Revision of the African species of the genus *Mesocyclops* Sars, 1914 (Copepoda: Cyclopidae)*

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Abstract

A revision is made of the African *Mesocyclops* species, based on type material (when extant) and on collections from various parts in Africa.

Diagnostic characteristics are: presence or absence of spinule patterns on antennular segments, structure of the hyaline membrane of the 17th antennular segment, spine pattern on the basipodite of the antenna, armature of the maxillulary palp, presence or absence of a spine on the basipodite of P_1, armature of the connecting lamella, coxopodite and basipodite of P_4, armature of the apical spines of Enp_3P_4, armature of the last thoracic segment, genital segment and the other abdominal segments, armature of the furcal rami and structure of the receptaculum seminis.

First, the taxonomical status of *M. leuckarti* (Claus) is redefined; this species does *not* occur in Africa and its geographical range is restricted to Europe and the western part of Northern Asia. On the African continent, twelve other taxa are found. Four are described as new to science: *M. kieferi* sp.n., *M. dussarti* sp.n., *M. spinosus* sp.n. and *M. aequatorialis similis* subsp.n. The remainder are: *M. major* Sars, *M. tenuisaccus* (Sars), *M. paludosus* Lindberg, *M. salinus* Onabamiro, *M. ogunnus* Onabamiro, *M. aspericornis* (Daday), *M. rarus* Kiefer and *M. aequatorialis aequatorialis* (Kiefer).

Their geographical distribution is discussed. Eleven taxa are restricted to the African continent (including the Arabian Peninsula and the Canary Islands). One taxon is also found in the Oriental Region. Madagascan representatives are briefly mentioned.

The importance of breeding and cross-breeding experiments should be stressed in copepod taxonomy. Experiments were performed on African species and *M. leuckarti* to evaluate the morphological characters used in the present study, and intraspecific morphological variability was examined up to and including the third generation (Van de Velde, in press).

In future one should critically reconsider the so-called cosmopolitan species; they may indeed represent a complex of related taxa, each with a geographical range more restricted than that of the species-complex itself.

Introduction

The genus *Mesocyclops* occurs worldwide. It is successful in the tropics and subtropics and marginal in temperate and arctic regions.

Today about 35 species of *Mesocyclops* s.s. are known. The most frequently cited taxa in Africa and elsewhere are *M. leuckarti leuckarti* (Claus) and *M.l. aequatorialis* Kiefer.

M. major Sars, *M. tenuisaccus* (Sars), *M. paludosus* Lindberg, *M. salinus* Onabamiro and *M. ogunnus* Onabamiro have not been reported since

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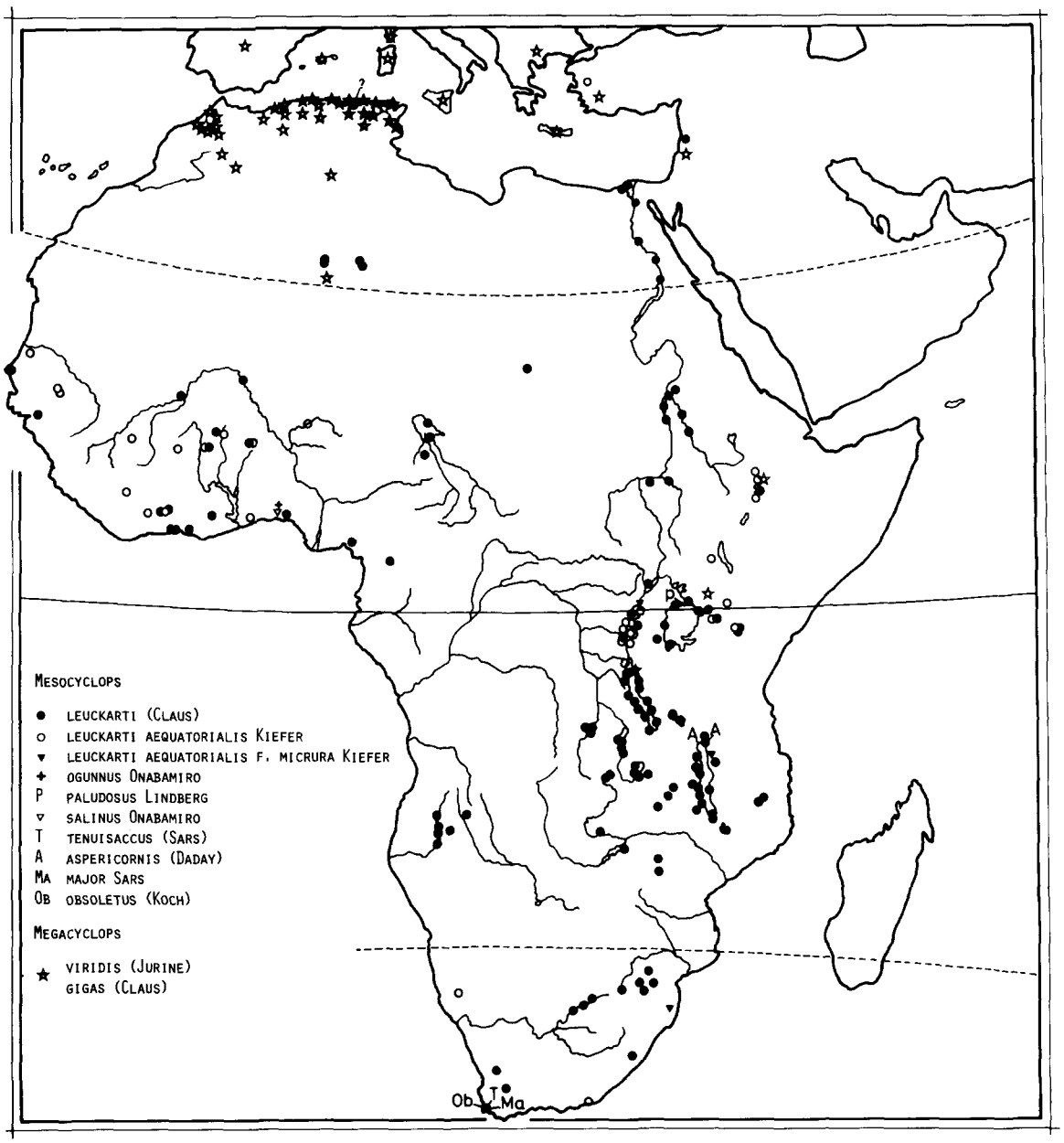

Fig. 1. The distribution patterns of *Mesocyclops* and *Megacyclops* in Africa as they appeared to be before the present revision. Names used are those from the literature (records up to 1981). Not all these are now valid. Note especially that *M. leuckarti*, once thought to be widespread there, does not occur in Africa.

their original descriptions. Further, a few citations of *M. leuckarti aequatorialis f. micrura* Kiefer and one record of *M. aspericornis* (Daday) for the African continent exist (Fig. 1). For detailed references concerning the distribution of *Mesocyclops* in Africa, see Van de Velde (1982). The records of *Megacyclops* on Fig. 1 are explained on p. 63.

Several authors report considerable variability in *M. leuckarti leuckarti* and *M.l. aequatorialis* from a single locality and from different localities. This led us to suspect that this variability might be due to more than two taxa.

A detailed study was undertaken to clarify the taxonomy of the genus. It revealed new diagnostic

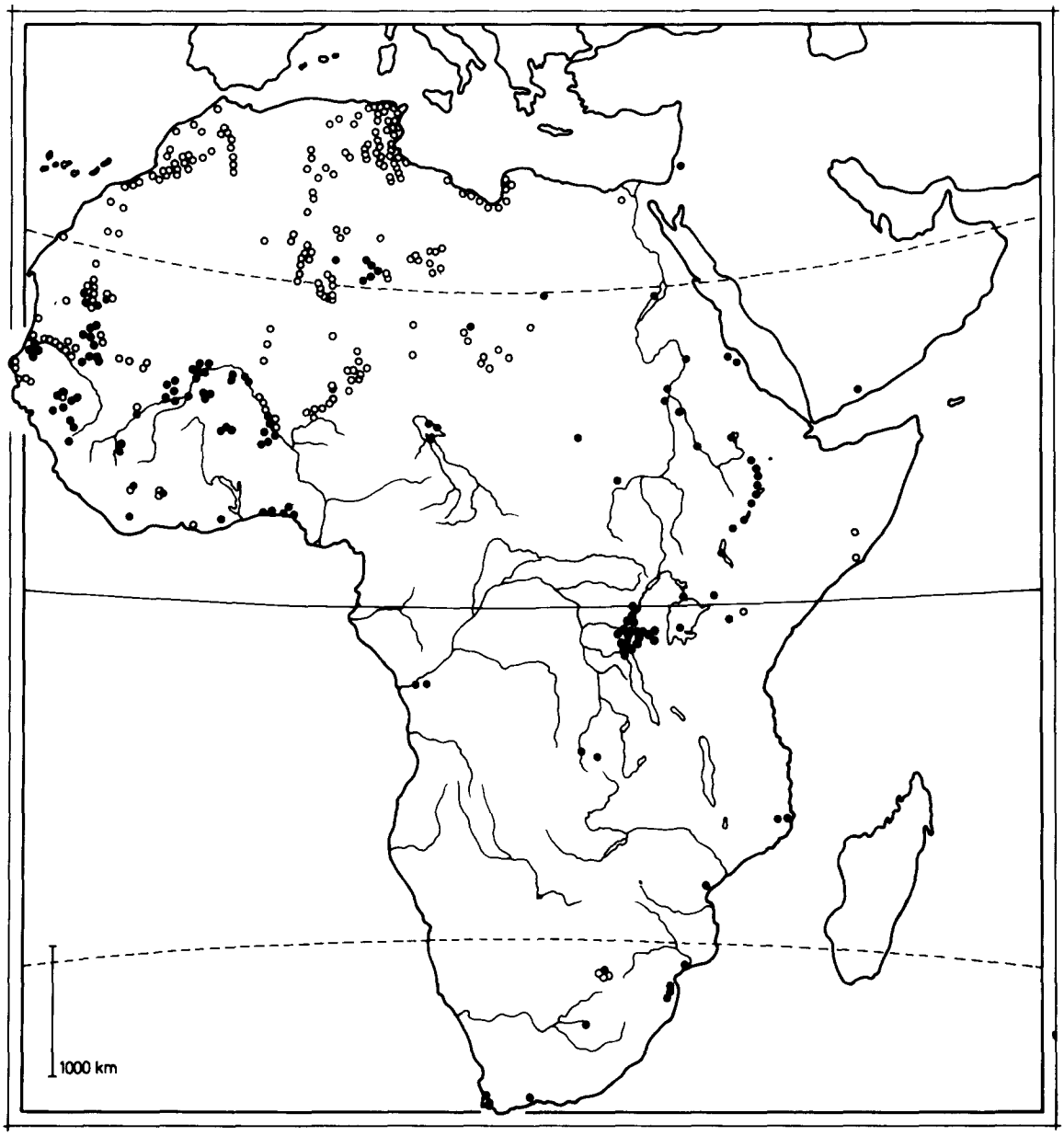

Fig. 2. Material examined: ●: *Mesocyclops* present, ○: *Mesocyclops* absent.

characteristics important in differentiating species. First, the status of *M. leuckarti*, the supposed cosmopolitan species *par excellence*, had to be redefined and after doing this, we found that it does not occur in Africa. Instead, twelve other taxa are recognized in continental Africa (Van de Velde, 1982 & in press).

To evaluate the morphological criteria used, breeding and cross-breeding experiments were performed with *M. major, M. salinus, M. rarus* and *M. leuckarti* (Van de Velde, *op. cit.*).

Close to the end of our research, we found that Prof. Dr. Kiefer (Konstanz) had just concluded a study on *Mesocyclops* of the Old World, based on specimens from his private collection (Kiefer, 1981). For Africa two new species were described: *M. rarus* and *M. curvatus* (but see p. 47). *M.l. aequatorialis* was raised to specific rank, and *M. thermocyc-*

lopoides Harada was cited as widely distributed in Africa. This last point is not confirmed in the present study (see p. 31). For *M. leuckarti,* Kiefer comes to the same conclusions we had reached. The range of this species is restricted to Europe and the western part of northern Asia.

Material

We used type material of *M. major, M. tenuisaccus, M. paludosus, M. ogunnus, M. salinus* and topotypical material of *M. leuckarti.* From Madagascar, type material of *M. insulensis* was examined. Also, *Mesocyclops* populations, made available to me by many persons, institutes or museums, originating from about 250 localities in various parts in Africa were examined (Fig. 2, Table 1). About 2 500 specimens have been dissected and 500 specimens resulting from breeding experiments were studied.

The material examined is summarized in Table 1. Samples collected during the Sahara-Sahel expeditions of the State University of Ghent (RUG) have a locality-number (column 1). The 2nd column indicates various access numbers given by a collector, institute or museum to samples or slides. Also listed are the localities (3th column), co-ordinates (4th column), sampling dates (5th column). For the type of biotope (6th column) abbreviations are used: V = pond, swamp, puddle in depression or riverbed (mostly ephemeral), G = guelta (rockpool Sahara), M = lake, P = well, SM = barrage, R = river, RV = rice-field, B = spring, Ma = temporary shallow lake. Some of the localities could not be localized and are followed by a question mark. TM means type material.

Methods

Measurements were taken according to the method of Kozminski (1933). The specimens were dissected in glycerine and mounted between two coverslips in an aluminum slide-holder and sealed with glyceel.

Each female was mounted on two slides: the first containing A_1–P_4, the second P_5-abdomen. Males were mounted on one slide.

Diagnostic characters

A detailed description and illustrations are given in Van de Velde (in press). For clarity, these characteristics are briefly summarized here:

1. presence or absence of spinule patterns on the antennular segments and structure of the hyaline membrane on the 17th segment;
2. spine pattern on the basipodite of the antenna; the terminology is illustrated in Fig. 3;
3. presence or absence of a spine group on the maxillulary palp;
4. presence or absence of a spine on the inner distal margin of the basipodite of P_1;
5. armature of the apical spines of the Enp_3P_4; a considerable degree of intraspecific variability is found in the length of these spines: the inner spine may be longer, equal to, or shorter than the outer one;
6. armature of the connecting lammela of P_4: the caudal side is provided or not with rows of setules and the size of the prominences on the distal margin are taxonomically important;
7. armature of the inner part of the caudal side of the coxopodite and basipodite of P_4;
8. armature of the last thoracic segment, the dorsal side of the genital segment and the remaining abdominal segments;
9. structure of the receptaculum siminis; the terminology is illustrated in Fig. 4;
10. armature of the furcal rami.

Results and descriptions

On the basis of these characteristics *Mesocyclops* of the African continent has been revised and twelve taxa are recognized. *M. aspericornis* also occurs in the Oriental Region, but the remaining species are restricted to Africa (including the Arabian Peninsula and the Canary Islands). The identification key includes *M. insulensis*, an endemic of Madagascar; *M. pilosus* and *M. annae* are not included since no material was available. Further, a redescription of *M. leuckarti* (Claus) is given but the *M. bodanicola* problem is left out of consideration here.

Table 1. Material examined.

Locality number	Sample or slide number	Locality	Co-ordinates	Date	Biotope	*aequatorialis*	*aequatorialis*	*aequatorialis similis* subsp.n.	hybrid population	*aspericornis*	*major*	*ogumnus*	*paludosus*	*rarus*	*salinus*	*tenuisaccus*	*kieferi* sp.n.	*dussarti* sp.n.	*spinosus* sp.n.
Algeria																			
Sahara-project (R.U.G.)																			
411	21H	Balouahi	26°20'N-08°29'E	1.6.1978	G						x								
411	22H	Balouahi	26°20'N-08°29'E	1.6.1978	G						x								
412	23H	El Bahtou	26°20'N-08°31'E	1.6.1978	G													x	
419	46H	Djanet	24°31'N-09°27'E	8.6.1978	V			x											
421	51H	Beibei	24°38'N-09°26'E	9.6.1978	G			x			x								
402	1H	Tin Eselmakene	26°24'N-05°20'E	26.5.1978	G						x								
418	44H	Iherir	25°23'N-08°25'E	7.6.1978	G													x	
538	67I	Oued Adjerii	24°45'N-10°07'E	29.4.1979	V			x											
416	12I	Efenni	25°31'N-07°59'E	17.4.1979	G													x	
Libya																			
Leg. J. Léonard (coll. Meise)																			
460	4705	Kufra (El Giof)	24°12'N-23°18'E	4.1.1965	V						x								
460	4718	Kufra	24°12'N-23°18'E	4.1.1965	V						x								
Egypt																			
Leg. T. Monod (Paris)																			
	18177	Lac Nasser-Abusimbel	23°21'N-31°33'E	22.3.1981	M							x							
	18251	Nile (Kaïro)	30°14'N-31°10'E	12.4.1981	R							x							
Mauritania																			
Sahara-project (R.U.G.)																			
43	35-37A	Molomhar	20°35'N-13°09'W	25.5.1975	G,V							x							
	24-35B			30.1.1976															
50	44-46A	Hamdoun	20°20'N-13°08'W	28.1.1976	G,V												x		
	19B			19.4.1975															
57	91-92A	El Berbera	19°59'N-12°49'W	26.4.1975	G						x								
	94A																		
90	98A	Rosso	16°30'N-15°48'W	1.5.1975	Ma													x	
64	120-122A	Moul Echnouk	18°00'N-25°15'W	4.5.1975	Ma						x								
81	144A	Mechra	16°41'N-11°31'W	6.5.1975	Ma						x						x		
	86B-87B																		
82	148-150A	Khouda	16°39'N-11°27'W	7.5.1975	Ma						x								
86	157A	Le Behr	16°34'N-12°04'W	8.5.1975	M							x							
69	112A	Tartega (Matmata)	17°53'N-12°07'W	3.5.1975	G						x								
129	54B-55B	Foum-'n-Meh	20°59'N-11°42'W	4.2.1976	G						x								
61	60-61B	Tefla	19°43'N-12°51'W	25.4.1975	G												x		
136	43-104B	Gamra Ouarbi	17°39'N-12°14'W	17.2.1976	G						x	x					TM		
137	108B	Lemzailgué	17°39'N-12°14'W	17.2.1976	G												x		
140	120-121B	Boumdeit	17°26'N-11°21'W	20.2.1976	V							x							
Senegal																			
Sahara-project (R.U.G.)																			
103	167A	Guiers	16°20'N-15°58'W	11.5.1975	M						x	x							
110	179-180A	Nieri Ko	13°23'N-13°19'W	15.5.1975	R			x											
112	186A	Simenti	13°03'N-13°24'W	16.5.1975	Ma			x											
114	189-190A	Sita Ndi	13°04'N-13°16'W	16.5.1975	R,V							x							
115	194-195A	Niokolo Koba	13°05'N-12°41'W	16.5.1975	R,Ma							x							
117	4B	Ross Bethio	16°10'N-16°06'W	25.1.1976	V			x			x	x							
Mali																			
Sahara-project (R.U.G.)																			
148	129-131B	Kabara	15°49'N-04°34'W	28.2.1976	M						x	x						x	
149	132B	Niafunke	15°56'N-03°59'W	29.2.1976	M			x											
154	140-141B	Horo	16°12'N-03°50'W	29.2.1976	M			x				x							
155	142-143B	Fati	16°18'N-03°44'W	29.2.1976	M						x								
156	144B	Tèlé	16°25'N-03°47'W	29.2.1976	M			x			x							x	
157	147-149B	Faguibine	16°41'N-03°58'W	29.2.1976	M							x							
157	150B	Mbuna	16°41'N-03°58'W	29.2.1976	M			x			x	x							
157	151-153B	Tindiba	16°41'N-03°58'W	29.2.1976	M							x							
157	154B	Tin Geicha	16°41'N-03°58'W	29.2.1976	M			x			x	x							
157	155-156B	Tin Geicha (S.)	16°41'N-03°58'W	29.2.1976	M			x				x							

Table 1. continued.

Locality number	Sample or slide number	Locality	Co-ordinates	Date	Biotope	*aequatorialis aequatorialis aequatorialis similis* subsp.n. hybrid population	*aspericornis*	*major*	*ogunnus*	*paludosus*	*rarus*	*salinus*	*tenuiaccus*	*kieferi* sp.n.	*dussarti* sp.n.	*spinosus* sp.n.
158	157B	Tombouctou	16°46'N-03°00'W	2.3.1976	Ma	x									TM	
159	158B	Goundam	16°25'N-03°40'W	2.3.1976	M										x	
160	159B	Dyabali (45 km N.W.)	14°45'N-05°52'W	3.3.1976	M	x			x						x	
162	163-164B	Dyabali	14°39'N-06°20'W	4.3.1976	M	x			x							
163	165-166B	Markala	13°39'N-06°08'W	4.3.1976	M	x			x						x	
164	169B	Mopti	14°30'N-04°07'W	6.3.1976	M	x		x								
171	180-182B	Gouma (Sanga)	14°23'N-03°31'W	7.3.1976	V	x									x	
172	188B	Kô (Bamako)	12°35'N-08°04'W	8.3.1976	R										x	
168	183B	Sanga	14°23'N-03°21'W	7.3.1976	V	x		x								
174	196-197B	Gossi	15°49'N-01°19'W	17.3.1976	V	x		x				x				
175	198B	Gao	16°16'N-00°05'W	17.3.1976	V	x		x							x	
596	17-18K	Aougoundou	15°50'N-03°35'W	14.4.1980	M	x		x							x	
595	19K	Norou	15°29'N-03°20'W	14.4.1980	M										x	
597	21K	Korarou	15°25'N-03°25'W	14.4.1980	M			x								
Upper-Volta																
Leg. B. Roman (coll. Tervuren)																
	51595	Loumbila (Massili)	12°29'N-01°40'W	25.10.1964	R	x		x							x	
	51597	Ouagadougou (Massili)	12°20'N-01°40'W	25.10.1964	R			x	x						x	
Niger																
Sahara-project (R.U.G.)																
315	55E	Parc W	12°26'N-02°24'E	15.2.1977	V			x								
316	57-58E	Mekrou	12°16'N-02°31'E	15.2.1977	Ma		x	x	x						x	
321	66E	Niger at Say	13°01'N-02°22'E	20.2.1977	R			x								
323	68E	Diakindé	13°22'N-02°10'E	20.2.1977	P									x		
325	69E	Niamey (20 km S.)	13°29'N-02°07'E	20.2.1977	P									x		
Tchad																
Leg P. Compère & J. Iltis (coll. Meise)																
	3807	Tchad (Chari)	12°49'N-14°30'E	6.12.1964	M				x							
	K	Tchad	13°30'N-14°30'E	28.3.1967	M				x							
	U	Tchad	13°30'N-14°30'E	4.4.1967	M				x							
	O	Tchad	13°30'N-14°30'E	29.3.1967	M				x							
	F	Tchad	13°30'N-14°30'E	26.3.1967	M				x							
	3880	Tchad	13°30'N-14°30'E		M				x							
Tibesti: Mission belge au Tibesti (coll. Tervuren)																
	51005	Zoui	21°20'N-17°05'E	2.6.1961	G						x					
Sudan																
Leg. A. Gautier (R.U.G.)																
	-	Crocodile Isle (Chartoum)	16°00'N-32°50'E	16.4.1981	?				x							
	-	Géale (Blue Nile)	-	25.4.1981	?				x							
Leg. T. Monod (Paris)																
	18281	El Fasher	-	16.1.1981	?				x							
Leg. H. Dumont (R.U.G.)																
	7	Chor Amat	-	17.12.1981	V		x									
	18	Chor Arbaat	-	20.12.1981	V									x		
	56	Atbara	-	27.3.1982	R				x							
	59	Kaboushia	-	28.3.1982	V		x	x								
	-	Rosseires	-	4.1969	SM			x	x							
Leg. J. Green (London)																
	-	Keilak	10°50'N-29°17'E	1.1976	M		x									
South-Yemen																
Leg. T. Monod (Paris)																
	17303	Sheriy Yibath	-	19.1.1978	V									x		
Guinea																
Leg.C. Lèvêque (ORSTOM, Paris)																
	11	Kokoulo	11°00'N-13°40'W	29.4.1980	R	x										

Table 1. continued.

Locality number	Sample or slide number	Locality	Co-ordinates	Date	Biotope	*aequatorialis*	*aequatorialis*	*aequatorialis similis* subsp.n. hybrid population	*aspericornis*	*major*	*ogumnus*	*paludosus*	*rarus*	*salinus*	*tenuisaccus*	*kieferi* sp.n.	*dussarti* sp.n.	*spinosus* sp.n.
	12	Kissidougou	10°05'N-10°15'W	4.5.1980	R			x										
	21	Koleuté	10°05'N-13°25'W	30.4.1980	R			x										
	13	Sala-Labé	11°40'N-14°50'W	26.4.1980	R			x										
	19	S. Kankan	09°50'N-10°10'W	4.5.1980	?			x										
	14	Tomine	12°15'N-14°40'W	25.4.1980	V			x										
Guinea-Bissau																		
Leg. C. Lévêque (ORSTOM, Paris)																		
	8	Rio Geba	12°25'N-14°20W	24.4.1980	V			x						x				
Ivory Coast																		
Leg. L. Samsoen (R.U.G.)																		
	L.S. 177a	Tai	09°50'N-07°35'W	6.8.1979	V					x								
	L.S. 212	Man	07°35'N-07°40'W	1.8.1979	V													TM
	L.S. 132	Gaguoin	-	27.7.1979	V			x										
		Kossou	07°10'N-05°50'W	19.4.1980	M						x							
Ghana																		
Leg. Graham (coll. British Museum)																		
	12.11.14.23	Obuasi	05°50'N-02°20'W	1909	?				x									
Benin																		
Leg. De Kimpe (coll. Tervuren)																		
	52038	Porto Novo	02°20'N-02°40'E	27.6.1963	?					x	x							
	52045	Porto Novo	02°20'N-02°40'E	26.4.1963	?						x			x				
	52024	Porto Novo	02°20'N-02°40'E	31.2.1964	?						x							
	52033	Porto Novo	02°20'N-02°40'E	8.2.1964	?						x							
Nigeria																		
Leg. Onabamiro (coll. British Museum)																		
	2.15.2	Abeokuta (river Ogun)	07°30'N-03°30'E	3.3.1951	V						TM							
	2.15.2	Korudu (Lagos)	06°10'N-03°40'E	24.2.1951	V									TM				
Coll. Lindberg (Lund)																		
		Okolom (Lagos)	06°10'N-03°40'E		?				x									
Zaïre (Z) - Ruanda (R) - Burundi (B)																		
1. Lake Kivu and surroundings																		
Leg. P. van Oye (R.U.G.)																		
	97	Wamba Bangwe (Z)	02°03'N-28°00'E	21.11.1957	V			x										
	93	Wamba Bangwe (Z)	02°03'N-28°00'E	21.11.1957	V			x										
	101	Wamba (Z)	02°03'N-28°00'E	22.11.1957	V			x										
	83	Kivu Kawa (Z)	01°34'S-30°32'E	11.1957	M	x												
	52	Kivu Kisengi (R)	01°42'S-29°18'E	5.11.1957	M	x												
	53	Kivu Kisengi (R)	01°42'S-29°18'E	5.11.1957	M	x												
	82	Kivu Buleke (Z)	?	15.11.1957	M	x												
	64	Bukavu Nyakabera (Z)	02°30'S-28°50'E	11.11.1957	V					x								
Leg. Damas (coll. Tervuren)																		
	52158	Lukoma Saké (Z)	01°34'S-29°03'E	21.3.1952	M			x										
	52157	Lukoma (Z)	01°34'S-29°03'E	20.3.1952	?			x										
Leg. Marlier (coll. Tervuren)																		
	47599	Lungwe (Z)	03°03'S-28°49'E	28.2.1953	M				x			x						
	47629																	
	47579	Lungwe (Z)	03°03'S-28°49'E	27.2.1953	M				x			x						
	47598																	
Leg. Damas (coll. Kiefer-Konstanz)																		
		Lake Kivu	-	12.4.1935	M	x												
	457	Lake Edward (Vitshumbi-bay)	00°43'S-29°22'E	17.1.1936	M									x				
Leg. R. Kiss (coll. Tervuren)																		
	52404	Kivu Tusoké	?	5.2.1959	?					x								
	52405	Kivu Karimurira	?	26.7.1960	V								x	x				

Table 1. continued.

Locality number	Sample or slide number	Locality	Co-ordinates	Date	Biotope	*aequatorialis*	*aequatorialis*	*aequatorialis similis* subsp.n.	hybrid population	*aspericornis*	*major*	*ogunnus*	*paludosus*	*rarus*	*salinus*	*tenuisaccus*	*kieferi* sp.n.	*dussarti* sp.n.	*spinosus* sp.n.
	52416	Kivu Luvungi (Z)	02°52'S-29°02'E	6.10.1959	?					x	x				x				
	52410	Kivu Mussisi (Z)	01°05'S-29°00'E	3.2.1959	V								x						
	52415	Kivu Uvira (Z)	?	7.7.1960													x		
	52408	Kivu Kalungwe (Z)	03°15'S-28°40'E	-	?					x									
	52387	Kivu Mulengwe (Z)	03°07'S-29°00'E	21.10.1960													x		
	50579	Lac Saké (Z)	01°34'S-29°03'E	7.6.1958	M		x												
	50580	Lac Saké (Z)	01°34'S-29°03'E	7.6.1958			x												
	50577	Ngwowashasha Astrida (R)	02°37'S-29°47'E	20.5.1958	?		x							x					
	50589	Kanyumgi	?	22.10.1959	?	x													
	52425	Lac Mugesera (R)	02°06'S-30°20'E	24.3.1958	M				x										
	50555	Lac Mugesera (R)	02°06'S-30°20'E	6.6.1958										x	x				
	-	Lac Mugesera (R)	02°06'S-30°20'E	6.6.1958									x		x				
	50557	Lac Mugesera (R)	02°06'S-30°20'E	9.6.1958									x						
	50586	Lac Mugesera (R)	02°06'S-30°20'E	7.6.1958									x	x	x				
	50570	Lac Tsohoho (R)	02°15'S-30°08'E	14.6.1958	M										x				
	-	Lac Tsohoho (R)	02°15'S-30°08'E	16.6.1958											x				
	50572	Lac Tsohoho (R)	02°15'S-30°08'E	12.6.1958			x												
	50584	Lac Milay (R)	02°13'S-30°15'E	10.6.1958	M										x				
	50561	Lac Milay (R)	02°13'S-30°15'E	10.6.1958											x				
	50553	Lac Rugwero (R-B)	02°24'S-30°19'E	13.6.1958	M		x								x				
	50554	Lag Rugwero (R-B)	02°24'S-30°19'E	13.6.1958									x						
	50585	Lac Rugwero (R-B)	02°24'S-30°19'E	13.6.1958			x						x		x				
	50564	Goshoba (Milay) (R)	02°13'S-30°15'E	10.6.1958	?									x	x				
	-	Goshoba (Milay) (R)	02°13'S-30°15'E	10.6.1958											x				
	50566	Goshoba (Milay) (R)	02°13'S-30°15'E	10.6.1958										x	x				
	50558	Lac Birira (R)	02°10'S-30°19'E	8.6.1958	M		x												
		Lac Birira (R)	02°10'S-30°19'E	9.6.1958			x							x	x				
	50560	Lac Birira (R)	02°10'S-30°19'E	8.6.1958											x				
	50587	Lac Birira (R)	02°10'S-30°19'E	8.6.1958			x												
2. Ruzizi																			
	Leg. R. Kiss (coll. Tervuren)																		
	52428	Ruzizi	3°/3°30'S-29°E	22.7.1958	V						x				x				
	Leg. H. Dumont (R.U.G.)																		
	11	Ruzizi (B)	3°/3°30'S-29°E	12.1979	R						x								
	14	Ruzizi (B)	3°/3°30'S-29°E	12.1979	V									x	x				
3. Tanganyika																			
	Leg. L. Symoens (coll. Tervuren)																		
	50570	Uvira (Z)	03°20'S-29°10'E		M	x													
	50611	25 samples taken on	03°20'S-29°10'E	8.1955		x													
	-	various depths:	03°20'S-29°10'E	till															
	50653	*0-130 m*	03°20'S-29°10'E	11.1955		x													
	Leg. D. Vervoort (coll. Tervuren)																		
	-	40 km S. Bujumbura (B)	03°25'S-29°30'E	10.1980	V									x					
	Leg. R. Kiss (coll. Tervuren)																		
	52398	Tanganyika	-	7.2.1960	M	x													
4. Shaba (Z)																			
	Leg. P. van Oye (R.U.G.)																		
	5	Jadotville (Likasi)	11°31'S-27°10'E	8.10.1957	R			x											
	Leg. K. Martens (R.U.G.)																		
	13	Katebe (Kolwezi)	-	11.10.1981	V			x											
	33	Potopot (Kolwezi)	-	23.10.1981	SM													x	
5. W. Zaïre																			
	Leg. P. van Oye (R.U.G.)																		
	1	Matadi	06°00'S-13°00'E	1.1947	?						x								
	2	Saké Banza	-	16.3.1947	V										x				
Mozambique																			
	Leg. J. den Hengst (The Netherlands)																		
		Dondo	19°35'S-35°00'E	1979	?							x			x				

Table 1. continued.

