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Taxonomic review of the *Sebastes pachycephalus* complex (Scorpaeniformes: Scorpaenidae)

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Abstract

A taxonomic review of the *Sebastes pachycephalus* complex established the existence of two valid species, *S. pachycephalus* and *S. nudus*. Similarities between them include: cranium armed dorsally with robust preocular, supraocular, postocular, and parietal spines; interorbital space concave; lower jaw lacking scales, shorter than upper jaw; thickened rays in ventral half of pectoral fin; dorsal fin usually with 13 spines and 12 soft-rays; pored lateral line scales 27–35 (usually 29–33). However, *S. pachycephalus* is distinguishable from the latter in having minute scales below the entire dorsal-fin spine base (vs. lacking minute scales below first to fifth or variously to the posteriormost spine in the latter), dark spots scattered on the dorsal, anal and caudal fins (vs. no distinct dark spots), and lacking distinct colored markings on the dorsum (vs. yellow or reddish-brown markings present). Although both species occur off the southern Korean Peninsula and in the Bohai and Yellow Seas, in Japanese waters, the former is distributed from northern Honshu Is. southward to southern Kyushu Is., whereas the latter extends from southern Hokkaido southward along the Pacific coast of Japan to Kanagawa, and along the Sea of Japan coast to northern Kyushu Is., including the Seto Inland Sea. *Sebastes nigricaus*, *S. nigricans*, and *S. latus* are confirmed as junior synonyms of *S. pachycephalus*, and *S. chalcogrammus* as junior synonym of *S. nudus*, based on the examination of type specimens.

Key words: *Sebastes nudus*, *S. nigricaus*, *S. nigricans*, *S. latus*, *S. chalcogrammus*, redescription

Introduction

The rockfish genus *Sebastes* Cuvier 1829 is the most specious genus in the family Scorpaenidae (Teleostei: Scorpaeniformes) with approximately 110 species worldwide (Nelson 2006), most being subjected to substantial commercial and recreational fisheries. They exhibit great morphological and ecological diversity, exploiting coastal habitats ranging from shallow rocky areas to depths of ca. 1000m (Love *et al*. 2002; Nakabo 2002a). However, some species groups exhibit few or only minute morphological differences due to their recent speciation (Kai *et al*. 2002; Hyde & Vetter 2007), resulting in some areas of taxonomic confusion. As a result, a considerable amount of effort has been spent in recent years investigating the evolutionary relationships of such species groups by way of molecular markers, resulting in gradual clarification (eg. Kai & Nakabo 2008; Orr & Hawkins 2008).

Sebastes pachycephalus Temminck & Schlegel 1843 is a common inhabitant of shallow coastal waters of the western North Pacific, extending from the coast of southern Hokkaido southward to Kyushu, and off the southern coast of the Korean Peninsula (Nakabo 2002a). Because of variations in coloration and other morphological characters, its taxonomy has been confused. Since Jordan & Starks (1904) first reported color variations in their *S. pachycephalus*, several authors have recognized distinct forms or subspecies within *S. pachycephalus* (eg., Matsubara 1943; Nakabo 1993, 2000, 2002a), whereas others considered such variations to be taxonomically insignificant (eg., Amaoka 1984; Amaoka *et al*. 2011). Recently, Kai *et al*. (2011) demonstrated that *S. pachycephalus* included two distinct species, on the basis of comprehensive morphological and genetic analyses, and also suggested a low level of hybridization between them. In that paper, the two species were referred to as

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"Species P-Ni", characterized by a lack of distinct markings on the dorsum and minute scales present below the dorsal-fin spines, and "Species Nu-C", characterized by yellow or brownish-red markings on the dorsum and minute scales absent below the dorsal-fin spines.

In the present paper, the two species within "*S. pachycephalus*", as revealed by Kai *et al*. (2011), are reviewed and detailed descriptions presented. Nominal species referable to "*S. pachycephalus*" include *Sebastes pachycephalus* Temminck & Schlegel 1843, *Sebastodes nigricaus* Schmidt 1930, *Sebastodes nigricans* Schmidt 1931, *Sebastichthys latus* Matsubara 1934, *Sebastes pachycephalus nudus* Matsubara 1943, and *Sebastes pachycephalus chalcogrammus* Matsubara 1943. Critical examination of the types and original descriptions resulted in "Species P-Ni" of Kai *et al*. (2011) being identified as *S. pachycephalus*, and "Species Nu-C" as *S. nudus*, the latter in accordance with the elevation to species rank of a subspecies proposed by Matsubara (1943). *Sebastodes nigricaus*, *S. nigricans* and *S. latus*, and *S. chalcogrammus* are herein regarded as junior synonyms of *S. pachycephalus* and *S. nudus* respectively.

Materials and methods

All the specimens genetically examined in Kai *et al*. (2011) were included in the present study, plus additional specimens representing the distributional range of "*S. pachycephalus*". Methods of counts and measurements followed Kai & Nakabo (2002), except as otherwise mentioned. Body depth followed Nakabo (2002b). The last two soft rays of the dorsal and anal fins were counted as single rays, each pair being associated with a single pterygiophore. Counts of gill rakers were taken from the first gill arch on the right side. Terminology of the head spines follows Randall & Eschmeyer (2001). Standard length is abbreviated as SL. To provide an objectively defined score that summarizes the major components of variable measurements between specimens and characterizes putative hybrid specimens, a standard principal component analysis (PCA) was conducted on morphometric characters using the function *prcomp* in the software package R 2.15.1. (R Development Core Team 2012). PCA was performed on the covariance matrix of log- transformed raw morphometric data and the correlation matrix of raw meristic data.

Specimens examined are held in the collections of the following institutions: Kyoto University, Kyoto, Japan (FAKU), Kagoshima University Museum, Kagoshima, Japan (KAUM), Faculty of Agriculture, Miyazaki University, Miyazaki, Japan (MUFS), Noto Marine Center, Ishikawa, Japan (NMCI), Osaka Museum of Natural History, Osaka, Japan (OMNH), National Natuurhistorisch Museum, Leiden, Netherlands (RMNH), and Zoological Institute of Russian Academy of Science, St. Petersburg, Russia (ZIN).

Sebastes pachycephalus Temminck and Schlegel 1843

[Japanese name: Murasoi]

(Figs. 1, 2A, 3A, 4; Tables 1–2)

Sebastes pachycephalus Temminck & Schlegel 1843: 47, pl. XX-III (type locality: Nagasaki, Japan); Amaoka 1984: 312, pl. 278-E (in part, southern Hokkaido southward to Kyushu, Japan and southern Korean Peninsula); Suzuki & Kataoka 1997: 213, pl. 118-628 (Mie, Japan); Kim *et al*. 2004: 100 (in part, Hokkaido southward to Kyushu, Japan and southern Korean Peninsula; photo identifiable as *S. nudus*); Kim *et al*. 2005a: 117, fig. 148 (in part, Hokkaido southward to Kyushu, Japan and southern Korean Peninsula); Kim *et al*. 2005b: 222 (in part, southern Hokkaido southward to Kyushu, Japan, off coasts of Korean Peninsula, and China; photo identifiable as *S. nudus*).

Sebastes (*Murasoius*) *pachycephalus*, form. *pachycephalus*: Matsubara 1943: 239, pl. II-1 (Chiba, Kanagawa, Aichi, Wakayama, and Kobe, Japan).

Sebastes (*Murasoius*) *pachycephalus*, form. *nigricans*: Matsubara 1943: 242, pl. III-1 (Shimonoseki and Nagasaki, Japan).

Sebastes pachycephalus complex "Species P-Ni": Kai *et al*. 2011: 340 (Nagasaki, Shimane, Fukui, Ishikawa, Hiroshima, Wakayama, and Fukushima, Japan).

Sebastes pachycephalus pachycephalus: Matsubara 1955: 1077, key, fig. 377 [after Matsubara (1943)] (Chiba southward to Kyushu, Japan, Busan, Korea, and China); Hiyama & Yasuda 1961: 112, pl. 148 (in part?, Hokkaido southward to Kyushu, Japan and southern Korea); Matsubara 1965: 426, unnumbered fig. [after Matsubara (1943)] (Aomori southward to Kyushu, Japan, Busan, Korea, and China); Kanayama & Kitagawa 1982: 42, unnumbered fig. (Iwate, Japan); Lindberg & Krasyukova 1987: 75, fig. 32 [after Matsubara (1943)] (Yokohama and Nagasaki, Japan and Busan, Korea); Nakabo 1993: 518, key (Chiba southward to Kyushu, Japan, Busan, Korea, and Yellow Sea); Masuda & Kobayashi 1994: 85, figs. 3–4

(Izu, Japan); Nakabo 1995: 177, color photo (Shimane, Japan); Motomura & Iwatsuki 1997: 130 (Nango, Miyazaki, Japan); Nakabo 2000: 595, key (Chiba southward to Kyushu, Japan, Busan, Korea, and Yellow Sea); Hirata *et al.* 2001: 48, color photo (Kochi, Japan); Nakabo 2002a: 595, key (Chiba southward to Kyushu, Japan, Busan, Korea, and Yellow Sea); Kitagawa *et al.* 2008: 59, unnumbered fig. [after Kanayama & Kitagawa (1982)] (Pacific coast of Tohoku District, Northern Honshu, Japan).

Sebastes pachycephalus nigricans: Matsubara 1955: 1077, key, fig. 378 [after Matsubara (1943)] (Shimonoseki and Nagasaki, Japan); Matsubara 1965: 427, unnumbered fig. [after Matsubara (1943)] (Shimonoseki and Nagasaki, Japan); Lindberg & Krasyukova 1987: 76, fig. 32 [after Schmidt (1931)] (Nagasaki and Misaki, Kanagawa, Japan); Nakabo 1993: 518, key (Shimonoseki and Nagasaki, Japan); Nakabo 2000: 594, key (Shimonoseki and Nagasaki, Japan); Nakabo 2002a: 595, key (Shimonoseki and Nagasaki, Japan).

Sebastes (*Sebastodes*) *pachycephalus*: Barsukov 2003: 200, fig.86 [after Matsubara (1943)] (Nagasaki, Japan).

Sebastes (*Murasoius*) *pachycephalus*: Jin 2006: 143 [Dalian, Yantai, and Qingdao, China; figure after Li (1955) identifiable as *S. nudus*].

Sebastichthys pachycephalus: Jordan and Starks 1904: (in part, Wakanoura, Kobe, Hiroshima and Shimonoseki, Japan); Tanaka 1930: 950, fig. 516 (Wakayama, Japan): Okada *et al*. 1935: 206, pl. 115-1 (in part, Hokkaido southward to Kyushu, Japan and Korean Peninsula); Okada & Matsubara 1938: 306 (in part, Hokkaido southward to Kyushu, Japan and Korean Peninsula).

Sebastichthys (*Pteropodus*) *latus* Matsubara 1934: 208 (type locality: Tokyo Bay, Japan).

Sebastodes nigricaus Schmidt 1930: 461 (type locality: Japan).

Sebastodes (*Acumentum*) *nigricans* Schmidt 1931: 97, fig. 13 (type locality: Nagasaki, Japan).

