First Record of the Lizardfish * Synodus mundyi (*Actinopterygii: Aulopiformes: Synodontidae) from Japan

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A rare lizardfish, *Synodus mundyi* Randall, 2009, is newly reported from the northwestern Pacific around Japan, based on a single specimen (147 mm in standard length) collected from off Muko-jima island of the Ogasawara Islands at a depth of 63 m. Prior to the present study, the species was represented by only the two type specimens collected from the Hawaiian Islands. Among Japanese congeners, it is most similar to the Indo-Pacific *Synodus doaki* Russell and Cressey, 1979 especially in having a very long nasal flap, but differs notably from the latter in that the tip of the pectoral fin extends well beyond a line connecting the dorsal- and pelvic-fin origins (*vs.* just reaching this level). The Japanese specimen is fully described, with a color photograph of the fresh specimen. A new standard Japanese name, “Kaede-eso”, is proposed for *S. mundyi*.

**Key Words:** Distribution, range extension, description, Ogasawara Islands, northwestern Pacific.

**Introduction**

The lizardfish genus *Synodus* Scopoli, 1777 currently includes about 50 valid species worldwide (Allen et al. 2017); of these, the Indo-Pacific *Synodus doaki* Russell and Cressey, 1979 was originally described from New Zealand (type locality), northeastern Australia, the Hawaiian Islands, and the western Indian Ocean off Kenya. Subsequently, in their review of the Hawaiian species of *Synodus*, Waples and Randall (1988) listed four specimens (including a paratype) of this widespread species from their study area. However, Randall (2009) described *Synodus mundyi* as a new species based on two specimens that Waples and Randall (1988) had identified as *S. doaki*, suggesting that none of the above Hawaiian specimens represented the true *S. doaki*. Since its original description, *S. mundyi* has not been collected elsewhere. During an annual training cruise for third-year undergraduate students of the Department of Marine Biology, School of Marine Science and Technology, Tokai University, a single specimen of a reddish *Synodus* with a well-developed nasal flap was collected from 63 m depth off Muko-jima, a remote island located at the northern end of the Ogasawara Islands, southern Japan. Subsequent examination revealed that it represents the first record of *S. mundyi* from the northwestern Pacific. Herein, we describe this specimen and propose a new standard Japanese name for the species.

**Materials and Methods**

The specimen examined was frozen on board the vessel, then thawed at a laboratory to take muscle tissues for future molecular analyses and to record fresh coloration (Fig. 1A) before formalin fixation. Counts and measurements follow Hubbs and Lagler (1947), Randall and Pyle (2008), and Randall (2009). The standard and head lengths are expressed as SL and HL respectively. Counting scale rows was facilitated by a temporal stain with a Cyanine Blue solution (Akihito et al. 1993; Saruwatari et al. 1997). Osteological features were examined using radiographs. Institutional abbreviations follow Sabaj (2019). The specimen examined here is deposited at the ichthyological collection of the Marine Science Museum, Tokai University, Shizuoka (MSM).

*Synodus mundyi* Randall, 2009

[New standard Japanese name: Kaede-eso]

(Figs 1–3, Table 1)

*Synodus doaki* (not of Russell and Cressey, 1981): Waples and Randall, 1988: 191, fig. 1, pl. 1C [in part, 2 spec. from Hawaii: BPBM 28623 and USNM 392810 (ex. BPBM 24758); comparisons with other Hawaiian spp.]; Mundy, 2005: 200 (listed from Hawaiian Archipelago); Randall, 2007: 110, lower fig. (compiled; Hawaiian Is.).

*Synodus mundyi* Randall, 2009: 410, fig. 7, table 5 (original description; 2 spec. from Hawaii; holotype: BPBM 28623, 68 mm SL, Penguin Bank, Kaiwi Channel, 84 m depth; paratype: USNM 392810, 140 mm SL, male, northwest of O‘ahu, 21°39′N, 158°06′W, 180–200 m depth).

**Material examined.** MSM-19-152, male, 147 mm SL, northwest of Muko-jima I., Ogasawara Is., Japan, 27°47′12″N, 142°02′36″E, 63 m, T/V Bosei-maru, cr. 19-06, sta. 6-4, rod and reel, 5 June 2019.

