

Distributional range extension of a scorpionfish, *Scorpaenodes quadrispinosus*, in the Indo–Pacific, and comments on synonymy of *S. parvipinnis* (Scorpaeniformes: Scorpaenidae)

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Abstract *Scorpaenodes quadrispinosus*, previously known only from type specimens from Fiji and the Marshall Islands, is reported here on the basis of 27 specimens from the eastern Indian Ocean (Christmas Island, Australia) and the Pacific Ocean (East Asia, Micronesia, Melanesia, Timor Sea, and Polynesia). Validity of diagnostic characters of *S. quadrispinosus* given in the original description is assessed and newly recognized diagnoses are provided. *Paronescodes asperrimus* is regarded here as a junior synonym of *S. parvipinnis*.

Key words: Scorpaenidae, *Scorpaenodes quadrispinosus*, *S. parvipinnis*, *Paronescodes asperrimus*.

Introduction

The shallow water scorpionfish, *Scorpaenodes quadrispinosus*, was originally described by Greenfield and Matsuura (2002) on the basis of five specimens (47.5–76.2 mm standard length) from Fiji (type locality) and the Marshall Islands. Subsequently, Randall (2005) based his account for this species on the original description without reference to additional specimens. No specimens of *S. quadrispinosus* have been reported since its original description.

Ongoing taxonomic studies of *Scorpaenodes* by the first author and colleagues (e.g., Motomura et al., 2009) revealed that *S. quadrispinosus*, previously known only from Fiji and the Marshall Islands, is in fact widely distributed in the eastern Indian Ocean and Pacific Ocean. The species is redescribed here on the basis of 27 new specimens, collected from Japan, Taiwan, Pohnpei, Marshall Islands, Solomon Islands, Papua New Guinea, Australia, and French Polynesia. The validity of diagnostic characters of *S. quadrispinosus* given by Greenfield and Matsuura (2002)

is also assessed and newly recognized diagnostic characters are provided.

Scorpaenodes parvipinnis, originally described as *Scorpaena parvipinnis* by Garrett (1864) on the basis of a single specimen (deposited at CAS, but destroyed by fire in 1906; Eschmeyer, 1998) from the Hawaiian Islands, is closely related to *S. quadrispinosus* (see Greenfield and Matsuura, 2002; Randall, 2005). This similarity is supported by the fact that most of our 27 specimens of *S. quadrispinosus*, except for newly collected specimens from Yaku-shima Island, Japan, were registered as *S. parvipinnis* in museum collections.

Paronescodes asperrimus was originally described as a new genus and species by Smith (1958) on the basis of 19 specimens reported as *S. parvipinnis* by Smith (1957) from the Seychelles, Mozambique, and Tanzania. The only publication dealing with *P. asperrimus* since its original description is that of Eschmeyer (1986) in which it was regarded as a junior synonym of *S. parvipinnis* without giving reasons or examined specimens.

In their description of *Scorpaenodes quadrispinosus*, Greenfield and Matsuura (2002) did not discuss Eschmeyer's decision that *P. asperrimus* was a junior synonym of *S. parvipinnis*. To clarify this situation, we examined the 19 type specimens of *P. asperrimus* in this study and confirmed the validity of *S. quadrispinosus* and taxonomic status of *P. asperrimus* as a synonym.

Materials and methods

Counts and measurements follow Motomura et al. (2005a–c) and Greenfield and Matsuura (2002) respectively. The last two soft rays of the dorsal and anal fins are counted as single rays, each pair being associated with a single pterygiophore. Standard length is expressed as SL. Terminology of head spines follow Randall and Eschmeyer (2002: fig. 1) and Motomura (2004: fig. 1), with the following additions: the spine occurring at the base of the uppermost preopercular spine is referred to as the supplemental preopercular spine (Eschmeyer, 1965); the spine occurring at the lateral surface of the lacrimal bone is referred to as the lateral lacrimal spine (Motomura and Senou, 2008: fig. 2); the coronal and pretympanic (as an extra spine) spines are as figured in Chen (1981: fig. 1) and Motomura et al. (2004: fig. 14b) respectively; and the longitudinal ridge on the anterior portion of the lacrimal is referred to as the lacrimal ridge. The formula for configuration of the supraneural bones, anterior neural spines and anterior dorsal-fin pterygiophores follows Ahlstrom et al. (1976). The presence of a swimbladder was confirmed by dissection of the abdomen on the right side of KAUM–I. 11475. The osteological characters were confirmed from X-ray images taken of two specimens (YCM–P 34209, 34291). 'Description' is based only on specimens examined in this study, and 'Diagnosis' is based on this study and Greenfield and Matsuura (2002).

