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**A new species of *Prohatschekia* Nunes-Ruivo, 1954 (Siphonostomatoida: Hatschekiidae) from the scorpaenid fish, *Scorpaena neglecta* Temminck & Schlegel, 1843 (Scorpaeniformes: Scorpaenidae), in Korean waters**

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**Abstract**

A new species of parasitic copepod, *Prohatschekia pseudocremouxi* **sp. nov.** is described based on adult females collected from the gills of the scorpaenid fish, *Scorpaena neglecta* Temminck & Schlegel, 1843 caught in Korean waters. The new species is most closely related to *P. cremouxi* Nunes-Ruivo, 1954, but differs from it by the following combination of characters in the adult female: the size of the trunk which is about 3.7 times as long as cephalothorax; the short and strongly curved antennary claw; and the distal segment of the maxilla is tipped with a simple seta. This discovery raises the number of nominal species in *Prohatschekia* Nunes-Ruivo, 1954 to eight and represents the first record of the genus in Korea.

**Key words:** Copepoda, *Prohatschekia pseudocremouxi* **sp. nov.**, taxonomy, fish parasite, Korea

**Introduction**

Gills of marine fishes are a common habitat for many ectoparasitic copepods (Boxshall & Halsey 2004), including all members of the genus *Prohatschekia* Nunes-Ruivo, 1954 (Siphonostomatoida: Hatschekiidae) (Yamaguti 1939; Nunes-Ruivo 1954; Shiino 1957; Avdeev & Kazachenko 1986; Kabata 1990; Hamza *et al.* 2007). The genus *Prohatschekia* was first established by Nunes-Ruivo (1954) to accommodate the type species *Hatschekia sebastisci* Yamaguti, 1939 in the family Hatschekiidae, based on the presence of three pairs of biramous legs. The genus currently contains seven valid species, all of which utilize marine actinopterygian fishes as hosts (Yamaguti 1939; Nunes-Ruivo 1954; Shiino 1957; Avdeev & Kazachenko 1986; Kabata 1990; Hamza *et al.* 2007). The host specificity and geographical distribution of the various species was summarized by Hamza *et al.* (2007), who also provided a key based on adult females. Four species have been reported from Japanese waters, *i.e.* *Prohatschekia antennalis* Avdeev & Kazachenko, 1986, *P. awatati* (Yamaguti, 1939), *P. laguncula* Shiino, 1957, and *P. sebastisci* (Yamaguti, 1939) (Yamaguti 1939; Shiino 1957; Avdeev & Kazachenko 1986). The other congeners, *P. cremouxi* Nunes-Ruivo, 1954, *P. mediterranea* Hamza, Boxshall & Kechemir-Issad, 2007 and *P. stocki* Kabata, 1990 were recorded from the coastal waters of Senegal (Nunes-Ruivo 1954), Algeria (Hamza *et al.* 2007), and Australia (Kabata 1990), respectively.

Recent examination of the scorpaenid fish, *Scorpaena neglecta* Temminck & Schlegel, 1843 (Actinopterygii: Scorpaeniformes: Scorpaenidae), collected off Jeju Island resulted in the discovery of a new species of *Prohatschekia* described below, representing the first record of the genus in Korean waters.

## Materials and methods

Specimens of the scorpaenid host *Scorpaena neglecta* (n = 5) were collected by bottom trawl north off Jeju Island, Korea (33°43'47"N, 126°48'16"E) on 18 June 2010. Parasitic copepods were carefully removed from the gills of the hosts, using fine forceps, and observed under a dissecting microscope. Copepod specimens were preserved in 70% ethanol and subsequently cleared in a drop of 80% lactic acid prior to examination using an Olympus BX51 differential phase contrast microscope. Examination was carried out using the wooden slide method (Humes & Gooding 1964). Drawings were made with the aid of a drawing tube mounted on a Nikon Eclipse 80i microscope. After microscopical examination, the dissected appendages were mounted on a slide in lactophenol mounting medium. Preparations were sealed with transparent nail varnish. The morphological terminology follows Kabata (1979) and fish names conform to FishBase (Froese & Pauly 2016). The body length of each examined specimen was measured from the frontal tip of the cephalothorax to the posterior margin of the caudal rami excluding the caudal setae, using a micrometer. Type specimens were deposited in the National Institute of Biological Resources (NIBR), Incheon, Korea.

