

Juveniles of a Rare Callanthiid Fish Genus *Grammatonotus* (Pisces: Perciformes) from Japan

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Abstract Juveniles of a rare callanthiid fish genus *Grammatonotus* are described based on six specimens (18.6–22.8 mm SL) from Tosa Bay, Pacific coast off Shikoku Island, Japan; the occurrence represents the first record of *Grammatonotus* juveniles from the northern Pacific. Although we could not determine their certain species name, they were most probably identical with *G. surugaensis*, based on geographic distribution and osteological characters. The characters useful for identification of the juveniles of *Grammatonotus* are discussed with other *Grammatonotus* juvenile specimens from other areas.

Key words: Callanthiidae; *Grammatonotus*; juveniles; identification.

The callanthiids of the genus *Grammatonotus* Gilbert are small-sized, reddish perchlet-like fishes, collected rarely from deep reefs in the tropical to temperate regions of the Indian and Pacific oceans (Matsuura and Tachikawa, 1994; Nelson, 1994; Miskiewicz *et al.*, 2000). The following four, apparently allopatric, nominal species are currently assigned to *Grammatonotus*: *G. crosnieri* (Fourmanoir, 1981), from Luzon, Philippines; *G. laysanus* Gilbert, 1905, from Emperor Seamount Chain and Laysan Island of Hawaii; *G. macrophthalmus* Katayama, Yamamoto & Yamakawa, 1982, from Kyushu-Palau Ridge and Ogasawara Islands; and *G. surugaensis* Katayama, Yamakawa & Suzuki, 1980, from the temperate regions of Japanese waters (Katayama *et al.*, 1982; Anderson and Johnson, 1984; Matsuura and Tachikawa, 1994; Senou and Imai, 1994; Anderson, 2000).

All known adult specimens of *Grammatonotus* have been collected north of the equator in the Pacific Ocean. Yet larvae and juveniles of the genus have been reported only from the southern hemisphere of the Pacific and western Indian

Ocean. Fourmanoir (1976) first showed a fine illustration of a juvenile of *Grammatonotus* (13 mm SL) from the Gilbert Islands, under the name of *Zabulon roseus* (Günther) that was considered a senior synonym of *Grammatonotus laysanus* by him (according to Eschmeyer (1998), *Heliastes roseus* (= *Zabulon roseus*) is a pomacentrid, and thus, Fourmanoir's synonymy is not accurate). Leis and Rennis (1983) described the morphological aspects of the *Grammatonotus* larvae, and figured an unidentified postflexion larva (13.7 mm SL) from the Bismark Sea. Johnson (1984) subsequently referred to the Leis and Rennis (1983) illustration as a late-stage larva of *G. laysanus*. However, no evidence was provided to justify this identification. Most recently, Miskiewicz *et al.* (2000) surveyed the available data on the larvae and juveniles of the genus, and gave a new illustration of the unidentified postflexion larva of *Grammatonotus* (7.2 mm SL) from the Mozambique Channel, along with the Leis and Rennis (1983) illustration. No species name was suggested for the juveniles they examined.

During the bottom trawl surveys of 1998 in Tosa Bay, Pacific coast off Shikoku Island of Japan, six juvenile specimens of *Grammatonotus* were collected (18.6–22.8 mm SL; Fig. 1). These are hereafter referred to as the “Tosa Bay juveniles.” These juveniles were collected with many argentines (*Glossanodon semifasciatus*) and greeneyes (*Chrolophthalmus albatrossis*) from muddy bottoms at a depth of 150–200 m. The occurrence represents the first record of *Grammatonotus* juveniles from the northern hemisphere of the Pacific Ocean. We herein describe the morphology of the Tosa Bay juveniles in detail, and compare them with the postflexion larvae illustrated in the preceding publications and with available specimens from other areas.

Materials and Methods

The Tosa Bay juveniles were captured by the bottom trawls of R/V Kotaka-maru of the National Fisheries Research Institute, Japan. These were fixed in 10% formalin/seawater, and subsequently transferred to 70% ethanol for preservation. For identification of the Tosa Bay juveniles, we observed several specimens of *Grammatonotus*, including both larvae and adults from various areas. Abbreviations of institutions, where the examined specimens are deposited, followed Leviton *et al.* (1985).