Specimens examined in this study have been deposited in the California Academy of Sciences, San Francisco (CAS); Fish Division, Field Museum of Natural History, Chicago (FMNH); Kagoshima University Museum, Kagoshima (KAUM); Kanagawa Prefectural Museum of Natural History, Odawara (KPM); South Afri-

can Institute for Aquatic Biodiversity, National Research Foundation, Grahamstown (SAIAB); Museum Support Center, Smithsonian Institute, National Museum of Natural History, Suitland (USNM); Fish Department, Western Australian Museum of Natural Science, Welshpool (WAM); and Yokosuka City Museum, Yokosuka (YCM).

Scorpaenodes quadrispinosus

Greenfield and Matsuura, 2002

[New English name: Furry Coral Scorpionfish]

[New Japanese name: Atsuhimesangokasago]

(Figs. 1–2; Table 1)

Scorpaenodes quadrispinosus Greenfield and Matsuura, 2002: 973, figs. 1, 2A (type locality: off Suva, Viti Levu Island, Fiji); Randall, 2005: 121 (color figure of Fijian specimen).

Material examined. 27 specimens, 27.3–99.8 mm SL. **JAPAN:** KAUM–I. 11469, 74.7 mm SL, Isso, Yaku-shima Island, Kagoshima, Japan, 30°27'23"N, 130°29'59"E, 0.1–5 m, KAUM fish team, 13 Aug. 2008; KAUM–I. 11475, 79.6 mm SL, same data as KAUM–I. 11469; YCM–P 34209, 93.7 mm SL, Setouchi, Amami-oshima Island, Ryukyu Islands, Japan, 28 Aug. 1994; YCM–P 34291, 99.8 mm SL, Hamazaki, Setouchi, Kakeroma Island, Amami-oshima Island, Ryukyu Islands, Japan, 29 Aug. 1994. **TAIWAN:** USNM 361037, 2 specimens, 62.3–64.9 mm SL, Ch'uan-fan-shih, 21°56'08"N, 120°49'20"E, 5–6 m, V. Springer et al., 24 Apr. 1968; USNM 361042, 2 specimens, 58.5–81.2 mm SL, south of Chin-chiao-wan, 21°55'15"N, 120°49'45"E, 0–6 m, V. Springer and J. Choat, 8 May 1968. **POHNPEI:** USNM 224495, 3 specimens, 33.7–81.7 mm SL, Nanmatol, Ponape, 5°51'N, 158°20'E, 0–2 m, V. Springer et al., 3 Sept. 1980. **MARSHALL ISLANDS:** USNM 140488, 74.2 mm SL, Bikini Atoll, between Bikini and Amen Islands, V. Brock et al., 21 July 1947; USNM 140489, 2 specimens, 55.8–65.3 mm SL, Bikini Atoll, Eman Island, L. Schultz et al., 19 July 1947; USNM 140490, 64.0 mm SL, Bikini Atoll, Eman Island, L. Schultz et al., 17 July 1947; USNM 360997, 3 specimens, 72.1–74.4 mm SL, Bikar, Taka or Kwajalein Atolls, A. Amerson, 15 Oct.–11 Nov. 1964. **SOL-**