Locality number	Sample or slide number	Locality	Co-ordinates	Date	Biotope	*aequatorialis*	*aequatorialis*	*aequatorialis similis* subsp.n. hybrid population	*aspericornis*	*major*	*ogunnus*	*paludosus*	*rarus*	*salinus*	*tenuisaccus*	*kieferi* sp.n.	*dussarti* sp.n.	*spinosus* sp.n.
		Meconta	15°00'S-39°50'E	1979	R.V.									x				
		Xai Xai (Chai Chai)	25°58'S-32°40'E	1979	?						x			x				
		Mossuril	14°59'S-40°45'E	1979	?									x				
South Africa																		
	Coll. South Africa Museum & Zoologisk Museum Oslo																	
	A12463 F6673-F6676	Cape Peninsula: Bergvliet	-	5.1896	V					TM								
	A12460	Salt River	-		R										TM			
	A12464	Cape Flats	-		?					x								
	Leg. H. Dumont (R.U.G.)																	
		Pongolo River (Yosini)	27°05'S-32°19'E	19.7.1980	R					x								
		Pongolo: Tete Pan	27°10'S-32°19'E	19.7.1980	V					x								
		Pongolo: Bumbe Pan	27°04'S-32°19'E	18.7.1980	V					x	x							
		Knysna	34°05'S-23°00'E	7.1980	V					x								
		Bumbe Pan	27°03'S-32°19'E	18.7.1980	V					x								
		Mhlolo	27°04'S-32°19'E	18.7.1980	V						x							
		Bloemfontein	29°05'S-27°10'E	7.1980	V					x								
	Leg. M. Seaman (Pretoria)																	
		Rietvlei	25°43'S-27°51'E		V					x								
Uganda																		
	Coll. Lindberg (Lund)																	
	Ou 4 (93)	Nmanve (Kampala)	00°15'N-32°40'E	3.7.1953	V							x						
	Leg. E. Worthington (coll. British Museum)																	
	571	Lake Edward	2°45'S-30°25'E	1931	M			x										
	Leg. R. Ross (coll. British Museum)																	
		Lake Victoria	2°20'S-33°09'E	21.1.1953	M			x										
Kenya																		
	Leg. K. Mavuti (Nairobi)																	
		Lake Naivasha	0°40'S-32°00'E	4.10.1979	M		TM											
	Leg. R. Ross (coll. British Museum)																	
		Lake Rudolf (Ferguson Gulf)	3°40'N-36°15'E	8.1.1953	M						x							
	Leg. E. Worthington (coll. British Museum)																	
	117	Lake Baringo	0°46'N-36°15'E	1931	M					x								
Ethiopia																		
	Coll. B. Dussart (Les Eyzies)																	
	15032	Affl. Awash	-	-	R				x									
	Leg. H. Dumont & H. Verheye (R.U.G.)																	
	47	Lake Koka	08°23'N-38°46'E	19.5.1982	M		x											
	37	Lake Awassa	07°02'N-38°20'E	18.5.1982	M		x								x			
	38	Black River	07°03'N-38°21'E	18.5.1982	R		x							x				
	48	Addis Abeba (100 km S.)	08°23'N-39°02'E	19.5.1982	V											x		
	34	Lake Hora	08°45'N-39°00'E	16.5.1982	M		x											
	52	Bishoftu	08°44'N-38°58'E	19.5.1982	M		x											
	56	River Fanta at Akaki	08°58'N-38°50'E	19.5.1982	R		x											
	64	Debre Marcos (40 km S.)	10°11'N-38°10'E	23.5.1982	R		x											
	50	Awash	08°30'N-39°03'E	19.5.1982	R					x								
	Leg. K. Wedayo (Addis Abeba)																	
		Lake Langano	07°35'N-38°44'E	17.9.1981	M		x											
		Lake Abaya	06°34'N-37°57'E	3.1981	M						x							
	Z 12A	Lake Tana	11°10'N-37°36'E	10.1981	M		x											
		Lake Zway	08°01'N-38°47'E	2.1981	M		x											
		Lake Abyata	07°33'N-38°38'E	10.11.1981	M		x											
Israel																		
	Leg. F. Por (Jerusalem)																	
		Lake Kinneret	32°42'N-35°31'E	30.5.1977	M						x							

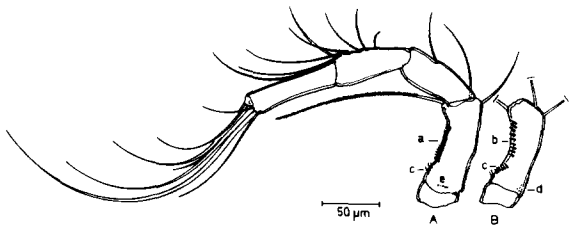

Fig. 3. Spine pattern on basipodite of A_2, common to all *Mesocyclops* species; A. A_2, frontal side; B. Basipodite, caudal side. Terminology: a. longitudinal row of spines on frontal side; b. longitudinal row of spines on caudal side; c. proximal row of spines, continues with an interruption along the external margin; d. spinules on basal part of the internal margin which continue as a group on the caudal side and as a row on the frontal side; e. transversal row of spinules on frontal side.

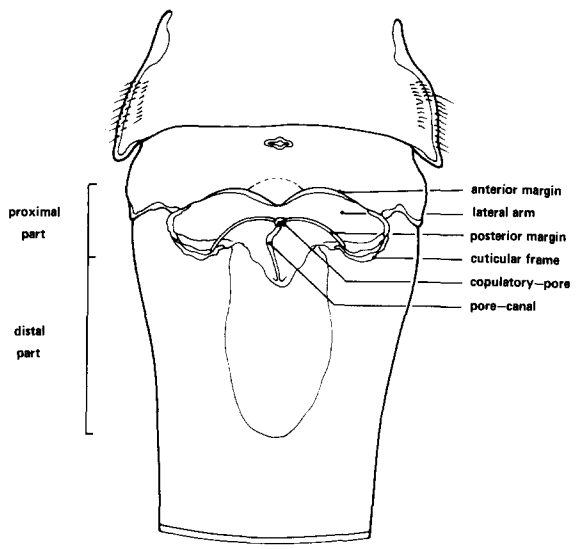

Fig. 4. Terminology used for description of receptaculum seminis.

Key to M. leuckarti *(Claus) and to the African species of* Mesocyclops*

1. - Frontal side of the basipodite of the antennae with a group of spines proximal to the implantation of the exopodite seta (Fig. 33C:✗) 10
   - Frontal side of the basipodite of the antennae without such a group of spines proximal to the implantation of the exopodite seta; inner distal margin of basipodite P_1 without a spine 2

* *M. annae* Kiefer and *M. pilosus* (Kiefer) are not included in the key since the spine pattern on the basipodite of the A_2 is unknown.

2. - Last thoracic segment laterally without setules (Figs. 8D-E & Figs. 10B-C); connecting lammela P_4 without setules on the caudal side; spine pattern on the basipodite of the antennae as in Figs. 5D-E or in Figs. 9D-E ..... 3.
   - Last thoracic segment laterally with setules 4
3. - Last abdominal segment only with a few rows of minute spinules (Fig. 8A); inner caudal side of the basipodite P_4 with a group of setules distally, naked proximally (Fig. 7e:✗); receptaculum seminis as in Fig. 8E .... *M. leuckarti* (Claus)
   - Abdominal segments provided with numerous rows of spinules as in Figs. 10E-F; inner caudal side of the basipodite P_4 with a row of spinules distally and a row of setules proximally (Fig. 9H:✗); receptaculum seminis as in Fig. 10C ..... *M. kieferi* sp.n.
4. - Inner margin of the furcal rami devoid of setules 5
   - Inner margin of the furcal rami with setules .9
5. - Ventral distal margin of last thoracic segment, between the implantations of right and left P_5 with a row of spines (Fig. 14B:✗); connecting lamella P_4 with setules on the caudal side; spine pattern on the basipodite of the antennae as in Figs. 11C-D or Fig. 15 6
   - Ventral distal margin of the last thoracic segment without such a row of spines; connecting lamella P_4 without setules on the caudal side 7
6. - Dorsal surface of genital segment completely covered with short setules (Fig. 14D); spine pattern on the basipodite of the antennae as in Figs. 11C-D ..... *M. major* Sars
   - Dorsal surface of genital segment devoid of setules; spine pattern on the basipodite of the antennae as in Fig. 15 .... *M. insulensis* Dussart
7. - Dorsal surface of genital segment completely covered with short setules (Fig. 17B); spine pattern on the basipodite of the antennae as in Figs. 16A-B..... *M. dussarti* sp.n.
   - Dorsal surface of genital segment without setules 8
8. - Basis of maxillulary palp provided with a row of spines (Fig. 19C:✗); spine pattern on the basipodite of the antennae as in Figs. 19A-B;

receptaculum seminis as in Fig. 20D..... ..... *M. ogunnus* Onabamiro

- Basis of maxillulary palp without any row of spines (Fig. 23C); receptaculum seminis as in Fig. 24D or Fig. 26B .... *M. aequatorialis* (Kiefer)*

9. - Inner margin of the furcal rami armed with setules along the entire margin (Figs. 29F-G); spine pattern on the basipodite of the antennae as in Figs. 28D-E; receptaculum seminis as in Fig. 29C..... *M. aspericornis* (Daday)
- Inner margin of the furcal rami armed with setules only in its proximal part (Figs. 31F-G); rows of spines present posterior to P_6 (Fig. 31B;↗); spine pattern on the basipodite of the antennae as in Figs. 30C-D; receptaculum seminis as in Fig. 31D.. *M. spinosus* sp.n.

10. - Inner distal margin of basipodite P_1 with a spine (Fig. 35A:↗) 11
- Inner distal margin of basipodite P_1 without a spine (Fig. 32I); connecting lamella P_4 with setules on the caudal side; spine pattern on the basipodite of the antennae as in Figs. 32A-D or Figs. 33B-C; receptaculum seminis as in Fig. 33E ..... *M. salinus* Onabamiro

11. - Connecting lamella P_4 with setules; inner margin of the furcal rami setose along their entire margins (Figs. 36F-G); spine pattern on the basipodite of the antennae as in Figs. 34A-B; receptaculum seminis as in Fig. 36C..... ..... *M. tenuisaccus* (Sars)
- Connecting lamella P_4 without setules; inner margin of the furcal rami smooth..... 12

12. - Ventral side of the furcal rami with a patch of spines distally (Fig. 38G); spine pattern on the basipodite of the antennae as in Figs. 37A-B; receptaculum seminis as in Fig. 38C..... ..... *M. paludosus* Lindberg
- Ventral side of the furcal rami without a patch of spines distally (Fig. 40G); spine pattern on the basipodite of the antennae as in Figs. 39A-B; receptaculum seminis as in Fig. 40B..... ..... *M. rarus* Kiefer

* Key to subspecies of *M. aequatorialis;* see p. 41.

Species descriptions

Mesocyclops leuckarti (Claus, 1857)

1857 *Cyclops leuckarti* Claus, Arch. Naturgesch., Vol. 23, p. 35, Pl. 1: fig. 4; Pl. 2, figs 13–14.
1874 *Cyclops simplex* Poggenpol, Nachr. Ges. Moskou, Vol. 10, part 2, p. 70, Pl. 15: figs 1–3.
1878 *Cyclops leeuwenhoeki* Hoek, Tijdschr. ned. dierk. Ver., Vol. 3, p. 19, Pl. 3: figs 1–12.
1892 *Cyclops scourfieldi* Brady [partim], Trans. nat. Hist. Soc. Northumb., Vol. 11, part 1, p. 75, Pl. 4, [non Pl. 6: figs 6–8].
1914 *Mesocyclops obsoletus*, Sars, [non Koch], Crust. Norway, Vol. 6, p. 58, Pl. 35.
1929 *Mesocyclops leuckarti*, Kiefer, [partim], Z. wiss. Zool., Vol. 133, p. 4, Figs 1–6.
1981 *Mesocyclops leuckarti*, Kiefer, Arch. Hydrobiol., Suppl. 62, p. 159, Fig. 3.

Type locality: 'Umgegend Giessen', Germany; without further specifications.

Type material: lost.

Material examined

Belgium: Gent, fish-pond, collected May 1979; Ostend, sluice-dock, salinity: 27‰–28‰, 14-7-1978; Lokeren: 'Molsbroek', pond, April 1979; Teralfene, pond, 26-6-1974; Diksmuide: Stuivekenskerke, old clay pit, 22-8-1978 and April 1980 (also live material used for breeding experiments).

Germany: Giessen: Lich, pond and adjacent ditch, (?) type locality, collection made in February 1980 and 17-8-1980 (also live material used for breeding experiments); Karlsruhe, swamp, three females mounted on slides, coll. Kiefer, 1935.

Unless stated otherwise, females and males were present.

Redescription of female (Lich)

As the type material of *M. leuckarti* is not longer extant (Kiefer, pers. commun.), an attempt was made to collect topotypical specimens from the vicinity of Giessen.

On the basis of information given by local inhabitants we could localize the type locality with a reasonable certainty. It is a pond with adjacent ditches at Lich (near Giessen), and has existed there more than a century.

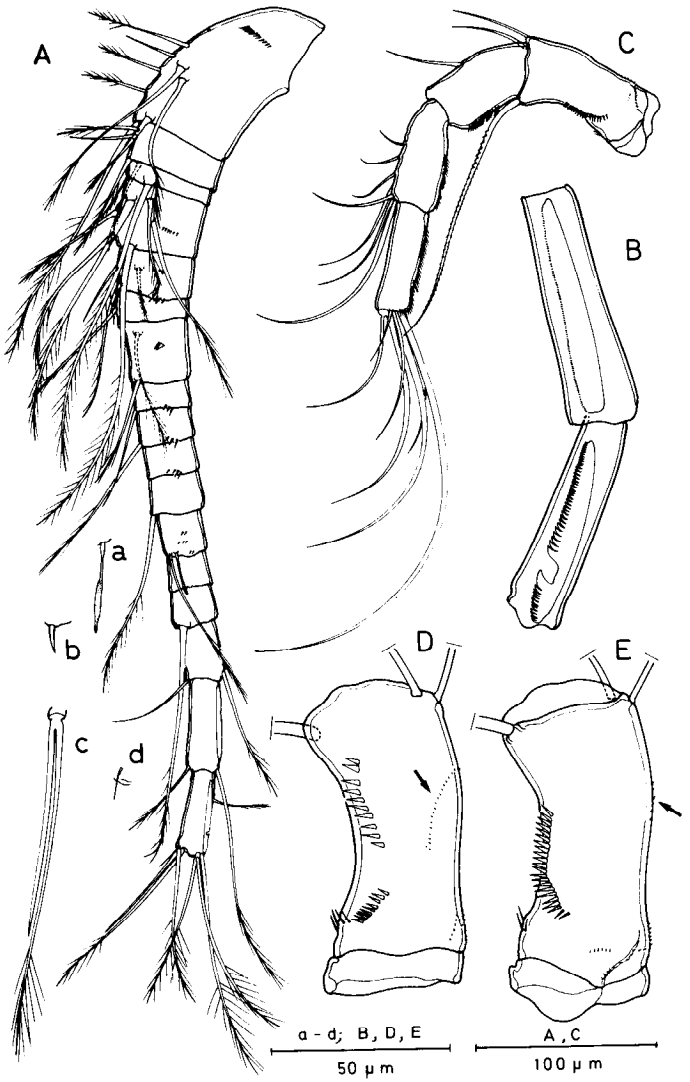

Fig. 5. Mesocyclops leuckarti (Claus) Giessen, Germany. A. A_1; a. aesthete, b. robust spine on segment 6, c. apical setae on segment 17, d. setule on segment 16; B. Antennular segments 16 & 17; C. A_2, frontal side; D. Basipodite A_2, caudal side; E. Basipodite A_2, frontal side.

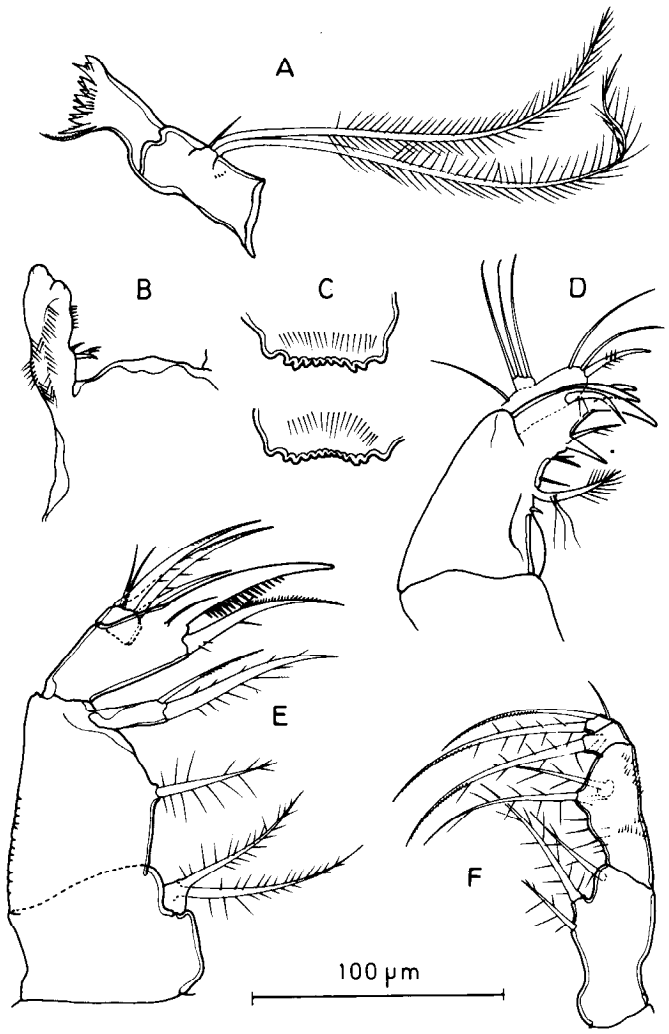

Fig. 6. Mesocyclops leuckarti (Claus) Giessen, Germany. A. Mandible; B. Labium; C. Labrum; D. Maxillule; E. Maxilla; F. Maxilliped; A-C: ventral side; D-F: caudal side.

Mean total body length: 1 001 μm (n = 10).

Antennule (Fig. 5A). Composed of seventeen segments and usually reaching the distal margin of the third thoracic segment. Armature as in Fig. 5A; most frequent are feathered and non-feathered setae of various lengths and widths. An aesthete on the distal margin of the twelfth segment (Fig. 5A: a). The sixth segment distally with a robust spine of typical structure: *viz.* the basal part is strongly chitinized as compared with the apical part (Fig. 5A: b). On the outer distal margin of the sixteenth segment a fine setule, implanted on a kind of socle (Fig. 5A: d). On the apex of the ultimate segment, four ordinary feathered setae, one short seta, and two setae implanted on a common base (Fig. 5A: c). One of the setae is feathered, the other is naked and ends very abruptly. Spinule patterns are present on segments 1, 4–5, 7–10 and 12–13. The last two segments with a hyaline lamella; that of the seventeenth segment is provided with one deep notch (Fig. 5B).

Antenna (Figs. 5C-E). Endopodite: 3-segmented. First segment on the external side with a row of fine spinules, internal side with one medially placed seta. Segment 2 with seven setae implanted on the internal side as follows: three setae on the margin of the segment, and an apical group of two subdistal and two distal setae. Segment 3 with a row of fine spinules on the external side and with an apical group of seven setae.

Basipodite: distal margin with on the inner caudal side two apical setae and on the external frontal side one long seta (vestigial exopodite). Spine pattern on the basipodite (Figs. 5D-E): in addition to the basic pattern, an oblique row of minute spinules is present on the caudal side (Fig. 5D: ↗), continued by a few spinules on the internal margin of the segment (Fig. 5E: ↗). The longitudinal row of the caudal side is composed of ten spines, the row proximal to this row of ten spines and the longitudinal row on the frontal side of 22 spines.

Labrum (Fig. 6C) Posterior margin with 8–11 rounded, strong teeth. Laterally to this row, one broadly rounded tooth. On the ventral side, a row of long fine setules.

Labium (Fig. 6B). Irregular in shape, consisting of two lobes connected by a post-oral plate. Ventral external side of the lobes with two rows of setules and inner side with a row of about seven short spines. Towards the base of the lobe, four larger spines.

Mandible (Fig. 6A). Pars molaris composed of a series of sharp teeth and one long spinous tooth that bears on its concave side a row of minute spinules. Medio-ventral side with a row of fine setules. Mandibular palp one-segmented, with two long feathered setae and one short naked seta.

Maxillule (Fig. 6D). Arthrite provided terminally with three clawlike spines; at their base a seta-shaped spine is implanted (caudal side of the arthrite). This spine provided in its basal portion with two setules. On the concave margin of the arthrite, five spines of various length and one strongly curved spinous seta. On the boundary between the precoxa and the arthrite, a small spine.

Maxillulary palp. Basis furnished apically with one spine and two setae; endopodite with three setae of equal length; exopodite reduced to one seta. Basis of palp lacks a row of frontal spines.

Maxilla (Fig. 6E). Precoxa partly fused with the coxa (caudal side). Inner side of precoxa with two feathered setae, implanted on a kind of lobe. Coxa with one medial seta; outgrowth of coxa with one fine and one robust spinous seta. Basis of the maxilla distally prolonged into a stout clawlike spine, that bears on its concave margin a row of spinules. At the base of the clawlike spine, a spinous seta is implanted that forms a kind of chela-structure with the spine. On the base of the clawlike spine a fine seta is implanted caudally.

Endopodite: one-segmented, provided apically with two spinous setae and three setae.

Maxilliped (Fig. 6F). Internal side of basal segment (composed of the fused precoxa and coxa)

Table 2. Spine- and seta-formula of *Mesocyclops*.

	Endopodite						
	1		2		3		
	int.	ext.	int.	ext.	int.	apic.	ext.
P_1	1s	–	2s	–	3s	1s, 1sp	1s
P_2	1s	–	2s	–	3s	1s, 1sp	1s
P_3	1s	–	2s	–	3s	1s, 1sp	1s
P_4	1s	–	2s	–	2s	2sp	1s
	Exopodite						
	1		2		3		
	int.	ext.	int.	ext.	int.	apic.	ext.
P_1	1s	1sp	1s	1sp	2s	2s, 1sp	1sp
P_2	1s	1sp	1s	1sp	3s	1s, 2sp	1sp
P_3	1s	1sp	1s	1sp	3s	1s, 2sp	1sp
P_4	1s	1sp	1s	1sp	3s	1s, 2sp	1sp

s = seta; sp = spine

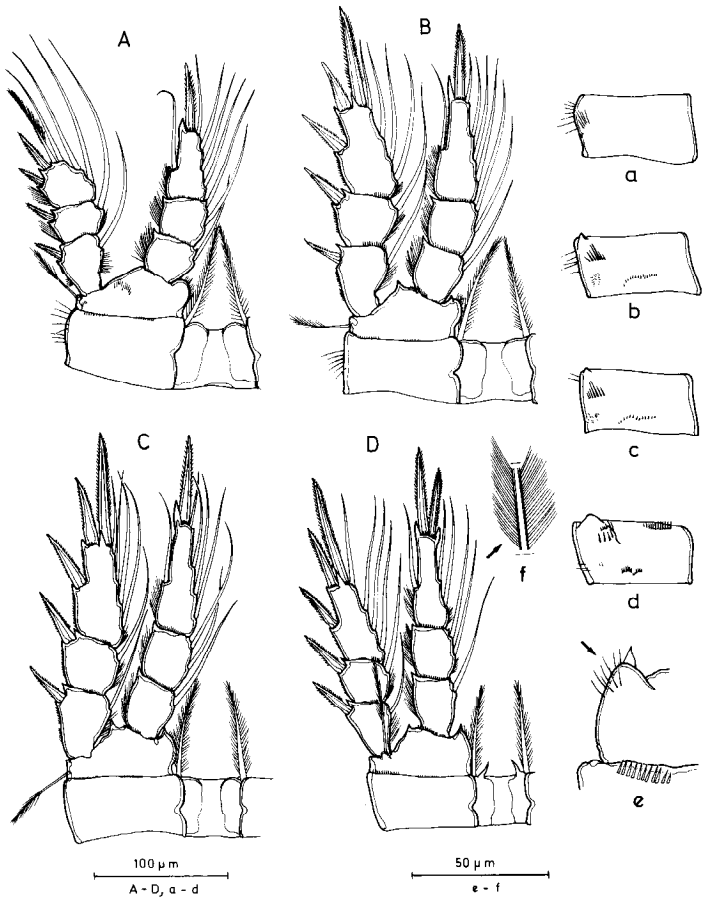

Fig. 7. Mesocyclops leuckarti (Claus) Giessen, Germany. A-D. Structure of P_1-P_4, frontal side; a-d: coxopodite P_1-P_4, caudal side; e: inner portion of basipodite of P_4, caudal side; f: ornamentation setae of endo- and exopodites.

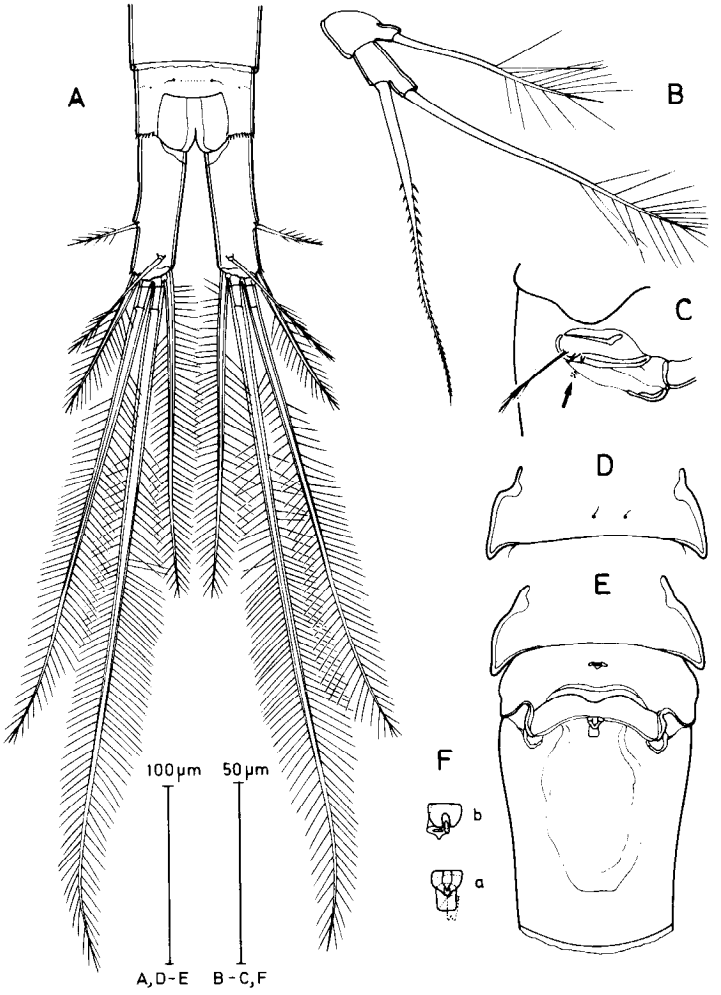

Fig. 8. Mesocyclops leuckarti (Claus) Giessen, Germany. A. Last abdominal segment and furca, dorsal view; B. P_5; C. P_6; D. Last thoracic segment, dorsum; E. Last thoracic segment and genital segment with receptaculum seminis; F. Detail area of copulatory-pore, a: specimen of Fig. E, b: other specimen.

provided with three spinous feathered setae. Basis of maxilliped with two spinous setae implanted respectively on the internal side and on the frontal side. Endopodite two-segmented; proximal with one inner spinous seta and distal with two spinous setae and one short unfeathered seta. Basis and proximal segment of the endopodite with spinules.

Thoracopods P_1-P_4 (Fig. 7). Spine- and seta-formula as in Table 2. The armature of the various segments as illustrated in Fig. 7.

P_1. Inner distal margin of the basipodite not provided with a spine.

P_4. Enp_3 3.4 times as long as wide. Inner apical spine shorter than the outer one. Armature of both spines as illustrated in Fig. 7D. Caudal side of the connecting lamella naked; prominences on the distal margin well developed. Caudal side of the coxopodite on the lateral internal side naked (Fig. 7d: ↗). Inner part of the caudal side of the basipodite with only one group of distal setules (Fig. 7e: ↗).

P_5 (Fig. 8B) and P_6 (Fig. 8C). Of the usual structure. Distal to the implantation of P_6 a group of six pores occurs (Fig. 8C: ↗). This pore group is present in all *Mesocyclops* species and also occurs in other cyclopid genera.

Last thoracic segment (Figs. 8D-E). Totally devoid of setules.

Receptaculum seminis (Figs. 8E-F). Area of the copulatory-pore strongly cuticularised and with a typical structure (Fig. 8F:a-b). Copulatory-pore with a tongue-shaped projection distally. Course of the pore-canal sinuous, inwardly-directed, and difficult to follow. Lateral arms broad, slightly curved backwards. Anterior margin of the proximal part with a slight medial depression.

Abdominal segments. Only the last segment is set with a few transversal rows of minute spinules: three median rows on the ventral and one median row on the dorsal side, located between the two body-pores on the anal operculum (Fig. 8A). Distal margin of this segment fringed dorsally and ventrally with a row of spines.

Furca (Fig. 8A). Furcal rami 3.4 times as long as wide. No spinule patterns visible on the furcal rami with the light microscope; inner margin without setules. Length of the furcal setae: $S_i = 200\ \mu m$; $S_{mi} = 361\ \mu m$; $S_{me} = 313\ \mu m$; $S_e = 83\ \mu m$; $S_d = 67\ \mu m$. Lateral and external setae provided with spines at their implantation.

Redescription of male (specimens Giessen)

Mean total body length: 892 μm (n = 10)

Antennule with respectively three, one and one aesthete on the 1st, 4th and the 9th segment. Only the first segment with a row of minute spinules. Spine pattern on the basipodite of the antennae, structure of P_1-P_4 and armature of the last thoracic segment as in the female. P_6 composed of one spine (22 μm) and two setae (respectively 29 μm and 48 μm). No group of pores distal to the implantation of P_6.

Variability: females

Measurements were taken on 30 females from a population in Teralfene (Belgium); some of these are listed in the following table:

	$\bar{x}$	s_x
Total body length	1,153 μm	26 μm
Cephalothorax W	370 μm	13 μm
Genital segment L:W	1.36	0.05
Furcal rami L:W	3.08	0.08
Enp_3P_4 L:W	2.73	0.15

However, when populations from geographically scattered localities are considered, greater variations in measurements are found (see also *M. ogunnus*).

Total body length varies from 998 μm up to 1 183 μm (n = 45). Length:width ratio of furcal rami is between 3.0 and 3.4. In all specimens the dorsal furcal seta did not exceed the external one in length.

Spine pattern on basipodite of antenna is constant; only the number of spines per row varies between narrow limits. Longitudinal row on the caudal side 10–13 spines; longitudinal row on the frontal side 18–22 spines.

The length of the inner apical spine on Enp_3P_4 varies in length but remains shorter than the outer apical spine. Both spines can be equal in length (Kiefer, 1929) in specimens from Scotland and Sweden.

In the area of the copulatory-pore, the pore-canal can be located on the right, on the left or behind the copulatory-pore (see Fig. 8F: a-b) but, the structure of the receptaculum seminis, characteristic of *M. leuckarti*, is maintained.

Distribution

We can say with certainty that all literature records of *Mesocyclops* from Europe are *M. leuckarti* (except species found in greenhouses and botanical gardens, *M. ruttneri* Kiefer, 1981). According to Kiefer (1981) its range reaches as far as the western part of Northern Asia. All other records of *M. leuckarti* are incorrect.

Mesocyclops kieferi sp.n.

Type locality: Gamra Ouarbi, Tagant, Mauritania (17°39'N-12°14'W), guelta (permanent rockpool), leg. H. Dumont and I. Miron, 17-12-1976.

Type material

holotype: one dissected female (non-ovigerous) mounted on two slides in glycerine; the first slide contains A_1-P_4, the second P_5-abdomen;

allotype: one dissected male mounted on one slide in glycerine;

paratype material:

- ten females (without eggs), dissected and mounted as described above;
- one tube with undissected specimens preserved in a formaldehyde/glycerine mixture: 50 females, ten males and five copepodids (stage V).

Repository of type material: holotype, allotype and five undissected specimens (females) are deposited in the Koninklijk Museum voor Midden Afrika, Tervuren, Belgium. Five undissected females are in the collection of Prof. Dr. F. Kiefer, Konstanz, Germany. The remaining paratype material is in the collection of the Zoological Institute, University of Gent, Belgium.

Etymology: the species is named after Prof. Dr. F. Kiefer.

Material examined (specifications see Table 1): Mauritania: Gamra Ouarbi (type material as described above), Hamdoun, El Mechra, Dâyet et Te-

Table 3. Morphometry of *Mesocyclops kieferi* sp.n. (Gamra Ouarbi, Mauritania). Measurements in μm.

