

## **Redescription of *Tegastes nanus* Sars, 1904 (Copepoda: Harpacticoida: Tegastidae) from Spitsbergen in the Arctic Ocean**

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**ABSTRACT:** *Tegastes nanus* Sars, 1904 (Copepoda, Harpacticoida, Tegastidae) is reported from Ny Ålesund, Spitsbergen (Svalbård) in the Arctic Ocean. The morphology of adult females and males is redescribed. Specimens from Ny Ålesund are similar to Norwegian specimens collected by Sars from Eggesbønes and Ålesund, as well as to published descriptions of specimens of this species by Chislenko (1967) from the White Sea. Specimens from Ny Ålesund, Eggesbønes and Ålesund differ from published description of the species collected in the Gulf of Maine (McAlice & Coffin, 1990) by the shape of the extension of the genital somite plus 6th thoracic somite of females, the spermatophore reservoir of males, and several limbs. This is the first detailed description of the mouthparts of *T. nanus* and the first report of a harpacticoid copepod from Spitsbergen.

**KEY WORDS:** systematics, morphology, phytal, Harpacticoida, Copepoda, Crustacea.

## **Переописание *Tegastes nanus* Sars, 1904 (Copepoda: Harpacticoida: Tegastidae) с архипелага Шпицберген в Северном Ледовитом океане**

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**РЕЗЮМЕ:** *Tegastes nanus* Sars, 1904 (Copepoda, Harpacticoida, Tegastidae) отмечен в Северном Ледовитом океане у архипелага Шпицберген (район Ny Ålesund). Переописана морфология взрослых самок и самцов этого вида. Экземпляры из Шпицбергена схожи с экземплярами, собранными Сарсом у берегов Норвегия (Eggesbønes и Ålesund), и соответствуют описанию этого вида из Белого моря (Численко, 1967). Экземпляры, собранные у берегов Шпицбергена и Норвегии, отличаются от описания данного вида из залива Мэн (McAlice & Coffin, 1990) формой выроста генитального сомита самки, сросшегося с 6-м торакальным сомитом, формой выроста генитального сомита самца, несущего

сперматофор, и некоторыми конечностями. В данной работе впервые для *T. nanus* дается описание морфологии ротовых конечностей, и сообщается о его находке у архипелага Шпицбергена.

**КЛЮЧЕВЫЕ СЛОВА:** систематика, морфология, фиталь, Harpacticoida, Copepoda, Crustacea.

## Introduction

The harpacticoid copepod genus *Tegastes* Norman, 1903 is one of six genera in Tegastidae. There are 38 nominal species of *Tegastes*, all distinctive in their laterally compression and ventrally protruding cephalosome. Species of *Tegastes* are encountered infrequently and relatively little is known about their biology. During a survey of the marine fauna of Spitsbergen, an island archipelago (75°–85°N; 10°–30°E) in the Arctic Ocean, three specimens of *Tegastes nanus* Sars, 1904 were washed from red algae collected in the harbor of Ny Ålesund. Here we redescribe females and males of *T. nanus* from Ny Ålesund, Spitsbergen, and compare these to Sars's Norwegian specimens from Eggesbønes and Ålesund, Norway.

## Materials and methods

Samples of the red alga *Ceramium* sp. from the rocky shore of Ny Ålesund, Spitsbergen (78°33'N, 12°E) were taken during July 1998. The algal thalli were washed and the wash water passed through a 42µm sieve. Specimens retained in the sieve were then fixed in 4% formaldehyde solution and subsequently transferred into glycerin for slide preparation. Specimens of *Tegastes nanus* were observed with a Leitz Diaplan microscope using phase contrast at 1250x magnification for preliminary observations and for the line drawings. Systematic accounts were compared with Bodin (1997) and amended. One female (# 31032) and one male (# 31031) are deposited in the collection of the Senckenberg Museum, Frankfurt/a.M. Germany. The specimens studied by Sars' cannot be located because he did not designate type specimens of this species or label a vial as new

species. However, vial F20359 with one female and two males from Eggesbønes, Norway (62°19'N, 05°39'E), and vial F20366 with one female and one male from Ålesund (62°19'N, 5°30'E) belonging to Sars and now in the Crustacea Collection of the Zoological Museum at the University of Oslo were kindly sent by Åse Wilhelmsen, Principal Engineer of the Crustacean Collection to one of us (FDF) for study. These specimens were cleared through 50% lactic acid/ 50% de-ionized freshwater to 100% lactic acid, stained by adding a solution of chlorazol black E dissolved in 70% ethanol/ 30% de-ionized freshwater, and examined with bright-field and with differential interference optics. Specimens of *T. nanus* studied by Chislenko could not be located.

Specimens of *T. nanus* are curved ventrally along the anterior-posterior axis so that they are difficult to measure in either dorsal or lateral view. Total length was measured laterally, in sections along the anterior-posterior curve, and includes caudal rami and rostrum.

In general, descriptive terms follow (Ferrari, 1995). Interpretations of homologies of the first maxilla follow Boxshall (1985), of the second maxilla follow Ferrari & Ivanenko (2005), of the maxilliped follow Ferrari & Dahms (1998); the protopod of these three limbs has a coxa with one setiferous endite.