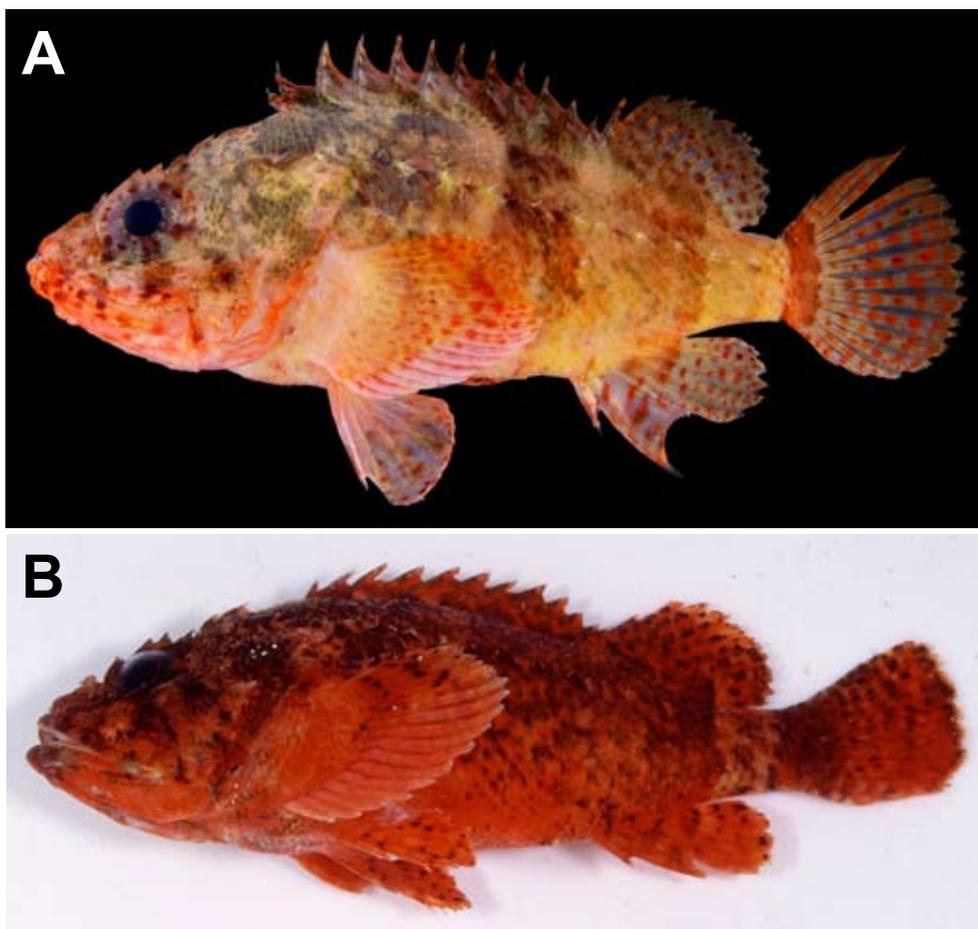
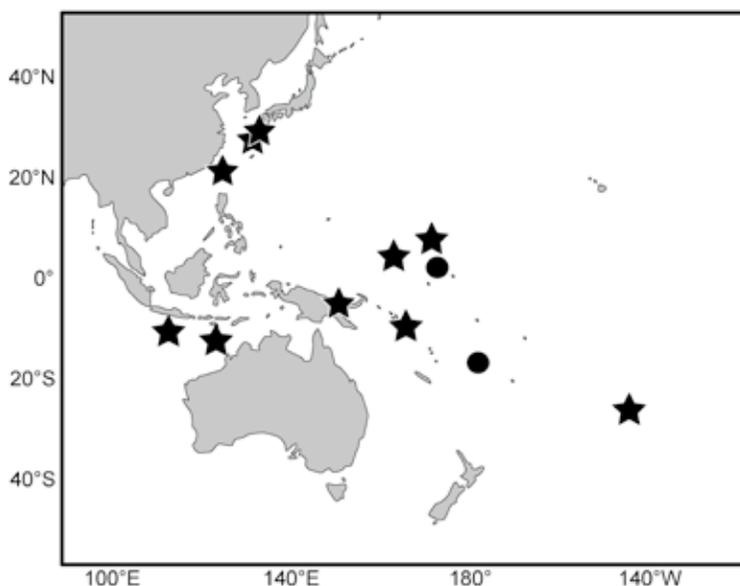


Fig. 1. Fresh specimens of *Scorpaenodes quadrispinosus* from Japan. **A**, KAUM-I. 11475, 79.6 mm SL, Yaku-shima Island, Kagoshima Prefecture; **B**, YCM-P 34209, 93.7 mm SL, Amami-oshima Island, Kagoshima Prefecture, photo by M. Hayashi.

