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A redescription of *Mesocyclops thermocyclopoides* HARADA, 1931 (Copepoda, Cyclopidae)

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Abstract

A redescription of *Mesocyclops thermocyclopoides* HARADA, 1931, based upon the examination of topotype specimens, is given. The description of the adult female and male is supplemented with the characterization of the copepodid IV and V stages. Characters to distinguish *M. thermocyclopoides* from the related species are shown, some preliminary remarks on the previous zoogeographical records are made.
Keywords : Cyclopoida, *Mesocyclops thermocyclopoides*, redescription, topotypes.

Résumé

Mesocyclops thermocyclopoides HARADA, 1931 est redécrit, à la base de l'examen des individus topotypes. En plus de la description des femelle et mâle adultes, les stades copepodid IV et V sont caracterisés. Des remarques préliminaires sont faites sur l'aire de répartition de l'espèce, et ses caractères spécifiques sont présentés.
Mots-clés : Cyclopoida, *Mesocyclops thermocyclopoides*, redescription, topotypes.

Introduction

In 1931 HARADA described a new "*Thermocyclops*-like" Mesocyclops from Taiwan (Lake Candidius) under the name *Mesocyclops thermocyclopoides*. KIEFER (1981) presented an amended description based upon the examination of his own specimens collected in 1935-37 from the type locality. (In these papers the type locality, Lake Candidius, is referred to as Lake Zitugetutan also; the name most recently used is Sun Moon Lake.) Having noted the variability in several characters, KIEFER (1981) suggested that the *Mesocyclops thermocyclopoides*, which he had previously identified from various localities from tropical Africa to the Lesser Sundas, probably represented a complex of closely related species. KIEFER's opinion was explicitly expressed by VAN DE VELDE (1987).
Indeed, scrutinous morphological examinations have revealed several *thermocyclopoides*-like *Mesocyclops* to be "good species". *Mesocyclops dussarti* VAN DE VELDE, 1984 from West Africa, *M. affinis* VAN DE VELDE, 1987 and *M. woutersi* VAN DE VELDE, 1987 from New Guinea, *M. isabellae* DUSSART et FERNANDO, 1988 from India were described in the last ten years and are considered as members of the strictly defined (HOLYNSKI & FIERS, in press) *M. thermocyclopoides*-circle. Paradoxically enough, although several species of the group have been thoroughly described, morphological knowledge of the nominate species itself is still imperfect, and consequently the taxonomical and zoogeographical relations within the *M. thermocyclopoides*-circle (the biggest species complex in the Palaeotropis) have remained obscure. Study of recent *M. thermocyclopoides* material originating from the type locality has made it possible to fill this gap.

Material and Methods

Material examined (all the specimens found in the sample) : three adult females, one adult male, four copepodids V (1 female, three males) and seven copepodids IV. The specimens were collected by Mr. CHAO in Sun Moon Lake (23°51' N, 120°55' E) Taiwan, Oct. 1993, by horizontal trawl. No other *Mesocyclops* species was in the sample. Formaldehyde preserved specimens were dissected in glycerin and mounted between two coverslips in an aluminium slide holder (COBB-slide). Drawings were made with the aid of a camera lucida.
In the literature I have not found any reference to the existence of HARADA's original material. In the Zoology Department of National Taiwan University, where HARADA's collection is deposited, the inventory of a part of invertebrate material has not been taken yet (pers. comm. from Dr. Wen-Been Chang), therefore it is not known, if the original *M. thermocyclopoides* material still exists or not. The topotype specimens deposited in KIEFER's collection (Staatliches Museum für Naturkunde, Karlsruhe) were not accessible to me.
All my topotypes are deposited in the Fish Culture Research Institute, Szarvas. Females (N° 1/A, N° 1/B and N° 1/C) are dissected and mounted in two slides

each; the first contains A1-P4, the second P5-abdomen. One male (N° 1/D) is dissected and mounted on one slide. One CV female (N° 1/E) and one CV male (N° 1/F) are dissected and mounted on one slide each. Three CIV (N° 1/G, N° 1/H and N° 1/I) and one CIII (N° 1/J) are dissected and mounted on one slide each. One tube (N° 1) contains five CIV and one CV male larvae.
Abbreviations used in the text, and figures are : A1 = antenna, P4 = leg 4, P5 = leg 5, end = endopod, exp = exopod, RS = receptaculum seminis, s = seta, sp = spine, ae = aesthaetasc, CIV = copepodid IV, CV = copepodid V.

Results

Mesocyclops thermocyclopoides HARADA, 1931

Mesocyclops thermocyclopoides HARADA, 1931 : 161-162, figs. 23-25; KIEFER, 1981 : 162-165, Fig. 5; VAN DE VELDE, 1987; 156, figs. 28-30.
Mesocyclops cf. *thermocyclopoides* LIM & FERNANDO, 1985 : 82, figs. 46-50.
Non : *Mesocyclops thermocyclopoides* VAN DE VELDE, 1984 : 30, Fig. 18.; LIM & FERNANDO, 1985 : 82-83, figs. 51-53; DUSSART & FERNANDO, 1988 : 245-246, figs. 8-11.
Mesocyclops cf. *thermocyclopoides* DAHMS & FERNANDO, 1993 : 9-18, figs. 5-6.
Mesocyclops thermocyclopoides acutus DUSSART & FERNANDO, 1988 : 254, figs. 43-50; REID & KAY, 1992 : 340-341, fig. 4.

DIAGNOSIS

Hyaline lamella of antennula article 17 serrate with one deep notch. Antennary basis presents dorsally, in addition to spinule pattern of *M. leuckarti* (VAN DE VELDE, 1984), oblique row of relatively large spinules on distal part, proximal to implantation of inner apical setae. Maxillulary palp without row of spinules. Maxillar syncoxa provided frontally with distinct rows of spinules. Maxilliped syncoxa without group of large spinules on frontal surface, only oblique row of tiny spinules present. Inner distal margin of leg 1 basis not bearing spine. Leg 4 intercoxal sclerite with two small obtuse prominences. Medial part of caudal surface of coxa without setules. Medial expansion of leg 4 basis bearing hairs distally and proximally on caudal surface. Pediger 5 with hairs laterally and dorsally, and genital double somite dorsally haired over butterfly shaped area. Lateral arms of seminal receptacle wide, short, hardly curved posteriorly. Anterior margin of proximal part of seminal receptacle concave in the middle. Distal margin of anal segment armed dorsally with few hardly visible small teeth only. Furca not haired, no spinules at bases of anterolateral and posterolateral setae.