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Diagnosis. Modified from the diagnosis given in the original description by Randall (2009): dorsal-fin rays 13; anal-fin rays 9–10; pectoral-fin rays 13–14; lateral-line scales 58–60; scale rows between lateral line and dorsal-fin origin 3 1/2; vertebrae 58–60; predorsal vertebrae 15–17; 3–5 anterior palatine teeth of inner row distinctly longer than posterior teeth, arranged in discrete group; preopercle fully scaled; posterior flap of anterior nostril very long, slender to leaf-like, extending more than 2 posterior-nostril diameters beyond nostrils when laid back; body depth at pelvic-fin origin 6.3–7.35 in SL; pectoral fin extending beyond line connecting dorsal- and pelvic-fin origins, fin length 2.15–2.25 in HL; color when fresh reddish dorsally, abruptly white below lateral line, with about 8 brilliant red bars, each with 3 constrictions (uppermost obscure in lateral view); broad parts of each bar with faint yellowish spot; space between second constricted area of each bar with pale arc; color in alcohol uniformly pale yellowish.

Description of Japanese specimen. General features of the fish are shown in Fig. 1. Counts and measurements are given in Table 1.

Dorsal-fin rays 13, branched except first 2, last branched to base; anal-fin rays 10, unbranched except last 2, last branched to base; pectoral-fin rays 13, upper 2 and lower 1 unbranched; pelvic-fin rays 8, first and last unbranched; principal caudal-fin rays 19, upper and lower ones unbranched; procurrent caudal-fin rays (upper/lower) 18/15; lateral-line scales 58, not including tubed scales curving ventrally on caudal-fin base; scale rows between lateral line and dorsal-fin origin 3 1/2; scale rows between lateral line and...
anal-fin origin 51⁄2; median predorsal scales ca. 17; circumpeduncular scales 14; lower-limb gill rakers on ceratobranchial 21; peritoneal spots 3; total vertebrae 58; predorsal vertebrae 15.

Body slender, cylindrical, depth at pelvic-fin origin 6.3 in SL; body width 6.4 in SL; HL 3.6 in SL; snout length 3.9 in HL; orbit diameter 4.1 in HL; interorbital space a broad V-shaped concavity when viewed anteriorly, least bony width 10.6 in HL; caudal-peduncle depth 4.8 in HL; caudal-peduncle length 2.4 in HL.

Mouth terminal and very slightly oblique, forming an angle of about 10° to horizontal axis of body; mouth large, upper-jaw length 1.5 in HL; teeth in jaws needle-like, largest slightly shorter than pupil diameter, angling medially and anteriorly, except for a few teeth at front of jaws; teeth of upper jaw in 2 closely set rows, those of outer row fixed, about 1/2 length of inner teeth, and covered by lip; teeth of inner row inwardly depressible; teeth in lower jaw in 3 closely set rows, becoming progressively smaller laterally, middle and inner rows inwardly depressible, outer row hidden by lip; palatine teeth in about 3–4 rows; 5 anterior teeth of inner row elongate, longest nearly twice as long as posterior palatine teeth; bands of palatine teeth arranged in discrete rows and converging anteriorly, tips of longer anterior teeth overlapping when depressed; 5 rows of a total of about 45 posteriorly depressible teeth on anterior part of tongue, followed by numerous very small teeth.

Anterior nostril before middle of eye, nearly 1⁄2 distance from edge of orbit to base of upper lip; posterior flap of anterior nostril conspicuous, very long, broad, leaf-like,
with irregular edges and basal constriction (Fig. 2), reaching more than 2 posterior nostril diameters beyond nostrils when laid back; posterior nostril elliptical, with only slightly elevated rim, nearly directly behind anterior nostril; inter-narial distance about twice as long as greatest posterior nos-tril diameter.

Predorsal scales extending forward to a vertical about 2/3 orbit diameter behind posterior edge of orbit; preopercle fully scaled, with about 8 vertical, curving rows of scales, becoming smaller posteriorly; opercle with about 7 scales anteriorly, each crossed by branch of preoperculcan canal; remaining scales of opercle large, except for a few small dorsal scales; no scales on dorsal, anal, or paired fins; broad scaly zone basally on caudal fin, dividing into pointed part in each lobe, ending in large elongate scale reaching about 1/2 orbit diameter from fork of fin; triangular scaly process of 12 scales midventrally at base of pelvic fins.