OMON ISLANDS: USNM 391125, 76.3 mm SL, north end of Taumako Island, Duff Islands, Santa Cruz Islands, 9°51'00"S, 167°09'30"E, 0–8 m, J. Williams et al., 21 Sept. 1998. **PAPUA NEW GUINEA:** WAM P. 30624-028, 27.3 mm SL, Madang, 5°09'00"S, 145°50'00"E, 9–12 m, G. Allen et al., 28 Jan. 1993. **AUSTRALIA:** WAM P. 29061-007, 31.5 mm SL, Cartier Island, Northern Territory, 12°31'S, 123°33'E, 10–12 m, G. Allen, 20 Sept. 1986; WAM P. 29331-005, 2 specimens, 46.6–48.6 mm SL, Christmas Island, 10°27'S, 105°42'E, 0.1–3 m, G. Allen, 25 Feb. 1987. **FRENCH POLYNESIA:** USNM 379391, 4 specimens, 84.5–94.1 mm SL, east side of Isle Karapoo rahi, Rapa, 27°38'53"S, 144°19'49"W, 0–4 m, J. Williams et al., 1 Nov. 2002.

Diagnosis. A species of *Scorpaenodes* with the following combination of characters: 16–18 (usually 17) pectoral-fin rays; 39–47 (mode 45) scale rows in longitudinal series; 4 or 5 (5) gill rakers on upper limb, 7–9 (7) on lower limb, 11–13 (12) in total; anterior and posterior lacrimal spines simple, poorly developed; dorsal lacrimal bone with 1 (rarely 2) small, dorsally directed spine; no spine at lacrimal ridge; lateral lacrimal spine simple, well developed; 3 suborbital spines, first spine extending dorsally above ventral margin of orbit; an additional spine below second suborbital spine; interorbital and coronal spines usually present; no distinct black blotches on opercle or subopercle.

Fig. 2. Distributional records of *Scorpaenodes quadrispinosus*. ★ based on specimens examined in this study; ● based on Greenfield and Matsuura (2002).



villiform teeth, lacking canine teeth. Villiform teeth forming V-shaped patch on vomer. Palatine teeth absent. Underside of lower jaw without ridges. Gill rakers relatively short and spinous; slit present behind fourth gill arch. Swimbladder present, well developed.

Dorsal profile of snout steep, forming angle of about 40 degrees to horizontal axis of head and body. Ascending process of premaxilla slightly intruding into interorbital space, its posterior margin extending well beyond level of posterior margin of posterior nostril in dorsal view. Median interorbital ridge absent. Interorbital ridges weakly developed (sometimes absent), separated by relatively shallow channel; interorbital spines usually present at level of midline of eye. Interorbital space shallow, with about one-tenth of orbit extending above dorsal profile of head. Preopercular spine simple, slightly flattened anteriorly and posteriorly; anterior surface of spine without distinct ridges. Supraocular, postocular, and tympanic spines simple. Coronal spines usually present (sometimes absent on one side of head) between origins of tympanic spines. Pretympanic spines absent. Occipital region flat, with no distinct ridges in front or rear of occiput. Parietal and nuchal spines joined at base. Sphenotic with several small spines. Postorbital usually with tiny spines. Pterotic spine simple, directed posteroven-

trally. Upper and lower posttemporal spines present; length of upper spine about one-third of that of lower spine. Supracleithral and cleithral spines simple.

