

Paradulichia spinifera Gurjanova, 1946 (Amphipoda, Dulichiidae), a valid species?

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Examination of *Paradulichia*-material collected from the Barents Sea during the Mareano cruises indicated that there are clear morphological differences between *Paradulichia typica* Boeck, 1871 from the Hardangerfjord, W. Norway and *Paradulichia spinifera* Gurjanova, 1946 from the Arctic. Based on our material and the original descriptions, these differences are the acute ventral parts of the body segments, the triangularly shaped coxal plates 3 and 4, the shape and length of the mandible palp articles, the long merus of pereopods 5 and 6, the elongate telson and the 2-articulate rami of uropod 2.

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INTRODUCTION

The amphipod genus *Paradulichia* Boeck, 1871 is unique within the family Dulichiidae because of its rudimentary uropod 2. According to the latest revision of the family (Laubitz 1977) the genus has only a single species; *P. typica* Boeck, 1871. Two further species have been described in the genus; of these one, *P. secunda* Blake, 1927 from the US east coast, has been very imperfectly described, while the other one, *P. spinifera* Gurjanova, 1946 from the Russian Arctic was synonymized with *P. typica* by Laubitz (op. cit.). The present authors have examined fresh material from the Arctic regions of Norway, which cast doubt on this synonymy.

The descriptions of *P. typica* by Boeck (1871) and Sars (1894) are both based on adult females from the Hardangerfjord, SW Norway; Gurjanova's material came from the Russian Arctic, while it is not quite clear on what material Laubitz' illustrations were based. However, Laubitz mentions specimens from the Leningrad collection (ZI, three specimens from Russian Arctic). We have as yet been unable to ascertain whether *P. spinifera* type material exists in the collections of

the St Petersburg museum. In our opinion, the differences in habitus of *P. spinifera* and *P. typica* are so conspicuous that a thorough examination of these was needed. Therefore, our comparisons of *P. spinifera* and *P. typica* are based on own figures of adult females of *P. spinifera* from the Arctic, in addition to the figures and text of *P. typica* from Boeck (1871, 1872/76) and Sars (1894). The descriptions that Gurjanova (1946, 1951) gave of *P. spinifera*, were based on material from stations in the Arctic Polar Basin (78°4 – 80°5N and 34°0 – 142°1E). Our drawings and descriptions of *P. spinifera* have been made using three adult female specimens of *P. spinifera* collected in the eastern part of the Barents Sea.

MATERIAL AND METHODS

Since we did not succeed to obtain *Paradulichia spinifera* type material, our description is based on material collected in the eastern Barents Sea during the Mareano-cruises. The Mareano-project maps depth and topography, sediment composition, contaminants, biotopes and habitats in Norwegian waters. The

results of the surveys are available on the Mareano-website, visualised through maps (<http://www.mareano.no/en/>).

The collected material was initially fixed in 4 % formalin and later transferred to 96 % ethanol.

The total length of the analysed specimens was measured from rostrum to telson.

The animals were mounted on microscope slides in Faure's fluid. Stacks of photos were taken from a Bresser Biolux NG microscope with an electronic sensor and the drawings were made with an electronic pc-tablet using the techniques described by Coleman (2003, 2006, 2009). The examined material is kept in the collections of the University Museum in Bergen, Norway.

