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## Revision of the genus *Eucyclops* (Claus, 1893) and subfamily Eucyclopinæ of the world fauna

### Ревизия рода *Eucyclops* (Claus, 1893) и подсемейства Eucyclopinæ мировой фауны

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KEY WORDS: new genera in *Eucyclops*, new subgenera in *Eucyclops*, copepoda systematics, species key, Crustacea subgenus description, biodiversity.

КЛЮЧЕВЫЕ СЛОВА: новые роды *Eucyclops*, новые подроды *Eucyclops*, систематика копепод, видо-вые ключи, описание подродов, видовое разнообразие.

ABSTRACT. The revision of the most rich with species genus *Eucyclops* Claus, 1893 was done. The genus *Austriocyclops* Kiefer, 1964 has been moved back to the subfamily Cyclopinæ, as Kiefer suggested. The status of the genus *Australoeucyclops* Karanovic, 2006 is lowered to subgenus, and the status of the subgenus *Defayeicyclops* Alekseev et Vaillant, 2013 is erected to genus. Two new genera (former subgenera) *Isocyclops* Kiefer, 1957 stat.n. and *Stygocyclops* Pleša, 1971 stat.n. were erected from the genus *Eucyclops*. A key for 12 genera of the subfamily Eucyclopinæ is given. Genus *Eucyclops* including about 100 valid species was split into 9 subgenera: *Eucyclops* (*Eucyclops*), *Eucyclops* (*Breviramocyclops*), *Eucyclops* (*Ciliocyclops*), *Eucyclops* (*Denticyclops*), *Eucyclops* (*Macrurorocyclops*), *Eucyclops* (*Mrazekicyclops*), *Eucyclops* (*Sarsicyclops*), *Eucyclops* (*Speratocyclops*), and *Eucyclops* (*Subterrocyclops*). Descriptions and illustrations are provided for typical species, as well as keys to 9 new subgenera of *Eucyclops* genus and to subfamily Eucyclopinæ. For each subgenus, the total number of species and identifying keys for them are provided.

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РЕЗЮМЕ. Проведена ревизия подсемейства Eucyclopinæ с выделением ряда новых родов. Род *Austriocyclops* Kiefer, 1964 перемещен обратно в подсемейство Cyclopinæ, как это предполагал Кифер. Статус рода *Australoeucyclops* Karanovic, 2006 понижен до подрода, а статус подрода *Defayeicyclops* Alekseev et Vaillant, 2013 поднят до рода. Из состава рода *Eucyclops* выделены два новых рода (прежние подроды) *Isocyclops* Kiefer, 1957 stat.n. и *Stygocyclops* Pleša, 1971 stat.n. Приведен определительный

ключ для 12 родов подсемейства Eucyclopinæ. Оставшиеся виды рода *Eucyclops* разделены на 9 новых подродов: *Eucyclops* (*Eucyclops*), *Eucyclops* (*Breviramocyclops*), *Eucyclops* (*Ciliocyclops*), *Eucyclops* (*Denticyclops*), *Eucyclops* (*Macrurorocyclops*), *Eucyclops* (*Mrazekicyclops*), *Eucyclops* (*Sarsicyclops*), *Eucyclops* (*Speratocyclops*), and *Eucyclops* (*Subterrocyclops*). Приводятся описания и иллюстрации для типовых видов каждого из подродов, а также определительные ключи для 9 новых подродов и подсемейства Eucyclopinæ в целом. Для каждого подрода указывается общее количество видов и определительные ключи для них.

### Introduction

The genus *Eucyclops* Claus, 1893 is the largest one among continental cyclopids [Alekseev *et al.*, 2006; Alekseev, Defaye, 2011]. Even after separation of two former subgenera *Isocyclops* Kiefer, 1957 and *Stygocyclops* Pleša, 1971 the genus *Eucyclops* comprises about one hundred species and 15 subspecies [Dussart, Defaye, 2006; Alekseev, Defaye 2011; Mercado-Salas, Suárez-Morales, 2014]. Being one of the largest genus among continental copepods it has not been completed yet as within last decade new forms were being described at regular basis. The last revision of the whole genus was done by Lindberg [1957]. After his paper devoted to African *Eucyclops* and provided with a key for about 40 described for this time species only several regional revisions of *Eucyclops* were fulfilled: for Australia by Morton [1990], for Ukraine by Monchenko [1974], for Japan by Ishida [2002], for Mexico by Mercado-Salas & Suárez-Morales [2014], for Palearctic by Alekseev & Defaye [2011]. Altogether more than 120 taxons were described up to now that is difficult to manage with and create effective identification keys. The fast-going and dramatic changes in biogeog-

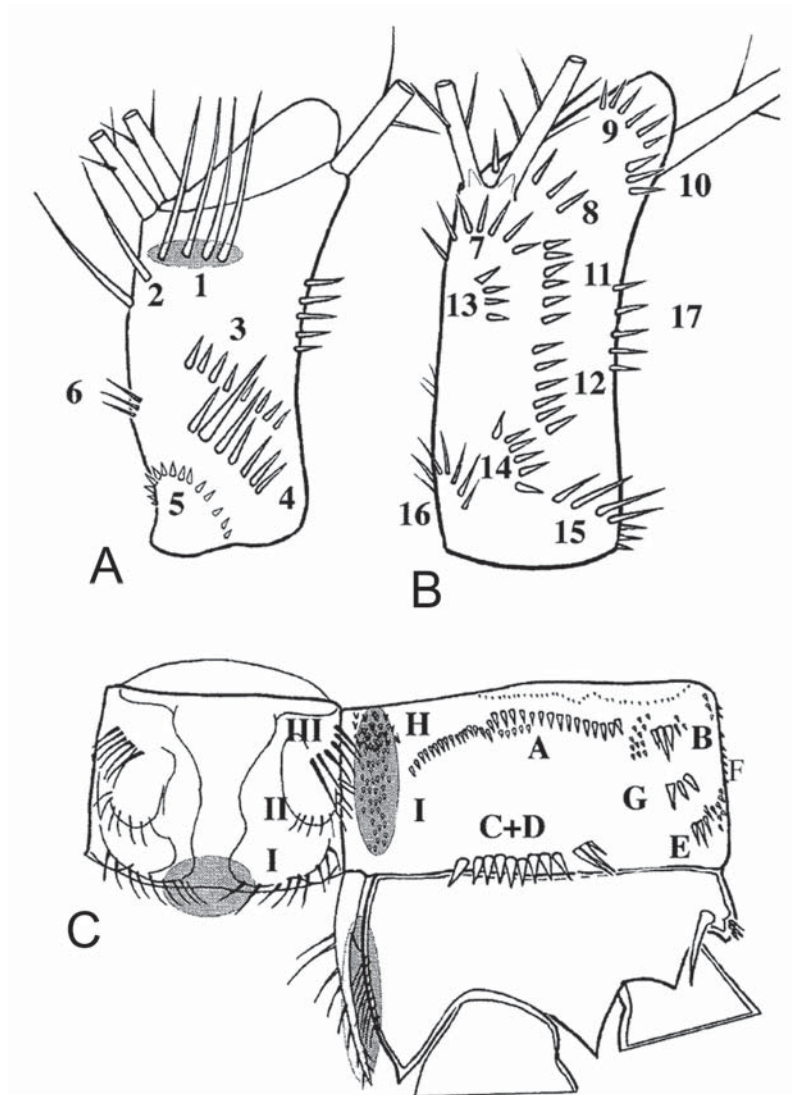


Fig. 1. Numbering system for micromorphological patterns in *Eucyclops*: A — basipodite of A2, posterior; B — A2 basipodite, anterior; C — intercoxal sclerite and coxa of P4. Orig.

Рис. 1. Система нумерации для микроморфологической картины у *Eucyclops*: А — базиподит А2, вид сзади; В — базиподит А2, вид спереди; С — соединительная пластинка и коксоподит Р4. Ориг.

raphy and biodiversity of continental invertebrates caused by climate changes and bioinvasions set up the necessity to provide taxonomists with world faunistic keys. This study is devoted to revision of *Eucyclops* and creating of new system within the genus to make species identification more easy and reliable.

Redescription of the type for genus *Eucyclops serulatus* (Fischer, 1851) [Alekseev *et al.*, 2006] with using of plenty methods including molecular-genetic and interspecific hybridization revealed several micro-characters important for species identification as ornamentation of antenna (A2) basipodite and swimming leg 4 (P4) coxopodite with coxal spine (Fig. 1). Along with traditionally used morphological features including antennule segmentation, proportions in distal segments and spines/seta of endopodite (Enp) and ex-

opodite (Exp) of P4 and caudal rami, relative length of antennule (A1) and construction of hyaline plate at three distal segments, rudimental leg 5 (P5) construction and armament in female, and leg 6 (P6) in males these characters were used here for subgenus separation, description and identification keys creation. For practical reasons and due to morphological similarities 9 subgenera were erected.

### Material studied

Several important collections of freshwater cyclopids were studied that included: Prof. Kiefer reference collection placed in Karlsruhe, Germany; Prof. Henry Dumont collection of African species (mainly Tanganyika and Victoria Lakes) in Ghent University, Belgium; Prof. C.H. Fernando

collection (University Waterloo, Canada), Singapore University; Prof. T. Ishida type collection sent by him to Zoological Institute of RAS; Prof. B. Dussart collection in Natural History National Museum, Paris, France; Prof. V. Monchenko type collection of *Eucyclops* in Institute of Zoology, Kiev, Ukraine; Prof. G.O. Sars collection in Natural History Museum, London (G. Boxshall as curator); Prof. G. Mazepova collection of Baikalian copepods in Limnological Institute, Irkutsk, Russia; Prof. A. Brancelj copepod collection from Slovenia caves in National Institute of Biology, Ljubljana, Slovenia; Prof. M. Miraclea zooplankton of mountain reservoirs of the Central Spain (University of Valencia, Spain); Prof. D. Defaye collection in National Museum of Natural History, Paris, France; Prof. F. Lescher-Moutoué personal collection; Prof. E. Borutzky collection, Zoological Museum of Moscow State University, Russia; Prof. L. Sanoamuang tropical zooplankton collection (University of Khon-Kaen, Thailand); Anna Kosova zooplankton collection of the river Volga delta (Astrakhan State Reservation, Astrakhan, Russia). Furthermore, Victor Alekseev personal copepod collection that includes samples from following countries: Russia (all regions), Ukraine, Georgia (Kura River and its tributary), Armenia (Sevan Lake, Hrazdan River), Uzbekistan (Syr Darya River, waterbodies in Fergana Valley), Kazakhstan (Aral Sea, Lake Balkhash), Kirgizia (Issyk-Kul mountain lake), Hungary (Danube River, Lake Balaton), France (lakes in Boulogne park, Paris; botanical garden in Wimereux; Marseille vicinity etc.), Belgium (Ghent vicinity), Norway (vicinity of Bergen and Oslo), Sweden (vicinity of Lund and Stockholm), Germany (vicinity of Lübeck, Hamburg and Plön), Denmark (vicinity of Copenhagen), Finland (vicinity of Helsinki, Turku, Mariehamn, Gulf of Bothnia), Spain (Albufera Lake, Turia River, Guadalquivir River, waterbodies in vicinity of Valencia, Barcelona and Madrid), Portugal (vicinity of Lisboa), Poland (vicinity of Kraków, Wrocław, Warsaw, Masurian lakes), Italy (vicinity of Rome, Venice and Florence, the Tiber River), Ireland (vicinity of Dublin), Turkey (vicinity of Istanbul, Anatolia, small rivers along the sea coast), Northern Macedonia (Lake Ohrid), Israel (springs in desert, Lake Kinneret), Egypt (The Nile Delta near Cair), Tunisia (small rivers and waterbodies along sea coast in Tunis city and Hammamet district), Ethiopia (the White Nile and Blue Nile, large lakes in the Lake Valley), Mongolia (the Selenga river with tributaries, rivers and lakes in Gobi desert, Uvs Lake), China (the Yellow River (Huang He), Yangtze River and Pearl River, waterbodies in Hainan, Hong-kong islands, waterbodies in Beijing vicinity, Shanghai vicinity, Guangzhou vicinity), Japan (vicinity of Tokyo, Hiroshima, Kyoto), Taiwan (Moon lake, small rivers along sea coast in Northern and Southern parts, vicinity of Taipei and Kaohsiung), Laos (the Mekong River), Vietnam (vicinity of Hanoi, Da Nang and Ho Chi Minh City, the Mekong Delta), Malaysia (vicinity of Kuala Lumpur, Borneo island), Singapore, Thailand (vicinity of Bangkok and Khon-Kaen), Cambodia (the Mekong River), Indonesia (vicinity of Jakarta, Ci Liwung River, Java island), Australia (vicinity of Sydney, Melbourne, Dr. D. Lajus as collector), USA (lake Erie, vicinity of New York and Washington), Canada (lakes in Quebec province, lakes and rivers in Ontario province), Mexico (vicinity of Mexico city, Acapulco, Cozumel island, lakes and rivers in Yucatan Peninsula). Most of type slides of *Eucyclops* species described by Kiefer and Dussart were observed and used for personal drawing by VA. Neotypes of several species described by Fischer and Lilljeborg were established from the

type localities. Altogether more than 60% of known *Eucyclops* species were observed and used for comparison. All the rest species were studied on authors' descriptions.

## Methods

A classical taxonomical method of external morphology examination has been used. Adult females and males before dissecting were pictured from dorsal side for a common view of animal with a 12-megapixel digital photo camera equipping Zeiss Imager.A1 microscope. Then specimens were dissected in a drop of glycerol on a microscope glass covered with a cover glass supported by droplets of plasticine on opposite corners to prevent damage of taxonomically important parts. Drawings were made at 400–1000x magnification with microscope equipped with Nomarski optics and a camera lucida, converted in ink than digitized with scanner (resolution 1200 dpi) and used for mounting in table of drawing. Each picture was provided with a scale bar. Along with classical morphological features (number of spines, setae, segments of A1, P1–P6, caudal rami shape, proportion and armament, several new microcharacters were selected for *Eucyclops* revision that includes ornamentation of basipodite A2 with groups of hairs and denticles counted as 1–24, length and pinnation of coxal spine/seta in swimming leg 4, ornamentation of caudal side of coxal plate in P4; pinnation of inner outgrowth P4 basipodite (see Fig. 1). Stability of the microcharacters within species and variation of them among distant populations of *Eucyclops* species were studied in hybridization examining for the type species of the genus *Eucyclops serrulatus* (Fischer, 1851) [Alekseev *et al.*, 2006].

All *Eucyclops* species slides obtained and used for the genus revision were catalogized and placed in the Federal Collection of Zoological Institute of RAS #96-03-16.

