A New Species of *Parastenhelia* (Copepoda: Harpacticoida: Parastenheliidae) from Korea

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ABSTRACT—A new species belonging to the genus *Parastenhelia* of family Parastenheliidae is described on the basis of the specimens of both sexes collected from the zosteran bed at Seungbong Island and from the shallow sandy bottoms of Jeju Island in Korea. It is distinguished from the congeners by its character combination of inserted location and the length proportion of the inner seta on the first endopodal segment of leg 1, shape of female leg 5, the modified male legs 2-3 endopods, and the number of setae on male leg 5 exopod. An emended table of morphological characters for the genus is provided.

Key words: Copepoda, Harpacticoida, Parastenheliidae, *Parastenhelia*, Korea

INTRODUCTION

The genus *Parastenhelia* Thompson and A. Scott, 1903 including ten valid species and two forms is known to be morphologically variable in the length proportion of an inner seta on the first endopodal segment of leg 1, the armature of swimming legs, the modification of male legs 2-3 endopod and the segmentation of male leg 5 exopod. Especially, *P. spinosa* Fischer and *P. hornelli* Thompson and A. Scott which occurred worldwide are highly variable in the morphology. Both species have the serious problems for the species diagnosis due to the inadequate and unclear descriptions in the past. Vervoort (1964) pointed out that *P. spinosa* has a wide range of variabilities in the body length and setal formula, although he did not split the species into the varieties. Wells *et al*. (1982) indicated that *P. hornelli* has a high degree of morphological variability in segmentation and setation of the antennal exopod, setal formula of legs 2–4, male legs 2–3, and leg 5 exopod. He also stated the poor descriptions and illustrations in the published data.

Parastenhelia is entirely unknown from Korea as well as East Asia still yet. In this report, we describe a new species from Korea, and discuss on its taxonomic position based on the character comparison with its related congeners.

MATERIALS AND METHODS

Materials were obtained from the washings of *Zostera japonica* from Seungbong Island in the Yellow Sea and of sediments at shal-

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low sublittoral zone of Sehwa Beach, Jeju Island. Specimens were dissected, drawn and measured in lactophenol or lactic acid on H-S slide (Shirayama *et al*., 1993). All figures have been prepared using a drawing tube, under a differential interference contrast microscope (Olympus BX-50) with Nomarski optics. Morphological terminology and abbreviations used in the description and table are as follows: P1-P6 indicate the first to sixth legs (pereiopods); enp 1–3 or exp 1–3 refer to the first to third endopodal or exopodal segment of each leg; seg. to the segment. Type series are deposited in the collection of the Natural History Museum, London (NHM).

DESCRIPTION

Family Parastenheliidae Lang, 1944
Genus *Parastenhelia* Thompson and A. Scott, 1903
Parastenhelia pyriformis new species
(Figs. 1–4)

Type material: Three females and 2 males, Sehwa Beach, Jeju Is. (33°28'07"N, 126°54'43"E), 28 October 1993, C. Y. Chang and S. J. Song. Holotype: female (NHM reg no. 2002.846). Paratypes: two females and two males (NHM reg no. 2002.847–850). All are preserved in 70% ethylalcohol.

Additional material examined: Two females, same locality as above, 7 June 2001, C. Y. Chang and J. M. Lee; two females (1 ovigerous), Seungbong Is., 14 April 2001, S. J. Song.