## Descriptive part

*Tegastes nanus* Sars, 1904

**Female.** Colour pale yellowish brown, darkening to chestnut along sutures between somites. Total body length 0.30 mm. Body laterally compressed; dorsal margin strongly curved anteriorly and posteriorly (Fig. 1). Cephalosome

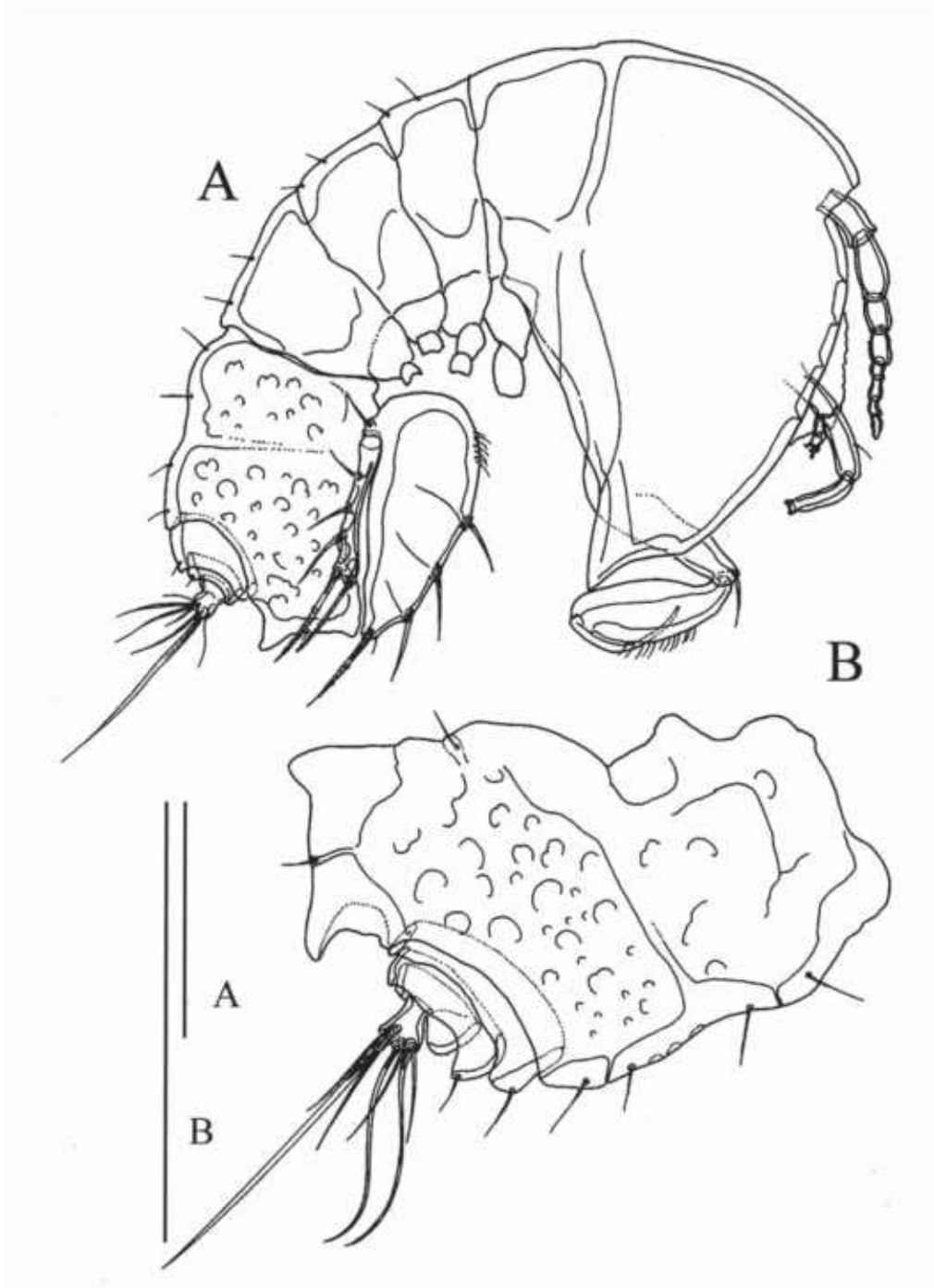


Fig. 1. *Tegastes nanus* Sars, 1904. Female.

A — right lateral habitus; B — left lateral urosome without leg 5. Scale bars: A — 100  $\mu$ m; B — 50  $\mu$ m.

Рис. 1. *Tegastes nanus* Sars, 1904. Самка.

A — внешний вид справа; B — уросома без ноги 5-й ноги, вид слева. Масштабные отрезки: A — 100 мкм; B — 50 мкм.