RESULTS

Systematics

Order Amphipoda Latreille, 1816,

Family Dulichiidae Dana, 1849,

Genus *Paradulichia* Boeck, 1871,

Diagnosis (Barnard & Karaman 1991): Body cylindrical, smooth, pereon segments 1–2 short, last 2 pereon segments fused together; urosomites 2–3 coalesced, urosomite 1 very elongate. Rostrum short, ocular lobes obsolescent, blunt, antennal sinus weak. Eyes large. Antennae elongate, 1 longer than 2, both slender, peduncular article 3 of antenna 1 much longer than 1, peduncular articles 2–3 longest, accessory flagellum 3–5 articulate. Antenna 2 peduncular article 3 short, main flagellar articles very few. Epistome [?unproduced anteriorly]. Labrum broad, bilobed. Mandible normal, palp strong, very slender, article 3 rectilinear, shorter than 2. Labium with entire outer lobes, with well-developed inner lobes, mandibular lobes long, blunt. Inner plate of maxilla 1 triangular, large, without setae, outer plate with 9 spines, palp 2-articulate. Plates of maxilla 2 ordinary, inner plate slightly shortened, without mediomarginal setae. Inner plate of maxilliped with distal spines (fide Dr Laubitz but in illustrations appearing as setae), outer plate short, reaching halfway to apex of palp article 2, with only spine-setae on medial margin, palp with 4 articles, article 2 long, article 3 unlobed, article 4 short, with long setae. Coxae very small, short, not contiguous, not spiniform, coxa 1 not dilated, not produced forward, coxa 4 not longer than coxa I, not lobed, coxa 5 somewhat longer than 4, coxae 6–7 not smaller than anterior coxae. Gnathopods 1–2 of subequal size, small, both with sublinear articles, gnathopod 1 in male poorly subchelate, article 5 long, linear, unlobed, palm short, gnathopod 2 subchelate, article 5 slightly longer than 6, poorly lobed, article 6 expanded. Pereopods 3–4 longer than gnathopods, similar, with slender article 2, article 4 dilated, dactyls short. Pereopods 5–7 similar to each other, scarcely progressively longer, not prehensile, with linear article 2, dactyls short, curved. Sternal processes of thorax absent. Coxal gills present on segments

2–5. Pleopods normal. Epimeron 3 not bisinuate (posteriorly?). Uropod 1 biramous, rami slightly unequal, much longer than peduncle, peduncle without ventrodistal process; uropod 2 very small, with only 1 ramus or forming small leaf lacking rami. Uropod 3 absent. Telson entire, as long as broad, ovate.

Type species. *Paradulichia typica* Boeck, 1871.

Paradulichia spinifera Gurjanova, 1946

(Figures 1–3)

Paradulichia spinifera Gurjanova, 1946

Paradulichia spinifera Gurjanova, 1951

Paradulichia typica Laubitz, 1977

Material examined

Three adult females with oostegites, total body length, each 7 mm long, taken at station R-1416: 72°36.99N 34°33.0, RP-sledge, 273 meter depth, 27 August 2014: ZMBN 130813-A-D, ZMBN 130814-A-D and ZMBN 130815-A-B.

Description, (ZMBN 130813 (α), ZMBN 130814 (β) and ZMBN 130815 (μ)).

Head:

Eyes large and protruding. Rostrum broadly convex. Eye lobes forming a blunt angle. Both antennae with long setae along ventral margin. Antennae 1 and 2 shorter than the body. Antenna 1 longer than antenna 2.

Antenna 1, peduncle article 1 broader than and half the length of article 2, peduncle article 3 subequal to article 1 and 2 combined. Flagellum subequal to peduncle article 2, flagellum consisting of five articles where the first article is the longest. A few long setae on the margin of flagellum article 1 and between the successive articles. Accessory flagellum with three articles where the last article is very small.

Antenna 2, peduncle article 1–3 short and broader than article 4 and 5, peduncle article 4 and 5 subequal in length. Flagellum consisting of three articles and shorter than peduncle article 5. Flagellum article 1 subequal to the two successive articles combined.

Lower lip broad, bi-lobed. Inner lobes well developed, reaching almost to the upper margin of the outer lobes. The upper margins of inner and outer lobes with short setae.

Upper lip triangular.

Mandible. Incisor and lacinia mobilis dentate. Four serrate strong accessory spines. Molar tubercles robust. Mandible palp robust, the second palp article 2x the third article, third article subequal to the first article. Long setae on the second and third article. Third article curved with three apical setae.

Maxilla 1. Inner plate small and triangular. Outer plate with more than ten forked apical spines in addition to spinelike setae that are decreasing in length along medial margin. Palp with

two articles, the second article with four apical spines and long setae on the distal margin.

Maxilla 2. Plates oval in shape. Outer plate with long apical setae, inner plate with apical and medial setae.

Maxilliped. Inner plate broad with six apical spines and setae along inner margin. Outer plate broad with spines and setae along inner margin. Outer plate reaching the middle of palp article 2. Palp article 2 with long setae along inner margin. Palp article 3 with parallel margins and long apical setae. Palp article 4 with two strong apical setae.