Predorsal length slightly shorter than length from dorsal-fin origin to origin of adipose fin, 2.4 in SL; dorsal-fin base 1.7 in HL; 3rd dorsal-fin ray longest, but 2nd nearly equal, 1.8 in HL; anal-fin base 2.9 in HL; 4th anal-fin ray longest, but 3rd nearly equal, 3.3 in HL; caudal fin forked, with pointed lobes, longest ray 1.7 in HL; caudal concavity 4.1 in HL; pectoral fins reaching well posterior to line connecting origins of dorsal and pelvic fins, rounded when spread, 2.2 in HL; 6th pelvic-fin ray longest, 1.2 in HL.

Color when fresh (Fig. 1A). Ground color reddish dorsally, abruptly white below lateral line; body with about 8 brilliant red bars, each with 3 constrictrions (uppermost obscure in lateral view); broad parts of each bar with faint yellowish spot; space between second constricted area of each bar with pale arc; space between lowermost broad part of each bar with less prominent red spots; narrow orange stripe running along lateral line; faint, dashed, yellow stripe running along ventral counter of body; about 7 diagonal red stripes on dorsal fin, their interspaces whitish on each ray; small red spots scattered on pectoral and pelvic fins; anal fin whitish, with 2 diagonal red stripes and small red spot on middle of first ray; caudal fin red, each lobe with about 4 diagonal, zigzag, narrow, white bars.

Color in alcohol. Uniformly pale yellowish.

Distribution. So far known only from the Hawaiian Islands at depths of 84–200 m and the Ogasawara Islands at a depth of 63 m (Fig. 3; Randall 2009; this study).

Remarks. The Japanese specimen examined belongs to the genus Synodus in having eight pelvic-fin rays, the outermost pelvic-fin ray distinctly shorter than the inner ones, 10 anal-fin rays, the length of the anal-fin base longer than the dorsal-fin base, and in lacking scales on the procurent caudal-fin rays (Cressey 1981; Russell 1999). In addition, it agrees well with the original description of S. mundyi, and was identified as this species, especially in having a very long nasal flap (Fig. 2) reaching more than two posterior nostril diameters beyond the nostrils when laid back, 13 dorsal-fin rays, 10 anal-fin rays, 3 1/2 scale rows between the lateral line and the dorsal-fin origin, the tip of pectoral fin extending well beyond a line connecting the dorsal- and pel-vic-fin origins, and characteristic fresh coloration described above.

Morphometric values of the Japanese specimen lie within or only slightly outside (less than 2% of SL) the range of the two type specimens of S. mundyi provided in the original description (Table 1). Additionally, no differences were found in the meristic features, except for slight differences in the numbers of lateral-line scales (58 in Japanese specimen vs. 59–60 in type specimens), predorsal scales (ca. 17 vs. 16), circumpeduncular scales (14 vs. 15), and vertebrae (total 58 vs. 59–60; predorsal 15 vs. 16–17). In the Japanese specimen only three peritoneal spots were found in the inner wall of the abdomen (while skin on the inner wall appeared to be poorly preserved), whereas Randall (2009) described that the type specimens had 14 spots. However, Randall (2009: 404) considered the character to be unuseful to separate species of Synodus, noting that it varied from one to eight in his new species, Synodus isolatus. The Japanese specimen also differs from the original description in that five anterior palatine teeth of the inner row are elongate, and distinctly longer than posterior ones (vs. only three anterior teeth longer). Because, the species is poorly represented in museum collections, the above differences
are treated here as geographical variations. Randall (2009: 411) described the holotype of *S. mundyi* (BPBM 28623, 68 mm SL) as having the "posterior flap of anterior nostril a long, slender, tapering flap with a thin middle rod". However, he also noted that the flap was "more leaf-like in paratype, with irregular edges" (USNM 392810, 140 mm SL). The Japanese specimen (147 mm SL) has a large, broad, leaf-like flap, with irregular edges and a basal constriction (Fig. 2), similar to the condition found in the paratype. This suggests that the nasal flap of *S. mundyi* becomes broader with increasing size. When comparing fresh coloration, the Japanese specimen is much more reddish than the holotype (Fig. 1A vs. 1B). However, the former (147 mm SL) is much larger in size than the latter (68 mm SL), and the differences are most likely to be attributable to ontogenetic variations.