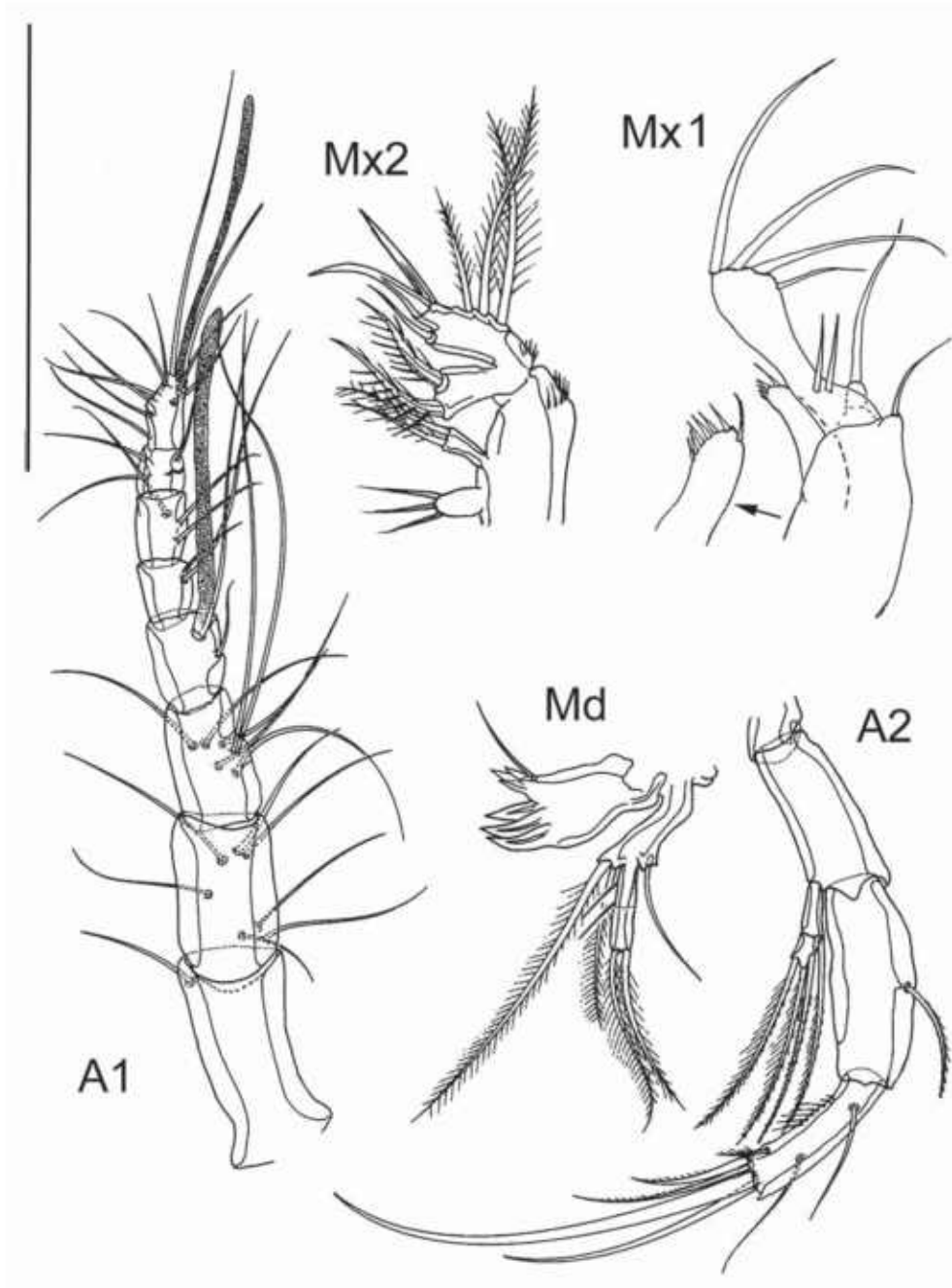


Fig. 2. *Tegastes nanus* Sars, 1904. Female.

A1 — first antenna; A2 — second antenna; Md — mandible; Mx1 — first maxilla (praecoxal endite separate); Mx2 — second maxilla. Scale bar 50  $\mu$ m.

Рис. 2. *Tegastes nanus* Sars, 1904. Самка.

A1 — антенна первая; A2 — антенна вторая. Md — мандибула. Mx1 — максилла первая (эндит прекокссы отделен); Mx2 — максилла вторая. Масштабный отрезок 50 мкм.

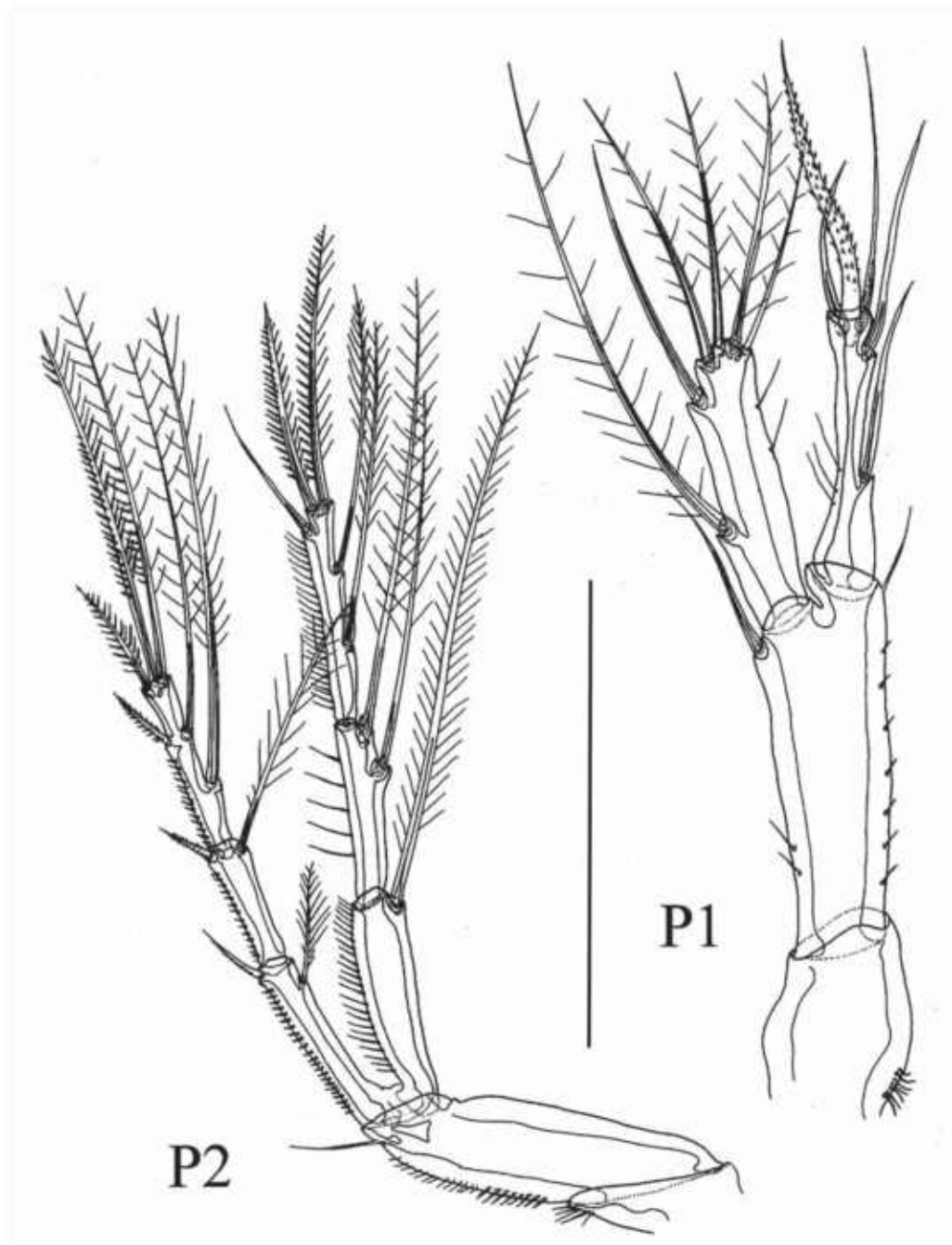


Fig. 3. *Tegastes nanus* Sars, 1904. Female.