DESCRIPTION OF FEMALE

Antennula. (Fig. 1. A) 17-segmented, last two segments with finely serrate hyaline lamella. Hyaline lamella of segment 17 with one deep notch. Anterior surface of articles 1, 4, 5, 7-13 bearing transverse rows of spinules. Armature formula as in *M. leuckarti* (VAN DE VELDE, 1984) : 8s, 4s, 2s, 6s, 4s, 1s+1sp, 2s, 1s, 1s, 0, 1s, 1s+ae, 0, 1s, 2s, 3s, 7s+ae. Aesthetasc of segment 17 sharing common base with a terminal seta.
Antenna. Coxa, basis, and three-segmented endopod armed with 0, 3, 1, 7, 7 setae respectively. Right antenna of one specimen abnormal with 8 setae on the second article of endopod (Fig. 1. B). Outer margin of endopod with continuous spinule rows on segment 1 and 2, and two intermittent rows on segment 3.
Basis, caudal spinule pattern (Fig. 1. D α-γ) essentially the same as in KIEFER's topotype specimens (VAN DE VELDE, 1987) : Near base, relatively long spinules on outer rim (α), very small ones on inner rim (β). Next to spinules on outer rim, oblique row of 6-8 smaller spinules (χ). Starting from distal two thirds of inner rim, oblique row of several very fine spinules (δ). Near the outer rim, longitudinal spinule row (consisting of 9-11 spinules) (ε). Next to implantation of inner setae, group (ϕ) of large spinules (5-8). Few, very tiny spinules (γ) on distal rim in 2 of 3 specimens.
Basis, frontal spinule pattern (Fig. 1. C α'-χ') similar to that in KIEFER's topotype specimen (VAN DE VELDE, 1987) : Longitudinal row of spinules (19-23) (α') on outer rim. No spinule group next to implantation of exopod seta. Transverse row of fine spinules (β') near base. Relatively long spinules on outer rim proximally (observable from caudal view as well). Starting above tip of the proximal triangular lobe, row of spinules (χ') extending paralllel to base line, continuing on inner rim.
Labrum. (Fig. 1. E) Distal margin of labrum toothed; row of strong rounded teeth flanked by two smaller acute, outward directed teeth, and each separated by a short space, with two larger teeth. On external (ventral) surface two longitudinal ridges bearing long hairs, more lateral hairs shorter. Salivary duct opening with large circular pore on the midline of inner (oral) face.
Paragnaths. (Fig. 1. F) Two lobes connected by postoral plate, bearing three lappets distally.
Ventral armature : isolated spinules on medialmost lappets, two longitudinal rows of setules, external ones longer, starting at ca. midlength of paragnath, inner setae shorter, occurring over the whole length of the lobe. On inner sides of each lobe, perpendicular to its axis, three large, serrate teeth.
Mandibula. (Fig. 3. A) Gnathobase with strongly chitinized teeth, outermost the biggest, innermost a spinulose seta. One-segmented palp with two long and one short setae. Near the palp, three groups of spinules on frontal face. Those forming transversal row, next to

