A NEW GENUS OF CYCLOPINID COPEPODS (CRUSTACEA), WITH A REDESCRIPTION OF *SMIRNOVIPINA BARENTSIANA* COMB. NOV. (SMIRNOV, 1931)

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A new genus, *Smirnovipina* gen. nov., is proposed to accommodate the cyclopinid copepod *Cyclopina barentsiana*. The species is redescribed on the basis of new material from hyperbenthic layers in the northern Barents Sea (Arctic Ocean). *Smirnovipina* gen. nov. is the only member of the Cyclopoida which has a rudimentary 1-segmented antennary exopod as an adult. The new genus is the sistergroup of a taxon comprising *Cyclopinoides* LINDBERG, 1953 and *Ginesia* JAUME & BOXSHALL, 1997. It shares with these taxa the absence of coxal inner seta on leg 5, structure of the inner basal spine on leg 1, modification of the inner seta on the first endopod segment of leg 4 and fusion of ancestral female antennulary segments XII-XIV.

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KEYWORDS: *Smirnovipina* gen. nov.; *Smirnovipina barentsiana* comb. nov.; Copepoda; Cyclopoida; Arctic Ocean; Barents Sea; phylogenetic systematics.

INTRODUCTION

The cyclopoid family Cyclopinidae has successfully colonized marine and brackish coastal habitats (e.g. SARS 1913; HERBST 1955), including the interstitial of marine sandy beaches (e.g. HERBST 1952; LOTUFO & ROCHA 1991). Cyclopinidae are present in the plankton (e.g. SMIRNOV 1931, 1935a), in sea-ice crevices (e.g. MOHAMMED & NEUHOFF 1985), and recently have been described from anchihaline caves (JAUME & BOXSHALL 1996). My own investigations on Arctic copepod biocenoses, showed Cyclopinidae to be present at every depth, from shallow waters (< 40 m) down to the deep-sea (> 3400 m). Although Cyclopinidae are constant elements of every marine habitat, they have been largely neglected in ecological studies. This may be due to their moderate importance in terms of abundance and diversity in benthic and planktonic communities, and to the lack of accurate systematic descriptions.

Smirnovipina barentsiana comb. nov. was rediscovered, after over 60 years, in a multicorer sample taken in the Barents Sea, during the German-Russian expedition to the Arctic Ocean ARK-IX/4. This remarkable primitive cyclopinid was first described by SMIRNOV (1931) as *Cyclopina barentsiana*, on the basis of one female specimen collected with a plankton net at 247 m depth in the Motowskoy Bay (north-western Russia, off Murmansk). Re-examination of the type material allowed SMIRNOV (1935b) to add some complementary notes to his first description. Smirnov recognized similarities between *C. barentsiana* and species of the genus *Cyclopinodes* WILSON, 1932, and proposed to transfer it to this genus. LINDBERG (1953), in his comprehensive revision of Cyclopininae, removed *C. longicornis* (BOECK, 1872), *C. littoralis* (BRADY, 1872), *C. dilatata* (SARS, 1921) and *C. bisetosa* (GRANDORI, 1925) from *Cyclopinodes*, and united them in a new genus, *Cyclopinoides* LINDBERG, 1953. The present redescription of *Smirnovipina barentsiana* comb. nov., based on new material from the Barents Sea, reveals some hitherto overlooked characters, which show this species to be more closely related to *Cyclopinoides* than to *Cyclopinodes*.

MATERIAL AND METHODS

Meiobenthic samples were collected with a Multicorer during the German-Russian expedition to the Arctic Ocean ARK-IX/4 (6 August - 5 October 1993) with the R/V *Polarstern* (Bremerhaven). Station 27/006, yielded 2 cyclopinid specimens used in the present study. Immediately after collection, the samples were transported into a cooling container at 4 °C. The supernatant water of each corer was extracted using a silicone tube, filtered through a 40 µm sieve, and returned to a bottle. The residue was washed from the sieve into a petri dish, using the bottom water. Live observations were made in the cooling container using a stereo-binocular at x25, x50

magnification. Specimens later were fixed with formalin at a final concentration of about 4 %. For slide preparation, specimens were transferred into glycerine. Drawings were made using a camera lucida on a Leitz Dialux phase contrast microscope.

Terminology is adopted from Huys & Boxshall (1991), except for the terms of phylogenetic systematics used according to Hennig (1982), and the term 'telson' used according to Schminke (1976) instead of 'anal somite'.

The material is stored in the copepod collection of the Arbeitsgruppe Zoomorphologie, University of Oldenburg, Germany.

DESCRIPTION

Family Cyclopinidae Sars, 1913

Subfamily Cyclopininae Sars, 1913

Smirnovipina gen. nov.

Diagnosis. Cyclopininae. First pedigerous somite free, concealed beneath a posterior carapace-like extension of the cephalosome. Caudal rami elongate, bearing 7 setae. Antennule 19-segmented in female. Antenna with rudimentary 1-segmented, bisetose exopod. Mandibular palp with 2-segmented endopod and 4-segmented exopod, first exopodal segment partially subdivided. Maxillule with discrete coxal endite. Maxilla with discrete praecoxa and coxa. Maxillipedal praecoxa and coxa partially subdivided, endopod 5-segmented, with setal formula 1, 2, 2, 1, 3. Legs 1-4 with 3-segmented rami; armature formula as the type species. Fifth leg coxa without inner seta, basis with outer seta, exopod 1-segmented bearing 3 setae and 1 inner spine; intercoxal sclerite present. Sixth leg with 2 setae.

Type species. *Smirnovipina barentsiana* (Smirnov, 1931) comb. nov.

Etymology. The genus is named after the Russian zoologist Sergius Smirnov, who described the type species.

Smirnovipina barentsiana comb. nov.

Material. Two females, collected in the Barents Sea, north-east of Spitsbergen, at 197 meters depth, 12 August 1993 (81°12.61'N, 30°36.20'E). The redescription is based on specimen with collection number (1997.17/1-1997.17/4), dissected and mounted on four slides. Second female has the collection number (1997.18/1).