Pereon:

Pereon segments 1 and 2 shorter than the following pereon segments. Pereon segments 6 and 7 coalesced. The ventral parts of the pereon segments are bent on both sides, each forming an almost horizontal plate with acute processes. Gnathopods 1 and 2 similar in length and shorter than pereopods 3 and 4. Pereopods 5, 6 and 7 longest, successively increasing.

Gnathopod 1. Coxa triangular-oval. Carpus broad and longer than both basis and propodus. Ventral margin of carpus plumose, ventral and medial margin of propodus with long plumose setae. Dactylus curved with short setae on inner margin. Small distal notch on propodus. Dactylus with a slim medial spine.

Gnathopod 2. Coxa triangular-oval. Basis, carpus and propodus subequal in length. Carpus and propodus less setose than in gnathopod 1. Dactylus curved and with short setae on inner margin. Three spines and short setae on the ventral margin of propodus. There is a distal notch on the propodus. Dactylus with a slim medial spine.

Pereopod 3. Coxal plate 3 broadly triangular. Basis longer than merus and posterior side of basis convex. Carpus distally widening. Carpus and propodus subequal in length. Dactylus with a broad oval medial spine.

Pereopod 4. Coxal plate 4 broadly triangular. Basis longer than merus and carpus. Carpus longer than propodus. Dactylus with a broad oval medial spine.

Pereopod 5. Coxal plate 5 broadly triangular. Basis longer than merus. Carpus and propodus subequal. Merus longer than carpus and propodus combined. Setae on the margins of basis and merus. Margins of carpus with spines. Dactylus with a slim medial spine.

Pereopod 6. Coxal plate 6 oblong-triangular. Basis subequal to merus. Merus longer than carpus and propodus combined. Setae on the margins of basis and merus. Margins of carpus with spines. Dactylus with a slim medial spine.

Pereopod 7. Coxal plate 7 oval-triangular. Basis shorter than merus. Merus subequal to carpus and propodus combined. Setae on the margins of basis and merus. Margins of carpus with spines. Dactylus with a slim medial spine.

Pleon:

Pleon segment 3 subequal to pleon segments 1 and 2 combined. Between the pleopods on the ventral side of the pleon there is a

tubercle, a circular elevation.

Urosome:

Urosome segment 1 strongly elongated. Uropod 3 not developed. Uropod 1 long, outer margin of peduncle with one row of small spines, distal part of inner margin of the peduncle with a few setae, rami longer than peduncle, inner ramus longer than outer. Each ramus with two spine rows.

Uropod 2, vestigial, with a 2-articulate ramus, which is longer than peduncle. The last article stretches far beyond telson. Telson longer than broad. Upper part of telson elevated.

DISCUSSION

The descriptions of *P. typica* by Boeck (1871, 1872/76) and Sars (1894) were all based on 5–6 mm long adult females collected from the Hardangerfjord, SW Norway. Our examined 7 mm specimens from the eastern part of the Barents Sea were also adult females and should be directly comparable to Sars' and Boeck's descriptions. Since these examined specimens from the Barents Sea were recorded in the cold Arctic Basin and agreed largely with Gurjanova's description of the 8 mm specimen of *P. spinifera* from further east in the Russian Arctic, our drawings were used in the comparisons with *P. typica*. A review of the observed differences is given in Table 1.

The most pronounced differences which distinguish *P. spinifera* from *P. typica* are the acute ventral parts of the body segments, the triangularly shaped coxal plates 3 and 4, the long merus of pereopods 5 and 6, the elongate telson and the 2-articulate rami of uropod 2.

In the following, the corresponding traits in *P. typica* are given in parenthesis.

The frontal view of the rostrum is broadly convex and the lateral lobe of the head shows a concave antennal sinus (rostrum triangular; antennal sinus inconspicuous).

Antenna 1 peduncle article 2 is 2x peduncle article 1 (almost 3x in *P. typica*).

The mouth parts are quite similar in the two species. There are a few differences, however. The mandible palp is less slender, and article 1 is longer (very slender, with shorter article 1).