Materials examined. 105 specimens, 24.9–318.0 mm SL (one specimen, FAKU 85940 was or used for counts and measurements). **Japan:** FAKU 3269, 3297, 131.0–131.8 mm SL (2 specimens), Shimonoseki, Yamaguchi; FAKU 38149, 125.3 mm SL, Oki Is., Shimane; FAKU 41897, 109552–109553, 130095, 130127, 133026, 120.8–146.2 mm SL (6), Maizuru, Kyoto; FAKU 50088, 217.1 mm SL, Choshi, Chiba; FAKU 50168, 50169, 131.4–148.0 mm SL (2), Yawatahama, Ehime; FAKU 50279–50283, 62.6–111.5 mm SL (5), Takahama, Fukui; FAKU 59217, 143.9 mm SL, Futo, Izu, Shizuoka, coll. T. Murai; FAKU 63147–63148, 129.6–181.0 mm SL (2), Kushimoto, Wakayama; FAKU 63366–63372, 87605, 98.3–184.0 mm SL (8), Susaki, Shimoda, Shizuoka; FAKU 64210–64213, 83.7–88.0 mm SL (4), Shirahama, Wakayama; FAKU 64290, 106.2 mm SL, Koza, Wakayama; FAKU 65097, 154.8 mm SL, Susaki, Shimoda, Shizuoka; FAKU 69927, 124.7 mm SL, Okozu, Fukui, coll. R. Doiuchi; FAKU 73673, 124.0 mm SL, Ushimado, Okayama; FAKU 82393, 97.7 mm SL, Shimabara, Nagasaki, coll. K. Nakayama; FAKU 82408–82410, 146.1–175.1 mm SL (3), Obama, Fukui, coll. R. Doiuchi; FAKU 82524, 82525, 84104–84105, 86958–86961, 96080–96081, 130008–130009, 93.6–169.4 mm SL (16), Ushitsu, Noto, Ishikawa, coll. Y. Kai and K. Sakai; FAKU 84876, 168.3 mm SL, Onahama, Fukushima, coll. T. Sato; FAKU 85918, 86.1 mm SL, Aki, Hiroshima, coll. K. Watanabe; FAKU 85937–85941, 87654–87657, 63.9–106.6 mm SL (9), Yatsuka, Shimane, T. Morihisa; FAKU 87650–87652, 77.4–129.0 mm SL (3), Tamano, Okayama, coll. K. Nozaki; FAKU 101806, S3690, 96.1–114.7 mm SL (2), Shigoshi, Tsushima Is., Nagasaki; FAKU 104349, 67.0 mm SL, Kominato, Chiba; FAKU 133308, 274.8 mm SL, Kobe, Hyogo, coll. K. Matsubara; FAKU 133309 (holotype of *S. latus*), 138.1 mm SL, Tokyo Bay, coll. S. Masuda; FAKU 133431–133432, 166.8–169.8 mm SL (2), Miyako, Iwate, coll. Y. Kai; FAKU 134304–134305, 166.8–318.0 mm (2), Onahama, Fukushima, coll. T. Wada; KAUM–I. 3845, 40.6 mm SL, Ibusuki, Kagoshima Bay, Kagoshima, coll. KAUM Fish Team; KAUM–I. 9257, 164.7 mm SL, Sanwa, Kagoshima Bay, Kagoshima, coll. T. Ojiro; MUFS 12606–12608, 67.0–69.4 mm SL (3), Nango, Miyazaki; NMCI–P. 1530–1532, 125.0–145.2 mm SL (3), Ushitsu, Noto, Ishikawa; OMNH–P 3108, 68.3 mm SL, Kasumi, Hyogo, coll. Kasumi High School; OMNH–P 7929, 13607, 60.2–71.0 mm SL (2), Takeno, Hyogo; OMNH–P 9214, 37.3 mm SL, Muroto, Kochi, coll. K. Hatooka; OMNH–P 9434, 17402, 41.2–78.2 mm SL (2), Matsusaka, Mie; OMNH–P 9735, 91.7 mm SL, Kamijima, Toba, Mie, coll. K. Hatooka; OMNH–P 13415, 33.2 mm SL, Kunimi, Nagasaki, coll. K. Hatooka; OMNH–P 19307, 38367, 24.9–69.0 mm SL (2), Misaki, Osaka, coll. K. Hatooka; OMNH–P 30495, 78.3 mm SL, Kada, Wakayama, coll. K. Hatooka; RMNH D566 (lectotype of *S. pachycephalus*), 261.8 mm SL, Japan (detailed collection site not given), coll. H. Bürger; ZIN 22686 (holotype of *S. nigricans*), 150.0 mm SL, Nagasaki, coll. P. J. Schmidt. **South Korea:** FAKU 60725, 155.5 mm SL, Seogwipo, Cheju Is. **Locality unknown:** FAKU 13–15, 103482, 187.7–275.2 mm SL (4).

Diagnosis. A species of *Sebastes* with the following characters: cranium armed dorsally with robust preocular, supraocular, postocular, and parietal spines; interorbital space concave; lower jaw without scales, shorter than upper jaw; base of entire spinous portion of dorsal fin densely covered with minute scales; body with three dark brown saddles and lacking yellow or brownish-red markings on dorsum when fresh; soft-rayed portion of dorsal and anal fins, and caudal fin with dark spots.

Description. Measurements as percentages of SL of the specimens examined are given in Table 1. Selected counts are given in Table 2.

Body relatively deep, moderately compressed anteriorly, progressively more compressed posteriorly. Nape and anterior body moderately convex. Tentacles absent on head and body, except for nostril tentacle. Head completely covered with ctenoid scales, except for tip of snout, maxillary, lacrimal, lower jaw, interopercle, and branchiostegal rays. Posterior part of maxillary sometimes with minute embedded scales. Body covered with ctenoid scales usually with some accessory scales in posterior field, except for pectoral fin base, prepelvic region and ventral abdominal surface. Embedded cycloid scales covering pectoral fin base and prepelvic region; remaining ventral abdominal surface completely covered with minute cycloid scales. Base of entire spinous portion of dorsal fin densely covered with minute scales, usually extending onto basal spines and membranes (Fig. 2A); anterior part of spinous portion of base sometimes with very narrow naked area in smaller specimens (under ca. 60 mm SL). Patches of minute scales sometimes on membrane of spinous dorsal fin. Bases of soft-rayed portion of dorsal and anal fins covered with minute scales, extending onto basal membranes.

Mouth large, slightly oblique; posterior margin of maxilla reaching or nearly reaching (reaching in lectotype) level with posterior margin of orbit. Maxilla covered with thick skin. Lower jaw shorter than upper jaw, without distinct symphysial knob. Upper and lower jaws with band of villiform teeth. Palatines and vomer with villiform teeth, latter forming V-shaped patch.

Nasal spine simple, sharp, directed dorsally. Preocular spine robust, well developed, directed dorsoposteriorly; tip of spine reaching or extending slightly beyond level with anterior margin of pupil (ocular prosthesis in lectotype). Supraocular spine robust and well developed, directed posteriorly; tip of spine reaching or extending beyond (reaching in lectotype) level of posterior margin of orbit. Postocular spines simple, directed dorsoposteriorly. Interorbital space concave without ridge, its width about half of orbit diameter. Parietal spine well developed, somewhat divergent posteriorly in dorsal view. Supracleithral spine simple, directed posteriorly. Upper posttemporal spines flattened, with embedded base, lower posttemporal spine absent. Sphenotic, tympanic, and pterotic spines absent. Lacrimal with round lobe anteriorly and one spine posteriorly; spine flattened, blunt, directed ventroposteriorly, its tip below level of anterior margin of pupil. Suborbital without spine or ridge. Preopercle with five spines; two uppermost spines large, directed posteriorly; third moderate, directed posteriorly; forth and fifth small, blunt, directed ventroposteriorly. Opercle with two simple flattened spines directed posteriorly; upper spine somewhat larger than lower spine.

Dorsal fin with 13 spines (rarely 12 or 14; 13 in lectotype) and 10–13 (usually 12 including lectotype) soft rays; all soft rays branched (first ray weakly branched). Dorsal-fin origin above anterodorsal portion of gill slit. Dorsal fin gradually increasing in height to fifth spine, decreasing thereafter to 12th spine; 13th spine usually much larger than 12th, forming anterior support of soft-rayed portion of dorsal fin. Soft-rayed portion of dorsal fin with entire margin rounded; anterior rays longer (second or third ray longest, third in lectotype), posterior rays gradually shortening. Anal fin with three spines and six (rarely five or seven, six in lectotype) soft rays; all soft rays branched. First anal-fin spine slightly posterior to last dorsal-fin spine; second spine robust, longest. Anterior rays on soft-rayed portion of anal fin longest; posterior margin rounded. Posterior margin of caudal fin rounded. Pectoral fin rounded; its tip not reaching posteriorly to level with anus; ventral 10–13 (usually 11, 12 in lectotype) rays unbranched and thickened. Posterior tip of depressed pelvic fin below tip of pectoral fin, not or rarely reaching anus.

Gill rakers short, blunt, longest raker in joint between cerato- and hypobranchial, length of preceding and succeeding rakers progressively shorter; ceratobranchial rakers six–eight (usually seven), hypobranchial rakers 14–17, often rudimentary and united, being difficult to distinguish individually (gill arches removed in lectotype).

Color when fresh (Fig. 1). Head and body brown or gray dorsally and laterally, somewhat paler ventrally. Head with three indistinct dark brown bands radiating from eye. Body with three dark brown saddles, two anteriormost extending onto dorsal fin; anteriormost positioned under fifth to 11th dorsal-fin spines, second under soft-rayed portion of dorsal fin, posteriormost on caudal peduncle. Underside of head, pectoral fin base, and ventral abdominal surface with (Figs. 1A, B) or without dark brown spots (Figs. 1C–F). Dorsal fin brown or gray; dark brown spots present or absent on spinous portion, but usually present on soft-rayed portion. Anal fin brown or gray with dark brown spot on soft-rayed portion. Caudal fin brown with darker brown spots; membranes darker. Pectoral fin dark brown or grey, usually with dark spots basally; ventral half somewhat paler. Pelvic fin brown, membranes darker. In smaller specimens (under ca.10 cm SL), dorsal, anal, caudal, and pelvic fins somewhat reddish (Fig. 1F).