		Holotype	Allotype	Paratypes (♀)			
Cephalothorax	L	431	311	452	444	470	460
	W	392	231	409	392	409	425
	L:W	1.10	1.35	1.11	1.13	1.15	1.08
Ceph. + Thorax	L	740	505	792	740	813	815
Genital segment	L	165	87	165	157	169	173
	W	131	96	131	126	131	134
	L:W	1.26	0.90	1.26	1.25	1.29	1.29
Abdomen	L	335	218	339	305	335	356
Furca	L	100	66	104	100	109	104
	W	33	22	39	35	37	36
	L:W	3.0	3.0	2.67	2.86	2.95	2.89
Total body length		1 175	789	1 235	1 145	1 257	1 275
Enp_3P_4	L	77	52	75	75	74	75
	W	28	20	29	29	27	27
	L:W	2.75	2.60	2.59	2.59	2.74	2.78
Enp_3P_4	sp_i	66	51	61[a] 66[b]	63	67	69
	sp_e	64	39	58 63	58	67	54
	sp_i:sp_e	1.03	1.31	1.15 1.05	1.09	1.0	1.28
Furcal setae	S_i	220	157	218	226	218	244
	S_{mi}	480	374	470	487	470	487
	S_{me}	348	252	365	357	331	357
	S_e	86	62	87	78	83	92
	S_d	76	61	–	70	75	71
P_6 spine			25				
seta (i)			20				
seta (e)			45				

[a] right Enp_3P_4

[b] left Enp_3P_4

fla, Lemzailgue; Niger: Diakindé, Niamey; Zaïre: Mulengwe, Uvira; South-Yemen: Sheruy; Sudan: Chor Arbaat (Red Sea hills); Ethiopia: pond near Lake Koka (Rift valley).

Description of female (holotype)

Measurements (in μm) of part of the type material is presented in Table 3.

Antennule. Reaching to the middle of the third thoracic segment. Spinules arranged in groups or rows, on segments 1, 4–5 and 7–13 (Fig. 9A). Hyaline membrane of segment 17 with one deep notch (Fig. 9B).

Antenna. Endopodite as in *M. leuckarti.* Basipodite (Fig. 9D-E): spine pattern very similar to that of *M. leuckarti* except that the longitudinal row of spines on the frontal side extends further towards the exopodite seta. Longitudinal row of spines on the caudal side composed of nine spines; the row proximal to this row with five spines. Longitudinal row on the frontal side with 23 spines.

Maxillule. Basis of the maxillulary palp not provided with spines (Fig. 9C).

Thoracopods P_1-P_4. Spine- and seta-formula typical for the genus. Connecting plates without setules on their caudal side.

P_1. Inner distal margin of the basipodite on the frontal side not armed with a spine (Fig. 9G). Internal margin of the apical external seta of Exp_3 with setules, external margin with spinules (Fig. 9F).

P_4. Enp_3 2.75 times as long as wide. Apical spines subequal, inner spine 1.03 times as long as outer. Outer spine on both margins equally serrated. Internal margin of the inner spine completely set with spinules, external margin in the median part with four spinules (Fig. 9I). Connecting lamella on the caudal side without setules; prominences on the distal margin well developed, their length about equal to their width (Fig. 9H). Caudal side of the coxopodite on its lateral internal part without setules. Caudal side of the basipodite on its distal internal part with a row of minute spines, on its proximal internal part with a row of setules (Fig. 9H).

P_5 (Fig. 10A). Spinous seta 1.03 times as long as seta implanted on the same segment. Setae of P_5 not reaching to the posterior margin of the genital segment.

P_6 (Fig. 10D). Consists of two spines of about equal length (6 μm) and one seta (53 μm).

Last thoracic segment (Figs. 10A-C). Totally devoid of setules.

Receptaculum seminis. Structure as in Fig. 10C. Lateral arms broad. Lateral connection between the anterior and posterior margin of the proximal part perpendicular to the transversal axis of the genital segment. Posterior margin of the proximal part departs, slightly V-shaped, from the copulatory-pore. Pore-canal curved to the right with regard to the copulatory-pore.

Abdominal segments. Posterior part of the genital segment ventrally with two rows and dorsally with one row of minute spines. Other abdominal segments abundantly provided with distinct patterns of spinules (Figs. 10E-F). Posterior margin of last abdominal segment fringed with spines, dorsally as well as ventrally.

Furca. Furcal index 3.0. Rami not pilose on their inner margins; their dorsal and ventral sides covered with spinules (Figs. 10E-F). Dorsal furcal seta (76 μm) shorter than the external seta (86 μm); length of the remaining furcal setae as in Table 3. Lateral and external setae with spines at their implantation.

Description of male (allotype)

Length 789 μm. Antennule with 3, 1, 1 aesthetes on segments 1, 4 and 9 respectively. Only the first antennular segment bears a row of spinules. Spine pattern on the basipodite of the antenna similar to that of the female. Structure of P_1-P_4 as in the female, except for the armature of the basipodite of P_4. Distal internal part of the caudal side provided with a group of setules instead of a row of spinules. Last thoracic segment devoid of setules. Minute spine patterns present on abdominal segments and furcal rami, but less distinct than in the female. P_6 consists of one spine (25 μm) and two setae (20 μm and 45 μm).

Variability: females

Measurements were taken from ten specimens from different localities.

Total body length varies between 1 065 μm–1 295 μm. The length:width ratio of the furcal rami between 2.65–3.76. Dorsal furcal seta usually shorter than external seta; in only few specimens this seta slightly exceeds the length of the external one.

Length:width ratio of Enp_3P_4 varies between 2.50–2.84. Inner apical spine on Enp_3P_4 longer or

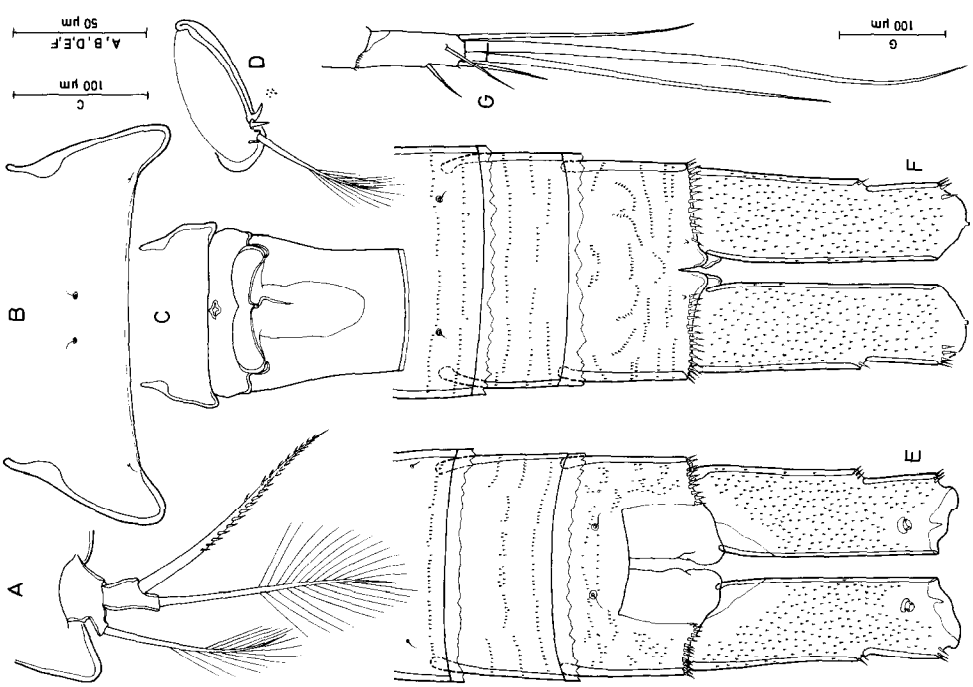

Fig. 10. Mesocyclops kieferi sp.n. (holotype) Gamra Ouarbi, Mauritania. A. P_5; B. Last thoracic segment, dorsum; C. Last thoracic segment and genital segment with receptaculum seminis; D. P_6; E. Abdominal segments and furcal *rami*, dorsal view; F. Abdominal segments and furcal rami, ventral view; G. Furca.

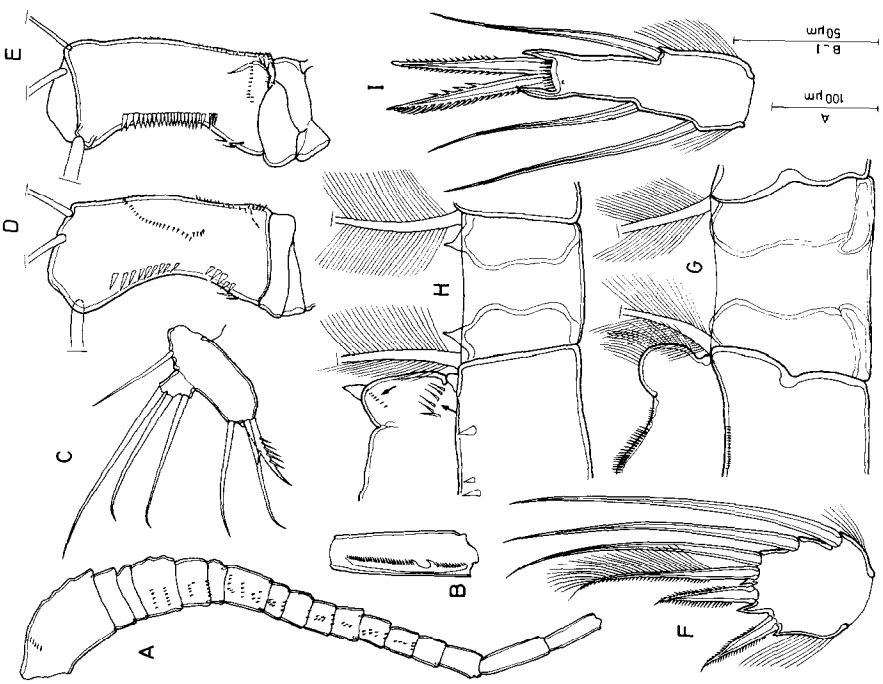

Fig. 9. Mesocyclops kieferi sp.n. (holotype) Gamra Ouarbi, Mauritania. A. A_1; B. Antennular segment 17; C. Maxillulary palp; D. Basipodite A_2, caudal side; E. Basipodite A_2, frontal side; F. Exp_3P_1; G. Connecting lamella and inner portion of coxo- and basipodite of P_1, frontal side; H. Connecting lamella and inner portion of coxo- and basipodite of P_4, caudal side; I. Enp_3P_4.

equal to outer apical spine, but it remains possible that the inner spine can be shorter than the outer one. External margin of inner spine never completely set with spinules. Their number varies from zero to six. Prominences on the distal margin of the connecting lamella well developed their length:-width ratio always about 1.

Spine pattern on basipodite of antenna constant; only the number of spines per row varies. Longitudinal row of spines on the frontal side 18–23 spines; longitudinal row of spines on the caudal side 7–10 spines; row of spines proximal to this last row 4–6 spines (but in specimens from Uvira the number varied from 7–9 spines).

Differential diagnosis

Mesocyclops kieferi sp.n. differs from other *Mesocyclops* species by the spine pattern on the basipodite of the antenna and by the pattern of spinules on the abdominal segments.

Distribution (Fig. 44)

M. kieferi occurs on a west-east axis across the entire African continent. In West Africa, populations are found mostly in guelta's in the Adrar, Tagant and Assaba mountains; further south it has not been found in surface waters but in wells along the River Niger. In the Western Rift, it occurs near Lake Kivu and in the littoral of Lake Tanganyika. In the Eastern Rift it was found in a pond south of Addis Abeba. Its presence is the Red Sea Hills links up with its occurrence on the Arabian Peninsula (South-Yemen).

Mesocyclops major Sars, 1927

1927 *Mesocyclops major* Sars, Ann. s. afr. Mus., Vol. 25, p. 116, Pl. XI: figs. 16–20.
1927 *Mesocyclops obsoletus*, Sars, Ann. s. afr. Mus., Vol. 25, p. 112, Pl. X: figs 14–18.
1978 *Mesocyclops leuckarti*, Van de Velde [partim], Biol. Jaarb., Vol. 46, p. 195.
1981 *Mesocyclops* sp. 4, Dumont *et al.*, Hydrobiologia, Vol. 80, p. 165.

Type locality: South-Africa, Cape Province, Cape Peninsula: Bergvliet, pond; sample collected by Purcell in May 1896.

Type material

Zoologisk Museum, Oslo: four slides
- F. 6673 Mp. 359: one female without eggs, dissected.
- F. 6774 Mp. 359: one female without eggs, undissected
- F. 6775 Mp. 359: one female without eggs, undissected
- F. 6776 Mp. 360: one female without eggs, dissected

All slides were labelled *Mesocyclops major* in Sars' handwriting; none of them are marked with the name of the type locality.

South African Museum, Cape Town: one tube A 12463 containing one undissected female without eggs, preserved in alcohol; labelled in Sars' handwriting: *Mesocyclops major*; no mention of the type locality.

Lectotype designation

The four specimens in the collection of the Zoologisk Museum are in a very poor state. The specimens in toto are completely wrinkled, in the dissected specimens only the outlines of the structures are recognizable. Therefore these specimens are insufficient for a redescription of the species. Since Sars (1927) designated no holotype, the undissected female from tube A 12463 (South African Museum) was selected as the lectotype. This has been dissected and mounted in glycerine on two slides and sealed with glyceel: the first slide contains A_1-P_4, the second P_5-abdomen. The remaining specimens are considered as paralectotypes.

As mentioned above, no type locality was indicated for the material, but since the original material of *M. major* was only found in one locality, all slides were labelled: Bergvliet, Cape Peninsula, South Africa.

Material examined (specifications see Table 1)

South Africa: Bergvliet (type material as described above), Knysna, Yosini, Tete Pan, Bumbe Pan, Rietvlei; Mauritania: El Berbera, Moul Echnouk; Mechra, Khouda, Tartega, Foum-n-meh, Gamra Ouarbi; Senegal: Guiers, Ross Bethio; Mali: Kabara, Fati, Télé, Mbouna, Tin Geicha, Mopti, Sanga, Gossi, Gao, Aougoundou, Kararou; Niger: Parc 'W', Mekrou, Say; Benin: Porto Novo; Upper Volta: Loumbila, Ouagadougou; Mozambique: Dondo, Xai-Xai; Sudan: Rosseires, Kaboushia, Keilak;

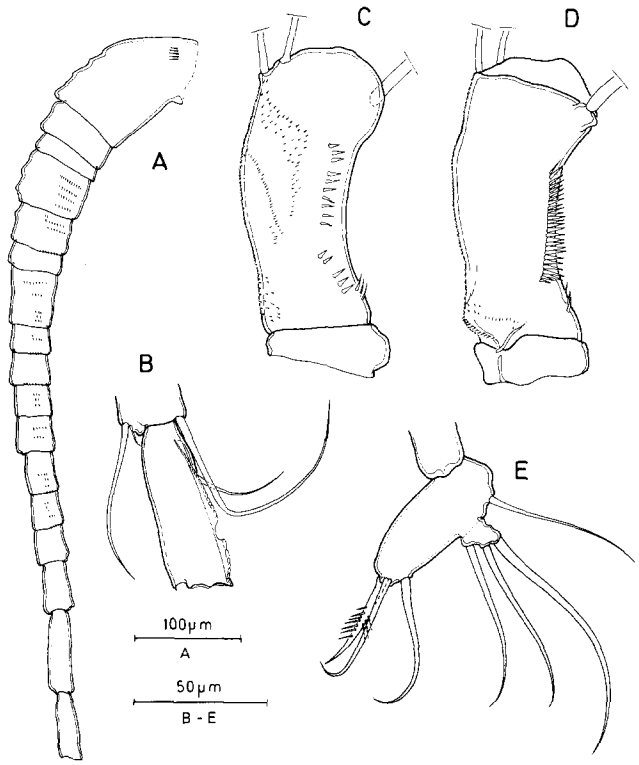

Fig. 11. Mesocyclops major Sars (lectotype) Bergvliet, South Africa. A. A_1; B. Antennular segment 17; C. Basipodite A_2, caudal side; D. Basipodite A_2, frontal side; E. Maxillulary palp.

Ivory Coast: Tai; Algeria: Balouahi, Beibei, Tin Eselmakene; Libya: Kufra; Zaire: Matadi; Burundi: Ruzizi; Ruanda: Tusoké, Luvungi, Nyakabera, Ruzizi; Kenya: Baringo.

Redescription of female (lectotype)

M. major was characterized by Sars (*op. cit.*) as closely resembling *M. obsoletus* (sic!) but bigger and with more strongly built thoracopods.

The following description is based on the lectotype; measurements are presented in Table 4.

Antennule. Reaching to the middle of the third thoracic segment. Spinules arranged in groups or rows are present on segments 1, 4–5, 7–13. Hyaline membrane of the segment 17 with one deep notch (Figs. 11A-B).

Antenna. Endopodite as in *M. leuckarti.* Basipodite (Figs. 11C-D): in addition to the basic pattern, a continuous row of minute spines is present on the inner caudal side; at its proximal end, a group of minute spines. Medial part of the caudal side set with a row of spinules which expands, as a patch of spinules, as far as the apical internal setae. Longitudinal row of spines on the caudal side com-

Table 4. Morphometry of *Mesocyclops major* Sars. Measurements in µm.

		lectotype ♀ Bergvliet	♂ Cape Flats
Cephalothorax	L	566	333
	W	475	242
	L:W	1.18	1.38
Ceph. + Thorax	L	908	500
Genital segment	L	204	75
	W	167	83
	L:W	1.22	0.90
Abdomen	L	421	225
Furca	L	127	57
	W	37	19
	L:W	3.43	3.0
Total body length		1 456	782
Enp_3P_4	L	94	53
	W	33	19
	L:W	2.85	2.79
Enp_3P_4	sp_i	77	53
	sp_e	65	47
	sp_i:sp_e	1.18	1.13
Furcal setae	S_i	275	141
	S_{mi}	–	366
	S_{me}	425	249
	S_e	109	67
	S_d	82	53

posed of ten spines; row proximal to this row: five spines. Longitudinal row of spines on the frontal side built by 27 spines.

Maxillule. Basis of the maxillulary palp without a group of spines (Fig. 11E).

Thoracopods P_1-P_4. Spine- and seta-formula typical for the genus. Armature of the various segments as in Figs. 12 & 13. Connecting plate of P_1-P_3 without setules on the caudal side; connecting plate of P_4 with setules.

P_1. Inner distal margin of basipodite without a frontal spine (Fig. 12A). External apical seta of Exp_3 peculiar in structure: internal margin provided with setules, external margin in its proximal part with seven setules followed by a row of spinules. This typical structure has hitherto been found only in *M. major* and in *M. insulensis* Dussart (1982) from Madagascar.

P_4. Enp_3 2.85 times as long as wide. Inner apical spine (77 μm) longer than outer apical spine (65 μm); armature of both spines illustrated in Fig. 13D. Caudal side of the connecting lamella with a row of setules distally prominences well developed and approximately 1.5 times as long as wide (Fig. 13D). Caudal side of the coxopodite set with setules on its lateral internal side. Inner part of the caudal side of the basipodite distally with a group of setules and proximally with a row of setules (Fig. 13D).

P_5. Seta implanted on the distal segment in both P_5 broken off (Fig. 14C). In the illustration by Sars (1927, Fig. 19) the spinous seta is considerably shorter than the seta implanted on the same segment.

P_6. Composed of two spines and one seta.

Last thoracic segment (Figs. 14A-D). Ventral distal margin, between left and right P_5, with a row of spines (Fig. 14B:↗). Proximally to the implantation site of P_5 two groups of spines occur. Side and dorsum covered with setules.

Receptaculum seminis. Structure as illustrated in Fig. 14B. Lateral arms slightly curved backwards; anterior and posterior margin parallel. Copulatory-pore horseshoe-shaped and with a tongue-shaped projection at its posterior end. Pore-canal slightly curved anteriorly.

Abdominal segments (Fig. 14D). Dorsum of genital and subsequent segment completely covered with setules. Last abdominal segment on ventral and dorsal sides with patterns of minute spinules; distal and ventral margin fringed with spines (Figs. 14E-F).

Furca. Furcal rami 3.43 times as long as wide, not pilose on inner margin. Dorsal and ventral sides covered with minute spinules (Figs. 14E-F). Dorsal furcal seta (82 μm) shorter than the external seta (109 μm). Length of remaining setae represented in Table 4. Lateral furcal seta, in contrast to external seta, not provided with spines at its implantation (Figs. 14E-F).

Description of male

No description of the male was given by Sars (1927); the type material did not comprise any male specimens. The following description is based on specimens obtained from cultures and from preserved material.

Total length: 782 μm. Measurements of a specimen originating from the Cape Flats (coll. Sars) represented in Table 4. Antennules with 3, 1 and 1 aesthetes on segments 1, 4 and 9 respectively. Spine pattern on basipodite of antenna as in female. Structure of thoracopods P_1-P_4 similar to female. Last thoracic segment naked, in contrast to female; only groups of spines proximal to implantation of P_5 present and ventral distal margin with a row of spines as in female. Genital and following abdominal segment devoid of dorsal setules. Furcal index: 3.0; measurements of furcal setae: Table 4. Lateral and external furcal setae with spines at their implantation. P_6: one spine (13 μm) and two setae (13 μm and 33 μm).

Variability: females

Measurements were taken on eleven specimens from various localities. Range in total length 1 128 μm–1 513 μm. Length:width ratio of furcal rami 2.71–3.43. Dorsal furcal seta usually longer than external furcal seta; occasionally not.

Length:width ratio of Enp_3P_4 1.69–2.85. Inner apical spine longer or shorter than outer one. Variability in armature of inner apical spine: external margin set with a variable number of spinules, distributed along the entire margin, or only present on its proximal part, or completely absent.

Connecting lamella of P_4 with a row of setules at its distal margin, continuous along the side of the lamella. A second row of setules, implanted in the median part, either present or absent. This variability also found in offspring from one pair of parents. Prominences of the lamella well developed and their length:width ratio always about 1.5.

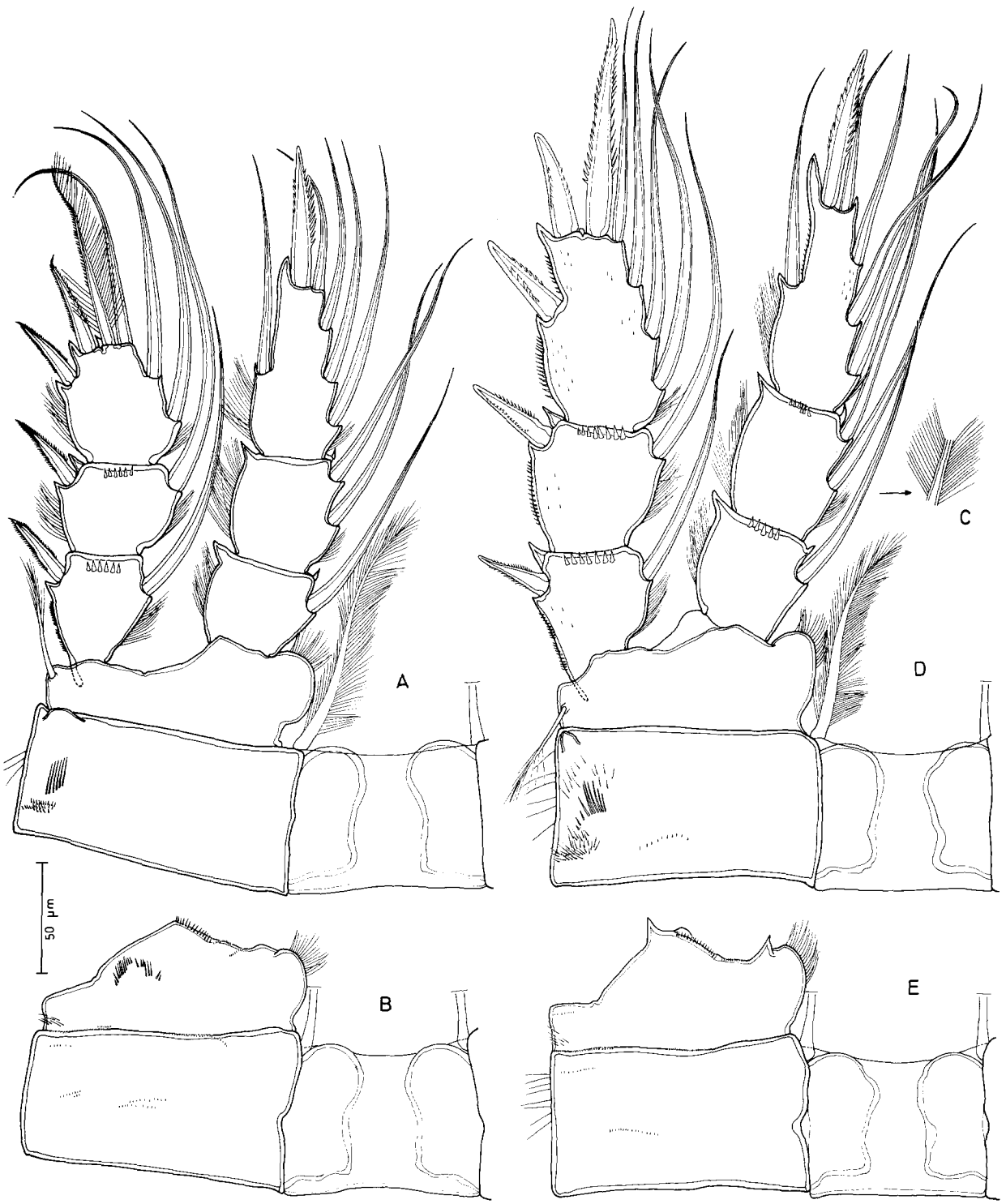

Fig. 12. Mesocyclops major Sars (lectotype) Bergvliet, South Africa. A, D. Structure P_1-P_2, caudal side; B, E. Connecting lamella and coxo- and basipodite of P_1-P_2, frontal side; C. Ornamentation of setae of endo- and exopodites.

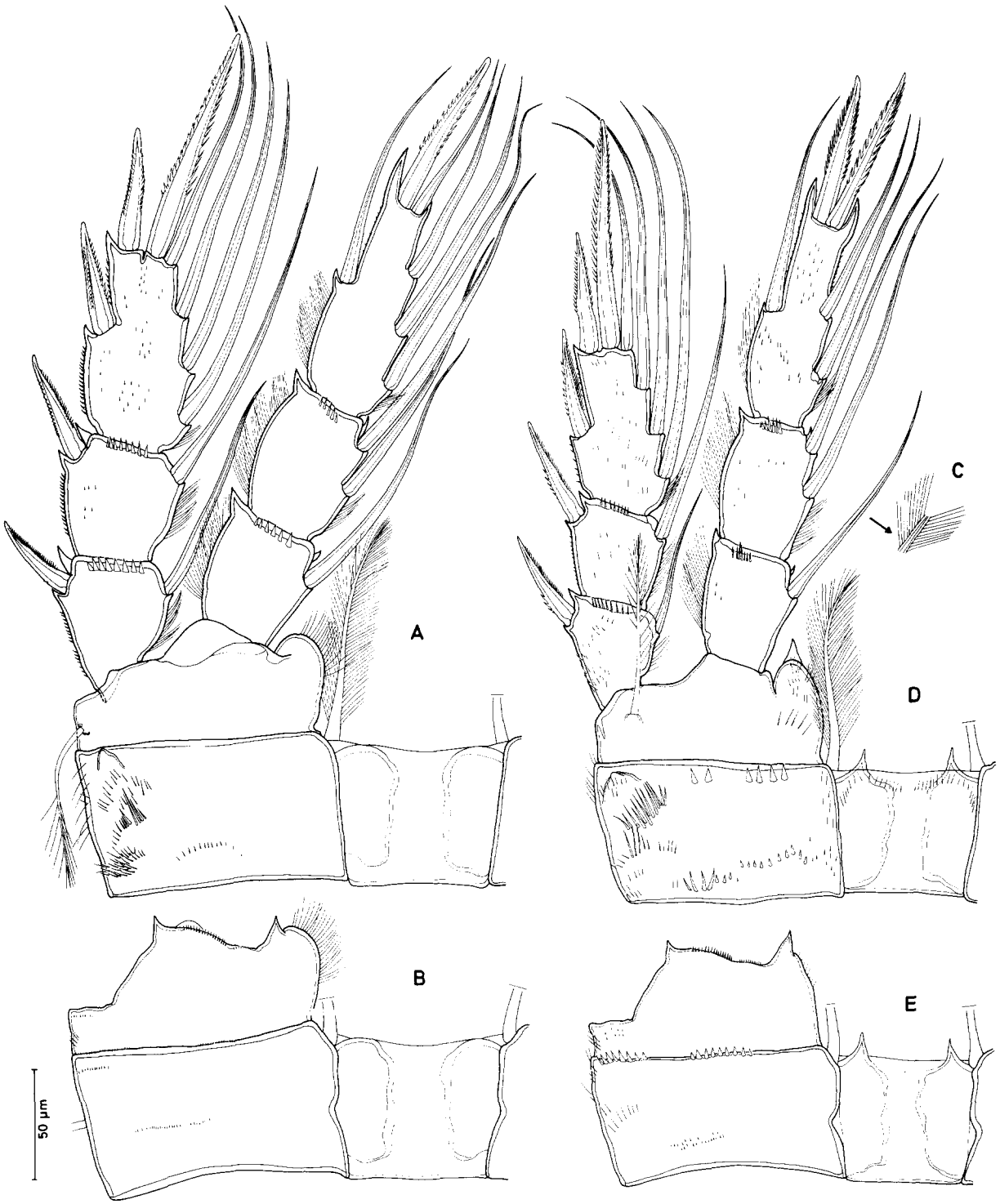

Fig. 13. Mesocyclops major Sars (lectotype) Bergvliet, South Africa. A, D. Structure P_3-P_4, caudal side; B, E. Connecting lamella and coxo- and basipodite of P_3-P_4, frontal side; C. Ornamentation of setae of endo- and exopodites.

Spine pattern on basipodite of antenna species-specific; variability only in number of spines per row: longitudinal row on caudal side 7–13 spines, row of spines proximal to this row 4–7, longitudinal row on frontal side 23–29 spines.

Differential diagnosis

M. major can be differentiated from its congeners by the spine pattern on the basipodite of the antennae. *M. major* closely resembles *M. insulensis* Dussart, 1982 from Madagascar. The following differences exist: *M. insulensis* is much smaller (759 μm), the number of spines of the longitudinal row of spines on the caudal side (four spines) and on the frontal side (sixteen spines) is smaller, the patch of minute spines situated proximal of the apical internal setae, reaches as far as the most distally placed internal seta (Fig. 15), the dorsal side of the genital segment and the following abdominal segment are not pilose.

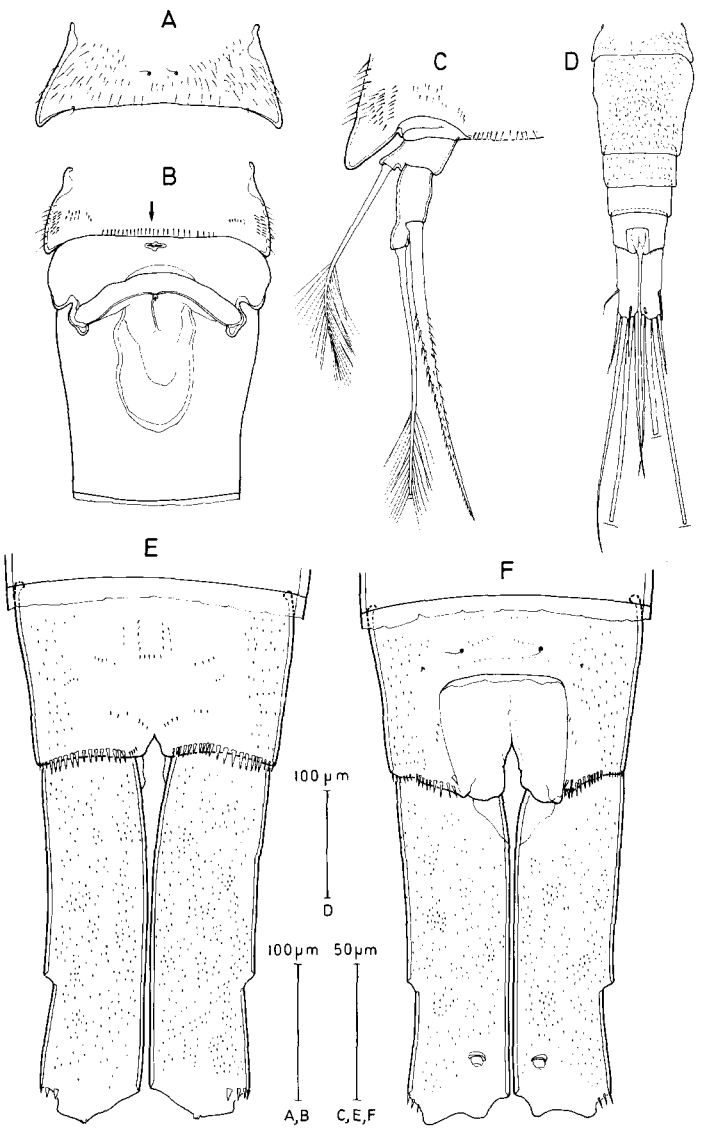

Fig. 14. Mesocyclops major Sars (lectotype) Bergvliet, South Africa. A. Last thoracic segment, dorsum; B. Last thoracic segment and genital segment with receptaculum seminis; C. P_5; D. Last thoracic segment and abdomen; E. Last abdominal segment and furcal rami, ventral view; F. Last thoracic segment and furcal rami, dorsal view.