Lateral lacrimal spine simple, well developed. Anterior and posterior lacrimal spines simple, triangular or rounded, not strongly developed. Dorsal lacrimal with 0–2 sharp spines directed dorsally. Suborbital ridge with 3 well developed spines in a row; first spine canted dorsally, its tip below posterior margin of pupil; second and third spines behind orbit. An additional spine below second suborbital spine. No space between ventral margin of eye and suborbital ridge. Suborbital pit small. Preopercle with 3 spines; uppermost spine largest with supplemental preopercular spine on its base; space between second and third spines broader than that between first and second spines. Preopercle, between uppermost preopercular spine and upper end of preopercle, without serrae or spines, and its margin completely covered with scales. Upper opercular spine simple without median ridge. Lower opercular spine simple with low median ridge. Space between upper and lower opercular spines without ridges. Posterior tips of upper and lower opercular spines reaching and extending slightly beyond opercular margin respectively.

Origin of first dorsal-fin spine above supra-

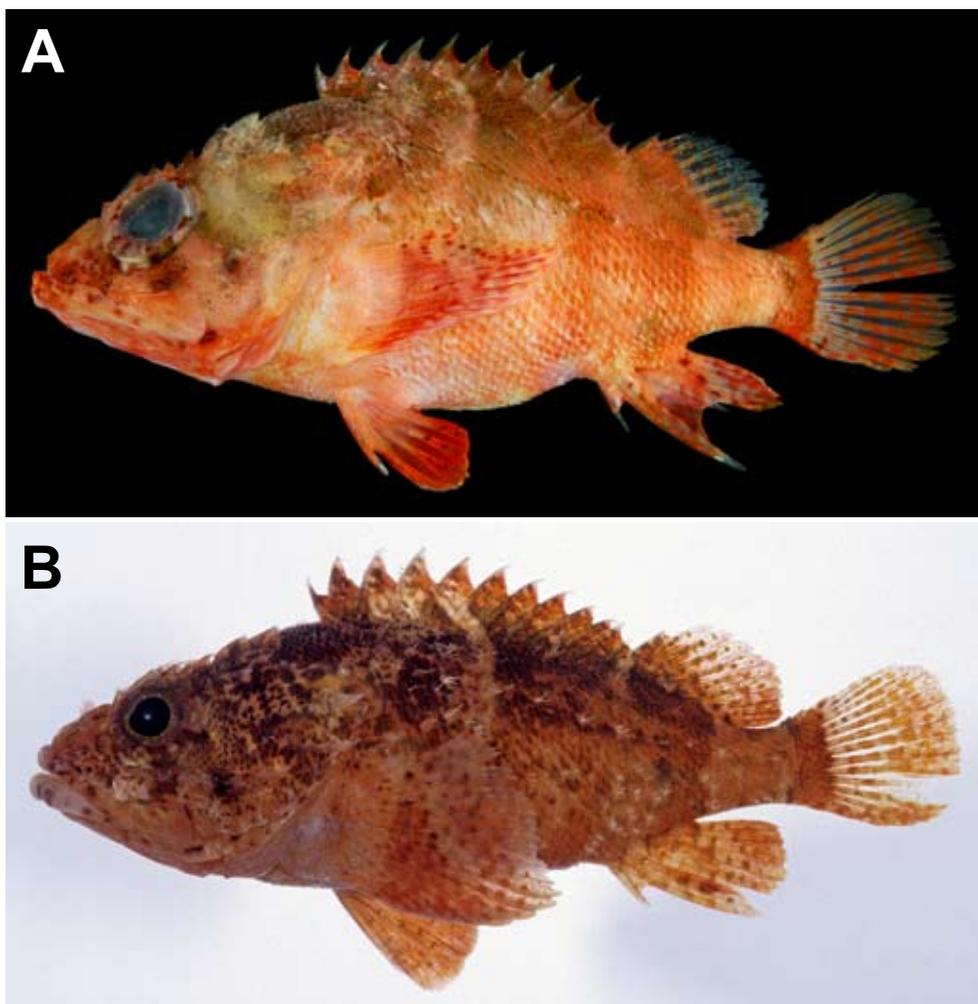


Fig. 3. Fresh specimens of *Scorpaenodes parvipinnis* from Japan. **A**, KAUM-I. 6601, 72.6 mm SL, Okinawa-jima Island, Ryukyu Islands; **B**, KPM-NI 4855, 81.2 mm SL, Ie-jima Island, Ryukyu Islands, photo by H. Senou.

cleithral spine. Posterior margin of opercular membrane reaching a vertical through base of third dorsal-fin spine. Posterior tip of pectoral fin not reaching a vertical through origin of anal fin. Origin of pelvic-fin spine slightly posterior to a vertical through origin of pectoral fin. Posterior tip of depressed pelvic fin not reaching origin of anal fin. Origin of first anal-fin spine anterior to a vertical through last dorsal-fin spine.

