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FULL PAPER

A new species of the grenadier genus *Coryphaenoides* (Actinopterygii: Gadiformes: Macrouridae) from Japan and a range extension of *Coryphaenoides rudis* Günther 1878 in the northwestern Pacific

Naohide Nakayama[1,2] · **Hiromitsu Endo**[1]

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Abstract A new species of grenadier, *Coryphaenoides soyoae*, is described from two specimens collected from the Shichito-Iojima Ridge (type locality) and off Fukushima, Honshu, Japan, at depths of 2740–2991 m. The new species belongs to the subgenus *Coryphaenoides* and is most similar to *Coryphaenoides castaneus* Shcherbachev and Iwamoto 1995 and *Coryphaenoides longicirrhus* (Gilbert 1905). It differs from all other congeners in having the following combination of features: pelvic-fin rays 11; snout short, scarcely protruding beyond upper jaw; terminal snout scute absent; scales on lateral angles of snout and head ridges only slightly enlarged and thickened; dorsal contour of head prominently humped over nape; posterior end of upper jaw extending to below hind 1/3 of orbit or beyond; posterior end of rictus not restricted by lip folds; outer gill slit greatly restricted, length 7–8 % of head length (HL); barbel length 11–15 % HL; head bones and body flesh firm; teeth in posteriorly tapering bands on both jaws, with outer premaxillary series enlarged; body scales not deciduous, covered with narrowly divergent rows of needle-like spinules, and the last spinule in each row greatly overlapping posterior scale margin; snout fully scaled dorsally, broadly naked ventrally; interdorsal space slightly less than first dorsal-fin base length; origins of second dorsal and anal fins on about same vertical; height of first dorsal fin 87 % HL; second spinous ray of first dorsal fin serrated along its leading edge; outer pelvic-fin ray greatly prolonged, its tip extending well beyond anal-fin origin; head and body uniformly blackish. In addition, *Coryphaenoides rudis* Günther 1878 is recorded for the first time from Japan, based on six specimens collected from Hyuga-nada, Suruga Bay, and the west of Minami-torishima Island (=Marcus Island), at depths of 1100–1481 m. A previous record of this species from Japanese waters was based on a misidentified specimen of a different genus.

Keywords *Coryphaenoides soyoae* · *Coryphaenoides rudis* · Taxonomy · Distribution · Japanese Archipelago

Introduction

The grenadier genus *Coryphaenoides* Gunnerus 1765, which is the second largest group of the gadiform fish family Macrouridae, is widely known from continental slopes to hadal depths of the world's oceans (Iwamoto 1990; Iwamoto et al. 2015). According to Eschmeyer and Fricke (2016), at least 65 species are currently regarded as valid, but some of these will be eventually synonymized with other species (NN unpubl. data). The genus is well represented in the northwestern Pacific, with 13 species recorded from the Japanese Archipelago (Nakabo and Kai 2013). Due to the lack of distinctive diagnostic characters, species of *Coryphaenoides* may be mistakenly confused with those of other genera, especially when young. However, the genus is readily diagnosed within the family by

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✉ Naohide Nakayama
gadiformes@gmail.com

[1] Laboratory of Marine Biology, Faculty of Science, Kochi University, 2-5-1 Akebono-cho, Kochi 780-8520, Japan

[2] Present Address: The Kyoto University Museum, Kyoto University, Yoshida, Sakyo, Kyoto 606-8501, Japan

the following combination of features: light organ and ventral striae absent; anus immediately before anal-fin origin; second spinous ray of first dorsal fin usually serrated along its leading edge; infraorbital ridge not connected with preopercular ridge; reticulate structure absent on body scales; chin barbel present; and six branchiostegal rays (Iwamoto and Stein 1974; Iwamoto and Sazonov 1988; Iwamoto 1990; this study).

During our study of Japanese grenadiers, two specimens of a unique *Coryphaenoides* were found among the collections of the Laboratory of Marine Biology, Faculty of Science, Kochi University (BSKU), and the National Museum of Nature and Science, Tsukuba (NSMT). Each specimen was originally collected on the lower continental slope at the Shichito-Iojima Ridge (2740 m) and off Fukushima, Honshu (2948–2991 m), respectively. A further examination revealed that they represent an undescribed species, and we herein describe it as new to science. In addition, *Coryphaenoides rudis* Günther 1878 is reported here for the first time from Japan, based on six specimens collected from Hyuga-nada, Suruga Bay, and off Minami-torishima Island (=Marcus Island), at depths of 1100–1481 m. A previous record of *C. rudis* from Japanese waters is also discussed, with comments on the type specimens of this species.

Materials and methods

Methods for counts and measurements follow procedures described by Iwamoto (1970) and Iwamoto and Sazonov (1988). Head and total lengths are expressed as HL and TL, respectively. The terminology of the head ridges is as redefined by Nakayama et al. (2015). In addition to a standard binocular microscope, a scanning electron microscope (SEM) was used to examine the fine structure of the body scales. Methods for SEM preparation follow Roberts (1993). SEM photos were taken at the Center for Advanced Marine Core Research, Kochi University. Institutional abbreviations follow Fricke and Eschmeyer (2016).

Comparative materials examined. Coryphaenoides asper: BMNH 1887.12.7.88, syntype (not holotype; NN unpubl. data), 65.7 mm HL, 316+ mm TL, off Boso Peninsula, Japan, 34°37′00″N, 140°32′00″E, 3429 m depth, *Challenger* sta. 237, 17 June 1875. *Coryphaenoides castaneus*: CAS 71486, holotype, 95.4 mm HL, 416+ mm TL, Ninety-Degree East Ridge, central Indian Ocean, 14°42.4′S, 86°49.4′E, 1760 m, R/V *Prof. Mesiatzev*, cr. 7, tr. 12, 19 March 1979. *Coryphaenoides longicirrhus*: USNM 51592, holotype, 126 mm HL, 586+ mm TL, off Kauai Island, Hawaii, 22°04′45″N, 159°16′05″W, 1829–2404 m depth, *Albatross* sta. 4185, 13 August 1902; and BPBM 3429, 1 specimen, 197 mm HL, 827+ mm TL, Honolulu fish market, Hawaii, 10 February 1927.

Coryphaenoides soyoae sp. nov.