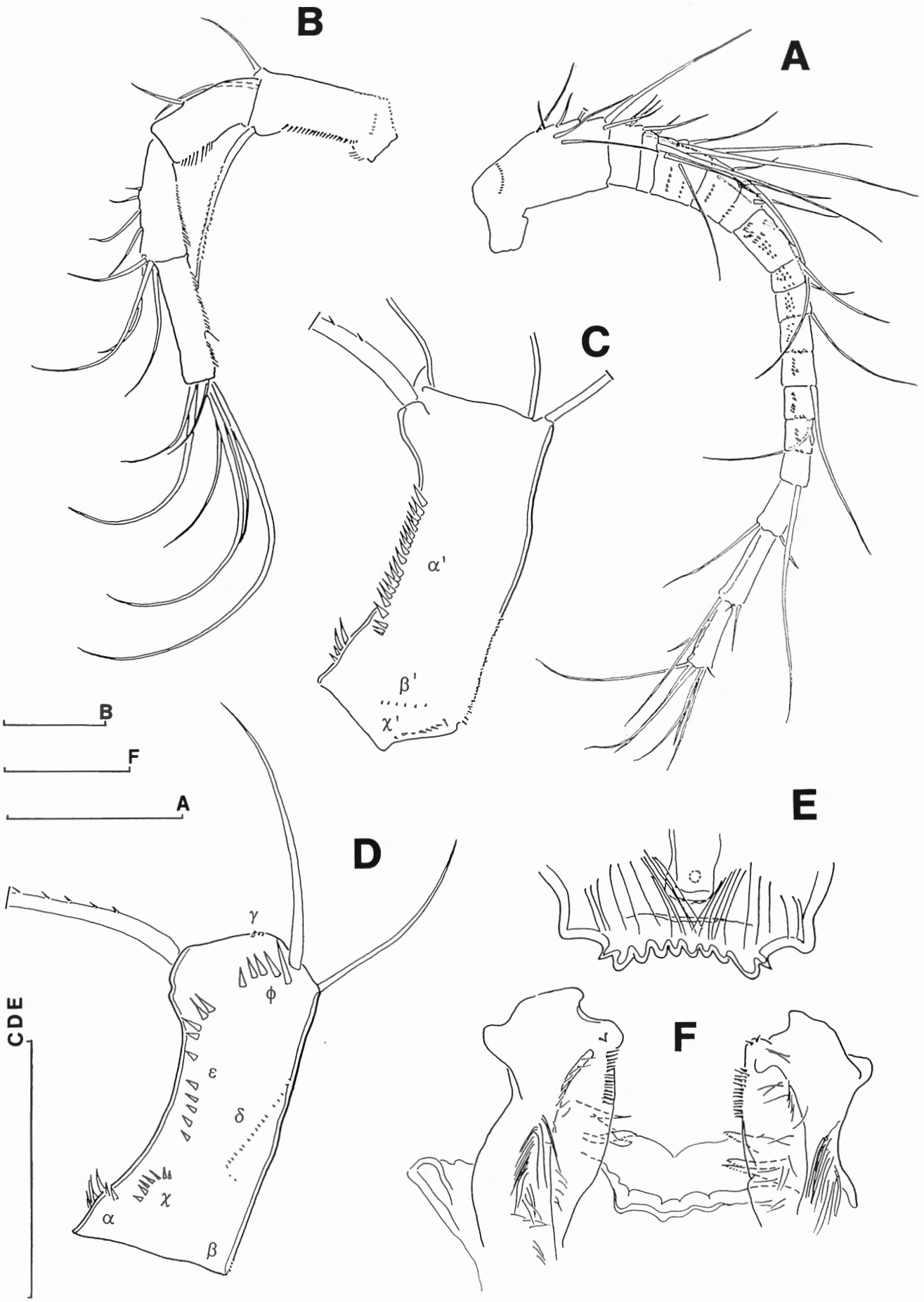

Fig. 1. – Mesocyclops thermocyclopoides, *adult female topotype : A. antennula (anterior), B. antenna (frontal), C. antennary basis (frontal), D. antennary basis (caudal), E. labrum (ventral), F. paragnaths (ventral). A.-E. show specimen 1/A, F. shows specimen 1/B.*
Scales = 50 µm.

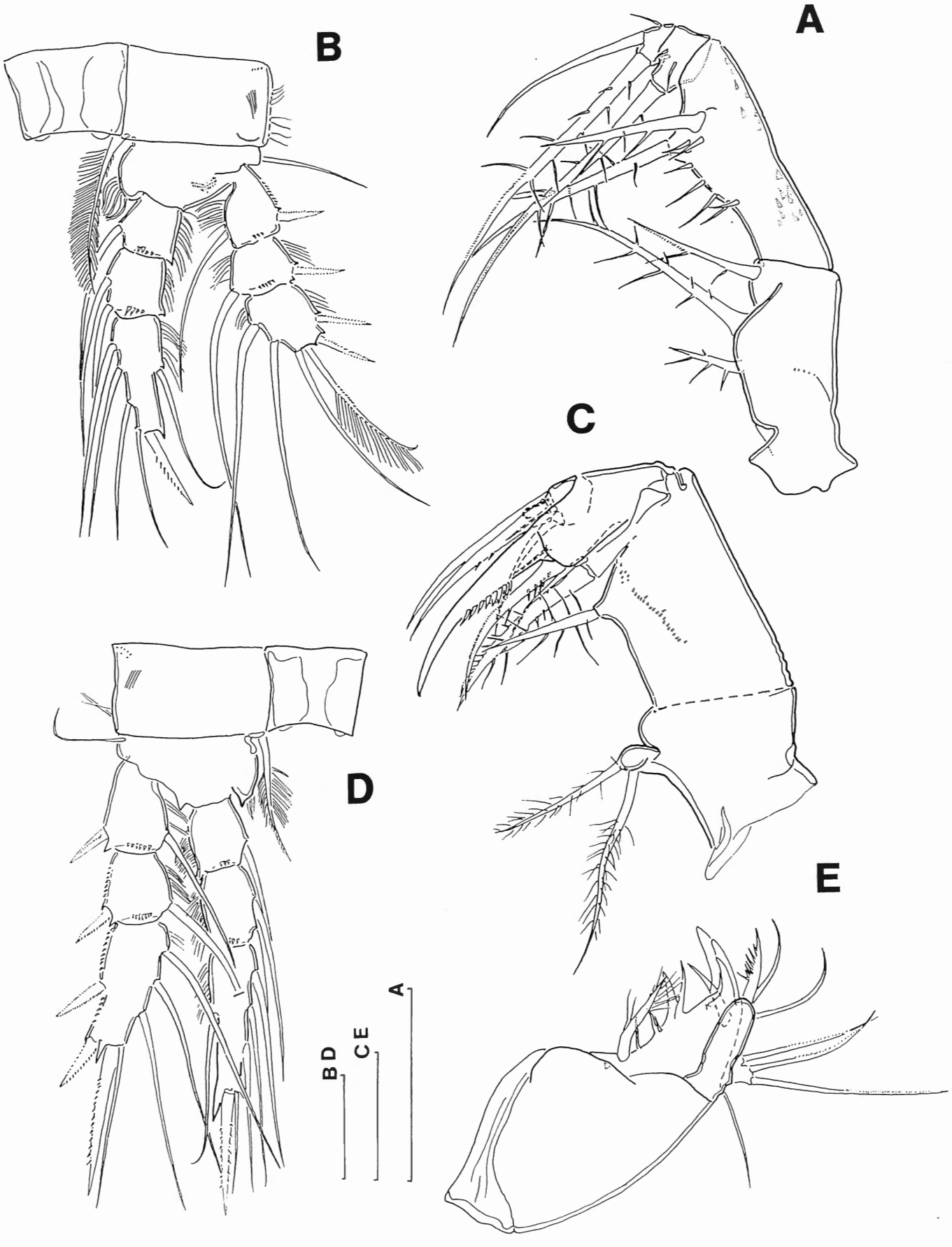

Fig. 2. – Mesocyclops thermocyclopoides, *adult female topotype : A. maxilliped (frontal), B. leg 1 (caudal), C. maxilla (frontal), D. leg 2 (caudal), E. maxillula (frontal). All figures are made from specimen 1/A.*
Scales = 50 µm.

praecoxal-coxal boundary conspicuously bigger than others.

Maxillula. (Fig. 2. E) Praecoxal arthrite with three claw-like elements distally, at their base one spiniform seta on caudal side. On inner rim, one large curved setulose, two medium-sized and three small spiniform setae. At base of praecoxal arthrite small spine caudally. Palp consists of separate exopod bearing three setae, endopod with one pinnate spine and two setae, and baseoendopod with one external seta. No rows of spinules on palp.

Maxilla. (Fig. 2. C) Syncoxa, basis and one-segmented endopod. Preacoxa and coxa fused, praecoxal-coxal suture present only on caudal surface. Praecoxa bears one endite with two setae, coxa has one seta at mid-length and one distal endite bearing one long spiniform apical seta and one ca. half as long, slender subapical seta. Spiniform seta furnished with spinules, of which one subapical spinule conspicously longer. Basis with two setae. Shorter seta placed caudally, the longer one, having small teeth along its posterior edge, inserted in front of the claw-like basal endite. On the longer seta, next to the row of fine teeth, one pair of long spinules proximally. Basal endite armed with relatively few (9-12) large teeth along its anterior edge. Endopod one-segmented, bears five setae. Two small setae on endopod inserted on caudal surface of external spiniform seta, very near its articulation on endopod. Coxa frontally ornamented with distinct longitudinal rows of spinules.