## Results

Since the genus erection [Claus, 1893] as cyclopid with unisegmented P5 armed with three appendages this genus was partly revised by Kiefer who separated *Tropocyclops* [Kiefer, 1960], *Thaumasiocyclops* [Kiefer, 1930], *Ochridacyclops* [Kiefer, 1937] and by Sars [1927] who described *Afrocyclus*. All these genera were separated each from other as well from other Eucyclopinæ genera by armament of P5 — the most important feature for cyclopid system on above species level, and segmented or not segmented rudimental leg body (*Ochridacyclops*, *Thaumasiocyclops*). Later on only two subgenera were established by Pleša [1971] and Kiefer [1957] both on armament of P5 with two appendages in monotypic *Stygocyclops* and relatively long segment of P5 with length/width (L/W) ratio 1.6–1.8 and unusually long lateral seta of caudal rami that is clearly longer than outermost seta and more that 2–2.5 times longer than ramus width in *Isocyclops* when in *Eucyclops sensu stricto* inner appendages of P5 always presented with more or less strong spine clear different from middle and outer setae. To my mind, so large differences in P5 construction have to be recognized as genus level features. Hereafter these two small subgenera are redescribed as genera under the same



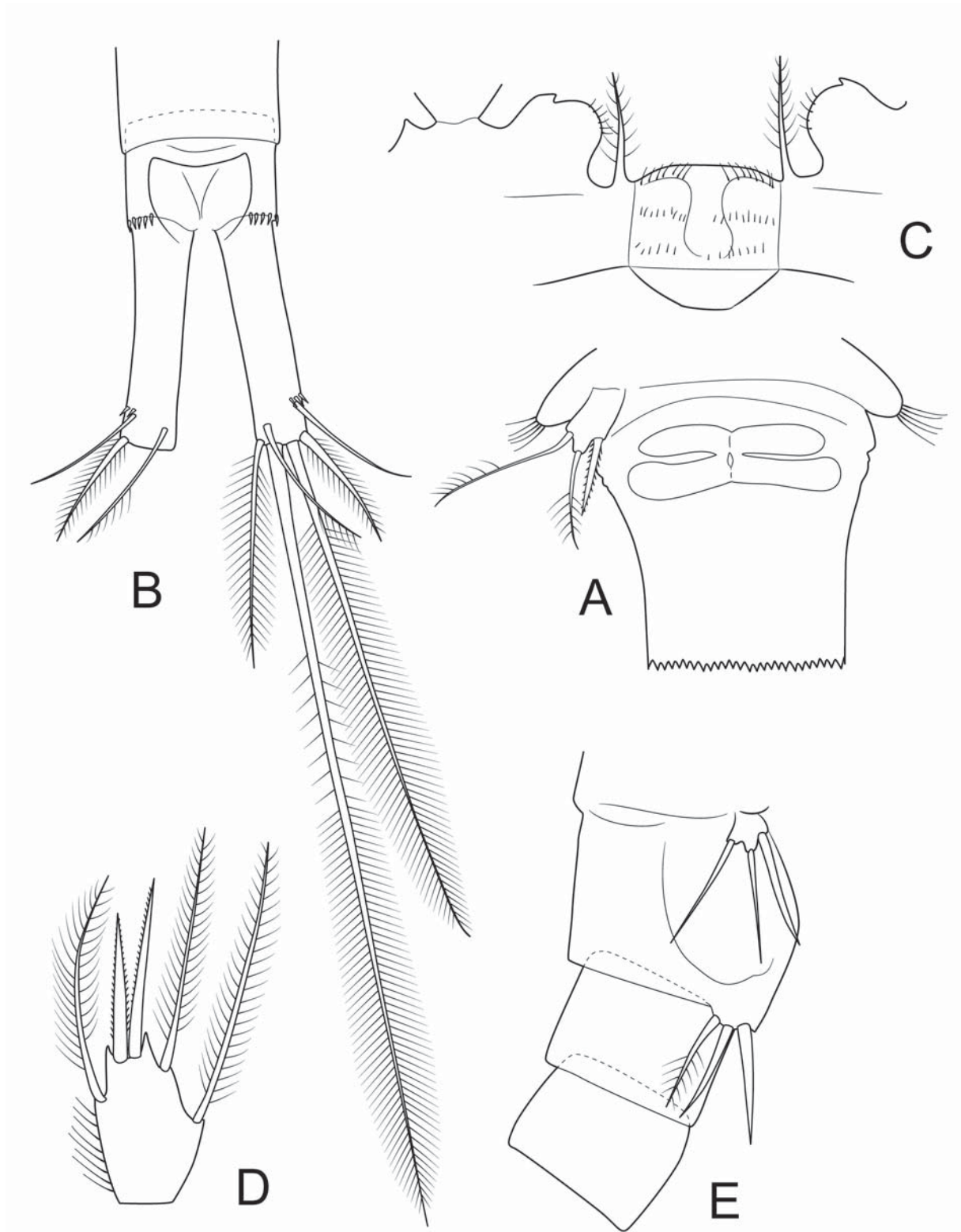


Fig. 2. *Isocyclops caparti* Lindberg, 1951 stat.n.: A — genital segment and P5, ventral; B — caudal rami, dorsal; C — P4 coxal connective plate; D — distal segment of endopodite P4; E — P5 & P6, ♂. Redrawn from Lindberg, 1951.

Рис. 2. *Isocyclops caparti* Lindberg, 1951 stat.n.: A — генитальный сегмент и P5, вентрально; B — каудальные ветви, дорсально; C — соединительная пластинка P4; D — дистальный сегмент эндоподита P4; E — P5 & P6, ♂. Воспроизведено по Lindberg, 1951.

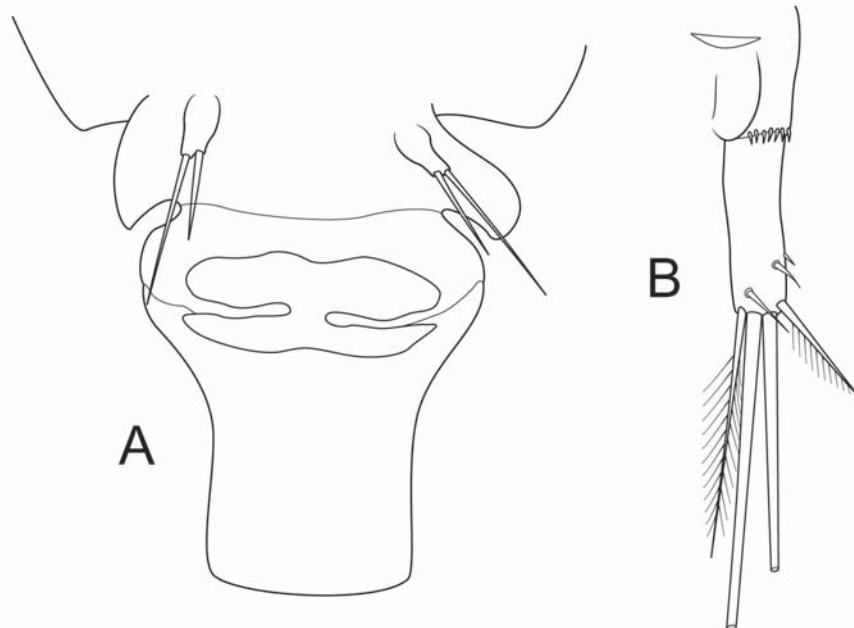


Fig. 3. *Stygocyclops teras* (Graeter, 1907) stat.n.: A — genital segment and P5, ventral; B — caudal ramus, dorsal. Redrawn from Graeter, 1907.

Рис. 3. *Stygocyclops teras* (Graeter, 1907) stat.n.: A — генитальный сегмент и P5, вентрально; B — каудальная ветвь, дорсально. Воспроизведено по Graeter, 1907.

names and authors: genus *Isocyclops* Kiefer, 1957 stat.n. and genus *Stygocyclops* Pleša, 1971 stat.n. One more subgenus *Tropocyclops* (*Defayeicyclops*) that has P5 with 2 long setae instead of 3 and includes now two species *T. (Defayeicyclops) jamaicensis* (Reid et Janetzky, 1996) and *D. matanoensis* (Defaye, 2007) also should be erected till genus level. So far in the key for Eucyclopiniae subfamily genera I include: *Eucyclops*, *Tropocyclops*, *Afrocylops*, *Thaumasiocyclops*, *Ochridacyclops*, *Paracyclops*, *Ectocyclops*, *Macrocylops*, *Defayeicyclops*, *Isocyclops*, *Stygocyclops*, *Homocyclops*.

#### Brief description of new erected genera

##### Genus *Isocyclops* Kiefer, 1957 stat.n.

Type species: *I. caparti* Lindberg, 1951 (Fig. 2).

FEMALE. Moderate length 840–940  $\mu\text{m}$  with relatively short 12-segmented antennule just reaching cephalothorax distal edge; three distal segment A1 provided with smooth hyaline membrane. The 4th free thoracic segment with dense group of long spinules laterally, genital double-somite about as long as wide. Swimming legs with 3-segmented exopodite and endopodite, spinal formula 3/4/4/3. Distal segment endopodite 4 with both distal spines (or at least outer one) longer than segment; distal seta exceeding distal ends of nearest spine. Coxal spines homogeneously covered with spinules, coxal connective plate with three rows of very short hairs, inner outgrowth of basipodite round shaped but with small reduced angular protrusion. P5 very long, L/W ratio 1.6–1.8 with relatively weak inner spine subequal or shorter than outermost seta. Caudal rami clearly divergent

without lateral *serra* or with significantly reduced into 6–8 denticles near lateral seta, which is very long, longer than outermost seta and about 2–2.5 as long as ramus width. Outermost seta subequal in length or even longer than ramus length. Dorsal seta about as long as outermost seta; innermost seta 1.6–1.9 times as long as outermost seta.

MALE. Smaller than females 650–680  $\mu\text{m}$ . Caudal rami divergent but shorter than in females. P5 similar to females. P6 with strong inner spine and two subequal in length but more weak setae only reaching to the distal end of next abdominal segment.

The genus comprises two species *I. caparti* Lindberg, 1951 and *I. paucidenticulatus* Lindberg, 1951 both are endemics of lake Tanganyika (Africa).

##### Genus *Stygocyclops* Pleša, 1971 stat.n.

Type species: *S. teras* (Graeter, 1907) (Fig. 3).

FEMALE. Moderate length about 1000  $\mu\text{m}$ . Common view, relative length of antennule similar to *E. serrulatus*, body color in contrast missing. Forth free thoracic somite without lateral setules, caudal rami without saw. Swimming legs 3-segmented; exopodite spine formula 3/4/4/3; endopodite P4 elongated (L/W ratio more than 2.3), outer/inner spine ratio 1.6, distal setae reaching beyond distal tips of nearest spines. Genital double-somite elongated L/W ratio more than 1 with distal part of cylindrical shape. Caudal rami parallel or slightly divergent about 3.2–4.6 times as long as wide, practically without saw on lateral edge with only few small dents near lateral seta insertion place. Outer middle seta about half of inner middle seta or even shorter. Innermost seta clearly longer than ramus length and about 2.5 times as long as outermost seta; dorsal seta about as long as outermost seta; lateral seta 1.25 as long as ramus width. Rudimental P5 elongated shape 1.4 times as long as

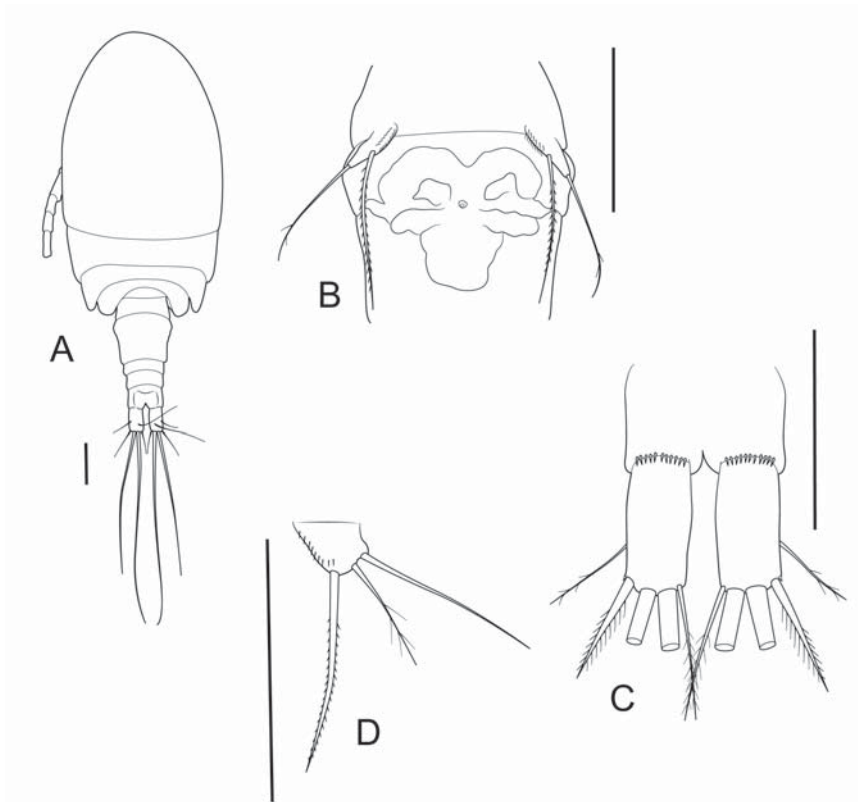


Fig. 4. *Defayeicyclops jamaicensis* (Reid et Janetzky, 1996) stat.n.: A — habitus, dorsal; B — genital segment and P5, ventral; C — caudal rami, ventral; D — P6, ♂. Scale bars: 50  $\mu$ m. Redrawn from Reid et Janetzky, 1996.

Рис. 4. *Defayeicyclops jamaicensis* (Reid et Janetzky, 1996) stat.n.: A — общий вид, дорсально; B — генитальный сегмент и P5, вентрально; C — каудальные ветви, вентрально; D — P6, ♂. Масштабные шкалы: 50  $\mu$ m. Воспроизведено по Reid et Janetzky, 1996.

broad with only 2 appendages (two naked setae), inner seta longer than outer seta or they subequal in length, outer seta seems like missing. Connecting coxal plate in P4 with long hairs along distal edge; coxal spine significantly longer than inner outgrowth of basipodite, the last looks similar to *E.serrulatus*.

**MALE.** Smaller than female 700–900  $\mu$ m with a parallel caudal rami, slightly shorter than in female. P5 similar to female with 2 appendages. P6 close to *E.serrulatus* with strong inner spine and two weak shorter setae, outer seta slightly longer than medial seta.

The monotypic genus presented with only one species *S. teras* (Grater, 1907) found in underground water of Switzerland.

**Genus *Defayeicyclops* Alekseev et Vaillant, 2013 stat.n.**

Type species: *D. jamaicensis* (Reid et Janetzky, 1996) (Fig. 4).

**FEMALE.** Small-sized cyclopid (600–700  $\mu$ m) widest at the posterior part of cephalothorax. The 4<sup>th</sup> free thoracal somite without long posterolateral setules, but sometimes with row of short spinules presence on lateral margins. Genital double-somite elongated and about 1.5 times longer than broad, with butterfly-like shaped seminal receptacle in anterior part differed from the same in *Tropocyclops*. Anal oper-

culum smooth without denticles or hairs. Caudal rami rather short, about 2 times longer than wide or even less, without hair-like spinules or denticles on lateral margins and on dorsal and ventral surfaces; with the usual 6 setae. Caudal setae: lateral seta inserted near middle of lateral margin of caudal rami; outermost and innermost setae of similar length and slightly longer than ramus; dorsal seta about twice the length of caudal rami and clearly longer than outermost seta. Antennule 12-segmented and long, reaching at least second thoracal somite. Antenna 4-segmented. P1–P4 with 3-segmented rami; exopodite spine formula 3/4/4/3 or 3/4/3/3. Distal segment endopodite P4 2.4–2.7 times longer than broad, medial terminal spine about 1.6–1.8 times longer than article, lateral terminal spine subequal to article. Elongated P5 one-segmented, more or less oval in lateral view, ornamented laterally with small, distal row of short spinules; and bearing 1 long spine inserted on the inner margin subapically and 1 apical seta subequal to spine.

**MALE.** Smaller than female 400–500  $\mu$ m with 14-segmented geniculate antennule. Segmentation and armature of P1–P4 identical to those in female. P5 one-segmented with 2 appendages similar to that of female, but with longer seta and a spine. P6 composed of 3 elements inserted close to each other on a small plate: 1 strong inner spine, 1 small and thin median seta, and 1 outer seta subequal to inner spine.

**COMMENTS.** The genus is distinguished from *Tropocyclops* and other genera of the family by combination of following characters: by the armature of P5 with one seta

and one spine; absence of lateral hairs on 4<sup>th</sup> thoracal free somite substituted with small spinules, the special shape of the seminal receptacle in female.

Based on P5 morphology only, the new genus might be placed in the Cyclopininae subfamily, as the free (distal) segment of P5 bears two setae in the genus *Defayeicyclops*. At the same time, it shares several characters with *Tropocyclops* such as: the shape and size of the body, the relative length and segmentation of A1, the segmentation and spine/seta armament of the swimming legs. The inner margin of the BAS of P4 is rounded in *Defayeicyclops*, similarly to *Tropocyclops* species, yet differentiating it from *Eucyclops* and most Cyclopininae species.

*Defayeicyclops* differs from *Tropocyclops* in the characters as follows: i) the fifth leg is armed with two elements only (bearing three elements in *Tropocyclops*); and ii) anterior part of the seminal receptacle is butterflyshaped (with horn-like processes in *Tropocyclops*).

*Defayeicyclops* currently comprises 2 species: *D. jamaicensis* (Reid et Janetzky, 1996) from Jamaica and *D. mataoensis* (Defaye, 2007) from Sulawesi. The representatives of the new genus were found in highly separated regions (tropical islands in the Pacific and Atlantic oceans).

#### KEY TO SUBFAMILIES OF CYCLOPIDAE

1. A1 21 segmented ..... Subfamily Euryteinae
- A1 6–18 segmented ..... 2
2. Distal segment P5 with 4–5 appendages .....  
..... Subfamily Halicyclopininae
- Distal segment P5 with 1–3 appendages ..... 3
3. Distal segment P5 with 3 appendages (rarely with 2, then  
P5 unisegmented bearing 2 long subequal setae) .....  
..... Subfamily Eucyclopininae
- Distal segment P5 with 1–2 appendages (unisegmented P5  
bears only one long seta ..... Subfamily Cyclopininae

After erection of three new genera subfamily Eucyclopininae one can count 14 genera. This number should be discussed meanwhile.