(New English name: Black grenadier; new Japanese name: Kuro-hige) (Figs. 1, 2a–c; Table 1).

Synonym none.

Holotype. BSKU 20297, 120 mm HL, 578+ mm TL, south–southeast of Torishima Island, Shichito-Iojima Ridge, 30°00.0′N, 140°32.5′E, 2740 m depth, FRV *Soyo-maru*, sta. 4, bottom trawl, 18 November 1972.

Paratype. NSMT-P 78018, 73.7 mm HL, 365+ mm TL, off Onahama, Fukushima, Honshu, Japan, 36°48.3′N, 142°22.3′E, 2948–2991 m depth, FRV *Soyo-maru*, cr. SO-07-02, benthos net, coll. by H. Saitoh and M. Okanishi, 2 August 2007.

Diagnosis. Pelvic-fin rays 11. Snout bluntly pointed, scarcely protruding beyond upper jaw. Terminal snout scute absent; scales on lateral angles of snout and head ridges only slightly enlarged and thickened. Dorsal contour of head prominently humped over nape. Mouth large, posterior end of upper jaw extending to below hind 1/3 of orbit or beyond; posterior end of rictus not restricted by lip folds. Outer gill slit greatly restricted, length 7–8 % HL. Barbel long, slender, length 11–15 % HL. Head bones stout; body flesh firm. Teeth in posteriorly tapering bands on both jaws, with outer premaxillary series distinctly enlarged. Body scales not deciduous, covered with narrowly divergent rows of long, slender, moderately reclined, needle-like spinules; tip of the last spinule in each row extending well beyond posterior scale margin. Snout fully scaled dorsally, broadly naked ventrally. Interdorsal space slightly less than first dorsal-fin base length; origins of second dorsal and anal fins on about same vertical. Height of first dorsal fin 87 % HL; second spinous ray serrated along leading edge. Outer pelvic-fin ray greatly prolonged, extending well beyond anal-fin origin. Head and body uniformly blackish.

Description. General features are shown in Fig. 1. Counts and measurements are given in Table 1. The following description is based on the holotype (with data and comments on the paratype in parentheses). Body deepest at first dorsal-fin origin, gradually tapering to end of tail. Trunk short, moderately compressed, width over pectoral-fin bases 1.6 (1.8) in depth at first dorsal-fin origin. Head large, HL about 4.8 (5.0) in TL; head bones fairly stout; flesh firm. Supraoccipital crest high, giving humpback appearance to dorsal contour of predorsal area, forming a distinct depression above orbits. Snout short, scarcely protruding beyond upper jaw, length 1.4 times orbit diameter; ventral contour steep in

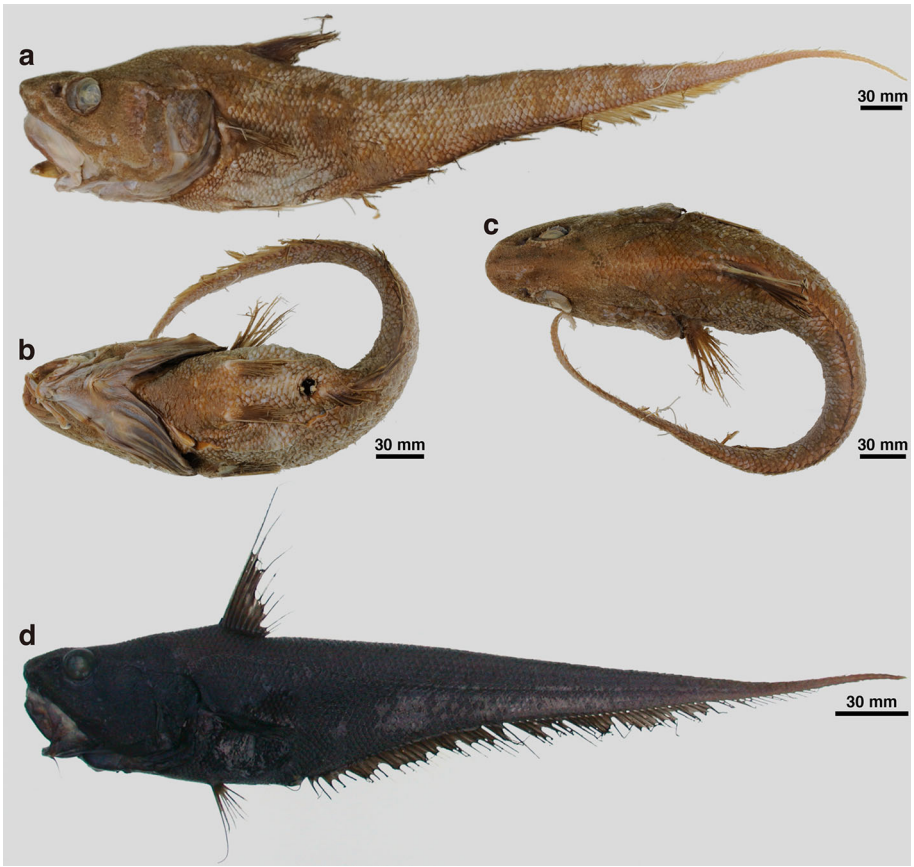

Fig. 1 *Coryphaenoides soyoae*. **a–c** BSKU 20297, holotype, 120 mm HL, 578+ mm TL, Shichito-Iojima Ridge, 2740 m depth, preserved condition; **d** NSMT-P 78018, paratype, 73.7 mm HL, 365+ mm TL, off Fukushima, 2948–2991 m depth, fresh condition (Photo: NSMT). **a, d** Lateral views of entire specimens; **b** dorsal and **c** ventral views of the head and trunk

lateral view; snout high, its tip above horizontal through midorbit. Orbit small, circular, greatest diameter 2.8 (2.7) in postorbital length. Interorbital space slightly concave, width 0.8 in orbit diameter. Mouth large, subinferior, upper jaw length 0.5 (0.6) in orbit diameter; posterior end of maxilla almost reaching vertical through hind rim of orbit (posterior 1/3 of orbit); posterior end of rictus not restricted by lip folds; lips moderately thick, highly papillose near tooth bands (lips thin, slightly papillose). Suborbital region weakly ridged; upper half almost vertical, lower half moderately inclined mesially. Preopercle large, posterior margin slightly inclined from vertical, forming a moderate lobe posteroventrally; preopercular ridge low, with a distinct backward extension at an angle. Interopercle mostly hidden behind preopercle, but posterior portion exposed as a broad tab. Subopercle and opercle closely adjoined, their margins smoothly curved. Gill membranes narrowly connected across and attached mesially to isthmus, with a posterior free fold; gill opening wide, extending forward to below posterior margin of lower jaw. Outer gill slit greatly restricted by folds of skin, length 2.4 (3.0) in orbit diameter. Gill rakers small, low, tubercular, tipped with short, slender spines; those on outer side of first arch much smaller than others. Gill filaments of moderate length. Barbel long, slender, length 1.8 (1.4) in orbit diameter.