Maxilliped. (Fig. 2. A) Syncoxa, basis and two-segmented endopod. Coxa armed with three inner setae, and oblique row of very fine spinules on frontal face at level of proximalmost seta. Basis with long inner stout seta at distal third, and shorter spiniform seta shifted to frontal surface. Caudally two groups of spinules on outer surface. Long spinules on inner margin and the frontal surface below the insertion of basal setae. Enp1 with one stout spinulose seta bearing row of fine spinules on distal half; few spinules on frontal face of segment. Enp2 with three setae of increasing length from outermost to innermost : the last armed similarly to seta of Enp1, middle and outer setae naked.

Leg 1-4. (Fig. 2. B, D, 3. B-E) Spine and seta formula (Table 1). Coxa of leg 1-3 with few small teeth in the outer proximal corner and row of spinules near the external rim on caudal face. Coxa of leg 1-4 laterally haired.

Intercoxal sclerite of leg 1-4 naked on frontal and caudal faces. Apical part of medial expansion of leg 1-4 basis bearing hairs latero-caudally. On leg 4 this group of hairs supplemented with proximal group of few long hairs (Fig. 3. E).

Leg 4. Caudal surface of coxa (Fig. 3. E) armed with intermittent group of teeth (5+2, or 6+2) near distal rim; oblique row of spiniform setae (8-9) on outer distal corner; proximal to these some long hairs; row of few teeth (6-7) near proximal rim; no hairs next to inner rim. Intercoxal sclerite with two obtuse prominences. Inner apical spine of end3 (Fig. 3. B) slightly shorter than outer apical spine, or equal to it (Table 2). Outer edge of inner apical spine of end3 ornamented with several spinules.

Leg 5. (Fig 3 F) Two-segmented. Baseoendopod with one outer setulose seta, exopod armed with long apical setulose- and one medial spiniform seta. Spiniform seta of exopod slightly longer than seta on baseoendopod (Table 2).

Leg 6. (Fig. 3. I) Long medial seta and two short spines of about equal length on ovoid plate. No tiny spines, only six pores posterior to plate.

Pediger 5. (Fig. 3. F, 4. C) Dorsally and laterally haired. In addition to this dorsal hair ornamentation, there are two pores with sensilla in middle and two other ones next to distal rim in outer region.

Genital double somite. Ventrum (Fig. 3. F) not haired. Lateral arms of receptaculum seminis short, relatively wide, weakly curved posteriorly. Anterior margin of proximal part concave in middle. Below the horseshoe-shaped copulatory pore, apparently another small circular pore. (The presence of the latter pore ought to be confirmed by SEM examinations). Curvature of pore canal varies from nearly straight to strongly curved. Distal part of RS elongated, sac-like.

Dorsum (Fig. 4. C) with butterfly shaped haired area in anterior part. Two pores with sensilla medially, two others laterally on boundary of haired area, and also two pores with sensilla distally.

Anal segment. (Fig. 3. G, H) Distal margin with several well-developed spinules ventrally, and only few small, thin spinules dorsally. Near distal rim, above innermost spinules, two pores on ventral face.

Furca. (Fig. 3. G, H) Not haired, no teeth at bases of anterolateral and posterolateral setae.

DESCRIPTION OF MALE

Sexual dimorphism in structure and armature of antennulae; armature of antennae, maxillary coxa, leg 4 coxa, and pediger 5; structure of genital segment and leg 6; spinulation at distal margin of anal segment and base of anterolateral and posterolateral furcal setae; body length and proportions (Table 2).

Antennula. (Fig. 4. A, B) 17-segmented. Last two segments partly fused, boundary of segments 16 and 17 visible in posterior view only. Armature formula : 8s+3ae, 4s, 2s, 2s+1ae, 2s, 2s, 2s, 2s, 1s+1ae+1sp, 2s, 2s, 1s+1sp, 1s+1ae, 2s, 1s, 5s, 7s.

Antenna. (Fig. 4. E, F) Coxa, basis and three-segmented endopod armed with 0, 3, 1, 6, 7 setae respectively. Spinule ornamentation of basis reduced; caudal group of large spinules next to implantation of inner setae, and frontal transverse row of fine spinules near the base, absent.