The Hawaiian specimen (135 mm SL; Fig. 1C) identified as *S. doaki* by Waples and Randall (1988) and Randall (2007) seems to be a large individual of *S. mundyi* in having 10 anal-fin rays [counted from photograph; vs. 8–9, usually 8, in *S. doaki* (fide Randall 2009)]. Unfortunately, according to J. E. Randall (who photographed it), the "specimen has not been found; it was apparently never cataloged at the Bishop Museum" (Randall 2009). Fresh coloration of the Japanese specimen agrees well with this missing specimen, rather than the small holotype.

As mentioned in the introduction, all four Hawaiian specimens reported as *S. doaki* by Waples and Randall (1998) represent other species, being differentiated by higher counts of anal-fin rays (9–10 vs. 8–9 in *S. doaki*) and lateral-line scales and vertebrae (58–60 vs. 55–58); the two specimens from the main Hawaiian Island have been described as *S. mundyi*. Randall (2009: 413) considered the two Maro Reef specimens to be neither *S. doaki* nor *S. mundyi*, but likely an undescribed species. According to Randall (2009), the two specimens differ from *S. mundyi* in having "14 or 15 dorsal-fin rays instead of 13, 58 instead of 59 or 60 lateral-line scales and vertebrae, 3 instead of 14 peritoneal spots, and a shorter and broader flap on the anterior nostril". The Japanese *S. mundyi* specimen examined is similar to this possible undescribed species in the numbers of lateral-line scales (58), vertebrae (58), and peritoneal spots (3, although the number was not considered useful to separate *Synodus* species in this study), but differs in the number of dorsal-fin rays (13) and the development of the nasal flap (very long). The relationship between *S. mundyi* and the possible undescribed species should be verified when additional Hawaiian specimens become available.

In the northwestern Pacific around Japan, *S. mundyi* is most similar to *S. doaki* in sharing the combination of a very long nasal flap, 3+2 scale rows between the lateral line and the dorsal-fin origin, anterior palatine teeth longer than posterior ones, and the absence of a pair of dark spots dorsally on the snout [data for *S. doaki* from Russell and Cressey (1979) and Randall (2009)]. The Japanese record of *S. doaki* is based on only a single specimen collected from Yokohama, and no additional materials have been obtained since Cressey (1981) reported it (he wrote the catalog number as FMNH 55488, but it is likely a mixtype of 55458; see Field Museum 2019). The two species differ most notably from each other in the posterior extent of the pectoral fin: in *S. mundyi* the tip of the pectoral fin extends well beyond a line connecting the dorsal- and pelvic-fin origins (Randall 2009; this study), whereas that of *S. doaki* only reaches this level (Russell and Cressey 1979). *Synodus mundyi* also differs from *S. doaki* in having higher counts of anal-fin rays (9–10 vs. 8–9, usually 8) and lateral-line scales (58–60 vs. 55–58) (Randall 2009; this study). *Synodus binotatus* is another Japanese species similar to *S. mundyi*, but readily differs from the latter in having a pair of prominent, small, black dots dorsally behind the snout tip (vs. absent) and lower counts of lateral-line scales (52–56 vs. 58–60) [data for *S. binotatus* from Cressey (1981) and Waples and Randall (1988)]. *Synodus rubromarmoratus* Russell and Cressey, 1979, which was recorded by underwater photographs (no specimens collected) from southern Japan [Ogasawara Islands (Randall 1998), Ie-jima island (Okinawa Pref.; Senou et al. 2006a), Izu-Oshima island (Kanagawa Pref.; Senou et al. 2006b), and Miyako Islands (Okinawa Pref.; Senou et al. 2007)], is also somewhat similar to *S. mundyi* in general appearance. However, it differs from *S. mundyi* especially in having fewer lateral-line scales (54–55 vs. 58–60) and in that the anterior palatine teeth are not longer (vs. distinctly longer) than those following nor do they constitute a discrete group (vs. arranged in discrete group) [data for *S. rubromarmoratus* from Russell and Cressey (1979) and Cressey (1981)].

The discovery of *S. mundyi* from the Ogasawara Islands extends its known range approximately 6,000 km westward from the Hawaiian Islands (Fig. 3). It brings the total number of Japanese lizardfish species to 26 (excluding *S. rubromarmoratus*; Yamada and Yagishita 2013; this study). A new standard Japanese name, "Kaede-esō", is proposed here for *S. mundyi* based on the specimen MSM-19-152. This name is derived from maples (= kaede), referring to the species’ reddish color and characteristic leaf-like nasal flap, and the Japanese name for lizardfishes (= eso).