Anus immediately before anal-fin origin; periproct (naked skin surrounding anus) poorly developed; ventral light organ absent.

Teeth short, conical, slender, in posteriorly tapering bands on premaxillary and dentary; posterior end of tooth bands falling short of posterior end of rictus. Premaxillary teeth with about six (five) tooth rows at widest point near symphysis; outer series distinctly enlarged. No teeth on vomer and palatines. Mandibular band much narrower than premaxillary, with about four tooth rows anteriorly; height of the teeth gradually increasing inwardly, but no teeth significantly enlarged. All teeth deeply embedded in thick layer of gum papillae (gum papillae poorly developed).

Body scales large, thin, not highly deciduous, covered with long, slender, moderately reclined, needle-like spinules in narrowly divergent rows (subparallel rows) (Fig. 2a–c); those on dorsum below interdorsal space with 8–9 (5–6) rows of spinules; height of spinules increasing posteriorly, with last spinules extending well beyond posterior scale margin; spinules of each row greatly overlapping, but free from one another; lateral buttresses barely developed; no reticulate structure on scale surfaces. Body completely and uniformly scaled except for fins.

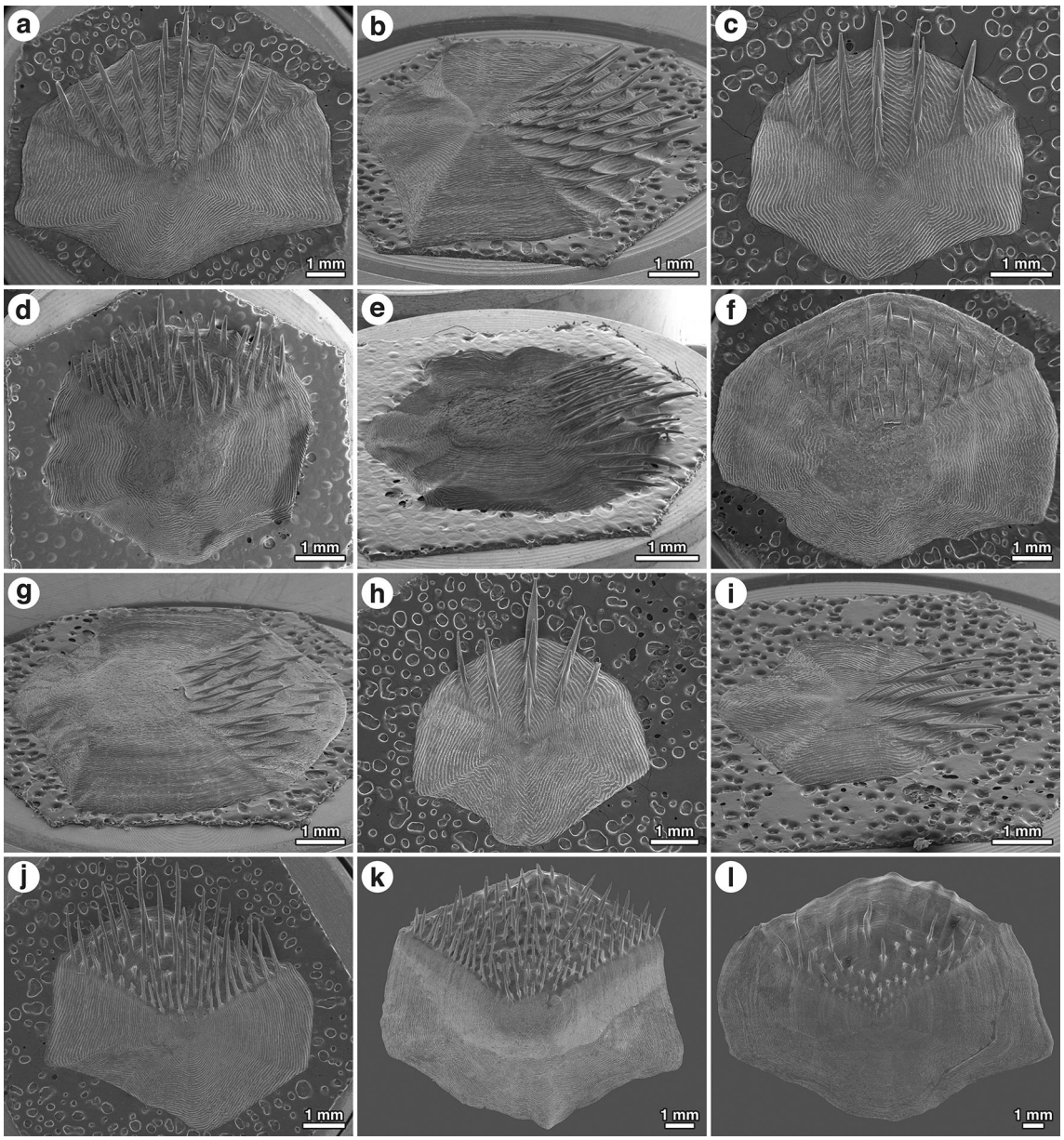

Fig. 2 Scanning electron micrographs showing body scales (from the dorsum below the interdorsal space) of five species *Coryphaenoides*. **a**–**b** *C. soyoae*, BSKU 20297, holotype, 120 mm HL; **c** *C. soyoae*, NSMT-P 78018, paratype, 73.7 mm HL; **d**–**e** *C. castaneus*, CAS 71486, holotype, 95.4 mm HL (Photo: NSMT); **f**–**g** *C. longicirrhus*, USNM 51592, holotype, 126 mm HL; **h**–**i** *C. asper*, BMNH 1887.12.7.88, syntype, 65.7 mm HL; **j** *C. rudis*, BSKU 49468, 120 mm HL; **k** *C. rudis*, BMNH 1887.12.7.74, lectotype, 168 mm HL; **l** *C. rudis*, HUMZ 72029, 248 mm HL. **a**, **c**, **d**, **f**, **h**, **j**–**l** Views from above; **b**, **e**, **g**, **i** oblique views