Description of female: Body (Fig. 1A) laterally depressed, about 382–388 μm long, excluding rostrum and caudal rami. Cephalothorax about 1.21 times longer than wide; sensillae scattered on dorsal surface. Rostrum (Fig. 2A) elongated and rounded apically, and directed downward; paired sensillae located near apex. Genital double somite (Fig. 1B) slightly narrowing posteriorly, about 1.03 times
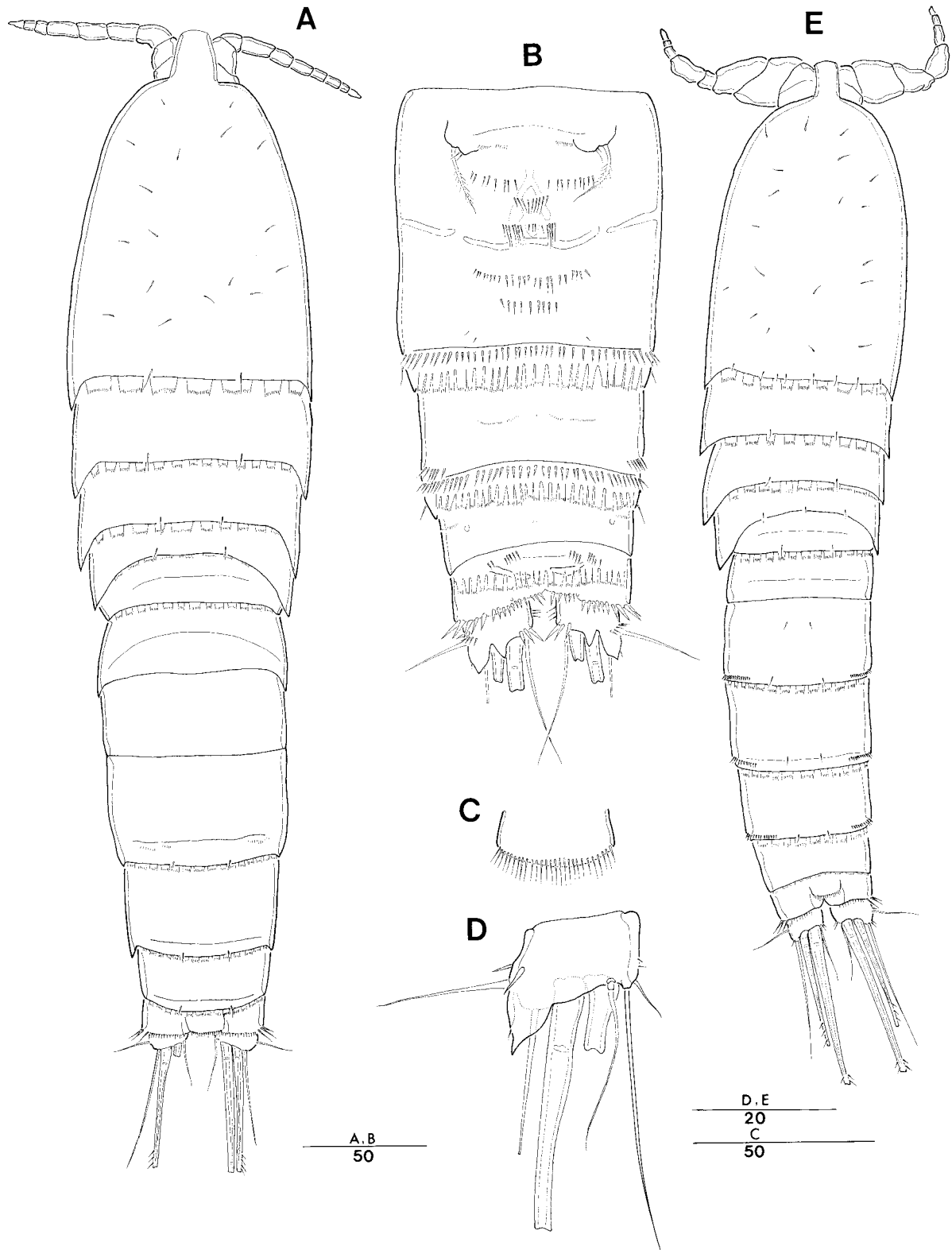
Fig. 1. *Parastenhelia pyriformis* n. sp. A–D, female: A, habitus, dorsal; B, urosome, ventral; C, operculum; D, caudal ramus, dorsal. E, male habitus, dorsal. Scales: μm.