P1 — swimming leg 1; P2 — swimming leg 2. Scale bar 50  $\mu$ m.

Рис. 3. *Tegastes nanus* Sars, 1904. Самка.

P1 — плавательная нога 1; P2 — плавательная нога 2. Масштабный отрезок 50 мкм.

strongly produced ventrally on both sides to a narrowly rounded tip. Anterodorsal face of cephalosome covered by dense tiny chitin platelets. Cephalosome [including 1st and 2nd thoracic somites] separated from metasome by a distinctly sclerotized strip (Fig. 1A). Urosome (Fig. 1B): rugose; genital somite fused to 6th thoracic somite and anterior abdominal somite; these segments quadrate posteroventrally and extending as well-pronounced corners (Fig. 1B); both posterior corners rounded. Last three abdominal somites small and articulating. Caudal rami small, about twice as long as wide; each ramus one thick dorsal seta on a lobe, plus one thin seta medial and one thin seta lateral to the thick seta, and 4 terminal setae along a curved, lateral edge (Fig. 1B).

First antenna (Fig. 2 A1): 8-segmented, aesthetascs on the 4th segment (exceeding slightly the tip of distal segment) and on the 8th segment (same length but more slender). Setal armature 1, 7, 7, 2+1 aesthetasc, 2, 3, 3, 10+1 aesthetasc.

Second antenna (Fig. 2 A2). Coxa short, engaging an irregular pedestal proximally; basis without ornamentation. Exopod small, 2-segmented; proximal segment with 1 medial seta, distal with 1 medial and 2 distal setae. Proximal endopodal segment with 1 medial seta and anterior scale-like attenuation; distal segment with longitudinal row of denticles laterally and with 2 medial, 1 lateral and 4 terminal setae.

Mandible (Fig. 2 Mn). Gnathobase with 2 groups of tooth-like attenuations, 3 teeth in proximal group, 3 teeth distally, plus a proximal seta. Basis with 2 medial setae. Exopod a simple knob-like segment with 1 terminal seta. Endopod 2 segmented; proximal segment with 2 medial setae; distal with 3 terminal setae.

First maxilla (Fig. 2 Mx1). Praecoxal endite with 7 short, thick setae and 1 longer, thinner seta distally. Coxal exite with 1 seta. Basis fused distally to endopod; proximal basal endite with 1 seta, distal basal endite unattenuated, with 2 setae. Endopod apparently 1-segmented, elongate, with 4 terminal setae.

Second maxilla (Fig. 2 Mx2). Syncoxa with transverse row of spinules proximolaterally; praecoxal endite with 3 setae; coxal endite with

2 setae. Basis elongate with transverse row of spinules proximolaterally; proximal basal endite with 2 setae; distal basal endite with 3 setae, middle seta curved and thick. Ramus a very small unarticulated segment with 3 setae.

Maxilliped (Fig. 5 Mxp). A subchela; syncoxa with 1 mediobasal seta with setules, proximomedial and proximolateral set of denticles plus another set of lateral denticles at mid-length. Basis with 1 mediobasal seta directed proximally and reaching about a 4<sup>th</sup> the length of palmar edge; palmar edge with plate-like seta medial row of larger denticles and row of slender ones anteriorly. Proximal endopodal segment with 1 long seta; distal endopodal segment attenuate, appressed to medial edge of basis, with 2 slender setae towards its base.

Swimming leg 1 (Fig. 3 P1). Coxa small with lateral longitudinal row of denticles proximally. Basis elongate with denticles along medial and lateral margin; distally with 1 medial seta and 1 lateral seta. Rami 1-segmented. Endopod wider and slightly shorter than exopod, with denticles along lateral edge and with 1 proximomedial seta, 1 distomedial seta and 4 terminal setae. Exopod with medial denticles proximally and with 1 proximal and 1 distal seta laterally, and 3 terminal setae, middle thickest and longest.

Swimming leg 2 (Fig. 3 P2). Coxa with a set of denticles on pronounced distolateral corner. Basis with denticles along medial margin and 1 lateral seta. Rami 3-segmented. Proximal segment of exopod with 1 lateral seta and 1 medial seta, and lateral denticles; middle segment with 1 lateral seta and 1 medial seta, and lateral denticles; distal segment with 1 lateral, 3 terminal and 2 medial setae, and lateral denticles. Proximal segment of endopod with 1 medial seta and lateral denticles; middle segment with 2 medial setae and lateral denticles; distal segment with 1 lateral, 2 terminal and 2 medial setae, and lateral denticles.