Scales on head ridges much larger and more thickened than those around, but not especially marked. Terminal snout scute absent; lateral angles of snout armed with small, but stout modified scales. Head scales covered with short, erect, needle-like spinules in widely divergent, comb-like ridges. Head almost completely scaled; underside of snout naked from its tip to vertical through anterior margin of orbit; other naked areas confined to anterior 1/3 of mandibular rami, exposed portion of interopercle, skin around anterior nostril, and gular and branchiostegal membranes.

No open pores on cephalic sensory canals. Free neuromasts scattered on head, most densely on underside of snout, lower suborbital region, and mandibular rami. Lateral line not interrupted throughout, but originating 1–2 scales behind end of temporal canal.

First dorsal-fin origin slightly behind pectoral- and pelvic-fin bases, the latter two on about same vertical. First

Table 1 Measurements and counts for four species of *Coryphaenoides*

Species	*C. soyoae*		*C. castaneus*		*C. longicirrhus*		*C. asper*
Type status Number of specimens	HT $n = 1$	PT $n = 1$	HT $n = 1$	HT + PT* $n = 3$	HT $n = 1$	NT $n = 1$	ST $n = 1$
Measurements (mm)							
TL	578+	365+	416	412–740+	586+	827+	316+
HL	120	73.7	95.4	95–159	126	197	65.7
% of HL							
Snout length	27	29	27	27–28	30	29	28
Orbit diameter	20	21	21	(18)20–23	22	19	23
Postorbital length	56	55	54	54–56	54	56	54
Postrostral length	74	74	74	75–76	73	74	76
Orbit–preopercle distance	49	49	51	51–53	51	53	51
Suborbital width	13	14	13	13–14	14	15	15
Upper-jaw length	40	35	36	38–42	38	39	35
Preoral length	14	12	14	12–14	12	12	13
Internasal width	20	23	23	22–24	24	24	–
Interorbital width	24	27	25	24–27(29)	29	29	28
Body width over P. bases	56	48	54	–	57	–	54
Body depth at 1D. origin	89	85	79	81–89	88	86	93
Body depth at A. origin	70	76	65	–	72	71	77
Pre-V. length	116	110	121	–	124	124	–
Pre-anus length	159	152	155	–	162	–	–
Pre-A. length	165	158	163	163–164	165	166	–
Isthmus–V. distance	46	45	46	–	51	46	50
V.–A. distance	43	52	49	–	49	53	–
V. length	83	66	122	61–122	117	75	85
P. length	–	49	48	50–54	62	49	62
Pre-1D. length	116	109	111	–	117	117	112
Height of 1D.	87	–	–	77	96	77	109
Length of 1D. base	28	27	23	–	27	19	27
Interdorsal length	24	23	19	18–27	29	44	22
Length of gill slit	8	7	7	6–8	8	7	10
Length of posterior nostril	6	6	6	5–6	6	5	7
Barbel length	11	15	16	16–23	18	20	12
Counts							
1D. rays	II, 10	II, 9	II, 10	II, 10–11	II, 10	II, 9	II, 11
P. rays	i19–i20	i21–i22	i19–i20	i18–i20	i21–i22	i20–i21	i24
V. rays	11	11	10	10	11	10	11–12
Outer GR on first arch	5–6	6	4	3–4	6	4	5–6
Inner GR on first arch	11–12	11	9	9	10	9–11	10–11
Outer GR on second arch	9	8–9	8	7–8	8	9	8–9
Inner GR on second arch	10	10	9	8–10	9	9	9–11
Lateral-line scales	37	34	41	34–39	34	36	36
Scales below 1D. origin	7	7.5	7.5	5.5–7.5	7.5	8	7–8
Scales below 1D. midbase	5	4	7	4.5–6	6	5.5	5
Scales below 2D. origin	7	7	6	7–8	6	5.5	6–7

HT holotype, *PT* paratype, *ST* syntype, *NT* non-type, *1D.* first dorsal fin, *2D.* second dorsal fin, *P.* pectoral fin, *V.* pelvic fin, *A.* anal fin, *GR* gill rakers

* Shcherbachev and Iwamoto (1995)

dorsal fin well developed, with moderately elongated second spinous ray; its height 1.3 times as long as its base length (tip broken); leading edge of second spinous ray armed with short, bluntly pointed, greatly reclined denticles. Second dorsal fin moderately separated from first dorsal, interdorsal space 0.8 (0.9) times first dorsal-fin base length. Outer pelvic-fin ray greatly elongated, its tip reaching base of 12th anal-fin ray when laid back (tip broken). Origin of anal fin just below that of second dorsal fin.

Color when fresh (Fig. 1d). Head, body, and fins uniformly blackish.

Color in 70 % ethanol after fixation (Fig. 1a–c). Almost same as in fresh condition; head, body, and fins uniformly chocolate brown; oral and gill cavities blackish; gill rakers and arches dusky, filaments yellowish brown.

Distribution. Known only from the Shichito-Iojima Ridge (type locality) and off Onahama, Fukushima, Honshu, Japan, at depths of 2740–2991 m (Fig. 3).

Etymology. Named for *Soyo-maru*, a fisheries research vessel of the National Research Institute of Fisheries Science, on which the type specimens of the new species were collected.

Remarks. To avoid further damage to the type specimens, the morphology of the swim bladder was not examined in this study. The holotype had already been dissected by someone, with its internal organs removed (and missing).

Coryphaenoides soyoae belongs to the catch-all subgenus *Coryphaenoides* (sensu Iwamoto 1990) in having the following combination of features: teeth in broad, posteriorly tapering bands on both jaws, with outer premaxillary series enlarged; origins of second dorsal and anal fins on about same vertical; head bones and body flesh firm; dorsal surface of snout fully scaled; and body scales not highly deciduous.