## Results

### Order Siphonostomatoida Burmeister, 1835

#### Family Hatschekiidae Kabata, 1979

#### Genus *Prohatschekia* Nunes-Ruivo, 1954

#### *Prohatschekia pseudocremonxi* sp. nov.

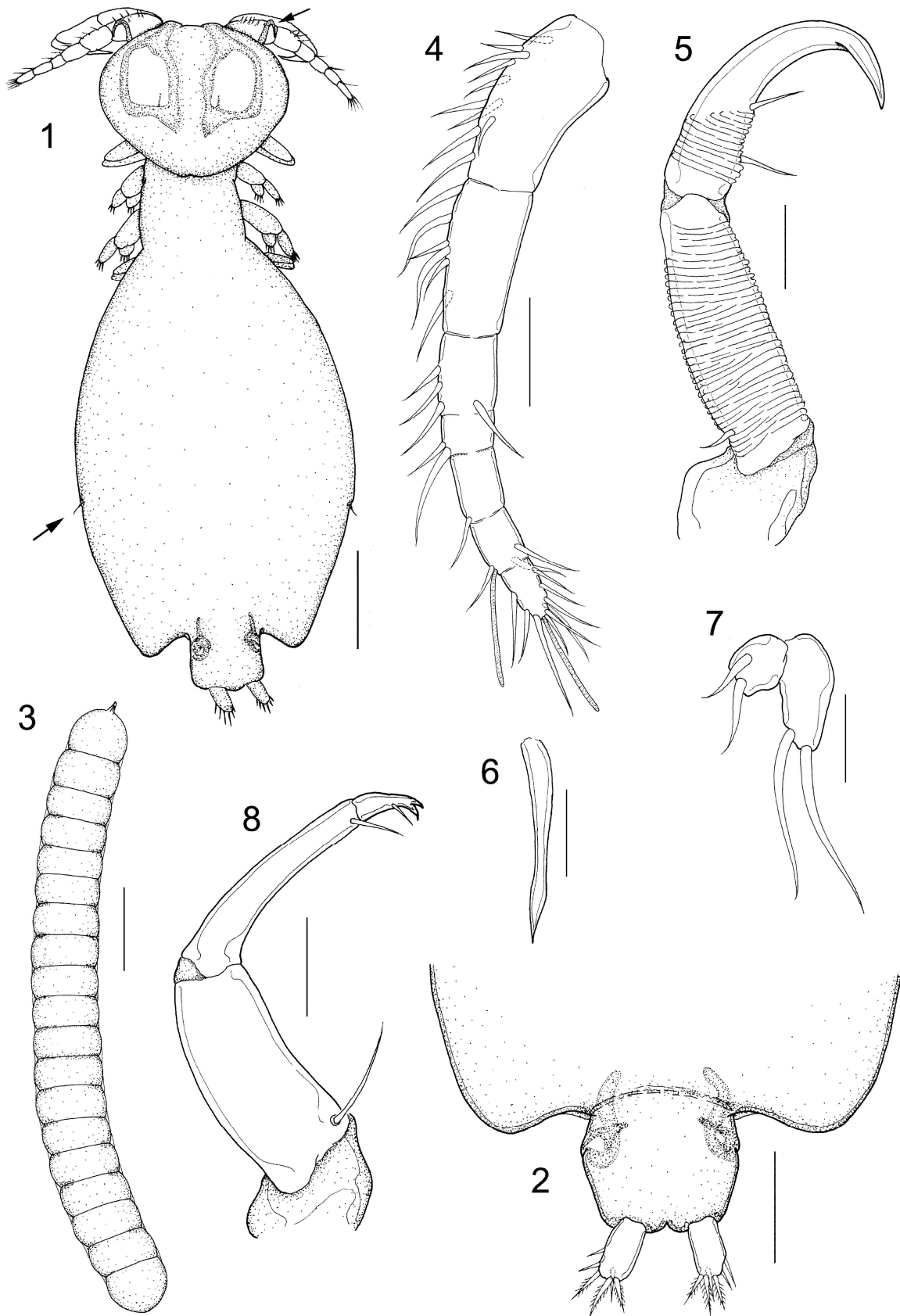
(Figs. 1–11)

**Type material.** Holotype ♀ (dissected and mounted on a glass slide; reg. no. NIBRIV0000266711) and paratype ♀ (preserved in ethanol; reg. no. NIBRIV0000266712), collected from the gills of five specimens of *Scorpaena neglecta* (Actinopterygii, Scorpaeniformes, Scorpaenidae), captured north off Jeju Island (33°43'47"N, 126°48'16"E), Korea, at 102 m depth.