Swimming leg 3 (Fig. 4 P3). Coxa with denticles on pronounced distolateral corner. Basis with denticles on distolateral corner and 1 lateral seta. Rami 3-segmented. Proximal segment of exopod with 1 lateral seta and 1 medial seta, and lateral denticles; middle seg-

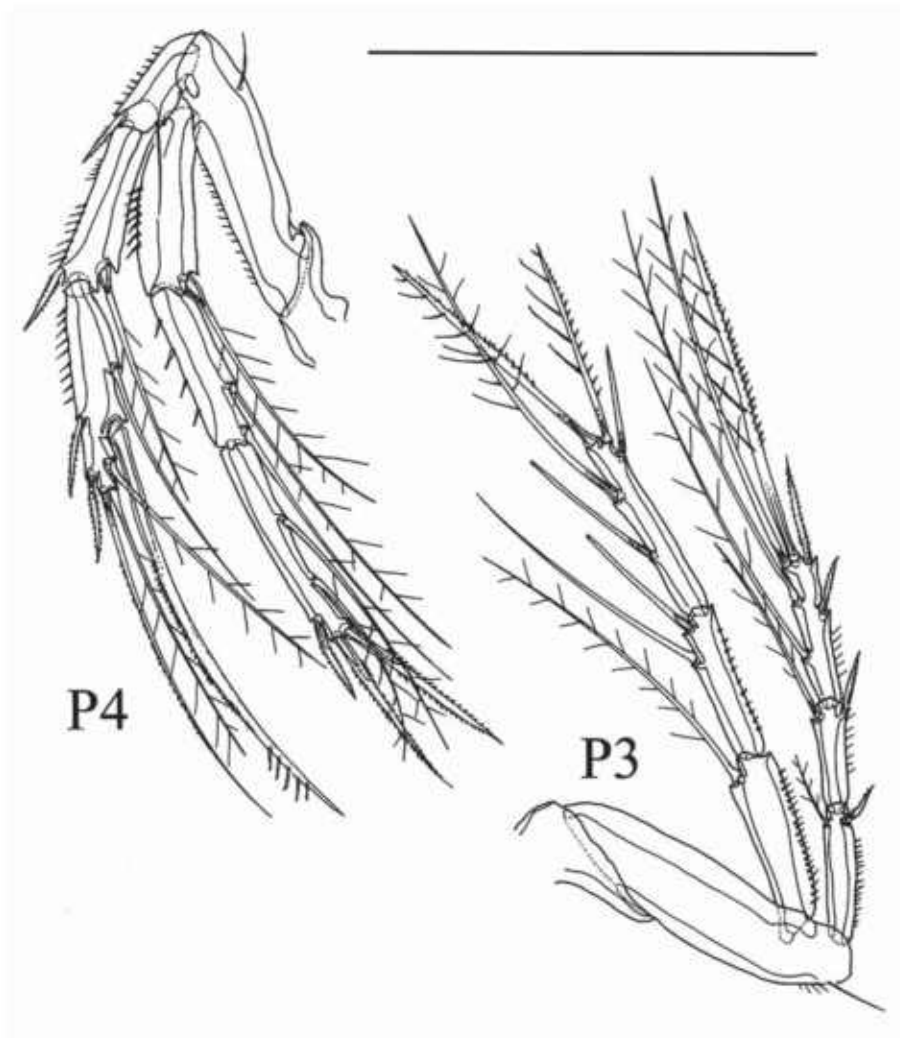


Fig. 4. *Tegastes nanus* Sars, 1904. Female.  
P3 — swimming leg 3; P4 — swimming leg 4. Scale bar 50  $\mu\text{m}$ .

Рис. 4. *Tegastes nanus* Sars, 1904. Самка.

Р3 — плавательная нога 3; Р4 — плавательная нога 4. Масштабный отрезок 50 мкм.

ment with 1 lateral seta and 1 medial seta, and lateral denticles; distal with 2 lateral, 2 terminal and 2 medial setae, and lateral denticles. Proximal segment of endopod with 1 medial seta, and lateral denticles; middle segment with 2 medial setae, and lateral denticles; distal segment with 2 medial, 2 terminal and 1 lateral setae.

Swimming leg 4 (Fig. 4 P4). Coxa without denticles. Basis with medial denticles, and

with 1 lateral seta. Rami 3-segmented. Proximal segment of exopod with 1 lateral seta and 1 medial seta, and lateral denticles; middle segment with 1 lateral seta and 1 medial seta, and lateral denticles; distal segment with lateral denticles and 2 lateral, 2 terminal and 3 medial setae; middle medial seta long and thick. Proximal segment of endopod with 1 medial seta and lateral denticles; middle segment with 2 medial setae and lateral denticles;

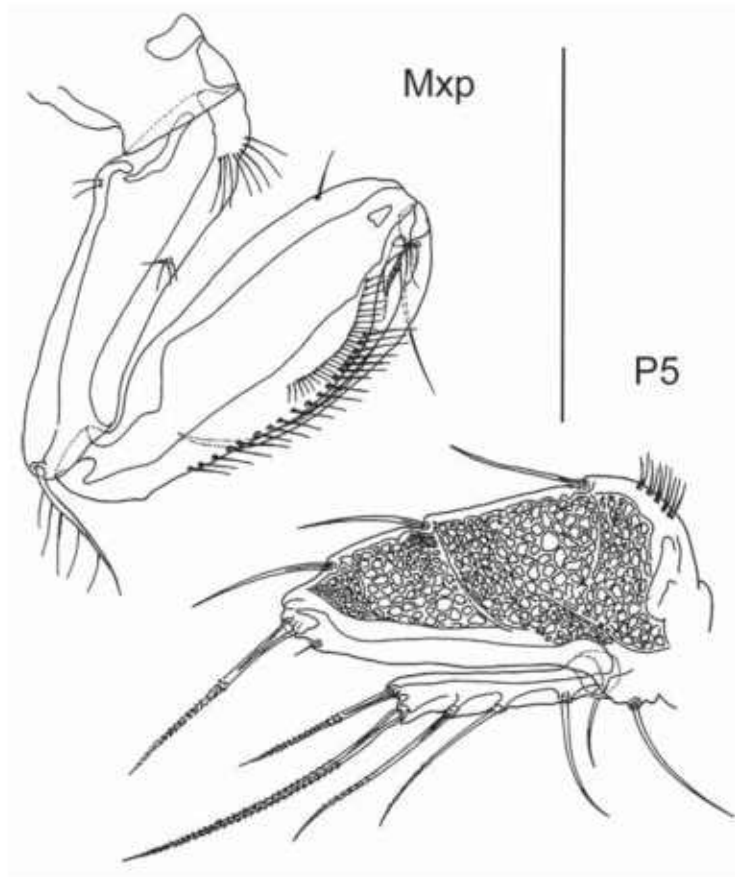


Fig. 5. *Tegastes nanus* Sars, 1904. Female.  
P5 — leg 5; Mxp — maxilliped. Scale bar 50  $\mu\text{m}$ .