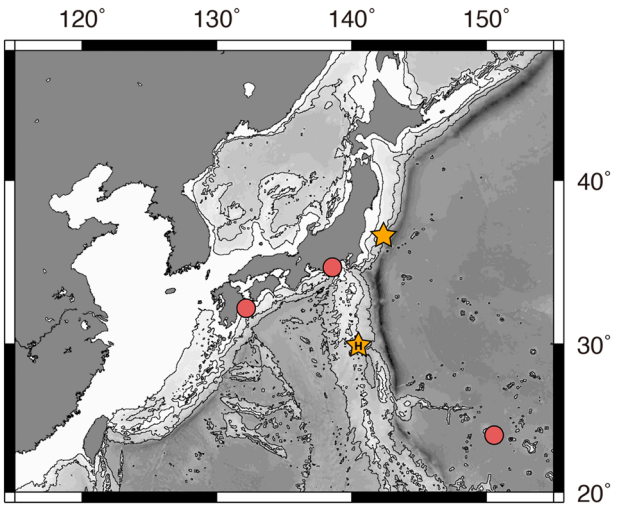

Fig. 3 Map of the northwestern Pacific off Japan showing distribution of *C. soyoae* (*orange stars*) and *C. rudis* (*red circles*) in the area. *H* indicates the type locality

The new species is most similar to *Coryphaenoides castaneus* Shcherbachev and Iwamoto 1995 known only from the Ninety East Ridge in the Indian Ocean and *Coryphaenoides longicirrhus* (Gilbert 1905) restricted to the Hawaiian Archipelago. These three species are distinguished from other members of the subgenus by having the combination of 10–11 pelvic-fin rays; head fairly deep, with moderate hump over nape; snout short, slightly protruding beyond upper jaw; orbit small, circular (18–23 % HL); chin barbel well developed (11–23 % HL); mouth large, posterior end of maxilla extending to below midorbit or beyond; first dorsal fin well developed (77–96 % HL), but second spinous ray not greatly prolonged; gill opening not restricted ventrally; outer gill slit greatly restricted by skin folds (6–8 % HL); body scales large, 5.5–8 scales between second dorsal-fin origin and lateral line; dorsal surface of head completely scaled; ventral surface of snout naked (except for large specimens of *C. longicirrhus*); and head and body uniformly black.

Coryphaenoides soyoae differs most notably from *C. castaneus* and *C. longicirrhus* in scale spinulation. In *C. soyoae*, the body scales are covered with narrowly divergent rows of spinules (Fig. 2a–c), whereas in the latter two species, the spinules, are arranged in irregular convergent rows (Fig. 2d–g). It also differs from *C. longicirrhus* in having much longer spinules, with the last spinule in each row greatly overlapping the posterior scale margin. The spinules of *C. longicirrhus*, by contrast, are fairly short and rudimentary so that the tips of the last spinules fall short of the posterior scale margin (Fig. 2f–g). The new species further differs from *C. castaneus* and *C. longicirrhus* in the absence of the terminal snout scute (vs. present, although the scute is fairly small and not prominently marked in the holotypes of the latter two species). Furthermore, *C. soyoae* has more gill rakers on the first arch as compared with *C. castaneus* (5–6 vs. 3–4 on the outer side; 11–12 vs. 9 on the inner side), and its body scales are much larger than those of *C. longicirrhus* (transverse scale rows below the first dorsal-fin midbase 4–5 vs. 5.5–6). It also differs from those two species in having a narrower cheek (orbit–preopercle distance 49 % HL in *C. soyoae* vs. 51–53 % in both *C. castaneus* and *C. longicirrhus*) and a shorter chin barbel (11–15 % HL vs. 16–23 % in *C. castaneus*, 18–20 % in *C. longicirrhus*), and from *C. longicirrhus* in having a narrower interorbital space (24–27 % HL vs. 29 %) and a shorter interdorsal length (23–24 % HL vs. 29–44 %).

Regarding other congeners, *C. soyoae* is similar in general appearance to *Coryphaenoides alateralis* Marshall and Iwamoto 1973 and *Coryphaenoides thelestomus* Maul 1951, both known only from the Atlantic Ocean.

Coryphaenoides alateralis is not likely to be confused with the new species in the absence of a grooved lateral line on the body (vs. present), whereas *C. thelestomus* readily differs from *C. soyoae* in having lower counts of gill rakers (8–9 vs. 11–12 on the inner side of the first gill arch), a shorter snout (23–26 % HL vs. 27–29 %), a wider interorbital space (27–33 % HL vs. 24–27 %), and a longer pectoral fin (57–59 % HL vs. 49 %). Those two species are further distinguished from *C. soyoae* by having eight pelvic-fin rays (vs. 11), a longer barbel (22–23 % HL in *C. alateralis*, 24–30 % in *C. thelestomus* vs. 11–15 %), and a greatly elongated outer pelvic-fin ray (pelvic-fin length 129–137 % and 86–150 % HL respectively vs. 66–83 %). Data for *C. alateralis* and *C. thelestomus* were based on Marshall and Iwamoto (1973) and Crabtree (1983).