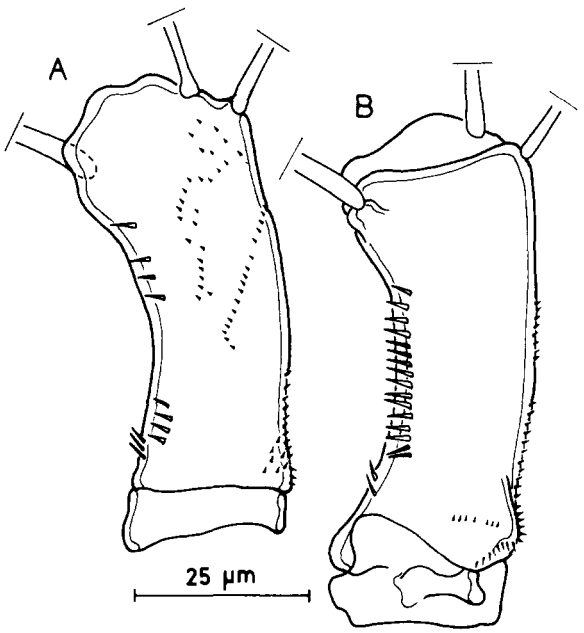

Fig. 15. Mesocyclops insulensis Dussart (syntype) Bemapaza, Madagascar. A. Basipodite A^2, caudal side; B. Basipodite A^2, frontal side.

Remarks

M. major has not been reported in the literature since its original description from South Africa. Kiefer (1981, p. 190: appendix) briefly describes the species.

M. obsoletus (Koch, 1838) was reported from the Cape Province by Sars (*op.cit.*) and differentiated from *M. major* by morphometric data. Examination of these specimens (coll. South African Museum, tube no. A 12464: five females, one male) showed that they are conspecific with *M. major*.

Distribution (Fig. 41)

M. major is one of the most successful *Mesocyclops* species of Africa; it occurs in all climatic belts, ranging from hyper-arid to equatorial. It is widespread south of the Sahara, relict populations were found in the Tassili-n-Ajjer (Algeria) and in Kufra-oasis (Libya).

Mesocyclops dussarti sp.n.

1981 *Mesocyclops* sp. 3, Dumont *et al.*, Hydrobiologia, Vol 80, p. 165.

1981 *Mesocyclops thermocyclopoides*, Kiefer [partim], [non Harada], Arch. Hydrobiol., Suppl. 62, p. 163.

Type locality: Tombouctou, Mali (16°46'N-3°00'W), large man-made irrigation pond, leg. H. Dumont and I. Miron, 2-3-1976.

Type material

holotype: 1 ♀ with eggs, dissected in glycerine and mounted on two slides: the first slide contains A_1-P_4, the second P_5-abdomen.

allotype: 1 ♂, dissected in glycerine and mounted on one slide sealed with glyceel.

paratypes: 8 ♀ with eggs and 2 ♂, dissected and mounted as described above; one tube containing 50 ♀, 10 ♂ and 5 copepodids stage V.

Repository of type material

The holotype, allotype and five undissected paratypes (4 ♀ and 1 ♂) are deposited in the Koninklijk Museum voor Midden-Afrika, Tervuren. The remaining paratype material is in the collection of the Zoological Institute, University of Ghent.

Etymology: the species is named after Prof. Dr. B. Dussart.

Material examined (specifications see Table 1)

Mauritania: Rosso; Mali: Tombouctou (type material), Kabara, Télé, Goundam, Dyabali, Markala, Sanga, Kô, Gao, Aougoundou, Narou; Niger: Mekrou; Algeria: El Bahtou, Iherir, Efenni; Upper-Volta: Loumbila, Ouagadougou; Zaire: Kolwezi.

Description of female (holotype)

Measurements of holotype, allotype, and part of the paratypes are presented in Table 5.

Antennule. Reaches to the middle of the third thoracic segment. Spinules present on segments 1, 4–5 and 7–14. Hyaline membrane with one deep notch (Figs. 16D-E).

Antenna. Structure of endopodite as in *M. leuckarti.*

Basipodite (Figs. 16A-B): in addition to the basic pattern a continuous row of minute spines present on the medial caudal side. This row continues with a few spinules on inner margin of basipodite. An oblique row of slender spines (7) present on distal part of caudal side proximal to implantation of internal apical setae. Longitudinal row of spines on

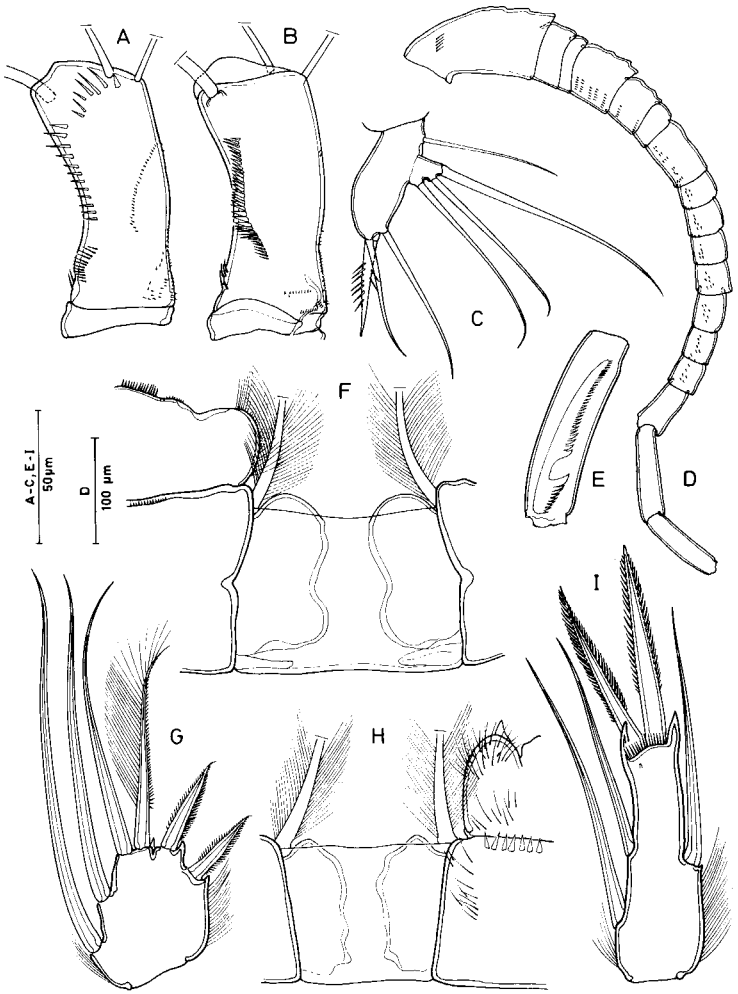

Fig. 16. Mesocyclops dussarti sp.n. (holotype) Tombouctou, Mali. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C. Maxillulary palp; D. A_1; E. Antennular segment 17; F. Connecting lamella and inner portion of coxo- and basipodite of P_1, frontal side; G. Exp_3P_1; H. Connecting lamella and inner portion of coxo- and basipodite of P_4, caudal side; I. Enp_3P_4.

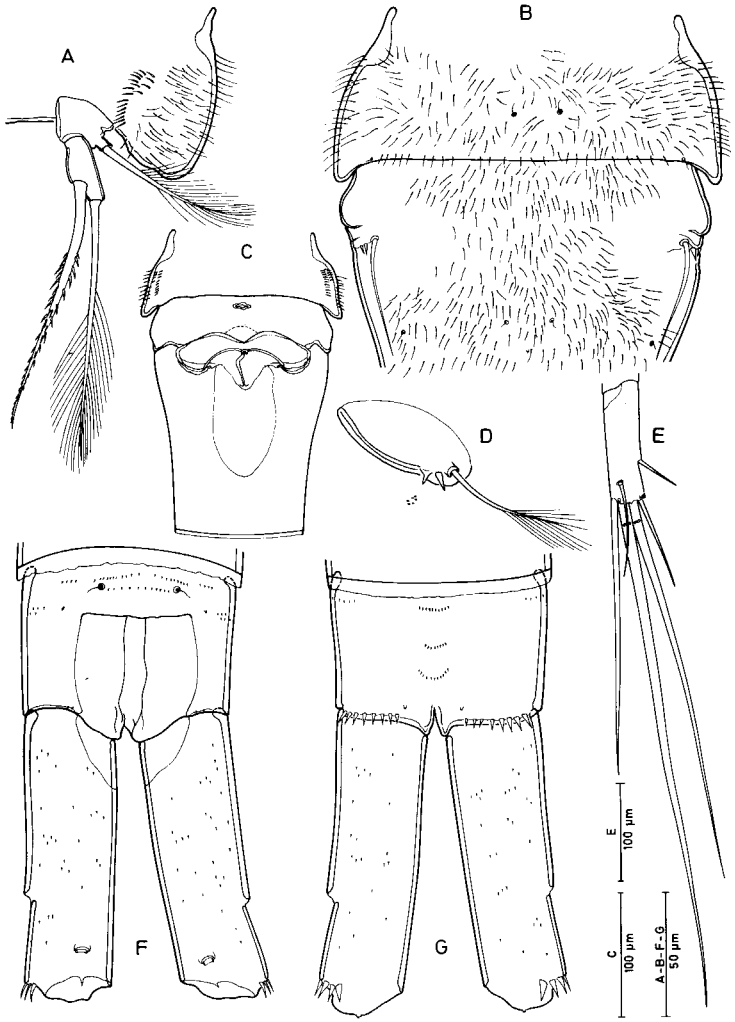

Fig. 17. Mesocyclops dussarti sp.n. (holotype) Tombouctou, Mali. A. P_5; B. Last thoracic segment and proximal part of genital segment dorsum; C. Last thoracic segment and genital segment with receptaculum seminis; D. P_6; E. Furca; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view.

Table 5. Morphometry of *Mesocyclops dussarti* sp.n. (Tombouctou, Mali). Measurements in μm.

		Holotype	Allotype	Paratypes (♀)		
Cephalothorax	L	492	283	492	533	450
	W	408	233	408	416	375
	L:W	1.20	1.22	1.21	1.28	1.20
Ceph. + Thorax	L	841	483	833	866	808
Genital segment	L	192	83	179	208	167
	W	133	83	129	117	125
	L:W	1.44	1.0	1.39	1.77	1.34
Abdomen	L	392	246	380	429	358
Furca	L	114	71	108	121	108
	W	33	25	31	33	35
	L:W	3.45	2.84	3.48	3.67	3.09
Total body length		1 320	800	1 321	1 416	1 274
Enp_3P_4	L	88	57	83	83	86
	W	32	18	29	31	29
	L:W	2.75	3.17	2.86	2.78	2.97
Enp_3P_4	sp_i	65	50	71	69	75
	sp_e	69	50	73	76	71
	sp_i:sp_e	0.86	1.0	0.97	0.90	1.05
Furcal setae	S_i	281	169	258	250	233
	S_{mi}	527	346	483	–	466
	S_{me}	399	246	366	375	350
	S_e	96	67	86	89	83
	S_d	96	67	86	88	80
P_6 spine			19			
seta (i)			23			
seta (e)			43			

caudal side composed of twelve spines; row proximal to this row has twelve spines; longitudinal row on frontal side has 35 spines.

Maxillule. Maxillulary palp without a group of spines (Fig. 16C).

Thoracopods P_1-P_4. Spine- and seta formula as in *M. leuckarti.* Connecting lamella of P_1-P_4 not pilose.

P_1. Inner distal margin of basipodite without a spine on frontal side (Fig. 16F).

P_4. Enp_3 2.75 times as long as wide. Inner apical spine shorter than outer. Armature of apical spines as in Fig. 16I. Prominences on distal margin small, 0.5 times shorter than wide. Inner part of basipodite distally and proximally with a group of setules on caudal side. Lateral inner part of caudal side of coxopodite provided with setules (Fig. 16H).

P_5 (Fig. 17A). Spinous seta (103 μm) equals length of seta (105 μm) implanted on the same segment. Appendages of P_5 do not reach to distal margin of genital segment.

P_6 (Fig. 17D). Two spines (5 μm and 7 μm) and one seta (55 μm).

Last thoracic segment (Figs. 17A-C). A row of spinous setules present on the ventro-lateral side; towards the side, the segment is set with setules which cover the complete dorsum of the segment.

Receptaculum seminis. As illustrated in Fig. 17C; copulatory-pore situated near to anterior margin of proximal part. Left and right part of posterior margin of proximal part strongly curved. Structure of copulatory-pore as in *M. major*; pore-canal slightly curved.

Abdominal segments (Figs. 17B-F-G). Entire dorsum of genital segment pilose. Only last abdominal segment ornamented with minute spinules (Figs. 17F-G). Distal margin of last abdominal segment ventrally fringed with a row of spines, dorsally with two minute spines.

Furca (Figs. 17E-F-G). Furcal rami 2.75 times as long as wide; not pilose on their inner margin. Rami dorsally and ventrally sparsely set with groups of minute spinules. Dorsal and external furcal setae of equal length. Measurements of furcal setae: see Table 5. External furcal seta, in contrast to lateral provided with spines at its implantation.

Description of male (allotype)

Length 800 μm. Armature of antennule as in other species. Spine pattern on basipodite of antenna as in female. Structure of P_1-P_4 as in female except for armature of caudal side of coxopodite which is not provided with setules on lateral inner portion. Last thoracic segment and genital segment, in contrast to female, not set with setules. Distal margin of last abdominal segment fringed with spines, ventrally as well as dorsally. Armature of furcal rami as in female, but implantation of lateral furcal seta provided with spinules. P_6 composed of one spine (19 μm) and two setae respectively 23 μm and 43 μm long.

Variability: females

Measurements were taken on eleven specimens from various localities. Total body length varies from 1 169 μm to 1 416 μm. Furcal index 2.90–3.56. Dorsal furcal seta either shorter or longer than external.

Length:width ratio of Enp_3P_4 2.53–2.97. In most specimens, inner apical spine shorter than outer one; occasionally inner spine equal to or slightly

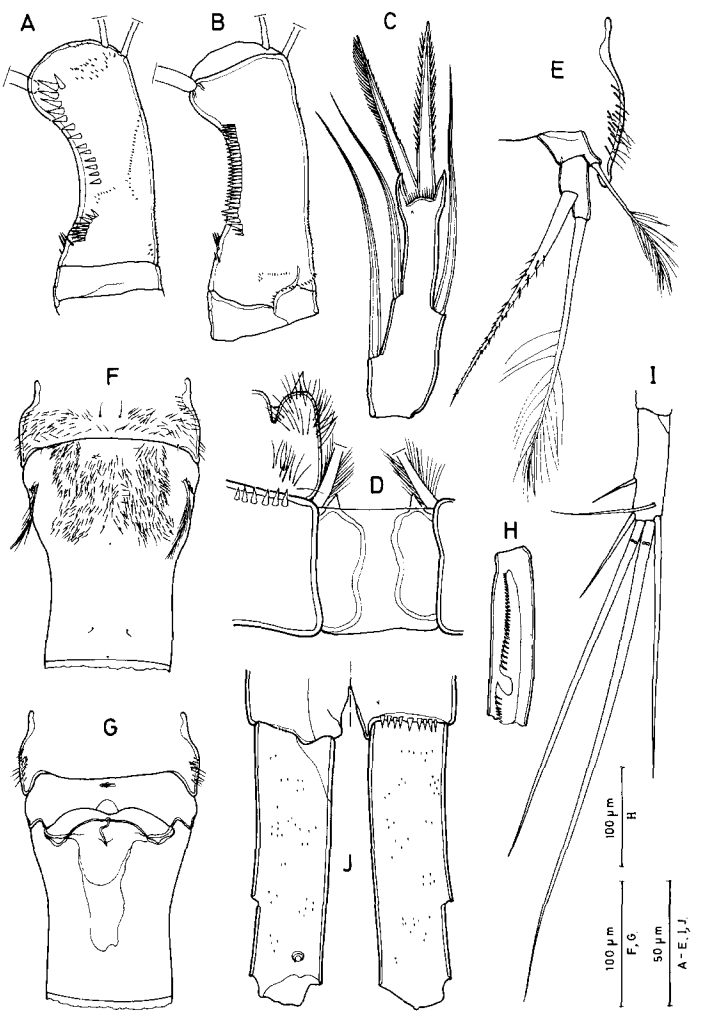

Fig. 18. Mesocyclops thermocyclopoides Harada Calcutta. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C. Enp_3P_4; D. Connecting lamella and inner portion of coxo- and basipodite of P_4; E. P_5; F. Last thoracic segment and genital segment, dorsum; G. Last thoracic segment and genital segment with receptaculum seminis; H. Antennular segment 17; I. Furca; J. Furcal rami, left: dorsal view, right: ventral view.

longer than outer. External margin of inner apical spine always completely set with spinules as in Fig. 16I.

Prominences on distal margin of connecting lamella of P_4 always moderately developed (approximately 0.5 times as long as wide); prominences rounded or pointed.

Spine pattern on basipodite of A_2 constant; variable only in number of spines per row: longitudinal row on caudal side 9–15 spines, row proximal to this row 9–13 spines, row of spines near to apical internal setae 4–7 spines, longitudinal row on frontal side 30–35 spines.

Number of spinules, fringing dorsal distal margin of last abdominal segment between zero and four spinules but never entire margin set with spinules. Spinules fringing ventral distal margin never reduced.

Differential diagnosis and remarks

Mesocyclops dussarti sp.n. is morphologically allied to *M. thermocyclopoides* Harada, a species described from Lake Candidius (Taiwan). Kiefer (1981) rehabilitated Harada's species and based his redescription on type specimens. According to Kiefer (*op.cit.*) *M. thermocyclopoides* is widely distributed from Africa to Taiwan.

Through the kindness of Prof. Kiefer we have been able to examine a slide of *M. thermocyclopoides* from Taiwan and specimens from Calcutta (Fig. 18). This led us to the conclusion that *M. thermocyclopoides* is not an African species. Instead two related species are present in Africa: *M. dussarti* sp.n. and *M. ogunnus* Onabamiro. The exact geographical range of *M. thermocyclopoides* remains to be established since examination of specimens from Jordan, Turkey and Japan revealed the presence of taxa here, morphologically different from but closely related to *M. thermocyclopoides*.

Comparing *M. thermocyclopoides* with *M. dussarti* sp.n. the following differences were noted with the latter species: the spine pattern on the basipodite of the antennae (Figs. 16A-B & 18A-B); the lateral inner part of the caudal side of the coxopodite is devoid of setules (Figs. 16H & 18D); the dorsum of the genital segment is provided with setules in its proximal half only (Figs. 17B & 18F); the structure of the receptaculum seminis is similar but the lateral arms are slightly more slender (Figs. 17C & 18G); no spinules at the implantation of the external furcal setae (Figs. 17F-G & 18J).

Distribution (Fig. 44)

M. dussarti sp.n. is a west African species that appears to have extended northwards during pluvials in the Pleistocene-Holocene and afterwards left relicts in the Sahara (see aquatic fauna movements: Dumont, 1979). Relict populations were found here in guelta's in the Tassili-n-Ajjer. In West Africa, the species is restricted to the Sahel-Sudan region, in swamps, pools and lakes associated with the river systems of the Senegal, Niger and Volta. The most southern record of *M. dussarti* sp.n. is the Lualaba, a tributary of the river Zaïre.

Mesocyclops ogunnus Onabamiro, 1957

1957 *Mesocyclops ogunnus* Onabamiro, J. linn. Soc. Lond., Vol. 43, p. 125, Figs. 7–12.
1966 *Mesocyclops leuckarti*, Dussart & Gras [partim], Cah. ORSTOM, sér. Océanogr., Vol. 4, No. 3, p. 81.
1978 *Mesocyclops leuckarti*, Van de Velde [partim], Biol. Jaarb. Vol. 46, p. 194.
1981 *Mesocyclops thermocylopoides,* Kiefer [partim], [non Harada], Arch. Hydrobiol., Suppl. 62, p. 163.
1981 *Mesocyclops* sp. 1, Dumont *et al.*, Hydrobiologia, Vol. 80, p. 615.

Type locality: Nigeria, River Ogun at Abeokuta: stagnant pools, covered with water-lettuce, formed by drying of the river. Collection made by S. D. Onabamiro on 3-3-1951.

Type material

Ibadan University College, index no. 6, 'Type', female (stated in Onabamiro's paper).

British Museum (Natural History, London): one tube containing two non-ovigerous undissected females, preserved in alcohol and, labelled: *syntypes,* Abeokuta, River Ogun, stagnant pools, Nigeria, S. D. Onabamiro 1957, 2.15.2.

Attempts made to obtain the type material deposited in Ibadan failed. The redescription is therefore based on syntypical material from the British Museum.

The two syntypes were treatened as follows: one female was dissected and mounted on two slides: the first contains A_1-P_4, the second P_5-abdomen. The second female was left intact.

Material examined (specifications see Table 1)

Nigeria: Abeokuta (type material as described above) Mauritania: Molomhar, Le Bheyr, Gamra Ouarbi, Boumdeit; Senegal: Guiers, Sita Ndi, Niokolo Koba, Ross Bethio; Mali: Kabara, Horo, Faguibine, Mbuna, Tindiba, Tin Geicha, Markala, Dyabali; Niger: Mekrou; Benin: Porto Novo; Upper Volta: Ouagadougou; Tchad: Lake Tchad; Egypt: Lake Naser; Sudan: Karthoum, Blue Nile, Rosseires, Atbara; Ivory Coast: Lake Kossou; Mozambique: Dondo, Xai-Xai; South Africa: Bumbe Pan, Mhlolo; Israel: Lake Kinneret; Ethiopia: Lake Abaya; Kenya: Lake Rudolf.

In all localities, *M. ogunnus* was abundantly present.

Redescription of female

Onabamiro's description of *M. ogunnus* may be briefly summarized as follows: inner margin of furcal rami sparsely pilose (incorrect! see below), structure of receptaculum seminis resembling that of *M. thermocyclopoides* Harada, connecting lamella of P_4 with small prominences, basipodite P_1 without a spine, hyaline membrane of 17th antennular segment with one deep notch, measurements as in Table 6.

The following redescription is based on syntype I; additional information is given on specimens from lake Tchad.

Total body length: 989 μm; other measurements on the syntype and those given by Onabamiro (*op.-cit.*) presented in Table 6.

Antennule (Figs. 19D-E). Reaches to distal margin of second thoracic segment. Armature of antennule identical to that of *M. leuckarti* (Figs. 5A and 21A: specimen Lake Tchad). Spinules present on segment 1, 4–5 and 7–13. Hyaline membrane with one deep notch.

Antenna. Endopodite as in *M. leuckarti.* Basipodite (Figs. 19A-B). Spine pattern very similar to that of *M. dussarti.* However, both can be differentiated by the number of spines in the longitudinal row on the frontal side; in *M. ogunnus* (20–28 spines) the number is always less than in *M. dussarti* (30–35).

Table 6. Morphometry of *Mesocyclops ogunnus* Onabamiro (Abeokuta, Nigeria). Measurements in μm.

		Syntype	Onabamiro (1957)
Cephalothorax	L	305	
	W	300	
	L:W	1.02	1.0
Ceph. + Thorax	L	600	
Genital segment	L	152	
	W	97	
	L:W	1.53	1.1
Abdomen	L	318	
Furca	L	71	
	W	26	
	L:W	2.7	3.1 – 3.3
Total body length		989	1 000 – 1 300
Enp_3P_4	L	64	
	W	26	
	L:W	2.46	2.5 – 3.0
Enp_3P_4	sp_i	57	
	sp_e	55	
	sp_i:sp_e	1.04	1 or >1
Furcal setae	S_i	200	257 – 286
	S_{mi}	461	535 – 580
	S_{me}	305	357 – 393
	S_e	78	89 – 100
	S_d	77	88 – 100

Longitudinal row of spines on caudal side with thirteen spines; row proximal to this with eight spines; row of spines located proximal to internal apical setae with ten spines. Longitudinal row on frontal side with 24 spines.

Mouthparts (Figs. 19C and 21D-H: specimen Lake Tchad). Labrum, labium, mandible and maxilliped as in *M. leuckarti.* In contrast to *M. leuckarti*, basis of maxillulary palp provided with a row of spines (Fig. 19C) and, frontal side of maxilla set with a row of minute spinules (Fig. 21G).

Thoracopods P_1-P_4. Seta- and spine-formula of endo- and exopodites as in *M. leuckarti.* Armature of the various segments as in Fig. 22 (specimen Lake Tchad).

P_1. Inner distal margin of basipodite without spine (Fig. 19H).

P_4. Enp_3 2.46 times as long as wide. Inner apical spine exceeds outer in length or both spines equal in length (Onabamiro, *op.cit.*). Armature of both spines as in Fig. 19F: external margin set with a row of uninterrupted spinules.

Connecting lamella on caudal side naked; prominences on distal margin weakly developed (Fig.

19G). Caudal side of coxopodite towards the lateral inner margin devoid of setules; inner part of the basipodite on caudal side proximally with a group of setules and distally with a row of setules (Fig. 19G).

P_5 (Fig. 20A) and P_6 (Fig. 20C). Of the usual structure, without any peculiarities.

Last thoracic segment (Figs. 20A-B, D). Laterally covered with setules. Two rows of setules present on the dorsum, near the distal margin of the segment.

Receptaculum seminis (Fig. 20D). Lateral arms broad and slightly curved backwards. Left and right part of posterior margin of proximal part depart without forming a 'jointed' canal (as e.g. in *M. spinosus*) from the copulatory-pore. Pore-canal curved in its proximal part.

Abdominal segments. Only last segment furnished with a few minute spinules on its ventrum as in Fig. 20G. Distal margin of this segment dorsally and ventrally fringed with a row of spines (Figs. 20F-G).

Furca (Figs. 20F-G). Furcal rami 2.7 times as long as wide, not pilose internally. Onabamiro's observation: 'The inner margin of the rami sparsely haired', is incorrect!
Both syntypes exhibit a kind of pilosity but this is due to attachment of bacteria on the inner margin of the furcal rami as well as on their ventrum and dorsum. Length of furcal setae as in Table 6; dorsal seta slightly shorter than external (but see variability). Lateral and external setae furnished with spines at their implantation.

Description of male

No description is given by Onabamiro (*op.cit.*) and the type material contains no male specimens. The following description is based on specimens from Lake Tchad.

Mean total body length 789 μm (n = 10). Armature of antennule as in the other species. In contrast to female, last thoracic segment naked; P_6 composed of one spine and two setae. Spine pattern on basipodite of antenna, maxillulary palp and structure of P_1-P_4 as in female. Armature of furcal rami as in female, mean L:W ratio 3.10 (n = 10).

Variability females

Measurements were taken on 30 females from a population of Lake Tchad; some of them and their standard error are listed in the following table; the values fluctuate within restricted limits.

	$\bar{x}$	s_x
Total body length	1 205 μm	44 μm
Cephalothorax W	385 μm	11 μm
Genital segment L:W	1.25	0.05
Furcal rami L:W	3.29	0.17
Enp_3P_4 L:W	3.49	0.20

When specimens originating from geographical more scattered populations are compared, a greater variability is found.

Total body length between 989 μm and 1 276 μm (n = 56). Length:width ratio of furcal rami between 2.6 and 3.6. Usually, dorsal furcal seta shorter than external seta but it can be equal to or longer than the external one.

Lenght: width ratio of Enp_3P_4 between 2.5 and 3.9. In most specimens, inner apical spine shorter than outer but this spine can also be equal to or longer than the outer even in one and the same specimen.

Spine pattern on basipodite of antenna constant, only the number of spines per row varies within restricted limits: longitudinal row on caudal side with 10–14 spines; row at the level of internal apical setae with 7–12 spines; longitudinal row on frontal side with 20–28 spines.

Differential diagnosis

Affinities are found with *M. dussarti* with regard to spine pattern on basipodite of A_2, structure of hyaline membrane, structure of P_1-P_4 and shape of the receptaculum seminis. However, the following differences are noted: maxillulary palp provided with a row of spines, setules present on inner portion of coxopodite of P_4 (only in females), last thoracic segment dorsally not completely covered with setules, dorsal side of genital segment devoid of setules and posterior margin of proximal part of receptaculum seminis strongly curved.

Distribution (Fig. 43)

M. ogunnus is distributed south of the Sahara; no pluvial relicts are found in the Central Sahara. In West Africa, it is distributed from the southern Sahara (Adrar in Mauritania) to the Guinea zone.

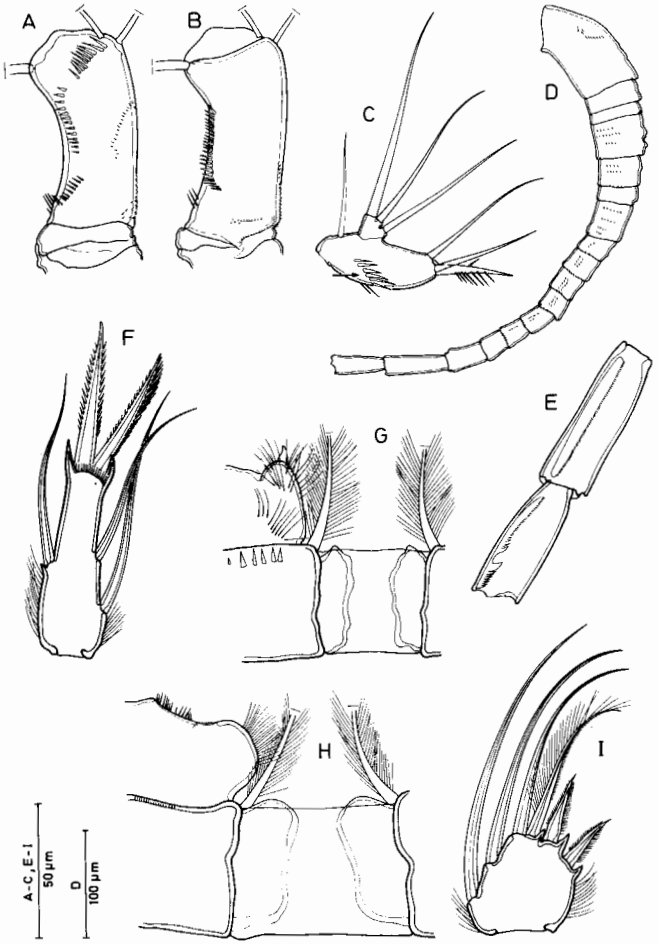

Fig. 19. Mesocyclops ogunnus Onabamiro (syntype) Abeokuta, Nigeria. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C. Maxillulary palp; D. A_1; E. Antennular segments 16 & 17; F. Enp_3P_4; G. Connecting lamella and inner portion of coxo- and basipodite of P_4; H. Connecting lamella and inner portion of coxo- and basipodite of P_1; I. Exp_3P_1.

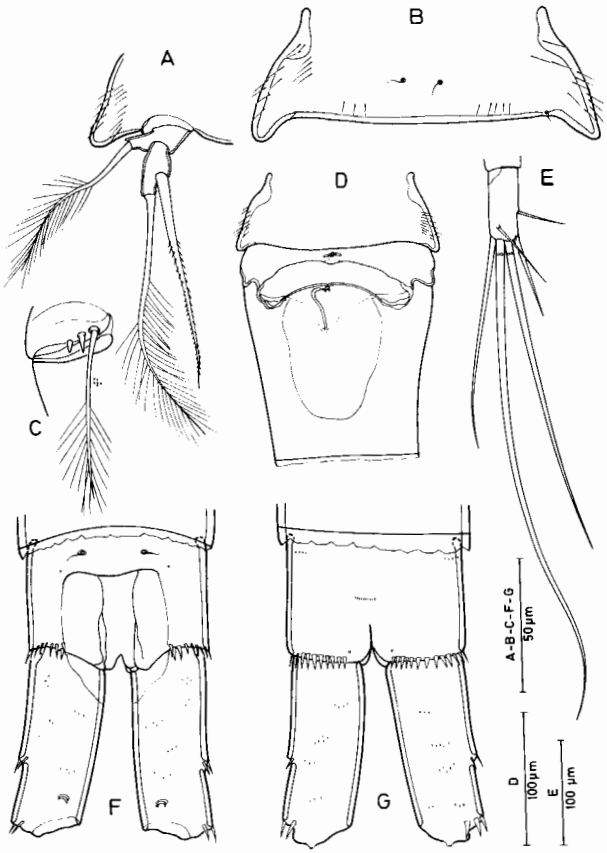

Fig. 20. Mesocyclops ogunnus Onabamiro (syntype) Abeokuta, Nigeria. A. P_5; B. Last thoracic segment, dorsum; C. P_6; D. Last thoracic segment and genital segment with receptaculum seminis; E. Furca; F. Last abdominal segment and furca, dorsal view; G. Last thoracic segment and furca, ventral view.