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References

Akihito, Sakamoto, K., Iwata, A., and Ikeda, Y. 1993. Cephalic sensory organs of the gobioid fishes. Pp. 1088–1116. In: Nakabo, T. (Ed.) Fishes of Japan with Pictorial Keys to the Species, First Edition. Tokai University Press, Tokyo. [In Japanese]

Allen, G. R., Erdmann, M. V., and Peristiwady, T. 2017. Synodus nigrotaeniatus, a new species of lizardfish (Aulopiformes: Synodontidae) from Indonesia. Journal of the Ocean Science Foundation 26: 59–67.

Cressey, R. 1981. Revision of Indo-West Pacific lizardfishes of the genus Synodus (Pisces: Synodontidae). Smithsonian Contributions to Zoology 342: 1–53.

Field Museum 2019. Zoological Collections, the Field Museum. Available at https://collections-zoology.fieldmuseum.org/?_ga=1.212748368.536257583.1436915437 (16 June 2019).

Hubbs, C. L. and Lagler, K. F. 1947. Fishes of the Great Lakes Region. Cranbrook Press, Bloomfield Hills, xi + 186 pp.

Mundy, B. C. 2005. Checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletin in Zoology 6: 1–704.

Randall, J. E. 1998. First record of the lizardfish Synodus rubromarmatus Russell and Cressey from Hawaii and Japan. I. O. P. Diving News 9(12): 6–7.

Randall, J. E. 2007. Reef and Shore Fishes of the Hawaiian Islands. Sea Grant Program, University of Hawaii, Honolulu, xiv + 546 pp.

Randall, J. E. 2009. Five new Indo-Pacific lizardfishes of the genus Synodus (Aulopiformes: Synodontidae). Zoological Studies 48: 402–417.

Randall, J. E. and Pyle, R. L. 2008. Synodus orientalis, a new lizardfish (Aulopiformes: Synodontidae) from Taiwan and Japan, with correction of the Asian records of S. lobeli. Zoological Studies 47: 657–662.

Russell, B. C. 1999. Synodontidae. Pp. 1928–1940. In: Carpenter, K. E. and Niem, V. H. (Eds) The Living Marine Resources of the Western Central Pacific, Volume 3: Batoid Fishes, Chimaeras and Bony Fishes Part 1 (Elopidae to Linophrynidae). FAO, Rome.

Russell, B. C. and Cressey, R. F. 1979. Three new species of Indo-West Pacific lizardfish (Synodontidae). Proceedings of the Biological Society of Washington 92: 166–173.

Sabaj, M. H. 2019. Standard symbolic codes for institutional resource collections in herpetology and ichthyology: an online reference, version 7.1 (21 March 2019). Available at http://www.ash.org (28 July 2019).

Saruwatari, T., Lopez, J. A., and Pietsch, T. W. 1997. Cyanine blue: a versatile and harmless stain for specimen observations. Copeia 1997: 840–841.

Senou, H., Kobayashi, Y., and Kobayashi, N. 2007. Coastal fishes of the Miyako Group, the Ryukyu Islands, Japan. Bulletin of the Kanagawa Prefectural Museum (Natural Science) 36: 47–74.

Senou, H., Kodato, H., Nomura, T., and Yunokawa, K. 2006a. Coastal fishes of Ie-jima Island, Ryukyu Islands, Okinawa, Japan. Bulletin of the Kanagawa Prefectural Museum (Natural Science) 35: 67–92.

Senou, H., Matsuura, K., and Shinohara, G. 2006b. Checklist of fishes in the Sagami Sea with zoogeographical comments on shallow water fishes occurring along the coastlines under the influence of the Kuroshio Current. Memoirs of the National Science Museum, Tokyo 41: 389–542.

Waples, R. S. and Randall, J. E. 1988. A revision of the Hawaiian lizardfishes of the genus Synodus, with descriptions of four new species. Pacific Science 42: 178–213, pls 1–3.

Yamada, U. and Yagishita, N. 2013. Synodontidae. Pp. 412–420, 1846–1848. In: Nakabo, T. (Ed.) Fishes of Japan with Pictorial Keys to the Species, Third Edition. Tokai University Press, Hadano. [In Japanese]