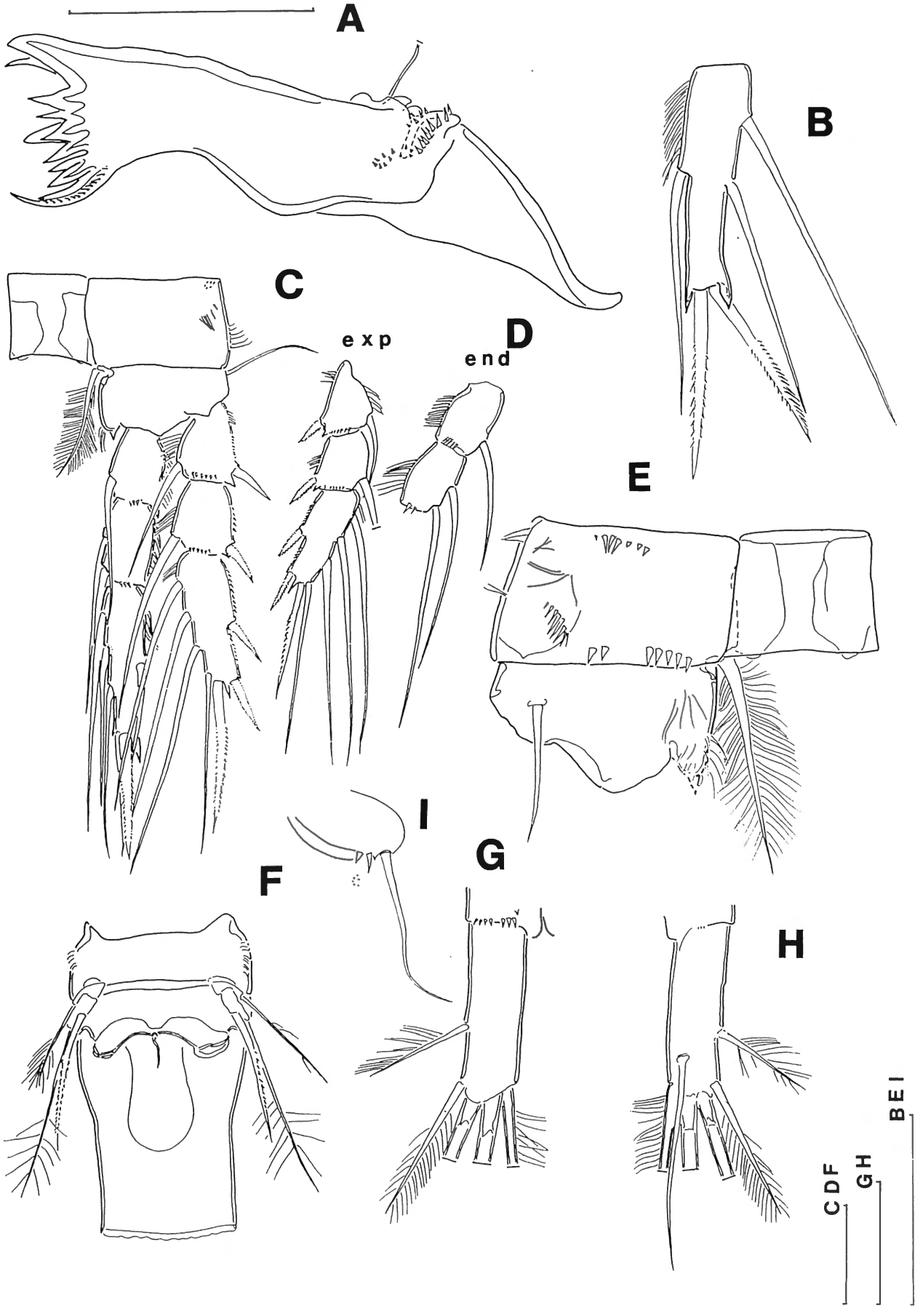

Fig. 3. – Mesocyclops thermocyclopoides, *adult female topotype : A. mandibula (frontal) - long setae of the palp bend to the caudal face, B. leg 4 end3 (caudal), C. leg 3 (caudal), D. leg 4 exo-, endopod (caudal), E. leg 4 basis, coxa, intercoxal sclerite (caudal), F. pediger 5, genital double somite (ventral), G. furcal ramus (ventral), H. furcal ramus (dorsal), I. leg 6. All figures are made from specimen 1/A.*
Scales = 50 µm.

Table 1.
Armature of leg 1-4 in CIV, CV and adult stages. (Spines are denoted by Roman-, setae by Arabic numerals. The armature on outer margin of any segment is given first, then it is followed by the appendages on the apical and inner margins.)

		Coxa	Basis	Exopod	Endopod
Leg 1	CIV	0-1	1-0	I-1; II-II, 1-3	0-1; 1-I, 1-5
	CV	0-1	1-0	I-1; II-II, 1-3	0-1; 1-I, 1-5
	adult	0-1	1-0	I-1; I-1; I-II, 1-2	0-1; 0-2; 1-I, 1-3
Leg 2	CIV	0-1	1-0	I-1; II-II, 1-4	0-1; 1-I, 1-5
	CV	0-1	1-0	I-1; II-II, 1-4	0-1; 1-I, 1-5
	adult	0-1	1-0	I-1; I-1; I-II, 1-3	0-1; 0-2; 1-I, 1-3
Leg 3	CIV	0-1	1-0	I-1; II-II, 1-4	0-1; 1-I, 1-4
	CV	0-1	1-0	I-1; II-II, 1-4	0-1; 1-I, 1-5
	adult	0-1	1-0	I-1; I-1; I-II, 1-3	0-1; 0-2; 1-I, 1-3
Leg 4	CIV	0-1	1-0	I-0; II-II, 1-4	0-1; 1-II-3
	CV	0-1	1-0	I-1; II-II, 1-4	0-1; 1-II-4
	adult	0-1	1-0	I-1; I-1; I-II, 1-3	0-1; 0-2; 1-II-2

Table 2.
Body length and proportions of adults and copepodid IV and V of *Mesocyclops thermocyclopoides*. In parentheses is the number of specimens measured (if other than the number of specimens shown in the first horizontal row) .

	Female	Male	CV female	CV male	CIV
Specimens measured	3	1	1	1	2
Total length (µm)	870-895	620	760	600-610 (3)	500- 630 (7)
Furcal s (µm)					
ter acces	175-205	120	130	80	85-95
in ter	375-380	260	350	—	290-305
out ter	260-270	200	240	—	185-200
post lat	60-65	50	55	50	45
Cephthx l : w	1.1-1.3	1.3	1.0	1.2-1.4 (2)	1.0-1.3 (6)
Gen dos l : w	1.3-1.5	—	—	—	—
Pros : Uros	1.5-1.7	1.6	1.6	1.6-1.8	1.8-2.0 (7)
Leg4 end3 l : w	2.8-3.6	3.3	—	—	—
Leg4 end3, ap sp					
in : out	0.9-1.0	0.9	0.9	1.0	0.8
Leg5,					
in exopod s : basend s	1.1-1.2	0.9	0.8	—	—
Furca l : w	3.2-3.4	3.1	3.1	2.9	2.7-2.8
Ant lat s : furca l	0.54-0.58	0.6	0.7	0.7	0.7-0.8
Dors s : post lat s	1.5-1.9	1.7	1.8	2.4	2.1-2.5

Abbreviations : l = length, w = width, cephthx = cephalothorax, gen dos = genital double somite, pros = prosome, uros = urosome, end = endopod, ap = apical, sp = spine, s = seta, basend = baseoendopod, in = inner, out = outer, ant = anterior, lat = lateral, dors = dorsal, post = posterior, ter acces = terminal accessory, in ter = inner terminal, out ter = outer terminal, post lat = posterolateral. (The terminology of furcal setae according to HUYS & BOXSHALL, 1991).