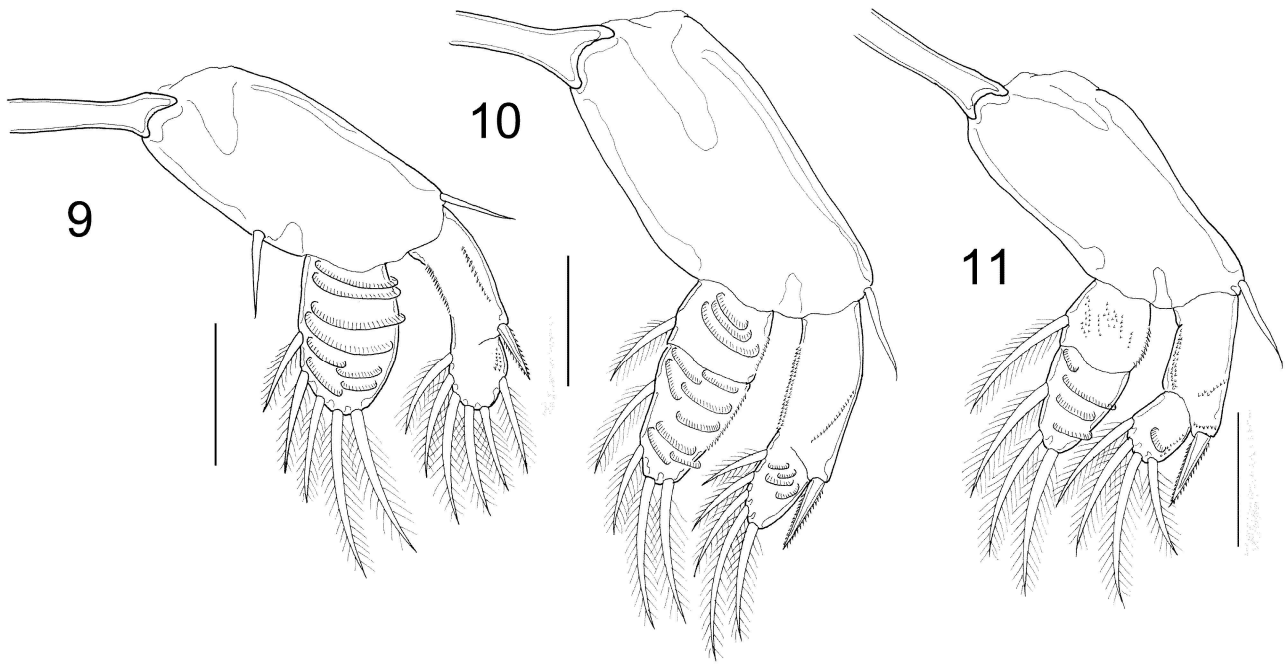
**Description of female.** Body comprising distinct cephalothorax, short neck region consisting of second and third pedigerous somites, and trunk (Fig. 1). Body (Fig. 1) 1.38 (paratype)–1.45 (holotype) mm long. Cephalothorax (Fig. 1) (253 × 346 µm), 1.36 times wider than long: dorsal cephalothoracic shield with frontal margin produced, slightly concave in mid-line, rounded laterally and well defined posteriorly; shield with conspicuous cuticular strengthening bars visible externally. Parabasal papillae on anterior margin of cephalothorax simple, anteriorly-directed, visible in dorsal view (arrowed in Fig. 1). Neck region formed by narrow second and third pedigerous somites, merging into broad, slightly dorsoventrally flattened trunk. Trunk (Fig. 1) ovoid (937 × 506 µm), about 1.85 times longer than wide, with swollen posterodistal margins. Abdomen (Fig. 2) wider than long (121 × 153 µm). Caudal rami (Fig. 1) longer than wide (59 × 34 µm), carrying one lateral and five terminal setae. Egg sac (Fig. 3) 1.64 mm long, containing 19 eggs.