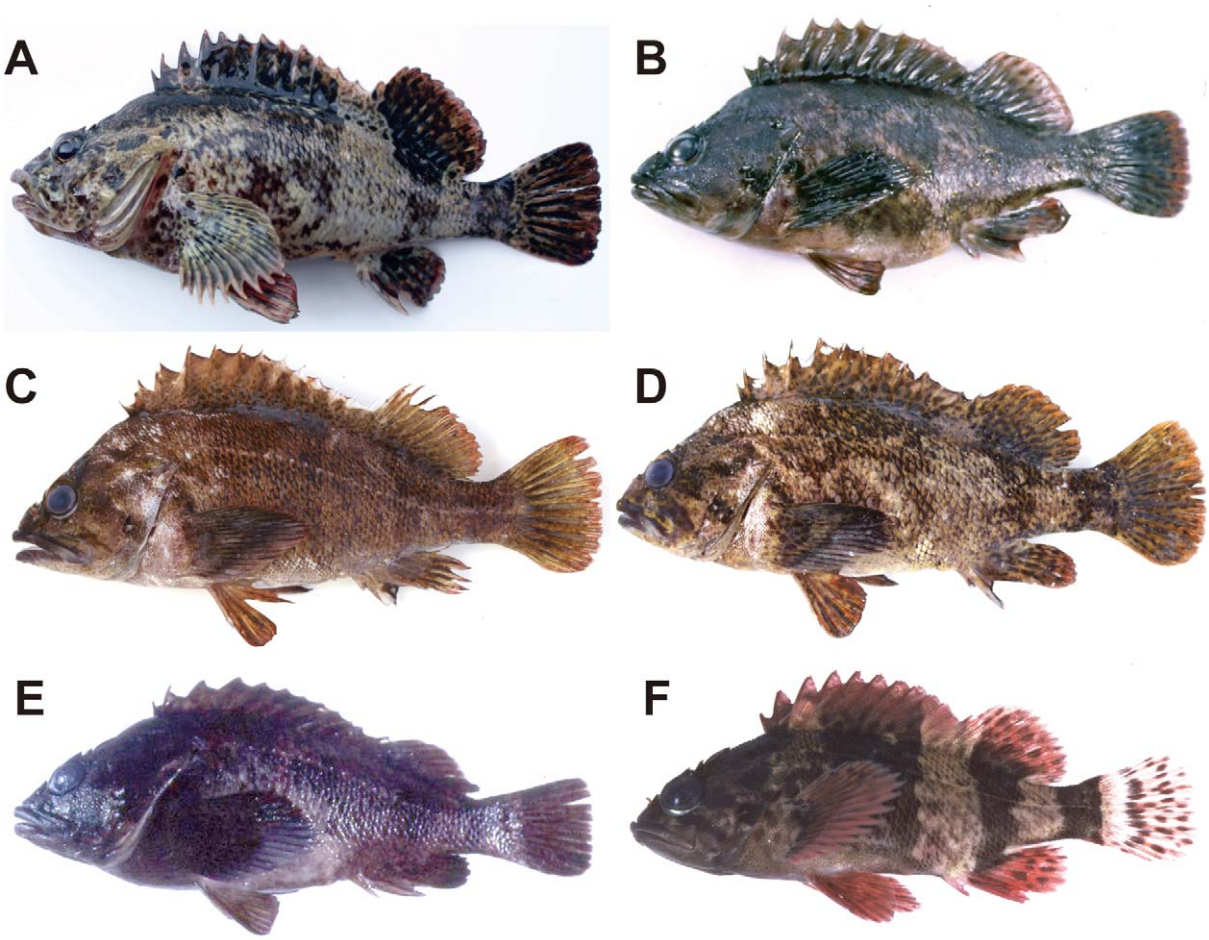

FIGURE 1. *Sebastes pachycephalus* in life (A) and when fresh (B–F). (A) FAKU 130127, 129.6 mm SL, Maizuru, Kyoto, Japan; (B) FAKU 73673, 124.0 mm SL, Ushimado, Okayama, Japan; (C) FAKU 133431, 169.8 mm SL, Miyako, Iwate, Japan; (D) FAKU 133432, 166.8 mm SL, Miyako, Iwate, Japan; (E) FAKU 84110, 141.9 mm SL, Noto, Ishikawa, Japan; (F) OMNH-P 9214, 37.3 mm SL, Muroto, Kochi, Japan. A–E photograph by Y. Kai, F photograph by K. Hatooka (OMNH).

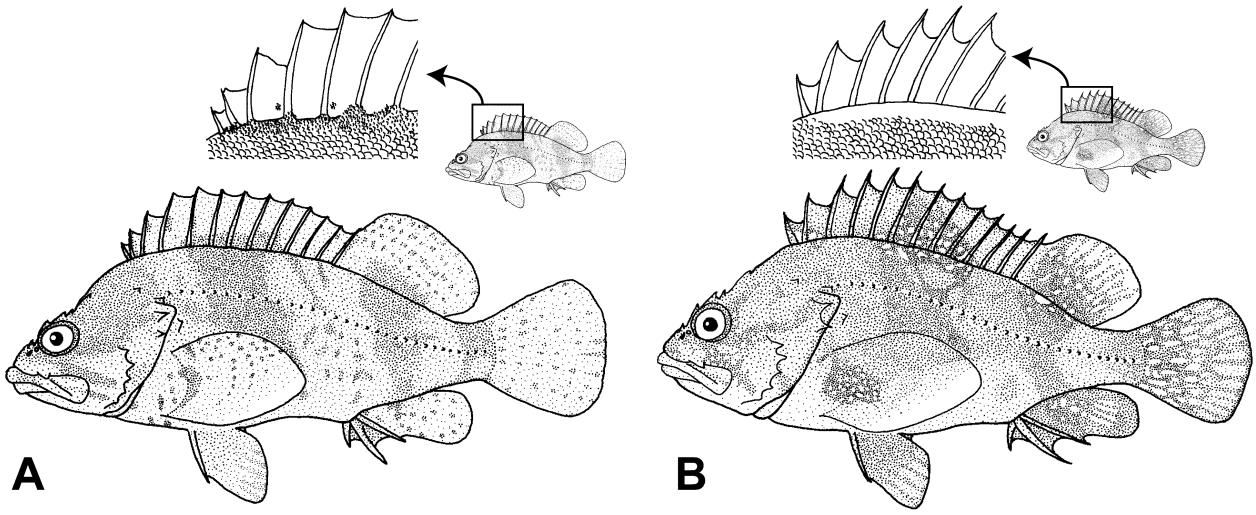

FIGURE 2. Schematic illustrations of *Sebastes pachycephalus* (A) and *S. nudus* (B), indicating the squamation pattern below the dorsal-fin spines. (A) FAKU 65097, 154.8 mm SL, Susaki, Shimoda, Shizuoka, Japan; (B) FAKU 84093, 158.3 mm SL, Miyako, Iwate, Japan.

TABLE 1. Measurements of specimens of *Sebastes pachycephalus* and *S. nudus*, expressed as percentages of standard length. Means in parentheses.

	S. pachycephalus				*S. nudus*		
	Holotype of *S. pachycephalus* RMNH-D 566	Holotype of *S. latus* FAKU 133309	Holotype of *S. nigricans* ZIN 22686	Non type specimens *n* = 101	Holotype of *S. nudus* FAKU 352	Holotype of *S. chalcogrammus* FAKU 6317	Non type specimens *n* = 86
Standard length (mm)	261.8	138.1	150.0	24.9–318.0 (122.2)	198.5	261.8	23.2–212.8 (143.6)
Head length	41.3	43.0	36.7	31.5–44.7 (39.4)	42.2	39.5	38.3–44.2 (40.9)
Snout length	9.6	11.0	10.0	8.5–11.9 (10.2)	9.8	9.5	9.0–12.4 (10.2)
Orbit diameter	8.3	9.8	8.1	7.8–12.8 (9.8)	9.9	8.6	8.2–12.3 (9.9)
Interorbital width	5.5	6.3	4.9	3.8–8.1 (5.2)	5.8	5.0	4.3–9.0 (5.7)
Body depth	32.5	42.2	34.0	28.6–44.4 (36.8)	39.3	38.8	33.4–43.8 (38.3)
Body width	17.7	22.0	17.3	15.2–32.3 (20.5)	18.9	22.1	14.5–37.4 (21.4)
Caudal peduncle depth	10.2	12.7	11.2	8.3–14.1 (11.3)	12.5	12.1	10.4–12.9 (11.8)
Upper jaw length	18.6	21.9	18.0	15.3–22.5 (19.2)	19.8	18.7	16.7–21.7 (19.5)
Predorsal fin length	32.8	36.6	33.2	28.6–39.2 (35.1)	36.4	35.3	32.7–38.5 (35.4)
Preanal fin length	-	69.8	76.5	55.7–80.9 (71.6)	72.3	72.3	41.7–80.5 (72.2)
Pectoral fin length	25.2	30.2	27.1	22.9–34.8 (28.9)	31.5	28.9	25.5–41.7 (30.4)
Pelvic fin length	21.2	27.3	23.1	19.8–28.1 (23.2)	24.6	22.1	20.0–27.0 (23.4)
Pelvic-fin spine length	-	16.4	13.3	10.3–17.3 (14.3)	17.0	14.4	11.9–17.9 (15.1)
1st dorsal-fin spine length	-	7.6	5.2	3.1–7.2 (5.5)	6.9	8.2	3.5–8.9 (6.6)
2nd dorsal-fin spine length	-	0.0	8.4	6.3–12.2 (9.1)	11.8	11.7	7.4–13.4 (10.8)
3rd dorsal-fin spine length	11.1	15.1	11.3	9.8–15.7 (12.7)	16.8	15.3	11.2–17.6 (15.1)
4th dorsal-fin spine length	13.1	17.5	13.3	11.2–17.3 (14.4)	18.4	17.2	13.7–19.9 (16.7)
5th dorsal-fin spine length	13.4	17.7	14.1	11.3–17.9 (14.7)	18.1	17.4	13.1–20.1 (16.9)
12th dorsal-fin spine length	9.1	12.0	8.3	7.6–12.0 (9.7)	12.2	13.0	8.0–13.6 (11.0)
13th dorsal-fin spine length	9.9	12.8	10.0	8.6–14.3 (11.4)	12.6	11.5	9.4–14.1 (11.9)
Longest dorsal-fin ray length	16	18.2	-	13.6–22.3 (17.6)	16.6	18.1	14.8–21.0 (18.3)
1st anal-fin spine length	6.1	8.3	6.8	4.9–9.7 (8.0)	17.0	8.3	6.3–10.7 (8.7)
2nd anal-fin spine length	10.3	17.3	15.7	11.9–21.5 (16.9)	18.4	15.5	10.4–20.3 (17.2)
3rd anal-fin spine length	9	16.2	15.3	10.8–18.9 (15.1)	15.9	14.6	8.8–18.7 (15.3)
Distance between pelvic and anal fins	-	30.6	-	24.7–47.5 (33.1)	30.3	35.8	25.6–40.1 (33.2)
Upper caudal peduncle length	-	11.5	-	9.6–14.1 (11.7)	12.6	11.5	7.9–13.0 (11.3)
Lower caudal peduncle length	18.1	20.8	-	15.1–21.7 (18.4)	18.0	19.0	15.5–20.3 (17.7)

TABLE 2. Frequency distribution of selected counts from specimens of *Sebastes pachycephalus* and *S. nudus*.

	Pectoral-fin rays (left side)						Pectoral-fin rays (right side)				
	16	17	18	19	20		16	17	18	19	20
S. pachycephalus	1	18	64	17[a, b]	2		-	23	60[c]	18[b]	2
S. nudus	9	67[d]	12[e]	-	-		6	70[d, e]	9	-	-
	Pored lateral-line scales										
	27	28	29	30	31	32	33	34	35		
S. pachycephalus	1	1	3	15	39[c]	24[b]	13	5	2		
S. nudus	1	1	9	13	23	26[d, e]	9	1	3		

a Lectotype of *S. pachycephalus*; b Holotype of *S. latus*; c Holotype of *S. nigricans*; d Holotype of *S. nudus*; e Holotype of *S. chalcogrammus*.

Color in preserved specimens (Fig. 2A). Head and body dark dorsally and laterally, somewhat paler ventrally. Head with three indistinct dark bands radiating from eye. Body with three dark saddles as when fresh. Underside of head, pectoral fin base, and ventral abdominal surface with or without dark brown spots. Soft-rayed portion of dorsal and anal fins, and caudal fin with dark spots.

Distribution (Fig. 3A). *Sebastes pachycephalus* is presently known from Aomori, northern Honshu Is. southward to Kagoshima Bay, southern Kyushu Is., Japan, in addition to the southern part of the Korean Peninsula, and the Yellow and Pohai Sea coasts of China. This species is solitary, inhabiting rocky reefs in shallow coastal waters.

