Wallacea-Expedition gesammelten Arten der Gattung *Thermocyclops* Kiefer. *Internationale Revue der gesamten Hydrobiologie und Hydrographie*, 38 (1/2): 54–98.
- Kiefer, F. 1981. Beitrag zur Kenntnis von Morphologie, Taxonomie und geographischer Verbreitung von *Mesocyclops leuckarti* auctorum. *Archiv für Hydrobiologie Suppl.* 62(1): 148–190.
- Lim, R. P. and C. H. Fernando. 1985. A review of Malaysian freshwater Copepoda with notes on new records and little known species. *Hydrobiologia*, 128(1): 71–89.
- Lindberg, K. 1936. Notes sur des Cyclopidae (Crustacés Copépodes) de l'Iran. *Bulletin du Musée royal d'Histoire naturelle de Belgique*, 12(17): 1–26.
- Marten, G. G., E. S. Bordes, and M. Nguyen. 1994. Use of cyclopoid copepods for mosquito control. *Hydrobiologia*, 292/293: 324–330.
- Metcalf, I. 1998. Palaeozoic and Mesozoic geological evolution of the SE Asian region: multidisciplinary constraints and implications for biogeography. pp. 25–41. In: R. Hall and J. D. Holloway (eds). *Biogeography and Geological Evolution of SE Asia*, Backhuys Publishers, Leiden.
- Mirabdullayev, I. M. 1996. The genus *Mesocyclops* (Crustacea: Copepoda) in Uzbekistan (Central Asia). *Internationale Revue der gesamten Hydrobiologie*, 81(1): 93–100.
- Nam, V. S., N. T. Yen, M. Holyńska, J. W. Reid, and B. H. Kay. 2000. National progress in dengue vector control in Vietnam; Survey for *Mesocyclops* (Copepoda), *Micronecta* (Corixidae) and fish as biological control agents. *American Journal of Tropical Medicine and Hygiene*, 62(1): 5–10.
- Onabamiro, S. D. 1957. Some new species of *Cyclops* sensu lat (Crustacea: Copepoda) from Nigeria. *Journal of the Linnean Society, (Zool.)*, 43: 123–133.
- Pesce, G. L. 1985. Cyclopids (Crustacea, Copepoda) from West Indian groundwater habitats. *Amsterdam Expeditions to the West Indian Islands*, Report 45. *Bijdragen tot de Dierkunde*, 55(2): 295–323.
- Rainboth, W. J. 1996. The taxonomy, systematics, and zoogeography of *Hypsibarbus*, a new genus of large barbs (Pisces, Cyprinidae) from the rivers of southeastern Asia. *University of California Publications in Zoology*, vol. 129, 199 pp.
- Reid, J. W. 1993. New records and redescrptions of American species of *Mesocyclops* and of *Diaacylops bernardi* (Petkovski, 1986) (Copepoda: Cyclopoida). *Bijdragen tot de Dierkunde*, 63(3): 173–191.
- Reid, J. W. and B. H. Kay. 1992. *Mesocyclops guangxiensis*, new species, and new records of four congeners (Crustacea: Copepoda: Cyclopidae) from China, Laos, and Viet Nam. *Proceedings of the Biological Society Washington*, 105(2): 331–342.
- Reid, J. W. and R. M. Pinto-Coelho. 1994. An Afro-Asian continental copepod, *Mesocyclops ogunnus* found in Brazil; with a new key to the species of *Mesocyclops* in South America and a review of intercontinental introductions of copepods. *Limnologia*, 24(4): 359–368.
- Reid, J. W. and J. F. Saunders III. 1986. The distribution of *Mesocyclops aspericornis* (von Daday) in South America. *Journal of Crustacean Biology*, 6(4): 820–824.
- Richard, J. 1889. Entomostracés d'eau douce de Sumatra et de Célèbes. I. Phyllopedes, Cladocères et Copépodes. *Zoologische Ergebnisse der Reise niederländische Ost-Indien* M. Weber, 2: 118–128.
- Richard, J. 1894. Entomostracés recueillis par M. E. Modigliani dans le Lac Toba (Sumatra). *Annali di Museo civico di Storia naturale di Genova*, (2) 14: 565–578.
- Rivière, F., B. H. Kay, J. M. Klein, and Y. Séchan. 1987. *Mesocyclops aspericornis* (Copepoda) and *Bacillus thuringiensis* var. *israelensis* for the biological control of *Aedes* and *Culex* vectors (Diptera: Culicidae) breeding in crab holes, tree holes and artificial containers. *Journal of Medical Entomology*, 24: 425–430.
- Ruttner, F. 1952. Planktonstudien der Deutschen Limnologischen Sunda-Expedition. *Archiv für Hydrobiologie, Suppl.* 21(1/2): 1–274.
- Samraoui, B., H. Segers, S. Maas, D. Baribwegure and H. J. Dumont. 1998. Rotifera, Cladocera, Copepoda, and Ostracoda from coastal wetlands in northeast Algeria. *Hydrobiologia*, 386: 183–193.
- Santer, B. 1998. Life cycle strategies of free-living copepods in fresh waters. *Journal of Marine Systems*, 15: 327–336.
- Sars, G. O. 1903. Fresh-water Entomostraca from China and Sumatra. *Archiv für Mathematik og Naturvidenskab*, 25(8): 3–44, +3 Pls.
- Suárez-Morales, E., J. McLelland and J. Reid. 1999. The planktonic copepods of coastal saline ponds of the Cayman Islands with special reference to the occurrence of *Mesocyclops ogunnus* Onabamiro, an apparently introduced Afro-Asian cyclopoid. *Gulf Research Reports*, 11: 51–55.
- Stingelin, T. 1900. Beitrag zur Kenntnis der Süßwasserfauna von Celebes. *Entomostraca. Revue Suisse de Zoologie*, 8: 193–207.
- Ueda, H. and T. Ishida. 1997. Species composition and description of limnoplanktonic copepods from Okinawa. *Plankton Biology & Ecology*, 44(1,2): 41–54.
- Van de Velde, I. 1984. Revision of the African species of the genus *Mesocyclops* Sars, 1914 (Copepoda: Cyclopidae). *Hydrobiologia*, 109: 3–66.
- Van de Velde, I. 1987. New *Mesocyclops* species (Copepoda, Cyclopidae) from Papua New Guinea. *Bulletin de l'Institut royal des Sciences naturelles de Belgique, Biologie*, 57: 149–162.
- Zhen, T.-M., C. D. Jennings and B. H. Kay. 1994. Laboratory studies of desiccation resistance in *Mesocyclops* (Copepoda: Cyclopoida). *Journal of the American Mosquito Control Association*, 10(3): 443–446.

Received: May 25, 2000
Accepted: August 3, 2000

Corresponding Editor: S. A. Šlipiński
Issue Editor: D. Iwan