Antennule (Fig. 4) 328 µm long, indistinctly 7-segmented; armature formula: 10, 6, 4, 2, 1, 3 + aesthetasc, 9 + aesthetasc. Antenna (Fig. 5) 3-segmented; basal segment unarmed; middle segment elongate, with single seta proximally and entire surface with fine, transverse cuticular ridges; distal segment strongly curved with transverse cuticular ridges in proximal half, subchela with two inner setae, one proximally and one near base of claw. Mandible (Fig. 6) forming stylet with pointed tip, marginal teeth lacking. Maxillule (Fig. 7) bilobate; anterolateral lobe with two small setae; posterior lobe longer, with two long distal setae. Maxilla (Fig. 8) 4-segmented, proximal segment unarmed; second segment largest, with long proximal seta on inner margin; third segment slender, with small distal seta on inner margin; distal segment bearing small inner seta at base of bifid claw. Maxilliped absent.

Legs 1–3 (Figs. 9–11) with coxa and basis largely fused, biramous. Exopods incompletely segmented. Setae on rami usually plumose.



**FIGURES 1–8.** *Prohatschekia pseudocremouxi* sp. nov. (female). 1, habitus, dorsal (right parabasal papilla and setae representing leg 4 arrowed); 2, posterior part of trunk and caudal rami, ventral; 3, egg sac, dorsal; 4, antennule, dorsal; 5, antenna, dorsal; 6, mandible, dorsal; 7, maxillule, dorsal; 8, maxilla, dorsal. Scale bars: 1, 3 = 200 µm; 2, 4–5 = 50 µm; 6–8 = 25 µm.



**FIGURES 9–11.** *Prohatschekia pseudocremouxi* sp. nov. (female). 9, leg 1, dorsal; 10, leg 2, dorsal; 11, leg 3, dorsal. Scale bars = 50  $\mu$ m.

Armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1-1	1-0; 6	5
Leg 2	1-0	1-0; 5	0-1; 4
Leg 3	1-0	1-0; 4	0-1; 3

Leg 1 (Fig. 9) exopod indistinctly 2-segmented; endopod unsegmented and ornamented with eight complete and incomplete transverse cuticular ridges on anterior and posterior surfaces. Leg 2 (Fig. 10) exopod indistinctly 2-segmented, proximal segment of exopod with tiny spinules on inner and outer margin, distal segment of exopod with four transverse cuticular ridges on anterior surface; endopod 2-segmented and ornamented with three transverse cuticular ridges, distal segment with eight incomplete transverse cuticular ridges on anterior and posterior surfaces. Leg 3 (Fig. 11) exopod distinctly 2-segmented and ornamented with tiny spinules on inner and outer margins of proximal segment, distal segment with four incomplete transverse cuticular ridges on anterior and posterior surfaces; endopod 2-segmented and ornamented with tiny spinules on inner and outer margin of proximal segment; four transverse cuticular ridges on anterior surface of distal segment. Leg 4 (arrowed in Fig. 1) represented by one seta located posteriorly at 2/3 distance along trunk. Leg 5 absent.

**Male.** Unknown

**Etymology.** The name of the new species refers to its morphological similarity with *Prohatschekia cremouxi* Nunes-Ruivo, 1954.

## Discussion

*Prohatschekia pseudocremouxi* sp. nov. is readily recognizable by four diagnostic features, *i.e.* the length of the antennules being shorter than the width of the cephalothorax; the parabasal papillae are simple; the trunk is oval in shape; and the distal segment of the maxilla is tipped with a naked, slender seta. The principal differences between *P. pseudocremouxi* sp. nov. and its congeners are summarized in Table 1.

TABLE 1. Comparison of morphological characteristics of adult female *Prohatschekia* spp.

Species	Distinct posterolateral lobes on trunk	Width neck region relative to cephalothorax	Antennule length relative to cephalothorax width	Length/width ratio of second segment of antenna	Form of parabasal papillae on cephalothorax
<i>P. antennalis</i> Avdeev & Kazachenko, 1986	absent	narrower	longer	2	unknown
<i>P. awatati</i> (Yamaguti, 1939)	absent	equal	shorter	unknown	unknown
<i>P. cremouxi</i> Nunes-Ruivo, 1954	absent	narrower	shorter	3.7	simple
<i>P. laguncula</i> Shiino, 1957	absent	narrower	shorter	2	simple
<i>P. mediterranea</i> Hamza, Boxshall & Kechemir-Issad, 2007	absent	narrower	longer	3	bifid
<i>P. pseudocremouxi</i> sp. nov.	absent	narrower	shorter	3	simple
<i>P. sebastisci</i> Yamaguti, (1939)	absent	narrower	shorter	2	unknown
<i>P. stocki</i> Kabata, 1990	present	narrower	shorter	3	bifid