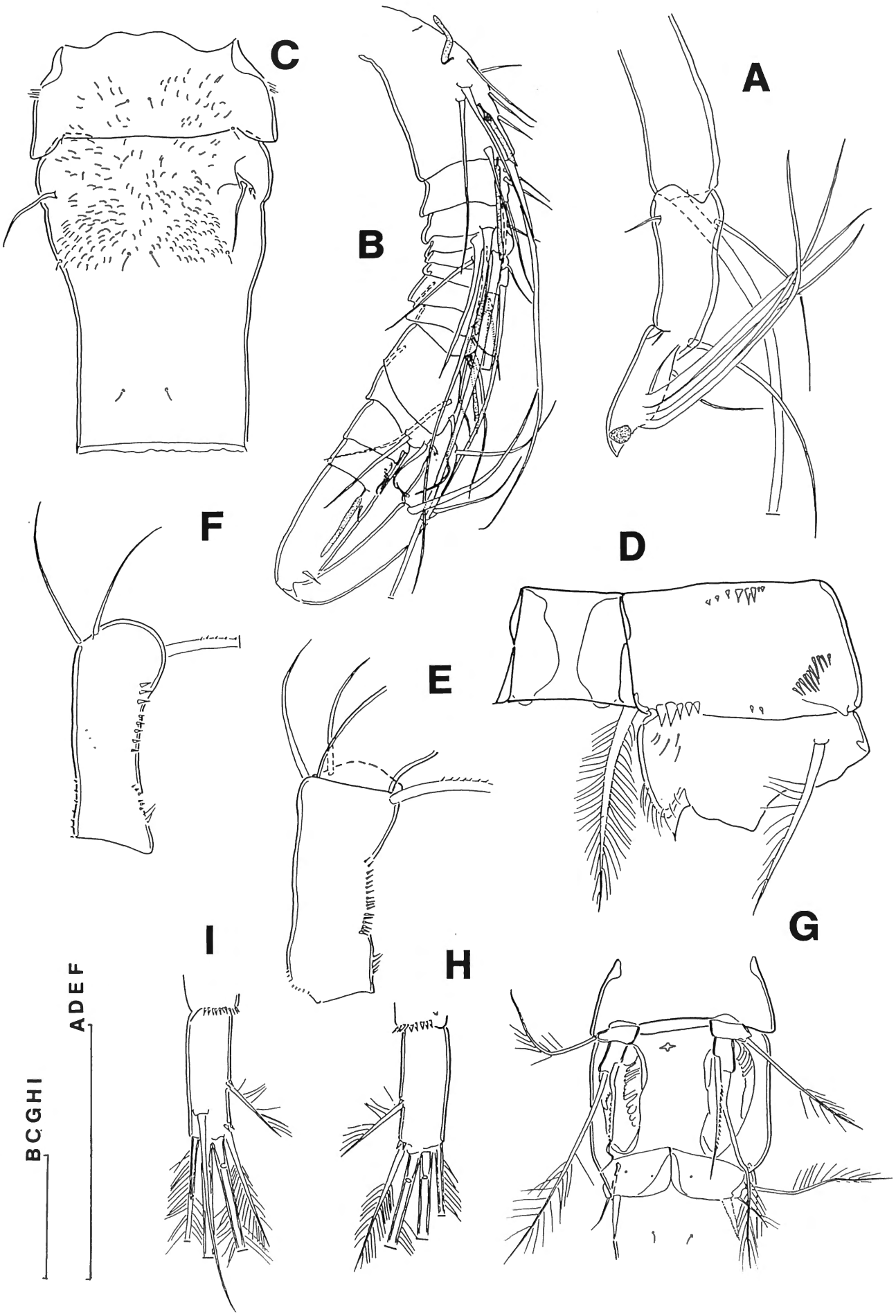

Fig. 4. – Mesocyclops thermocyclopoides *topotypes : A. antennula segment 16, 17 (posterior), B. antennula (anterior), C. pediger 5, genital double somite (dorsal), D. leg 4 basis, coxa, intercoxal sclerite (caudal), E. antennary basis (frontal), F. antennary basis (caudal), G. pediger 5, genital somite (ventral), H. furcal ramus (ventral), I. furcal ramus (dorsal) A, B, D-I are made from male topotype (specimen 1/D), C from female topotype (specimen 1/B). Scales = 50 µm.*

Mandibula. Structure and spinulation near palp as in female.
Maxillula. Structure and palp ornamentation as in female.
Maxilla. In contrast with female, no distinct rows of spinules on frontal face of maxillary coxa. General structure as in female.
Maxilliped. Structure as in female. Oblique row of very fine spinules, present in female on frontal face of syncoxa, not observable by light microscope.
Leg 1-4. Spine and seta formula, and armature of intercoxal sclerites of leg 1-4, as in female. Unlike female, outer lateral part of leg 4 coxa very weakly haired or not haired caudally (Fig. 4. D).
Medial expansion of leg 4 basis distally and proximally haired on caudal face. Outer edge of inner apical spine of leg 4 end3 bearing several spinules.
Leg 5. (Fig. 4. G) Form, setation as in female. Spiniform inner seta on exopod slightly smaller than baseoendopod seta (Table 2).
Leg 6. (Fig. 4. G) Consists of stout inner spine, slender seta of about equal length, and long outer seta.
Pediger 5. (Fig; 4. G) Not haired.
Genital segment. (Fig. 4. G) Rectangular somite with two kidney-shaped spermatophores inside.
Anal segment. (Fig. 4. I, H) Distal rim with spinules ventrally and dorsally. On ventral face, two pores above innermost spinules, near distal rim.
Furca. (Fig. 4. I, H) Not haired. Stout spinules at bases of anterolateral and posterolateral setae.

DESCRIPTION OF COPEPODID IV AND V STAGES

The dimorphism in body length (Table 2) and armature of leg 6 (Fig. 5. A, C) allow quick recognition of male and female larvae of CV (4 individuals in the sample); distinguishing characters for the different sexes in CIV (8 individuals in the sample) have not been found.

Antennula. 10- and 11-segmented in CIV and CV respectively. Ninth and tenth antennula segments of CV ♀ much more elongated than those in CV ♂ (length : widths of segments 9 and 10 in C5 ♀ 24 µm : 19 µm, 45 µm : 17 µm; in CV ♂ 13 µm : 17 µm, 21 µm : 16 µm respectively.) Hyaline membrane on last two segments in CIV and CV ♀ and only the last segment in CV ♂. No distinct notch on hyaline membrane in CIV and CV. Armature of antennulae as follows :

CIV : 5s, 6s, 2s, 1s+1sp, 2s, 3s, 2s+1ae., 2s, 2s, 7s+1ae.
1. 2-4. 5. 6. 7. 8-11.12-14. 15. 16. 17.

CV : 7s, 4s, 8s, 4s, 1s+1sp, 2s, 3s, 2s+1ae, 2s, 2s, 7s+1ae
1. 2. 3-4. 5. 6. 7. 8-11. 12-14. 15. 16. 17.