Gnathopod 1 has a broader basis, which is subequal to the propodus (slim and longer than propodus). Both gnathopods 1 and 2 have a narrow incision on the distal part of the propodus, close to the attachment of the dactylus (not shown in drawings of *P. typica*, but may have been overlooked). Pereopods 3 and 4 have a characteristic flat broad spine on the dactylus, pereopods 1, 2, 5, 6 and 7 have a flat slim spine on the dactylus (spines not shown in drawings of *P. typica*).

Uropod 2 ramus has 2 articles, as described by Gurjanova (1946) for *P. spinifera*. The total length of uropod 2 varied somewhat in our material, but there were always 2 articles. *Paradulichia typica* shows only 1 article in the descriptions by Boeck (1872/76) and Sars (1894); the ramus was absent in

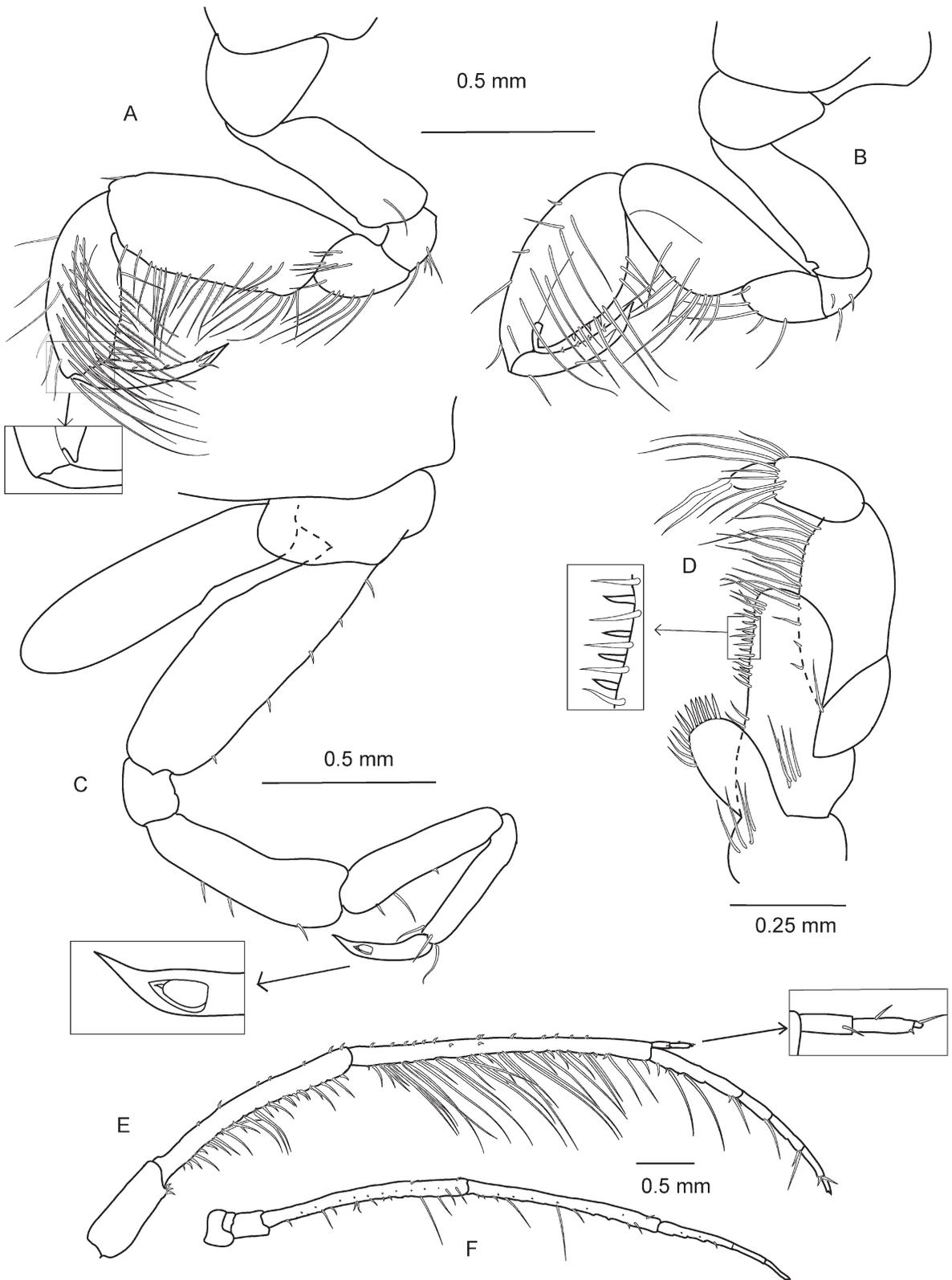


Figure 1. *Paradulichia spinifera*. A. left gnathopod 1 (β); B. left gnathopod 2 (β); C. right pereopod 3 with gill (β); D. right part of maxilliped (μ); E. antenna 1 (β); F. antenna 2 (β).