longer than wide; incompletely fused ventrally, with several spinular rows on surface, posterior border ornamented with setule line and hyaline frill ventrally. Next two segments also bearing hyaline frill on posterior margin. Anal operculum (Fig. 1C) bordered with fine hairs. Caudal rami (Fig. 1D), both sides nearly parallel, about 1.87 times wider than long,
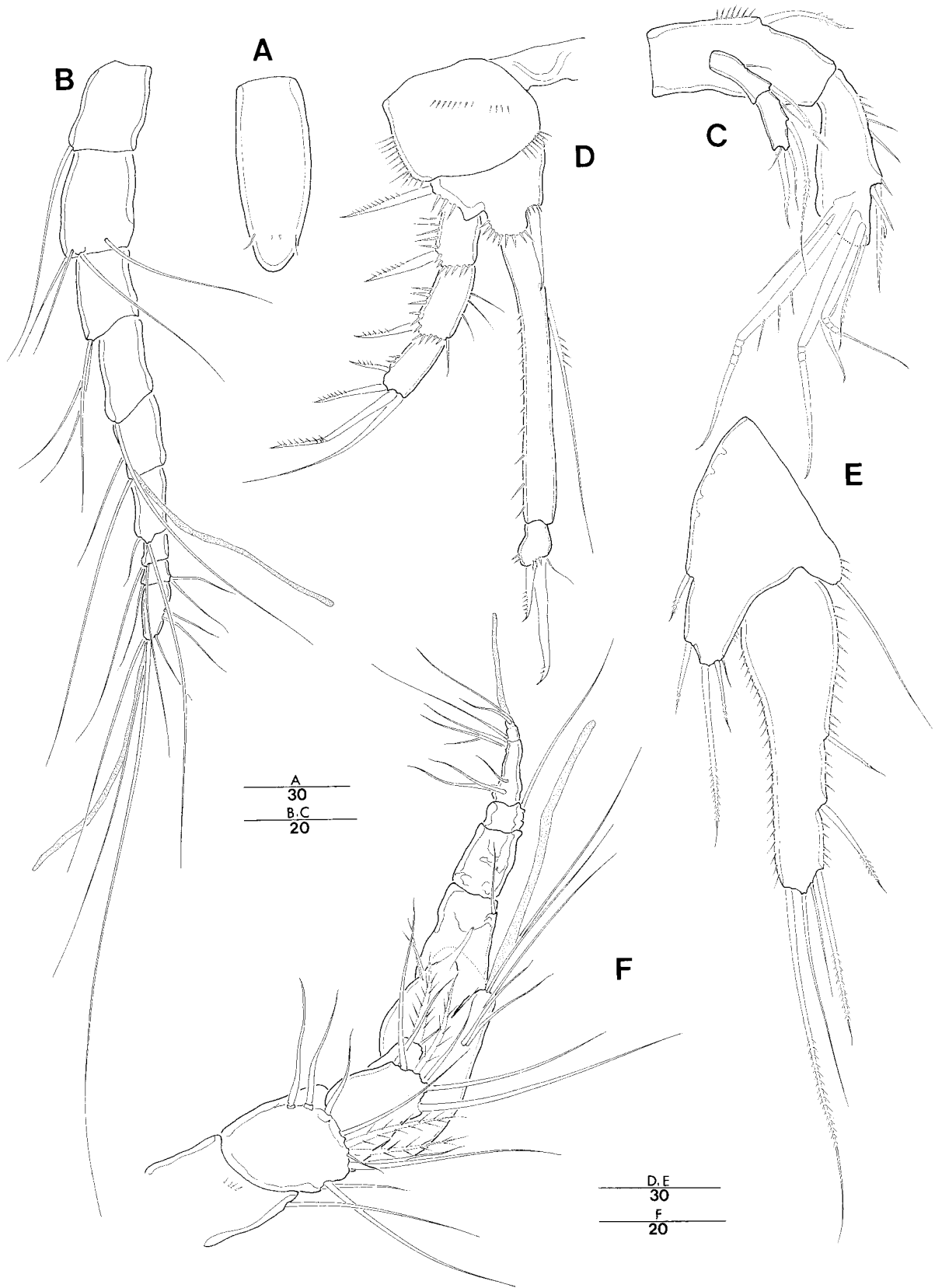
Fig. 2. *Parastenhelia pyriformis* n. sp. A–E, female: A, rostrum; B, antennule; C, antenna; D, P1; E, P5. F, male antennule. Scales: μm.
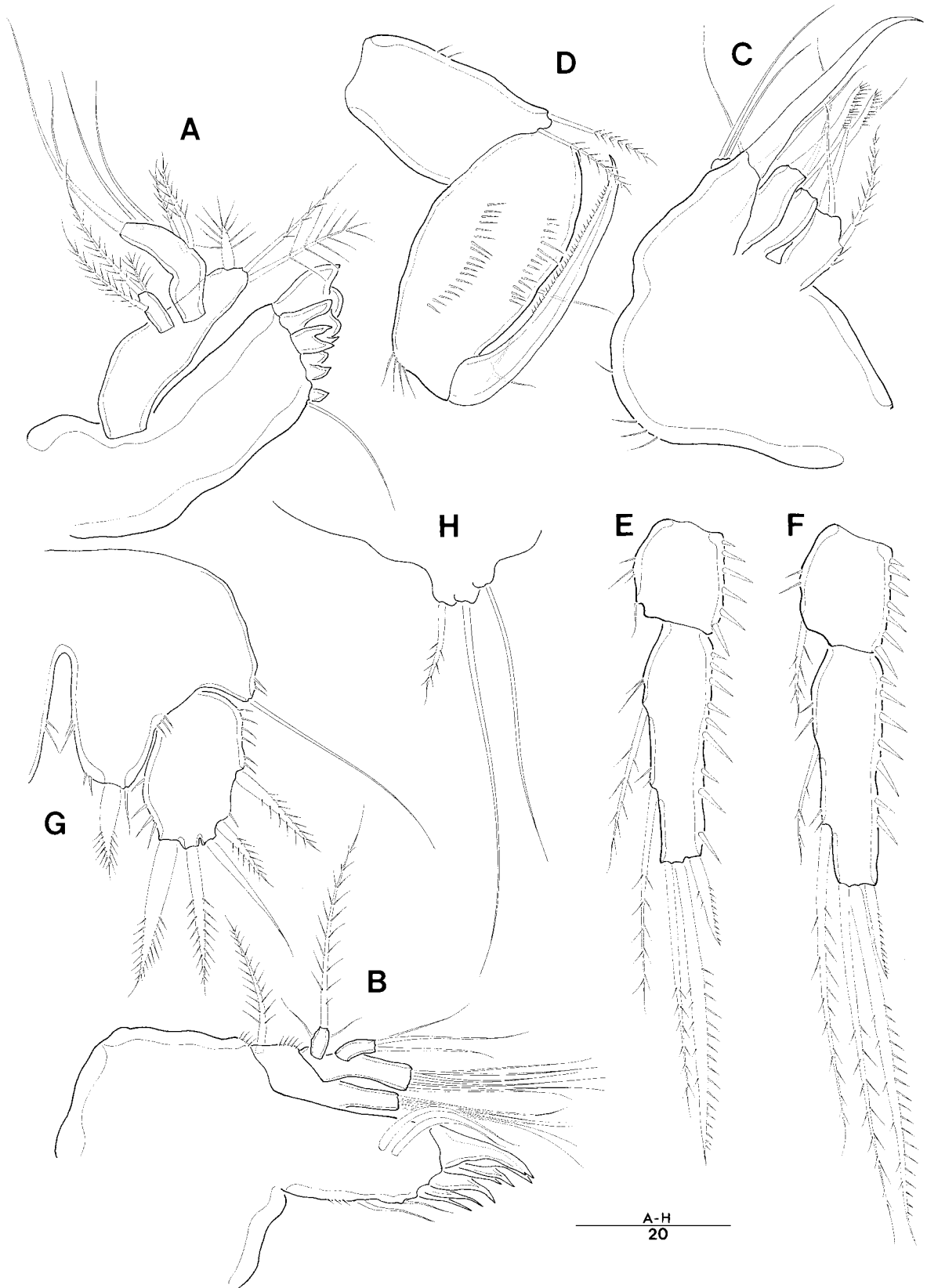
Fig. 3. *Parastenhelia pyriformis* n. sp. A–D, female: A, mandible; B, maxillula; C, maxilla; D, maxilliped. E-H, male: E, P2 endopod; F, P3 endopod; G, P5; H, P6. Scale: μm.