Female. Body form cyclopiform (Fig. 1), prosome about as long as urosome. Length measured from anterior border of cephalosome to posterior border of the

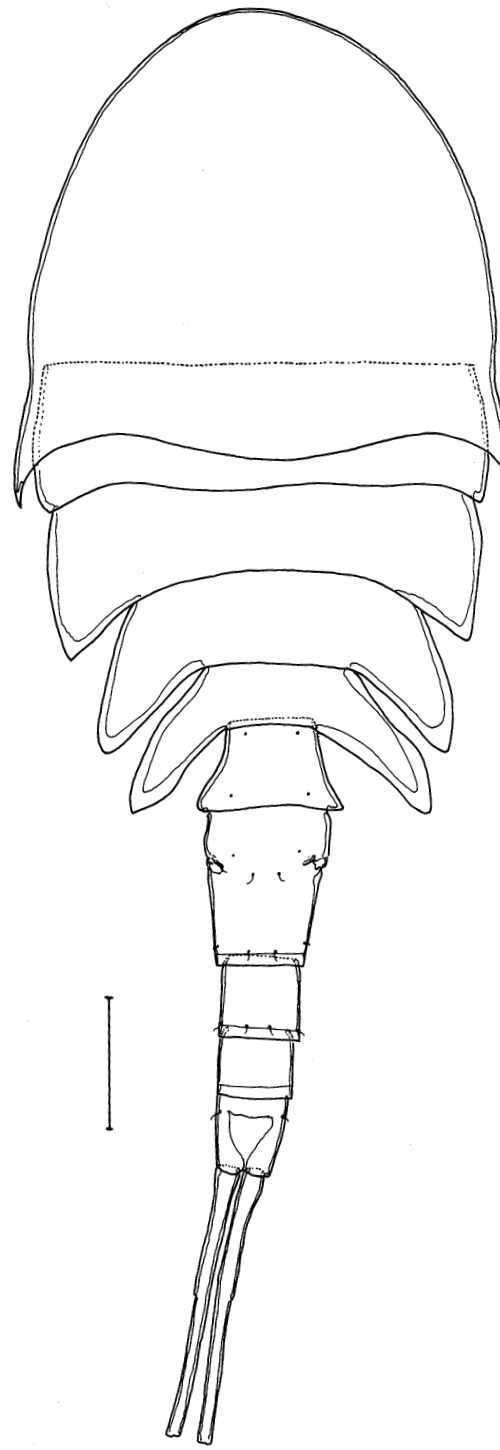

Fig. 1. *Smirnovipina barentsiana* comb. nov. Habitus, dorsal view. Scale bar 100 µm.

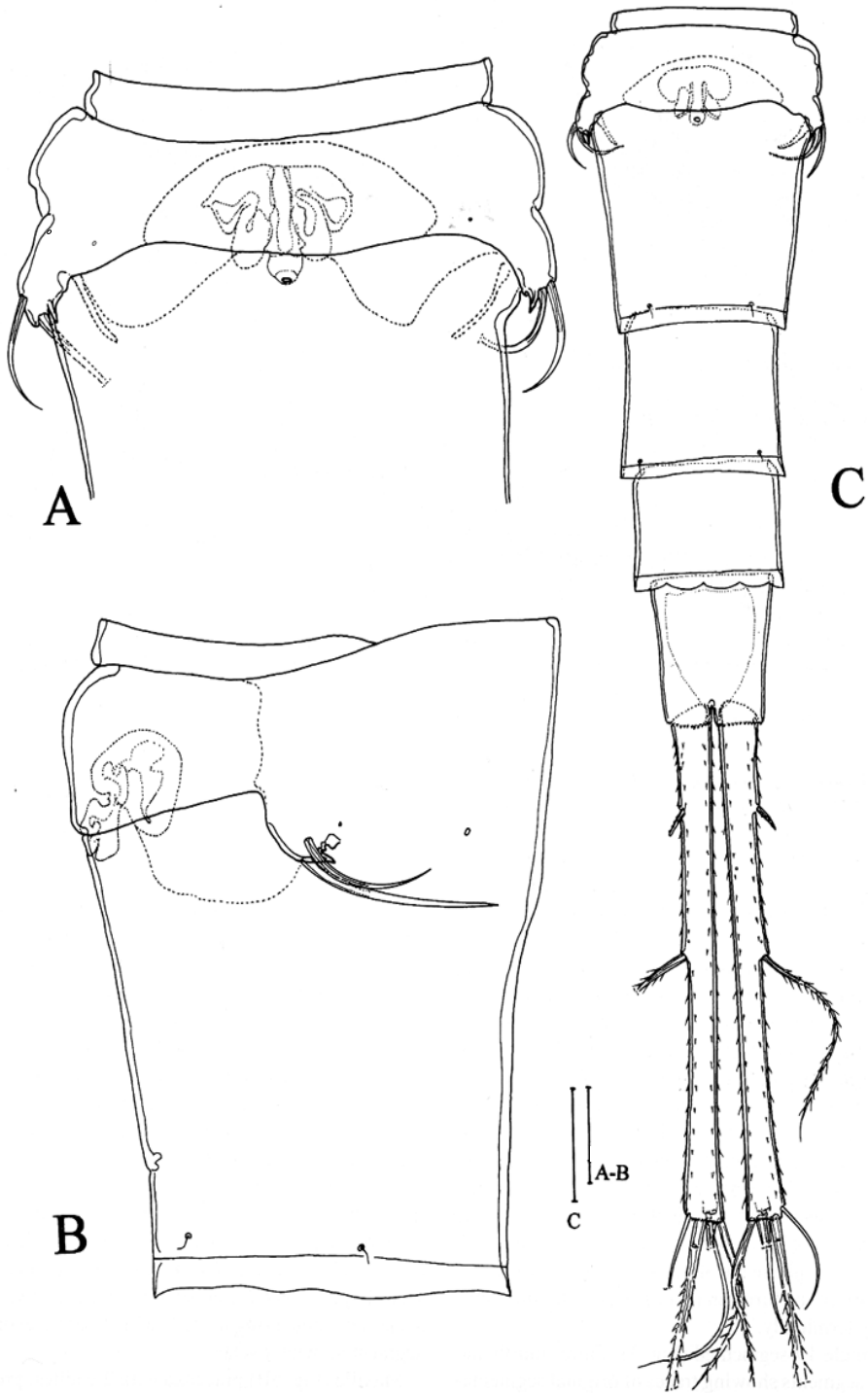

Fig. 2. *Smirnovipina barentsiana* comb. nov. A. Genital field, ventral view. B. Genital double somite, lateral view. C. Urosome, ventral view. Scale bars A, B 20 μm; C 50 μm.