Methods of measurements and counts follow Hubbs and Lagler (1958) and Katayama *et al.* (1982). Standard length (SL) and head length (HL) were used throughout. Video microscope and digital calipers were used for measurements. Observations of fin rays, head spination, body squamation, and cephalic sensory canals and pores were made from specimens stained with Cyanine Blue 5R. Osteological features were observed from radiographs and a single specimen (NSMT-PL 104) was cleared and counter stained for cartilage and bone using the methodology of Potthoff (1984). The terminologies of osteological features and developmental stages follow Rojo (1991) and Leis and Carson-Ewart (2000), respectively.

Identification of the Tosa Bay juveniles

All six Tosa Bay juveniles were assigned to the genus *Grammatonotus* by having the following characters: XI, 9 dorsal-fin rays; III, 9 anal-fin rays; I, 5 pelvic-fin rays; 24 total vertebrae, including 10 abdominal and 14 caudal vertebrae; a single opercular spine; 25 scales in longitudinal series (Katayama *et al.*, 1982; Anderson and Johnson, 1984; Miskiewicz *et al.*, 2000).

In adult specimens, species of *Grammatonotus* are distinguished by the elongation of caudal-fin rays, size of teeth on jaws, some proportional measurements, and coloration (see Katayama *et al.*, 1982). These features are, however, not developed in juveniles, owing to ontogenetic changes.

For identification of the Tosa Bay juveniles, we examined and compared the adult specimens of three *Grammatonotus* species (*G. laysanus*, *G. macrophthalmus*, and *G. surugaensis*); we could not obtain specimens of the remaining species, *G. crosnieri*. Examination of X-ray radiographs revealed that *G. macrophthalmus* differed from *G. laysanus* and *G. surugaensis* in the following features: 1) dorsal prezygapophyses well developed, long, blunt and dorsally directed (vs. not or only slightly developed, and, if present, very small and anteriorly directed in the latter two species) (Fig. 2); 2) 3rd epural 59.3–69.7% of 2nd epural in length (vs. 3rd epural slightly shorter and 73.9–86.1% (*G. laysanus*) or 71.2–80.0% (*G. surugaensis*) of 2nd epural in length) (Fig. 3). The axial skeleton of the Tosa Bay juveniles lacks large dorsal prezygapophyses and epural 3 in 75.0% of epural 2 (Fig. 4). This agrees with an identification of *G. laysanus* and *G. surugaensis*. Of these two species, *G. surugaensis* is the only species of the genus recorded from the temperate region of Japan, including Tosa Bay (Shinohara *et al.*, 2001). In contrast, *G. laysanus* is known only from the Hawaii and adjacent waters (Katayama *et al.*, 1982).

Evidence of both morphology and geographic distribution strongly suggest that the Tosa Bay juveniles are *Grammatonotus surugaensis*. How-

ever, as noted above, we did not examine the specimens of *G. crosnieri* (known only from the type specimens from the Philippines). In addition, our specimens are an incomplete series to plausibly identify them using the series method (see, e.g., Leis and Carson-Ewart, 2000). We thus tentatively identify the Tosa Bay juveniles as *Grammatonotus* sp. (cf. *G. surugaensis*).

***Grammatonotus* sp. (cf. *G. surugaensis*)**

(Figs. 1 & 4, Table 1)

Materials examined. Six specimens, 18.6–22.8 mm SL: NSMT-PL 104, 1 specimen (19.1 mm SL), Tosa Bay, Pacific coast off Shikoku Island, Japan, 150 m depth, 8 Dec. 1998; NSMT-PL 105, 2 specimens (18.6–22.8 mm SL), Tosa Bay, 175 m depth, 8 Dec. 1998; NSMT-PL 106, 2 specimens (19.2–19.9 mm SL), Tosa Bay, 200 m depth, 9 Dec. 1998; NSMT-PL 107, 1 specimen (18.9 mm SL), Tosa Bay, Dec. 1998.