At first some comments should be done about position of the recently described *Australoeucyclops* Karanovic, 2006. Description of this genus in fact fits very well to definition *Paracyclops* done by Kiefer [1927]. Few small morphological differences and claiming of Karanovic on geographical isolation of this group of species are in contradiction to his own mentioning on the leading role of P5 construction in cyclopid genera separation. To my mind, *Australoeucyclops* should be lowered to subgenus level in the frame of *Paracyclops* genus.

*Austriocyclops* Kiefer, 1964, the second case, after redescription by Pospisil & Stoch [1997] was replaced from Cyclopininae to Eucyclopininae family on the base of not well studied of other genera details. Indeed it seems like this genus occupies intermediate position between Eucyclopininae and Cyclopininae subfamilies, but, to my mind, *Austriocyclops* more close to Cyclopininae. My reasons are as following: missing of any setules along lateral edge 4<sup>th</sup> thoracal free somite; P5 seems like was 2-segmented with fused basis bearing lateral seta and tiny distal segment (as in some *Microcyclops*). Construction of similar *receptaculum seminis* can be found in some genera of Cyclopininae subfamily; 10–11-segmented antennule also is common in above mentioned subfamily. Only presence/absence aesthetascs on antennule in male and female and some patterns of basipodite of antenna, that are not well studied in most genera of

cyclopids, are not convincing enough for replacing of *Austriocyclops* to Eucyclopininae subfamily. More clear conclusion could be done if we knew morphology of naupliar stages in *Austriocyclops*. Also molecular-genetic based phylogeny could be useful in this case. This genus possibly occupies intermediate position between *Diacyclops* and *Microcyclops* families. Until additional information appears I propose to not include *Austriocyclops* into Eucyclopininae subfamily and to leave Kiefer's definition.

After these comments I include in subfamily Eucyclopininae 11 genera that can be separated with the help of the following key.

#### KEY TO GENERA OF SUBFAMILY EUCYCLOPININAE

1. Distal segment unisegmented P5 with only 2 long subequal setae/spines attached to rudimental leg, Th4 rarely with few long setules laterally, Bifidaeucyclopinina group (possibly a new subfamily) ..... 2
- Distal segment P5 one-two segmented or fused to thoracal somite bearing 3 appendages of different length, Th4 always with group of long setules laterally, Trifidaeucyclopinina group (possibly comprised two subfamilies) .... 4
2. Caudal rami more than 4 times as long as broad, Th4 smooth laterally ..... *Stygocyclops* Pleša, 1971 stat.n.
- Caudal rami shorter, about 2–3 times as long as broad, Th4 with group of tiny setules or few long hair-like setae laterally ..... 3
3. P5 equipped with 2 long subequal setae, Th4 smooth or with tiny spines laterally; inner outgrowth of basipodite P4 round shaped .....  
..... *Defayeicyclops* Alekseev et Vaillant, 2013 stat.n.
- P5 equipped with strong inner spine and weak seta 1.5 times as short as spine; Th4 with long setules laterally .....  
..... *Thaumascyclops* Kiefer, 1930
4. P5 two-segmented ..... *Macrocyclops* Claus, 1893
- P5 one-segmented or the segment fused to th ..... 5
5. Antennule 17-segmented ..... *Homocyclops* Forbes, 1897
- Antennule with less number of segments; 12 or less ..... 6
6. P4 basipodite with triangular internal outgrowth ..... 7
- P4 with round shaped internal outgrowth ..... 8
7. Caudal rami with very long lateral setae more than 2 times as long as ramus width .. *Isocyclops* Kiefer, 1957 stat.n.
- This seta as long as ramus width or shorter .....  
..... *Eucyclops* Claus, 1893
8. Caudal rami at least 5.2 times as long as broad, P5 one-segmented with 2 setae and spine subequal in length ...  
..... *Afroscyclops* G.O. Sars, 1927
- Caudal rami usually shorter, spine in P5 usually shorter than setae ..... 9
9. A1 long, reaching 3<sup>rd</sup> free thoracal somite, receptaculum semini in upper part horn-like shaped .....  
..... *Tropocyclops* Kiefer, 1927
- A1 shorter, even not reaching distal edge of cephalothorax, receptaculum semini of different shape ..... 10
10. Caudal rami smooth, P5 with very short inner spine .....  
..... *Ochridacyclops* Kiefer, 1937
- Caudal rami with one or several rows of spinules in dorsal surface ..... 11
11. P5 fused to thoracal somite and represented with 3 spiniform setae, caudal rami very short (L/W less than 2, with 3 diagonal rows of spinules .....  
..... *Ectocyclops* Brady, 1904
- P5 more or less separated from thoracal somite and represented with one seta and two spines; caudal rami longer



and with only one row of spinules .....  
 ..... *Paracyclops* Claus, 1893

After separation of *Stygocyclops* and *Isocyclops* genera the genus *Eucyclops* was split into 9 subgenera on the construction of classical morphological features and microcharacters studied during *serrulatus*-group revision [Alekseev *et al.*, 2006; Alekseev, Defaye, 2011].

The most important characters were as following: A1 segmentation; presence and type of hyaline membrane; basipodite antenna ornamentation, especially groups 1 and 2 presence (see Fig. 1); construction and ornamentation of P4 including coxal spine pinnation; P5 size, shape and armament; genital-double somite proportion; caudal rami shape, size, setae proportion, presence (absence) of lateral *serra* and hairs or spine presence on inner ventral and dorsal surfaces.

Hereafter a key for subgenera and description of the type for subgenera species as well as key for species of the world *Eucyclops* fauna are provided.

#### KEY FOR SUBGENERA OF *EUCYCLOPS*

1. Antennule 12 segmented ..... 2  
 – Antennule 11-segmented ..... *Mrazekicyclops* subgen.n.
2. Caudal rami with hair-setae at inner surface .....  
 ..... *Ciliocyclops* subgen.n.  
 – Caudal rami without hairs on inner margin ..... 3
3. Caudal rami very short ( $L/W < 2.7$ ) .....  
 ..... *Breviramocyclops* subgen.n.  
 – Caudal rami longer ( $L/W > 2.7$ , usually more than 3) ..... 4
4. Distal setae of third endopodal segment of leg 4 long, extending above distal ends of nearest spines .....  
 ..... *Subterrocyclops* subgen.n.  
 – Distal setae of third endopodal segment of leg 4 shorter, usually shorter than nearest spine or sometime only outer seta can reach distal end of next spine ..... 5
5. Antennule with denticulate hyaline membrane at distal segments, caudal rami with saw .....  
 ..... *Denticyclops* subgen.n.  
 – Antennule with smooth hyaline membrane or without it; if not then caudal rami smooth or P5 inner spine clearly shorter than segment; caudal rami with *serra* or not ... 6
6. Caudal rami with more or less developed spinal row extending along outer edge ..... 7  
 – Caudal rami smooth with only few spinules near setae inserted places, leg 5 with weak inner spine .....  
 ..... *Macruricyclops* subgen.n.
7. Leg 5 with very small inner spine, shorter than leg length and about half of outer seta ..... *Sarsicyclops* subgen.n.  
 – Leg 5 with larger inner spine, longer than leg length and about half of outer ..... 8
8. Basis of antenna on caudal surface with 1–2 groups of hair-setae in distal-lateral positions (groups 1 & 2) .....  
 ..... *Eucyclops* subgen.n.  
 – This segment without hair-setae rows on caudal surface of antennal basis ..... *Speratocyclops* subgen.n.

#### *Eucyclops (Eucyclops)* subgen.n.

Type species: *Eucyclops serrulatus* Fischer, 1851.

Small and average size cyclopids 650–1150  $\mu\text{m}$  without caudal rami seta. Antennula 12-segmented, last 3 segments with narrow or wide smooth hyaline membrane usually reaching to distal edge of cephalothorax. A2 basipodite on posterior

or side with 1–2 groups of hair-setae in distal-lateral positions. Genital double-somite as long as wide, caudal rami of average size (3.5–6.5, rarely up to 8 times as long as broad). Swimming legs spine formula 3/4/4/3. Distal segment endopodite P4 about 2 times as long as wide, distal seta of the segment never reach distal ends of nearest spines. P5 with inner spine strong, shorter than middle seta, at least 1.5 times as long as segment itself and usually about as long as outer setae or longer. Caudal rami with more or less long lateral saw and don't covered with hairs or dents on inner edge or inner/ventral surfaces. Males always smaller than females with P5 construction and armament like in females, P6 usually with strong inner spine, caudal rami shorter than in female. Subgenus includes more than 28 species and 10 subspecies.

#### *Eucyclops serrulatus* Fischer, 1851

Fig. 5.

FEMALE. Body color rusty brown, rarely dark brown or greyish. Full length without caudal seta from 800 to 1700  $\mu\text{m}$ . Cephalosome as long as wide, maximum width close to posterior margin. Last somite of prosome with lateral group of short setules. Genital double somite 0.7–1.2 times as long as wide. Caudal rami 3.5–6.5 times as long as wide, with longitudinal row of spinules along most of outer edge of each ramus, but partly reduced in some taxa inhabiting subterranean or spring environments and never with hair-like setae or denticles on dorsal or ventral surfaces. Six setae inserted on distal part of ramus. Dorsal seta about half the length of innermost terminal seta (VI), covered with long setules on both sides; outermost seta (III): a spiny seta with dense setules on both sides, but longer on inner margin, about 3 times as long as dorsal seta yet distinctly shorter than seta VI. Antennule 12-segmented, with smooth membrane along 3 distal segments. Posterior side of antenna (A2) basipodite (see Fig. 1A): apical group N1 with 2–6 long setules and group N2 with variable number of the same setules (0–4) subdistally along inner margin; with three oblique and parallel rows of spinules (N3–5) and 2 groups of marginal spinules (N17) and (N15). Anterior side of basipodite A2 (see Fig. 1B): 3–5 strong spinules, of different length among species, subdistally (N8), groups 9 and 10 sometimes united in one row; a long row of 10–17 spinules medially (N11 + N12); N13 and N14 represented by 2 isolated groups of tiny spinules; groups 15 and 17 usually composed of long spinules and group 16 of short or even tiny denticles.

Setae on all segments of P1–P4 uniformly seta-like, not constricted, flanked with series of long setules on both edges. The setules at least twice as long as the distance between them. Inner edge of basipodite of P1–P4 usually with group of long setules. Intercostal plate of P1 with two protuberances, a transversal row of small denticles around midway, and two groups of thin spinules on main body of protuberances, not extending beyond their edges. Intercostal plates of P2–P3 also with protuberances on free edge and with groups of setules. Distal segment of Enp P4 elongated, 2.2–2.8 times as long as wide, with 2 strong apical spines; inner spine 1.2–1.5 times as long as outer spine. Coxopodite of P4 with strong inner spine, dense hair-setae on inner side, and in many taxa with large gap among short hair-like setae on inner side. Posterior side of coxopodite with tiny spinules on inner side not organized in groups, and groups of spinules and setules, giving the formula A-B-C+D-E-H (see Fig. 1C). Intercostal plate of P4 with protuberances wide but not pro-

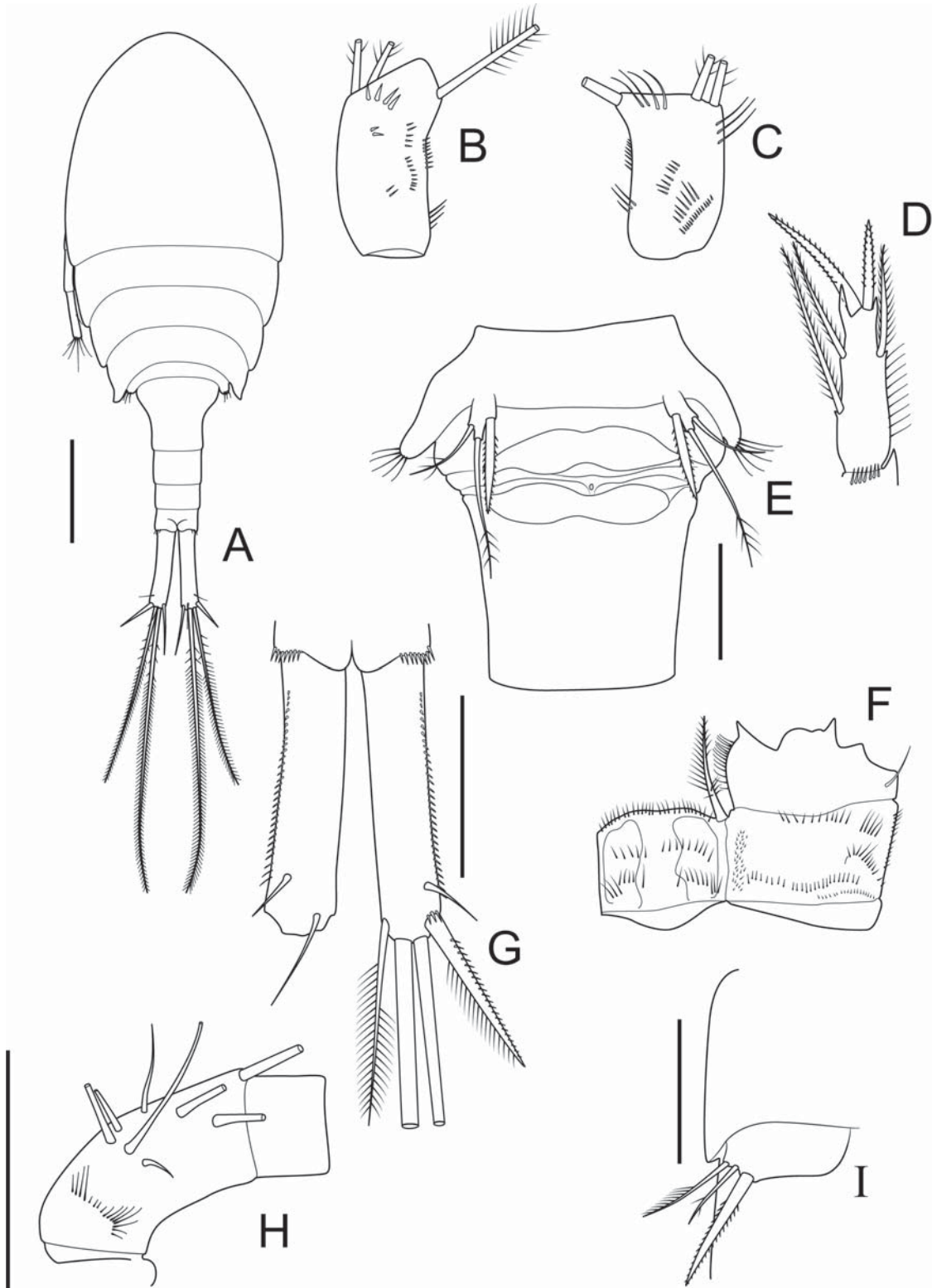


Fig. 5. *Eucyclops serrulatus* (Fischer, 1851): A — habitus, dorsal; B — A2 basipodite, anterior; C — basipodite of A2, posterior; D — distal segment of endopodite P4; E — genital segment and P5, ventral; F — coxa and coupler of P4; G — caudal rami, dorsal; H — first segment of A1; I — P6, ♂. Scale bars: A — 75  $\mu$ m; E, H, I — 50  $\mu$ m; G — 40  $\mu$ m. Orig.

Рис. 5. *Eucyclops serrulatus* (Fischer, 1851): A — общий вид, дорсально; B — базиподит A2, спереди; C — базиподит A2, сзади; D — дистальный членик эндоподита P4; E — генитальный сегмент и P5, вентрально; F — соединительная пластинка и коксоподит P4; G — каудальные ветви, дорсально; H — первый сегмент A1; I — P6, ♂. Масштабные шкалы: A — 75  $\mu$ m; E, H, I — 50  $\mu$ m; G — 40  $\mu$ m. Ориг.

truding beyond free edge of plate; group of hair-like, long setules along edge, 2 groups of setules and spinules on main body of plate. P5 1-segmented, with wide and strong inner spine, and 2 setae; outer seta subequal in length to spine, middle seta about 1.1–2 times as long as spine.