furnished with 7 caudal setae.

Antennule (Fig. 2B) 9-segmented; first segment with 1 seta; second one longest; fourth one with 1 long aesthetasc, its tip much exceeding the last segment; antepenultimate and penultimate segments short; last segment bearing 1 aesthestasc. Antenna (Fig. 2C) with allobasis about 2.38 times as long as maximum width. Exopod distinctly 2-segmented; proximal segment as long as distal one, with 1 small bare seta on midst and 1 pinnate seta near distal edge; distal segment bearing 2 inner setae and 3 apical setae. Endopod elongated, gradually widened posteriorly and bearing spinules along inner margin; disteromedial armature consisting of 3 spines; distal armature consisting of 1 pinnate seta, 1 slender seta, and 4 geniculate setae.

Mandible (Fig. 3A) with well developed gnathobase bearing several multicuspidate teeth along distal margin and 1 seta at dorsal corner. Basis elongated and tapering distally, with 2 plumose setae and 1 bulbous seta distally. Endopod 1-segmented, much smaller than exopod, bearing 3 plumose setae. Exopod elongated and tapering distally with 6 setae. Praecoxal arthrite of maxillula (Fig. 3B) narrowing distally, ending with about 9 setae/spines around distal margin and 2 setae on anterior surface. Coxal arthrite with cylindrical endite bearing 5 setae and epipodite represented by 1 plumose seta. Basis with 6 apical setae. Exopod a little shorter than endopod, bearing 1 plumose seta distally and 2 tiny setae subapically. Endopod with 3 bare setae. Syncoxa of maxilla (Fig. 3C) with 3 endites: proximal one with 3 setae; middle and distal one each forming sharp process and 1 seta. Allobasis bearing strong claw, with 2 setae. Endopod represented by a small protuberance with 2 long setae. Maxilliped (Fig. 3D) prehensile; syncoxa with 2 pinnate setae; basis with 2 spinule rows on palmar surface and 1 seta on medial margin. Endopod represented by 1 strong and curved claw; bearing 2 short setae as accessory armature.

Coxa of P1 (Fig. 2D) a little wider than long, with many spinules along outer margin, and spinular row on postero-
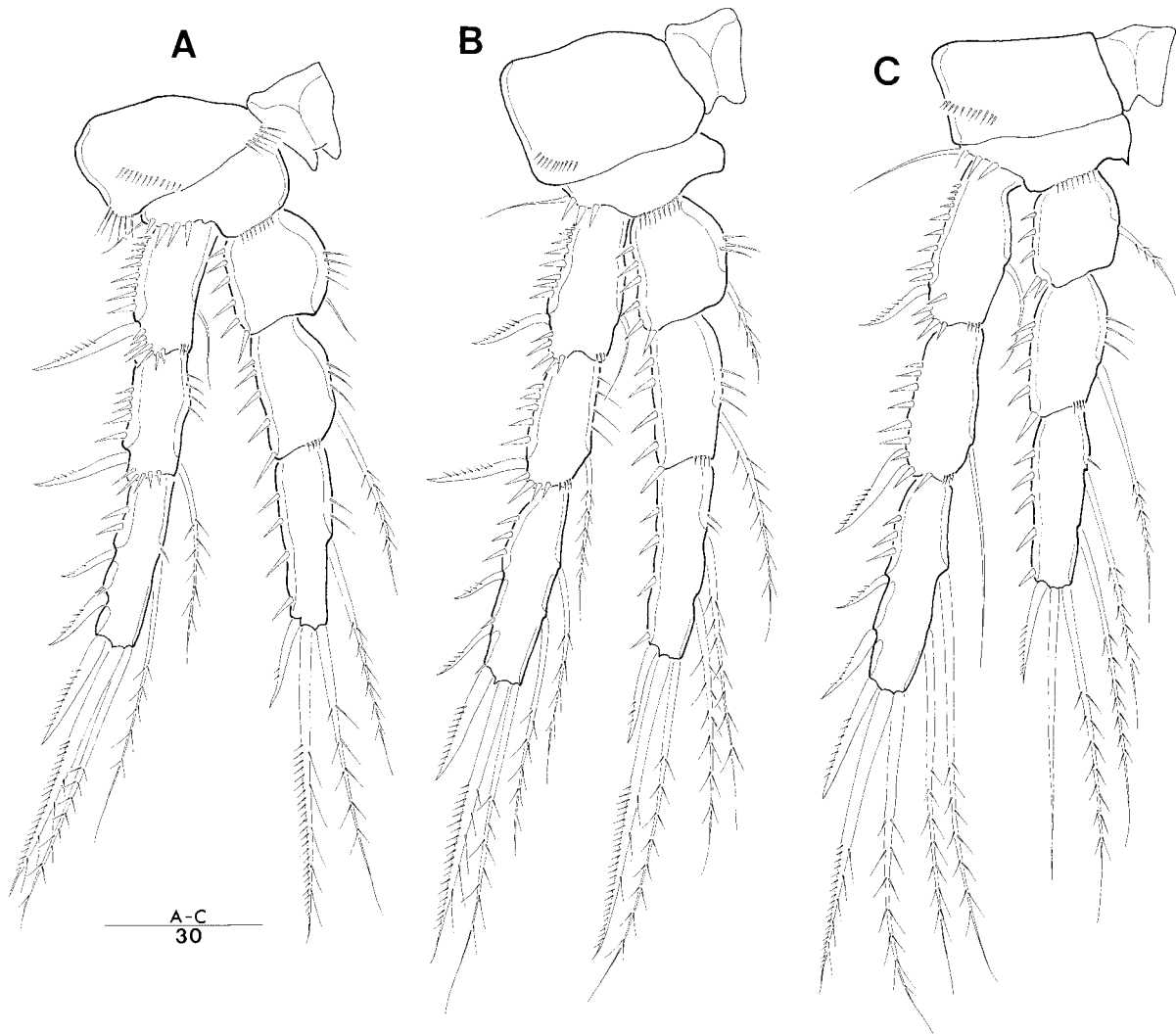