Color when fresh. Based on color photographs of KAUM and YCM specimens (Fig. 1). Body strongly variegated, mainly from pale pink to dense red, with 4 indistinct, vertical, dark bands on lateral surface of body; first band above oper-

cle, second between middle of spinous portion of dorsal fin and pectoral fin, third below ninth to twelfth spines of dorsal fin, and fourth below soft-rayed portion of dorsal fin. All fins, except for spinous portion of dorsal fin, pinkish to reddish, with small reddish to blackish spots scattered on rays. Caudal-fin base with a vertical, reddish band, its width less than pupil diameter. No distinct black blotches on opercle or subopercle.

Color of preserved specimens. Head and trunk yellowish-white, mottled with black blotches; few black spots on ventral surface of body. Black spots scattered on all fins, except for lower portion of pectoral fin.

Distribution and habitats. Currently known from the eastern Indian Ocean (Christmas Island, Australia) and the Pacific Ocean (East Asia, Micronesia, Melanesia, Timor Sea, and Polynesia) (Fig. 2). The northernmost and easternmost recorded ranges of the species are considered to be Yaku-shima Island, Japan, and Rapa, French Polynesia (Fig. 2). The northernmost and easternmost recorded ranges of the species are considered to be Yaku-shima Island, Japan, and Rapa, French Polynesia (Fig. 2). Yoshigou (2004: fig. 2) reported a single specimen of *Scorpaenodes* sp. from Minamidaito-jima Island (ca. 400 km east of Okinawa Island), Japan, and gave an illustration of the head of the specimen. His specimen is identified here as *S. quadrispinosus*. Collection data for the species indicated capture depths less than 12 m. The species occurs on rocky reefs with strong surge. Most specimens of *S. quadrispinosus* were collected with *S. parvipinnis*.

Remarks. Characters of the present 27 specimens agreed with those of type specimens of *S. quadrispinosus* given by Greenfield and Matsuura (2002). As Greenfield and Matsuura (2002) mentioned, *S. quadrispinosus* can be easily distinguished from all other congeners by the first suborbital spine (= Greenfield and Matsuura's second suborbital spine, their first spine is equivalent to the lateral lacrimal spine in this study; see Motomura and Senou, 2008: fig. 2) extending dorsally above the ventral margin of the orbit (vs. spine tip in line with suborbital ridge and not projecting dorsally in the latter). Although some spines in *S. parvipinnis* (Fig. 3) point dorsally, they do not reach the ventral margin of the orbit (Greenfield and Matsuura, 2002: fig. 2; this study). Greenfield and Matsuura (2002) considered that the dorsally directed suborbital spine could possibly be a synapomorphy uniting *S. quadrispinosus* and *S. parvipinnis*. Detailed comparisons of *S. quadrispinosus* with other congeners were given in Greenfield and Matsuura (2002).

Greenfield and Matsuura (2002) distinguished *S. quadrispinosus* from *S. parvipinnis* by lacking the dorsally directed spine on the lacrimal ridge (vs. having the spine in the latter). However, examination of specimens of *S. parvipinnis* in this study showed that they often lacked the spine from the lacrimal ridge, indicating that the character is not always reliable for species' discrimination. In addition, Greenfield and Matsuura

(2002) mentioned four color pattern differences between the two species; viz., *S. quadrispinosus* is characterized by having four prominent dark spots along the base of the spinous portion of the dorsal fin, a dark spot running between the bases of the parietal and tympanic spines, three rows of dark spots on the caudal fin, and the general background color of cream with some pink overtones. These color characters, however, vary considerably between individuals and cannot be used as diagnoses. The density and pattern of coloration of *S. quadrispinosus* may be influenced by environmental conditions for protective mimicry or camouflage.