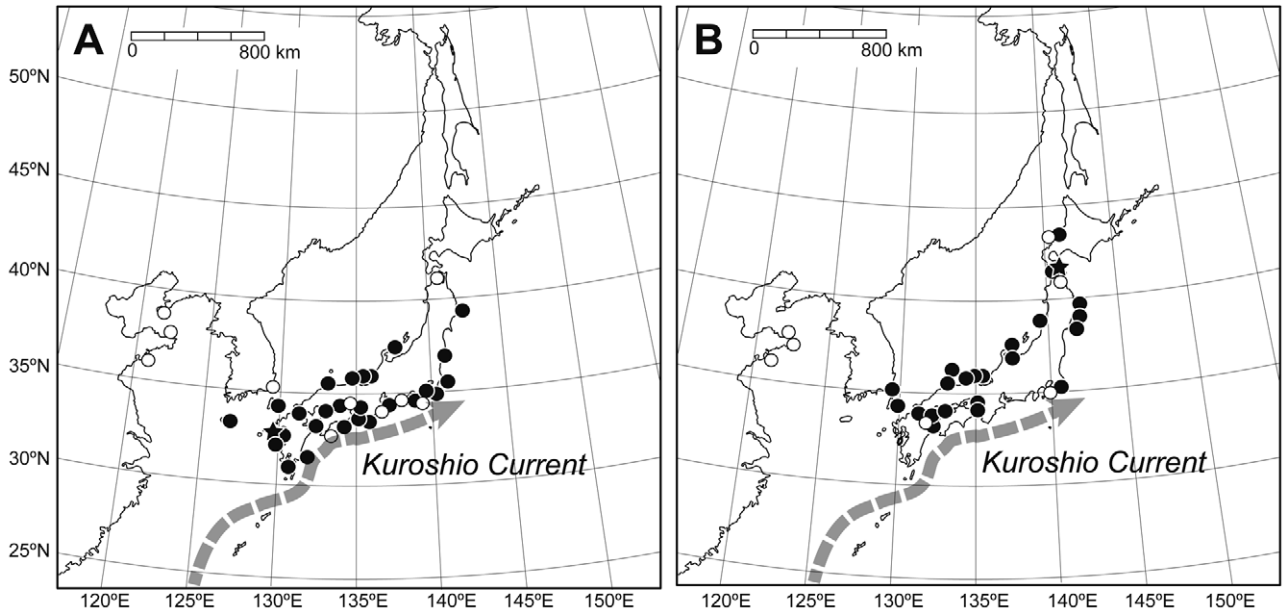

FIGURE 3. Distribution of *Sebastes pachycephalus* (A) and *S. nudus* (B). Closed circles based on specimens examined in this study; open circles based on literature records.

Remarks. The present description of *S. pachycephalus* is based on the specimens genetically identified as "Species P-Ni" *sensu* Kai *et al*. (2011), plus additional specimens not genetically examined here, but considered as conspecific with the former due to their having minute scales below the entire dorsal-fin spine base and on the caudal fin, and lacking yellow or brownish-red markings on the dorsum.

Sebastes pachycephalus was originally described by Temminck & Schlegel (1843), based on specimens collected by H. Bürger and Ph. F. von Siebold. Later, Boeseman (1947), who reviewed the Japanese fishes collected by Bürger and von Siebold, considered four stuffed specimens (RMNH D563, D564, D565, D566) and two specimens in alcohol (RMNH 654, 655) as the type series of *S. pachycephalus*, designating one of them (RMNH D566) as the lectotype. The latter (RMNH D566: Fig. 4A) had 19 pectoral-fin rays, minute scales below

the entire dorsal-fin spine base, and dark spots on the belly, anal, caudal, and pelvic fins, being characteristic of specimens identified as "Species P-Ni" *sensu* Kai *et al*. (2011). Although the remaining five specimens are paralectotype of *S. pachycephalus*, Boeseman (1947) noted that two (RMNH 654, 655) had been identified as "*Sebasichthys elegans*" *sensu* Jordan & Starks (1904) owing to their having 14 dorsal-fin spines, subsequently included under *Sebastes hubbsi* Matsubara 1937 [see Matsubara (1936) and Matsubara (1937)]. The identity of those specimens, not examined during the present study, remains to be confirmed.

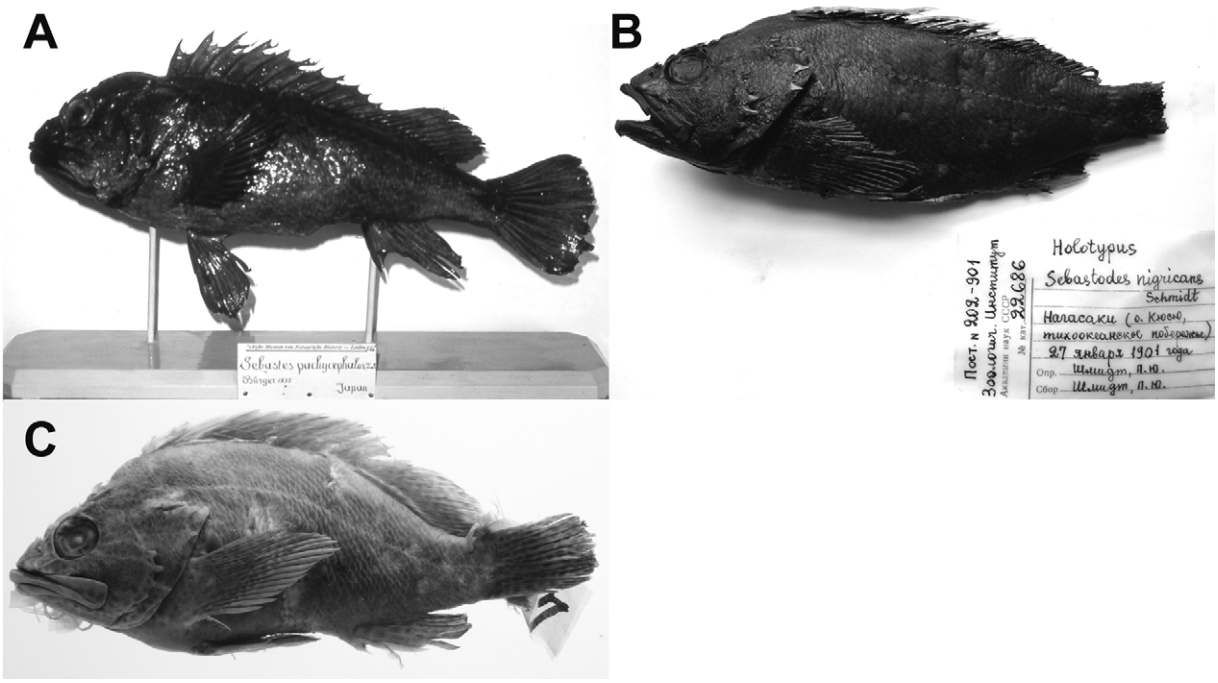

FIGURE 4. Type specimens of nominal species related to *Sebastes pachycephalus*. (A) Holotype of *S. pachycephalus*, RMNH-D 566, 261.8 mm SL; (B) holotype of *S. nigricans*, ZIN 22686, 150.0 mm SL; (C) holotype of *S. latus*, FAKU 133309, 138.1 mm SL.

Schmidt (1930) reported *Sebastodes nigricaus* as a new species from Japan (detailed locality not given), providing a brief description but without designating a holotype. That species was characterized as having: D XIII, 13; A III, 7; pored lateral line scales 32; maxillary without scales; blackish coloration. Later, Schmidt (1931) described, *Sebastodes* (*Acutomentum*) *nigricans* on the basis of a single specimen (ZIN 22686), collected from Nagasaki, Japan. Many authors have overlooked the former name, citing only *S. nigricans* of Schmidt (1931) in reviews of *Sebastes* (e.g., Matsubara 1943; Barsukov 2003). However, Eschmeyer (2012) considered that the description of Schmidt (1930) included a definition of the species, "*nigricaus*" being a misspelling of "*nigricans*", and thus regarded "*Sebastodes nigricans* Schmidt 1930" as an available name. We agree that Schmidt's (1930) description included a valid definition of the species following ICZN (1999: Art. 12). However, "*nigricaus*" is the correct original spelling following ICZN (1999: Art. 32). Although Schmidt (1930) may have misspelt his intended original name for the species, we here regard "*Sebastodes nigricaus* Schmidt 1930" as an available name. Schmidt (1930) did not note any museum registration number for his specimen, but the counts given for dorsal- and anal-fin rays and lateral line scales were identical with those given later (Schmidt 1931), indicating that the two descriptions had been based upon the same specimen (ZIN 22686). This specimen, the holotype of *S. nigricans* (Fig. 4B), has 18 pectoral-fin rays (lower 11 rays unbranched) and minute scales below the entire dorsal-fin spine base, agreeing closely with the present specimens regarded as *S. pachycephalus*. Therefore, we concluded that both *S. nigricaus* and *S. nigricans* are synonyms of *S. pachycephalus*.

The description of *Sebastichthys* (*Pteropodus*) *latus* by Matsubara (1943) was based on a specimen collected from Tokyo Bay, Japan. Although the holotype of that species was believed lost (not at FAKU) (Eschmeyer 2012), many of Matsubara's specimens are in fact housed at FAKU, including the holotype of *Sebastes melanostictus* and syntypes of *Sebastes longispinis*, both species having been described as new in the same paper as *S. latus*. Recently, a specimen (FAKU 133309; Fig. 4C) bearing two of Matsubara's collection numbers (577 and 651) was found that

corresponded to the length and preservation condition of the type specimen of *S. latus*, as originally described by Matsubara (1934). According to the original description, the holotype of *S. latus* was 174 mm in total length and characterized by 19 pectoral-fin rays (lower 12 unbranched), a deep body (44.2% of SL), 24 gill rakers, and many dark spots on fins and underside of head. FAKU 133309 (172.5 mm in total length) had 19 pectoral-fin rays (lower 12 unbranched), deep body (42.2% of SL), and 24 gill rakers (see Tables 1–2, Fig. 4C), completely matched the original description. In addition, Matsubara (1934) noted "frontal ridges not visible without dissection"; FAKU 133309 had been dissected around the frontal ridges. Therefore, we consider that the original description of *S. latus* was based on FAKU 133309, being the holotype. However, this species now is believed to be an example of *S. pachycephalus*, owing to the minute scales below the entire dorsal-fin spine base, and many dark spots on the fins and underside of the head and body. Thus, *S. latus* can be confirmed here as a junior synonym of *S. pachycephalus*. In fact, Matsubara (1943) had already synonymized *S. latus* under *S. p. pachycephalus*, because the diagnostic characters given in Matsubara (1934) fell within the range of the latter.

Jordan & Starks (1904) described *Sebastichthys pachycephalus* on the basis of specimens collected from Wakayama, Kobe (Seto Inland Sea), and Shimonoseki, Japan, referring to their color variations as follows: "golden-yellow blotches and sometimes having dark spots on breast and base of pectoral fin." "Golden-yellow blotches" is consistent with the present specimens of *S. nudus*, whereas "dark spots on breast and base of pectoral fin" is consistent with those of *S. pachycephalus*. Similarly, the description of *Sebastichthys pachycephalus* given by Okada *et al*. (1935) includes "two variations have been known; one with dark spots on the ventral body surface and the fins, and the other without such spots but with yellow or reddish-yellow markings on the dorsum." These are consistent with presently-recognized *S. pachycephalus* and *S. nudus* respectively. However, the supporting plate matched the former in having dark spots on the ventral surface of body and the dorsal, anal and caudal fins. Okada & Matsubara (1938) also described *S. pachycephalus* as having variations in body coloration, following Okada *et al*. (1935). Thus, we consider that both species recognized here were included in their descriptions.