Description. Counts and proportional measurements are given in Table 1. Body fusiform, moderately deep and strongly compressed. Caudal peduncle short and deep, its depth 54.0–66.7% of length. Head strongly compressed, large, rounded in lateral view. Snout short (snout length 15.0–18.0% HL) and rounded, slightly projecting beyond jaws. Eye rounded, large, its diameter longer than snout length; postorbital length of head longer than eye diameter. Interorbital area slightly convex, its width shorter than eye diameter. Mouth moderately large, reaching posteriorly to a vertical line through anterior border of pupil; gape oblique, forming an angle of about 30 degrees with body axis; upper jaw only slightly projecting beyond lower jaw. Anterior nostril opens at tip of short tube in front of eye; posterior nostril a pore, widely separated from the anterior nostril, located on upper orbital rim but a little in advance of the pupil. Teeth on jaws small, conical, slightly incurved, forming a single row on each jaw, no enlarged canine-like teeth on jaws; some teeth around symphysis of lower jaw large, almost directed anteriorly. No teeth on vomer; some minute teeth on palatine (visible in

cleared and stained specimen). A single, pungent opercular spine present; margins of preopercle, subopercle and interopercle smooth. A small cleithral spine located immediately above the pectoral-fin base. Most of the head and body covered by deciduous, large ctenoid scales; anterior part of snout, lips and ventral surface of head naked. Lateral line ascending rapidly to posterior and runs along base of dorsal fin. The other pores of sensory canal on mandible and orbital rim small.

In the cleared and stained specimens (19.1 mm SL), ossification of all neural and haemal arches almost completed, i.e., all neural and haemal arches fused to relevant centra, other than ultimale haemal spine (Fig. 4B). Small dorsal pre- and postzygapophyses are present on the centra, and directed anteriorly (Fig. 4A).

Pigmentation. A cluster of large stellate melanophores at the end of caudal peduncle, forming a broad, vertical band at caudal-fin base, the anteriormost melanophore the largest at mid-lateral body wall; a series of internal and external melanophores located at angle of myosepta of trunk and caudal peduncle; small melanophores scattered on snout, nape, dorsal part of operculum, anterior to the pectoral-fin base, and a small area just above pectoral-fin base. Melanophores along myosepta beneath the soft dorsal fin form a diagonal band across the body.

Remarks. The Tosa Bay juveniles are very similar in the general appearance to the unidentified postflexion larvae of *Grammatonotus* illustrated by the previous authors (e.g., Fourmanoir, 1976; Leis and Rennis, 1983; Miskiewicz *et al.*, 2000). The main discrepancies between the Tosa Bay juveniles and others are lack of all head spination except for a single opercular spine. The juvenile of *Grammatonotus* (13 mm SL) illustrated by Fourmanoir (1976) had a single long spine at the angle and 4–5 weak spines on the upper half of the preopercle. Leis and Rennis (1983) noted that the preopercular margin of juveniles of *Grammatonotus* examined by them was weakly serrate, but the spine at the angle was not as long as found in the specimen of Fourmanoir (1976);