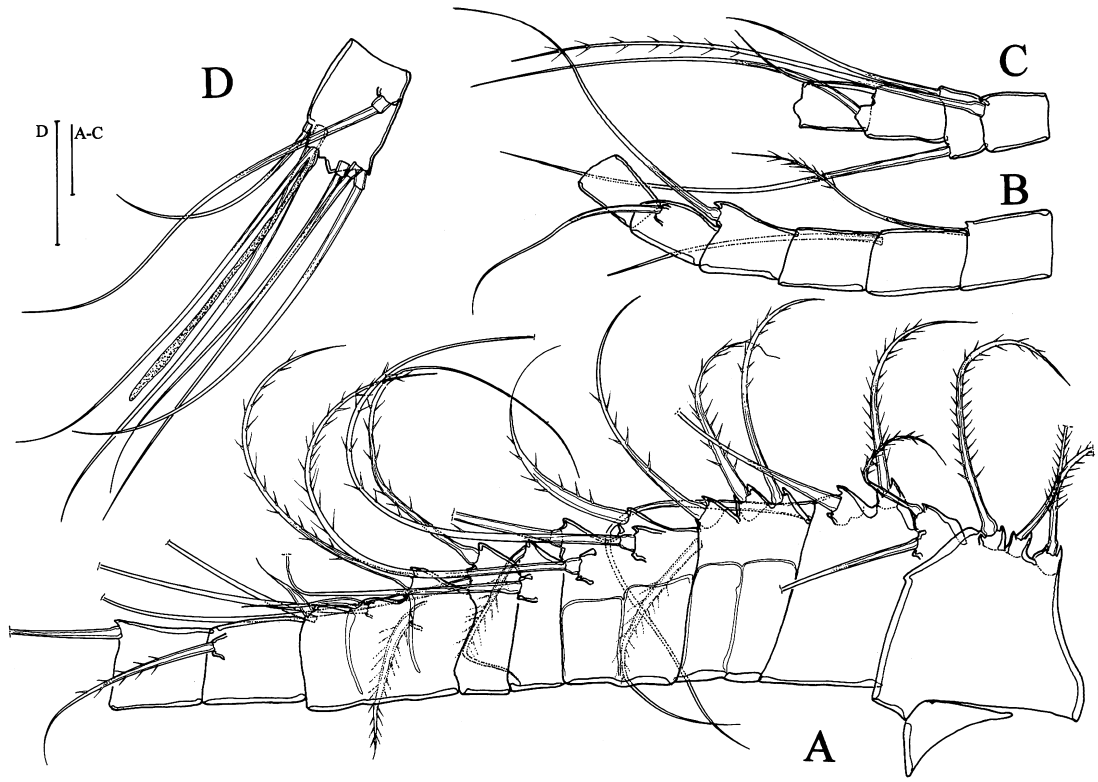

Fig. 3. *Smirnovipina barentsiana* comb. nov. Antennule. A. Segments 1st to 9th. B. Segments 10th to 15th. C. Segments 16th to 19th. D. Detail of segment 19th. Scale bars 20 µm.

telson 885 µm (length with furca 1100 µm). First pedigerous somite free, but concealed, both dorsally and laterally, by a carapace-like extension of the cephalosome (Fig. 1). Tergites of third and fourth pedigerous somites produced posteriorly. Urosome 5-segmented. Pseudosomite present ventrally between fifth and sixth pedigerous somites (Fig. 2A, B). Genital and first abdominal somites fused to form a genital double-somite. Genital field with single medioventral copulatory pore, produced into a copulatory tube leading to a pair of seminal receptacles (Fig. 2A). Furca elongate (Fig. 2C) ornamented with longitudinal rows of fine spinules, about 17 times longer than median width, with 7 setae; seta I inserted at about 1/5, seta II at about 1/2 of the base of the furca on outer margin; all other setae inserting terminally.

Antennule 19-segmented (Fig. 3). Third, fourth and seventh segments showing traces of original segmentation anteriorly, but fused into compound segments posteriorly (Fig. 3A). Setation formula as follows: 3, 5, 4, 4, 2, 2, 6, 1, 1, 1, 1, 0, 1, 1, 0, 1, 2, 2, 7 + aesthetasc.

Antenna (Fig. 4A) with well developed praecoxal sclerite; coxo-basis with 1 inner seta; endopod 3-segmented, setal formula 1, 5, 7; rudimentary 1-segmented exopod present as a small oval structure on which 1 terminal and 1 lateral seta insert (Fig. 4 A, B).

Mandible (Fig. 5A) with well developed coxal gnathobase; palp biramous; basis with 1 inner seta; endopod 2-segmented, setal formula 2, 6; exopod 4-segmented, setal formula 1, 1, 1, 2; first exopodal segment subdivided at one side.

Maxillule (Fig. 6A) praecoxal arthrite with 11 terminal elements and a seta on anterior surface; coxal epipodite represented by 2 unequal setae, coxal endite armed with 1 seta; basis with 2 endites, proximal endite with 2 spines and 1 slender seta, distal endite with 2 setae; endopod 1-segmented, with 7 setae; exopod 1-segmented, with 4 setae.

Maxilla (Fig. 5B) praecoxa with 2 endites, proximal endite with 3 setae and 1 spine, distal endite with 1 seta; coxa with 2 endites each produced into a strong claw and armed additionally with 2 setae; basis pro-