Matsubara (1943) recognized four forms in his *Sebastes* (*Murasoius*) *pachycephalus*; viz. "*S. pachycephalus*, form. *pachycephalus*", "*S. pachycephalus*, form. *nigricans*", "*S. pachycephalus*, form. *nudus*", and "*S. pachycephalus*, form. *chalcogrammus*", the latter two being described as new. The subsequent recognition of these "forms" as subspecies by numerous authors (see below) is supported by ICZN (1999: Art. 45.6). *Sebastes p. pachycephalus*, based on 30 specimens (no catalog number given) collected from Chiba, Kanagawa, Aichi, Wakayama (Pacific coast of Japan) and the Seto Inland Sea, Japan, was characterized as having minute scales below the entire dorsal-fin spine base and many dark spots on the fins and underside of the head. Such characters are consistent with the present specimens regarded as *S. pachycephalus*. Matsubara's (1943) description of *S. p. nigricans*, based on two specimens (no catalog number given), included "spinous dorsal covered by minute scales behind the second dorsal spine." Although all of the larger specimens examined here had minute scales below the entire dorsal-fin spine base, *S. p. nigricans* of Matsubara (1943) was most likely to have been *S. pachycephalus*. Matsubara (1943) also considered *S. p. pachycephalus* to be distinguishable from *S. p. nigricans* in having "black spots on belly, breast, and underside of head, usually 19 pectoral-fin rays (17 or 18 in the latter), maxillary without scales, and accessory scales on body." However, the presence or absence of black spots as described have been recently demonstrated as representing intraspecific variation in *S. pachycephalus*, based on genetic analysis (Kai *et al*. 2011: as "Species P-Ni"). Furthermore, the pectoral-fin ray counts fell within the present range established for *S. pachycephalus*, the latter two characters in fact being subject to significant individual variation in the present specimens. A discussion of Matsubara's (1943) *S. p. nudus* and *S. p. chalcogrammus* is given under "Remarks" for *S. nudus*. In later papers, Matsubara (1955, 1965) similarly recognized four subspecies (not forms) under *S. pachycephalus* (*S. p. pachycephalus*, *S. p. nigricans*, *S. p. nudus*, and *S. p. chalcogrammus*), following Matsubara (1943). All of the figures included in Matsubara (1955, 1965) were modified from those in Matsubara (1943).

Hiyama & Yasuda (1961) redescribed *S. pachycephalus pachycephalus*, commenting that the four forms were defined by differences in body coloration, thereby apparently following Matsubara (1943). It is unclear whether or not they considered the "four forms" to be included under their *S. p. pachycephalus*. However, the accompanying figure (pl. 148) appears to be of *S. pachycephalus*, owing to the dark spots on the ventral abdominal surface and dorsal, anal and caudal fins.

The status of *S. pachycephalus* subspecies was not addressed by Amaoka (1984), who considered *S. pachycephalus* simply as a single species, owing to the existence of equivocal specimens between subspecies. However, *S. pachycephalus* of Amaoka (1984) clearly included both *S. pachycephalus* and *S. nudus* as recognized

here, one of the color photos (pl. 278-E) given by him being referable to the former in having dark spots on the dorsal, anal, and caudal fins, and two (pl. 278-F and G) to the latter in having distinct yellow or reddish markings on the dorsum.

Nakabo's (1993, 2000, 2002a) descriptions of four subspecies, *S. pachycephalus pachcephalus*, *S. p. nigricans*, *S. p. nudus*, and *S. p. chalcogrammus*, generally followed Matsubara (1943), that of *S. p. pachycephalus* having been based on FAKU 40153 (unavailable for the present study) and that of *S. p. nigricans*, on FAKU 3297 and FAKU 109552. The latter two specimens were herein re-identified as *S. pachycephalus*. In addition, the diagnoses of *S. p. pachycephalus* proposed by Nakabo matched the specimens presently regarded as *S. pachycephalus*. *Sebastes pachycephalus nudus* and *S. p. chalcogrammus* of Nakabo (1993, 2000, 2002a) were both identified here as *S. nudus* (see "Remarks" under *S. nudus*).

Lindberg & Krasyukova's (1987) description of *S. pachycephalus nigricans* apparently followed the original description of *S. nigricans* given by Schmidt (1931). Their description of *S. p. pachycephalus* apparently followed that of Matsubara (1943).

In his description of *Sebastes* (*Sebastodes*) *pachycephalus*, Barsukov (2003) provided only pectoral-fin ray counts (usually 19) and a figure modified from that of *S. p. pachycephalus* of Matsubara (1943). Judging from the counts, it is most likely to have been *S. pachycephalus*. Barsukov (2003) also described *S.* (*Sebastodes*) *nigricans* as a valid species, but provided no useful diagnostic characters.

Because *S. pachycephalus* is common in shallow coastal waters around Japan and Korea, many records of the species exist in the literature. Tanaka (1930) reported *Sebastichthys pachycephalus* from Wakayama, Japan, characterized as having minute scales below the dorsal-fin spines, his supporting figure having dark spots on the dorsal, anal, caudal, and upper pectoral fins, and anterior ventral abdominal surface. Such characters agreed well with those of the present specimens regarded as *S. pachycephalus*. The photos of *S. pachycephalus pachycephalus* in Kanayama & Kitagawa (1982), Masuda & Kobayashi (1994), Nakabo (1995), Suzuki & Kataoka (1997), Hirata *et al*. (2001), and Kitagawa *et al*. (2008) are all clearly of *S. pachycephalus*, owing to the dark spots on the soft-rayed portion of the dorsal fin and caudal fin. The photo of *S. pachycephalus* in Kim *et al*. (2005a) also matched presently recognized *S. pachycephalus* in having dark spots on the caudal fin. Our re-examination of Motomura & Iwatsuki's (1997) specimens of *S. p. pachycephalus* (MUFS 12606–12608; Miyazaki, Japan) also confirmed them as *S. pachycephalus*. Although the description of *S.* (*Murasoius*) *pachycephalus* from the Pohai and Yellow Seas given by Jin (2006) was identifiable as *S. pachycephalus*, as recognized here, on the basis of minute scales below the entire dorsal-fin spine base and black spots on the ventral abdominal surface, as well as on the dorsal and caudal fins, the accompanying figure was apparently modified from that of Chang *et al*. (1955), herein identified as *S. nudus* (see Remarks under *S. nudus*).

Many authors, including Jordan & Starks (1904), Tanaka (1930), and Matsubara (1943), have cited Richardson's (1854) report of *Sebastes pachycephalus* from China (no specific locality record given). However, "several large, pale or bluish round spots" on the body sides in Richardson's description do not occur in either *S. pachycephalus* or *S. nudus*, as recognized here. Cheng's (1997) *S. nigricans* was characterized as having reddish markings above the opercle and between the soft-rayed portions of the dorsal and anal fins, and vertical stripes on the caudal fin. Such characters agree rather more with *Sebastes longispinis* (Matsubara 1934) (see Nakabo 2002a). *Sebastes pachycephalus* of Steindachner & Döderlein (1884) is likely to have been *S. hubbsi*, owing to the dorsal-fin spine count (14).

The following reports cannot now be attributed with certainty to either of their two species of *Sebastes* recognized here because of the lack of definitive characters: Jordan & Snyder (1900) as "*Sebastodes pachycephalus*" (Misaki, Kanagawa, Japan), Jordan & Snyder (1901) as "*Sebastodes pachycephalus*" (Yokohama, Japan), Jordan & Metz (1913) as "*Sebastichthys pachycephalus*" (Busan, Korea), Jordan *et al.* (1913) as "*Sebasichthys pachycephalus*" (Wakayama southward to Nagasaki, Japan), Jordan & Thompson (1914) as "*Sebastichthys pachycephalus*" (Misaki, Kanagawa, Japan), Jordan & Hubbs (1925) as "*Sebastichthys pachycephalus*" (Otaru of Hokkaido, Yokohama, and Toyama, Japan), Ueno (1971) as "*Sebastes pachycephalus*" (Hokkaido and northern Honshu Is., Japan), Shiogaki *et al*. (2004) as "*Sebastes pachycephalus pachycephalus*, *S. p. chalcogrammus*, *S. p. nudus*" (Aomori, Japan), Shinohara & Williams (2006) as "*Sebastes pachycephalus*" (Sagami Sea, Japan).

***Sebastes nudus* Matsubara 1943**
[Japanese name: Ohgon-murasoi]
(Figs. 2B, 3B, 5, 6; Tables 1–2)

Sebastes (*Murasoius*) *pachycephalus*, form. *nudus* Matsubara 1943: 239, pl. II-2 (type locality: Hakodate, Hokkaido, Japan and Busan, Korea).
Sebastes (*Murasoius*) *pachycephalus*, form. *chalcogrammus* Matsubara 1943: 244, pl. III-2 (type locality, Shimonoseki, Japan).

Sebastes pachycephalus (not of Temminck & Schlegel): Jordan & Starks 1904: 117 (in part, Wakanoura, Kobe, Hiroshima and Shimonoseki, Japan); Okada *et al*. 1935: 206 (in part, Hokkaido southward to Kyushu, Japan and southern Korean Peninsula; plate based on *S. pachycephalus*); Amaoka 1984: 312, pl. 278-F and G (in part, southern Hokkaido southward to Kyushu, Japan and southern Korean Peninsula); Cheng 1997: 408, fig. 301 [after Li (1955)] (Qingdao, Weihai and Yantai, China); Kim *et al*. 2004: 100, unnumbered fig. (in part, Hokkaido southward to Kyushu, Japan and southern Korean Peninsula); Kim *et al*. 2005a: 117 (in part, Hokkaido southward to Kyushu, Japan and southern Korean Peninsula; figure identifiable as *S. pachycephalus*); Kim *et al*. 2005b: 222, unnumbered fig. (in part, Hokkaido southward to Kyushu, Japan, all coast of Korea, and China); Amaoka *et al*. 2011: 187, unnumbered figs (Hokkaido, Japan).
Sebastes pachycephalus complex "Species Nu-C": Kai *et al*. 2011: (Hiroshima, Kyoto, Ishikawa, Miyagi, Iwate, and Hokkaido, Japan).
Sebastes pachycephalus pachycephalus: Hiyama & Yasuda 1961: 112 (in part, Hokkaido southward to Kyushu, Japan and southern Korea; plate identifiable as *S. pachycephalus*).
Sebastes pachycephalus nudus: Matsubara 1955: 1077, fig. 376 [after Matsubara (1943)], key (Hakodate, Hokkaido, Japan and Busan, Korea); Matsubara 1965: 427, unnumbered fig. [after Matsubara (1943)] (Hokkaido and Aomori, Japan and Busan, South Korea); Nakabo 1993: 518, key (Hakodate, Hokkaido, Japan and Busan, Korea); Masuda & Kobayashi 1994: 85, figs. 5 (Shakotan Peninsula, Hokkaido, Japan); Nakabo 1995: 177, color photos (Iwate and Fukui, Japan); Nakabo 2000: 595, key (Hakodate, Hokkaido, Japan and Busan, Korea); Nakabo 2002a: 595, key (Hakodate, Hokkaido, Japan and Busan, Korea).
Sebastes pachycephalus chalcogrammus: Matsubara 1955: 1077, fig. 379 [after Matsubara (1943)], key (Chiba, Kanagawa, Kobe, and Shimonoseki, Japan and Busan, Korea); Matsubara 1965: 426, unnumbered fig. [after Matsubara (1943)] (Chiba southward to Kyushu, Japan); Kanayama & Kitagawa 1982: 43, unnumbered fig. (Miyako, Iwate, Japan); Lindberg & Krasyukova 1987: 77, fig. 34 [after Matsubara (1943)]; Nakabo 1993: 518, key (Chiba, Kanagawa, Kobe, and Shimonoseki, Japan and Busan, Korea); Masuda & Kobayashi 1994: 85, fig. 6 (Shakotan Peninsula, Hokkaido, Japan); Nakabo 2000: 595, key (Chiba, Kanagawa, Kobe, and Shimonoseki, Japan and Busan, Korea); Shimizu 2001: 25, fig. 36 (Ehime, Japan); Nakabo 2002a: 595, key (Chiba, Misaki of Kanagawa, Kobe, Shimonoseki, Japan and Busan, Korea); Kitagawa *et al*. 2008: 60, unnumbered fig. [after Kanayama & Kitagawa (1982)] (Pacific coast of northern Honshu Is., Chiba, Kanagawa, Kobe, and Shimonoseki, Japan and Busan, Korea).
Sebastes nudus: Lindberg & Krasyukova 1987: 77, fig. 34 [after Matsubara (1943)] (Hakodate, Hokkaido, Japan and Qingdao, China).
Sebastes (*Sebastodes*) *nudus*: Barsukov 2003: 191, fig.82 (Qingdao, China).
Sebastichthys pachycephalus: Jordan & Starks 1904: (in part, Wakanoura, Kobe, Hiroshima, and Shimonoseki, Japan); Okada *et al*. 1935: 206 (in part, Hokkaido southward to Kyushu, Japan and Korean Peninsula; plate based on *S. pachycephalus*); Okada & Matsubara 1938: 306 (in part, Hokkaido southward to Kyushu, Japan and Korean Peninsula); Li 1955: 236, fig. 150 (Qingdao and Yantai, China).