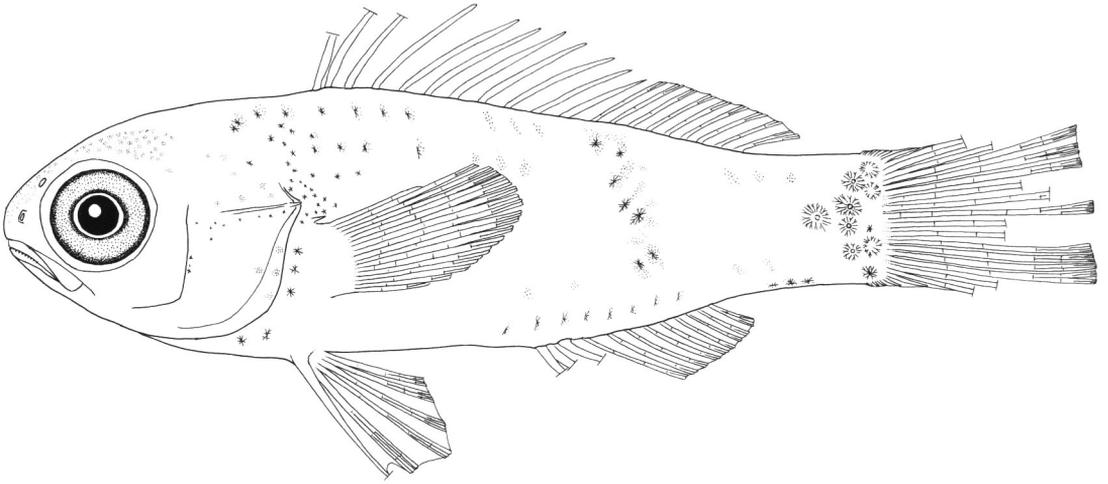


Fig. 1. A juvenile of *Grammatonotus* sp. (cf. *G. surugaensis*), NSMT-PL 107, 18.9 mm SL, Tosa Bay, Pacific coast off Shikoku Island, Japan.

Table 1. Counts and measurements of juvenile *Grammatonotus* sp. (cf. *G. surugaensis*) from Tosa Bay.

	SL (mm)					
	18.6	18.9	19.1	19.2	19.9	22.8
Counts						
Pectoral-fin rays	19	19	18	18	20	19
Pelvic-fin rays	1, 5	1, 5	1, 5	1, 5	1, 5	1, 5
Branchiostegal rays	6	6	6	6	6	6
Dorsal-fin rays	XI, 9	XI, 9				
Anal-fin rays	III, 9	III, 9				
Scales in longitudinal series	25	damaged	damaged	damaged	damaged	25
Vertebrae	10+14	10+14	10+14	10+14	10+14	10+14
Predorsal bones	2	2	2	2	2	2
Measurements						
As % of SL						
HL	35.2	34.4	34.2	34.1	34.6	36.1
Body depth	31.7	30.2	29.3	30.2	29.1	32.9
Predorsal length	38.2	39.7	39.3	39.1	40.2	39.5
Caudal peduncle length	25.8	25.9	22.0	26.0	22.6	25.0
Caudal peduncle depth	15.1	14.3	14.7	14.1	13.6	14.9
As % of HL						
Snout length	17.8	15.4	16.1	16.9	16.4	14.9
Eye diameter	31.4	35.5	34.1	33.1	34.4	34.5
Postorbital length of head	49.2	52.1	47.6	48.3	47.5	46.6
Upper jaw length	28.0	30.8	32.5	32.2	31.1	29.7
Interorbital width	28.6	28.6	29.3	29.7	32.8	29.1

in their figured specimen (13.7 mm SL), the preopercular spine at the angle is slightly longer than the others. Miskiewicz *et al.* (2000) stated that the postflexion larvae of *Grammatonotus* have small spines at the margins of the preoper-

cle, interopercle and subopercle, in addition to a slender but conspicuous opercular spine. On the other hand the adult specimens of all *Grammatonotus* species lack preopercular, interopercular, and subopercular spines. The Tosa Bay ju-