Homologization of larval and adult antennule segments is made possible by the presence of some special features (spine, aesthaetasc, posteriorly positioned setae, hyaline lamella) displayed by adult females (Fig. 1. A). Transverse rows of spinules on antennula sections homologous with those on adult female segments 1, 5, 7-13 in CIV and CV ♂ and 1, 4-5, 7-13 in CV ♀.
Antenna. Coxa, basis and three-segmented endopod furnished with 0, 3, 1, 6, 7 setae in CIV and CV ♂, and 0, 3, 1, 7, 7 setae in CV ♀.
Antennary basis caudal spinule pattern (Fig. 5. D) : There is a tendency toward elaboration in pattern and size of spinules from larval stages to adult female. Oblique row of fine spinules starting from the inner rim, hardly visible in CIV, absent in CV ♂ and consists of very small spinules in CV ♀. Distal row of spinules near the implantation of inner setae represented only by few (3-4; 4-6) short spinules in CIV and CV ♀ and not at all in CV ♂. Other elements of spinule pattern of adult female present in larval stages also.
Frontal spinule pattern (Fig. 5. E) : Number of spinules in longitudinal row on outer rim increases with growth (CIV : 9-11; CV ♂: 10-11; CV ♀: 10-12;). No transverse row of tiny spinules near base.
Mandibula. Structure and spinulation near palp as in adults.
Maxillula. CIV and CV have the same armature as adults.
Maxilla. CIV, CV and adults share the same setation pattern. No distinct rows of spinules on frontal face of syncoxa.
Maxilliped. Structure in CIV and CV shared with adults.
Leg 1-4. Two-segmented rami at both stages. Armature of leg 1-4 in CIV and CV (Table 1.) In CV three new setae added (leg 3 end2, leg 4 exp1, leg 4 end2,) to the setae present in CIV, by this transformation reaching the number of spines and setae typical of adult stages.
Intercoxal sclerites of leg 1-4 naked on either frontal or caudal face. Intercoxal sclerite of leg 4 with two obtuse prominences in CIV and CV. Ornamentation of leg 4 coxa of both copepodid stages is essentially the same as in the adult female : only the number of teeth and spiniform setae within groups is reduced. Medial expansion of leg 4 basis bearing hairs distally, but not proximally in CIV and CV. Outer edge of inner apical spine with several spinules.
Leg 5. (Fig. 5. F) Segmentation and setation as in adults.
Leg 6. (Fig. 5. A-C) It is represented by one stout spine and one long, slender seta positioned ventrally in CIV, one stout spine and two setae ventrally in CV ♂ and two small spines of about equal size and one long seta shifted to laterodorsal face in CV ♀.
Anal segment. (Fig. 5. G, H) Distal rim furnished with spinules dorsally and ventrally.
Furca. (Fig. 5. G, H) Not haired. Spinules at bases of anterolateral and posterolateral setae in both stages.

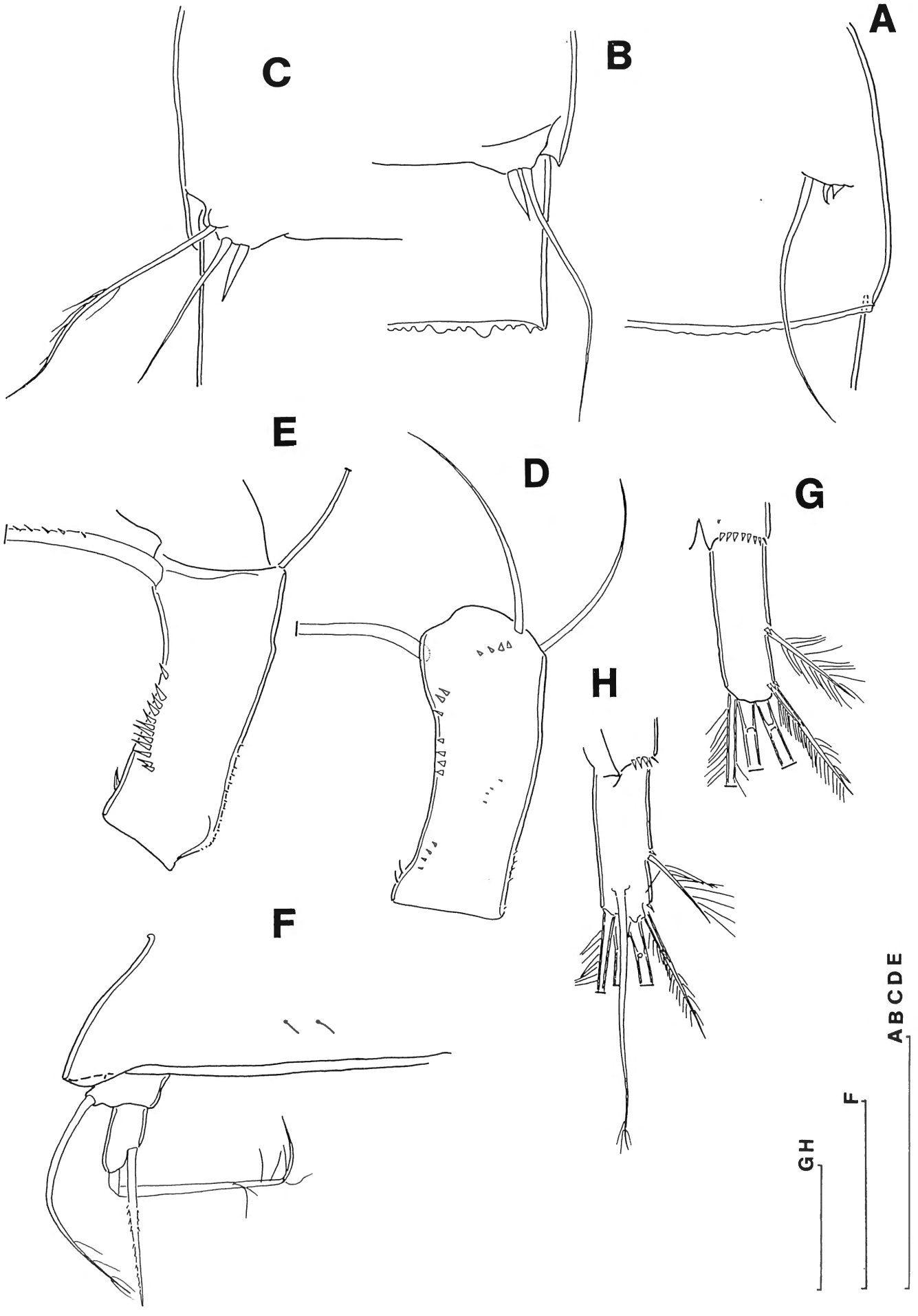

Fig. 5. – Mesocyclops thermocyclopoides *copepodid stages. A. CV ♀ leg 6, B. CIV leg 6, C. CV ♂ leg 6, D. CV ♀ antennary basis (caudal), E. CV ♀ antennary basis (frontal), F. CV leg 5, G. CV furcal ramus (ventral), H. CV furcal ramus (dorsal). A, D-H show specimen 1/E, C is made from specimen 1/F, B from specimen 1/G.*
Scales = 50 µm.