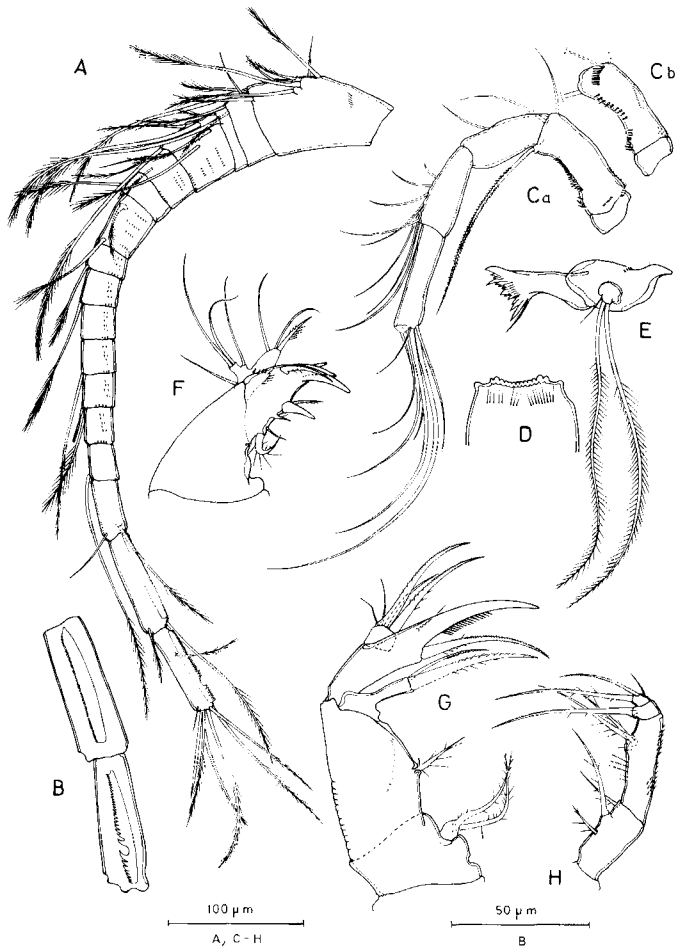

Fig. 21. Mesocyclops ogunnus Onabamiro Lake Tchad. A. A_1; B. Antennular segments 16 & 17, C_a. A_2, frontal side; C_b. Basipodite A_2, caudal side; D. Labrum; E. Mandible; F. Maxillule; G. Maxilla; H. Maxilliped; D-E: ventral side, F-H: caudal side.

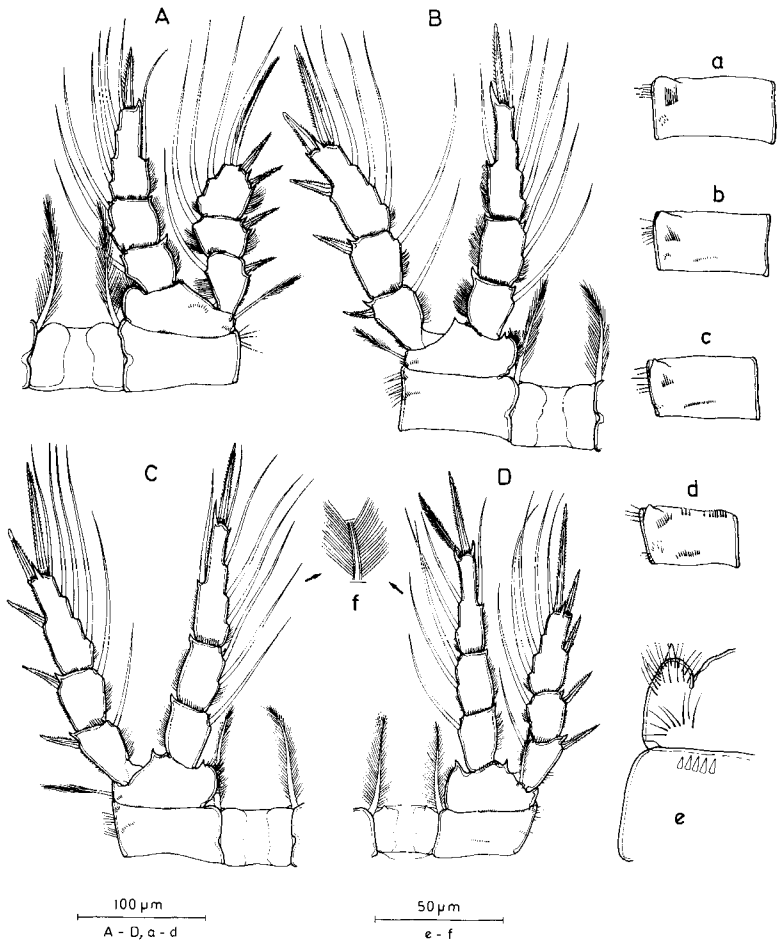

Fig. 22. Mesocyclops ogunnus Onabamiro Lake Tchad. A-D. Structure P_1-P_4, frontal side; a-d: coxopodite P_1-P_4, caudal side; e: inner portion coxo- and basipodite of P_4, caudal side; f: ornamentation setae of endo- and exopodites.

Further records are in South-East Africa: South Mozambique and Natal (river Pongolo). *M. ogunnus* appears to be absent from the Western Rift. It is present in Lake Rudolf and in the Ethiopian highland and it has used the river Nile to extend northwards. It is found as far as Lake Kinneret (Israel). It also tolerates brackish and saline waters.

Mesocyclops aequatorialis aequatorialis (Kiefer, 1929)

1929 *Mesocyclops leuckarti aequatorialis* Kiefer [partim], Z. wiss. Zool., Vol. 133, p. 17.
1952 *Mesocyclops leuckarti aequatorialis*, Kiefer [partim], Explor. Parc Natn. Albert Mission H. Damas 1935/1936, Vol. 21, p. 99.
1956 *Mesocyclops leuckarti aequatorialis*, Kiefer, Revue Zool. Bot. afr., Vol. 54, p. 254, Figs 26–38.
1981 *Mesocyclops aequatorialis*, Kiefer [partim], Arch. Hydrobiol., Suppl. 62, Vol. 1, p. 168, Fig. 7.

Type locality: ? Lake Kivu (see remarks)

Type material: not indicated

Material examined (specifications see Table 1)
- Lake Kivu: Kanyumgi, Kisenyi, Kawa, Buleke.
- Lake Tanganyika: Uvira.

Redescription of female

Since Kiefer (1929, 1981) indicated no type material, the following description is based on specimens from Lake Kivu (coll. Kiefer).

Mean total body length: 919 μm (n = 5).

Antennule. Reaches to middle of third thoracic segment. Spinule patterns on segments 1, 4–5 and 7–13 (Fig. 23D). Hyaline membrane with one deep notch (Fig. 23E).

Antenna. Structure of endopodite as in *M. leuckarti.*

Basipodite (Figs. 23A-B): in addition to the basic pattern an oblique row of minute spinules occurs on medial caudal side. A group of spinules can be present on caudal side near exopodite seta (Fig. 27A). This group of spinules may be present or absent, even in specimens from the same locality. Longitudinal row of, on average, seven spines on caudal side; row proximal to this, on average with five minute spinules; longitudinal row on frontal side with, on average, fifteen spines.

Maxillule (Fig. 23C). Basis of maxillulary palp without a group of spines.

Thoracopods P_1-P_4. Spine- and seta-formula as in *M. leuckarti.* Connecting lamella of P_1-P_4 not pilose.

P_1 (Figs. 23F-G). Spine on inner distal margin of basipodite absent.

P_4 (Figs. 23H-I). Enp_3 on the average 3.52 times as long as wide. Inner apical spine usually longer than outer one, at times equal to outer spine. Armature of external margin of outer spine as in Fig. 23I. Caudal side of connecting lamella not pilose; prominences weakly developed just reaching over distal margin of connecting lamella. Inner lateral part of caudal side of coxopodite naked (Fig. 23H). Inner part of caudal side of basipodite proximally with a row of setules, distally with a group of setules (Fig. 23H).

P_5 (Fig. 24A). Spinous seta (63 μm) considerably shorter than seta (131 μm) implanted on same segment. Seta (100 μm) of distal segment longer than spinous seta and, reaches as far as, or slightly exceeds distal margin of genital segment.

P_6 (Fig. 24C). Composed of two spines and one seta.

Last thoracic segment (Figs. 24A-B-D). Bears only ventro-laterally and laterally a few setules.

Receptaculum seminis. As in Fig. 24D; striking is the structure of the posterior margin of the proximal part which is strongly chitinized. Pore-canal straight, without any curvature.

Abdominal segments. Only last abdominal segment set with a few rows composed of minute spinules as in Figs. 24F-G. Dorsal and ventral distal margin of last abdominal segment fringed with a row of spines.

Furca (Figs. 24F-G). Furcal rami on the average 3.0 times as long as wide and, not pilose internally. With the light microscope no patterns of spinules can be seen on the ventrum and dorsum. Dorsal furcal seta distinctly longer than external seta. Implantation of lateral and external setae provided with spinules.

Description of male

Illustrations of abdomen and P_6 of a male from Lake Kivu are given by Kiefer (1981, p. 168: Fig.

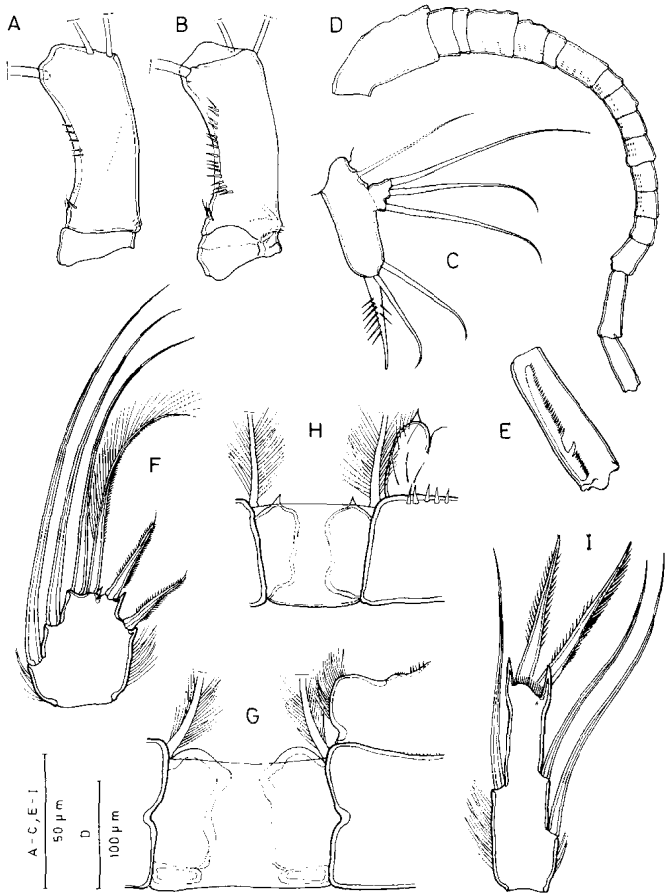

Fig. 23. Mesocyclops aequatorialis aequatorialis (Kiefer) Lake Kivu. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C. Maxillulary palp; D. A_1; E. Antennular segment 17; F. Exp_3P_1; G. Connecting lamella and inner portion of coxo- and basipodite of P_1; H. Connecting lamella and inner portion of coxo- and basipodite of P_4; I. Enp_3P_4.

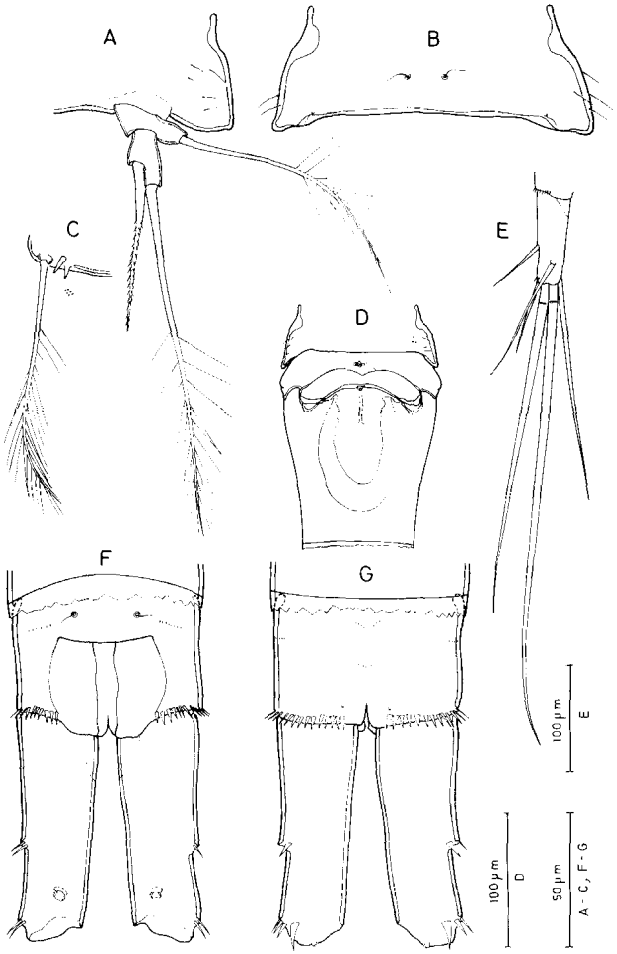

Fig. 24. Mesocyclops aequatorialis aequatorialis (Kiefer) Lake Kivu. A. P_5; B. Last thoracic segment, dorsum; C. P_6; D. Last thoracic segment and genital segment with receptaculum seminis; E. Furca; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view.

10–11). The following description is based on specimens from Lake Tanganyika (Uvira).

Mean total body length: 679 μm (n = 5). Armature of antennule as in the other species. Spine pattern on basipodite of antenna as in female; the same variability, i.e. presence or absence of the group of spinules near exopodite seta, was found. Structure of P_1-P_4 and P_5 as in female. P_6 composed of one spine (23 μm) and two setae (24 μm and 80 μm). Last thoracic segment in contrast to female with no setules ventro-laterally and laterally. Dorsal furcal seta as in female longer than external furcal seta.

Variability: females

Total body length between 835 μm and 966 μm. Furcal index: 2.92–3.38. No structural differences were found between the populations of Lake Kivu and Lake Tanganyika. Variability in spine pattern on basipodite of antenna only in one locus: spine group on caudal side at level of exopodite seta may be absent or present (Figs. 27A: ♂, B). The usual variability, between restricted limits, was found in the number of spines per row: longitudinal row on caudal side 5–8 spines, row proximal to this last row 3–6 spines and longitudinal row on frontal side 13–17 spines.

Differential diagnosis

M.a. aequatorialis can be differentiated from *M. a. similis* subsp. n. by the spine pattern on the basipodite of the antenna, the structure of P_5 and by the length of the dorsal furcal seta which exceeds the external in length.

Distribution (Fig. 42)

M.a. aequatorialis is abundantly present in both the pelagial and the littoral of Lake Kivu and Lake Tanganyika. At present it is the only representative of *Mesocyclops* in Lake Kivu; in Lake Tanganyika in addition one record is known of *M. kieferi.*

Remarks

In 1929 Kiefer described *M. leuckarti aequatorialis* from specimens collected in Africa and Asia (without designating type specimens) and no doubt this material was a mixture of several taxa. In his work of 1981, the author redescribed the taxon using specimens from Lake Kivu as the material of 1929 was no longer usable for redescription (Kiefers, pers. commun.). *M. leuckarti aequatorialis* was raised to specific rank as from both biogeographical and morphological point of view '*aequatorialis*' could no longer be considered as a subspecies of *M. leuckarti.*

According to Kiefer (1981) *M. aequatorialis* is distributed in the East African Lake District, Lake Tchad and on Tenerife. A closer examination showed that *M. aequatorialis* is composed of two subspecies: *M.a. aequatorialis,* restricted to Lakes Kivu and Tanganyika and *M.a. similis* subsp. n., widely distributed on the African continent.

Mesocyclops aequatorialis similis subsp.n.

1952 *Mesocyclops leuckarti aequatorialis*, Kiefer [partim], Explor. Parc natn. Albert, Mission H. Damas 1935/1936, Vol. 21, p. 99.
1978 *Mesocyclops leuckarti*, Van de Velde [partim], Biol. Jaarb., Vol. 46, p. 194.
1981 *Mesocyclops* sp. 5, Dumont *et al.*, Hydrobiologia, Vol. 80, p. 165.
1981 *Mesocyclops aequatorialis*, Kiefer [partim], Arch. Hydrobiol., Suppl. 62, p. 167.

Type locality: Kenya, Lake Naivasha (1 020 m a.s.), leg. K. Mavuti, Nairobi, 4-10-1979.

Type material

holotype: one ♀ without eggs, mounted on two slides as described above;
allotype: one ♂, mounted on one slide;
paratypes: four dissected females, each mounted on two slides; one tube containing undissected specimens preserved in a formaldehyde/glycerine mixture: 35 ♀ (with and without eggs), five ♂ and ten copepodids stage V.

Repository of type material

Holotype, allotype and six undissected specimens (4 ♀, 2 ♂) deposited in the Koninklijk Museum voor Midden-Afrika, Tervuren, Belgium. Five paratype females in the collection of Prof. Kiefer (Konstanz). Remaining paratypes in the collection of the Zoological Institute, University of Gent.

Etymology: the subspecies is named '*similis*' due to its close resemblance with *M. aequatorialis aequatorialis.*

Material examined (specifications see Table 1)
Kenya: Naivasha (type material); Senegal: Nieri Ko, Simenti, Ross Bethio; Mali: Niafunké, Horo, Télé, Mbuna, Tin Geicha, Tombouctou, Dyabali, Markala, Mopti, Sanga, Gossi, Aougoundou; Guinée Buissau: Rio Geba; Ivory Coast: Gagouin; Upper-Volta: Loumbila; Algeria: Djanet, Beibei, Oued Adjerii; Zaire: Kolwezi, Jadotville, Wamba, Saké; Ruanda-Burundi: Astrida, Rugwero, Birira, Tsohoho; Ethiopia: Koka, Awassa, Black River, Hora, Bishoftu, Akaki, Debre Marcos, Langano, Zway, Abyata, Tana.

Description female (holotype)

Total body length of the holotype: 1 495 μm; for other measurements see Table 7.

Antennule (Fig. 25A-B). As in *M.a. aequatorialis*.

Antenna. Structure of endopodite as in the nominate subspecies.

Basipodite (Figs. 25D-E). In addition to the basic pattern a row of minute spinules present on medial caudal side. At the level of exopodite seta a group of spines and, at the level of inner apical setae a patch of minute spinules present. Longitudinal row of spines on caudal side with fourteen spines, row proximal to this with thirteen spines; longitudinal row on frontal side with 33 spines.

Mouthparts. As in the nominate subspecies.

Thoracopods P_1-P_4. The following differences are noted from *M.a. aequatorialis*. Segments more robustly built, prominences on distal margin of connecting lamella of P_4 slightly more prominent and L:W ratio of Enp_3P_4 2.81 (Fig. 25I). Armature of inner apical spine of Enp_3P_4: external margin set with robustly built spinules whereas in *M.a. aequatorialis* the spinules are fine.

P_5 (Fig. 26C). Spinous seta on distal segment slightly shorter than seta implanted on the same segment and markedly longer than seta implanted on basal segment.

P_6 (Fig. 26D). Composed of two spines and one seta; this seta is markedly shorter than in the nominate subspecies.

Last thoracic segment (Figs. 26A-C). Laterally more densely setose than in *M.a. aequatorialis*.

Receptaculum seminis (Fig. 26B). As in nominate subspecies.

Abdominal segments (Figs. 26F-G). As in *M.a. aequatorialis*.

Table 7. Morphometry of *Mesocyclops aequatorialis similis* subsp.n. (Naivasha, Kenya). Measurements in μm.

		Holotype	Allotype	Paratypes (♀)			
Cephalothorax	L	541	354	533	525	491	516
	W	499	300	508	499	433	492
	L:W	1.08	1.18	1.05	1.05	1.13	1.05
Ceph. + Thorax	L	949	621	916	949	883	882
Genital segment	L	216	117	167	166	158	208
	W	167	113	208	233	212	154
	L:W	1.29	0.97	1.25	1.40	1.34	1.33
Abdomen	L	425	300	425	458	412	433
Furca	L	121	76	125	123	106	121
	W	38	25	44	40	37	38
	L:W	3.18	3.04	2.84	3.07	2.86	3.18
Total body length		1 495	997	1 511	1 530	1 401	1 436
Enp_3P_4	L	104	70	104	108	91	91
	W	37	21	38	38	33	33
	L:W	2.81	3.33	2.74	2.84	2.76	2.79
Enp_3P_4	sp_i	79	63	79	75	75	77
	sp_e	80	58	77	79	65	79
	sp_i:sp_e	0.98	1.09	1.03	0.94	1.15	0.97
Furcal setae	S_i	292	183	308	283	266	283
	S_{mi}	566	400	566	575	533	516
	S_{me}	358	308	433	425	383	408
	S_e	121	79	120	121	108	133
	S_d	83	58	92	83	75	79

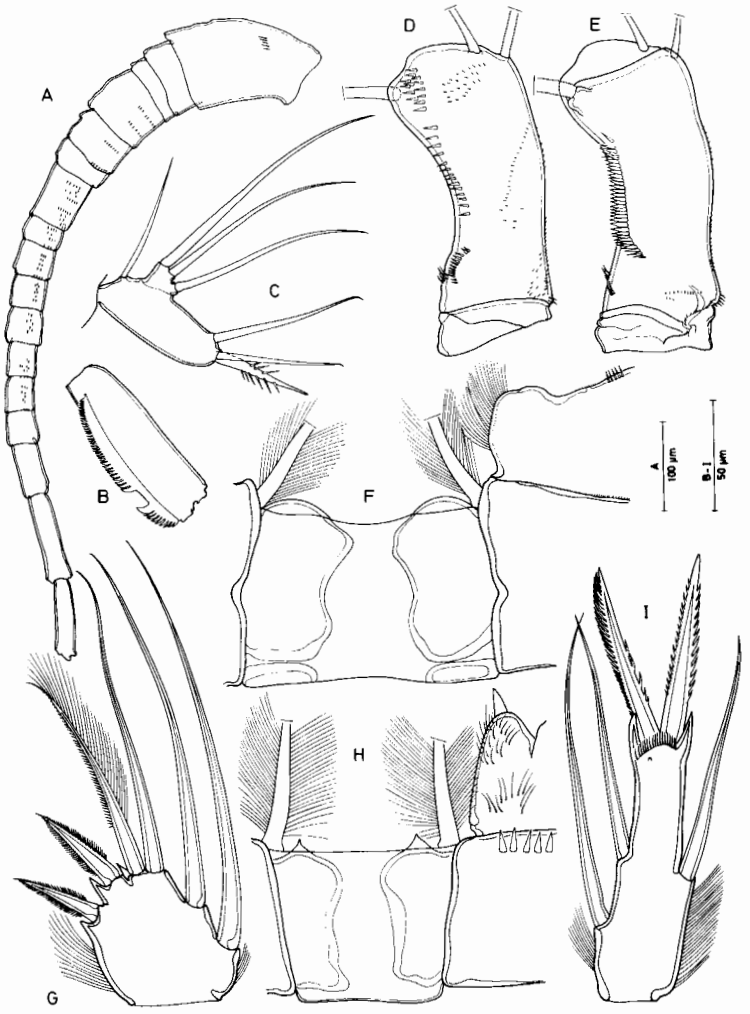

Fig. 25. Mesocyclops aequatorialis similis subsp.n. (holotype) Naivasha, Kenya. A. A_1; B. Antennular segment 17; C. Maxillulary palp; D. Basipodite A_2, caudal side; E. Basipodite A_2, frontal side; F. Connecting lamella and inner portion of coxo- and basipodite of P_1; G. Exp_3P_1; H. Connecting lamella and inner portion of coxo- and basipodite of P_4; I. Enp_3P_4.

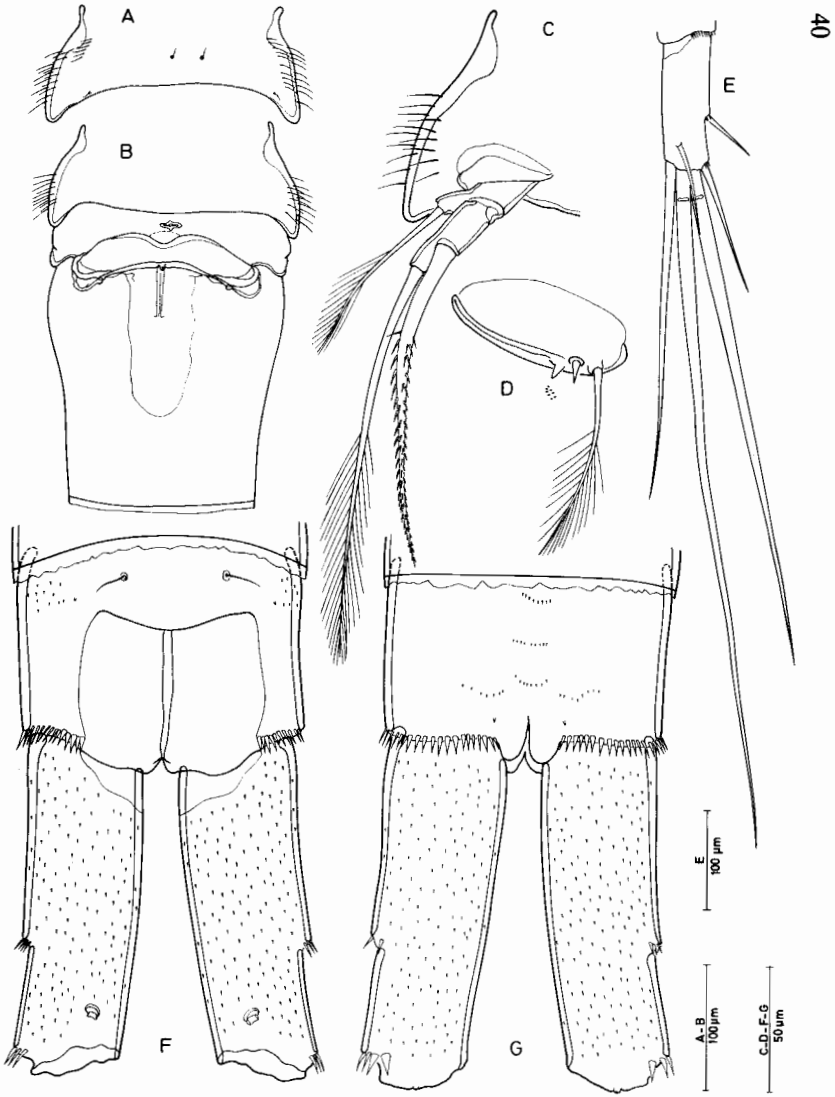

Fig. 26. Mesocyclops aequatorialis similis subsp.n. (holotype) Naivasha, Kenya. A. Last thoracic segment, dorsum; B. Last thoracic segment and genital segment with receptaculum seminis; C. P_5; D. P_6; E. Furca; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view.

Furca (Figs 26F-G). Differences from nominate subspecies in that: furcal rami more robustly built (L:W: 3.18), dorsum and ventrum with minute spinules; dorsal furcal seta shorter (83 μm) than external (121 μm).

Description of male (allotype)

Total body length: 997 μm, other measurements see Table 7. Armature of antennule as in nominate subspecies. Spine pattern on basipodite of antenna, structure of P_1-P_4, armature of last thoracic segment, structure of P_5 and furcal rami as in female. P_6 composed of one spine (33 μm) and two setae (respectively 30 μm and 47 μm); last seta considerably shorter than the seta of *M.a. aequatorialis*. Dorsal furcal seta, as in female, shorter than external.

Variability: females

Measurements were taken on fifteen specimens from various localities. Total body length between 1 201 μm and 1 547 μm. Furcal index between 2.65 and 3.21. Dorsal furcal seta always shorter than external.

L:W ratio of Enp_3P_4 2.52–3.04. Inner apical spine longer or shorter than outer.

Spine pattern on basipodite of antenna constant; variability only in number of spines per row, between restricted limits: longitudinal row on caudal side with 9–14 spines, row proximal to this with 9–13 spines, longitudinal row on frontal side 23–34 spines.

Differential diagnosis

M. aequatorialis similis subsp.n. differs from the nominate subspecies in the spine pattern on the basipodite of the antenna, structure of P_5 and in the length of the dorsal furcal seta compared to the external.

Distribution (Fig. 42)

The range of *M.a. similis* is located south of the Sahara. In the Sahara pluvial relicts are found in the Tassili-n-Ajjer. It is abundant in the Sahel and Guinea zone in Western Africa and is widely distributed in the East African lake district where it occurs in lakes and swamps situated in the Eastern Rift Valley, the Western Rift Valley, and on the Ethiopian plateau. Further records are in Southern Zaire.

Remarks

Examination of populations from Lakes Victoria, Edward, and Mugesera (east of Lake Kivu) showed that these specimens did not completely agree with the above defined subspecies.

Individuals from Lake Victoria are robustly built (mean total body length: 1 145 μm; n = 5) and characterized by a spine pattern on the basipodite of A_2 as in *M.a. similis* but the dorsal furcal seta exceeds the external in length and the spinous seta on the distal segment of P_5 almost is as long as the seta implanted on the basal segment (Figs. 27F-G-H).

Specimens from Lake Edward (mean total body length: 1 276 μm; n = 5) are characterized by a spine pattern on the basipodite of A_2 similar to that of *M.a. aequatorialis*, the dorsal furcal seta exceeds the external in length and the spinous seta on the distal segment of P_5 equals in length the seta of the basal segment (Fig. 27C).

Lake Mugesera specimens showed the following characteristics: left antenna with the spine pattern on the basipodite of A_2 of *M.a. similis*, right antenna with the spine pattern of *M.a. aequatorialis*. Dorsal furcal seta considerably longer than external and spinous seta on the distal segment of P_5 equal in length to the seta of the basal segment (Figs. 27D-E).

We suggest that in a zone of contact between the two subspecies, hybrid populations occur, with character combinations of both subspecies. The populations described above are considered to be such hybrids of *M.a. aequatorialis* and *M.a. similis*.

Key to the subspecies of M. aequatorialis *and hybrids*

- Spine pattern on the basipodite of the antenna as in Figs. 23A-B or 27A-B, P_5: spinous seta of the distal segment distinctly shorter than the seta of the basal segment (Fig. 24A), dorsal furcal seta considerably longer than the external furcal seta (Fig. 24E) ..... *M.a. aequatorialis* (Kiefer)
- Spine pattern on the basipodite of the antenna as in Figs. 25D-E, P_5: spinous seta of the distal segment distinctly longer than the seta of the basal segment (Fig. 26C), dorsal furcal seta shorter than the external furcal seta (Fig. 26E) .... *M.a. similis* subsp.n.
- These characters not combined in that way (Figs. 27C-H) ... *M. aequatorialis*, hybrid populations

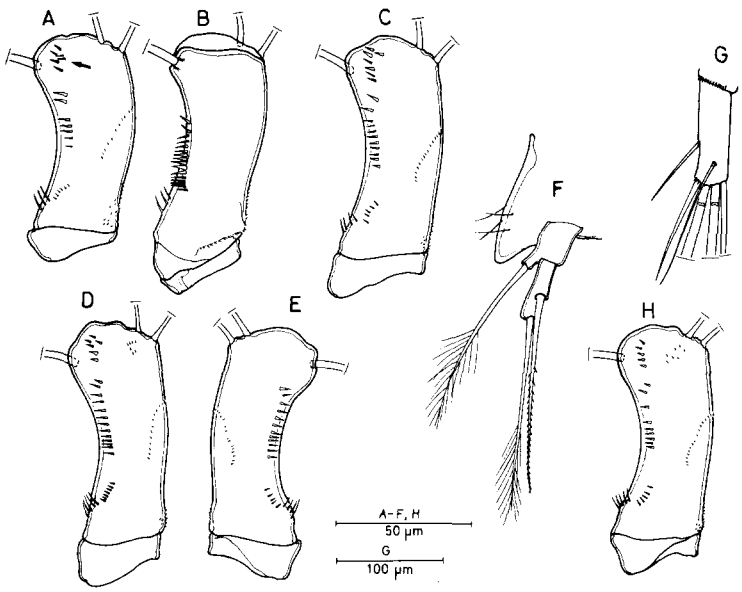

Fig. 27. Mesocyclops aequatorialis aequatorialis (Kiefer) Lake Tanganyika. A. Basipodite A^2, caudal side; B. Basipodite A^2, frontal side. *Mesocyclops aequatorialis,* hybrid populations. Specimen Lake Edward: C. Basipodite A^2, caudal side; Specimen Lake Mugesera: D. Left basipodite A^2, caudal side, E. Right basipodite A^2, caudal side; Specimen Lake Victoria: F. P^5, G. Furca, H. Basipodite A_2, caudal side.

Mesocyclops aspericornis (Daday, 1906)

1906 *Cyclops aspericornis* Daday, Zool. Jb. Syst., Vol. 24, p. 18, Pl. 14: figs. 1–6.
1910 *Cyclops aspericornis,* Daday, Zoologica, Vol. 8, p. 60, Figs. 27–29.
1938 *Mesocyclops leuckarti*, Kiefer [partim], Bull. biogeogr. Soc. Japan, Vol. 8, p. 60, Figs. 27–29.
1951 *Mesocyclops leuckarti*, Lindberg, Bull. Soc. zool. Fr., Vol. 76, p. 10.
1974 *Mesocyclops leuckarti aequatorialis*, Dussart, Bull. I.F.A.N., A. Vol. 36, p. 114.
1981 *Mesocyclops aspericornis*, Kiefer, Arch. Hydrobiol., Suppl. 62, p. 172, Fig. 10.

Type locality: originally described from Sumatra, Singapore and Hawaï.

Type material: collection von Daday, Zoologisch Museum, Budapest; not examined.

Material examined (specifications see Table 1)
Sumatra: Lake Toba (3 ♀); Nigeria: Okolom (1 ♀); Ethiopia: Awash (3 ♀, 1 ♂); Ghana: Obuasi (3 ♀); Zaire (Kivu): Luvungi (1 ♀), Kalungwe (2 ♀), Lungwe (3 ♀); Sudan: Kaboushia (3 ♀), Chor Amat (1 ♀, 1 ♂); Niger: Mekrou (1 ♀).