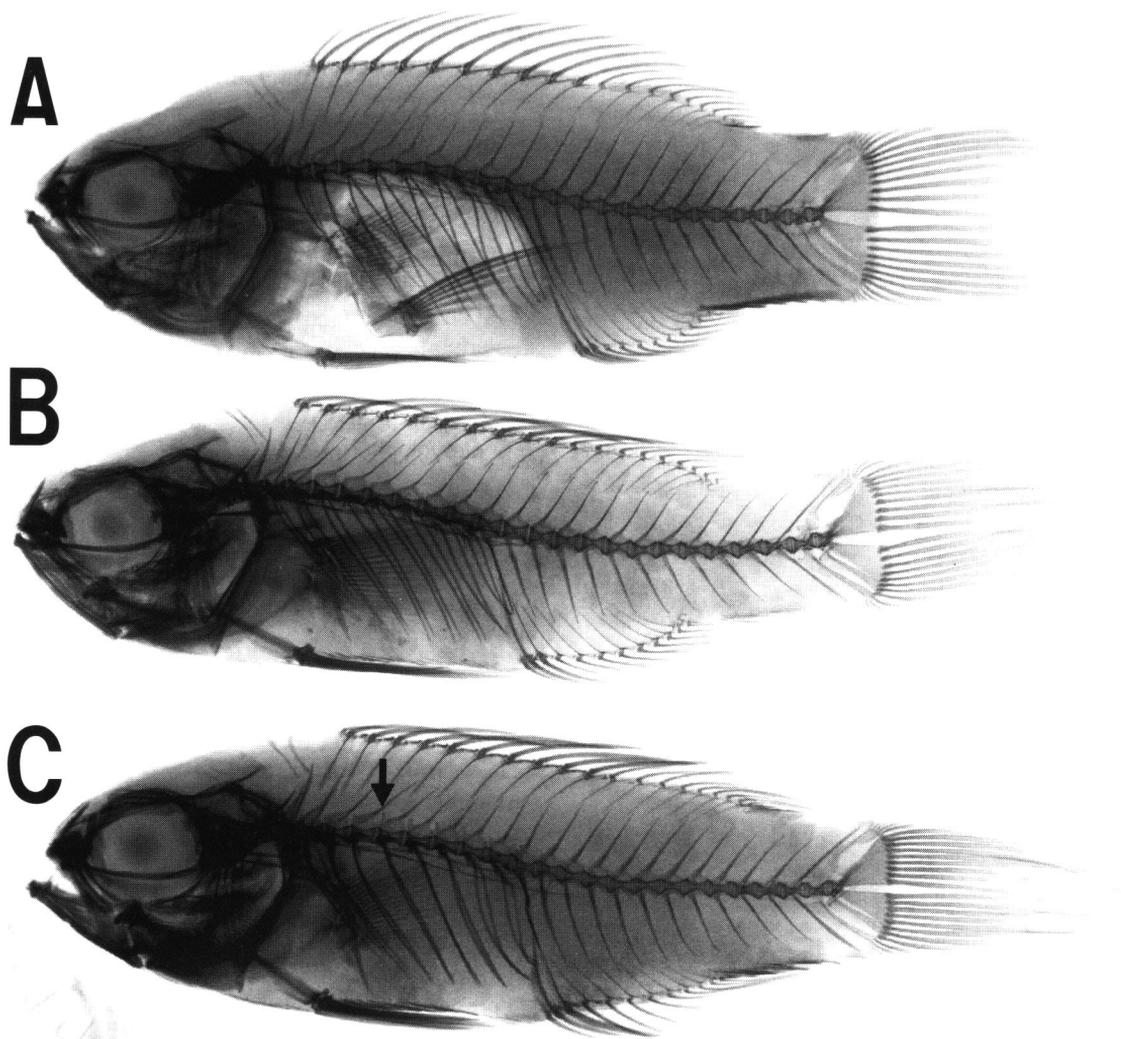


Fig. 2. Radiographs of *Grammatonotus*. A) *G. surugaensis*, NSMT-P 19445, 81.2 mm SL; B) *G. laysanus*, HUMZ 68678, 137.6 mm SL; C) *G. macrophthalmus*, HUMZ 75143, 95.0 mm SL. Arrow indicates dorsally-directed dorsal prezygapophysis of *G. macrophthalmus*.

juveniles are larger than the larvae figured by the previous authors, and, thus, the preopercular spines of the former might have been already disappeared with growth; this is the reason we call our specimens “juveniles” (not “larvae”; see also Miskiewicz *et al.*, 2000).