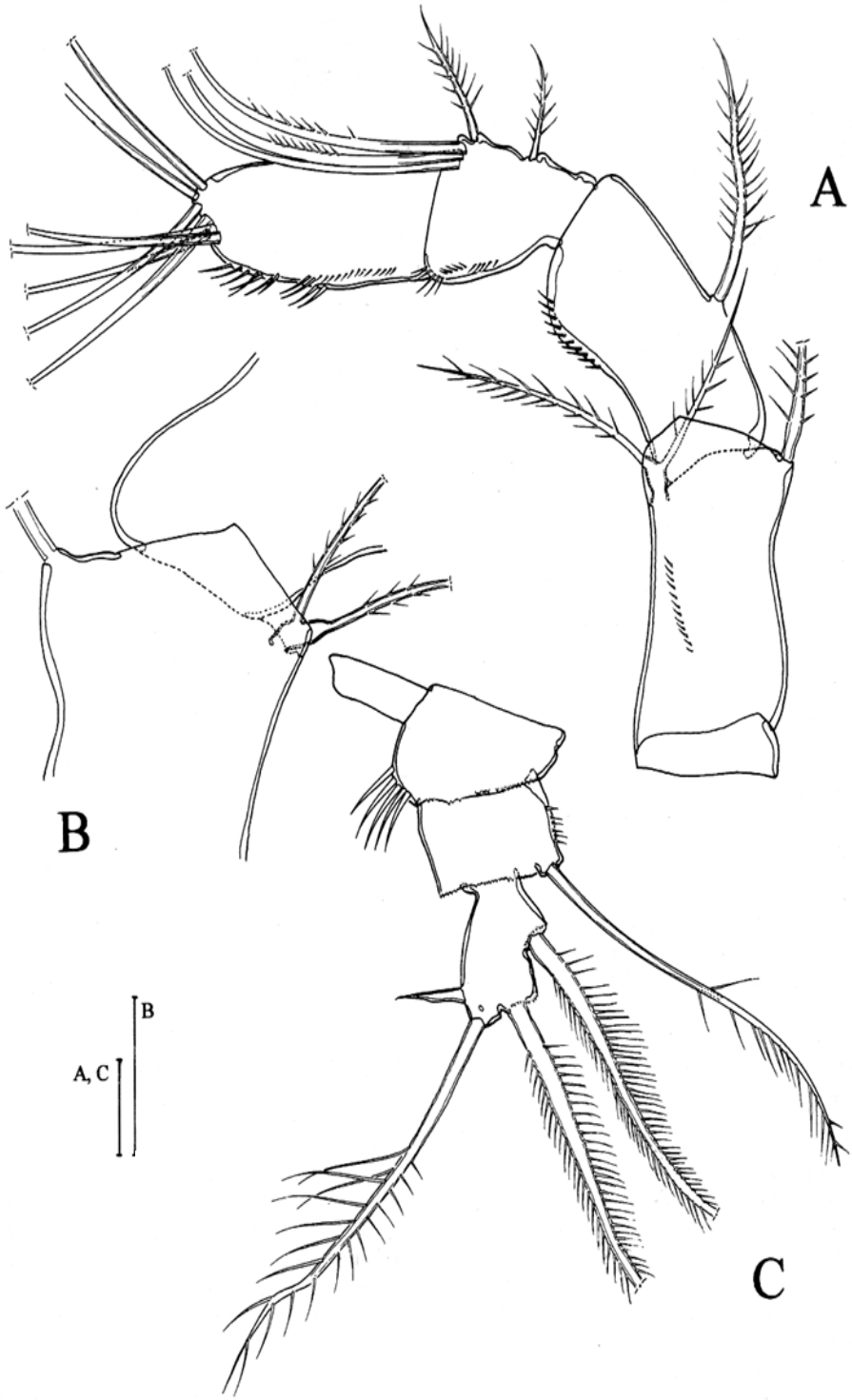

Fig. 4. *Smirnovipina barentsiana* comb. nov. A. Antenna. B. Detail of exopod of right antenna. C. Fifth leg. Scale bars 20 µm.

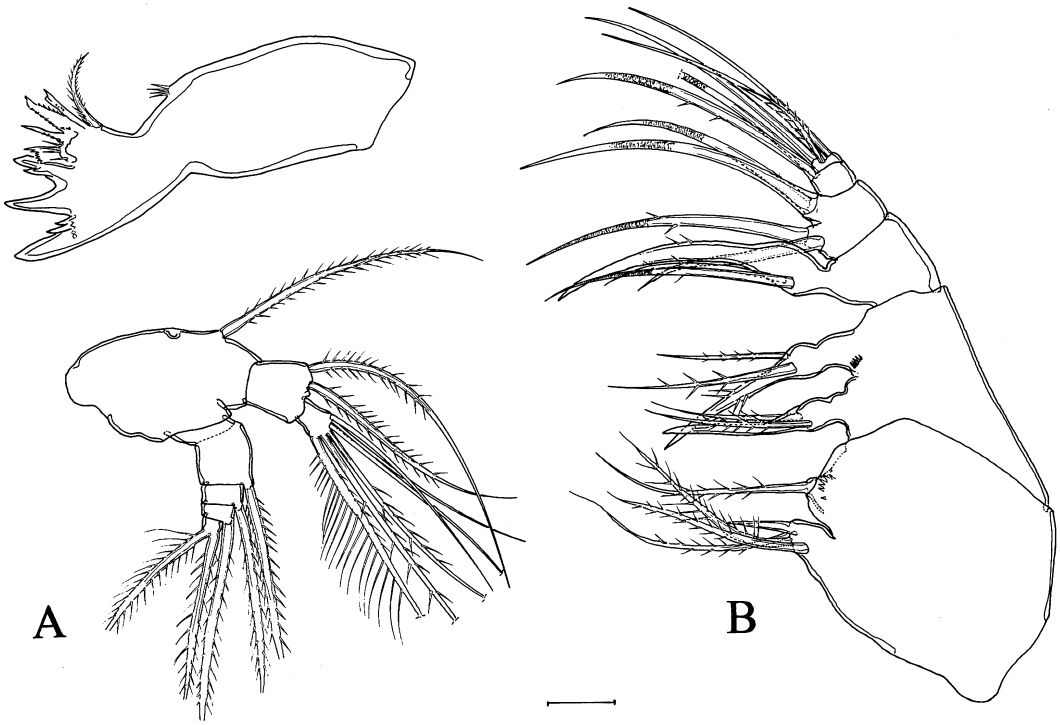

Fig 5. *Smirnovipina barentsiana* comb. nov. A. Mandible. B. Maxilla. Scale bar 20 µm.

duced into a strong claw flanked by 2 setae, endopod 3-segmented, setal formula 4, 2, 4; first endopodal segment originated by fusion or lack of division of 2 segments.

Maxilliped (Fig. 6C) slender, praecoxa and coxa indistinctly separated on one side only, setal formula of syncoxal endites 1, 3, 2; basis with row of spinules along inner margin, and 2 setae; endopod 5-segmented, setal formula 1, 2, 2, 1, 3.

Legs 1-4 biramous (Figs. 7; 8), with 3-segmented rami; spine and setal formula:

	coxa	basis	exopod	endopod
leg 1	0-1	1-I	I-1; I-1; III,I,4	0-1; 0-2; 1,2,3
leg 2	0-1	1-0	I-1; I-1; III,I,5	0-1; 0-2; 1,2,3
leg 3	0-1	1-0	I-1; I-1; III,I,5	0-1; 0-2; 1,2,3
leg 4	0-1	1-0	I-1; I-1; II,I,5	0-1; 0-2; 1,2,2

Leg 1 on basis with large inner spine (Fig. 7B), this being serrate on distal 2/3 and ornamented with slender spinules at lateral and anterior margins on proximal 1/3.

Legs 3 and 4 with inner seta on first endopodal segment being thick and broadened at base (Fig. 8A-C). Leg 4 inner setae on second as well as proximal inner seta on third endopodal segments (Fig. 8B, D) densely plumose along inner margin of distal half.

Leg 5 (Fig. 4C) with well developed intercoxal sclerite; coxa with row of slender spinules at inner margin, without inner seta; basis with long and slender outer seta; exopod 1-segmented with 4 elements i.e. 2 slender outer setae, 1 terminal slender seta, and a short naked spine subterminally on inner margin.