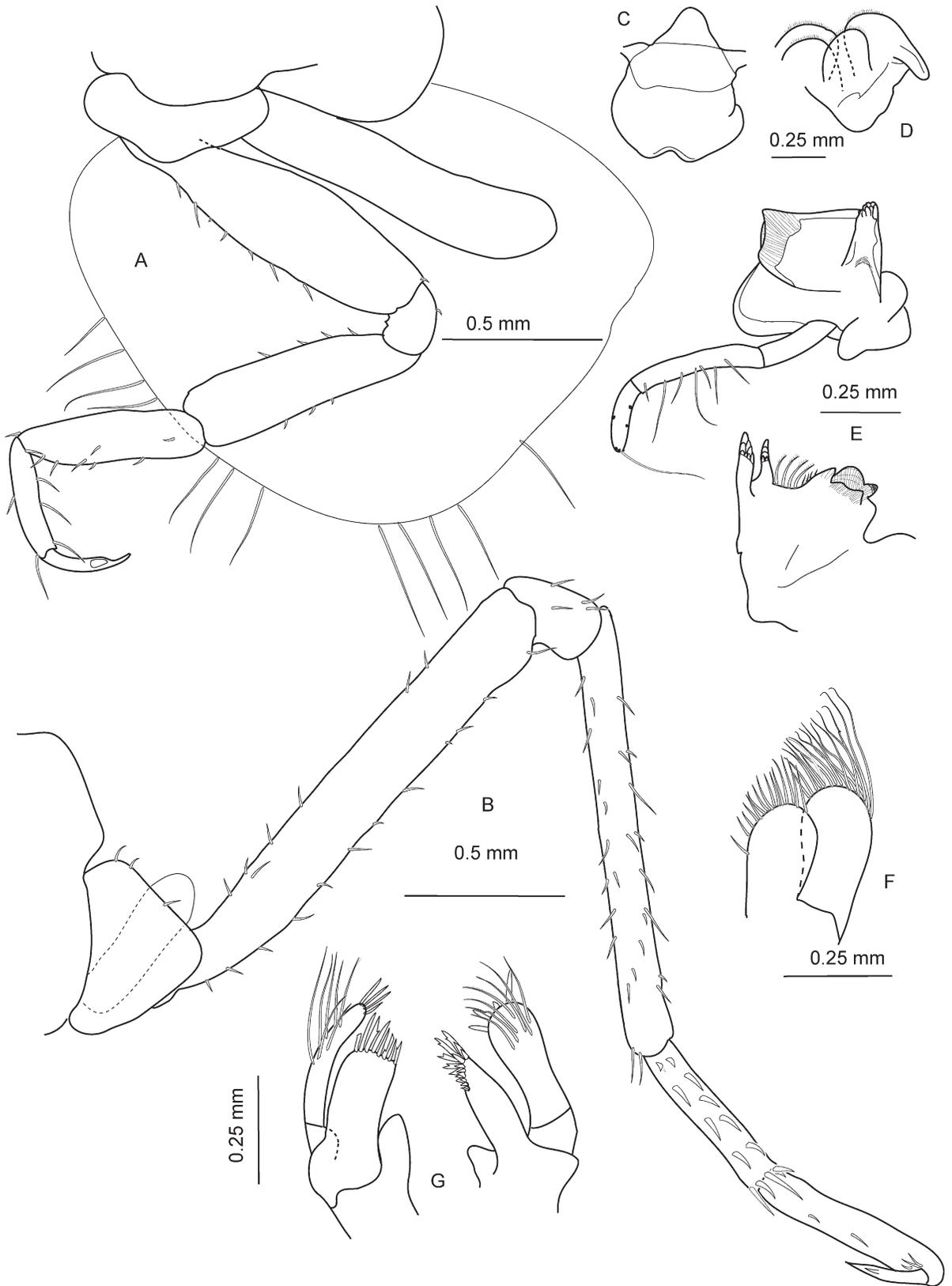


Figure 2. *Paradulichia spinifera*. A. left pereopod 4 with gill and oostegite (β); B. right pereopod 5 with gill (β); C. upper lip (μ); D. lower lip (μ); E. mandibles (μ); F. maxilla 2 (μ); G. maxilla 1 (μ).