Materials examined. 88 specimens, 23.2–212.8 mm SL. **Japan:** FAKU 352 (holotype of *S. p. nudus*), 198.5 mm SL, Hakodate, Hokkaido; FAKU 6317 (holotype of *S. p. chalcogrammus*), 261.8 mm SL, Shimonoseki, Yamaguchi; FAKU 6325, 115.0 mm SL, Kominato, Chiba; FAKU 6529, 130.3 mm SL, Kobe, Hyogo; FAKU 41969, 142.0 mm SL, Maizuru, Kyoto; FAKU 50141–50145, 50146–50150, 50153–50155, 84093, 84094, 96286, 133427–133430, 133433, 133434, 151.3–195.8 mm SL (21), Miyako, Iwate; FAKU 50151–50152, 50167, 118.8–125.2 mm SL (3), Yawatahama, Ehime; FAKU 70827, 135.0 mm SL, Tai, Maizuru, Kyoto, coll. R. Doiuchi; FAKU 82522, 82523, 84106, 84111, 84112, 85919, 85921, 97.1–167.3 mm SL (7), Ushitsu, Noto, Ishikawa, coll. Y. Kai and K. Sakai; FAKU 84036–84040, 131.1–181.7 mm SL (5), Otaru, Hokkaido; FAKU 84087, 84088, 84092, 149.1–174.8 mm SL (3), Kesennuma, Miyagi, coll. Y. Kai; FAKU 84089–84091, 156.0–169.3 mm SL (3), Kamaishi, Iwate, coll. Y. Kai; FAKU 84095–84099, 136.4–154.4 mm SL (5), coll. Y. Kai; FAKU 85917, 99.2 mm SL, Aki, Hiroshima, coll. K. Nozaki; FAKU 87653, 86.3 mm SL, Yatsuka, Shimane, coll. T. Morihisa; FAKU 130187, 138.8 mm SL, coll. K. Takatsu; FAKU 130486, 130487, 92.0–106.6 mm SL, Hakodate, Hokkaido, coll. Y. Kai; KAUM–I. 26561, 165.7 mm SL, Tobi-shima, Yamagata, coll. H. Motomura; NMCI–P. 1528, 1529, 102.2–124.6 mm SL (2), Ushitsu, Noto, Ishikawa; OMNH–P 3111, 23.2 mm SL, Kasumi, Hyogo, coll. Kasumi High School; OMNH–P 5859, 109.0 mm SL, Hamasaka, Hyogo, coll. A. Uno; OMNH–P 8586–8587, 108.9–114.4 mm

SL (2), Misaki, Osaka, coll. Osaka Fisheries Experimental Station; OMNH–P 13889, 133.2 mm SL, Himi, Toyama, coll. K. Hatooka; OMNH–P 14496–14497, 149.3–167.8 mm SL (2), Higashi-Tarumi, Kobe, Hyogo, coll. Y. Shibata. **South Korea:** FAKU 6337, 103094, 133289–133294, 133297, 133310, 126.2–212.8 mm SL (10), Busan. **Locality unknown:** FAKU 102295, 102297, 102298, 102300–102302, 102305, 104150, 133296, 133298, 63.3–174.7 mm SL (10).

Diagnosis. A species of *Sebastes* with the following characters: cranium armed dorsally with robust preocular, supraocular, postocular, and parietal spines; interorbital space concave; lower jaw without scales, shorter than upper jaw; base of dorsal fin lacking minute scales from below first to fifth or variously to posteriormost spine; body with two indistinct, darkish brown saddles; yellow or brownish-red markings on dorsum when fresh.

Description. Measurements as percentages of SL of the specimens examined are given in Table 1. Selected counts are given in Table 2.

Body relatively deep, moderately compressed anteriorly, progressively more compressed posteriorly. Nape and anterior body moderately convex. Tentacles absent on head and body, except for nostril tentacle. Head completely covered with ctenoid scales, except for tip of snout, maxillary, lacrimal, lower jaw, interopercle, and branchiostegal rays. Posterior part of maxillary sometimes with minute embedded scales. Body covered with ctenoid scales usually with some accessory scales in posterior field, except for pectoral fin base, prepelvic region and ventral abdominal surface. Embedded cycloid scales covering pectoral fin base and prepelvic region; remaining ventral abdominal surface covered with minute cycloid scales, usually with narrow naked area anteriorly. Base of entire spinous portion of dorsal fin typically naked, sometimes with minute scales below first to fifth or variously to posteriormost spine (Fig. 2B). Bases of soft-rayed portion of dorsal and anal fins covered with minute scales, usually extending onto basal membranes.

Mouth large, slightly oblique; posterior margin of maxilla reaching or nearly reaching (reaching in holotype) level with posterior margin of orbit. Maxilla covered with thick skin. Lower jaw shorter than upper jaw, without distinct symphysial knob. Upper and lower jaws with band of villiform teeth. Palatines and vomer with villiform teeth, latter forming V-shaped patch.

Nasal spine simple, sharp, directed dorsally. Preocular spine robust, well developed, directed dorsoposteriorly; tip of spine reaching or extending slightly beyond (reaching in holotype) level with anterior margin of pupil. Supraocular spine robust, well developed, directed posteriorly; tip of spine reaching or extending beyond (reaching in holotype) level with posterior margin of orbit. Postocular spines simple, directed dorsoposteriorly. Interorbital space concave without ridge, its width about half of orbit diameter. Parietal spine well developed, somewhat divergent posteriorly in dorsal view. Supracleithral spine simple, directed posteriorly. Upper posttemporal spines flattened, with embedded base, lower posttemporal spine absent. Sphenotic, tympanic, and pterotic spines absent. Sphenotic, tympanic, and pterotic spines absent. Lacrimal with round lobe anteriorly and one spine posteriorly; spine flattened, blunt, directed ventroposteriorly, its tip below level of anterior margin of pupil. Suborbital without spine or ridge. Preopercle with five spines; two uppermost spines large, directed posteriorly; third moderate, directed posteriorly; forth and fifth small, blunt, directed ventroposteriorly. Opercle with two simple flattened spines directed posteriorly; upper spine somewhat larger than lower spine.

Dorsal fin with 13 spines (rarely 12 or 14; 13 in holotype) and 10–13 (usually 12 including holotype) soft rays; all soft rays branched (first ray weakly branched). Dorsal-fin origin above anterodorsal portion of gill slit. Dorsal fin gradually increasing in height to fifth spine, decreasing thereafter to 12th spine; 13th spine somewhat larger than 12th, forming anterior support of soft-rayed portion of dorsal fin. Soft-rayed portion of dorsal fin with entire margin rounded; anterior rays longer (usually third or forth ray longest; third in holotype), posterior rays gradually shortening. Anal fin with three spines and six (rarely five or seven; five in holotype) soft rays; all soft rays branched. First anal-fin spine slightly posterior to last dorsal-fin spine; second spine robust, longest. Anterior rays on soft-rayed portion of anal fin longest; posterior margin rounded. Posterior margin of caudal fin rounded. Pectoral fin rounded; its tip not reaching posteriorly to level with anus; ventral 9–12 (usually 10 including holotype) rays unbranched and thickened. Posterior tip of depressed pelvic fin below tip of pectoral fin, rarely reaching anus.

Gill rakers short, blunt, longest raker in joint between cerato- and hypobranchial, length of preceding and succeeding rakers progressively shorter; ceratobranchial rakers usually seven, including holotype (rarely six), hypobranchial rakers 14–17 (14 in holotype), often rudimentary and united, being difficult to distinguish individually.

Color when fresh (Fig. 5). Head and body brown or beige dorsally and laterally, somewhat paler ventrally. Head with three dark brown irregular bands radiating from eye, sometimes with small yellow spots. Body usually with two indistinct faintly brown saddles; anteriormost positioned under fifth to 11th dorsal-fin spines, posterior saddle under soft-rayed portion of dorsal fin; irregular yellow or brownish-red markings often extending onto ventral part of body, and dorsal and anal fins (Figs. 5A, B); but sometimes small and indistinct (Figs. 5C–E), occasionally absent (Fig. 5F). Lower jaw, pectoral fin base, and prepelvic region without dark brown spots. Dorsal and anal fins brown or pale brown, sometimes with dark brown blotches; membranes of soft-rayed portion darker. Caudal fin brown or light brown, sometimes with yellow or brownish-red markings basally; membranes somewhat darker. Pectoral fin brown or pale brown with irregular brown markings basally; dorsoposterior portion dark; ventral half somewhat paler. Pelvic fin light brown; membranes somewhat darker.