Рис. 5. *Tegastes nanus* Sars, 1904. Самка.  
P5 — нога 5; Mxp — максиллипод. Масштабный отрезок 50 мкм.

distal segment with 2 medial, 2 terminal and 1 lateral setae.

**Leg 5 (Fig. 5).** Baseoendopod well-developed, with denticles on proximomedial corner and 3 medial setae without setules, 1 apical pinnate seta, 1 small, lateral seta, and 1 proximolateral seta; surface relief an irregular pattern of thickened cuticle. Exopod 2-segmented, elongate, 2/3 length of endopod; proximal segment with 1 lateral seta, distal segment with 3 lateral setae and 2 terminal setae.

Leg 6 not found.

**Male.** Length 0.29 mm. Similar to female in size, color, shape and surface relief of somites

(Fig. 6A). Corners of cephalosome somewhat less narrowly produced ventrally. Sixth and 7th thoracic somites (Fig. 6B) protruding more ventrally as spermatophore reservoir (Sars 1904: 68) with a slight bump between 2 pronounced extensions; spermatophore large, ovoid. Each abdominal somite compressed within adjacent anterior somite. Terminal setae of caudal rami shorter and broader than female.

First antenna (Fig. 7 A1). A 9-segmented haplocer with geniculations between 4th and 5th, and 8th and 9th segments. Seta formula: 1, 6 (2+2+2), 3+1 aesthetasc, 11+2 aesthetascs, 1, 1, 1, 1, 8+1 aesthetasc.



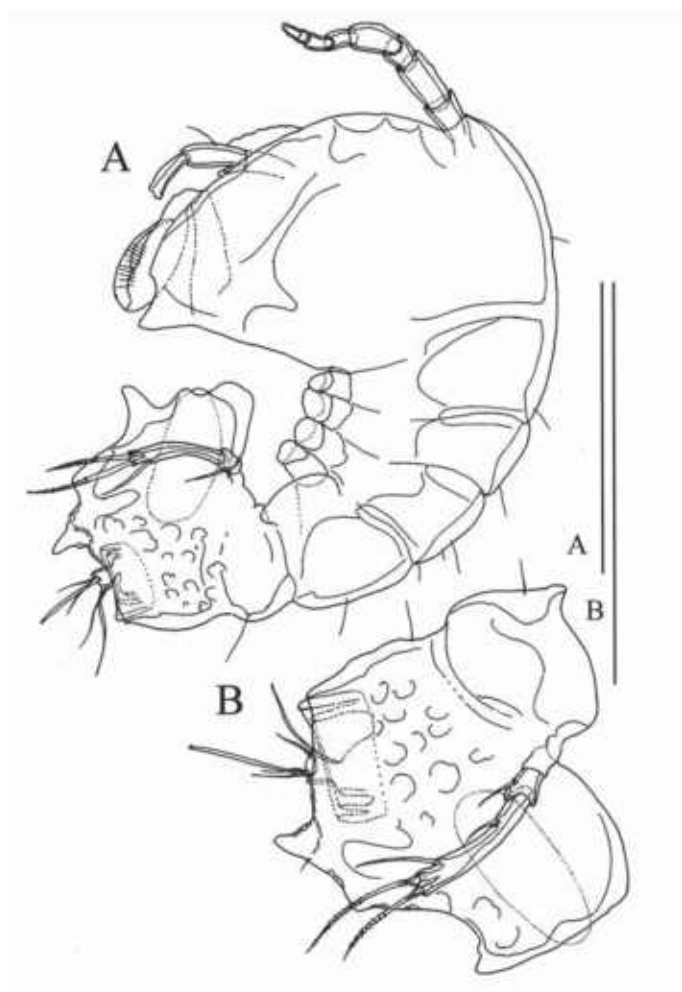


Fig. 6. *Tegastes nanus* Sars, 1904. Male.

A — left lateral habitus; B — left lateral urosome. Scale bars: A — 100  $\mu\text{m}$ ; B — 50  $\mu\text{m}$ .

Рис. 6. *Tegastes nanus* Sars, 1904. Самец.

A — внешний вид слева; B — уросома, вид слева. Масштабные отрезки: A — 100 мкм; B — 50 мкм.

Second antenna, mandible, maxilla 1, maxilla 2, maxilliped similar to female.

Swimming legs 1–4 similar to female with the following exceptions: distal endopodal segment of P2 and P4 (Figs. 8 P2, 9 P4) with 3 medial setae; middle medial seta on distal segment of P4 long and thick (Fig. 9 P4).

P5 (Fig. 6B). Exopod long, 2-segmented; proximal segment with 1 lateral seta, distal segment with 2 lateral and 2 terminal setae.