During the present study, we examined the juveniles “*Grammatonotus laysanus*” from Hawaiian waters (2 specimens, 18.0–23.0 mm SL), and the unidentified postflexion larvae and juvenile of *Grammatonotus* from the Sea of Japan (3

specimens, 4.3–5.7 mm SL) and East China Sea (1 specimen, 12.6 mm SL), respectively, all of which are housed at AMS. Of these, the Hawaiian juveniles (already lacking preopercular spines) clearly differ from the Tosa Bay juveniles and the postflexion larvae illustrated by previous authors in having: 1) two isolated stellate melanophores anterior to the dark vertical band on the caudal-fin base (vs. one in the others); 2) a dorsoventral pair of elongated dusky spots at the middle of caudal fin. There are no morphological

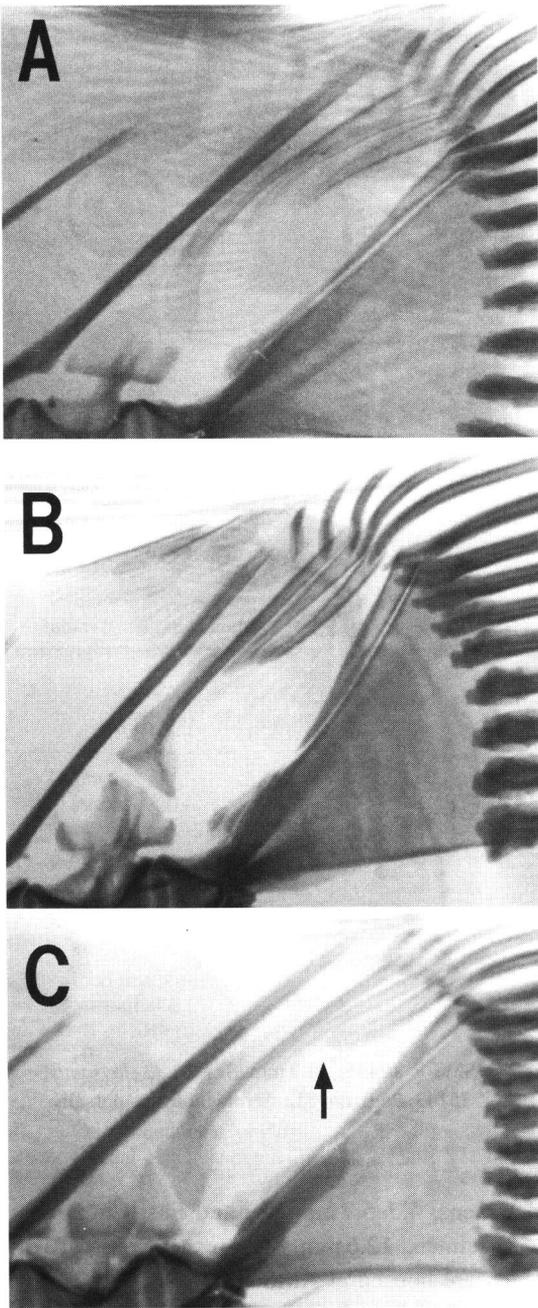


Fig. 3. Radiographs of the caudal skeleton of *Grammatonotus*. A) *G. surugaensis*, NSMT-P 19445, 81.2 mm SL; B) *G. laysanus*, HUMZ 68678, 137.6 mm SL; C) *G. macrophthalmus*, HUMZ 75143, 95.0 mm SL. Arrow indicates medial end of 3rd epural of *G. macrophthalmus*.