Among Japanese congeners, *C. soyoae* closely resembles *C. rudis*, which is newly reported from Japan in this paper; these species are compared in detail below in the Remarks of the latter species. The new species is also similar to *Coryphaenoides asper* Günther 1877 known only from a single specimen collected from Japan (NN pers. observ.). They share most of the diagnostic characters distinguishing the latter species from its congeners, but *C. soyoae* differs notably from *C. asper* in scale morphology. The scale spinules of the new species are much shorter as compared with *C. asper*, giving a fairly smooth texture to the head and body surfaces. The spinules of *C. asper* (Fig. 2h–i), by contrast, are definitively longer and more erect (especially on the head scales), with the middle row fairly enlarged, giving a more spiny appearance to the head and body; this characteristic spinulation somewhat resembles that of the genus *Trachonurus* (see Günther 1887: pl. XXVI). Although the relative length of the scale spinules generally decreases with growth in *Coryphaenoides* (NN pers. observ., see also Fig. 2j–l for *C. rudis*), the paratype of the new species (73.7 mm HL) is almost equal in size to the syntype of *C. asper* (65.7 mm HL); thus, the above differences are unlikely to reflect ontogenetic variation. These two species are also distinguished from each other by physiognomy. In *C. soyoae*, the dorsal contour of the head is prominently humped over the nape, with a distinct depression above the orbits (Fig. 1a, d), whereas the predorsal contour of *C. asper* is smoothly curved from the snout tip to the first dorsal-fin origin (see Günther 1887: pl. XXXVI, fig. A). The new species further differs from *C. asper* in having a smaller orbit (20–21 % HL vs. 23 %), a narrower cheek (49 % HL vs. 51 %), a shorter pectoral fin (49 % HL vs. 62 %), a lower first dorsal fin (87 % HL vs. 109 %), a more restricted outer gill slit (7–8 % HL vs. 10 %), and lower counts of pectoral-fin rays (i19–i22 vs. i24). The differences in morphometric and meristic characters appear to warrant specific separation of the new species from *C. asper*, although these differences should be confirmed when more specimens become available. The first author has prepared a review of Japanese grenadiers, in which a redescription of *C. asper* will be provided.

Coryphaenoides rudis Günther 1878

[English name: Rudis rattail (based on Froese and Pauly 2015); new Japanese name: Daikoku-hige] (Figs. 2j–l, 4; Table 2).

Coryphaenoides rudis Günther 1878:24 (original description; type locality: west of Kermadec Islands, southwestern Pacific, 28°33′0″S, 177°50′0″E, 1097 m depth, *Challenger* sta. 171).

Macrourus paradoxus Smith and Radcliffe *in* Radcliffe 1912:115, pl. 25, fig. 1 (original description; type locality: east of Palawan Island, Sulu Sea, 9°13′00″N, 118°51′15″E, 2021 m depth, *Albatross* sta. 5428).

Nematonurus macrocephalus Maul 1951:17, figs. 3, 4c (original description; type locality: off Madeira, 600–1000 m depth).

Materials examined. Lectotype: BMNH 1887.12.7.74, 168 mm HL, 814+ mm TL, west of Kermadec Islands, 28°33′0″S, 177°50′0″E, 1097 m depth, *Challenger* sta. 171, 15 July 1874. JAPAN: BSKU 49468, 49570, and 49577, 3 specimens, 64.8–127 mm HL, 322+–599+ mm TL, off Miyazaki, Hyuga-nada, 32°18.5′N, 132°10.9′E, 1453–1481 m depth, R/V *Shinkai-maru*, 3 April 1991; HUMZ 72029 and 72030, 2 specimens, 248–269 mm HL, 1079+–1200+ mm TL, west of Minami-torishima Island (=Marcus Island), 23°56′N, 150°36′E, 1100–1160 m depth, 10 October 1977; MSM-93-18, 1 specimen, 62.6 mm HL, 336 mm TL, Suruga Bay, F/V *Nishimiya-maru*, crab trap, 10 March 1993.

Diagnosis. Pelvic-fin rays 8–11 (usually 9–10). Snout bluntly pointed, extending slightly beyond upper jaw. Tip and lateral angles of snout armed with small scute-like scales. Scales along head ridges slightly enlarged and thickened. Orbit small, greatest diameter 16–26 % HL. Mouth large, posterior end of upper jaw extending to about vertical through hind rim of orbit; posterior end of rictus not restricted by lip folds. Outer gill slit greatly restricted, length 5–9 % HL. Barbel long, slender, length 10–23 % HL. Head bones stout; body flesh firm. Premaxillary teeth in broad, posteriorly tapering band, with outer series notably enlarged; dentary teeth in narrow, posteriorly tapering band, with inner series enlarged. Body scales covered with short, erect, needle-like spinules in irregular convergent rows or quincunx order; the last spinule in each row significantly overlapping posterior scale margin (except for large adults). Head fully scaled, including ventral surface of snout. Interdorsal space usually almost equal to first dorsal-fin base length; origins of second dorsal and

Table 2 Measurements and counts for *Coryphaenoides rudis*

Source	This study			I&S*	I&W†
Type status	LT	NT		NT	LT + NT
Locality	KI	HN + SB	MTI	SEP	Worldwide
Number of specimens	$n = 1$	$n = 4$	$n = 2$	$n = 3$	–
Measurements (mm)					
TL	814+	322+–599+	1079+–1200+	765–1200	–
HL	168	64.8–127	248–269	155–268	–
% of HL					
Snout length	26	27–30	24–26	26–28	23–29
Orbit diameter	18	21–23	18–19	17–20	17–20
Postorbital length	60	53–56	60–61	57–59	57–59
Postrostral length	78	74–77	77–79	74–77	–
Orbit–preopercle distance	54	48–52	53–59	–	–
Suborbital width	15	13–15	15	14–15	14–15
Upper-jaw length	39	35–38	42–42	41–43	37–43
Preoral length	12	12–15	9–11	10–12	10–12
Internasal width	20	21–23	18–19	17–19	17–19
Interorbital width	31	28–30	29–30	27–35	26–35
Body width over P. bases	60	37–50	67	–	–
Body depth at 1D. origin	86	86	96	84–90	80–100
Body depth at A. origin	77	64–67	81–85	71–76	–
Pre-V. length	107	103–112	114–115	108–127	–
Pre-anus length	156	156	–	–	–
Pre-A. length	161	163	176–177	156–168	156–168
Isthmus–V. distance	48	42–47	46–52	–	–
Isthmus–A. distance	–	–	–	100–131	–
V.–A. distance	60	60	75	48–55	48–55
V. length	76	44–69	48	52–66	50–111 (50–70)
P. length	57	49–57	50–62	49–63	45–63
Pre-1D. length	119	113–117	115–115	116–119	
Height of 1D.	76	76–84	–	55–67	43–73
Length of 1D. base	26	24–26	26–30	–	–
Interdorsal length	28	20–27	33–38	23–39	–
Length of gill slit	7	5–7	6	6–9	6–9
Length of posterior nostril	7	6–8	6	–	–
Barbel length	18	21–23	14–15	15–20	15–20
Counts					
1D. rays	II, 9	II,9–10	II, 9–10	II, 9–10	II, 9–11
P. rays	i19	i20–i23	i19–i22	i20–i21	i17–i21 (i19–i21)
V. rays	10	9–10	9–10	8–10	8–11 (9–10)
Outer GR on first arch	1	3–5	1–5	3–4	ca. 3–4
Inner GR on first arch	9	10–11	10–11	10	9–10
Outer GR on second arch	8	9–10	8–9	8–10	8–10
Inner GR on second arch	9	9–10	9–11	9	9
Lateral-line scales	37	38–40	31–37	36–47	30–47
Scales below 1D. origin	8.5	8.5–10	9.5–11	7–ca. 10	7–9
Scales below 1D. midbase	8.5	6.5–8.5	8.5–9	5.5–6.5	5.5–7.5