Species	Short conical process on subchela of antenna	Simple seta on distal segment of maxilla	Size of leg 2 endopod	Armature formula of leg 3 exopod	Number of setae on the distal segment of leg 3 endopod
<i>P. antennalis</i> Avdeev & Kazachenko, 1986	absent	absent	not massive	I-0; 4	2 apical
<i>P. awatati</i> (Yamaguti, 1939)	absent	absent	not massive	I-0; 4	2 apical
<i>P. cremouxi</i> Nunes-Ruivo, 1954	absent	absent	not massive	I-0; 4	2 apical and 1 inner
<i>P. laguncula</i> Shiino, 1957	present	absent	massive	I-0; 3	1 apical
<i>P. mediterranea</i> Hamza, Boxshall & Kechemir-Issad, 2007	absent	absent	not massive	I-0; 4	2 apical and 1 inner
<i>P. pseudocremouxi</i> sp. nov.	absent	present	not massive	I-0; 4	2 apical and 1 inner
<i>P. sebastisci</i> Yamaguti, (1939)	absent	absent	not massive	I-0; 3	2 apical and 1 inner
<i>P. stocki</i> Kabata, 1990	absent	present	not massive	I-0; 4	3 apical

Continued.

The new species is most closely related to *P. cremouxi* and *P. mediterranea* based on the morphology of the cephalothorax, the trunk, and the armature formula of leg 2 exopod. All three species utilize hosts belonging to the same scorpaenid genus, *Scorpaena* Linnaeus, 1758 (Hamza *et al.* 2007). The new species differs from *P. cremouxi* (host: *S. normani*) in the size of the trunk which is about 3.7 times as long as the cephalothorax (vs. less than 3.0 times in *P. cremouxi*), the short and strongly curved antennary claw (vs. long and slightly curved in *P. cremouxi*), and the presence of a small seta on the distal segment of the maxilla (vs. absent in *P. cremouxi*) (Nunes-Ruivo 1954). *Prohatschekia pseudocremouxi* **sp. nov.** differs from *P. mediterranea* (host: *S. elongata*) in the trunk being more than 3.0 times as long as the cephalothorax (vs. less than 3.0 times in *P. mediterranea*), the length of the antennule being shorter than the width of the cephalothorax (vs. longer in *P. mediterranea*), the parabasal papilla being simple in shape (vs. bifid in *P. mediterranea*), and by the presence of a small seta on the distal segment of the maxilla (vs. absent in *P. mediterranea*) (Hamza *et al.* 2007). *Prohatschekia pseudocremouxi* **sp. nov.** can be readily differentiated from *P. antennalis* by the antennules being shorter than the width of the cephalothorax (vs. longer in *P. antennalis*), the slender shape of the second antennary segment (vs. not slender in *P. antennalis*), and the presence of five setae on the distal endopodal segment of leg 1 (vs. two setae in *P. antennalis*) (Avdeev & Kazachenko 1986). The new species also differs from *P. awatati* by the shape of the neck, being narrower than the cephalothorax (vs. equally wide in *P. awatati*), the presence of a simple seta on the distal segment of the maxilla (vs. absent in *P. awatati*), and the armature formula of leg 1 exopod (I-0; 6 vs. I-0; 4 in *P. awatati*), leg 2 exopod (I-0; 5 vs. I-0; 4 in *P. awatati*) and the distal endopodal segment of leg 3 (with four setae vs. three in *P. awatati*) (Yamaguti 1939).

The new species differs from *P. laguncula* in the oval shape of the post-cephalic trunk (vs. bottle-shaped in *P. laguncula*), the distal segment of leg 1 exopod and endopod bearing six and five setae, respectively (vs. three and two, respectively, in *P. laguncula*), the absence of an acute process on the distal endopodal segment of leg 2 (vs. present in *P. laguncula*), leg 2 endopod being only slightly larger than the exopod and with parallel sides (vs. massive, nearly twice as long as exopod and forming tapering conical ramus in *P. laguncula*), and the distal endopodal segment of legs 2–3 bearing four and three setae, respectively (vs. single spine in *P. laguncula*) (Shiino 1957).