**MALE.** Body length 650–1100 µm. Cephalosome 1.1–1.5 times as long as wide, with maximal width near to its posterior end. Last somite of prosome smooth, last urosomal somite with a row of denticles on caudal side. Caudal rami 3.8–5 times as long as wide, without lateral spinules. Slender innermost terminal seta (VI) about twice the length of spine-like outermost seta (III). Lateral seta (II) shifted to dorsal side, with several spinules at base. Dorsal seta (VII) near insertion of innermost seta (VI), about 0.8 times as long as outermost seta. Antennule 14-segmented. Antennary basipodite basically as in female, with 4–6 long setules posteriorly corresponding to groups N1 and N2; anteriorly with 3 rows of strong spinules and an additional row of spinules subdistally. Coxopodites and intercoxal plates of P1–3 with apical setules. Inner edge of basipodite of P4 with short setules. Coxopodite of P4 with strong spine, bearing 8–10 stiff inner hair-like setae and 2–3 hair-like setae at apex and 1 at base of spine, so also with a gap in those setae at the outer margin. Also coxopodite of P4 has a narrow row of small spinules on its inner side and several groups of spinules (corresponding to A-B-C+D-F) posteriorly (see Fig. 1C). Intercoxal plate of P4 with small protuberances, strong hair-like setae on free edge, and 3 groups of setules on both sides. Distal segment of endopodite of P4 about 2.2–3.2 times as long as wide, with inner spine as long as segment and always longer than outer spine. P5 with inner spine slightly shorter than in female, outer seta as long as spine, middle seta significantly longer than spine. P6 with inner spine and two setae with variable length proportions.

There appeared to be appreciable variation among the specimens from the locus typicus as well as in other populations of the species and in other species of the *serrulatus*-group. We identified three morphotypes, based on the type population (*E. serrulatus* s.str.) from St. Petersburg [Aleksseev *et al.*, 2006]. **Type A**, with plumose setae on the endopodite and exopodite segments of P1–P4, and innermost and outermost setae of the caudal rami with dense long setules. Intercoxal plate of P4 with dense long setules, sometimes as long as half of the plate's width. At some distance from seta I, the setules are much longer than the distance between them. **Type B**, with a few short setules on caudal setae III and VI; characterized by a reduction in length of the setules of the exopodal and endopodal setae of P4, and also of the setae of the caudal rami. Distal half of setae of Enp3P4 and most setae of Exp3P4 blade-shaped, narrowed, and with much shorter setules on distal part than on proximal part. Intercoxal plate of P4 with short marginal setules of about 1/3 or less the membrane width. **Type C** (pitted form). In the caudal setae, a configuration similar to that of form A is found, but this form is provided with a pitted integument on the cephalosome, urosome, caudal rami, and first antennae. In the Peterhoff ponds, Type C was rare during spring (15%) but became more frequent in fall (40%). Types A and B were most abundant in spring (about 40% each), hybrids between these three types dominated during summer and fall. The specimens of these three groups can live together at the same time in the same waterbody and easily hybridize in both laboratory experiments and in the field. The possible reasons for the coexistence of these types had been discussed in Aleksseev *et al.* [2006].

Hereafter a key for valid species of subgenus is provided.

KEY TO SUBGENUS *EUCYCLOPS* (*EUCYCLOPS*) SPECIES AND SUBSPECIES

1. Caudal rami very short L/W = 3–3.5 ..... 2  
– Caudal rami more than 3.5 times as long as wide ..... 3
2. Dorsal caudal seta longer than outermost seta .....  
..... *E. (E.) bondi* Kiefer, 1934 [Haiti, Americas]  
– Dorsal caudal seta shorter than outermost seta .....  
..... *E. (E.) conrowae* Reid, 1992 [Americas]
3. Caudal rami quite long, L/W > 6 ..... 4  
– Caudal rami of moderate length, 3.6–6 times as long as 9
4. Caudal rami *serra* extending along less than third of ramus length ..... 5  
– Caudal rami *serra* extending along at least half of ramus length ..... 6
5. Basipodite of A2 on caudal surface with 2 groups of long hair-setae (1, 2) and with one group of hair-seta on frontal surface ..... *E. (E.) neumani* (Pesta, 1927) s.lat. [Central and South America]  
– Basipodite of A2 on caudal surface with one group of long hair-setae (1) and without such armament on frontal surface ..... *E. (E.) titicacae* Kiefer, 1957 [partly, for females with smooth hyaline membrane in A1; possibly endemic of lake Titicaca]
6. Caudal rami *serra* extending along practically whole rami length (exception — underground populations), coxal spine of P4 on outer edge with clearly seen gap in hair-setae or even almost without hair-setae, smooth maxilar palp ..... 7  
– Caudal rami with reduced *serra*, P4 coxal spine on outer edge with full line of hair-setae, maxilar palp with group of small dents ..... *E. (E.) pacificus* Ishida, 2000 [SEA, Pacific coast rivers]
7. Caudal rami very long, L/W = 6.5–8; P5 inner spine 1.5–2 times as long as outer setae; in P4 connective plate of coxa along external margin with strong hair-setae ..... 8  
– Caudal rami usually shorter but sometimes with L/W up to 7, inner spine of P5 less than 1.25 times as long as outer setae; in P4 connective plate of coxa along external margin with very fine hair-setae .....  
..... *E. (E.) serrulatus* (Fischer, 1851) [populations of cold season, in high latitudes and altitudes]
8. Caudal rami L/W = 7–8, caudal dorsal seta shorter or less than 1.1 times as long as outermost seta; medial seta of P5 1.3–1.5 times as long as inner spine .....  
..... *E. (E.) elegans* (Herrick, 1884) [America]  
– Caudal rami L/W less than 7 (about 6.5), caudal dorsal seta at least 1.35 times as long as outermost seta; P5 medial seta twice as long as inner spine .....  
..... *E. (E.) solitarius* Herbst, 1959 [South America, Brazil]
9. Hyaline plate of distal segments A1 usually very wide, about one third of segment width; P4 coxal spine homogeneously covered with quite long rare hair-seta; P5 inner spine about as long as outer seta; anal plate with double wrinkle at distal edge .....  
..... *E. (E.) agiloides* (Sars, 1909) s.lat. with 3 subspecies: *E. (E.) a. a.* (Sars, 1909), *E. (E.) a. roseus* Ishida, 1997, *E. (E.) a. miracleae* Aleksseev, 2010 [Moderate and tropic climate zones of the Old World]



- Combination of the characters different ..... 10
- 10. Caudal rami with long *serra* practically along all rami length ..... 11
- Caudal rami with more or less reduced *serra*, coxal spine of P4 on outer edge with full line of hair-setae, maxilar palp with group of small dents ..... 27
- 11. Innermost caudal seta very short, shorter than dorsal seta and about as long as outermost seta; outermost caudal spine-like seta perpendicularly joined to ramus .....  
..... *E. (E.) acanthoides* (Van Douwe, 1914)  
[Tropical Africa]
- Innermost caudal seta longer; outermost caudal seta not joined perpendicularly to ramus ..... 2
- 12. Innermost caudal seta short, subequal or not more than 1.2 times as long as outermost seta; if longer then P5 with inner spine longer than outer seta ..... 13
- Innermost caudal seta usually more than 1.2 times as long as outermost seta; if shorter then P5 with inner spine equal or longer than outer seta ..... 18
- 13. P5 inner spine longer or equal to outer seta; P4 Enp with distal outer spine as long as segment itself; caudal rami with very long (sometimes up to half of caudal rami width) spines on outer edge ..... 14
- P5 inner spine shorter than outer seta; P4 Enp with distal outer spine shorter than segment itself; caudal rami with moderate or short spines on outer edge ..... 15
- 14. P4 Enp with subequal spines; P5 inner spine as long as outer seta .....  
..... *E. (E.) vandouwei* Brehm, 1909 [Tropical Africa]
- P4 Enp with inner spine significantly longer than outer spine; P5 inner spine longer than outer seta .....  
..... *E. (E.) albuferensis* Alekseev, 2008 [Spain]
- 15. Caudal rami relatively long ( $L/W > 5$ ) ..... 16
- Caudal rami usually shorter ..... 17
- 16. P4 Enp distal setae long and almost reaching ends of distal spines; caudal rami about 5–6 times as long as wide ..... *E. (E.) extensis* Hsiao, 1950 comb.n. [China]
- These setae reaching only the middle of distal spines; caudal rami more than 6 times as long as wide .....  
..... *E. (E.) procerus* Dussart, 1981 [Africa]
- 17. Inner medial caudal seta about two times as long as outer medial seta ..... *E. (E.) ensifer* Kiefer, 1936  
[Central and South America]
- Inner medial caudal seta 2.5 times and more as long as outer medial seta ..... *E. (E.) pectinifer* (Cragin, 1883)  
[Northern America]
- 18. Caudal rami long ( $L/W = 4.8-5.9$ ) ..... 19
- Caudal rami short ( $L/W = 3.7-4.7$ ) ..... 21
- 19. P5 outer seta very long, practically equal to medial seta and about twice of inner spine; caudal saw with very small and equal in size lateral spines .....  
..... *E. (E.) spatulatus* Morton, 1990 [Australia]
- P5 outer seta clearly shorter than medial seta and about as long as inner spine; caudal saw with relatively large and different in size lateral spines ..... 20
- 20. Outermost caudal seta elongated and about 2/3 of ramus length; lateral caudal seta twice of ramus width .....  
..... *E. (E.) demacedoi* Lindberg, 1957 [Chili]
- Outermost caudal seta not more than half of ramus length; lateral caudal seta not longer than ramus width, coxal spine of P4 on external edge always with gap among strong hair-setae ..... *E. (E.) serrulatus* (Fischer, 1851)  
[Populations of cold season in low-lands and moderate climate or warm season in Arctic and in mountains]
- 21. Innermost caudal seta not less than 1.2–1.5 as long as outermost seta ..... 22
- Innermost caudal seta less than 1.2 as long as outermost seta or equal to it ..... 23
- 22. Caudal rami parallel; dorsal seta about as long as outermost seta .....  
..... *E. (E.) australensis* Morton, 1990 [Australia]
- Caudal rami divergent; dorsal seta about half of outermost seta; P4 coxal spine external edge always with gap among strong hairs ..... *E. (E.) serrulatus* (Fischer, 1851)  
[Populations of warm season in moderate and southern climate zones in Palearctic and in some enclaves]
- 23. P4 Enp distal spines about similar length (not more than 1.2 times difference); P5 inner spine about half of outer seta ..... *E. (E.) silvestrii* (Brian, 1927) [South America]
- P4 Enp with inner distal spine 1.3–1.5 as long as outer one; inner spine of P5 variable length ..... 24
- 24. P5 inner spine at least two times as short as outer seta ..... 25
- This spine equal or longer than outer seta ..... 26
- 25. P5 inner spine at about three times as short as outer seta and practically equal to segment length .....  
..... *E. (E.) cuatrocieneegas* Suárez-Morales et Walsh, 2009  
[Mexico]
- This spine about two times as short as outer seta and clearly longer than segment .. *E. chilensis* Löffler, 1963 [Chile]
- 26. Dorsal caudal seta longer or equal to innermost seta; P4 Enp outer distal seta about reaching distal tip of nearest spine ..... *E. (E.) ariguanabensis* Brehm, 1949 [Cuba]
- Dorsal caudal seta clearly shorter than innermost seta; P4 Enp outer distal seta reaching to the middle of nearest spine; A1 short, not reaching distal end of cephalothorax ..... *E. (E.) prionophorus* Kiefer, 1931 [America]
- 27. Caudal rami with very short *serra* occupying less than half of outer edge ..... 28
- Caudal rami *serra* occupies not less than half of outer edge ..... 33
- 28. In P4 Enp with inner distal spine as long as segment itself ..... 29
- This spine shorter than segment length ..... 30
- 29. P5 inner spine as long as outer seta and about 2/3 of medial seta .....  
..... *E. (E.) alticola* Kiefer, 1957 [South America]
- P5 inner spine about half of outer seta and as short as half of medial seta ... *E. (E.) farsicus* Lindberg, 1941 [India]
- 30. Innermost caudal seta twice of outermost seta ..... 31
- Innermost caudal seta 1.5 times or less as long as outermost seta ..... 32
- 31. P4 Enp inner and outer setae reaching distal tips of spines .....  
..... *E. (E.) rutneri* Kiefer, 1933 s.lat. [Japan, Oceania]
- These setae significantly shorter and never reaching distal tips of adjacent spines .....  
..... *E. (E.) defectus* Lindberg, 1937 [Switzerland]
- 32. P5 inner spine strong, knife-shaped, about as long as medial seta; caudal rami with parallel and relatively short branches ( $L/W < 4$ ) .....  
..... *E. (E.) hadjebensis* (Kiefer, 1926)  
[Morocco, North Africa]
- P5 inner spine shorter, caudal rami divergent ..... 33
- 33. Innermost caudal seta shorter than outermost seta .....  
..... *E. (E.) romaniensis* Alekseev, 2010
- Innermost caudal seta equal or longer than outermost seta ..... 34
- 34. P5 inner spine relatively long, as long as outer setae .... 35
- P5 inner spine shorter ..... 36
- 35. Caudal rami at external edge with more or less long *serra*



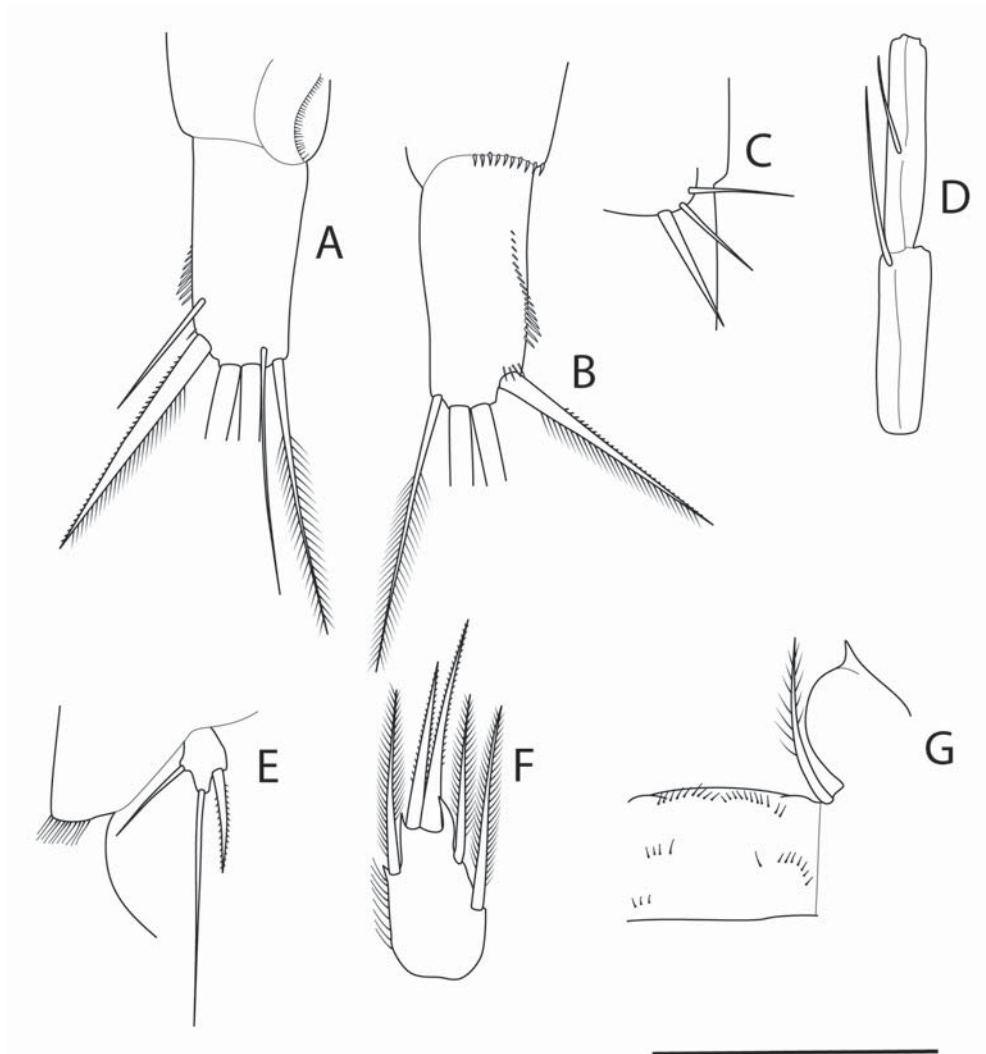


Fig. 6. *Eucyclops (Breviramocyclops) breviramatus* Löffler, 1963: A — caudal ramus, dorsal; B — caudal ramus, ventral; C — P6, ♂; D — distal segments of A1; E — P5; F — distal segment of endopodite P4; G — intercoxal plate of P4. Scale bar: 100 μm. Redrawn after Löffler [1963].

Рис. 6. *Eucyclops (Breviramocyclops) breviramatus* Лöffлер, 1963: А — каудальная ветвь, дорсально; В — каудальная ветвь, вентрально; С — P6, ♂; D — дистальные сегменты A1; E — P5; F — дистальный сегмент эндоподиты P4; G — соединительная пластинка P4. Масштабные шкалы: 100 μm. Воспроизведено по Лöffлер [1963].