Leg 6 (Fig. 2B) a small plate covering gonopore located laterally on the genital double somite, bearing 2 unequal setae and a pointed process.

Male. Unknown.

Live observations. Live specimens were colourless, and no naupliar eye could be observed. They swam slowly through the water of the petri dish, by rapid vibration of some mouthparts (probably mandible and maxillule). During this slow gliding the antennules were kept perpendicular to the body axis, not completely outstretched, but in the position shown in Fig. 6B. They avoided being caught with a pipette by escaping with a rapid jump, probably produced by a rapid movement of the swimming legs.

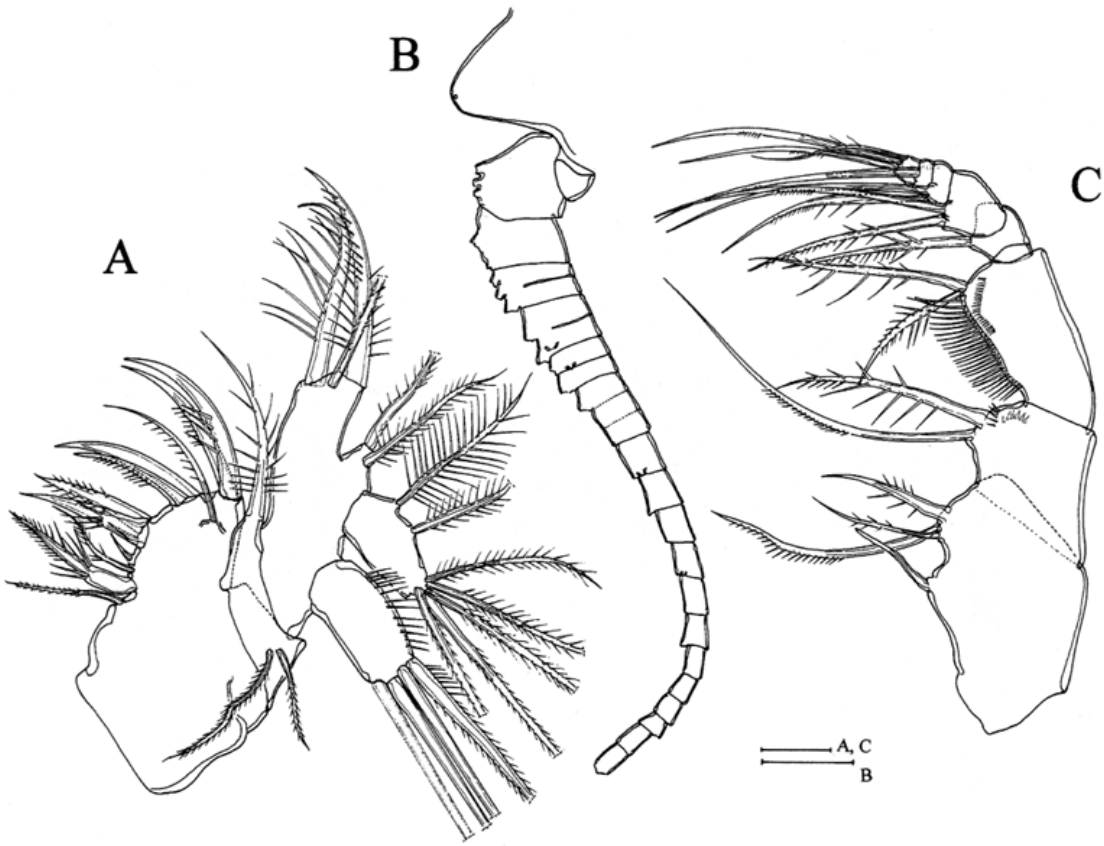

Fig. 6. *Smirnovipina barentsiana* comb. nov. A. Maxillule. B. Antennule and rostrum. C. Maxilliped. Scale bars A, C 20 µm; B 50 µm.

DISCUSSION

Smirnov's (1931) original description of '*Cyclopina*' *barentsiana* is incomplete. Only furca, fifth and sixth legs, endopod and last exopod segment of fourth leg were figured. The written description is rather vague. One of the most important pieces of information given by Smirnov (1931) refers to the 19-segmented antennule with traces of subdivision on second (double segment) and seventh (triple segment) segments. Despite the incompleteness of the original description, Smirnov's experience with Cyclopinidae led him to choose the most characteristic features for describing the species (antennule, fifth leg, furca), so that it can be recognized. The new material from the northern Barents Sea agrees in every detail with Smirnov's description, allowing the conclusion that it belongs to the same species. The discovery of this species in near bottom waters (less than 40 cm of water usually are retained in multicorer samples) suggests that this species should be described as bentho-pelagic. This could explain its presence in two relatively distant localities (the new locality is about 1200 km away from the type locality); it is possible that specimens after emerging to the water column are transported by currents.

By far the most striking character of the new genus is the structure of the antennary exopod. All Cyclopoida have as adults lost the antennary exopod, which is represented by at most 3 setae inserting at the outer distal margin of the basis. The adult female of *Smirnovipina barentsiana* comb. nov., shows at this position an elongate, more or less oval structure, on which one terminal and one lateral seta insert. This structure is interpreted here as a rudimentary 1-segmented exopod. Reports on multisegmented antennary exopods in Cyclopoida are restricted to copepodid stages. Grainger & Mohammed (1990) report on a 4-segmented antennary exopod in the first copepodid stage of *Cyclopina schneideri* T. Scott, 1903, this exopod being reduced in the next moult. However, in most Cyclopoida the antennary exopod is reduced to a single, poorly sclerotized, often wrinkled segment bearing one or more setae, during the moult from the sixth naupliar stage to the first copepodid stage.