Redescription of female

In 1929 Kiefer considered *M. aspericornis* as a synonym of *M. leuckarti aequatorialis*. In his recent work he revised his opinion and redescribed *M. aspericornis* based on Daday's type material from Sumatra.

Prof. Kiefer kindly let us examine specimens from Lake Toba and a comparison with African specimens showed that no morphological differences exist.

The following description is based on specimens from Obuasi, Ghana.

Total body length: 1 183 µm.

Antennule (Figs. 28A-B). Reaches to distal margin of second thoracic segment. Spinules on segments 1, 4–5 and 7–13. Hyaline membrane with one deep notch.

Antenna. Structure of endopodite as in in *M. leuckarti.*

Basipodite (Figs. 28D-E): in addition to the basic pattern a continuous row of minute spinules occurs

on medial caudal side, continuing with a few spinules on inner margin. A patch of minute spinules present near inner apical setae. On the caudal side, a group of minute spinules is implanted between longitudinal row of spines (13) and row of spines (10) proximal to that row (Fig. 28D:↗). Longitudinal row on frontal side with 24 spines.

Maxillule. Basis of maxillulary palp without a row of spines (Fig. 28C).

Thoracopods P_1-P_4. Spine- and seta-formula as in *M. leuckarti*. Connecting lamella of P_1-P_4 naked.

P_1. Inner distal margin of basipodite without a spine (Fig. 28F).

P_4. Enp_3 2.50 times as long as wide. Inner apical spine exceeds external in length. External margin of inner apical spine smooth (Fig. 28I). Prominences of distal margin of connecting lamella well developed and as long as wide (Fig. 28H). Lateral inner part of caudal side of coxopodite without setules. Inner part of caudal side of basipodite distally with a group of setules and proximally with a row of setules (Fig. 28H).

P_5 (Fig. 29A). Spinous seta (95 μm) shorter than seta (125 μm) implanted on same segment; seta of basal segment 100 μm.

P_6. Of the usual structure, composed of two spines and one seta (Fig. 29D).

Last thoracic segment. Beset dorso-laterally with groups and rows of setules and spinous setules as in Fig. 29B; laterally and ventro-laterally with setules as in Figs. 29A-C.

Receptaculum seminis. As in Fig. 29C; lateral arms slightly curved backwards, anterior margin of proximal part bears a median incision. Copulatory-pore circular, pore-canal curved near the copulatory-pore.

Abdominal segments. Last segment with patterns of minute spinules dorsally and ventrally as in Figs. 29F-G. Dorsal and ventral distal margin of last abdominal segment fringed with a row of spines.

Furca. Furcal rami 3.45 times as long as wide with setules on inner margin (Figs. 29F-G). Minute spinules present on dorsum and ventrum of rami. Implantation of lateral and external furcal setae with spines. Dorsal furcal seta slightly shorter than external (Fig. 29E).

Description of male (specimen Awash)

Total body length: 762 μm. Armature of antennule as in the preceeding species. Spine pattern on basipodite of antenna and structure P_1-P_4 as in female. Last thoracic segment with setules on sides only. Furcal index 3.09; inner margin of rami without setules in contrast to female. P_6 composed of one spine and two setae.

Variability: females

Range in total length 1 183 μm and 1 313 μm. According to Kiefer (1981) the adult female reaches a length of 1.5 mm. Furcal index 3.37–3.45; 3–3.5 according to Kiefer (*op.cit.*). Dorsal furcal seta slightly shorter than external, but possibly sometimes longer.

Length: width ratio of Enp_3P_4 about 2.5. Inner apical spine of Enp_3P_4 shorter than outer apical spine, but possibly sometimes longer. Outer margin of inner apical spine smooth or bears a few spinules proximally. No variability in size of prominences on distal margin of connecting lamella of P_4, only shape of prominences differs (pointed or rounded at their apex).

Spine pattern on basipodite of antenna species-specific; variability only in number of spines per row; longitudinal row on caudal side 11–15 spines, proximal row 7–11 spines, longitudinal row on frontal side 20–25 (except in specimens from Kalungwe: 34 spines). In specimens from West Africa a row of spinules can be seen distal to the patch of spinules near the inner apical setae (Fig. 28D: ↗). This row is absent in specimens from East Africa and from Sumatra.

Differential diagnosis

M. aspericornis is easily distinguished from its congeners by the spine pattern on the basipodite of its antenna and by the shape of the receptaculum seminis. As regards the armature of the furcal rami, *M. aspericornis* (only females) and *M. tenuisaccus* are the only species in Africa that possess setules along the entire margin of the rami, but in the latter species the rami are extremely long.

Distribution (Fig. 45)

M. aspericornis is the only *Mesocyclops* species found in Africa that also has a wide distribution in the Oriental Region: India, Taiwan, Java, Sumatra, Philippines, Marian- and Marshall Islands and Hawaï (*vide* Kiefer, 1981).

On the African continent it is distributed along a

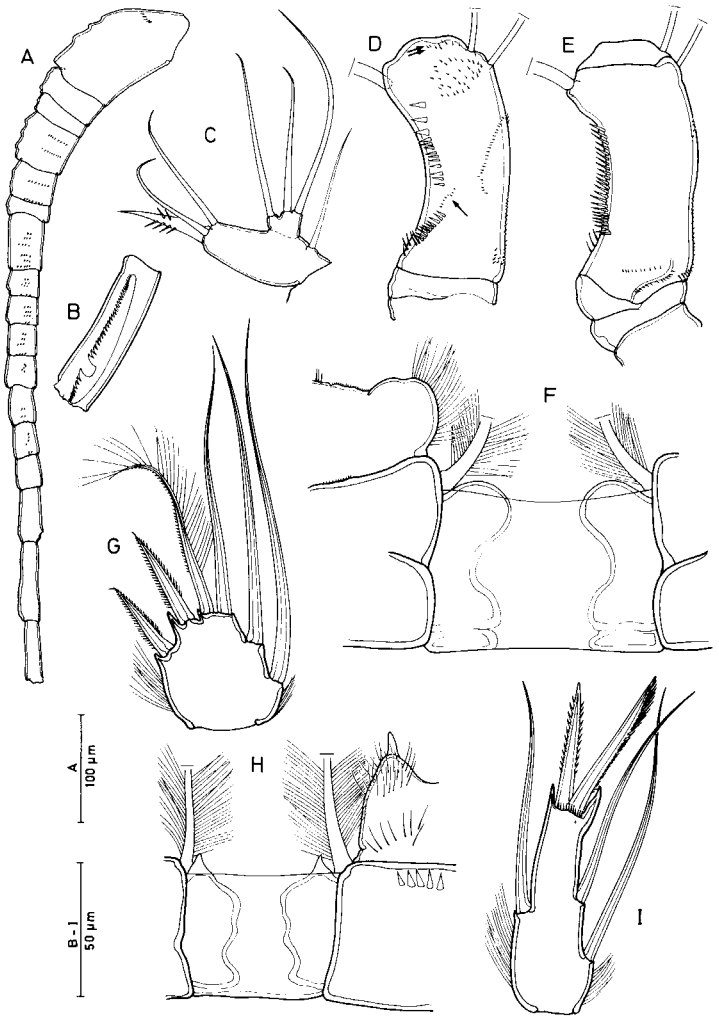

Fig. 28. Mesocyclops aspericornis (Daday) Obuasi, Ghana. A. A_1; B. Antennular segment 17; C. Maxillulary palp; D. Basipodite A_2, caudal side; E. Basipodite A_2, frontal side; F. Connecting lamella and inner portion of coxo- and basipodite of P_1; G. Exp_3P_1; H. Connecting lamella and inner portion of coxo- and basipodite of P_4; I. Enp_3P_4.

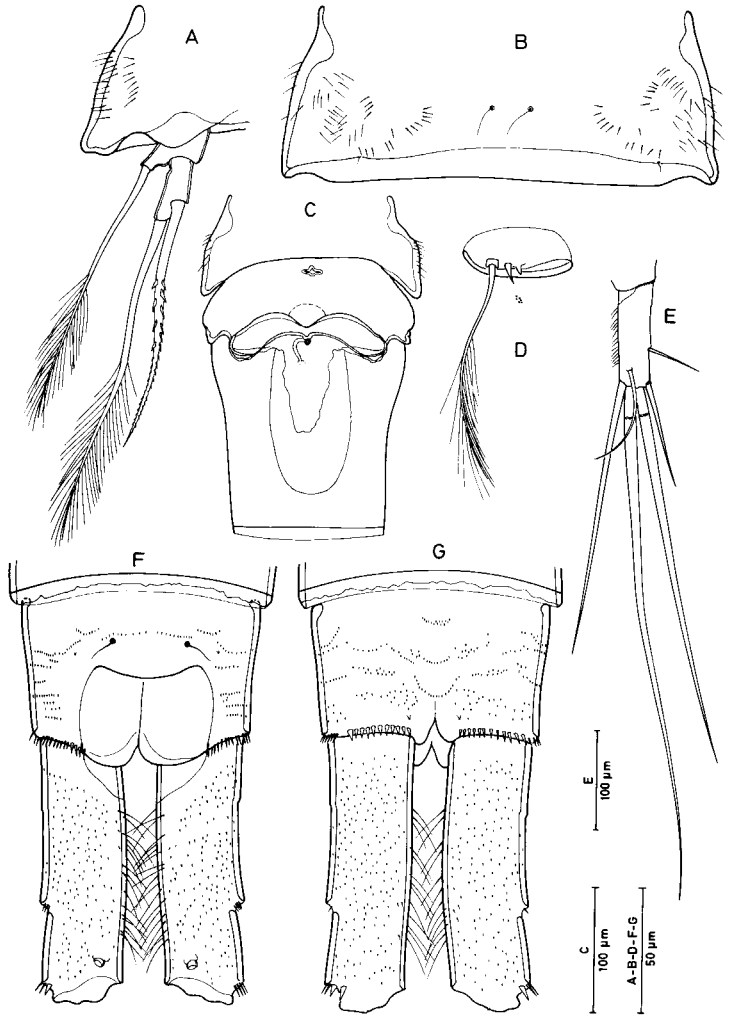

Fig. 29. Mesocyclops aspericornis (Daday) Obuasi, Ghana. A. P_5; B. Last thoracic segment, dorsum; C. Last thoracic segment and genital segment with receptaculum seminis; D. P_6; E. Furca; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view.

west-east axis: West Africa (south of the Sahara), East African Lake District, Ethiopian highland, Nile-valley, and Red Sea hills. *M. aspericornis* is rather rare. In all localities, it was found in low numbers only.

Probably, the records of *M. iranicus* from Iran (Lindberg, 1936) and *M. leuckarti* (sic!) with pilose furcal rami from Afghanistan (Lindberg, 1948) refer to this species and this would fill up the present gap between the Afrotropical and Oriental regions.

Mesocyclops spinosus sp.n.

Type locality: Man (07°10'N-05°50'W), Ivory Coast: 2.5 km on the road Man-Danané, shallow pool in tropical rain forest at the foot of the Tonkoui mountain; leg. L. Samsoen, Gent, 1-8-1979.

Type material

holotype: one ovigerous female, dissected and mounted on two slides;

paratype material: nine females without eggs;

- five dissected females;
- one tube containing four undissected females, preserved in a formaldehyde/glycerine mixture.

Repository of type material

Holotype, two dissected and two undissected females, deposited in the Koninklijk Museum voor Midden-Afrika, Tervuren, Belgium.

Remaining paratype material in the collection of the Zoological Institute, University of Gent.

Etymology: the name '*spinosus*' point to the presence of spines on the genital segment, distal to P_6.

Material examined: type material, as described above.

Description of female (holotype)

Total body length: 1 408 μm. For other measurements see Table 8.

Antennule (Figs. 30A, E). Reaches middle of third thoracic segment. Spinules on segments 1, 4–5, 7–10 and 12–13. Hyaline membrane with one deep notch.

Antenna. Structure of endopodite as in *M. leuckarti*.

Basipodite (Figs. 30C-D). Spine pattern very similar to that of *M. kieferi* except that longitudinal row of spines on frontal side is composed of 30 spines (*M. kieferi*: 18–23 spines, *M. spinosus*: 26–30 spines).

Maxillule (Fig. 30B). Basis of maxillulary palp not provided with a row of spines.

Thoracopods P_1-P_4. Spine- and seta-formula as in *M. leuckarti*. Connecting lamella of P_1-P_4 naked.

P_1. Spine absent on inner distal margin of basipodite (Fig. 30I).

P_4. Enp_3 2.91 times as long as wide. Inner apical spine shorter than outer; armature of these spines as in Fig. 30F. Prominences on distal margin of connecting lamella well developed (Fig. 30G). Lateral inner part of coxopodite without setules; inner part of caudal side of basipodite distally with a group of setules and proximally with a row of setules (Fig. 30G).

P_5 (Fig. 31E). Spinous seta (129 μm) of distal segment shorter than seta (169 μm) implanted on same segment; seta of basal segment 131 μm long.

P_6. Of the usual structure. Distally to implantation of P_6, a group of spines more or less arranged in rows, occurs (Fig. 31B: ↙).

Last thoracic segment (Figs. 31C-D). Proximal part of dorso-lateral side with a curved row of spinous setules (Fig. 31C); and setules present along sides of segment.

Receptaculum seminis (Fig. 31D). Proximal part exhibits a narrow lengthened outlook; left and right part of posterior margin depart as one 'jointed' canal from copulatory-pore. Pore-canal curved proximally.

Abdominal segments. As described above, genital segment provided with a group of spines on its dorso-lateral side. Of the remaining abdominal segments only the last one ornamented with spinules as in Figs. 31F-G. Distal margin of last abdominal segment fringed with a row of spines.

Furca (Figs. 31A, F-G). Furcal rami 2.52 times as long as wide. Dorsum and ventrum of rami with spinules; in addition two groups of spines occur on distal part of dorsum. Inner margin furnished with a group of setules proximally. In contrast to external seta, lateral has no spines at its implantation. Length of setae as in Table 8.

Male: unknown.

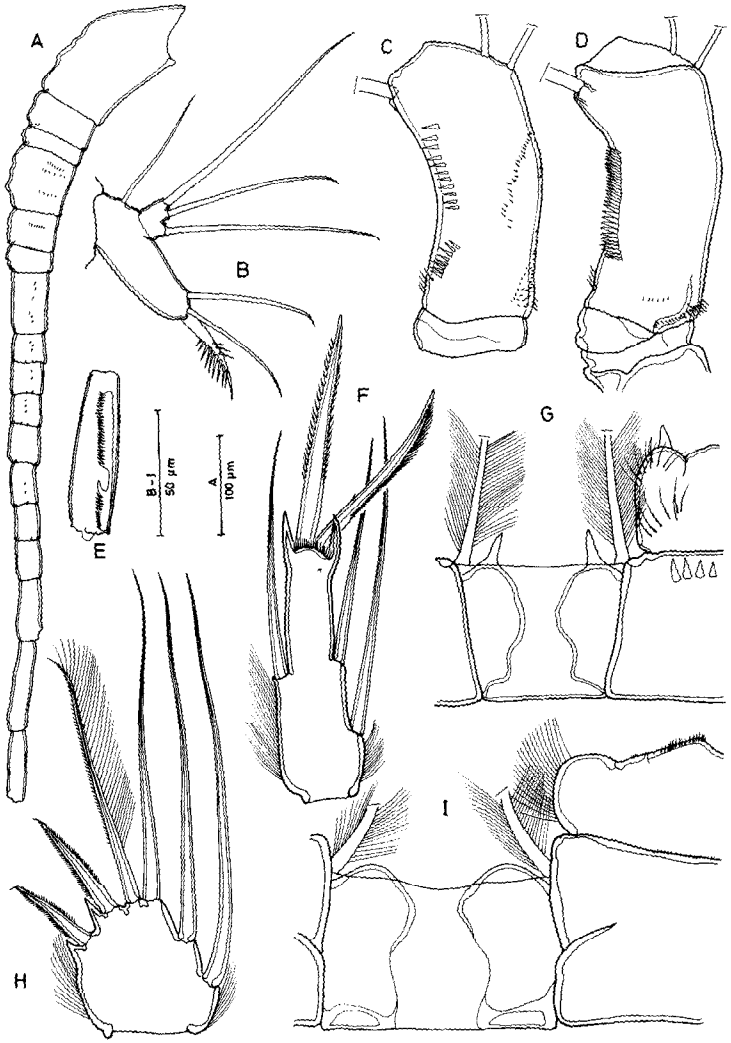

Fig. 30. Mesocyclops spinosus sp.n. (holotype) Man, Ivory Coast. A. A_1; B. Maxillulary palp; C. Basipodite A_2, caudal side; D. Basipodite A_2, frontal side; E. Antennular segment 17; F. Enp_3P_4; G. Connecting lamella and inner portion of coxo- and basipodite of P_4; H. Exp_3P_1; I. Connecting lamella and inner portion of coxo- and basipodite of P_1.

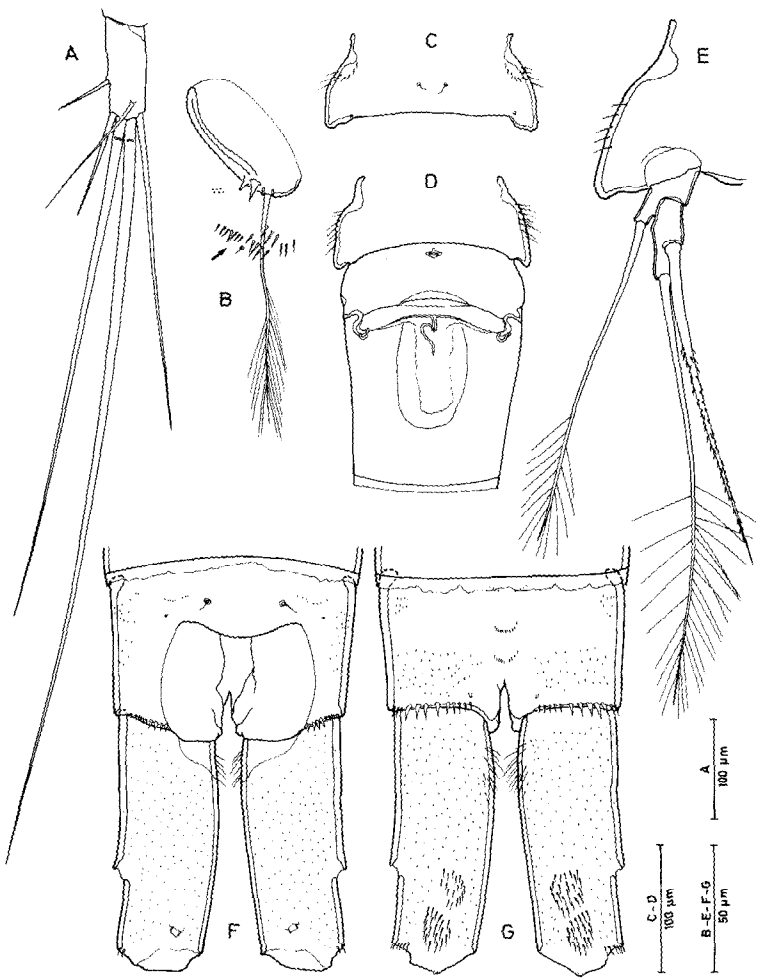

Fig. 31. Mesocyclops spinosus sp.n. (holotype) Man, Ivory Coast. A. Furca; B. P_6, note group of spines distally to implantation of P_6; C. Last thoracic segment, dorsum; D. Last thoracic segment and genital segment with receptaculum seminis; E. P_5; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view.

Table 8. Morphometry of *Mesocyclops spinosus* sp.n. (Man, Ivory Coast). Measurements in μm.

		Holotype	Paratypes (♀)		
Cephalothorax	L	541	500	500	558
	W	475	475	491	475
	L:W	1.14	1.05	1.02	1.17
Ceph. + Thorax	L	908	900	841	925
Genital segment	L	200	192	183	200
	W	150	142	142	142
	L:W	1.33	1.35	1.28	1.41
Abdomen	L	392	375	358	408
Furca	L	108	96	102	96
	W	42	33	35	38
	L:W	2.52	2.91	2.91	2.53
Total body length		1 408	1 371	1 301	1 429
Enp_3P_4	L	99	92	103	96
	W	34	30	29	29
	L:W	2.91	3.06	3.55	3.31
Enp_3P_4	sp_i	80	82	80	75
	sp_e	94	87	88	83
	$sp_i:sp_e$	0.85	0.94	0.99	0.90
Furcal setae	S_i	320	292	333	342
	S_{mi}	762	716	758	758
	S_{me}	511	483	450	483
	S_e	107	100	104	120
	S_d	135	86	121	129

Variability: females

Total length between 1 301 μm and 1 429 μm. Furcal index 2.52–2.91. Dorsal furcal seta shorter or longer than external.

Length:width ratio of Enp_3P_4 2.91–3.55. In the examined specimens the inner apical spine does not exceed the outer in length. External margin of inner spine bears one to ten spinules, but it is possible that these spinules can be completely absent.

Spine pattern on basipodite of antenna constant; variability only in number of spines per row: longitudinal row on frontal side 26–30 spines, longitudinal row on caudal side 9–11, row proximal to this last row 9–11 spines.

Differential diagnosis

M. spinosus sp.n. is unique in possessing a group of spines on the genital segment. It also differs from its congeners by the structure of the receptaculum seminis and the armature of the furcal rami.

Distribution (Fig. 45)

At present *M. spinosus* sp.n. is known from its type locality only.

Mesocyclops salinus Onabamiro, 1957 [emend.]

1952 *Mesocyclops leuckarti aequatorialis*, Kiefer [partim], Explor. Parc natn. Albert, Mission H. Damas 1935/1936, Vol. 21, p. 99, Fig. 159.

1957 *Mesocyclops salina* Onabamiro, J. linn. Soc. London, Vol. 43, p. 123, Figs. 1–6.

1981 *Mesocyclops* sp. 2, Dumont *et al.*, Hydrobiologia, Vol. 80, p. 165.

1981 *Mesocyclops curvatus* Kiefer, Arch. Hydrobiol., Suppl. 62, p. 169, Fig. 8.

Type locality: Nigeria, Korudu beach near Lagos, brackish water. Collection made by S. D. Onabamiro on 24-2-1951.

Type material

Ibadan University College, index no. 5: 'Type', Female (stated in Onabamiro's paper). As already mentioned for *M. ogunnus*, no type material is available from this Institute.

Britisch Museum (Natural History, London): one tube containing four undissected females (one ovigerous female), preserved in alcohol; labelled

syntypes, Korudu beach, Lagos, Nigeria, S. D. Onabamiro 1957, 2.15.1. These specimens are in a rather bad condition probably due to former dessication: all specimens are shrunken, parts of the furcal rami and several setae are broken off. The syntypical material has been manipulated as follows: all specimens were dissected and mounted each on one slide and, labelled according to the indications on the tube and marked respectively syntypes I-IV.

Material examined (specifications see Table 1)
Nigeria: type material, as described above; Guinea-Bissau: Rio Geba; Benin: Porto Novo; Zaire: Saké Banza, Kivu district: Karimurira, Luvungi, Lake Edward (Vitshumbi); Ruanda-Burundi: Tsohoho, Milay, Rugwero, Mugesera, Goshoba, Birira, Ruzizi (+ specimens resulting from breeding experiments); Mozambique: Dondo, Meconta, Xai-Xai, Mossuril; Mali: Gossi; Ethiopia: Lake Awassa, Black River.

Redescription of female

Onabamiro's description of *M. salinus* can be summarized as follows: furcal rami naked on their inner margin and rather short (2.5–2.8 times as long as wide); connecting lamella of P_4 with pointed prominences, Enp_3P_4 2.6 times as long as wide, terminal spines subequal; hyaline membrane of 17th antennular segment with three notches; receptaculum seminis resembling that of *M. longisetus* (Thiebaud).

The following redescription is based on the syntypes. Because of their poor condition additional information is given for specimens from lake Edward.

Total body length could not be measured accurately; length given by Onabamiro: 1.0 mm.

Antennule (Figs. 32E-F). Reaches to distal margin of second thoracic segment. Hyaline membrane with several notches.

Antenna. Endopodite as in *M. leuckarti.*

Basipodite (Figs. 32A-D). Spine pattern on basipodite of antenna very similar to that of *M. rarus* but differing in the number of spines in the group proximal to the exopodite seta (but see variability). Several spines are broken off, but remains of their implantation are still visible. Longitudinal row of spines on frontal side 12–16 spines; longitudinal row on caudal side of 9–12; spine row proximal to this last row with 4–7 spines. Group of spines proximal to the exopodite seta with 4–6 spines.

Maxillule. Maxillulary palp provided with a row of small spines (Fig. 32G).

Thoracopods P_1-P_4. Seta- and spine-formula as in *M. leuckarti.* Connecting lamella P_1, P_2 and P_3 devoid of setules.

P_1. Spine absent on inner distal margin of basipodite (Fig. 32I).

P_4. Enp_3 in four syntypes respectively 2.44, 2.44, 2.70 and 2.54 times as long as wide. Inner apical spine exceeds outer in length. Armature of both spines illustrated in Fig. 32J. Caudal side of connecting lamella provided with two rows of setules; distal margin with strongly developed prominences (Fig. 32K). Caudal side of coxopodite devoid of setules on lateral inner part; distal internal part of caudal side of basipodite only proximally with a group of setules (Fig. 32K).

P_5 (Fig. 32L) and P_6 (Fig. 32M). Of the usual structure.

Last thoracic segment (Figs. 32L & 33A, E: specimen from Lake Edward). Naked.

Receptaculum seminis. The illustration of Onabamiro (*op.cit.*, p. 124, Fig. 2) is certainly inadequate. Due to shrinkage of the syntypes, structure of receptaculum seminis could not be reconstructed. Only in syntype III is the region of the copulatory pore visible (Fig. 33H). The following description is based on a specimen from Lake Edward. Left and right part of posterior margin of proximal part depart as a short 'jointed' canal from copulatorypore. Lateral arms widen towards laterally, due to the strongly curved posterior margin (Fig. 33E). There is little resemblance to the receptaculum seminis of *M. longisetus* as stated by Onabamiro (*op.cit.*).

Abdominal segments. Last segment only ornamented with minute spinules dorsally and ventrally. Distal margin of last segment fringed dorsally with spines, ventrally with smaller spines (Figs. 32N-O).

Furca (Figs 32N-O). L:W ratio of rami in syntypes I-IV respectively 2.88, broken off, 2.78 and 2.89. Rami dorsally and ventrally with minute spinules. Most of furcal setae are broken off in syntypes. Onabamiro (*op. cit.*) states that dorsal seta is shorter than external. Lateral furcal seta lacks spines at its implantation, in contrast to external.

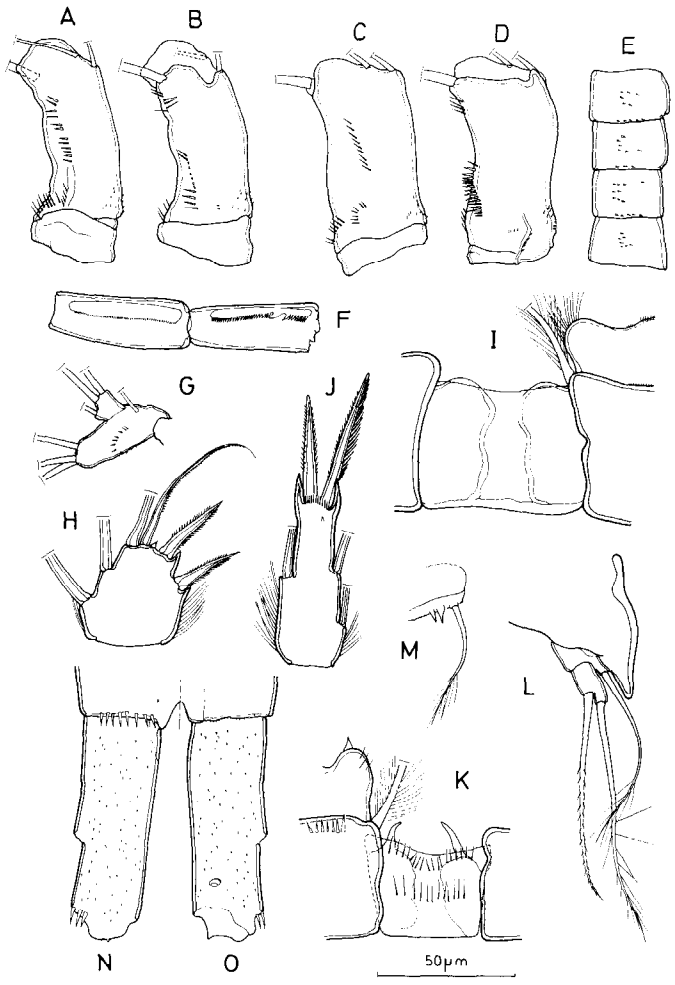

Fig. 32. Mesocyclops salinus Onabamiro (syntype I) Korudu, Nigeria. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C-D. Idem, syntype II; E. Antennular segments 9–12; F. Antennular segments 16 & 17; G. Maxillulary palp; H. Exp_3P_1; I. Connecting lamella and inner portion of coxo- and basipodite of P_1; J. Enp_3P_4; K. Connecting lamella and inner portion of coxo- and basipodite of P_4; L. P_5; M. P_6; N. Furcal ramus, ventral view; O. Furcal ramus, dorsal view.

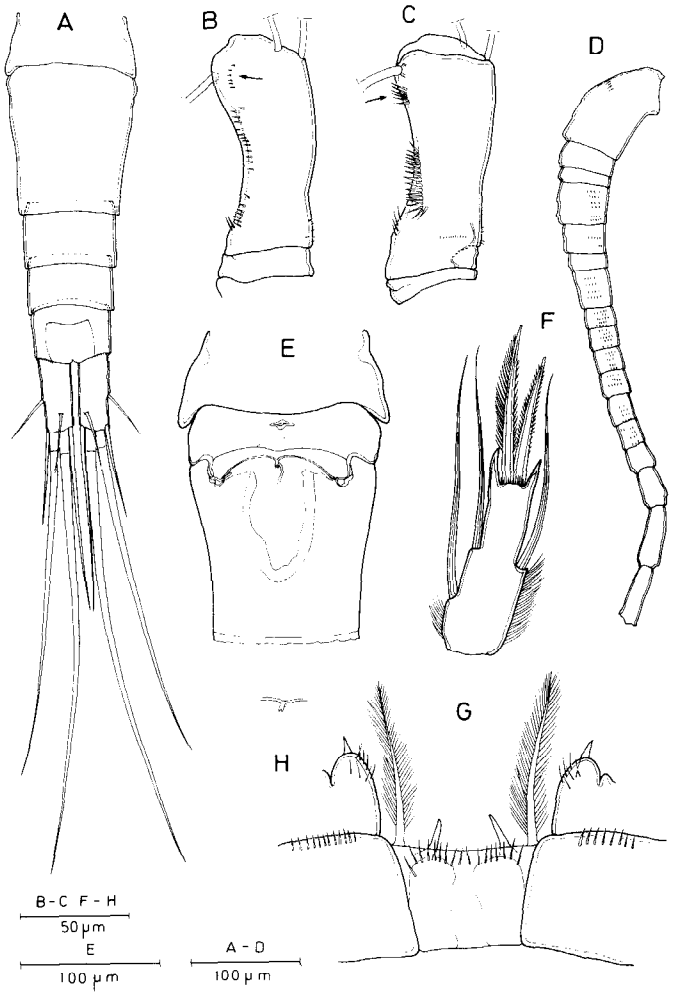

Fig. 33. Mesocyclops salinus Onabamiro Lake Edward. A. Last thoracic segment and abdomen; B. Basipodite A_2, caudal side; C. Basipodite A_2, frontal side; D. A_1; E. Last thoracic segment and genital segment with receptaculum seminis; F. Enp_3P_4; G. Connecting lamella and inner portion of coxo- and basipodite of P_4; H. Area copulatory-pore of syntype II.

Description of male

The male was hitherto unknown; the following description is based on specimens resulting from breeding experiments.

Mean total body length: 637 μm (n = 10). Armature of antennule as in preceeding species. Spine pattern on basipodite of antenna, armature of maxillulary palp, last thoracic segment, structure of P_1-P_4 as in female. P_6 of the usual structure, composed of one spine and two setae. Furcal rami short, on the average 2.4 times as long as wide (n = 10); lateral and furcal setae provided with spines at their implantation.

Variability: females

Range, in total body length 952–1 268 μm (n = 10). L:W ratio of furcal rami never exceeds 3 (2.28–2.89). In the examined specimens dorsal furcal seta always shorter than external.

L:W ratio of Enp_3P_4 2.44–2.90. Mostly inner apical spine longer than outer; in a few cases both spines equal in length. External margin of inner apical spine with spinules along its entire margin, or spinules only occur proximally. Prominences on distal margin of connecting lamella P_4 always strongly developed; their shape either straight (Fig. 33G) or slightly bent (Fig. 32K). Caudal side of connecting lamella always provided with setules, arranged in one (Fig. 33G) or two rows (Fig. 32K).