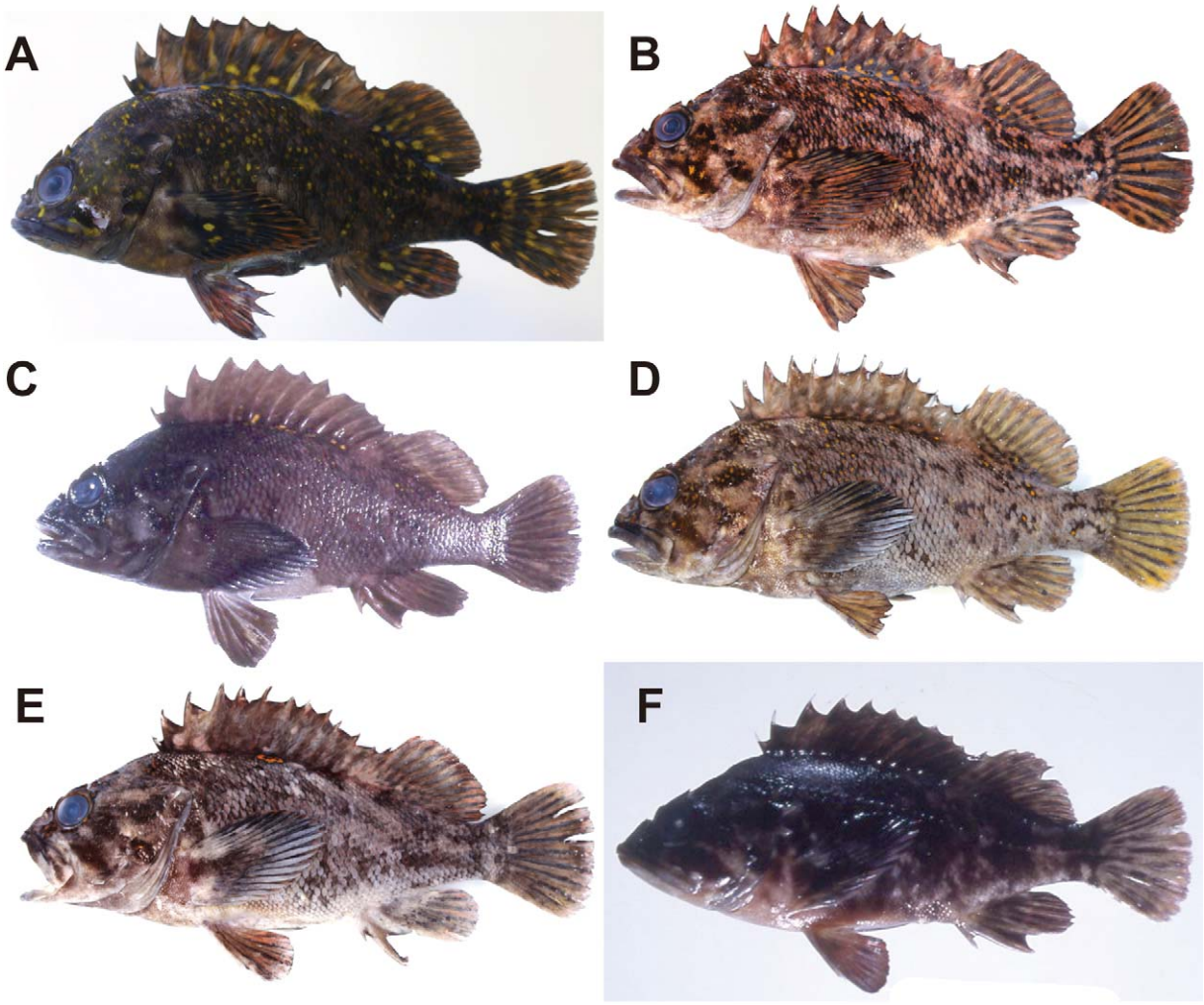

FIGURE 5. *Sebastes nudus* when fresh. (A) FAKU 13486, 92.0 mm SL, Hakodate, Hokkaido, Japan; (B) FAKU 133429, 162.5 mm SL, Miyako, Iwate, Japan; (C) FAKU 84037, 181.7 mm SL, Otaru, Hokkaido, Japan; (D) FAKU 133434, 166.3 mm SL, Miyako, Iwate, Japan; (E) FAKU 133430, 170.0 mm SL, Miyako, Iwate, Japan; (F) FAKU 84106, 97.1 mm SL, Noto, Ishikawa, Japan. All photographs by Y. Kai.

Color in preserved specimens (Fig. 2B). Head and body dark or gray dorsally and laterally, somewhat paler ventrally. Head with three irregular dark bands radiating from eye. Body with two indistinct dark saddles, extending onto dorsal fin. Yellow and brownish-red markings when fresh represented by pale or white markings when preserved.

Distribution (Fig. 3B). *Sebastes nudus* is presently known from southern Hokkaido southward along the Pacific coast of Japan to Kanagawa and along the Sea of Japan coast of Japan to northern Kyushu Is. and the Seto Inland Sea, in addition to the southern Korean Peninsula, and the Bohai and Yellow Seas. This species is solitary, inhabiting rocky reefs in shallow coastal waters.

Remarks. The present description of *S. nudus* is based on specimens genetically identified as “Species Nu-C”

in Kai et al. (2011), plus additional specimens not genetically examined here, but considered as conspecific with the former, due to their lacking scales below the dorsal-fin spines and having yellow or brownish-red markings on the dorsum (when fresh).

The names "*nudus*" and "*chalcogrammus*" first appeared in Matsubara (1943) as forms of *S. pachycephalus*, subsequently being recognized as subspecies of *S. pachycephalus* (see "Remarks" above under *S. pachycephalus*). The holotype of *S. pachycephalus nudus* (Fig. 6A) was characterized by a lack of minute scales below the entire spinous dorsal-fin base, and had 17 pectoral-fin rays (ventral 10 rays unbranched and thickened) on both sides, whereas the holotype of *S. p. chalcogrammus* (Fig. 6B) lacked minute scales below first to fifth dorsal-fin spine, and had 18 pectoral-fin rays (ventral 11 rays unbranched) on the left side and 17 (10) rays on the right side. The non-type specimens examined in this study all lacked minute scales below the dorsal-fin spine base (although sometimes with minute scales posteriorly from below the fifth spine) and usually had 17 pectoral-fin rays (ventral 10 rays unbranched) (Table 2), therefore considered as conspecific with the holotypes of *S. p. nudus* and *S. p. chalcogrammus*. In addition, the described above holotypes when fresh had yellow and brownish-red markings respectively (Matsubara 1943), similar to the present non-type specimens. Because all of these specimens represent a single taxon specifically distinct from *S. pachycephalus*, it is necessary to establish which of *S. p. nudus* and *S. p. chalcogrammus* has priority, both names having been newly proposed on the same date in the same publication (Matsubara 1943). However, Barsukov (2003) considered *S.* (*Sebastodes*) *nudus* as a valid species, having priority over *S. chalcogrammus*. Thus, we considered his action as a "determination by the first reviser" of ICZN (1999: Art. 24), and identified the present specimens as *S. nudus*. Although a detailed description of the species was not given in Barsukov (2003), a figure (based on a specimen collected from Qingdao) clearly showed pale markings on the dorsum, confirming its identity as *S. nudus*. As stated in "Remarks" under *S. pachycephalus*, the figures and descriptions of *S. pachycephalus nudus* and *S. p. chalcogrammus* given by Matsubara (1955, 1965) generally followed those of Matsubara (1943).

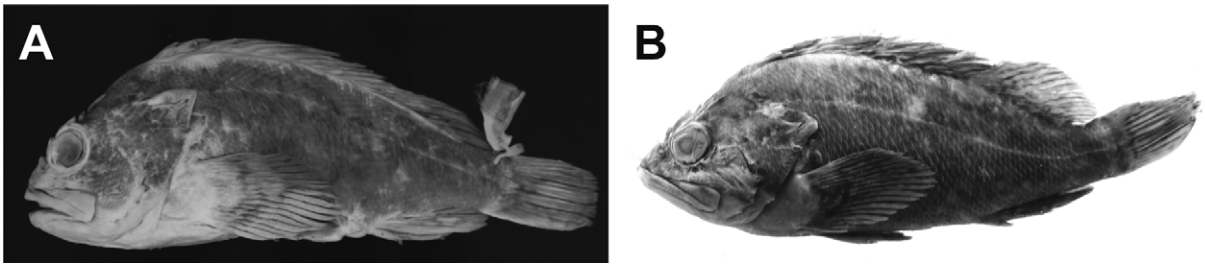

FIGURE 6. Type specimens of nominal species included under *Sebastes nudus*. (A) Holotype of *S. nudus*, FAKU 352, 198.5 mm SL; (B) holotype of *S. chalcogrammus*, FAKU 6317, 163.0 mm SL.

Lindberg & Krasyukova (1987) reported *Sebastes nudus* on the basis of two specimens collected from Hakodate, Japan and Qingdao, China. Except for the counts of the dorsal, anal and pectoral fins, and pored lateral line scales, their description followed Matsubara (1943). Judging from the pectoral fin count (17), those specimens were most likely to have been *S. nudus* as recognized here. In addition, the description of *S. pachycephalus chalcogrammus* given by Lindberg & Krasyukova (1987) followed that of Matsubara (1943).

Nakabo's (1993, 2000, 2002a) descriptions of four subspecies of *S. pachycephalus* (*S. p. pachycephalus*, S. *p. nigricans*, *S. p. nudus*, and *S. p. chalcogrammus*) generally followed Matsubara (1943). Although his description of *S. p. nudus* was based on FAKU W461 and that of *S. p. chalcogrammus* on FAKU 102296, FAKU 102299, and FAKU 102303, none of these specimens were available here. Judging from the descriptions given, both *S. p. nudus* and *S. p. chalcogrammus* of Nakabo (1993, 2000, 2002a) corresponded to *S. nudus* as recognized here, due to their lacking minute scales below the dorsal-fin spines. Nakabo (1993, 2000, 2002a) further distinguished *S. p. nudus* from *S. p. calcogrammus* on the basis of the former having yellow markings on the dorsum (vs. brownish-red markings in the latter), but such a difference has been shown by genetic analysis to represent intraspecific variation (Kai *et al*. 2011).

Descriptions and figures of *S. pachycephalus* given by Li (1955) and Cheng (1977) are undoubtedly attributable to *S. nudus* because of the yellow body markings. Similarly, the photos of *S. p.chalcogrammus* in Kanayama & Kitagawa (1982) and Kitagawa *et al*. (2008), apparently of the same specimen, are clearly *S. nudus*, owing to the reddish-yellow markings on the dorsum and dorsal, anal and caudal fins. Shimizu's (2001) description

of *S. pachycephalus chalcogrammus* as having a broad naked area below the dorsal-fin spines, 17 pectoral-fin rays, and brownish-red markings on the dorsum is also indicative of *S. nudus*. Although the descriptions of *S. pachycephalus* in Kim *et al*. (2004) and Kim *et al*. (2005b) were clearly based on both *S. pachycephalus* and *S. nudus*, the photos are identifiable as *S. nudus* because of the yellow markings on the dorsum. Although Amaoka *et al*. (2011) mentioned the color variations of *S. pachycephalus*, their figures were clearly of *S. nudus*, also because of the yellow and brownish-red markings on the dorsum.

The Japanese name "Ohgon-murasoi", first applied to the subspecies *S. p. nudus* by Matsubara (1955), is herein recognized as the standard Japanese name of *S. nudus*.

TABLE 3. Measurements and counts of hybrid specimens of *Sebastes pachycephalus* and *S. nudus*. Measurements expressed as percentages of standard length.