Fig. 4. *Parastenhelia pyriformis* n. sp. A–C, female P2–P4. Scale: μm.

Table 1. Morphological features of the species of *Parastenhelia* (Emended from Wells, Hicks and Coull, 1982).

			P. spinosa	*P. hornelli*	*P. anglica*	*P. gracilis*	*P. ornatissima*	*P. reducta*
Seta on A1 seg.1			present	present	?	present	?	?
A1 no. of seg.			7–9	9	9	9	8	8
A2 exp. no. of seg.			2	2–3	2–3	2	2	2
A2 exp no. of setae			2:4(5)	2:3(4), 2:1:3	2:4[b], 2:1(2):3	1:6	2:4	1:4
P1 exp 2 elongate?			yes	no	slightly	yes	no	no
P1 exp 2 inner seta			present	present	present	present	present	absent
P1 enp 1 inner seta origin, length			proximal 1/3, short	proximal 1/3, elongate	medial, short	medial, short	medial, ?	proximal 1/3, short
P1 enp 2 length: width			1:1	1.3:1	1.1:1	1.5:1	1.7:1	1.1:1
Rostrum length			midway A1 seg.2	enp A1 seg.2	2/3 length A1 seg.2	?	2/3 length A1 seg.2	2/3 length A1 seg.2
	P2	Exp	1, 1, 1-2-3	1, 1, 1-2-3	1, 1, 2-2-3[b]	1, 1, 1-2-3	0, 1, 2-2-3	0, 1, 2-2-3
		Enp	1, 1(2), 1-2-1[a]	0(1), 1, 1-2-1	1, 1, 2-2-1	1, 1, 1-2-1	1, 1, 1-2-1	1, 1, 1-2-1
setal formulae	P3	Exp	0(1), 1, 2(3)-2-3	0(1), 1, 3-2-3	1, 1, 3-2-3	1, 1, 2-2-3	0, 1, 2-2-3	0, 1, 2-2-3
		Enp	1, 1, 2-2-1	1, 1, 2-2-1	1, 1, 3-2-1	1, 1, 2(3)-2-1	1, 1, 2-2-1	1, 1, 1-2-1
	P4	Exp	0(1), 1, 2(3)-2-3	0(1), 1, 3-2-3	1, 1, 3-2-3	1, 1, 2-2-3	0, 1, 2-2-3	0, 1, 2-2-3
		Enp	1, 1, 1(2)-2-1	1, 1, 2-2-1	1, 1, 2-2-1	1, 1, 1-2-1	1, 1, 2-2-1	1, 1, 1-2-1
P5 Benp.: Exp., no. of setae			5:6-8	5:6(7)	5:6	4(5):6	5:6	5:6
P5 Benp.: Exp., no. of setae			2:6(7)	2:6(7)	2:4(5)[b,c]	?	unknown	2:5
P5 Exp. no. of segs.			1-3	1-3	1	?	unknown	1
Operculum			naked	naked	fine hairs	naked	spinulose	spinulose
P2 Enp., seg.(setae)			–	2(1,5)	2(1,6)	–	–	–
P3 Enp., seg.(setae)			3(1,1,2+proj.)	3(1,1,2+proj.)	-	3(1,1,2+proj.)	–	–
References			[a]Mielke, 1974 Apostolov & Marinov, 1988	Well & Rao, 1987	[c]Wells, 1961 [b]Kunz, 1963	Pallares, 1968	Por, 1964	Apostolov, 1975 Apostolov & Marinov, 1988
Distribution			Cosmopolitan	Cosmopolitan	Southwest Africa, Scilly, England	Argentina, Germany, Sweden, Campbell Is. England	Israel France	Mer Noire