Table 2 continued

Source	This study			I&S*	I&W†
Type status	LT	NT		NT	LT + NT
Locality	KI	HN + SB	MTI	SEP	Worldwide
Number of specimens	$n = 1$	$n = 4$	$n = 2$	$n = 3$	–
Scales below 2D. origin	7	5.5–8.5	7–8	5.5–6	5.5–6.5

LT lectotype, *NT* non-type, *1D.* first dorsal fin, *2D.* second dorsal fin, *P.* pectoral fin, *V.* pelvic fin, *A.* anal fin, *GR* gill rakers, *KI* Kermadec Island, *MTI* Minami-torishima Island, *SB* Suruga Bay, *SEP* southeastern Pacific

* Iwamoto and Sazonov (1988)

† Iwamoto and Williams (1999); 4 specimens from Australia, with data compiled mostly from Marshall and Iwamoto (1973), Iwamoto and Sazonov (1988), and Shcherbachev and Iwamoto (1995); normal ranges in parentheses

anal fins on about same vertical. Height of first dorsal fin less than HL (43–84 % HL); second spinous ray serrated along leading edge. Outer pelvic-fin ray slightly prolonged, its tip usually extending beyond anal-fin origin. Body uniformly brownish to dusky grey. [Modified from Iwamoto and Sazonov (1988), Sazonov and Iwamoto (1992), Iwamoto and Williams (1999), and Iwamoto et al. (2015).]

Distribution. Widely known from tropical and temperate waters of the world's oceans at depths of 600–2400 m. Pacific: off the Kermadec Islands (type locality; Günther 1878, 1887), Norfolk Ridge (Merrett and Iwamoto 2000), New Zealand (Paulin et al. 1989; McMillan and Iwamoto 2015), New South Wales (Iwamoto and Williams 1999; Iwamoto and Graham 2001), Darwin Seamount (Wilson et al. 1985; Iwamoto and Sazonov 1988), Nazca and Sala y Gomez ridges (Iwamoto and Sazonov 1988; Sazonov and Iwamoto 1992), Sulu Sea (Radcliffe 1912), South China Sea off Taiwan (Shao et al. 2008a, 2008b; Iwamoto et al. 2015), and Japan (this study). Indian Ocean: off Western Australia (Shcherbachev and Iwamoto 1995; Iwamoto and Williams 1999), and West Australian Ridge and Gulf of Aden (Shcherbachev and Iwamoto 1995). Atlantic: off Madeira (Maul 1951), Gulf of Mexico, Caribbean Sea, and Guyana (Marshall and Iwamoto 1973), and Brazil (Melo et al. 2010). In Japan, so far known from Hyuga-nada, Suruga Bay, and the west of Minami-torishima Island, at depths of 1100–1481 m (Fig. 3).

Remarks. *Coryphaenoides rudis* is considered to be a widespread species, being a senior synonym of *Coryphaenoides paradoxus* (Smith and Radcliffe *in* Radcliffe 1912) and *Coryphaenoides macrocephalus* (Maul 1951). This species has been well described by several authors, and thus does not need repetition. For a full description see Iwamoto and Sazonov (1988:72 as *C. paradoxus*). This species is recorded here for the first time from Japan, based on six specimens collected from Hyuga-nada, Suruga Bay, and off Minami-torishima Island (Fig. 4a–e). Counts and measurements for the Japanese specimens are given in Table 2. The occurrence of *C. rudis* in this area is not surprising, considering a possible worldwide distribution of the species (see Distribution above).

The three specimens from Hyuga-nada and the one from Suruga Bay agree with the lectotype of *C. rudis* (Fig. 4f) and diagnoses given by previous authors [e.g., Iwamoto and Sazonov 1988 (as *C. paradoxus*); Sazonov and Iwamoto 1992 (as *C. paradoxus*); Shcherbachev and Iwamoto 1995; Iwamoto and Williams 1999; Iwamoto et al. 2015], including counts and measurements (Table 2), dentition, squamation, and spinulation on the body scales (Fig. 2j–k). However, regarding the remaining two specimens, their identification should be considered provisional. In the specimens from off Minami-torishima Island, the body scales are covered with fewer spinules than in typical specimens of *C. rudis* (Fig. 2j–l). This difference could be attributed to their large body size (248–269 mm HL, 1079+–1200+ mm TL), but the number of spinules generally increases with growth in other species of *Coryphaenoides* (NN pers. observ.). Further study is therefore necessary to confirm their conspecificity, especially based on a more complete ontogenetic series.

Coryphaenoides rudis was originally described by Günther (1878) from the southwestern Pacific off the Kermadec Islands (*Challenger* sta. 170 and 171). According to Günther (1887:131), five specimens were collected from the type locality, of which two were from sta. 170 (3.5 inches) and the other three from sta. 171 (3, 11, and 33 inches). Günther (1887) also reported three additional specimens (6–12 inches) from sta. 170A. Apart from the lectotype (BMNH 1887.12.7.72, 168 mm HL, 814+ mm TL, from sta. 171; Fig. 4f), Günther's (1887) specimens obviously belong to other genera, as he wrote "in young