- (about 2/3 ramus length); dorsal seta very short, less than half of outermost seta .....
- ..... *E. (E.) agiloides azorensis* Defaye et Dussart, 1991 [Azores]
- Caudal rami at external edge with short *serra* (less than 1/2 ramus length); dorsal seta about as long as outermost seta ..... *E. (E.) permixtus* Kiefer, 1929 [Java]
- 36. Caudal rami more or less long (L/W > 4.5) with very small spine on external edge ..... 37
- Caudal rami short (L/W < 4.5) with spine of normal size ..... 39
- 37. P4 Enp with outer distal seta very short and not extending above the end of the segment; innermost caudal seta as long as outermost seta .....
- ..... *E. (E.) parvicornis* Harding, 1942 [East Africa]
- P4 Enp with outer distal seta much longer and extending up to the middle of distal adjacent spine; innermost

caudal seta at least 1.15 times as long as outermost seta ..... *E. (E.) serrulatus tsushimensis* Ishida, 2001 stat.n.

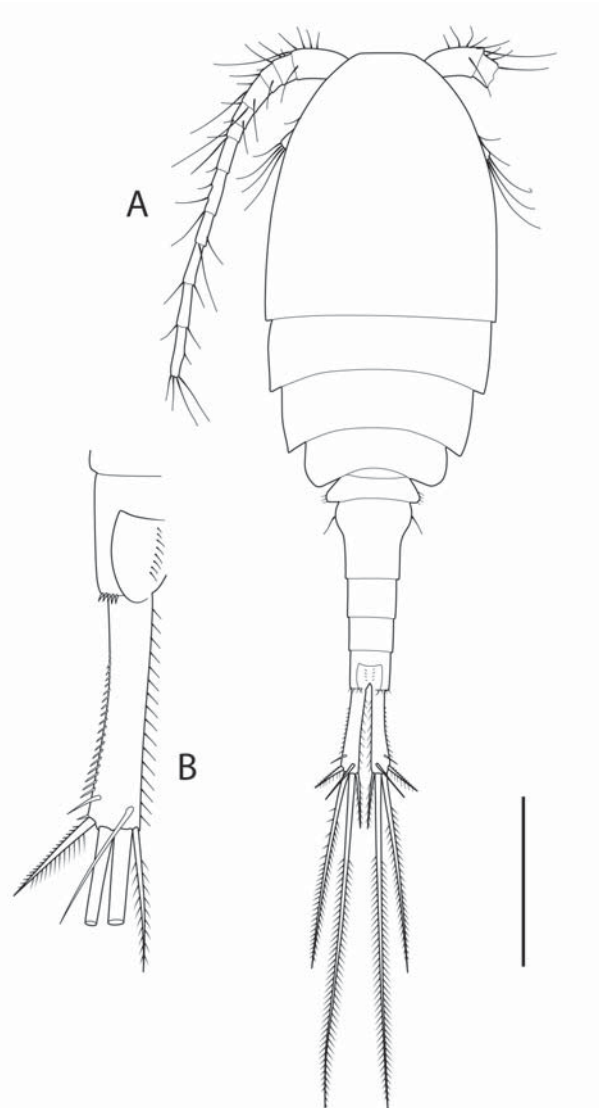
Several other species described by Ishida (*E. ohtakai* Ishida, 2000, *E. borealis* Ishida, 2001) are very doubtful and possibly represent seasonal variation of *E. serrulatus*, but for sure they do not belong to *speratus*-group as was suggested by author. Taxonomical position of them ♂ not clear.

***Eucyclops (Breviramocyclops) subgen.n.***

Type species: *Eucyclops breviramatus* Löffler, 1963.  
 Small and average size cyclopids with body length without caudal seta about 800–1200 μm inhabiting mainly marsh habitats. Body colour brown or brown-yellowish. Antennule

Fig. 7. *Eucyclops (Ciliocyclops) ciliatus* (Sars, 1909): A — habitus, dorsal; B — caudal ramus, dorsal. Scale bar: 200  $\mu\text{m}$ . Redrawn from Sars, 1909.

Рис. 7. *Eucyclops (Ciliocyclops) ciliatus* (Sars, 1909): А — общий вид, дорсально; В — каудальная ветвь, дорсально. Масштабная шкала: 200  $\mu\text{m}$ . Воспроизведено по Sars, 1909.



12-segmented, reaching the distal edge of first free somite, three distal segments with smooth hyaline membrane. Swimming leg exopodite spinal formula 3/4/4/3. Rudimental P5 with quite long seta and strong inner spine. Caudal rami very short, L/W ratio less than 3.

*Eucyclops (Breviramocyclops) breviramatus*

Löffler, 1963

Fig. 6.

FEMALE. Body length 1163  $\mu\text{m}$ . Genital double-somite slightly wider than long. Caudal rami very short, L/W ratio 2.5 (2.3–2.6). Outermost caudal seta about as long as ramus length. Caudal rami laterally with a short saw occupied about half of ramus length. Distal four spines of saw significantly longer than others. Dorsal seta subequal to outermost seta. Innermost seta significantly longer than outermost seta (1.6–1.8). Swimming legs exopodite spinal formula 3/4/4/3. Distal segment endopodite P4 1.5 times as long as wide. Distal spines of the segment ratio: inner/outer 1.2; inner spine to segment ratio 1.4–1.5. Rudimental P5 about 1.3 times as long as wide, inner spine longer than segment itself

but shorter than both setae, length of armaments beginning from spine 27–34 /68–85/ 34–39 ( $\mu\text{m}$ ).

MALE. Body length 980  $\mu\text{m}$ . Caudal rami significantly shorter than in female, without serra laterally, but with several small spines near lateral and outermost seta insertation place. P4 and P5 similar to female. Rudimental P6 with inner spine about as long as second abdominal segment and just a little longer than two other setae.

KEY TO SUBGENUS *EUCYCLOPS (BREVIARAMOCYCLOPS)* SPECIES

1. Caudal rami very short (L/W < 2) .....  
*E.(B.) edytiae* Tang et Knott, 2009 [Caves in Australia]  
 – Caudal rami longer (L/W > 2) ..... 2
2. Innermost seta more than twice as long as outermost seta .....  
*E.(B.) puteincola* Kiefer, 1982 [wells in Syria]  
 – Innermost seta less than twice as long as outermost seta ..... 3
3. Inner weak spine of P5 about as long as segment length and at least 3 times shorter than outer seta .....  
*E. (B.) siolii* Herbst, 1962 [Brazil]

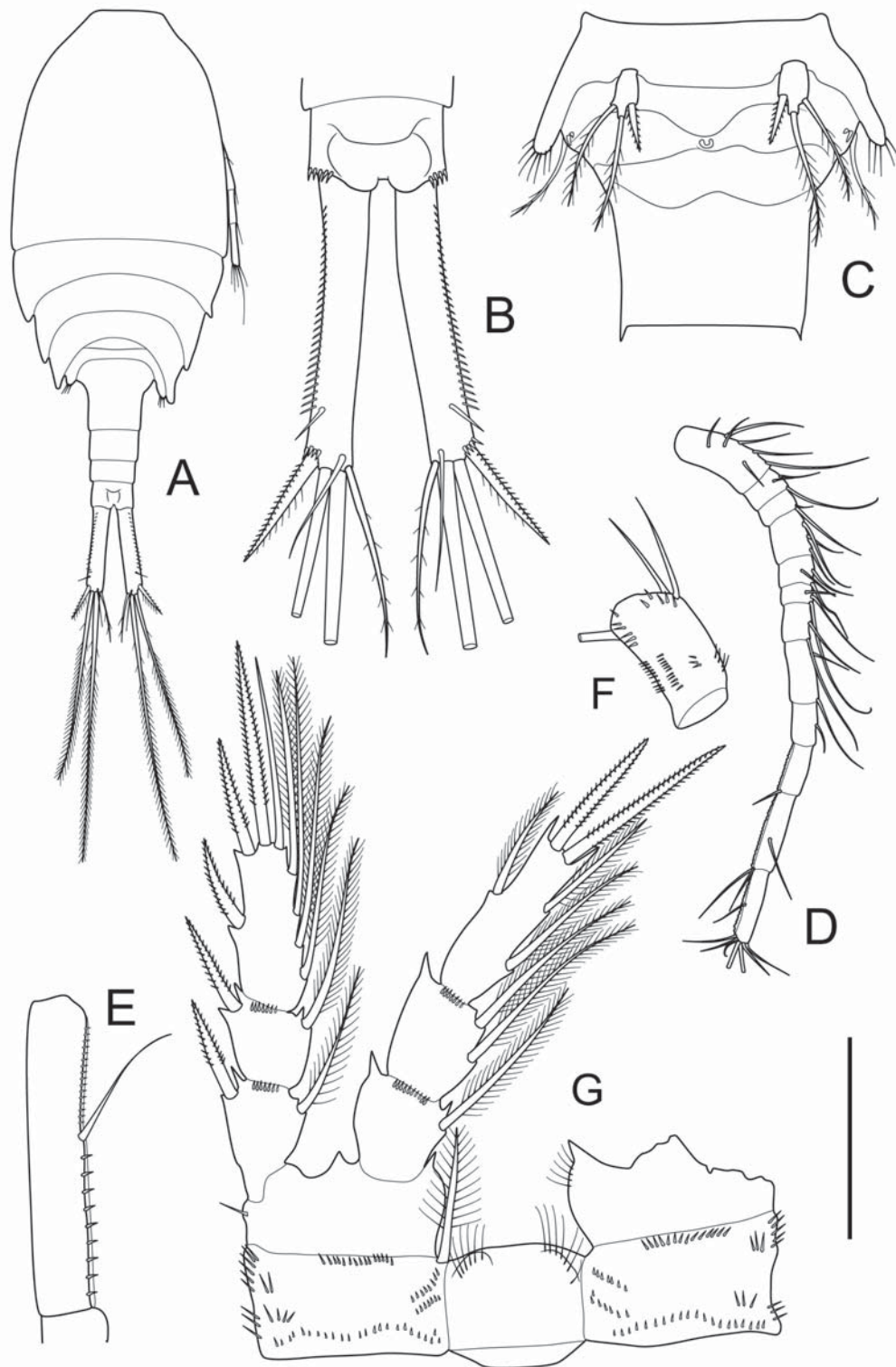


Fig. 8. *Eucyclops (Denticyclops) denticulatus* (Graeter, 1903): A — habitus, dorsal; B — caudal rami, dorsal; C — genital segment and P5, ventral; D — A1; E — distal segment of A1; F — basipodite of A2, anterior; G — P4. Scale bars: A — 400  $\mu\text{m}$ ; B, C — 120  $\mu\text{m}$ ; D — 200  $\mu\text{m}$ ; E — 50  $\mu\text{m}$ ; F, G — 100  $\mu\text{m}$ . Orig.

Рис. 8. *Eucyclops (Denticyclops) denticulatus* (Graeter, 1903): A — общий вид, дорсально; B — каудальные ветви, дорсально; C — генитальный сегмент и P5, вентрально; D — A1; E — дистальный сегмент A1; F — базиподит A2, вид спереди; G — P4. Масштабные шкалы: A — 400  $\mu\text{m}$ ; B, C — 120  $\mu\text{m}$ ; D — 200  $\mu\text{m}$ ; E — 50  $\mu\text{m}$ ; F, G — 100  $\mu\text{m}$ . Ориг.

- This spine twice as long as segment and nearly equal to outer seta in length .....  
 ..... *E. (B.) breviramatus* Löffler, 1963 [Ecuador]

*Eucyclops (Ciliocyclops) subgen.n.*

Type species: *Eucyclops ciliatus* (G.O. Sars, 1909).

Small size *Eucyclops* inhabiting tropical areas. Caudal rami with hairs on inner/dorsal surfaces. Antennule relatively long reaching second free somite with narrow smooth hyaline membrane or without it at all. Caudal rami 5 times and more as long as broad with long lateral *serra* consisting of small spines. Innermost seta clearly longer than outermost seta. Distal seta of endopodite P4 not reaching distal end of nearest spine. Rudimental P5 with small and weak inner spine close in length to segment itself or even smaller.

*Eucyclops (Ciliocyclops) ciliatus* (G.O. Sars, 1909)  
 Fig. 7.

FEMALE. Body length 860  $\mu\text{m}$ . Antennule reaching second free somite without or with invisible hyaline membrane on three distal segments. Last thoracal somite with rare hair-like seta laterally. Genital double somite slightly longer than wide. Caudal rami slightly divergent, 5 times and more as long as wide. Distal caudal seta ratio beginning from outermost: 1:5.7:9.7:1.6; dorsal seta slightly longer than outermost seta; lateral seta as long as ramus width. Rudimental P5 with very short and weak inner spine about as long as segment itself or even less.

MALE. Not known.

KEY TO SUBGENUS *EUCYCLOPS (CILIOCYCLOPS)* SPECIES

1. Caudal rami with short and rare hair-setae only on proximal/inner edge and with very short lateral *serra* (about third of caudal length) produced by tiny denticles .....  
 ..... *E. (C.) neotropicus* Kiefer, 1936  
 [South America, Brazil]
- Caudal rami more or less homogeneously plumose and with better developed lateral *serra* (half of caudal length or more) produced by strong denticles ..... 2
2. Caudal rami long, L/W > 5 .....  
 ..... *E. (C.) ciliatus* (Sars, 1909) [Tanganyika]
- Caudal rami shorter, L/W < 5 ..... 3
3. Innermost caudal seta about 2 times as long as outermost seta, lateral *serra* about half of caudal length .....  
 ..... *E. (C.) rarispinus* (Sars, 1909) [Tanganyika]
- Innermost caudal seta about 1.1–1.5 times as long as outermost seta, *serra* extending along practically whole outer margin ..... *E. (C.) subciliatus* Dussart, 1984 [Brazil]

*Eucyclops (Denticyclops) subgen.n.*

Type species: *Eucyclops denticulatus* Graeter, 1903.

Female of moderate length, caudal rami of different proportion but always length/wide ratio more than 3.5. Innermost seta usually significantly longer than outermost seta. Outermost seta in several species inserted at some distance from other distal caudal seta. Inner surface of caudal rami smooth, lateral edge usually with long saw produced with denticles of large size. Antennule 12-segmented, relatively long, 1–3 distal segments with clear seen serrated hyaline membrane. Distal setae of endopodite P4 never extend beyond

distal tips of nearest spine. Rudimental P5 with inner spine of different lengths, but always strong and at least 1.5 wider than middle seta width and as long as segment itself.

*Eucyclops (Denticyclops) denticulatus* Graeter, 1903  
 Fig. 8.

FEMALE. Length 900–1230  $\mu\text{m}$ . Cephalotorax as long as wide, last thoracal somite with long dense setae laterally. Genital double somite about as long as wide with *receptaculum semini* of typical for genus shape. Caudal rami 6–8 times as long as wide, clearly divergent, lateral edge with conspicuous lateral *serra*, extending nearly to base. Innermost outer seta 1.5–2 times as long as outer spine-like seta and nearly as long as ramus or shorter. Caudal setae ratio beginning from outermost: 1.0:5.0:7.1:1.3. Dorsal seta longer than outermost seta but shorter than innermost seta. Lateral seta small and weak, not longer than ramus width. Antennule 12-segmented reaching to the middle of first free somite. Three last segments with clearly serrated hyaline membrane. First segment with membrane serrated by different way, distal part with small denticles, proximal part with 8–12 large denticles. Antenna basipodite ornamentation as in Figure 5. Swimming legs P1–P4 3-segmented, Exp distal spines formula 3/4/4/3. P4 Enp three times as long as wide, inner apical spine nearly as long as Enp 3, and about 1.5 times as long as outer. Distal setae just reaching of the middle of nearest spines. P5 inner spine much shorter than outer seta, and more slender than in *C. (D.) macruroides* — the nearest congener. Spine-setae ratio beginning from the spine: 1.0:2.5:2.1. Spine slightly longer than segment length.

MALE. Significantly shorter than female with shorter caudal rami. P4 and P5 construction similar to female. P6 with strong inner spine and 2 short and weak setae.