			P. megarostrum	*P. costata*	*P. minuta*	*P. oligochaeta*	*P. pyriformis n. sp.*
Seta on A1 seg.1			present	present (Mielke, 1990) absent (Pallares, 1982)	?	present	present
A1 no. of seg.			9	9	9	9	9
A2 exp. no. of seg.			2	2	2	2	2
A2 exp no. of setae			2:4	2:5	2:5	2:4	2:5
P1 exp 2 elongate?			no	yes	yes	no	no
P1 exp 2 inner seta			present	present	present	present	present
P1 enp 1 inner seta origin, length			proximal 1/3, elongate	medial, short	proximal 1/5, short	proximal 1/3, elongate	proximal 1/4, elongate
P1 enp 2 length: width			2.2:1	1.2:1	1:1?	2.2:1	1.5:1
Rostrum length			end A1 seg.5	1/3 A1 seg.2	?	end A1 seg.5	end A1 seg.2
	P2	Exp	0(1), 1, 1-2-3	1, 0(1), 1-2-3	1, 1, 1-2-3	0, 1, 1-2-3	1, 1, 1-2-3
		Enp	0(1), 1, 1-2-1	1, 1, 1-2-1	1, 1, 0-2-1	0, 1, 0-2-1	1, 1, 1-2-1
setal formulae	P3	Exp	0(1), 1, 3-2-3	1, 0(1), 2(1)(3)[d]-2-3	1, 1, 2-2-3	0, 1, 3-2-3	1, 1, 2-2-3
		Enp	1, 1, 2-2-1	1, 1, 1(2)(3)[d]-2-1	1, 1, 1-2-1	0, 1, 0-2-1	1, 1, 2-2-1
	P4	Exp	0(1), 1, 3-2-3	1, 1, 1(2)(3)[d]-2-3	1, 1, 3-2-3	1, 1, 3-2-3	1, 1, 2-2-3
		Enp	1, 1, 2-2-1	1, 1, 1(2)-2-1	1, 1, 2-2-1	0, 1, 0-2-1	1, 1, 2-2-1
P5 Benp.: Exp., no. of setae			5:6	5:6	5:6	5:6	5:6
P5 Benp.: Exp., no. of setae			2:6	2:7	2:7	2:6	2:5
P5 Exp. no. of segs.			1	3	1	1	1
Operculum			fine hairs	spinulose	spinulose	naked	spinulose
P2 Enp., seg.(setae)			3(1,1,4)	2(1,5)	3(1,1,3)	2(0,4)	2(1, 5)
P3 Enp., seg.(setae)			3(1,1,4)	3(1,1,2+proj.)	3(1,1,2+proj.)	3(0,1,2+proj.)	2(1, 5)
References			Wells, Hick & Coull, 1982	[d]Pallares, 1982 Mileke, 1990	Pallares, 1982	Wells and Rao, 1987	present study
Distribution			New Zealand	Argentina	Argentina	India	Korea (Yellow Sea, Jeju Is.)