## Discussion

Tegastid harpacticoids have been collected with few exceptions from surfaces of benthic invertebrates and macroalgae (Ivanenko & Defay, 2005). *Tegastes nanus* Sars, 1904 is a temperate to boreal harpacticoid copepod originally described from western Norway (Sars, 1904). Records from the eastern Atlantic Ocean include the coasts of eastern Ireland (Roe, 1958)

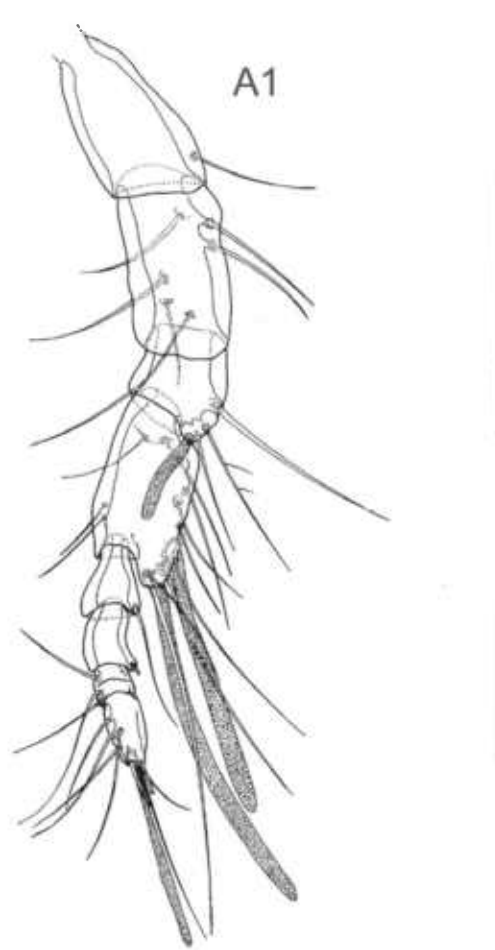


Fig. 7. *Tegastes nanus* Sars, 1904. Male.

A1 — first antenna. Scale bar 50  $\mu\text{m}$ .

Рис. 7. *Tegastes nanus* Sars, 1904. Самец.

A1 — антенна первая. Масштабный отрезок 50  $\mu\text{m}$ .

and western Ireland (Farran, 1913), and the western Baltic Sea (Kunz, 1935). The species also has been recorded from the White Sea of the Arctic Ocean (Chislenko, 1967), the western North Atlantic Ocean from James Bay, an extension of Hudson Bay (Willey, 1923), from the Gulf of St. Lawrence (Tremblay, 1944), and from the Damariscotta River, Gulf of Maine (McAlice & Coffin, 1990). Reports of this species from the subtropics, including the Suez Canal (records summarized by Lang, 1948) are considered doubtful, following the opinion of

Todaro et al. (1996). The phytal substrate known for *T. nanus* includes two genera of red algae, *Delesseria* (see Kunz, 1935) and *Ptilota* (see McAlice & Coffin, 1990), and two genera of brown algae, *Laminaria* (see Chislenko, 1967, McAlice & Coffin, 1990) and *Fucus* (see Chislenko, 1967).

Sars' (1904) original description was very brief; the figures include only the lateral view of the female P5, the male urosome and maxilliped. The five specimens we received in two lots from the University of Oslo were very

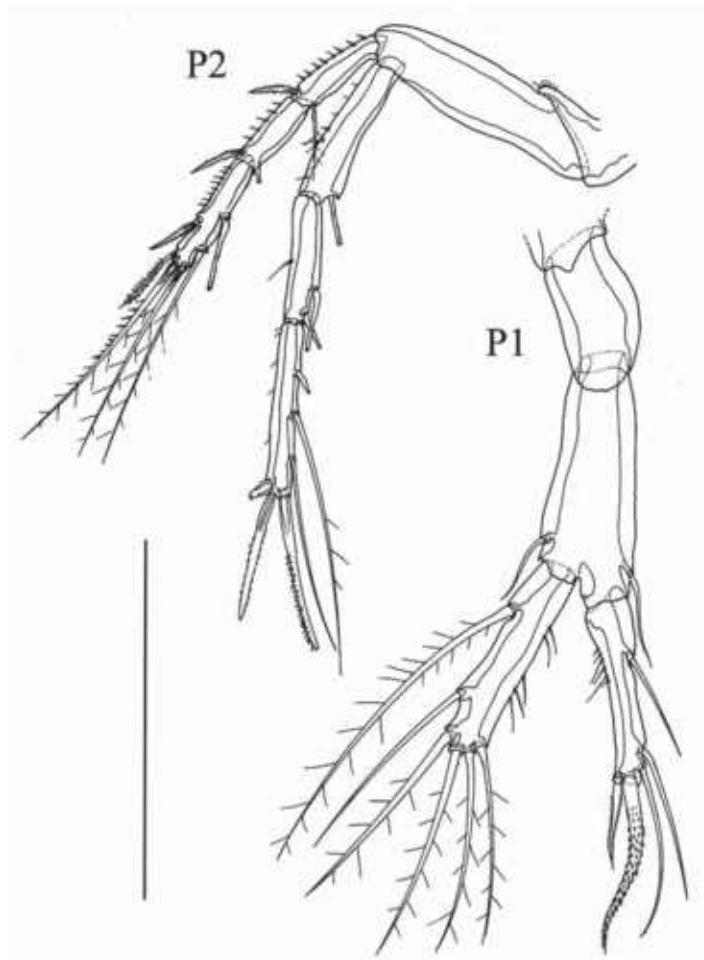


Fig. 8. *Tegastes nanus* Sars, 1904. Male.  
P1 — swimming leg 1; P2 — swimming leg 2. Scale bar 50  $\mu$ m.

Рис. 8. *Tegastes nanus* Sars, 1904. Самец.

P1 — нога 1; P2 — нога 2; Мхр — максиллипод. Масштабный отрезок 50 мкм.

brittle, presumably from long exposure to the dehydrating effects of the ethanol preservative. The 0.45 mm female (remaining male is 0.38 mm) from Ålesund (F 20366) and the 0.42 mm male from Eggesbønes (remaining male is 0.40 mm and female is 0.49 mm) (F 20357) were dissected and are morphologically similar to specimens from Ny Ålesund although both sexes are larger.