KEY TO SUBGENUS *EUCYCLOPS (DENTICYCLOPS)* SPECIES AND SUBSPECIES

1. Caudal rami long, L/W > 5.5 ..... 2
- Caudal rami less than 5.5 times as long as wide ..... 6
2. Inner spine of P5 longer than outer seta ..... 3
- This spine noticeably shorter than outer seta ..... 4
3. Inner spine of P5 wide, knife-like, caudal rami 6–8 times as long as wide, only the first distal segment of antennule with serrated hyaline plate in proximal part .....  
 ..... *E. (D.) neomacruroides* Dussart et Fernando 1990  
 [North America]
- Inner spine of P5 thin, seta-like, caudal rami 4–6 times as long as wide, three distal segments of antennule with serrated hyaline plate .....  
 ..... *E. (D.) longispinosus* Pesce et Galassi 1987  
 [Caves in Italy]
4. Caudal rami with reduced saw (5–9 short spines) .....  
 ..... *E. (D.) titicacae* Kiefer, 1957  
 [partly, for females with serrated hyaline membrane in A1; endemic of lake Titicaca]
- Caudal rami with row of denticles along outer margin .. 5
5. Caudal rami 7–9 times as long as wide, the first distal segment of antennule in proximal part with fine serrated hyaline plate (20–25 tiny denticles) .....  
 ..... *E. (D.) macruroides* Lilljeborg, 1901 [Palearctic]
- Caudal rami 5–7 times as long as wide, the first distal segment of antennule in proximal part with ruffle serrated hyaline plate (10–18 relatively large denticles) .....  
 ..... *E. (D.) denticulatus* (Graeter, 1903) [Palearctic]



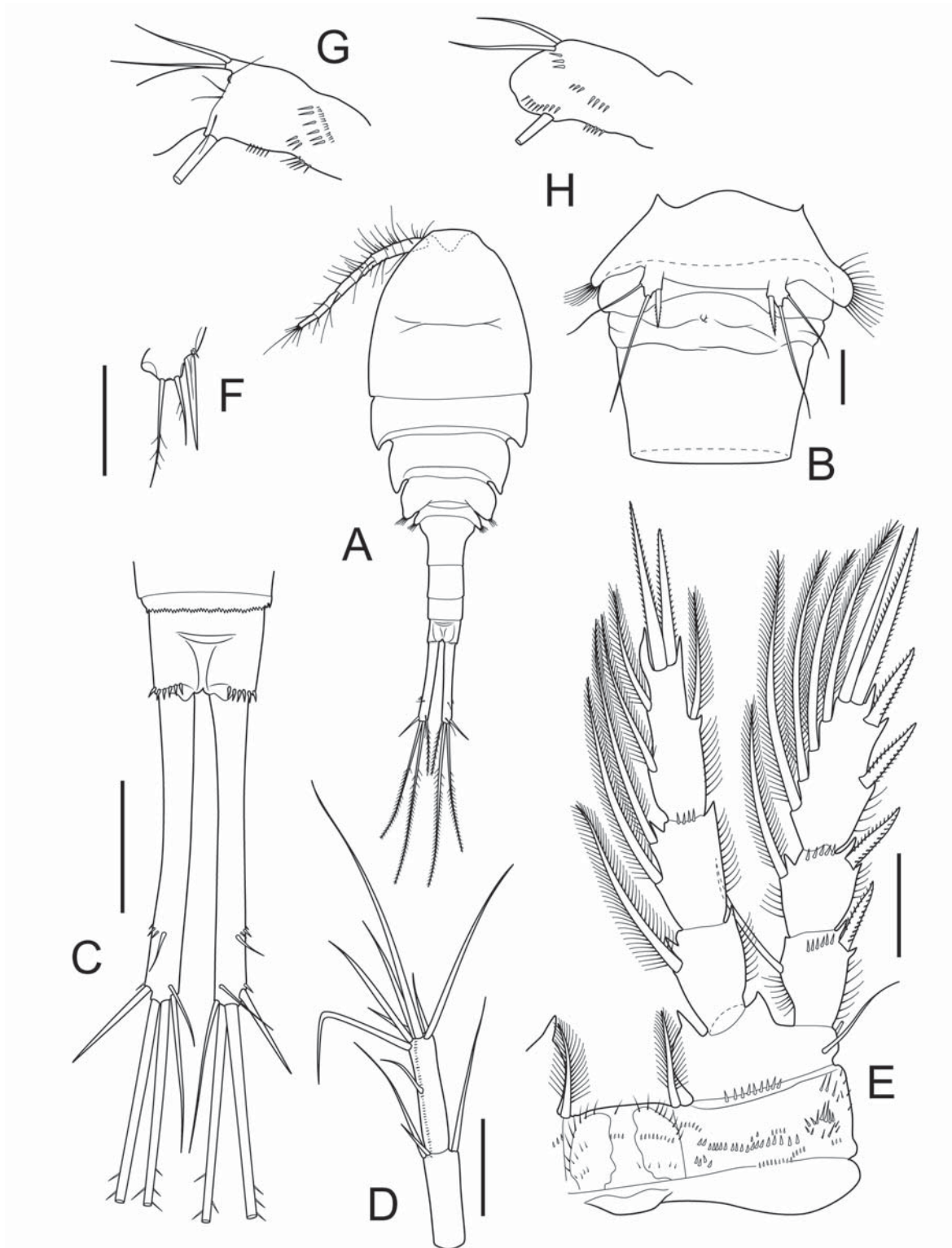


Fig. 9. *Eucyclops (Macrrocyclops) macrurus* (Sars, 1863): A — habitus, dorsal; B — genital segment and P5, ventral; C — caudal rami, dorsal; D — distal segments of A1; E — P4; F — P6, ♂; G — basipodite of A2, posterior; H — basipodite of A2, anterior. Scale bars: B, F — 30  $\mu\text{m}$ ; D, E — 50  $\mu\text{m}$ ; C — 100  $\mu\text{m}$ . P6, ♂ redrawn from Gurney, 1931, others — orig.

Рис. 9. *Eucyclops (Macrrocyclops) macrurus* (Sars, 1863): А — общий вид, дорсально; В — генитальный сегмент и P5, вентрально; С — каудальные ветви, дорсально; D — дистальные членики A1; E — P4; F — P6, ♂; G — базиподит A2, вид сзади; H — базиподит A2, вид спереди. Масштабные шкалы: B, F — 30  $\mu\text{m}$ ; D, E — 50  $\mu\text{m}$ ; C — 100  $\mu\text{m}$ . P6, ♂ воспроизведен по Gurney, 1931, остальные — ориг.

6. Inner spine of P5 short, nearly equal to segment length, if not then not less than twice shorter than outer seta; innermost caudal seta inserted above other setae .....  
 ..... *E. (D.) euacanthus* (Sars, 1909) s.lat. 7  
 [Pantropical, Japan, Kamchatka]
- Inner spine of P5 longer than segment length and not more than 1.5 times shorter than outer seta; innermost caudal seta inserted at the same level as other setae ..... 11
7. Outermost caudal seta naked or with external row produced by tiny spines ..... 8  
 – This seta pinnate at least at inner side ..... 10
8. Caudal rami with row of strong denticles along practically whole outer margin .....  
 ..... *E. (D.) euacanthus euacanthus* (Sars, 1909)  
 [Africa, SEA, Kamchatka, Japan, Australia]
- Caudal rami with markedly reduced row of denticles .... 9
9. Lateral row of denticles hardly reaching to the middle of caudal rami .....  
 ..... *E. (D.) euacanthus cognatus* Kiefer, 1928  
 [Caves in SAR]
- Lateral row of denticles reaching to the upper third of caudal rami margin .....  
 ..... *E. (D.) euacanthus lanceolatus* Dussart, 1974  
 [Ethiopia]
10. Inner spine of P5 short, nearly equal to segment length and about 4 times shorter than outer seta; dorsal caudal seta nearly 1.5 times as long as outermost seta .....  
 ..... *E. (D.) euacanthus baylyi* Morton 1990 [Australia]
- This spine nearly twice as long as segment and 2 times shorter than outer seta; innermost caudal seta inserted as other setae, dorsal caudal seta shorter .....  
 ..... *E. (D.) euacanthus birmanus* Lindberg, 1943 [Myanmar]  
 (synonym: *E. birmanus aequatorialis* Dussart et Fernando, 1985; New Guinea)
11. Caudal rami relatively short with L/W < 4.1; innermost caudal seta subequal to rami length and nearly 2 times as long as outermost seta ..... 12  
 – Caudal rami longer, innermost seta shorter ..... 13
12. Caudal rami very short, L/W < 3; inner spine of P5 subequal to outer seta .....  
 ..... *E. (D.) ibleicus* Pesce et Galassi 1987 [Caves in Italy]
- Caudal rami longer with L/W = 3.5–4; inner spine of P5 2 times as long as outer seta .....  
 ..... *E. (D.) leptacanthus* Kiefer, 1956 [Venezuela]
13. Caudal rami with small denticles along outer edge; inner spine of P5 1.5 times shorter than outer seta .....  
 ..... *E. (D.) microdenticulatus* Lindberg, 1939 [India]
- Caudal rami with strong denticles along outer edge; inner spine of P5 longer than outer ..... 14
14. Caudal rami long L/W 5–5.5 .....  
 ..... *E. (D.) festivus* Lindberg, 1955 [Mexico]
- Caudal rami long L/W 4.3–5 .....  
 ..... *E. (D.) pseudoensifer* Dussart, 1984  
 (synonym: *E. chihuahensis* Suarez-Morales et Walsh, 2009?)

#### *Eucyclops (Macrurocyclops) subgen.n.*

Type species: *Eucyclops macrurus* (G.O. Sars, 1863).

Caudal rami smooth with only few spinules near lateral setae inserting place, P5 with weak inner spine about as long as leg length or slightly longer; A1 12-segmented relatively short in the most species, just reaching to the first free thoracal somite, with narrow or even invisible hyaline membrane. The subgenus includes 8 species mainly with tropical distribution. Areal of the type species *E. macrurus* described

from Scandinavia by Sars covers Holarctic [Dussart, Defaye, 2006].

#### *Eucyclops (Macrurocyclops) macrurus* (G.O. Sars, 1863) Fig. 9.

FEMALE. Body length without caudal setae 1100–1300 µm. Yellowish or sometime brown in color. Cephalothorax about as long as width. 4<sup>th</sup> thoracal somite with long setae laterally. Genital double-somite 1,1 times as long as wide. Caudal rami very long, 8–10 times as long as wide, parallel or slightly divergent, without lateral *serra* but with few small denticles near lateral seta insertion place. Caudal rami about as long as three last abdominal segments. Outermost seta short and weak, 1.2 times longer than dorsal seta. Lateral seta small and weak, about as long as ramus width. Innermost seta 2 and more times as long as outermost seta. Distal setae ratio beginning from outermost: 1:4.8:6:2. Antennules 12-segmented, relatively short, just reaching the first free thoracal somite or even shorter; three distal segments with very narrow sometimes invisible hyaline membrane. The 12<sup>th</sup> segment sometimes has fine serration on surface of segment (see Fig. 9D) Basipodite of antenna on caudal side with few long hairs in position 1 (close to *E. serrulatus*); other ornamentation like in Fig. 6G; on frontal side with long diagonal row of denticles and with a group (8–10) of relatively short denticles near exopodite insertion place (see Fig. 9H). Swimming legs 3-segmented. Exp spine formula 3/4/4/3. Distal endopodite P4 with L/W ratio about 2.5 (2.4–2.7). Distal inner spine 1.25 (1.1–1.3) times as long as outer spine and about as long as segment itself or even longer; distal seta just reaching middle of nearest spine. Coxal plate with three rows of short hairs; coxal spine homogeneously covered with long fine hairs; coxal segment ornamentation as in Fig. 9E. Rudimental P5 with relatively short and slender inner spine shorter than outer seta but clearly longer than segment itself; middle seta about 2 times as long as spine or longer.

MALE. Body length 800–900 µm. Caudal rami shorter than in female, 6.2–7.5 times as long as broad. Caudal setae length similar to female. Ornamentation of antenna basipodite similar to female but with less number of denticles in each group. P1–4 as in female but outer apical spine relatively shorter. P5 seta ratio like in female. Rudimental P6 armed with inner strong spine and 2 setae; middle seta shorter than spine; outer seta subequal to spine but significantly slender.

#### KEY TO SUBGENUS *EUCYCLOPS (MACRUROCYCLOPS)* SPECIES

1. Caudal rami short with L/W < 5.5 ..... 2  
 – Caudal rami more long with L/W > 6 ..... 4
2. Innermost seta of caudal rami shorter than outermost seta .....  
 ..... *E. (M.) dubius* (Sars, 1909) [Tanganika]  
 – Innermost seta of caudal rami at least 1.5 times as long as outermost seta ..... 3
3. Inner spine of P5 short and weak, shorter than segment itself; innermost caudal seta more than 2 times longer than outermost seta .....  
 ..... *E. (M.) madagascariensis* (Kiefer, 1926)  
 (synonym *E. congolensis* Lindberg, 1951; Madagascar, Equatorial Africa)  
 – Inner spine of P5 longer than segment itself; innermost caudal seta shorter ..... 5

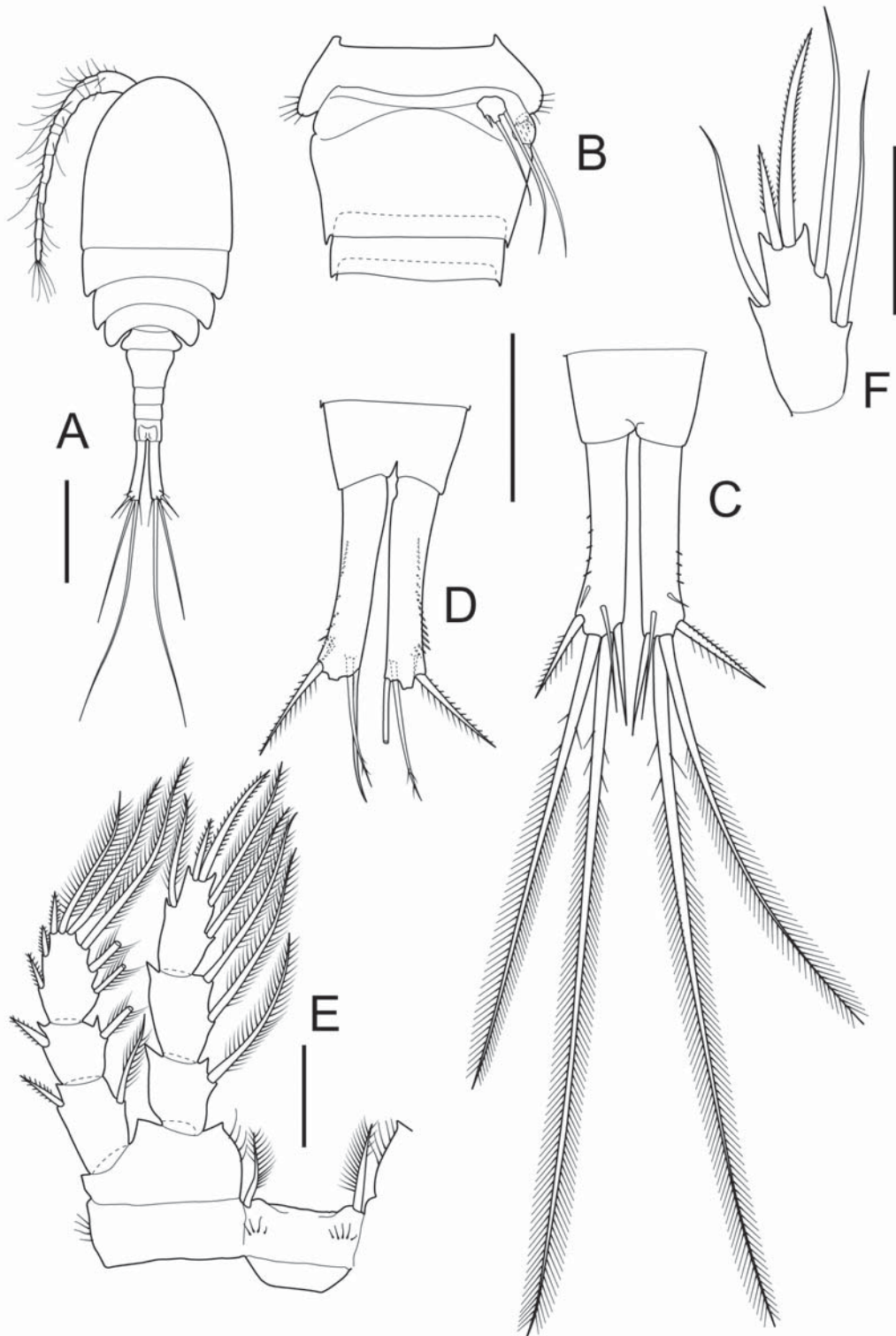


Fig. 10. *Eucyclops (Sarsicyclops) semiserratus* (Sars, 1909): A — habitus, dorsal; B — genital segment and P5, ventral; C — caudal rami, dorsal; D — caudal rami, ventral; E — P4; F — distal segment of endopodite P4. Scale bars: A — 200  $\mu$ m; B, C, D — 100  $\mu$ m; E — 50  $\mu$ m, F — 50  $\mu$ m. Habitus redrawn from Sars, 1909, others — orig..