Examination of specimens of *S. quadrispinosus* and *S. parvipinnis* during this study revealed that *S. quadrispinosus* also differs from the latter in having lower counts of pectoral-fin rays (usually 17 vs. 18 in *S. parvipinnis*), scale rows in the longitudinal series [39–47 (mode 45) vs. 49–62 (52)], scales above the lateral line [4–8 (6) vs. 9–11 (10)], and scale rows between last dorsal-fin base and lateral line [4–7 (5) vs. 7–8 (7)], and higher counts of scales below the lateral line [18–25 (21) vs. 14–18 (15)], in addition to characters given by Greenfield and Matsuura (2002) and Randall (2005), viz., three suborbital spines in *S. quadrispinosus* (vs. 5–15 spines in *S. parvipinnis*), and the first suborbital spine extending dorsally above the ventral margin of the orbit (vs. not reaching the orbital margin).

A nominal species, *Paronescodes asperrimus* Smith, 1958, was not mentioned in the original description of *S. quadrispinosus*, although Eschmeyer (1986) regarded it as a junior synonym of *S. parvipinnis*, a close relative to *S. quadrispinosus*. Examination of all type specimens [holotype (Fig. 4) and 18 paratypes; listed below] of *P. asperrimus* in this study showed them to be identical with *S. parvipinnis*; thus *P. asperrimus* is regarded here as a junior synonym of *S. parvipinnis*. Selected meristics of the type specimens of *P. asperrimus* are as follows (data for holotype are presented first, followed by data for paratypes in parentheses if different): Dorsal-fin rays XIII, 9; anal-fin rays III, 5; pectoral fin rays 18 on each side of body (18 on each side in 14 paratypes, and 19 in a paratype; asymmetrically 17 and 18 in



Fig. 4. Holotype of *Paronescodes asperrimus*, SAIAB 112, 90.6 mm SL, La Digue Island, Seychelles.

2 paratypes, and 18 and 19 in 1 paratype); scale rows in longitudinal series 52 (49–55); pored lateral-line scales 23; scales above lateral line 9 (9–11), below 14 (14–18); scale rows between last dorsal-fin base and lateral line 7 (7–8); scale rows between sixth dorsal-fin base and lateral line 8 (8–10); predorsal scale rows 11 (11–14); gill rakers on upper limb 4 (4–5), on lower limb 8 (7–8), on hypobranchial 0, total 12 (11–13).

Comparative material examined. Type specimens of *Paronescodes asperrimus* (= *Scorpaenodes parvipinnis*): SAIAB 112, holotype, 90.6 mm SL, La Digue Island, Seychelles, 04°22'00"S, 55°49'59"E, J. Smith and M. Smith; SAIAB 377, paratype, 23.0 mm SL, Ibo Island, Querimba Archipelago, Mozambique, 12°19'59"S, 40°37'00"E, Aug. 1951; SAIAB 378, 3 paratypes, 52.9–67.7 mm SL, Mafia Island, Tanzania, 07°50'60"S, 39°46'59"E, J. Smith, Nov. 1954; SAIAB 379, paratype, 66.1 mm SL, Pinda Island, Mozambique, 14°21'67"S, 40°7'667"E, J. Smith and M. Smith, 1956; SAIAB 380, 4 paratypes, 60.5–77.8 mm SL, Assumption Island, Cosmoledo Islands, Seychelles, 09°45'00"S, 46°30'00"E, J. Smith, Nov. 1954; SAIAB 381, paratype, 71.8 mm SL, Aldabra Island, Seychelles, 09°25'59"S, 46°19'59"E, J. Smith and M. Smith, Nov. 1954; SAIAB 382, paratype, 42.8 mm SL, Bazaruto Island, Mozambique, 21°40'00"S, 35°30'00"E, Sept. 1953; SAIAB 383, 2 paratypes, 65.1–76.2 mm SL, Bazaruto Island, Mozambique,

21°40'00"S, 35°30'00"E, Sept. 1953; SAIAB 384, paratype, 72.3 mm SL, Zanzibar Island, Tanzania, 06°10'00"S, 39°10'59"E, Sept. 1952; SAIAB 385, paratype, 58.3 mm SL, Zanzibar Island, Tanzania, 06°10'00"S, 39°10'59"E, Dec. 1957; SAIAB 386, 2 paratypes, 34.8–40.9 mm SL, collection data unknown; SAIAB 387, paratype, 82.4 mm SL, collection data unknown.