	FAKU 6319	FAKU 41980	FAKU 85922*	FAKU 86957*	NMCI-P 1527*
Standard length (mm)	119.0	173.2	128.8	128.8	122.7
Head length	40.3	38.4	42.7	41.1	41.5
Snout length	10.4	9.7	10.1	10.9	9.8
Orbit diameter	9.8	8.8	10.3	10.3	10.4
Interorbital width	5.7	5.7	5.1	6.0	4.8
Body depth	40.1	35.6	-	37.0	38.7
Body width	22.3	22.4	41.8	19.6	19.9
Caudal peduncle depth	11.2	11.4	11.3	11.4	10.2
Upper jaw length	19.6	19.8	20.9	21.8	20.1
Predorsal fin length	36.7	32.6	36.4	36.0	34.6
Preanal fin length	71.0	73.9	74.5	75.8	71.7
Pectoral fin length	-	28.0	30.0	31.0	30.6
Pelvic fin length	-	20.1	22.5	22.1	22.9
Pelvic-fin spine length	16.3	15.3	14.2	15.1	14.7
1st dorsal-fin spine length	6.2	7.5	6.6	6.8	5.6
2nd dorsal-fin spine length	10.0	11.5	10.7	10.4	9.5
3rd dorsal-fin spine length	15.0	15.7	13.7	14.3	13.2
4th dorsal-fin spine length	16.2	18.7	14.5	15.5	14.7
5th dorsal-fin spine length	17.0	18.1	17.1	15.6	14.4
12th dorsal-fin spine length	12.3	12.0	10.6	10.8	10.3
13th dorsal-fin spine length	11.5	11.5	12.0	12.6	11.9
Longest dorsal-fin ray length	18.3	16.9	18.3	18.7	17.7
1st anal-fin spine length	9.5	8.3	7.8	8.1	8.3
2nd anal-fin spine length	18.7	17.5	15.6	16.8	16.4
3rd anal-fin spine length	15.5	14.3	15.4	15.5	15.0
Distance between pelvic and anal fins	34.2	32.5	38.9	31.4	34.9
Upper caudal peduncle length	10.0	10.9	10.8	10.3	11.3
Lower caudal peduncle length	17.0	17.7	16.6	18.3	16.4
Counts					
Dorsal fin	XIII, 12	XIII, 12	XIII, 11	XIII, 12	XIII, 12
Anal fin	III, 6	III, 6	III, 6	III, 6	III, 6
Pectoral fin (left / right)	16 / 16	18 / 19	18 / 18	19 / 19	18 / 18
Pored lateral line scales	29	31	32	30	30

*: specimens genetically identified as hybrids in Kai *et al.* (2011).

Hybrids between *Sebastes pachycephalus* and *S. nudus*

Materials examined. 5 specimens, 119.0–173.2 mm SL, all from Japan: FAKU 6319, 119.0 mm SL, Shimonoseki, Yamaguchi; FAKU 41980, 173.2 mm SL, Maizuru, Kyoto; FAKU 85922, 86957, NMCI–P. 1527, 122.7–128.8 mm SL [3 specimens; all genetically identified as hybrids in Kai *et al*. (2011)], Noto, Ishikawa, coll. Y. Kai and K. Sakai.

Remarks. Counts and measurements of the hybrid specimens are shown in Tables 2 and 3 respectively. On the basis of genetic and morphological analyses, FAKU 85922 and 86957, and NMCI–P. 1527 were shown by Kai *et al*. (2011) to be hybrids of *S. pachycephalus* and *S. nudus*. FAKU 85922 had minute scales below the entire dorsal-fin spine base and dark spots the prepelvic region. Accordingly, Kai *et al*. (2011) initially identified the specimen as *S. p. pachycephalus sensu* Matsubara (1943) (= *S. pachycephalus* here). Similarly, FAKU 86957 and NMCI–P. 1527 had minute scales below the entire dorsal-fin spine base but lacked dark spots on the prepelvic region, and Kai *et al*. (2011) initially identified them as *S. p. nigricans sensu* Matsubara (1943) (= *S. pachycephalus* here). However, a principal co-ordinate analysis using genetic data indicated that all three specimens occupied intermediate positions between the two species. A principal component analysis based on morphometric characters also indicated that they occupied equivocal positions in Kai *et al*. (2011). Accordingly, they were judged to be hybrids (Kai *et al*. 2011).

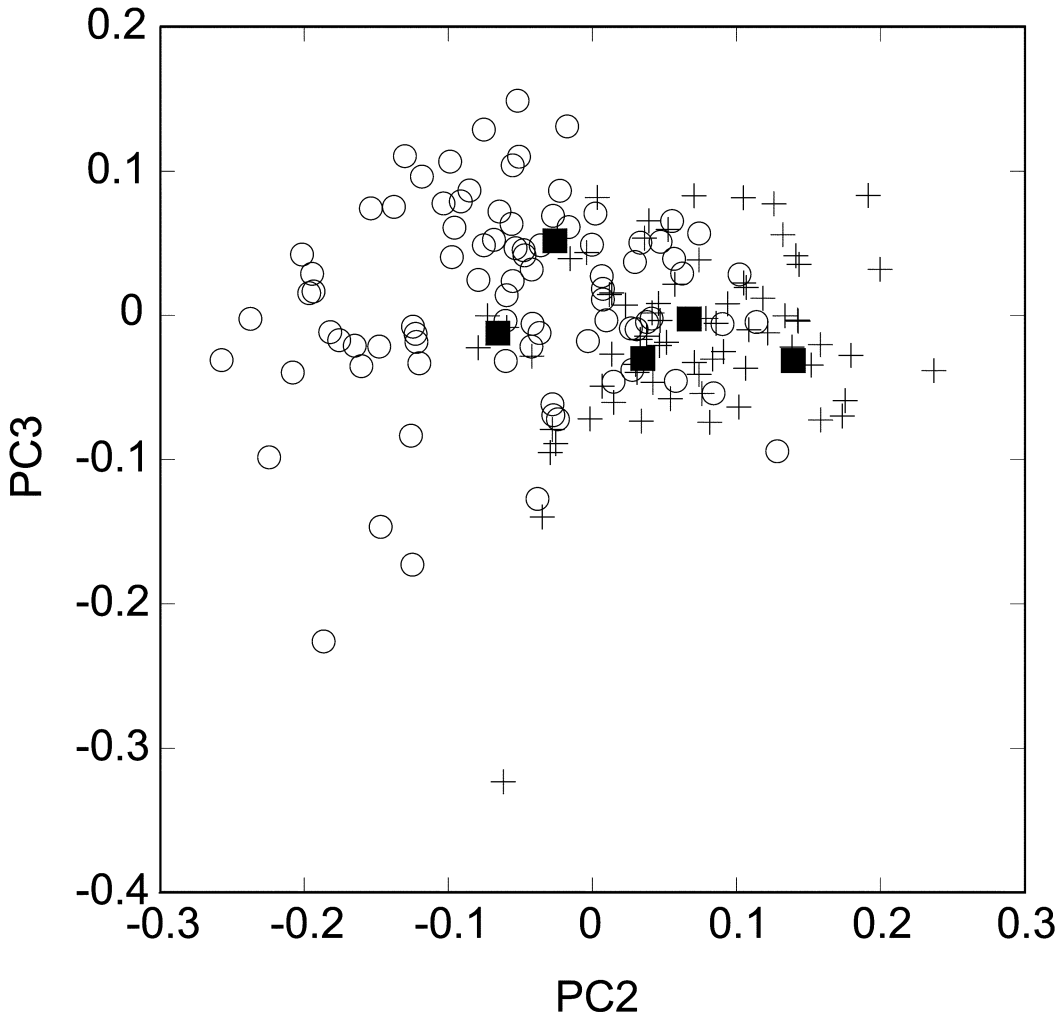

FIGURE 7. Plots of scores of principal components 2 and 3 based on 24 body measurements of the *Sebastes pachycephalus* complex: *S. pachycephalus* (open circles), *S. nudus* (crossed bars), hybrids (closed squares).

Although no genetic data was available for FAKU 6319 and FAKU 41980, both specimens had minute scales below the entire dorsal-fin spine base, pale markings on the dorsum (preserved condition), and no dark spots on the

dorsal, anal, and caudal fins, i.e. a combination of diagnostic characters of both *S. pachycephalus* and *S. nudus*. Accordingly, they were regarded as putative hybrid specimens of the two species.

For the principal component analysis (PCA) for the characterization of hybrid specimens, 24 morphometric characters were selected on the basis of having complete data sets for each specimen. Incomplete data sets resulted in the following characters not being considered: body depth, pectoral fin length, pelvic fin length, and longest dorsal-fin ray length. On this basis, data from 162 specimens was utilized. The first principal component accounted for 87.3% of variation, all loadings being positive; thus it was considered a size component. Principal components 2 and 3 were shape components, with both positive and negative loadings. Together, they accounted for an additional 16.5% of variation. These components were then visually assessed as dimensions of shape, thereby providing separation of *S. pachycephalus* and *S. nudus* (Fig. 7). PC2 was heavily loaded on the length of the first and second dorsal-fin spines, PC3 being loaded on interorbital width and length of the third anal-fin spine. Four of the five putative hybrid specimens fell into an equivocal position between *S. pachycephalus* and *S. nudus*, the fifth specimen (FAKU 41980) falling within the area of *S. nudus* specimens (Fig. 7). Although that specimen had diagnostic characters of both *S. pachycephalus* and *S. nudus*, the result of the PCA suggested it to be rather closer to *S. nudus* in morphometric characters.

Discussion

Sebastes pachycephalus and *S. nudus* are very similar in having robust head spines, a concave interorbital space, short lower jaw lacking scales, thickened rays in the ventral half of the pectoral fin, the dorsal fin usually with 13 spines and 12 rays, the anal fin with three spines and six rays, and usually 29–33 pored lateral line scales. However, the former is distinguishable from the latter in having minute scales below the entire dorsal-fin spine base (vs. lacking minute scales below first to fifth or variously to the posteriormost spine in the latter), dark spots scattered on the dorsal, anal and caudal fins (vs. no distinct dark spots), and lacking distinct colored markings on the dorsum (vs. yellow or reddish-brown markings present). Besides differences in scalation below the dorsal-fin spine base and coloration, *S. pachycephalus* differed from *S. nudus* in usually having 17–19 (mode 18) pectoral-fin rays (vs. 16–18, mode 17, in the latter) (Table 2) and longer dorsal-fin spines (Table 1).

Despite the confirmed existence of two valid, specifically distinct taxa (*S. pachycephalus* and *S. nudus*), their reproductive barrier is not yet completely effective, making discrimination of the two species somewhat difficult. In the present study, a total of 198 specimens were examined, with at least five (2.5%) being considered as hybrids. However, the range of similarity values detected among the species suggests that such hybrids are sufficiently viable to backcross with members of one of the source species. It is significant that interspecific hybridization has frequently been reported within *Sebastes* (eg., Seeb 1998; Roques *et al*. 2001; Buonaccorsi *et al*. 2005; Hyde *et al*. 2008; Orr & Hawkins 2008), Roques *et al*. (2001), in particular, presenting evidence for a high frequency (15%) of introgression between two North Atlantic species, *Sebastes mentella* Travin 1951 and *S. fasciatus* Storer 1854, within a region of distribution overlap.

The distributional range of *S. pachycephalus* differs somewhat from that of *S. nudus*, being more southerly (Fig. 3). In the Japanese Archipelago, the northern limit of *S. pachycephalus* was northern Honshu Island (Aomori) and the southern limit, southern Kyushu Island (the Kagoshima Bay). In contrast, the northern limit of *S. nudus* was southern Hokkaido, and the southern limit, Chiba (Pacific coast) and northern Kyushu Island (Sea of Japan coast). Such a distributional pattern may be strongly influenced by the warm Kuroshio Current, flowing along the Pacific coast of southern Japan (from southern Kyushu Island southeast off Shikoku Island to Chiba; see Fig. 3). Significantly, *S. nudus* was absent from the area influenced by the Kuroshio. Distributional patterns of the two species may indicate differences in their water temperature preferences.

Within *Sebastes*, bathymetric segregation between sister species is well known, depth and the patchy distribution of rocky habitats often being considered to play a significant role in the speciation process (Larson 1980; Barsukov 1981; Hyde *et al*. 2008). However, specimens of *S. pachycephalus* and *S. nudus* examined here were sometimes collected in the same gillnet, and therefore any bathymetric segregation between the two species is probably weak, if present at all. However, detailed ecological studies of interspecific competition, habitat selection, and bathymetric segregation may give some insight into speciation and reproductive isolation mechanisms operating between *S. pachycephalus* and *S. nudus*.

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