*Prohatschekia pseudocremouxi* **sp. nov.** can be distinguished from *P. Sebastisci* by the presence of a naked seta on the distal segment of the maxilla (vs. absent in *P. Sebastisci*), the distal segment of leg 2 endopod bearing four setae (vs. three in *P. Sebastisci*), the distal segment of the exopod of leg 3 bearing four setae (vs. three in *P. Sebastisci*), and the distal segment of leg 3 endopod bearing three setae (vs. two in *P. Sebastisci*) (Yamaguti 1939). Finally, the last congener, *P. stocki*, can easily be distinguished from the new species by having a somewhat heart-shaped cephalothorax and the presence of posterolateral lobes on the post-cephalic trunk (Kabata 1990).

*Prohatschekia* species possess a pair of very distinct, anteriorly directed, parabasal papillae which are visible in dorsal view (Nunes-Ruivo 1954; Shiino 1957; Kabata 1990; Hamza *et al.* 2007; present study). Hamza *et al.* (2007) used this character in their species identification key, however, it is likely that the presence of parabasal papillae has been overlooked in some earlier descriptions. We infer, therefore, that all species possess these papillae. Additional characters (not mentioned by Hamza *et al.* 2007), that are potentially useful for species identification are listed in Table 1, *i.e.* trunk with or without distinct posterolateral lobes, width ratio between neck and cephalothorax, ratio of antennule length/cephalothorax width, length/width ratio of second segment of antenna, shape of parabasal papillae, antennary subchela with or without short conical process, shape/size of leg 2 endopod, armature formula of leg 3 exopod, and number of setae on the distal exopodal segment of leg 3.

Members of *Prohatschekia* appear to show a preference for scorpaeniform hosts (Table 2). Species of the genus *Scorpaena* serve as hosts for *P. cremouxi*, *P. pseudocremouxi* **sp. nov.** and *P. mediterranea*. This host genus is one of the most speciose in the family Scorpaenidae, currently comprising 61 species (Froese & Pauly 2016), and is widely distributed in tropical and most temperate waters around the world. It is conceivable that future studies of other *Scorpaena* members will reveal additional new species of *Prohatschekia*. Five species of *Prohatschekia* have so far been reported from East Asian waters (Korea and Japan), *i.e.* *P. antennalis*, *P. awatati*, *P. laguncula*, *P. pseudocremouxi* **sp. nov.**, and *P. Sebastisci* (Yamaguti 1939; Shiino 1957; present study).

**TABLE 2.** Distribution and host records of *Prohatschekia* species (Siphonostomatoidea: Hatschekidae).

Species	Host	Host order: family	Locality	Reference
<i>P. antennalis</i> Avdeev & Kazachenko, 1986	<i>Lophiomus setigerus</i> (Vahl, 1797)	Lophiiformes: Lophiidae	off Japan	Avdeev & Kazachenko (1986)
<i>P. awatati</i> (Yamaguti, 1939)	<i>Neobythites macrops</i> Günther, 1887	Ophidiiformes: Ophidiidae	Maisaka, Japan	Yamaguti (1939)
<i>P. cremouxi</i> Nunes-Ruivo, 1954	<i>Scorpaena normani</i> Cadenat, 1943	Scorpaeniformes: Scorpaenidae	coast of Senegal	Nunes-Ruivo (1954)
<i>P. laguncula</i> Shiino, 1957	<i>Doederleinia berycoides</i> (Hilgendorf, 1879)	Perciformes: Acropomatidae	off Japan	Shiino (1957)
<i>P. mediterranea</i> Hamza, Boxshall & Kechemir-Issad, 2007	<i>Scorpaena elongata</i> Cadenat, 1943	Scorpaeniformes: Scorpaenidae	coast of Algeria	Hamza <i>et al.</i> (2007)
<i>P. pseudocremouxi</i> <b>sp. nov.</b>	<i>Scorpaena neglecta</i> Temminck & Schlegel, 1843	Scorpaeniformes: Scorpaenidae	coast of Korea	Present study
<i>P. sebastisci</i> (Yamaguti, 1939)	<i>Sebastiscus marmoratus</i> (Cuvier in Cuvier & Valenciennes, 1829)	Scorpaeniformes: Sebastidae	off Obama, Japan	Yamaguti (1939)
<i>P. stocki</i> Kabata, 1990	<i>Hoplichthys haswelli</i> McCulloch, 1907 [as <i>Rhinhoplichthys haswelli</i> (McCulloch, 1907)]	Scorpaeniformes: Hoplichthyidae	off New South Wales, Australia	Kabata (1990)



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