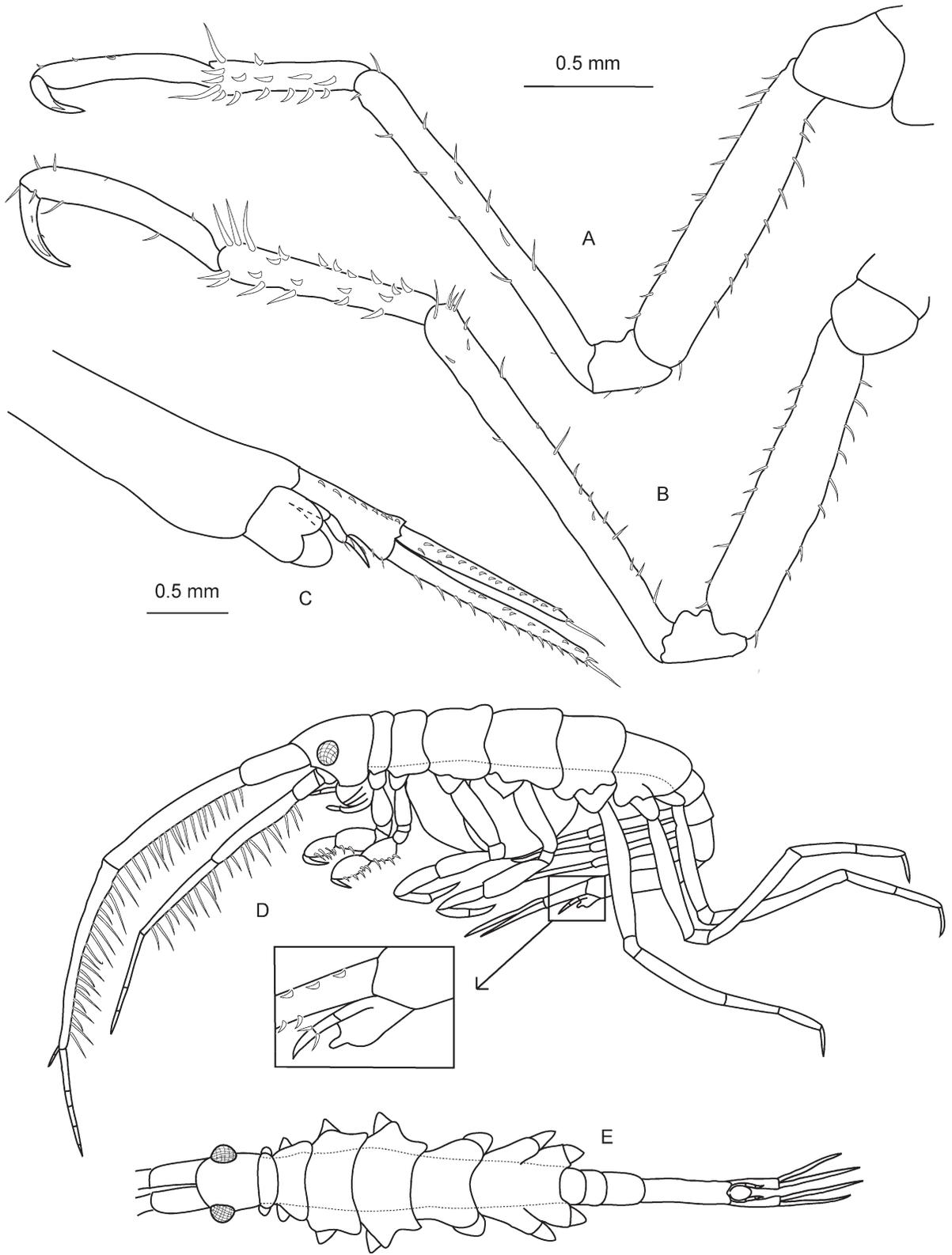


Figure 3. *Paradulichia spinifera*. A. right pereopod 6 (β); B. right pereopod 7 (β); C uropod 1, uropod 2 and telson (α). D. lateral view of female habitus; E. dorsal view of female habitus.

Table 1. Comparisons between *Paradulichia spinifera* and *Paradulichia typica*.

Body part	<i>P. typica</i> , Boeck 1871	<i>P. spinifera</i> , Gurjanova 1946
Rostrum	acute	broadly convex
Eye lobe	slightly curved, no antennal 2 sinus	blunt angle, concave antennal 2 sinus
Antenna 1	peduncle article 2 nearly 3x the length of article 1	peduncle article 2 2x the length of article 1
Lower lip	inner plates reaching 2/3 of outer plates	inner plates reaching 3/4 of outer plates
Mandible palp	Palp especially thin, article 3 2x the length of article 1. Article 3 rectilinear.	Palp broader, article 3 subequal to article 1. Article 3 curved.
Maxilliped	Palp article 3 distally widening	Palp article 3 with parallel margins.
Pereon	Ventral parts of body segments smooth.	Ventral parts of body segments horizontally bent, forming a distally acute plate.
Coxal plates 3 and 4	rectangular	triangular
Gnathopod 1 basis	slim and longer than propodus	broad and subequal to propodus
Gnathopods 1 and 2	-	Distal notching on propodus
Pereopods 1–7	-	Spine on dactylus
Pereopod 4 carpus	slim	broader
Pereopods 5 and 6 merus	subequal to carpus and propodus combined	longer than carpus and propodus combined
Pleon	-	Ventral abdominal tubercles
Uropod 2	Ramus with one article, article subequal to basal segment	Ramus with two articles, articles combined longer than basal segment.
Telson	length equal to width	longer than broad