Spine pattern on basipodite of antenna shows variability in one locus: spine group on caudal side at level of exopodite seta either present or absent (compare Figs. 32A, C and Fig. 33B:↗). This variability also found in offspring from one pair of parents. When this spine group is absent, the pattern resembles that of *M. rarus*. Usually both species can be distinguished by the number of spines in the group located proximal to exopodite seta (Fig. 33C:↗). The number of spines in *M. salinus* (4–9 spines) is inferior to that of *M. rarus* (11–14 spines); but exceptions are found in a few specimens of *M. salinus* that possess eleven spines. Longitudinal row of spines on caudal side 9–15 spines, row of spines proximal to this row 4–8 spines; longitudinal row of spines on frontal side 12–19 spines.

Remarks on synonymy

M. salinus too has never been reported since its original description.

In 1981 Kiefer described *M. curvatus* from East Africa of which the author put a few specimens at our disposal. A comparison was made with *M. salinus* and proved that *M. curvatus* is identical with *M. salinus*. Since Kiefer (*op. cit.*) did not study type material of *M. salinus*, specimens of *M. salinus*, designated by us as homeotypical, were sent to Prof. Kiefer who accepted the synonymy (see Kiefer, *op. cit.*, p. 190).

It should be noted that in Kiefer's figure 8:3 the connecting lamella is incorrectly drawn, i.e. without setules.

Differential diagnosis

With regard to the spine pattern on the basipodite of the antenna, *M. salinus* is related to the *'rarus-paludosus-tenuisaccus'* group, but it lacks the spine on the inner distal margin of the basipodite of P_1.

Distribution (Fig. 43)

M. salinus only occurs south of the Sahara. It is abundant in the Western Rift, and in the Eastern Rift it is found in Lake Awassa and the Black River (near Lake Awassa). In West Africa it occurs south of the rivers Senegal and Niger; in South-East Africa it lives in the coastal region. As the name reveals, *M. salinus* tolerates brackish and saline waters.

Mesocyclops tenuisaccus (Sars, 1927)

1927 *Cyclops tenuisaccus* Sars, Ann. s. afr. Mus., Vol. 25, p. 108, Pl. X: Figs. 1–13.

1929 *Mesocyclops tenuisaccus*, Kiefer, Z. wiss. Zool., Vol. 133, p. 25.

Type locality: South Africa (Cape Province): Salt River near Cape Town. Collection made by Purcell (no date stated).

Type material

South African Museum (Cape Town): one tube no. A 12460, containing 32 specimens preserved in alcohol: eighteen ♀ (egg sacs detached, loose in fluid), ten ♂ and four copepodids; labelled in Sars' handwriting *Cyclops tenuisaccus* GOS, Salt River.

No type material in the Sars collection in the Zoologisk Museum (Oslo) (Christiansen, *in litt.*).

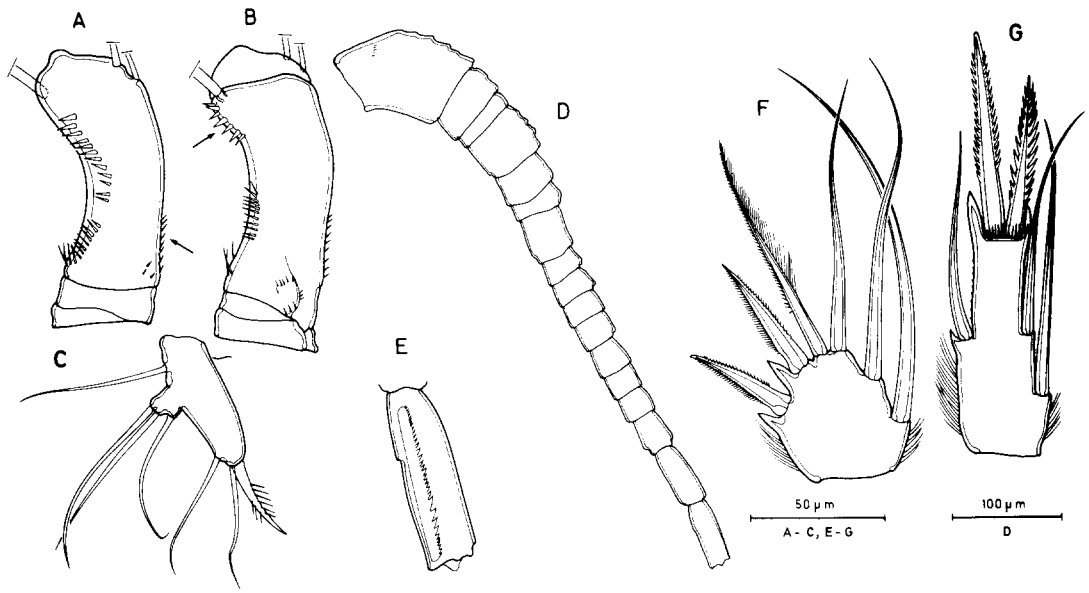

Fig. 34. Mesocyclops tenuisaccus (Sars) (lectotype) Salt River, South Africa. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C. Maxillulary palp; D. A_1; E. Antennular segment 17; F. Exp_3P_1; G. Enp_3P_4.

Lectotype designation

Probably due to a former desiccation the specimens are in a poor condition; some are shrunk and the setae on the furcal rami and the thoracopods are stuck to each other.

Since Sars (*op. cit.*) designated no type specimen, one female was selected as lectotype; the remaining specimens are considered as paralectotypes. The lectotype and seven paralectotypes (5 ♀ and 2 ♂) were dissected and mounted on slides (females: each on two slides, males: each on one slide) and the paralectotypes were respectively labelled I-VII.

Material examined: type material, as described above.

Redescription (lectotype)

The species was originally described as *Cyclops tenuisaccus* on the basis of the structure of the receptaculum seminis and the prolonged furcal rami. A rather extensive description was given by Sars (*op. cit.*, p. 108–112) considering the description standards used at that time.

Total body length: 1 517 µm, other measurements see Table 9.

Antennule (Figs. 34D-E). Reaches to distal margin of second thoracic segment. Armature as in *M. rarus* and *M. paludosus*: only first segment provided with a row of spinules. Hyaline membrane with several deep notches.

Antenna. Endopodite as in *M. leuckarti.*

Basipodite (Figs. 34A-B): spine pattern very similar to that of *M. rarus* and *M. paludosus*, except that the group of spines present proximal to exopodite seta is composed of robust spines implanted at some distance from each other (Fig. 34B:➶). Spines located in basal part of inner margin of basipodite are likewise robust (Fig. 34A:➶). Longitudinal row of spines on frontal side very short and composed of eleven spines. Longitudinal row of spines on caudal side with twelve spines; row proximal to this row with eight spines.

Maxillule. Lacks a row of spines on maxillulary palp (Fig. 34C).

Thoracopods P_1-P_4. Spine- and seta-formula as in *M. leuckarti.* Armature of connecting lamellae and of coxo- and basipodites illustrated in Fig. 35. Connecting lamella of P_1 devoid of setules; those of P_2, P_3 and P_4 with rows of setules.

Table 9. Morphometry of *Mesocyclops tenuisaccus* (Sars) (Salt River, South Africa). Measurements in μm.

		Lectotype	Paralectotypes			
			I (♀)	II (♀)	VI (♂)	VII (♂)
Cephalothorax	L	533	525	483	333	333
	W	425	475	425	267	242
	L:W	1.25	1.11	1.14	1.25	1.37
Ceph. + Thorax	L	900	816	924	633	616
Genital segment	L	188	217	183	83	83
	W	179	175	158	99	91
	L:W	1.05	1.24	1.16	0.84	0.91
Abdomen	L	425	425	375	267	258
Furca	L	192	208	191	108	104
	W	36	39	37	25	25
	L:W	5.33	5.33	5.16	4.32	4.16
Total body length		1 517	1 449	1 490	1 008	978
Enp_3P_4	L	97	94	102	75	67
	W	38	38	41	32	25
	L:W	2.55	2.47	2.49	2.34	2.68
Enp_3P_4	sp_i	68	79	100	79	63
	sp_e	58	66	75	50	46
	sp_i:sp_e	0.80	0.82	0.75	0.63	0.73
Furcal setae	S_i	233	267	267	188	191
	S_{mi}	599	666	633	399	416
	S_{me}	408	475	450	291	–
	S_e	115	138	133	73	–
	S_d	69	94	92	67	70
P_6 spine					16	18
seta (i)					33	34
seta (e)					62	56

P_1. Spine present at inner distal margin of basipodite (Fig. 35A).

P_2-P_3. Connecting lamella of P_2 on caudal side with two rows of setules (Fig. 35D); that of P_3 with three rows of setules (Fig. 35F).

P_4. Enp_3 2.55 times as long as wide. Inner apical spine on both sides ornamented with robust spinules and shorter than the outer one. Connecting lamella provided with setules implanted more or less in three rows. Prominences on distal margin well developed. Caudal side of coxopodite on lateral inner part with setules. Inner part of basipodite on caudal side proximally and distally with a group of setules (Fig. 35H).

P_5 (Fig. 36A). Spinous seta (111 μm) almost equals in length seta (95 μm) implanted on same segment. In the figured P_5 by Sars (Pl. X: Fig. 12) this spinous seta is considerably shorter than seta of the same segment.

P_6 (Fig. 36E). Of the usual structure, composed of two spines and one seta.

Last thoracic segment (Figs. 36B-C, H). Setules present on the flanks and groups of setules occur near distal margin of latero-dorsal side.

Receptaculum seminis (Figs. 36C-D). Its structure was hitherto unknown. Sars (*op. cit.*, p. 109) gives no illustration but states: 'The seminal receptacle, as far as I could make out in the preserved specimens is quite simple, without the large posterior expansion characteristic of the succeeding genus *Mesocyclops*'. (This was one of the reason the author placed '*tenuisaccus*' in the genus *Cyclops*). Indeed, its structure deviates from most *Mesocyclops* species (with the exception of some South-American species: *M. annulatus* (Wierzejski), *M. meridianus* Kiefer, *M. ellipticus* Kiefer). Outline of receptaculum seminis distinct due to strongly chitinized accessories. Region of copulatory-pore illustrated in Fig. 36D; pore-canal situated behind copulatory-pore, very short and strongly curved. Left and right part of posterior margin departs as one 'jointed' canal from copulatory-pore. Lateral

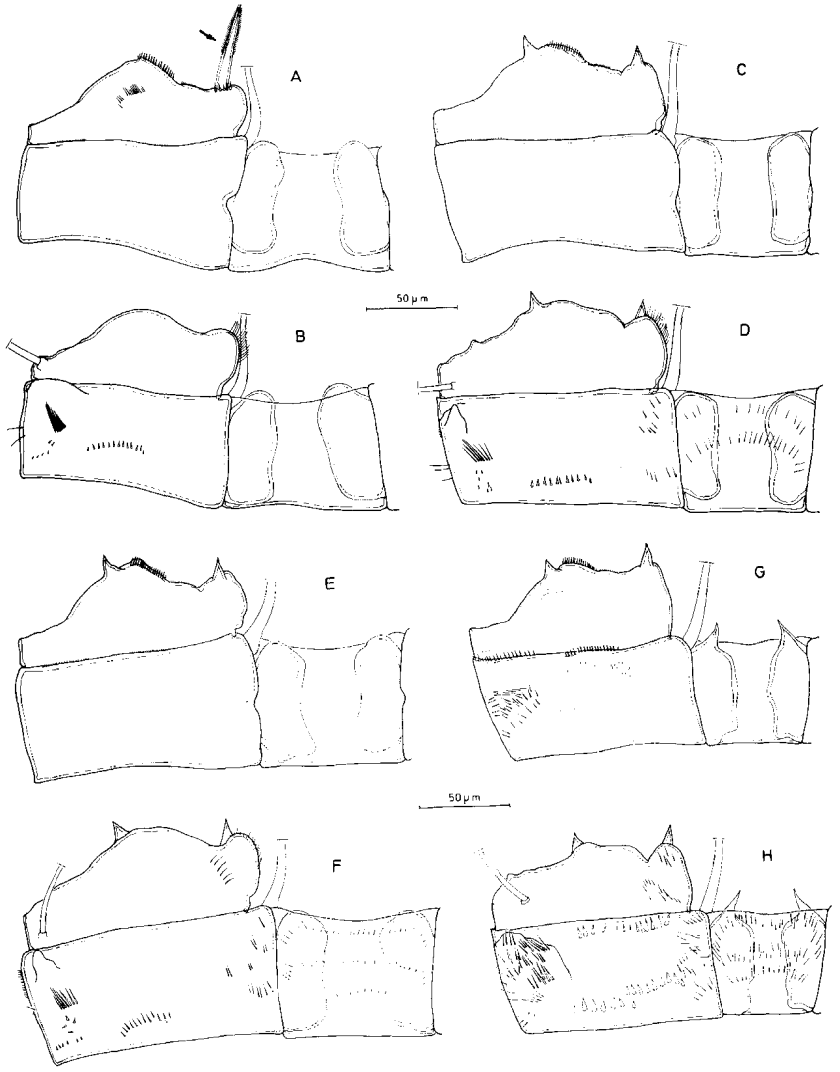

Fig. 35. Mesocyclops tenuisaccus (Sars) (lectotype) Salt River, South Africa. A, C, E, G. Connecting lamella, coxo- and basipodite of P_1-P_4, frontal side; B, D, F, H. Connecting lamella, coxo- and basipodite of P_1-P_4, caudal side.

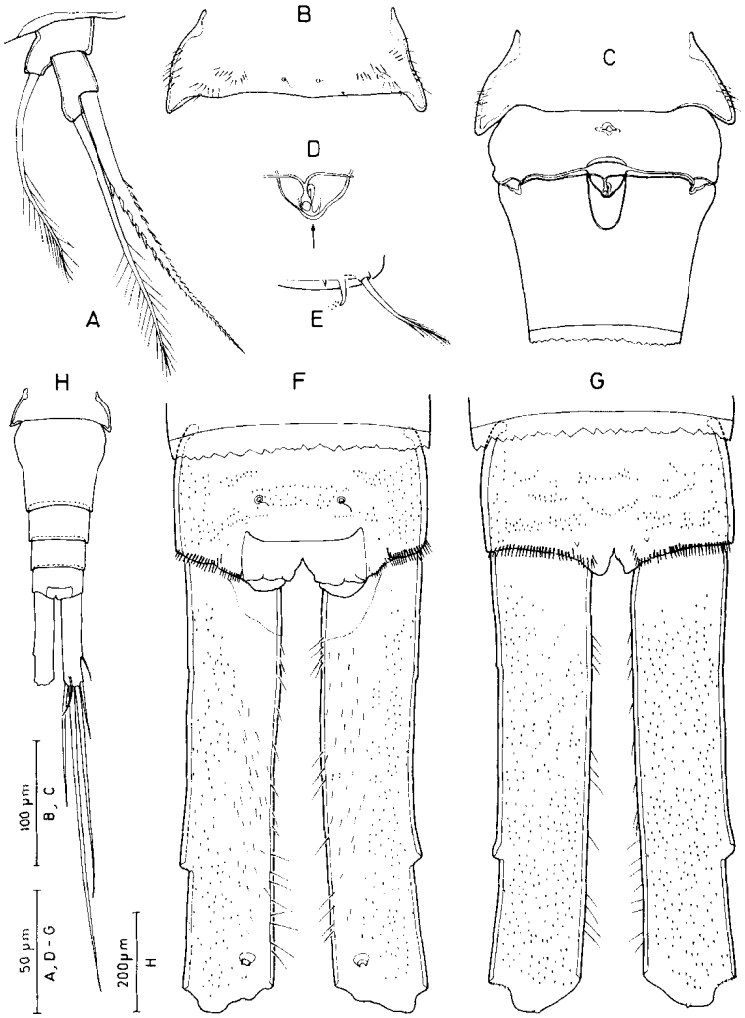

Fig. 36. Mesocyclops tenuisaccus (Sars) (lectotype) Salt River, South Africa. A. P_5; B. Last thoracic segment, dorsum; C. Last thoracic segment and genital segment with receptaculum seminis; D. Detail area of copulatory-pore; E. P_6; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view; H. Last thoracic segment and abdomen, dorsal view.

arms very narrow, not curved backwards; in this respect a certain affinity is found with the receptaculum seminis of *M. rarus* and *M. paludosus*. Laterally, the anterior margin appears as a double 'line'; at the level of the copulatory-pore, the foremost line duplicates, as well as the hindmost line but this line forms a loop that runs posteriorly around the copulatory pore (Fig. 36D:↙).

Abdominal segments (Figs. 36F-G). Spinules present only on last segment; dorsal and ventral distal margin of this segment fringed with spines.

Furca (Figs. 36F-H). Furcal rami elongate, 5.33 times as long as wide; ventrum with minute spinules, dorsum with minute spinules on the latero-external part and with short setules on the latero-internal part. Setules present along the inner margin. Probably due to a former desiccation of the specimens, some of the setules are broken off and as can be seen in Sars' Fig. 13 the inner margin of the furcal rami is more densely pilose than illustrated in Figs. 36F-G. Implantation of lateral furcal seta with spines; that of external seta with minute spinules ventrally. Length of the furcal setae as in Table 9.

Description of male (paralectotypes VI and VII)

The description given by Sars (*op. cit.*) is as follows: 'The male is of much smaller size than the female, and easily recognisable by the usual sexual differences in the structure of the tail and of the anterior antennae'.

Total body length respectively 978 μm and 1 008 μm; L:W ratio of furcal rami 4.16 and 4.32. Length of furcal setae as presented in Table 9; dorsal seta slightly shorter than external. Armature of antennule as in its congeners. P_6 of the usual structure, composed of one spine and two unequal setae.

The following differences are noted from the female: connecting lamella of P_2 not provided with setules, last thoracic segment only laterally pilose, furcal rami less densely pilose and lateral and external furcal setae provided with spines at their implantation.

Remarks

Since its original description *M. tenuisaccus* has never been reported in the literature; it has not been found by us in the localities examined.

On basis of the shape of the receptaculum seminis and because '*tenuisaccus*' has long furcal rami the species was placed in the genus *Cyclops* by Sars (*op. cit.*). Because of the structure of P_5, Kiefer (1929) transferred it to *Mesocyclops*, and synonymized *M. tenuisaccus* with *M. annulatus* (Wierzejski). In his recent study (Kiefer, 1981) gives no description of the species.

A comparative examination of *M. annulatus* from lake Titicaca with *M. tenuisaccus* confirmed their close relationship; only a single point of difference was noted, *viz.* in *M. annulatus* the distal part of the receptaculum seminis is prolonged, whereas in *M. tenuisaccus* it is rather short. Since this structure is strongly chitinized (in most species a kind of extensible membrane is present), it is probably not subject to deformation. Further, both species are disjunct, and have lived in geographical isolation for a long time.

Differential diagnosis

In the shape of the receptaculum seminis and the presence of a spine on the basipodite of P_1, its closest relatives are found in South America: *M. annulatus, M. meridianus, M. ellipticus.* In Africa, affinities are found with *M. rarus* and *M. paludosus* (presence of a spine on basipodite of P_1, occurrence of a group of spines proximal to implantation of exopodite seta on basipodite of antenna and narrowness of lateral arms of receptaculum seminis).

M. tenuisaccus is easily distinguished from its African congeners by its long and pilose furcal rami (females: L:W ratio greater than 5, males L:W ratio greater than 4). In addition the species is characterized by the spine pattern on the basipodite of the antenna and the structure of the receptaculum seminis.

Distribution (Fig. 45)

M. tenuisaccus is only known from its type locality and appears to be endemic to the Cape.

Mesocyclops paludosus Lindberg, 1956

1956 *Mesocyclops paludosus* Lindberg, K. Fysiogr. Sällsk. Lund Förhandl., Vol. 26, No. 3, p. 3, Fig. 1.

Type locality: Uganda: Nmanve situated near Kampala, northern border of Lake Victoria; *Papyrus* swamp at 1 130 m altitude. Collection made by L. Beadle on 3-7-1953.

Table 10. Morphometry of *Mesocyclops paludosus* Lindberg (Nmanve, Uganda). Measurements in μm.

		Lectotype	Paralectotypes		
			I (♀)	II (♀)	IV (♂)
Cephalothorax	L	525	508	500	383
	W	491	458	442	317
	L:W	1.07	1.11	1.13	1.21
Ceph. + Thorax	L	966	833	812	641
Genital segment	L	192	183	192	104
	W	163	158	159	108
	L:W	1.18	1.16	1.21	0.96
Abdomen	L	384	363	384	292
Furca	L	110	117	102	75
	W	40	35	35	27
	L:W	2.75	3.34	2.91	2.78
Total body length		1 460	1 305	1 298	1 008
Enp_3P_4	L	88	88	99	70
	W	33	34	35	22
	L:W	2.67	2.59	2.83	3.18
Enp_3P_4	sp_i	78	78	86	65
	sp_e	63	70	76	56
	sp_i:sp_e	1.24	1.11	1.13	1.16
Furcal setae	S_i	358	363	395	242
	S_{mi}	691	–	666	433
	S_{me}	508	–	508	333
	S_e	133	–	142	93
	S_d	88	100	88	71

Type material: Lund Museum (Sweden): one tube, labelled 'Ou. 4 Lindbergs' sampling nr. 93', containing five females (non-ovigerous), three males and 24 copepodids, preserved in alcohol.

Lectotype designation

Since Lindberg (*op. cit.*) designated no type specimen, one female was selected as lectotype; the specimen has been dissected and mounted on two slides. The remaining specimens are paralectotypes; from these, three females, one male and one copepodid (stage V) were dissected and mounted on slides, labelled paralectotypes I-V.

Material examined (specifications see Table 1)

Uganda: Nmanve, type material, as described above; Zaire-Ruanda: Massisi (5 ♀), Rugwero (abundant), Mugesera (3 ♀), Lungwe (3 ♀).

Redescription of female (lectotype)

Since its original description *M. paludosus* has not been reported in the literature. The species was characterized by Lindberg (*op. cit.*) as having prominent prominences on the connecting lamella of P_4 and as possessing a spine on the basipodite of P_1.

Total body length: 1 460 μm. For other measurements see Table 10.

Antennule. Reaches to middle of second thoracic segment. Only first segment bears a row of spinules, remaining segments devoid of spinules (Fig. 37C). Hyaline membrane with more than one deep notch (Fig. 37D).

Antenna. Structure of endopodite as in *M. leuckarti.*

Basipodite (Figs. 37A-B): in addition to the basic pattern, a group of ten spines present on frontal side proximal to implantation of exopodite seta. Longitudinal row on frontal side with seventeen spines; longitudinal row on caudal side with seventeen spines, row proximal to this with ten spines.

Maxillule (Fig. 37E). Basis of maxillulary palp not provided with a row of spines.

Thoracopods P_1-P_4. Spine- and seta-formula as in *M. leuckarti.* Connecting lamella of P_1-P_4 without setules.

P_1. Spine present on inner distal margin of basipodite (Fig. 37I).

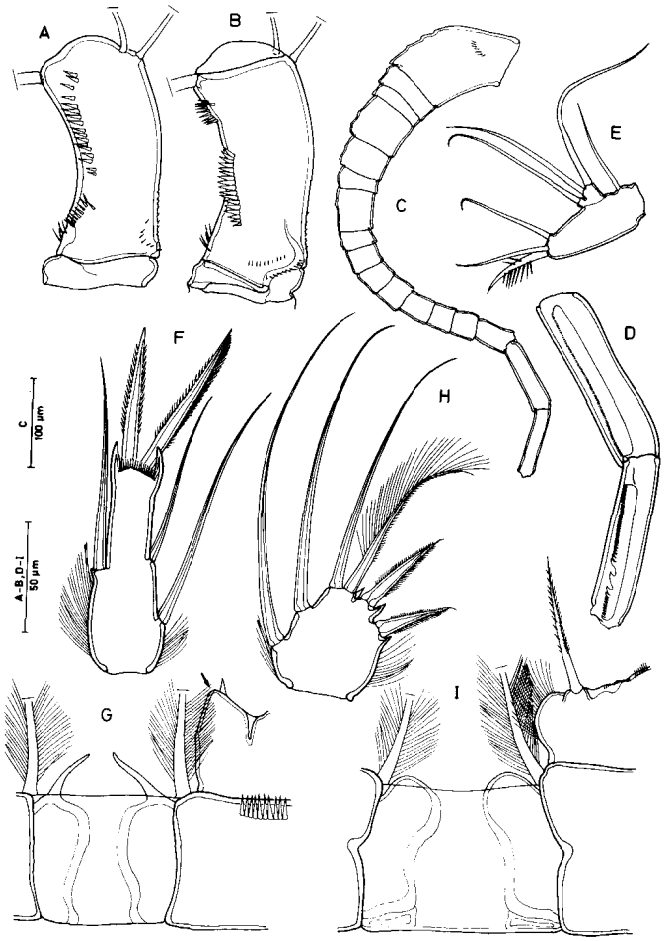

Fig. 37. Mesocyclops paludosus Lindberg (lectotype) Nmanve, Uganda. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C. A_1; D. Antennular segments 16 & 17; E. Maxillulary palp; F. Enp_3P_4; G. Connecting lamella and inner portion of coxo- and basipodite of P_4; H. Exp_3P_1; I. Connecting lamella and inner portion of coxo- and basipodite of P_1.

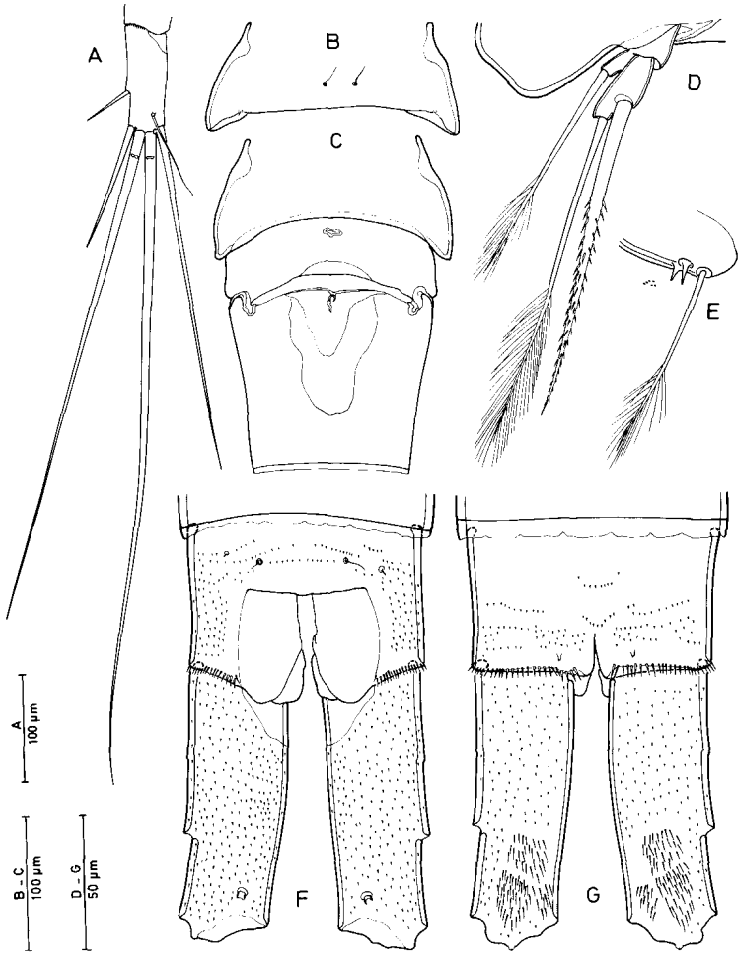

Fig. 38. Mesocyclops paludosus Lindberg (lectotype) Nmanve, Uganda. A. Furca; B. Last thoracic segment, dorsum; C. Last thoracic segment and genital segment with receptaculum seminis; D. P_5; E. P_6; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view.

P_4. Enp_3 2.67 times as long as wide; inner apical spine (78 μm) exceeds outer (63 μm) in length. Armature of these spines as illustrated in Fig. 37F. Prominences on distal margin of connecting lamella strongly developed (Fig. 37G). Inner part of caudal side of coxo- and basipodite naked. Inner distal margin of basipodite not rounded as in most species but with an elevation (Fig. 37G:↗).

P_5 (Fig. 38D). Without any peculiarities; spinous seta (121 μm) almost equals in length seta implanted on same segment (130 μm), seta of basal segment 87 μm.

P_6 (Fig. 38E). Of the usual structure.

Last thoracic segment (Figs. 38B-D). Completely devoid of setules.

Receptaculum seminis (Fig. 38C). Lindberg (1956, p. 5) states 'Réceptacle séminal ressemblant à celui de *M. leuckarti*'. This is obviously not so. Proximal part exhibits a narrow and slender outlook; copulatory-pore horseshoe-shaped and pore-canal very short.

Abdominal segments. Only last segment has spinule patterns (Figs. 38F-G). Distal margin of this segment, dorsally and ventrally, with a row of spines.

Furca (Figs. 38A, F-G). Furcal index 2.75. Inner margin naked and armed with spinules on dorsum and ventrum. Ventral side, in its distal part, with a patch of spines. Lateral and external furcal setae without spines at their implantation. Length of furcal setae as in Table 10.

Redescription of male (paralectotype IV)

Total body length 1 008 μm, other measurements see Table 10. The following differences from the female are noted. Inner distal margin of basipodite P_4 rounded, without an elevation. Distal part of ventral side of furcal rami without a patch of spines. Lateral and external furcal setae with spines at their implantation. P_6 composed of one spine and two setae.

Variability: females

Total body length between 1 298–1 473 μm. Furcal index 2.75–4.15. Dorsal furcal seta shorter than external; but probably variable as in other species.

Length: width ratio of Enp_3P_4 2.48–2.92. Inner apical spine longer than outer; but perhaps variable. External margin of outer apical spine set with spinules along its entire margin, or only ornamented proximally.

Spine pattern on basipodite of antenna constant, variability only in number of spines per row: longitudinal row on caudal side 16–19 spines, longitudinal row on frontal side 17–19 spines, spine group proximal to exopodite seta 10–13 spines.

Differential diagnosis

M. paludosus belongs to a group of species characterized by the presence of a spine on the basipodite of P_1, the presence of a spine group proximal to the exopodite seta on the basipodite of the antenna and the shape of the proximal part of the receptaculum seminis which exhibits a narrow and slender outlook. This group includes *M. tenuisaccus, M. rarus, M. paludosus* (in Africa), *M. meridianus*, M. ellipticus** and *M. annulatus* (in South America). Within this group, *M. paludosus* is most closely related to *M. rarus*; it differs from the latter in the spine pattern on the basipodite of the antenna, the presence of spines on the ventrum of the furcal rami (only in females) and by small differences in the shape of the proximal part of the receptaculum seminis.

Distribution (Fig. 44)

M. paludosus is restricted to the East African Lake District; more precisely it occurs in the littoral of lakes and in *Papyrus*-swamps around Lake Kivu and Lake Tanganyika and in lakes and swamps situated between the Eastern and Western Rifts.

Mesocyclops rarus Kiefer, 1981

1952 *Mesocyclops leuckarti aequatorialis*, Kiefer [partim], Explor. Parc natn. Albert, Mission H. Damas 1935/1936, Vol. 21, p. 101.

1981 *Mesocyclops rarus* Kiefer, Arch. Hydrobiol. Suppl. 62, p. 176, Fig. 13

Type locality: East-Africa: Lake Ondo (?).

Neither type locality nor type material was designated in the original description, but Kiefer based his description on specimens from Lake Ondo (Ruanda). Further records are Lake Albert and a swamp (unnamed) in Tanzania.

Material examined (specifications see Table 1)

Tchad: Tibesti: Mare de Zoui (1 ♀); Ruanda: Astri-

* spine pattern on basipodite of the antenna unknown.

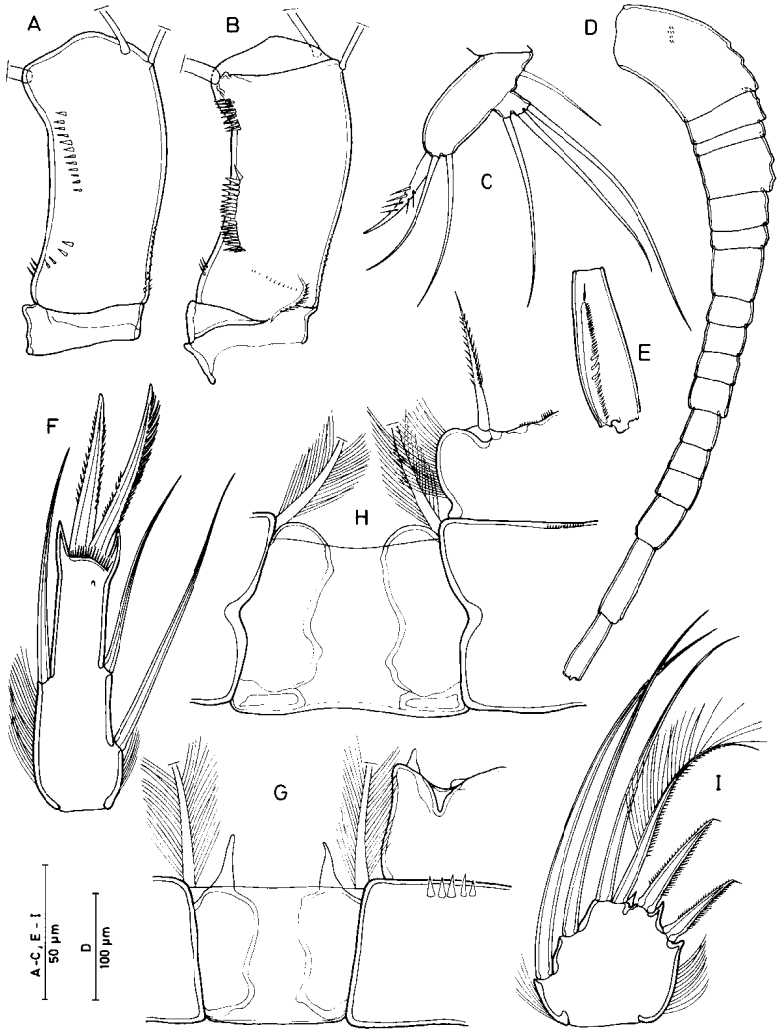

Fig. 39. Mesocyclops rarus Kiefer Ruzizi, Burundi. A. Basipodite A_2, caudal side; B. Basipodite A_2, frontal side; C. Maxillulary palp; D. A_1; E. Antennular segment 17; F. Enp_3P_4; G. Connecting lamella and inner portion of coxo- and basipodite of P_4; H. Connecting lamella and inner portion of coxo- and basipodite of P_1; I. Exp_3P_1.