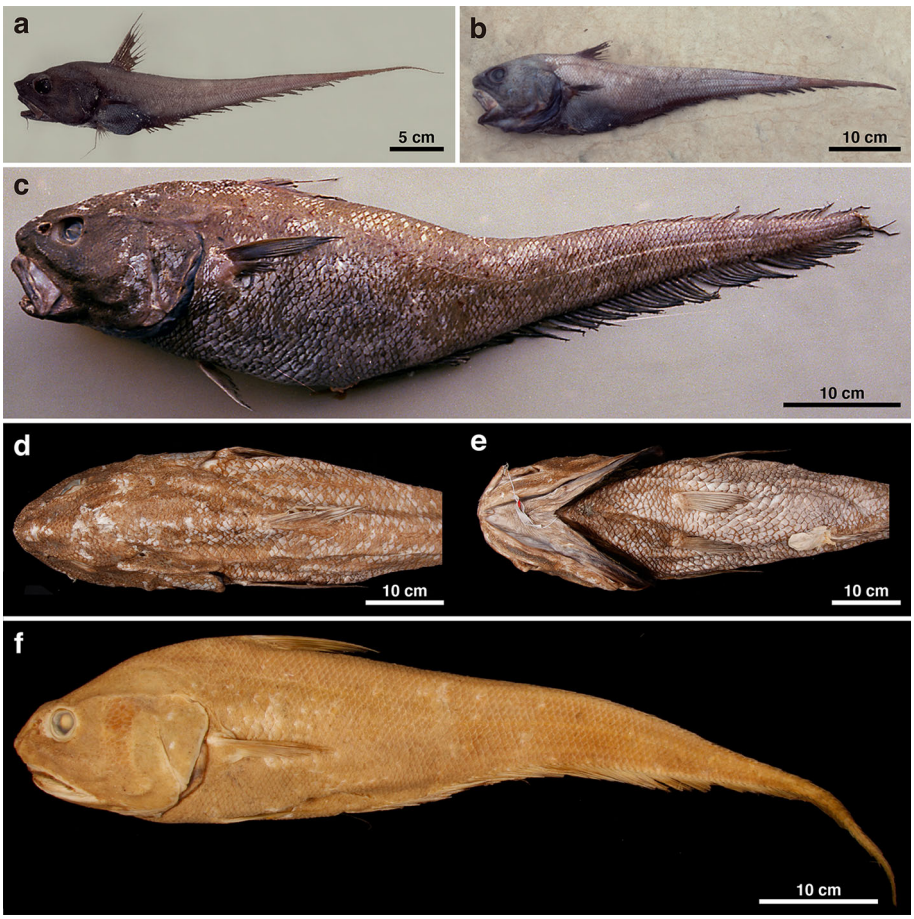

Fig. 4 *Coryphaenoides rudis*. **a** BSKU 49577, 75.7 mm HL, 384+ mm TL, off Miyazaki, Huga-nada, 1453–1481 m depth, fresh condition (reversed); **b** BSKU 49468, 127 mm HL, 599+ mm TL, collected with BSKU 49577, fresh condition; **c–e** HUMZ 72029, 248 mm HL, 1079+ mm TL, west of Minami-torishima Island, 1100–1160 m depth, **c** fresh (Photo: HUMZ) and **d–e** preserved condition; **f** BMNH 1887.12.7.74, lectotype, 168 mm HL, 814+ mm TL, west of Kermadec Islands, 1098 m depth, preserved condition. **a–c**, **f** Lateral views of entire specimens; **d** dorsal and **e** ventral views of the head and trunk

specimens (of 12 inches and less) the vent is placed between the ventrals … at some distance from the origin of the anal, …". In the current classification of grenadiers, *Coryphaenoides* is characterized by having the anus abutting the anal-fin origin (see "Introduction").

Without an examination of the type material, Gilbert and Hubbs (1916:144) designated the lectotype of *C. rudis* based on "the largest specimen, the one figured" by Günther (1887: pl. XXVII). They also considered the 12-inches-long specimen of Günther (1887) to be "some species of *Lionurus*" (=non-type, a specimen from sta. 170A). Shcherbachev and Iwamoto (1995:302) revealed that three of Günther's specimens that they examined represent two species of *Nezumia*, one of which is now known as a paratype of *Nezumia coheni* Iwamoto and Merrett 1997 (BMNH 1887.12.7.75, 51.3 mm HL, 274+ mm TL, from sta. 170A).

Franz (1910:26) recorded *C. rudis* from Japan based on a single specimen collected from Aburatsubo, Kanagawa (probably originally from Sagami Bay). He noted that his specimen agreed with young specimens of *C. rudis* reported by Günther (1887). As discussed above, apart from the lectotype, Günther's "*C. rudis*" represents different species of other genera. The record of Franz (1910) is therefore considered to be a misidentification. In their catalog of Japanese fishes, Jordan et al. (1913:417) listed *C. rudis* after Franz (1910), providing a Japanese name "Aka-sokodara" for this species. However, this is objectively invalid as it is based on the misidentification. A new and substitute Japanese name, "Daikoku-hige", is proposed here for *C. rudis* based on the specimen BSKU 49468 (Fig. 4b).

Coryphaenoides rudis belongs to the subgenus *Coryphaenoides* defined by Iwamoto (1990). Iwamoto (2009) recently suggested its close relationship with *Coryphaenoides bucephalus* (Garman 1899) known from the eastern central Pacific. According to Iwamoto (2009), *C. rudis* is distinguished from *C. bucephalus* by the head squamation (snout fully scaled vs. narrowly naked ventromedially) and modal counts of pelvic-fin rays (10 vs. 9). Data for *C. bucephalus* were from Iwamoto and Sazonov (1988).

In Japanese waters, *C. rudis* is most similar to *C. soyoae*, but readily differs in that the spinules on the body scales are arranged in irregular convergent rows or quincunx order (Fig. 2j–l vs. narrowly divergent rows, Fig. 2a–c). It

further differs from *C. soyoae* in lacking a naked area on the ventral surface of the snout (vs. broadly naked), and having fewer pelvic-fin rays [9–10 (rarely 8 or 11) vs. 11], smaller body scales (5.5–9 vs. 4–5 below the first dorsal-fin midbase), a wider interorbital space (26–35 % HL vs. 24–27 %), and a lower first dorsal fin (43–84 % HL vs. 87 %). Data for *C. rudis* were compiled from Marshall and Iwamoto (1973; as *C. paradoxus*), Iwamoto and Sazonov (1988; as *C. paradoxus*), Shcherbachev and Iwamoto (1995), Iwamoto and Williams (1999), Iwamoto et al. (2015), and this study.

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