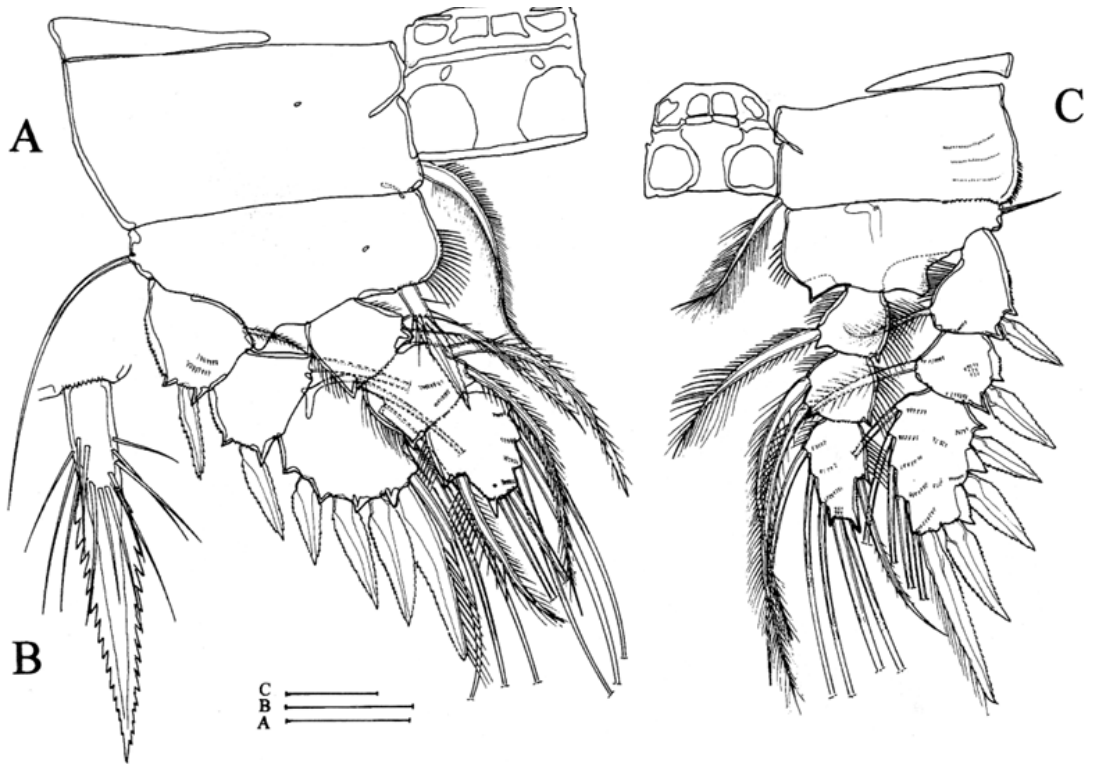

Fig. 7. *Smirnovipina barentsiana* comb. nov. A. First leg. B. Detail of inner basal spine of leg 1. C. Second leg. Scale bars A, B 50 µm; C 20 µm.

During the moult to the second copepodid stage, the poorly sclerotized segment is lost, but one or more setae may remain throughout copepodid development (Ferrari, pers. commn). It is possible that a 1-segmented antennary exopod represents the groundpattern of Cyclopoida, or the condition present in the stem-lineage leading to Cyclopoida. However, a second hypothesis cannot be excluded, i. e. that the presence of a 1-segmented antennary exopod in *Smirnovipina* gen. nov. may be the result of a delay in the reduction of the exopodal segment during ontogeny so that its retention must be interpreted as the apomorphic condition.

Also remarkable is the structure of the mandibular exopod. This exopod is described herein as 4-segmented, but it has to be noticed that the first exopodal segment is subdivided at one side, suggesting that it is the result of incomplete fusion (or failure of subdivision) of two ancestral segments. Within Cyclopoida, a 5-segmented mandibulary exopod has only been reported for the Arctic deep-sea cyclopinid *Cyclopicina sirenkoi* Martínez Arbizu, 1997. A very similar condition to that found in *Smirnovipina* gen. nov. is present in *Ginesia longicaudata* Jaume & Boxshall, 1997, where the proximal mandibular exopod has a constriction dividing this segment into two equal parts. This supports the hypothesis that a 5-segmented mandibulary exopod, with a setal formula of 0, 1, 1, 1, 2, is the condition present in the groundpattern of Cyclopoida (Martínez Arbizu 1997a).

The maxillipedal praecoxa-coxa boundary is slightly demarcated in *Smirnovipina* gen. nov. on one side only. This is unusual, because a syncoxa is believed to be always present in adult Cyclopoida. However Huys & Boxshall (1991) interpreted similar findings in other cyclopoids as 'surface folds of integument … derived as extensions of the origin of the endite' which do not form a true articulation. My impression is that the condition found in *Smirnovipina* gen. nov. reflects an original segmentation due to an incomplete syncoxal fusion.

The genus *Cyclopinodes* was introduced by Wilson (1932) to accommodate the species *C. elegans* (T. Scott, 1894) and *C. longicornis*. Several species were subsequently added (Lang 1946) including *C. barentsiana*. Lindberg (1953) decided to remove *C. longicornis*, *C. littoralis*, *C. dilatata*, and *C. bisetosa* from *Cyclopinodes*, and to include them into a new genus *Cyclopinoides*, but he still considered *C.*

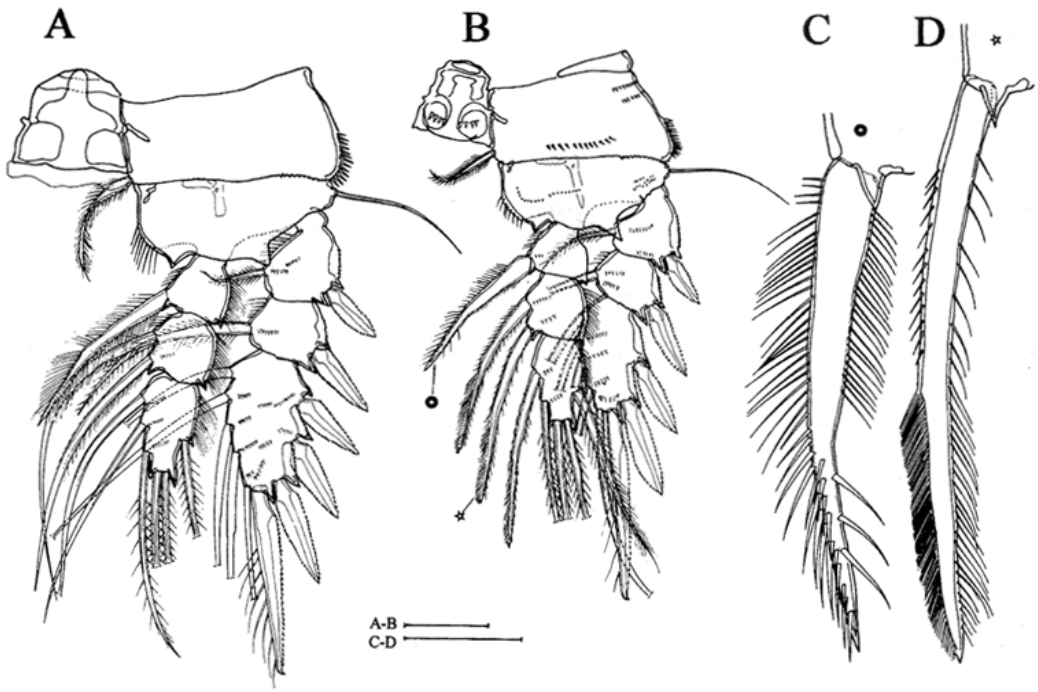

Fig. 8. *Smirnovipina barentsiana* comb. nov. A. Third leg. B. Fourth leg. C. Detail of inner seta on first endopod segment leg 4. D. Detail of distal inner seta on second endopod segment leg 4. Scale bars A, B 50 µm; C, D 20 µm.