* proj. = projection; a, b, c, d = references cited

medial corner. Basis triangular with 1 pinnate outer spine and 1 inner spine. Exopod distinctly 3-segmented; exp 1 with 1 spine on outerodistal edge and many spinules along outer margin; exp 2 subequal or slightly longer than other two exopodal segments, with 1 tiny seta on inner distal corner; exp 3 with 2 slender outer spines, 1 geniculate seta and 1 bare seta apically. Endopod much longer than whole exopod; enp 1 strikingly elongate, furnished with 1 pinnate seta situated at proximal quarter of inner margin and 11–13 setules along outer margin; second one slightly longer than wide, bearing 1 bare seta and 2 claws with setules near outer and posterior edge, of which inner claw about 2 times longer than outer one. Both exopods and endopods of P2–P4 (Fig. 4A–C) 3-segmented; each basis with outer bare seta; setal formula as follows:

	Exopod	Endopod
P2	1, 1, 1-2-3	1, 1, 1-2-1
P3	1, 1, 2-2-3	1, 1, 2-2-1
P4	1, 1, 2-2-3	1, 1, 2-2-1

P5 (Fig. 2E) well-developed. Baseoendopod reaching a proximal quarter of exopod, bearing 4 pinnate setae and 1 slender seta; inner edge with 4 chitinous stripes. Exopod elongated and calabash- or pyriform-shaped, as indicated in the specific name, with 2 lateral, 2 subdistal and 2 distal setae.

Description of male: Body (Fig. 1E) length about 332–354 μm, excluding rostrum and caudal setae. General body shape similar to that of female. Antennule (Fig. 2F) 9-segmented; first segment with 1 seta; second and third one with 2 plumose setae respectively; a long aesthetasc on fourth segment slightly beyond the tip of antennule; last segment with 1 short aesthetasc. Both endopods of P2 and P3 two-segmented. P2 (Fig. 3E) enp 1 with 1 minute inner seta; enp 2 with 2 inner and 3 distal setae/spine. P3 endopod (Fig. 3F) nearly similar to that of P2, except that inner seta of enp 1 much longer than that of P2, while proximal inner seta of enp 2 shorter than that of P2. P4 nearly same as in female.

Baseoendopod of P5 (Fig. 3G) extending to middle of exopod, confluent on middle of its inner portion, with 1 bulbous seta and 1 dwarf seta. Exopod oval, bearing 5 setae/spines, of which innermost one large and bulbous, middle one bare. P6 (Fig. 3H) bearing 3 long setae, of which innermost one plumose and middle one extending to middle of third abdominal somite.

Etymology: The specific name *pyriformis* refers to the pyriform shape of female's leg 5 exopod.

Remarks: *Parastenhelia pyriformis* n. sp. is most related to *P. hornelli* Thompson and A. Scott, 1903 and *P. megarostrum* Wells, Hicks and Coull, 1982 in sharing character combination as follows: (1) length of each exopodal segment of P1 subequal, (2) the position and length of inner seta on P1 enp 1, and (3) the nine-segmented antennule (Thompson and A. Scott, 1903; Wells *et al.*, 1982).

However, the present new species differs from the two congeners above by having two inner setae on P3–P4 exp

3 in both sexes (Table 1). Moreover, the new species shows the different endopodal segmentation of P2–P3 in male: two endopodal segments on both P2 and P3 in *P. pyriformis*, while three segments on both P2 and P3 in *P. megarostrum*, and two segments on P2 and three segments on P3 in *P. hornelli*, respectively. Additionally, the present new species shows the different ornamentation of male P3 endopod, that is, five normal setae/spine on distal segment as in *P. megarostrum*, while *P. hornelli* has a stout projection on the outer distal corner and two setae. *Parastenhelia pyriformis* also shows the minor discrepancies of the relatively small inner seta on enp 1 and exp 1 of P2-P4 in both sexes in comparison with those of the two related species.

The congeners of *Parastenhelia* generally have the two-segmented P2 endopod and three-segmented P3 endopod in male. However, *P. minuta* Pallares has three-segmented P2 endopod (Pallares, 1968). *Parastenhelia costata* Mielke has an incomplete segmentation between the second and third segments of the male P2 endopod (Mielke, 1990, p. 163, Fig. 4C).

Parastenhelia oligochaeta Wells and Rao is also somewhat similar to the new species in the length and location of inner seta of P1 enp 1, but *P. oligochaeta* is easily distinguished from the new species by the operculum ornamentations, the setal formula of P2-P4, the segmentation and number of setae in the male P2-P3 endopods, and six setae on the male P5 exopod (against five in *P. pyriformis*) (Wells and Rao, 1987).

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