Discussion

There are several records (COLLADO *et al.*, 1984; DUSSART & FERNANDO, 1985, 1988; KAWABATA, 1989, 1991; KIEFER, 1981; LIM & FERNANDO, 1985; REID & KAY, 1992) of *Mesocyclops thermocyclopoides* and *M. cf. thermocyclopoides* in the tropics from Malay Archipelago and Japan as far as Central America. VAN DE VELDE (1984) came to the conclusion that the distributional area of *M. thermocyclopoides* s. str. does not include Africa, but the validity of records outside Africa, due to insufficient description of the type specimens, has remained uncertain.

Based upon the spinule armature on the antennary basis and at the base of the posterolateral furcal seta, I consider the *Mesocyclops* specimens identified as *M. thermocyclopoides s. str.* by LIM & FERNANDO (1985) and DUSSART & FERNANDO (1988) (as opposed to LIM & FERNANDO's *M. cf. thermocyclopoides*), and *M. thermocyclopoides acutus* (DUSSART & FERNANDO, 1988; REID & KAY, 1992) as not conspecific with *M. thermocyclopoides* HARADA, 1931. These forms [with the exception of *M. thermocyclopoides s.str.* of LIM & FERNANDO (1985), the identity of which is not yet clear to me] are probably representatives of *M. affinis*, which is distributed from New Guinea at least to Laos (REID & KAY, 1992). DAHMS & FERNANDO (1993) gave a detailed description of naupliar development of *M. cf. thermocyclopoides*. Considering the conspicuous dorsal spinulation on the distal rim of the anal segment, and the presence of spinules at the bases of anterolateral and posterolateral setae, the adult female shown by the authors is likely *M. ogunnus* ONABAMIRO, 1957 rather than *M. thermocyclopoides*. The former species was described from Africa, but DUSSART & FERNANDO (1988) and REID & KAY (1992) found it in Bangladesh and Laos respectively, while I identified it from South India and Malaysia. To settle the question, examination of the armature of the maxillulary palp (not mentioned in DAHMS & FERNANDO's description) would be necessary. The male of *Mesocyclops cf. thermocylopoides* figured in DAHMS & FERNANDO's paper is probably not conspecific with the female. In males, the spinule pattern of the antennary basis is sometimes simpler than in females — I observed such reduction in *M. affinis* (type material), *M. ruttneri* (USA, Mississippi), *M. papuensis* (type material) and *M. thermocyclopoides* —, or retains the pattern typical of females, but new groups of spinules do not appear. The *Mesocyclops* male in DAHMS & FERNANDO's paper has a group of spinules caudally [between the proximal oblique (χ) and longitudinal (ε) rows], which is absent in the female illustrated, but is very characteristic of the Indian *M. isabellae* and the pantropical *M. aspericornis*. Therefore I suppose that the material of DAHMS & FERNANDO (Lake Beira, Sri Lanka) contains two *Mesocyclops* species, and the naupliar stages which they described might have originated from both species.

On the other hand *Mesocyclops cf. thermocyclopoides* from Malaysia (LIM & FERNANDO, 1985), as VAN DE VELDE (1987) also suggested, is very likely *M. thermocyclopoides s. str.* I had the opportunity to compare two *Mesocyclops* specimens collected in the same locality (Chemor, Malaysia) where LIM & FERNANDO's material originated from, with the topotype specimens, and have not found any essential difference between them, although I examined every character used in the present redescription of *M. thermocyclopoides*. The measurements showed the furcal rami slightly more dumpy (length/width : 2.9-3.0) the ratio of the length of the inner and outer apical spines of leg 4 end3 to be near 1 (1.1-1), and the body length 830 µm and 970 µm — other proportions were within the ranges for the Taiwan specimens. Though *Mesocyclops cf. thermocyclopoides* from Viet Nam (REID & KAY, 1992) has the spinule ornamentation on the antennary basis and no spinulation at bases of the anterolateral and posterolateral furcal setae, which are characteristics of the topotypes described here, they differ from the topotypes in having naked dorsum of the pediger 5 and genital double somite. The record of *M. thermocyclopoides* from Viet Nam together with those from Central America (COLLADO *et al.*, 1984), from Ceylon (DUSSART & FERNANDO, 1985) and Japan (KAWABATA, 1989, 1991) remain to be verified. Hence for the moment the genuine *M. thermocyclopoides* is known only from its type locality and Malaysia.

M. thermocyclopoides, *M. ogunnus* and *M. dussarti* belong to a morphological (though not necessarily phylogenetic) subgroup within the *M. thermocyclopoides*-circle, sharing a distal group (ϕ) of large spinules on the caudal surface of the antennary basis. *M. dussarti* differs from *M. thermocyclopoides* in having spinules at the base of the posterolateral furcal setae, hairs on the entire surface of the dorsum of genital double somite, and setules on the medial part of the leg 4 coxa on caudal face. *M. ogunnus* can be distinguished from *M. thermocyclopoides* in having dorsally several stout spinules on the distal rim of the anal segment, spinules at the base of anterolateral [usually these spinules are present, but may sometimes be absent (REID & KAY, 1992)] and posterolateral furcal setae, distinct spinule row on the maxillulary palp, and no hairs on the dorsum of the genital double somite.

On the other hand, the only character safely distinguishing *M. isabellae* from *M. thermocyclopoides* is the caudal spinule ornamentation of the antennary basis : *M. isabellae* has a field of tiny spinules in the area where *M. thermocyclopoides* has a group of few large spinules, and a group of spinules between the proximal oblique and longitudinal spinule rows, not displayed by *M. thermocyclopoides*.

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