barentsiana a member of the genus *Cyclopinodes*. Though Lindberg's generic diagnosis for *Cyclopinodes* is short, it contains some important characters that exclude *S. barentsiana* comb. nov. from this genus (condition present in *Smirnovipina* gen. nov. in brackets): 1.) antennary exopod represented by 1 seta [1-segmented with 2 setae], 2.) maxillipedal endopod 4-segmented [5-segmented], 3.) unmodified seta on first endopod segment leg 4 [this seta with a broadened basis], 4.) leg 5 coxa with inner seta [without inner seta]. In particular the condition present in *Smirnovipina* for characters 1, 3 and 4 were considered by Lindberg as diagnostic for the genus *Cyclopinoides*. According to Lindberg (1953), another important diagnostic character of *Cyclopinoides* is the transformation of an outer spine of leg 4 into a slender seta, a striking character not present in *Smirnovipina* gen. nov. Most recently, Jaume & Boxshall (1997) described a new genus and species *Ginesia longicaudata* from anchihaline caves in Mallorca (Spain). According to Jaume & Boxshall (1997), this species agrees with *Cyclopinoides longicornis* (the type species of the genus) in antennule, antenna, mouthparts (with the exception of maxillipedal endopodal setation), and limb segmentation as well as setation patterns, 'including the transformation of the distal armature element on the outer margin of the third exopodal segment of leg 4 from a spine into a seta'. Thus the decision to establish a new genus for *G. longicaudata* may be debatable. However, it is not necessary here to discuss the validity of the genus *Ginesia*, as a final decision can only be made after re-examination and redescription (where necessary) of all *Cyclopinoides* species. For further discussion, therefore, these taxa will be considered as separate genera.

The modification of the inner seta on the first endopodal segment of leg 4 is an important synapomorphy of *Smirnovipina* gen. nov., *Cyclopinoides* and *Ginesia*. This seta has become unusually broadened at its very base. A similar seta is present on the homologous endopodal segment of leg 3. In *Smirnovipina* gen. nov. the inner setae of the second endopodal segment and the proximal inner seta of the third endopodal segment on leg 4 are also modified, they are brush-like along the distal half of the inner margin.

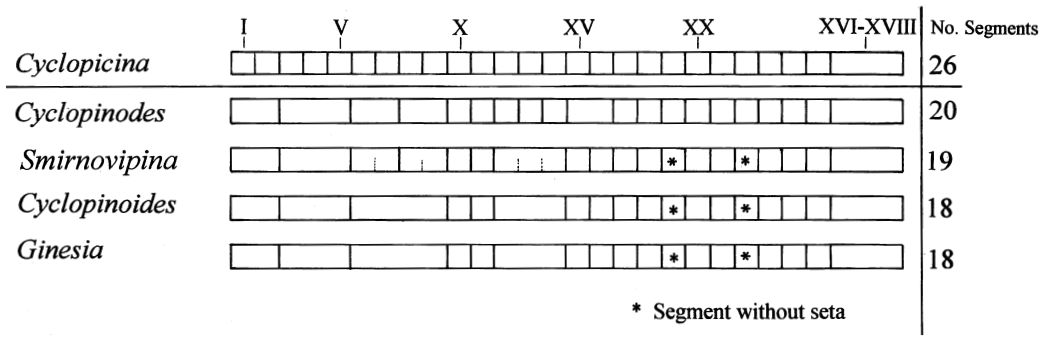

Fig. 9. Homologies of female antennulary segments of *Cyclopinodes*, *Smirnovipina*, *Cyclopinoides*, and *Ginesia*, compared with the groundpattern Cyclopoida represented by *Cyclopicina*.

Another interesting character is the structure of the inner spine of the basis leg 1. This spine is also modified, it is strongly serrate along the distal 2/3 on both margins, while rows of slender and long spinules insert proximally on the anterior surface. Jaume & Boxshall's excellent description shows that this modified seta is also present in *Ginesia*. Unfortunately, the species of *Cyclopinoides*, have not been described in enough detail to allow recognition of this modified seta. But this modified seta is present in an as yet undescribed species of *Cyclopinoides* collected by me in shallow waters of the Laptev Sea (Arctic Ocean), which makes me believe that this condition may also be present in the other species of the genus.

The modification of the armature elements on swimming legs, as discussed above is present only in *Smirnovipina* gen. nov., *Ginesia* and *Cyclopinoides*, and in no other of the 37 known cyclopinid genera, which demonstrates that the named three genera represent a monophyletic group.

In addition, the structure of female leg 5 exhibits a few potential synapomorphies for *Smirnovipina* gen. nov., *Ginesia*, and *Cyclopinoides*. All these taxa share the loss of the inner seta on the coxa, which is an autapomorphic character compared with the presence of this seta, for instance, in *Cyclopinodes*, *Pseudocyclopina* Lang, 1946 or *Metacyclopina* Lindberg, 1953. Huys & Boxshall's (1991, fig. 2.8.28 B) redescription of leg 5 of *Cyclopinoides schulzi* Herbst, 1964 show striking similarities with *Smirnovipina* gen. nov., in that the posterior margins of coxa and basis are delicately serrate, and in that the endopodal segment bears three long slender plumose setae and a spine inserting subterminally on the inner margin. *Cyclopinodes elegans* has retained the coxal inner seta, and the exopod bears two plumose setae, a slender naked seta and a pinnate spine inserting terminally at the inner margin.