Рис. 10. *Eucyclops (Sarsicyclops) semiserratus* (Sars, 1909): A — общий вид, дорсально; B — генитальный сегмент и P5, вентрально; C — каудальные ветви, дорсально; D — каудальные ветви, вентрально; E — P4; F — дистальный членок эндоподита P4. Масштабные шкалы: A — 200  $\mu$ m; B, C, D — 100  $\mu$ m; E — 50  $\mu$ m, F — 50  $\mu$ m. Общий вид воспроизведен по Sars, 1909, остальное — ориг.



4. Distal exopodial spine in P4 very short, not longer than other spines in the segment .....  
 ..... *E. (M.) maritimus* (Alekseev et Monchenko, 1991) [Caspian Sea]  
 – This spine clearly longer than other spines .....  
 ..... *E. (M.) persistens* Monchenko, 1978 [Black Sea]
5. Innermost caudal seta about as 2 times as long as outermost seta .....  
 ..... *E. (M.) macrurus* (G.O. Sars, 1863) [Palearctic]  
 – This seta not more than 1.3 times as long as outermost seta ..... 6
6. Caudal rami with small group of denticles near lateral seta insertion place .....  
 ..... *E. (M.) laevimargo* (G.O. Sars, 1909) [Tanganika]  
 – Caudal rami absolutely naked even without small denticles near lateral seta insertion place ..... 7
7. Caudal rami parallel .....  
 ..... *E. (M.) orthostylis* Lindberg, 1952 [Volga River Delta]  
 – Caudal rami divergent .....  
 ..... *E. (M.) angustus* (G.O. Sars, 1909) [Tanganyika]
3. Caudal rami short with  $L/W < 5$ , innermost caudal seta at least twice of outermost seta length ..... 4  
 – Caudal rami longer with  $L/W > 5$ , innermost caudal seta not more than 1.2 times as long as wide ..... 5
4. Caudal rami very short nearly 3.2 times as long as wide with reduced *serra*, adult female about 0.75 mm; innermost caudal seta at least 2.5 times as long as outermost seta ..... *E. (S.) neocaledoniensis* Dussart, 1984 [New Caledonia]  
 – Caudal rami about 4–5 times as long as wide with well developed *serra*; adult female about 1.2 mm long; innermost caudal seta not more than 2 times as long as outermost seta ..... *E. (S.) nichollsi* Brehm, 1950 [Tasmania]
5. Outer seta of P5 longer than medial seta; P4 Enp inner distal spine more than twice longer than outer spine .....  
 ..... *E. (S.) semiserratus* (Sars, 1909) [Endemic of Tanganyika?]  
 – Outer seta of 5 leg about 1.5 times shorter than medial seta, inner distal spine of P4 Enp less than 1.5 times longer than outer spine .....  
 ..... *E. (S.) spatharum* Harding, 1942 [Eastern Afrika]

*Eucyclops (Sarsicyclops) subgen.n.*

Type species: *Eucyclops semiserratus* (Sars, 1909).

Leg 5 with small inner spine, usually shorter than leg length and always not wider than medial seta; about half of length of outer seta or shorter. A1 12-segmented, distal segments with hyaline membrane smooth or denticulated. Caudal rami with well-developed *serra*.

Subgenus distributed in tropics and includes 6 species.

*Eucyclops (Sarsicyclops) semiserratus* (Sars, 1909)

Fig. 10.

FEMALE. Small species, female length about 860  $\mu\text{m}$ . Caudal rami 5–6 times as long as wide slightly bent on outer margin with partly reduced *serra* presented with relatively large denticles especially close to lateral seta insertion place. Lateral seta very small, less than ramus width. Distal seta ratio beginning from the outermost: 1:5:7.5:1.1. Dorsal seta subequal or even longer than outermost seta. Genital double-somite more broad than long. Th4 with short rare setae laterally. Antennula relatively long reaching the first free thoracal somite or longer, three distal segments with serrated hyaline membrane. Mouth appendages without clear seen differences from *E.serrulatus*. Swimming legs 3-segmented. Distal segment exopodite formula 3/4/4/3. Distal segment endopodite P4 with very long distal setae, inner spine about 2 times as long as outer spine and longer than segment itself;  $L/W$  ratio of segment  $< 2$ . Coxal spine in P4 with gap in hairs on outer margin similar to *E.serrulatus*.

MALE. Not described by Sars; description by Lindberg [1951] seems like doubtful due to large difference between small and large females identified as same species.

KEY TO SUBGENUS *EUCYCLOPS (SARSICYCLOPS)* SPECIES

1. Caudal rami very long with  $L/W > 7$  ..... 2  
 – Caudal rami not more than 6 times as long as wide ..... 3
2. Length of adult females more than 1 mm, caudal rami with tiny spinules at lateral edge .....  
 ..... *E. (S.) porrectus* Kiefer, 1932 [Endemic (?) of lake Ohrid, Balkan peninsula, Europe]  
 – Length of adult females less than 0.9 mm, caudal rami with strong denticles at lateral edge .....  
 ..... *E. (S.) crassispinosus* Kiefer, 1932 [Upper Volta, Africa]

*Eucyclops (Mrazekicyclops) subgen.n.*

Type species: *Eucyclops stuhlmanni* (Mrazek, 1895).

Small cyclopids, female length usually less than 1 mm. Subgenus unites females with 11-segmented antennule and two types of caudal rami construction. In *E.stuhlmanni* (Mrazek, 1895) and *E.echinatus* (Kiefer, 1926) caudal rami on dorsal surface with rows of setae and lateral *serra*. Two other species *E.miurai* Ito, 1952 and *E.inarmatus* Kiefer, 1932 have caudal rami naked both laterally and dorsally. These two groups possibly will become different subgenera especially if more species with 11-segmented antennule are found. Female antennule short; 3 distal segments without hyaline plate or with fine serrated narrow hyaline plate. The last segment of endopodite P4 with relatively long distal setae sometimes reaching distal tips of nearest spines but never extends beyond; inner spine of the segment usually longer than segment itself and significantly longer than outer spine. P5 with short and weak inner spine but long middle and outer setae. Subgenus includes 5 taxa, 2 species and 1 subspecies known from Afrika and 2 other species described from underground water in Europe and Japan.

*Eucyclops (Mrazekicyclops) stuhlmanni*  
(Mrazek, 1895)

Fig. 11.

FEMALE. Body length 850  $\mu\text{m}$ . Abdomen significantly shorter than cephalothorax. Genital double-somite very wide, 0.7 times as long as broad. Forth free thoracal somite with long rare setae laterally. Caudal rami relatively short and wide,  $L/W$  ratio 2.8; with 2–3 rows of spinules ventrally and short lateral *serra* occupies less than half lateral margin. Distal seta ratio beginning from the outermost: 1:6.5:10.3:0.9. Lateral seta as long as ramus width. Dorsal seta subequal to outermost seta. Antennula 11-segmented short, not reaching the distal end of cephalothorax; hyaline plate of 3 last segment absent or invisible; P4 coxal plate with 3 strong setae on each side; distal segment endopodite  $L/W$  ratio varied (1.9–2.7); inner distal spine 1.3 times as long as outer spine; distal setae hardly reaching of nearest spines or shorter. Rudimental P5 with weak and short inner spine subequal or shorter than segment itself and two long setae 2–3 longer than segment.



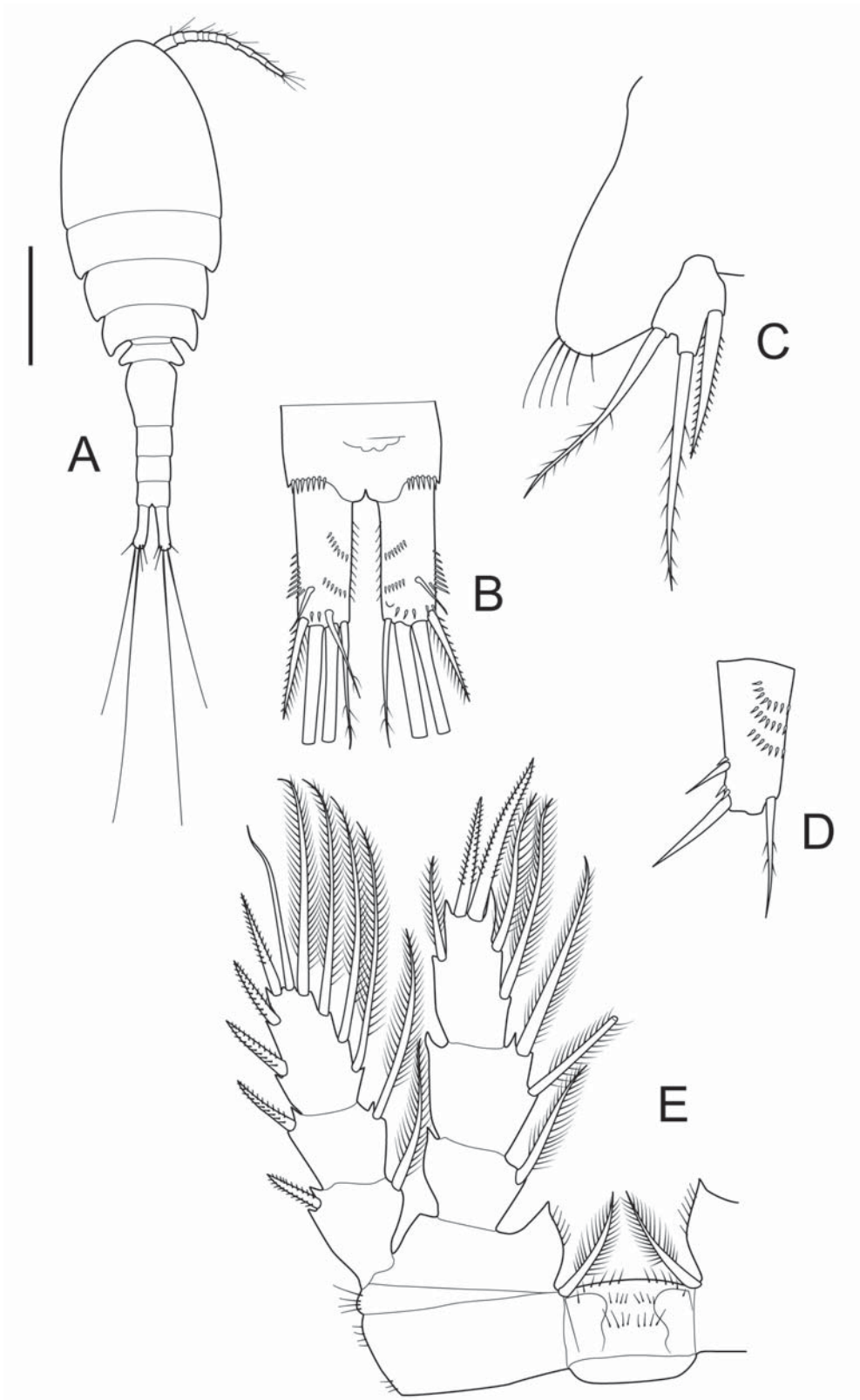


Fig. 11. *Eucyclops (Mrazekicyclops) stuhlmanni* (Mrazek, 1895): A — habitus, dorsal; B — caudal rami, dorsal; C — P5; D — caudal ramus, ♂; E — P4. Scale bar: A — 200  $\mu$ m. Habitus redrawn from Mrazek, 1895, others — orig.

Рис. 11. *Eucyclops (Mrazekicyclops) stuhlmanni* (Mrazek, 1895): A — общий вид, дорсально; B — каудальные ветви, дорсально; C — P5; D — каудальная ветвь, ♂; E — P4. Масштабная шкала: A — 200  $\mu$ m. Общий вид воспроизведен по Mrazek, 1895, остальные — ориг.

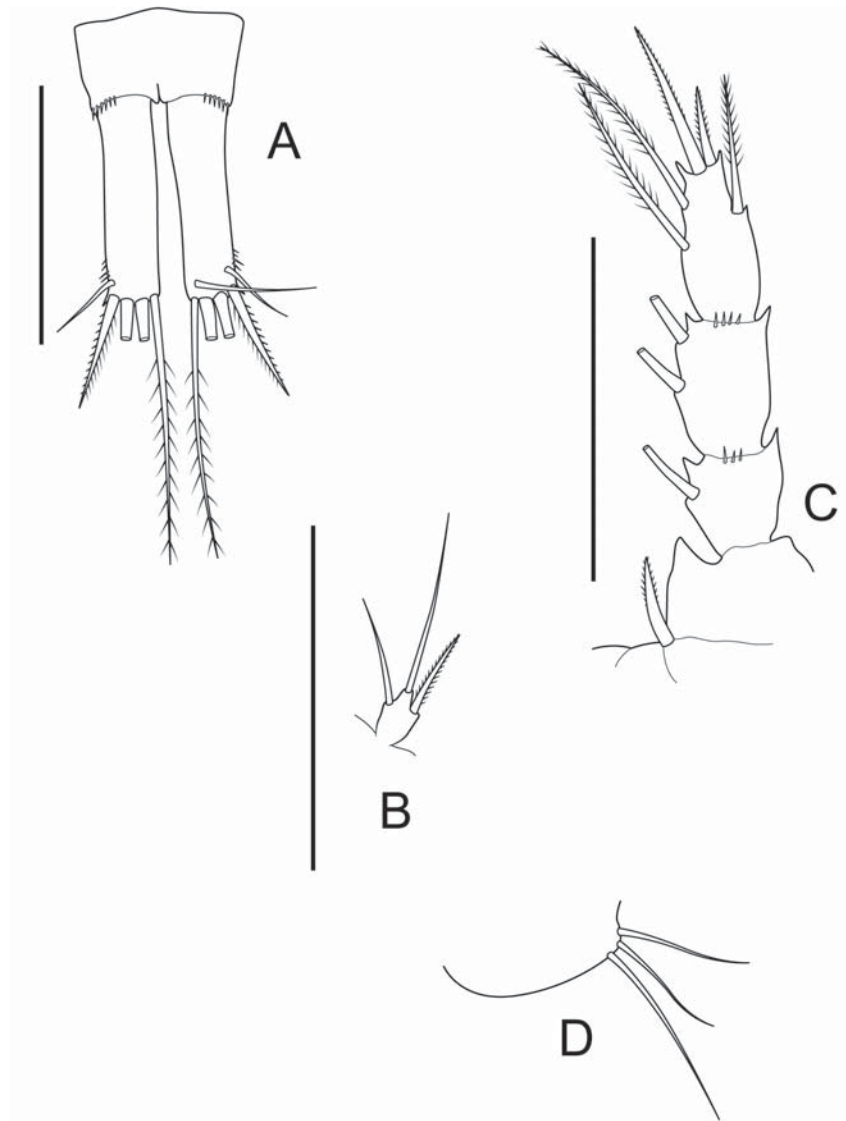


Fig. 12. *Eucyclops (Subterrocyclops) subterraneus* (Graeter, 1907): A — caudal rami, dorsal; B — P5; C — P4; D — P6, ♂. Scale bars: 100 μm. Redrawn from Pesce & Galassi, 1983 and Monchenko, 1974.

Рис. 12. *Eucyclops (Subterrocyclops) subterraneus* (Graeter, 1907): A — каудальные ветви, дорсально; B — P5; C — P4; D — P6, ♂. Масштабные шкалы: 100 μm. Воспроизведено по Pesce & Galassi, 1983 и Monchenko, 1974.

MALE. Body length 730 μm or 85% of female length. Abdomen also significantly shorter than thoracal part. Caudal rami of the same proportions and armament as in female excepting three instead of two spinules rows on dorsal surface of caudal rami and almost reduced caudal lateral serra. Rudimental P6 with strong long inner spine and two significantly shorter outer setae.

COMMENTS. Kiefer [1952] described *E. stuhlmanni tepidus* from hot spring in Kenya as small female (600 μm) with very short caudal rami (L/W ratio about 2) that possibly should be redescribed as a new species.

KEY TO SUBGENUS *EUCYCLOPS (MRAZEKICYCLOPS)* SPECIES

- 1. Caudal rami with lateral *serra* and rows of spinules on dorsal surface ..... 2
- Caudal rami naked ..... 3

- 2. Inner weak spine of P5 shorter than segment length and many times shorter than outer seta .....  
 ..... *E. (M.) stuhlmanni* (Mrazek, 1895) [East Africa]  
 (+ *E. s. tepidus*)
- Inner weak spine of P5 long and strong, about as long as outer seta ..... *E. (M.) echinatus* (Kiefer, 1926)  
 [Madagascar, Central Africa]
- 3. Innermost caudal seta plumose, forth distal segment of antennule very long due to junction of two segments ...  
 ..... *E. (M.) miurai* Ito, 1952 [caves in Japan]
- This seta naked, forth distal segment of antennule about the same length as adjacent ones .....  
 ..... *E. (M.) inarmatus* Kiefer, 1932 [Caves in Slovenia]

*Eucyclops (Subterrocyclops) subgen.n.*

Type species: *Eucyclops subterraneus* (Graeter, 1907).