Since Sars' (1904) original description of the species, *T. nanus* has been redescribed twice. More illustrations (lateral habitus, A1, P5 of

both sexes, P1 and second maxilla) were provided by Chislenko (1967) from White Sea specimens. The most recent redescription by McAlice and Coffin (1990) included a description and illustration of a male from a phytal habitat of the Gulf of Maine. This description is much more complete, but it lacks necessary detail for a complete comparative analysis. Unfortunately, the material upon which these authors based their descriptions is not available.

Females from Ålesund and Ny Ålesund agree with Sars' (1904) and Chislenko's (1967) brief

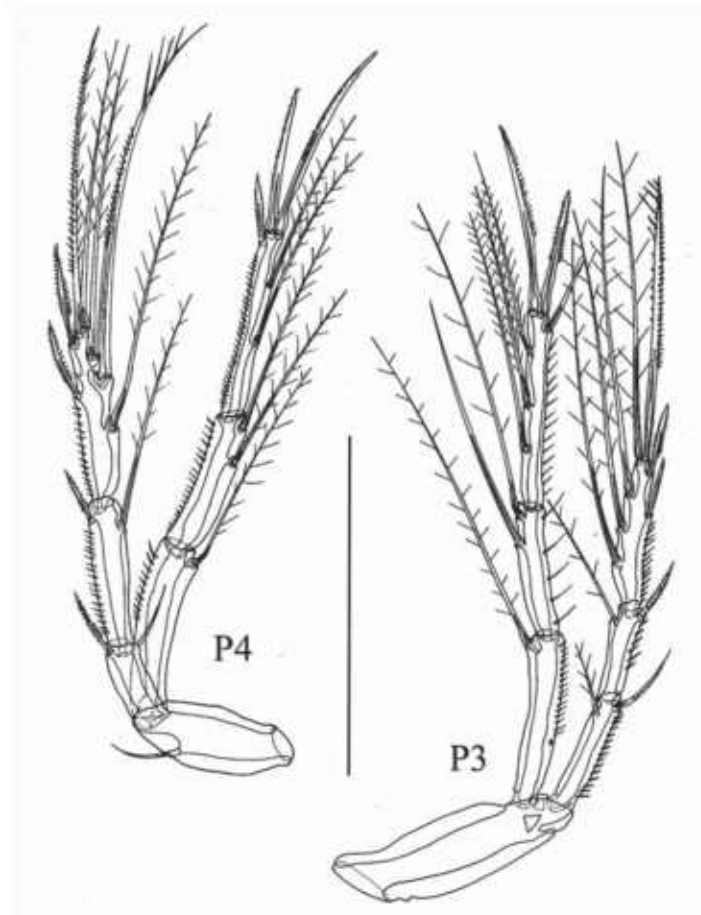


Fig. 9. *Tegastes nanus* Sars, 1904. Male.  
P3 — swimming leg 3; P4 — swimming leg 4. Scale bar 50  $\mu$ m.

Рис. 9. *Tegastes nanus* Sars, 1904. Самец.

Р3 — плавательная нога 3; Р4 — плавательная нога 4. Масштабный отрезок 50 мкм.

descriptions. Chislenko observed that females of *T. nanus* possessed small bristles on the lateral surface of the baseoendopod of P5; Sars' (1904) drawings show the same, although he did not mention this in the text.

The female and male from Ny Ålesund express sexual dimorphism in the shape of the cephalosome, thoracic somites 6 and 7, and the anterior abdominal somite, as well as antenna 1, leg 5, and swimming legs 2 and 4. The penultimate segment of the 8-segmented female antenna 1 corresponds to the antepenultimate and penultimate segment of the 9-segmented male antenna 1; an arthrodial membrane does not

form on the female's limb. The female from Ålesund and male from Eggesbønes expressed a dimorphism in swimming leg 3 similar to those of swimming legs 2 and 4 in specimens from Ny Ålesund.

Illustrations and setal formula of the male described by McAlice and Coffin (1990) differ from our specimens. The antenna 1 of the male from the Gulf of Maine has only one aesthetasc on the 5<sup>th</sup> segment. The male from Ny Ålesund and the male from Eggesbønes have 1, 2 and 1 aesthetascs on 3<sup>rd</sup>, 4<sup>th</sup> and 8<sup>th</sup> segments respectively. McAlice and Coffin (1990) note that in contrast to Chislenko's figures, the 5<sup>th</sup> segment

of A1 of their specimens are much longer. The specimens studied here have a 5<sup>th</sup> segment length similar to the ones given by Chislenko. Males from Ny Ålesund and from Eggesbønes have a seta on the 1<sup>st</sup> segment of the exopod of antenna 2 (not present on the male from the Gulf of Maine) and 4 terminal setae on the distal endopodal segment of antenna 2 (3 setae on the male from the Gulf of Maine). The Gulf of Maine male also expresses several differences in swimming legs compared to the males from Ny Ålesund and from Eggesbønes: there is no medial seta on the proximal exopodal segment of swimming legs 2–4 (present in the males from Ny Ålesund and from Eggesbønes); there are 2 medial setae on the distal endopodal segment of swimming legs 2 and 4 (3 males from Ny Ålesund and from Eggesbønes). It should be noted the differences in medial setae on the distal endopodal segment of swimming legs 2 and 4 also result in gender dimorphism in specimens from Ny Ålesund; it is possible that this state is simply polymorphic in this species. The other differences are more substantial. Equally important are differences in the posteroventral extension of the genital somite fused to the 6th thoracic somite and anterior abdominal somite of the female with less pronounced tips in the Gulf of Maine specimens, and spermatophore reservoir of the male without a bump between the tips of the Gulf of Maine specimens. Specimens of *T. nanus* from Ny Ålesund are conspecific with those from Ålesund and Eggesbønes, as described by Sars (1904) and the White Sea. *Tegastes nanus* from the Gulf of Maine (McAlice & Coffin 1990) probably is not conspecific with those from Ny Ålesund, Ålesund, Eggesbønes and the White Sea.

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