Finally segmental homologies of female antennulary segments (Fig. 9) clearly demonstrate that *Smirnovipina* gen. nov. is more closely related with *Cyclopinoides* and *Ginesia*, than any of these taxa with *Cyclopinodes*. Ancestral antennulary segments XII-XIV are fused forming a triplet segment in *Smirnovipina* gen. nov., *Cyclopinoides* and *Ginesia*, this being a synapomorphy of these taxa. Traces of subdivision of this segment have been retained in *Smirnovipina* gen. nov. on its anterior margin, but it is fully fused on the posterior margin. Ancestral antennulary segments XII, XIII, and XIV are completely separate in *Cyclopinodes*, this being the plesiomorphic state as shown by comparison with the condition present in the genus *Cyclopicina.* On the other hand, *Cyclopinodes* shows a fusion of ancestral antennulary segments XV-XVI, these segments being free in *Cyclopicina* as well as in *Smirnovipina* gen. nov., *Cyclopinoides* and *Ginesia*. The absence of armature elements on ancestral antennulary segments XIX and XXII in the three latter genera, could be interpreted as a synapomorphy, as these segments bear one seta each in *Cyclopinodes* and *Cyclopicina*. However, caution is necessary in this case, because these segments are asetose in several relatively unrelated genera e. g. the Cyclopinidae *Muceddina* (Jaume & Boxshall, 1996), *Oromiina* (Jaume & Boxshall, 1997), the Cyclopidae *Macrocyclops* (Dahms & Fernando, 1994), *Mesocyclops* (Dahms & Fernando, 1995), *Euryte* (Huys & Boxshall, 1991), and moreover in the genera of the copepod order Platycopioida (Huys & Boxshall, 1991; Martínez Arbizu, 1997b). The absence of these setae could be interpreted as a delay in the formation of elements, in a common ontogenetic pattern of antennulary development. This would make it relatively easy for this character to appear convergently in different unrelated taxa. The same applies to the fusions of ancestral antennulary segments I-II and III-IV, which are present in every cyclopinid genus, with the only exception of *Cyclopicina*.

In conclusion, the characters discussed above clearly show that *Smirnovipina barentsiana* comb. nov. should be removed from the genus *Cyclopinodes*. This species represents the sistergroup of a taxon comprising *Cyclopinoides* and *Ginesia*. It can be distinguished from the latter genera by the presence of a 19-segmented female antennule (instead of 18 segments), 2 inner setae on the second endopodal segment of leg 1 (instead of 1 seta), the presence of 3 spines on the outer margin of the third exopodal segment of leg 4 (instead of 2 spines and 1 seta), and the presence of longitudinal rows of fine spinules in the furca (without these spinules).

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REFERENCES

Dahms, H.-U. & C.H. Fernando 1994. Redescription of female *Macrocyclops fuscus* (Jurine, 1820) (Copepoda, Cyclopoida) from Ontario with a description of naupliar stages. – *Journal of Plankton Research* 16(1):9-21.

— 1995. Redescription of female and male *Mesocyclops edax* Forbes, 1891 (Copepoda: Cyclopoida). – *Journal of Crustacean Biology* 15(2):317-328.

Grainger, E.H. & A. A. Mohammed 1991. Some diagnostic characters of copepodite stages of the cyclopoid copepod *Cyclopina schneideri* T. Scott and adults of arctic marine Cyclopinidae. – *Canadian Journal of Zoology* 69:2365-2373.

Hennig, W. 1982. *Phylogenetische Systematik*. – Pareys Studientexte Nr. 34, Berlin-Hamburg, 246 pp.

Herbst, H.V. 1952. Neue Cyclopoida Gnathostoma (Crustacea: Copepoda) des Küstengrundwassers. – *Kieler Meeresforschungen* 9(1):94-111.

— 1955. Cyclopoida Gnathostoma (Crustacea: Copepoda) von der brasilianischen Atlantikküste. – *Kieler Meeresforschungen* 11(2):214-229.

Huys, R. & G.A. Boxshall 1991. *Copepod Evolution*. – The Ray Society No. 159, London, 468 pp.

Jaume, D. & G.A. Boxshall 1996. Two new genera of cyclopinid copepods (Crustacea) from anchihaline caves on western Mediterranean and eastern Atlantic islands. – *Zoological Journal of the Linnean Society* 117:283-304.

— 1997. Two new genera of cyclopinid Copepods (Cyclopoida: Cyclopinidae) from anchihaline caves of the Canary and Balearic Islands, with a key to genera of the family. – *Zoological Journal of the Linnean Society* 120:79-101.

Lang, K. 1946. Einige für die schwedische Fauna neue marine Cyclopoida Gnathostoma nebst Bemerkungen über die Systematik der Unterfamilie Cyclopininae. – *Arkiv för Zoologi* 38:1-16.

Lindberg, K. 1953. La sous-famille des Cyclopininae Kiefer (Crustacées copépodes). – *Arkiv för Zoologi* 4:311-325.

Lotufo, G.R. & C.E.F. da Rocha 1991. Copepods from intertidal interstitial water of Salvador, Brazil. I. *Cuipora janaina* gen. n., sp. n. & *Cyclopina caiala* sp. n. (Cyclopoida: Cyclopinidae). – *Bijdragen tot de Dierkunde* 61(2):107-118.

Martínez Arbizu, P. 1997a. *Cyclopicina sirenkoi* sp. n. (Copepoda: Cyclopinidae) from deep waters in the Laptev Sea (Arctic Ocean), with comments on the phylogenetic relationships of copepod orders. – *Senckenbergiana biologica* 77(1):89-99.

— 1997b. *Sarsicopia polaris* gen. et sp. n., the first Platycopioida (Copepoda: Crustacea) from the Arctic Ocean, and its phylogenetic significance. – *Hydrobiologia* 350:35-47.

Mohammed, A.A. & V. Neuhof 1985. *Arctocyclopina pagonasta*, a new genus and species of the family Cyclopinidae (Cyclopoida, Copepoda) from the annual sea ice in the Canadian Arctic. – *Canadian Journal of Zoology* 63:2389-2394.

Sars, G.O. 1913. Copepoda Cyclopoida. Parts I and II. Oithonidae. Cyclopinidae, Cyclopidae (part). – *An account of the crustacea of Norway* VI. Bergen Museum, 31 pp, 16 pls.

Schminke, H.K. 1976. The ubiquitous telson and the deceptive furca. – *Crustaceana* 30:292-300.

Smirnov, S. 1931. *Cyclopina barentsiana* nov. sp., eine neue Copepoden-Art aus dem Barents-Meer. – *Zoologischer Anzeiger* 94(9/10):269-273.

— 1935a. Einige neue Cyclopiniden-Gattungen (Copepoda) aus der Awatscha-Bucht. – *Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS* 4:161-163.

— 1935b. Zur Systematik der Copepoden-Familie Cyclopinidae G. O. Sars. – *Zoologischer Anzeiger* 109(7/8):203-210.

Wilson, C.B. 1932. The copepods of the Wood Hole region Massachusetts. – *Bulletin of the United States National Museum* 158:1-635.

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