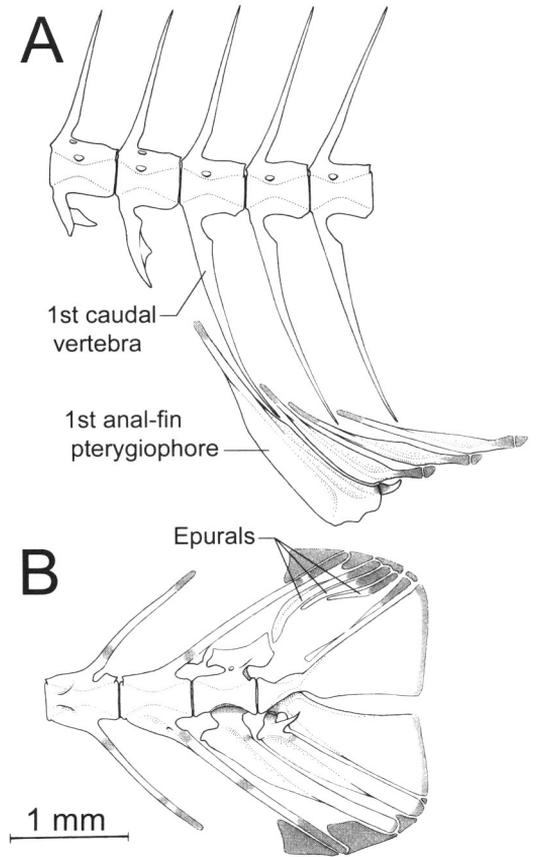


Fig. 4. Axial skeleton of the Tosa Bay juvenile (NSMT-PL 104, 19.1 mm SL). A) ultimate two precaudal and first three caudal vertebrae and associated anal-fin pterygiophores; B) caudal skeleton.

characters available to identify these specimens to species, but tentatively agree with the original AMS identification, judging from their collecting locality. The unidentified *Grammatonotus* larvae and juvenile from the Sea of Japan and East China Sea agree well with the Tosa Bay juveniles in pigmentation pattern. The close collecting localities and similar pigmentation pattern suggest that these specimens might be the same species as the Tosa Bay juveniles. We examined the preopercular spines on the three small specimens from the Sea of Japan (4.3–5.7 mm SL); they have a single long spine at the angle and some weak serration along the ventral margin. There are no preopercular spines in the 12.6 mm SL

specimens from the East China Sea, as in the Tosa Bay juveniles.

Comparative materials. Adults. — *Grammatonotus macropthalmus*: NSMT-P 18829 (holotype), 119.2 mm SL, Kyushu-Palau Ridge (26°46.0'N, 135°21.5'E–26°45.6'N, 135°24.5'E), Japan, 330 m depth, 30 Jan. 1978; NSMT-P 35093, 1 specimen (96.7 mm SL), Chichi-jima I., Ogasawara Is., Japan, 25 Nov. 1991; HUMZ 75141, 75143, 75144 (paratypes), 3 specimens (95.0–100.4 mm SL), Kyushu-Palau Ridge (26°47.2'N, 135°21.0'E–26°46.2'N, 135°20.7'E), Japan, 360 m depth, 31 Jan. 1978. *G. laysanus*: USNM 51546 (holotype), 37.4 mm SL, near Lysan Island, Hawaii Islands, USA, 97–199 fathoms (=178–364 m depths), 19 May 1902; HUMZ 68678, 1 specimen (137.6 mm SL), Emperor Seamount Chain (35°35.8'N, 171°18.9'E), 340 m depth, 30 July 1977. *G. surugaensis*: NSMT-P 19445 (holotype), 81.2 mm SL, 120 m depth, off Numazu, Suruga Bay, Japan, 23 Mar. 1979; NSMT-P 60859, 1 specimen (64.3 mm SL), Tosa Bay, Japan; BSKU 52001, 52158, 52903, 3 specimens (60.8–85.9 mm SL), Tosa Bay, Japan.

Larvae and juveniles. — *Grammatonotus* sp. (cf. *G. laysanus*): AMS I. 25362-001, 1 specimen (juvenile, 18.0 mm SL), Waianae coast, Oahu, Hawaii (21°26.0'N, 158°0.0'W), 300 m depth (collected by T. A. Clark); AMS I. 25362-002, 1 specimen (juvenile, 23.0 mm SL), same collecting data with AMS I. 25362-001. Unidentified *Grammatonotus* species: AMS. I. 32071-001, 2 specimens (4.3–4.8 mm SL), Sea of Japan (35°00.0'N, 131°50.0'E), 24 Oct. 1978–1 Nov. 1978 (collected by Hyogo Prefectural Fish. Exper. Stn.); AMS. I. 32081-001, 1 specimen (5.7 mm SL), Sea of Japan (35°45.0'N, 133°05.0'E), 26 Oct. 1981–5 Nov. 1981 (collected by Hyogo Prefectural Fish. Exper. Stn.); AMS. I. 31823-001, 1 specimen (12.6 mm SL), 520 km SW of Kagoshima, East China Sea (27°54.0'N, 127°39.3'E–27°53.5'N, 127°39.7'E), 3 July 1984, R/V Hakuho-maru.

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