Type specimens of *Scorpaenodes quadripinosus*: CAS 214498, holotype, 74.2 mm SL, off Suva, Viti Levu Island, Fiji, 4.6–6.4 m, D. Greenfield et al., 28 May 1999; FMNH 110236, paratype, 47.8 mm SL, same data as CAS 214498; USNM 367135, paratype, 76.8 mm SL, same data as CAS 214498.

Scorpaenodes parvipinnis: FMNH 112040, 64.7 mm SL, Ashmore Reef, 10°09'31"S, 144°35'26"E, FNQ team, 25 Jan. 1993; KAUM–I. 255, 76.9 mm SL, south side of Shin-nittetsu oil factory in Ishado, Nakagusuku, Nakagami, Okinawa-jima Island, Ryukyu Islands, Japan, 26°17'44"N, 127°48'38"E, Y. Sakurai, 9 July 2006, washed up by Typhoon No. 3; KAUM–I. 256, 74.3 mm SL, same data as KAUM–I. 255; KAUM–I. 6596, 77.2 mm SL, Nakagusuku-hama Port, Hama, Nakagusuku, Nakagami, Okinawa-jima Island, Ryukyu Islands, Japan, 26°15'29"N, 127°47'38"E, Y. Sakurai, 13 July 2007, washed up by Typhoon No. 4; KAUM–I. 6597, 72.2 mm SL, same data as KAUM–I. 6596; KAUM–I. 6598, 79.7 mm SL, same data as KAUM–I.

6596; KAUM-I. 6599, 69.2 mm SL, same data as KAUM-I. 6596; KAUM-I. 6600, 80.8 mm SL, same data as KAUM-I. 6596; KAUM-I. 6601, 72.6 mm SL, same data as KAUM-I. 6596; KAUM-I. 6602, 75.4 mm SL, same data as KAUM-I. 6596; KAUM-I. 7089, 60.8 mm SL, same data as KAUM-I. 6596; KAUM-I. 20324, 57.9 mm SL, west of Kamazeno-hana, Kurio, Yaku-shima Island, Kagoshima, Japan, 30°16'03"N, 130°24'48"E, 0–11 m, KAUM fish team, 30 Oct. 2008; KAUM-I. 12818, 72.6 mm SL, Sesoko Island, Okinawa-jima Island, Ryukyu Islands, Japan, 26°38'N, 127°51'E, Y. Sakurai, 1 Jan. 2008; KPM-NI 4855, 81.2 mm SL, Kananzaki, Ie-jima Island, Okinawa, Ryukyu Islands, 15 m, 6 June 1998; USNM 140483, 70.0 mm SL, Bikini Atoll, Namu Island, L. Schultz et al., 6 Aug. 1947; WAM P. 33056-008, 36.4 mm SL, Sekartaji, Nusa Penida, Indonesia, 08°48'S, 115°36'E, 15–20 m, G. Allen and M. Erdmann, Nov. 2008; WAM P. 31522-005, 25.1 mm SL, Pulau Weh, Sumatra, Indonesia, 05°54'N, 95°13'E, 20–23 m, G. Allen, 23 Jan. 1999; YCM-P 34221, 2 specimens, 78.7–94.0 mm SL, Hamazaki, Kakeroma Island, Amami-oshima Island, Ryukyu Islands, Japan, 28°09'31"N, 129°11'00"E, 6–15 m, Sagami Bay Marine Biological Research Club, 29 Aug. 1994; YCM-P 36425, 87.0 mm SL, Saneku, Kakeroma Island, Amami-oshima Island, Ryukyu Islands, Japan, 28°11'01"N, 129°15'32"E, 10–23 m, Sagami Bay Marine Biological Research Club, 24 Aug. 1995.

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