Antennule 12-segmented with short usually smooth hyaline membrane or sometimes without it. Caudal rami in most species divergent, on lateral edge with reduced serrula or sometimes without it. Most of species have both distal setae of third endopodal segment of leg 4 extending behind distal ends of nearest spines (only few species have long inner distal seta just reaching end of nearest spine). Comprises 14 species and 3 subspecies inhabiting ground water, living in caves, mosses, commensals of sponges.

*Eucyclops (Subterrocyclops) subterraneus*  
(Graeter, 1907)

Fig. 12.

FEMALE. Length 1700 µm (with caudal setae, after Thiébaud), without caudal setae 600–950 µm [Monchenko, 1974]. Body elongated, transparent, naupliar eye without pigment. Fourth free thoracic somite with dense long setae laterally but in some population naked. Genital double-somite rod, 0.8 times as long as wide. Caudal rami shorter than *E. macrurus*, about 4–6 times as long as wide without serrula laterally. Lateral seta usually shorter than ramus width. Innermost seta longer than ramus length and about 2.5 times as long as outermost seta. P5 with weak inner spine and 2 naked setae; medium seta about twice of spine length.

MALE. Body length 500–700 µm, colorless. Caudal rami shorter than in females, 3–4 times as long as broad.

KEY TO SUBGENUS *EUCYCLOPS (SUBTERROCYCLOPS)* SPECIES

1. Caudal rami practically naked ..... 2
- Caudal rami with more or less presented lateral serrula of denticles ..... 8
2. Fifth pedigerous somite without hair-setae on lateral margins ..... 3
- This somite with hair-setae on lateral surface ..... 4
3. P1–4 spine formula 3/4/4/3, inner distal spine of P4 Enp markedly longer than outer spine ..... 2
- ..... *E. (S.) graeteri* (Chappuis, 1927)  
[Underground water in Europe]
- P1–4 spine formula 3/4/3/3, inner distal spine of P4 Enp 1.5 times shorter than outer spine ..... 1
- ..... *E. (S.) linderi* Lindberg, 1948  
[Underground water in Australia]
4. P1–4 spine formula 2/3/3/3 ..... 3
- ..... *E. (S.) propinquus* Kiefer, 1932 [Eastern Africa]
- P1–4 spine formula 3/4/4/3 ..... 5
5. Caudal rami L/W about 3; inner spine of P5 sub equal to outer seta ..... *E. (S.) thienemanni* Kiefer, 1930 [Java]
- Caudal rami more long, L/W > 3.5; inner spine of P5 shorter than outer seta ..... 6
6. Inner spine of P5 thin and seta-like; P4 coxal spine significantly longer than inner outgrowth of basal segment ..... *E. (S.) naphaeus* Petkovski, 1971  
[Caves in Macedonia]
- Inner spine of P5 strong knife-like, P4 coxal spine do not extending more than distal end of inner basal outgrowth ..... 7
7. Caudal rami relatively long with L/W > 4, P4 coxal spine never reaching distal end of inner basal outgrowth, in male inner spine in P6 strong and long ..... 1
- ..... *E. (S.) glaber* Kiefer 1935 [Cameroon]
- Caudal rami with L/W about 4, P4 coxal spine practically reaching distal end of inner basal outgrowth; in male

- inner spine of P6 short and weak ..... 2
- ..... *E. (S.) chivahensis* Lindberg, 1960  
[Mountains in Afghanistan]
8. P1–4 spine formula 3/3/3/3 ..... 3
  - ..... *E. (S.) fragilis* (Kiefer, 1926) [Cameroon]
  - P1–4 spine formula 3/4/4/3 ..... 9
  9. Caudal rami very short with L/W = 3 ..... 4
  - ..... *E. (S.) bryophilus* Lindberg, 1950 [India]
  - Caudal rami with L/W > 3 ..... 10
  10. Caudal rami relatively long, L/W about 4–5; innermost caudal seta as long as outermost seta ..... 5
  - ..... *E. (S.) delachauxi* (Kiefer, 1925)  
[Underground water of Peru]
  - Caudal rami shorter, with L/W about 4; innermost caudal seta markedly longer than outermost seta ..... 11
  11. Innermost caudal seta more than 2 times as long as outermost seta ..... *E. (S.) subterraneus* (Graeter, 1907)  
[Underground water of Europe]
  - Innermost caudal seta less than 1.5 times as long as outermost seta ..... 12
  12. P5 inner spine 1.5–2 times shorter than outer seta; P4 coxal spine shorter or only reaching distal end of inner basal outgrowth ..... 6
  - ..... *E. (S.) elburziensis* Lindberg, 1941 [wells in Iran]
  - P5 inner spine longer than or equal to outer seta ..... 13
  13. P5 inner spine longer than outer seta; P4 coxal spine reaching far away of distal end of inner basal outgrowth ..... 7
  - ..... *E. (S.) nagasaki* Ueno, 1934  
[Underground water of Japan]
  - P5 inner spine and outer seta sub-equal in length; P4 coxal spine only reaching distal end of inner basal outgrowth ..... 8
  - ..... *E. (S.) torresphilipi* Suarez-Morales, 2004  
[pond in Chiapas, Mexico]

*Eucyclops (Speratocyclops) subgen.n.*

Type species: *Eucyclops speratus* (Lilljeborg, 1901).

Cyclopids of medial size. Females from 900 to 1400 µm. Antennule 12-segmented usually with smooth or fine serrated narrow hyaline membrane reaching to first free somite. Th4 somite with group of long setules laterally. Genital double-somite about as long as wide. Caudal rami of different length with L/W from 4 till 8, always with serrula on lateral side that varied in length and in size of denticles. A2 basipodite on caudal surface never has groups of hairs on the top. Coxal spine P4 homogeneously covered with fine setules. P5 with strong spine usually longer than outer seta but shorter than medial seta, the spine is always significantly longer than segment itself. Male rudimental P6 with strong inner spine and 2 weak setae usually shorter than spine.

The subgenus includes 8 species inhabiting Palearctic and Tropics (*E. (S.) trospersperatus*).

*Eucyclops (Speratocyclops) speratus*  
(Lilljeborg, 1901)

Fig. 13.

FEMALE. Body length 1000–1400 µm. Cephalosome as long as wide. Last segment of prosome with group of long seta-like spinules in lateral margin. Genital double-somite as long as wide, seminal receptacle typical for *Eucyclops*. Caudal rami L/W ratio 5 (in *E. (S.) biwensis*), 6–8; with longitudinal row of small spinules along outer margin dorsally in distal half (but with significant variation in this row length in type group, range: 0.25–0.75 of caudal rami length).

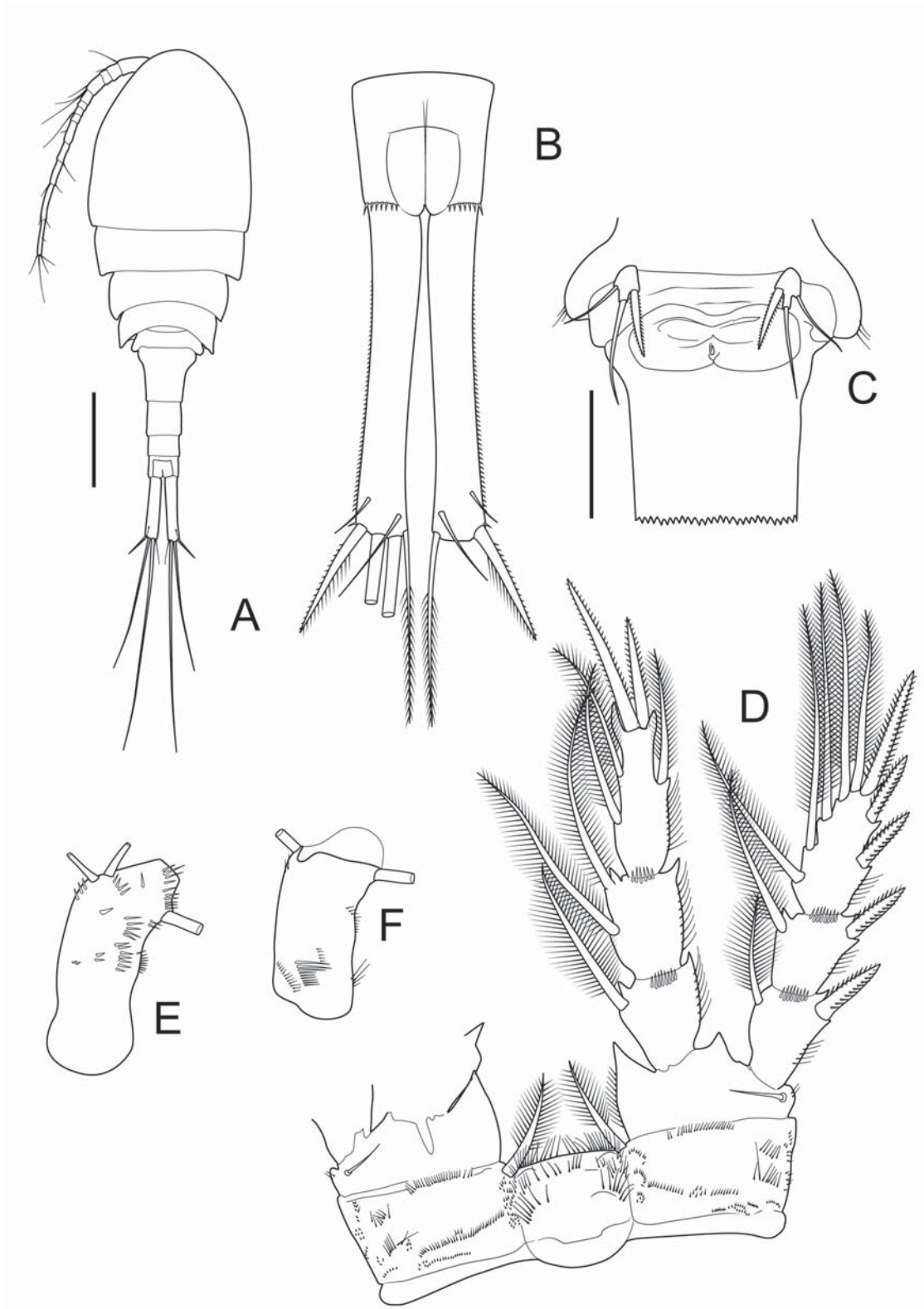


Fig. 13. *Eucyclops (Speratocyclops) speratus* (Lilljeborg, 1901): A — habitus, dorsal; B — caudal rami, dorsal; C — genital segment and P5, ventral; D — P4; E — A2 basipodite, anterior; F — basipodite of A2, posterior. Scale bars: A — 200  $\mu\text{m}$ ; C — 100  $\mu\text{m}$ . Caudal rami redrawn from Lilljeborg, 1901, others — orig.

Рис. 13. *Eucyclops (Speratocyclops) speratus* (Lilljeborg, 1901): A — общий вид, дорсально; B — каудальные ветви, дорсально; C — генитальный сегмент и P5, вентрально; D — P4; E — базиподит A2, вид спереди; F — базиподит A2, вид сзади. Масштабные шкалы: A — 200  $\mu\text{m}$ ; C — 100  $\mu\text{m}$ . Изображение каудальных ветвей воспроизведено по Lilljeborg, 1901, остальные — ориг.



Length proportion of four terminal setae, beginning from outermost: 1/5/8/1.5. Dorsal seta about half as long as outermost seta, and of middle seta outer seta about half as long as inner seta. Antennule 12-segmented, reaching posterior border of first thoracic somite, with a finely serrated or smooth narrow hyaline membrane along last three segments. Antennal basipodite without group of hair-setae distally on caudal surface, with three parallel rows of spinules placed diagonally in central part and with two groups of spinules and setules laterally. On frontal face with several groups of spinules (as shown in Fig. 13E). Swimming legs Exp spine formula 3/4/4/3. P4 Enp3 elongated, 2.6 times as long as wide, with two strong distal spines, inner spine 1.4–1.6 times as long as outer spine. Inner edge of basis of P1–P4 with long setules. Coxal spine P4 homogeneously covered with long setules. Coxa P4 with row of long spines (25–27) along distal border and several other groups of spinules and setules on caudal surface (as shown in Fig. 13D). Intercostal plate P4 without protuberances, with long and dense setules distally, and with two other groups of long setules on caudal surface. P5 1-segmented, with knife-like long inner spine and two setae, outer seta subequal in length to spine, middle seta about 1.8 times as long as spine.

MALE. Body length 750–900 µm. Caudal rami L/W ratio 4–6, innermost caudal seta shorter than ramus length. Rudimental P5 as in female. Rudimental P6 with strong inner spine and weak setae shorter than spine.

#### KEY TO SUBGENUS *EUCYCLOPS* (*SPERATOCYCLOPS*) SPECIES

1. In caudal rami innermost seta shorter than outermost seta ..... *E. (S.) leschermoutouae* Alekseev et Defaye, 2004 [well in Balearic Islands, Europe]
  - Innermost caudal seta longer than or sub equal to outermost seta ..... 2
2. Caudal rami long L/W > 5 usually with more or less reduced *serra* ..... 3
  - Caudal rami less than 5 times as long as wide often with full *serra* ..... 5
3. Inner spine of leg 5 very strong, knife-like; Caudal rami L/W 6–8 ..... 4
  - Inner spine of leg 5 weak, seta-like; Caudal rami L/W about 5 ..... *E. (S.) biwensis* Ishida, 1998 [Lake Biwa, Japan]
4. Coxal spine/seta homogeneously covered with long thin hairs; P4 connecting coxal plate on distal edge with long dense hairs .....
  - ... *E. (S.) speratus* (Lilljeborg, 1901) s.lat. [Palearctic?]
  - Distal part of this spine/seta armed with short denticles and proximal part — with a long hairs; P4 coxal plate with few rare hairs .... *E. (S.) productus* Kiefer, 1939 [India]
5. Caudal rami 4–5 times as long as wide ..... 6
  - Caudal rami shorter ..... 7
6. Caudal rami on lateral side with small short teeth of equal size ..... *E. (S.) troposperatus* Alekseev et Yusoff, 2013 [Malasia, South East Asea]
  - Caudal rami on lateral side with teeth of different size, distal part of this *serra* presented with more or less long denticles at least twice longer than in proximal part .....
    - ..... *E. (S.) delongi* Alekseev, 2019 [River Lena Delta, Far East of Asia, Arctic?]
7. Caudal rami very short, about 3 times as long as wide; inner edge of P4 basis hairless .....
  - ..... *E. (S.) dumonti* Alekseev, 2000 [Eastern Siberia, Mongolia, China, Thailand]

- Caudal rami at least 3.5 times as long as wide; inner edge of P4 basis of with hair-seta .....
  - ..... *E. (S.) arcanus* Alekseev, 1990 [Eastern Siberia, Mongolia, Northern China]

## Conclusion

The large genus *Eucyclops* encounter about 100 species is subdivided here in three genera: *Eucyclops* Claus, 1893 with about 90 species and 7 subspecies, *Isocyclops* Kiefer, 1957 stat.n. with 2 species and monotypic *Stygocyclops* Pleša, 1971 stat.n.

Previously described subgenus *Tropocyclops* (*Defayeicyclops*) was also erected to genus level and re-described as genus *Defayeicyclops* stat.n.

Genus *Eucyclops* is subdivided in 9 subgenera: *Eucyclops* (*Eucyclops*) subgen.n. with 35 taxa, *Eucyclops* (*Breviramocyclops*) subgen.n. with 4 taxa, *Eucyclops* (*Cilioicyclops*) subgen.n. with 4 taxa, *Eucyclops* (*Denticyclops*) subgen.n. with 15 taxa, *Eucyclops* (*Macrurocyclops*) subgen.n. with 7 taxa, *Eucyclops* (*Mrazekicyclops*) subgen.n. with 5 taxa, *Eucyclops* (*Sarsicyclops*) subgen.n. with 6 taxa, *Eucyclops* (*Speratocyclops*) subgen.n. with 8 taxa, *Eucyclops* (*Subterrocyclops*) subgen.n. with 14 taxa.

Keys for 11 genera of subfamily Eucyclopinæ, 9 subgenera and about 100 taxa of the genus *Eucyclops* are provided.

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