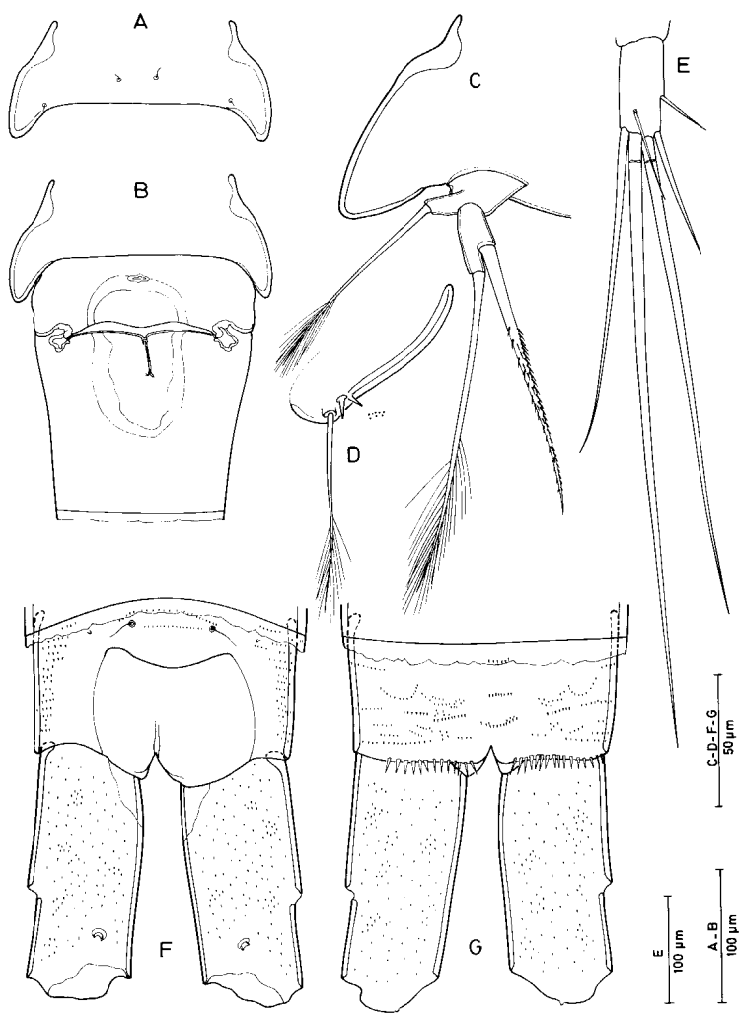

Fig. 40. Mesocyclops rarus Kiefer Ruzizi, Burundi. A. Last thoracic segment, dorsum; B. Last thoracic segment and genital segment with receptaculum seminis; C. P_5; D. P_6; E. Furca; F. Last abdominal segment and furcal rami, dorsal view; G. Last abdominal segment and furcal rami, ventral view.

da (5 ♀), Mugesera (11 ♀), Milay (6 ♀, 2 ♂), Birira (3 ♀), Goshoba (5 ♀); Zaïre (Kivu-district): Karimurira (3 ♀); Burundi: Ruzizi (breeding experiments: 140 specimens, ♀ and ♂), Bujumbura (breeding experiments, 35 specimens, ♀ and ♂); Mozambique: Xai-Xai (2 ♀).

Redescription of female

M. rarus is characterized by: the shape of the receptaculum seminis, short furcal rami, dorsal furcal seta shorter than external, basipodite P_1 with spine, connecting lamella P_4 with well developed prominences, L:W ratio of Enp_3P_4 less than 3, inner apical spine Enp_3P_4 longer than outer, and by the shape of the naked last thoracic segment (Kiefer, 1981).

The following additions are given and a comparison is made with *M. paludosus* (not examined by Kiefer, *op. cit.*) its closest relative. The redescription is based on specimens from the Ruzizi (Burundi).

Total body length 1 255–1 370 μm (n = 5).

Antennule, mouthparts and *thoracopods* P_1-P_5 as in *M. paludosus*, except that the prominences on the connecting lamella P_4 are more strongly built at their basis (Figs. 39C-I).

Antenna. Endopodite as in *M. leuckarti.*

Basipodite (Figs. 39A-B): spine pattern very similar to that of *M. paludosus*, except that in *M. rarus* the longitudinal spine row on the caudal side is much shorter and does not reach the level of the implantation of the exopodite seta, and is composed of 10–14 spines; in *M. paludosus* 16–19 spines (compare Fig. 37A & Fig. 39A).

Last thoracic segment (Figs. 40A-C). As in *M. paludosus*, completely devoid of setules.

Receptaculum seminis (Fig. 40B). Structure very similar to that of *M. paludosus*, but lateral arms more pointed at their extremities and cuticular frames more pronounced.

Abdominal segments. Last segment, as in *M. paludosus*, provided with minute spinules. In contrast to this species, only ventral distal margin of last segment fringed by a row of spines in *M. rarus* (Figs. 40F-G).

Furca (Figs. 40F-G). Rami shorter than in *M. paludosus*, L:W ratio 2.3 (n = 5). Inner margin naked; dorsum and ventrum with minute spinules, and in contrast to *M. paludosus* the ventral side lacks a patch of spines. Mean length furcal setae: $S_i = 253$ μm; $S_{mi} = 495$ μm; $S_{me} = 390$ μm; $S_e = 105$ μm; $S_d = 68$ μm (n = 5). Lateral and external setae not provided with spines at their implantation.

Description of male

Morphology hitherto unknown. The following description is based on specimens from the Ruzizi and on specimens resulting from breeding experiments.

Mean total body length 740 μm (n = 5). Armature of antennule as in other *Mesocyclops* species. With the following differences from the female: inner distal margin of basipodite of P_4 rounded without an elevation; distal margin of last abdominal segment dorsally and ventrally fringed with a row of spines; lateral and external furcal setae with spines at their implantation.

P_6 of the usual structure, composed of one spine and two setae.

Variability: females

Intraspecific morphological variability has also been examined by breeding experiments up to and including the third generation.

Total body length (n = 15) between 1 078–1 370 μm. In specimens resulting from breeding experiments lower values have been noted 974 μm. L:W ratio of furcal rami between 2.27–2.57. In the specimens examined dorsal furcal seta shorter than external. Usually dorsal distal margin of last abdominal segment not fringed by a row of spines, however, in a few specimens this margin set with minute spinules (3–6).

Inner apical spine on Enp_3P_4 longer than outer; in a few cases both spines equal in length. L:W ratio of Enp_3P_4 between 2.50–3.07. Prominences on distal margin of connecting lamella of P_4 always very prominent; their shape either straight of slightly bent at the apex.

Spine pattern on basipodite of antenna constant, variability only in number of spines per row: longitudinal row on caudal side 10–14 spines, row proximal to this row 4–7 spines; longitudinal row on frontal side 17–22 spines.

Differential diagnosis

As stated in the preceeding species, the closest relative of *M. rarus* is *M. paludosus.* It differs, however, from the latter in the spine pattern on the

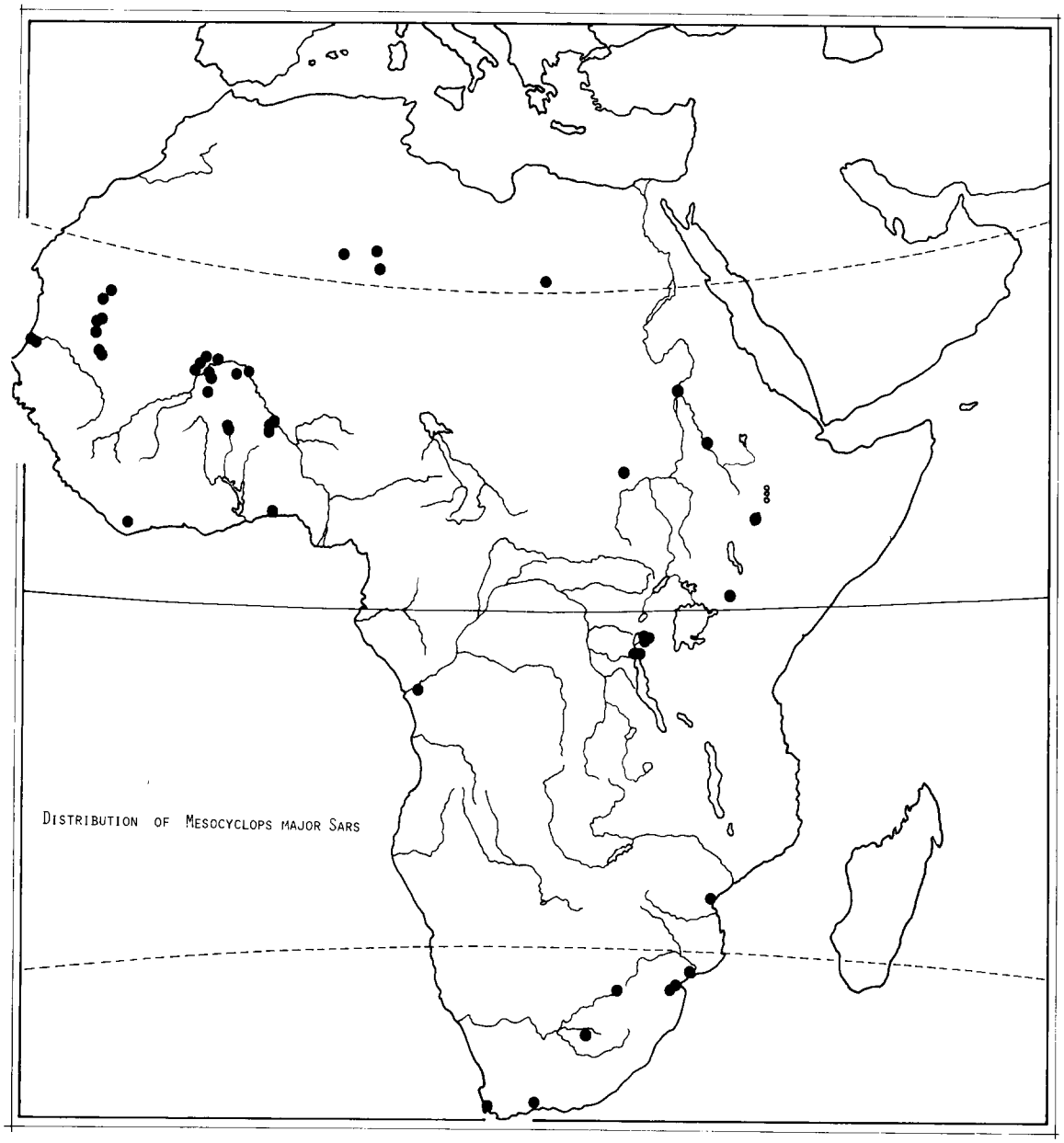

Fig. 41.

basipodite of the antenna, in the absence of a patch of spines in the distal part of the ventrum of the furcal rami and by minor differences in the shape of the receptaculum seminis.

Distribution (Fig. 44)

In the East African Lake District *M. rarus* exhibits a similar distribution to *M. paludosus* but its range extends from the Tibesti Mountains in the north to Mozambique in the south.

Distribution of *Mesocyclops* on the African continent (Figs. 1–2, 41–45)

Among the twelve known *Mesocyclops* taxa of the African continent, only *M. aspericornis* is also widespread in the Oriental Region. The remainder are endemic to Africa (including the Arabian Peninsula and the Canary Islands).

The main area of distribution of the genus is situated south of the Sahara (Figs. 1–2). In the

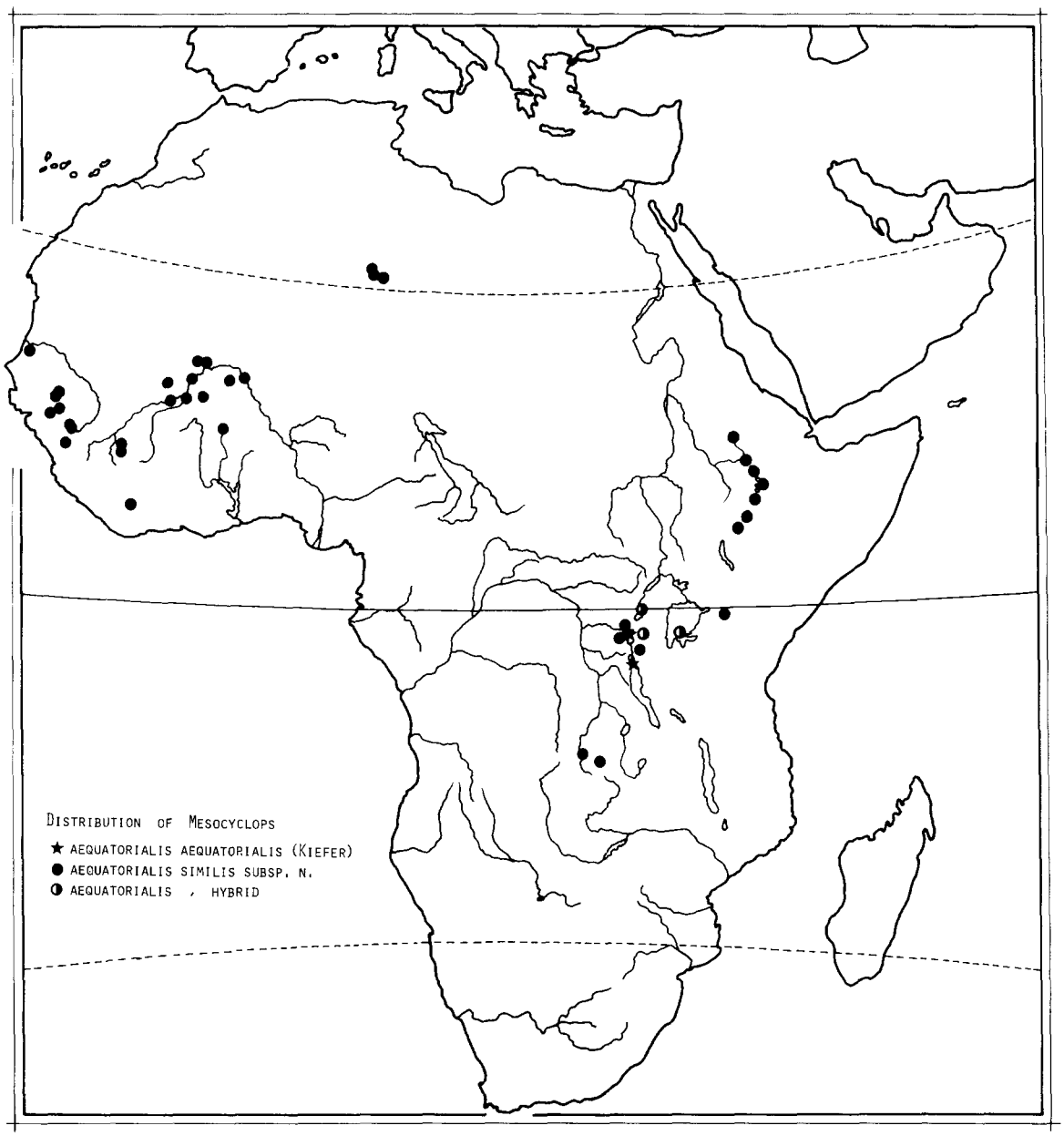

Fig. 42.

Sahara, apparently relict populations are found in the Tassili-n-Ajjer, Tibesti and the Kufra oasis: *M. major, M. aequatorialis similis, M. dussarti* and *M. rarus*. Populations of *M. major, M. aequatorialis similis* and *M. kieferi* are present in the Adrar mountains of Mauritania. The Nile valley has the following species: *M. ogunnus, M. major* and *M. aspericornis*. In the Sahara mountains (Hoggar, Aïr and Adrar des Iforas), *Mesocyclops* is absent. Its absence from the Hoggar may be due to extreme temperature fluctuations that occur here (guelta's are frozen during winter). Its absence from the Aïr and the Adrar des Iforas may be explained by the hypothesis of Dumont (1979): during the Holocene a hyper-arid phase occurred on the Sahel region and destroyed the local aquatic faunas. Later, re-population occurred from the North, mainly from the Hoggar mountains, where *Mesocyclops* does not occur.

The following taxa are the most widespread: *M.*

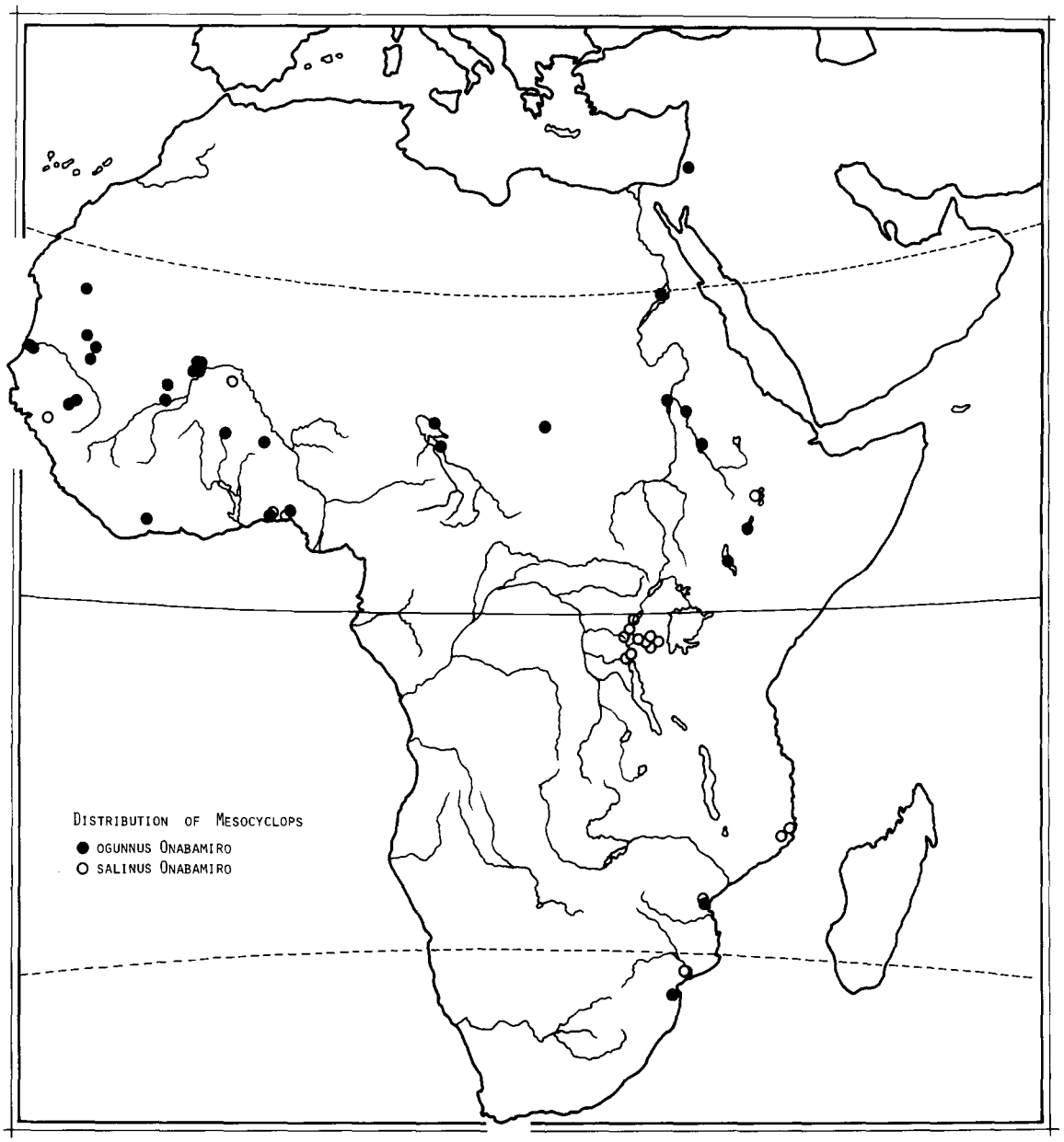

Fig. 43.

major, M. aequatorialis similis and *M. ogunnus*. The last however, does not occur in the Western Rift. *M. dussarti* is restricted to West Africa. Another group comprises *M. kieferi* and *M. aspericornis*, distributed along a west-east axis across the entire width of the African continent. *M. aequatorialis aequatorialis* and *M. paludosus* are restricted to the East African Lake District. *M. rarus*, closely allied to *M. paludosus*, has expanded in a north-south direction. *M. salinus* is abundant in the East African Lake District and outside this area, in West-Africa south of the rivers Senegal and Niger. In South-East Africa it mainly inhabits coastal regions. *M. spinosus* and *M. tenuisaccus* are respectively endemic for the Guinea zone and the Cape.

The fact that *Mesocyclops* is totally absent in the Maghreb, on the Iberian Peninsula, in the south of Greece, the south of Italy and on the islands of the Mediterranean Sea is extremely remarkable (Figs. 1-2). In the literature there is one record from

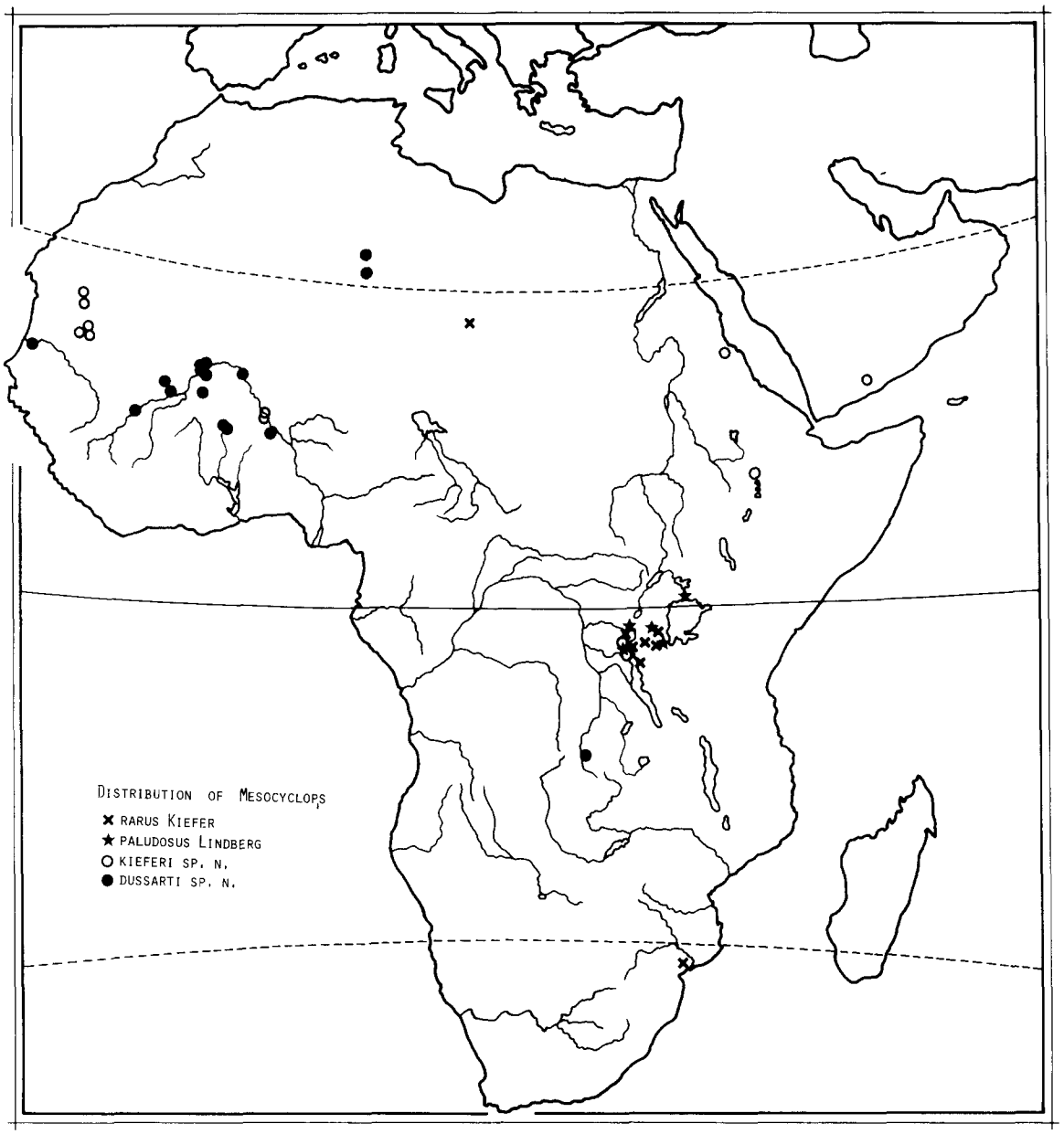

Fig. 44.

Northern Algeria (Oued Nil, sample collected on 2-7-1925) of *M. leuckarti* (sic) (Roy & Gauthier, 1927). However, in 1928 Gauthier did not confirm this record and, instead, *Megacyclops viridis* is reported from the Oued Nil (sample data the same as above). This suggests that the 1927 citation of *M. leuckarti* was an erroneous identification. Several samples from this region examined by us (Fig. 2) did not contain *Mesocyclops*.

The reasons behind this phenomenon are obscure, but competition with other cyclopids that have the same habitus and feeding preferencies as *Mesocyclops* might be involved. The genus *Megacyclops* is a likely candidate. It is well represented in the areas where *Mesocyclops* is completely absent (Fig. 1), and it has been reported from the Hoggar (Roy, 1929), from the Bale mountains (Löffler, 1978) and from lakes situated at 4 500 m on Mount Elgon (Lowndes, 1930; Kiefer, 1939; Löffler, 1968) where *Mesocyclops* is absent. In

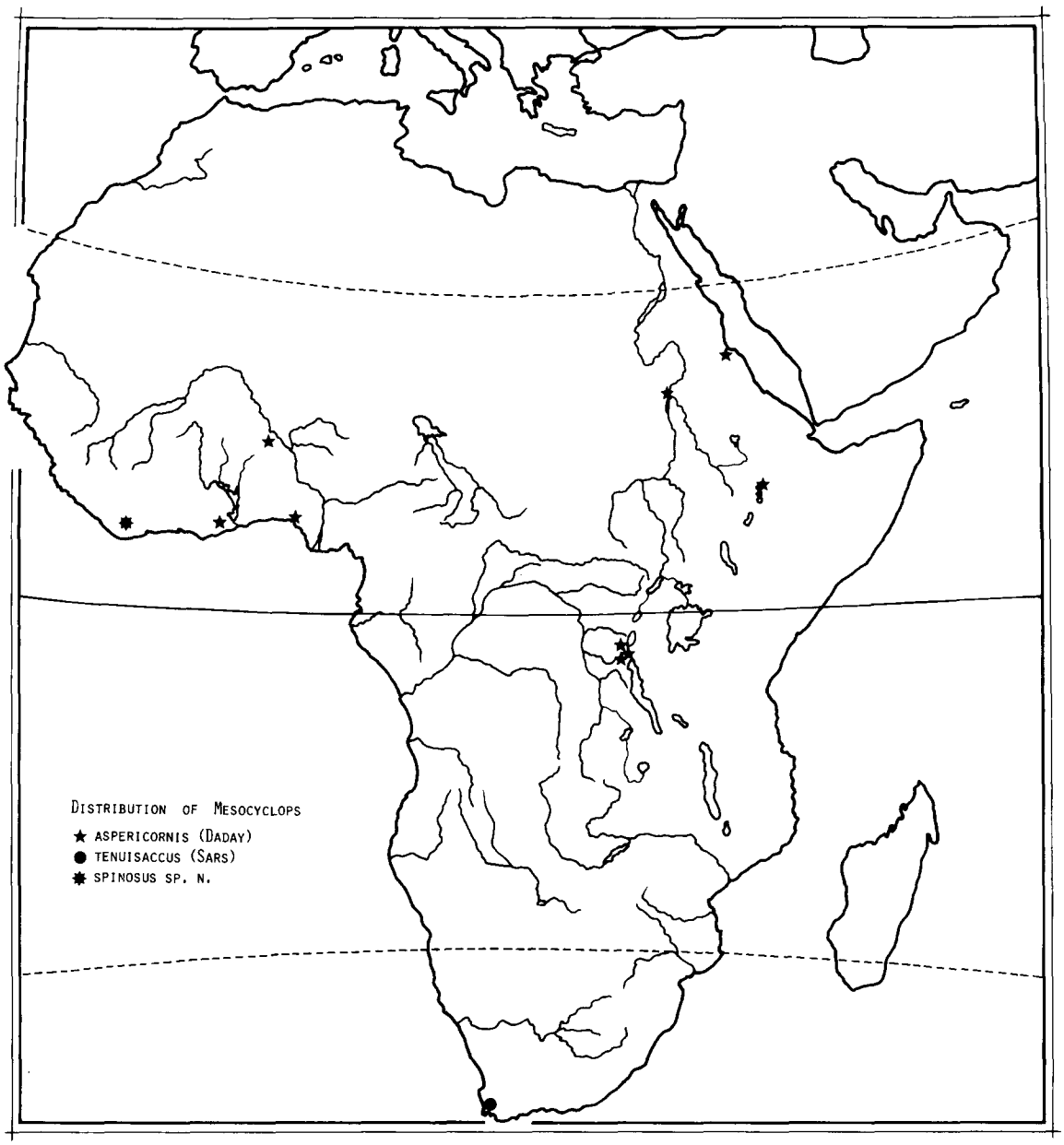

Fig. 45. M. aspericornis is also widely distributed in the Oriental Region.

lakes situated in the lowlands around Mount Elgon *Mesocyclops* replaces *Megacyclops*. The greatest altitude at which African *Mesocyclops* species have been found, is 2 700 m, *viz.* Lake Lungwe (*M. aspericornis, M. paludosus*).

In certain circumstances, however, both genera may co-occur, as in Lake Tanganyika (Lindberg, 1951) and in Serpent Lake in Ethiopia (Lowndes, 1930). Both genera frequently co-exist in Europe. In the Bodensee, *Megacyclops viridis* is present in deeper waterlayers, while *Megacyclops gigas* is found in the littoral and *M. leuckarti* mainly in the pelagial (Kiefer, 1978). A similar situation is found in Lago Maggiori (Tonolli, 1962). A vertical and/or horizontal separation in habitats could thus explain why both genera co-occur in Lake Tanganyika and

Serpent Lake. Indeed, Lindberg (*op. cit.*) states that in a pelagic sample *Mesocyclops* was abundant, while *Megacyclops* was only represented by two copepodids. No details are given by Lowndes (*op. cit.*) about Serpent Lake.

The co-existence of several *Mesocyclops* species in a single locality (see Table 1) is noteworthy. Up to 2–3 species frequently co-exist and in one case, *viz.* Mekrou (marigot in Niger) four species were found together.

The highest species-diversity is found in the East African Lake District where 65% of the total known *Mesocyclops* fauna on the African continent is present (7 species). Four species are known from the inner delta of the Niger.

Note on the *Mesocyclops* species of Madagascar

The following species are reported by Kiefer (1981): *M. annae* Kiefer, 1930, *M. pilosus* (Kiefer, 1930) and *M. salinus* Onabamiro, 1957. In addition Dussart (1982) records *M. aequatorialis* (Kiefer, 1929), *M. leuckarti* (Claus, 1857) and a new species *M. insulensis*.

We examined syntypical material of *M. insulensis* (coll. Dussart). It is indeed a good species. Its closest relative appears to be *M. major* (similar armature of antennule, maxillulary palp without a row of spines, characteristic armature of external apical seta of Exp_3P_1, structure of P_1-P_4, armature of last thoracic segment, structure of receptaculum seminis, and furca). Differences are found in the spine pattern on the basipodite of the antenna, armature of the genital and the following abdominal segments, and there are differences in size (see also p. 26).

The presence of *M. leuckarti* on Madagascar is incorrect, as argued before.

Dussart's citation of *M. aequatorialis* is criticized: a drawing of the receptaculum seminis (Dussart, *op. cit.*; Fig. 20:B) is not *M. aequatorialis*-like; rather does it resemble that of *M. pilosus*. And, in the text specimens are mentioned with and without setules on the inner margin of the furcal rami, indicating that two species are involved.

For a description of *M. annae* and *M. pilosus* we refer to Kiefer (*op. cit.*). No material was available to us for examination.

Acknowledgments

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