all the specimens studied by Laubitz (1977) from southern Norway; this author found considerable individual variety in the development of uropod 2 in specimens from the NW Atlantic. The geographical position of Laubitz' drawing of *Paradulichia* was not given and it resembles *P. spinifera* more than *P. typica*. The observed variations she found may be due to geographically separated populations.

Gurjanova (1946) mentioned that antenna 1 of *P. spinifera* has a flagellum with 7 articles and an accessory flagellum with 5 articles. The flagellum in the specimen we examined had 5 articles and accessory flagellum with 3 articles. The number of articles may vary with the size of the specimens as it is seen in other amphipod species. The number of articles on flagellum on antenna 2 of Gurjanova's description agrees with our observations.

Gurjanova (1951) mentions the lack of spines on uropod 1 peduncle margin and used this as a defining character; in our specimens we observed small tight spines along the outer margin of uropod 1. Laubitz (1977) also observed spines on her specimens from the Arctic.

Gurjanova (1951) found a ventrally situated tubercle between each pair of pleopods. This was also observed on our specimens from the Arctic, but this was not mentioned by Boeck (1871, 1872/76) or Sars (1894) on *P. typica*.

Our examination indicates that there are clear morphological differences between *P. typica* from the Hardangerfjord and *P. spinifera* from the Arctic; in our opinion sufficient to consider *P. spinifera* to be a valid species. The question whether *P. typica*

and *P. spinifera* are really two separate species and whether there may be a further species in the NW Atlantic (*P. secunda?*) should be finally decided by the use of molecular identifications of *Paradulichia* populations from its entire area of distribution. Molecular identification of this material is not possible, due to the conservation methods used.

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