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# First Pacific Record of the Rare Scaleless Dragonfish *Grammatostomias circularis* (Teleostei: Stomiiformes: Stomiidae) from the Ogasawara Islands, Japan

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A single specimen of a scaleless dragonfish in the genus *Grammatostomias* Goode and Bean, 1896 (Teleostei: Stomiiformes: Stomiidae) was collected off the Ogasawara Islands, Japan at a depth between 40–780 m. The specimen conformed to *G. circularis* Morrow, 1959 in having the following characters: dorsal-fin rays 21; anal-fin rays 23; pectoral-fin rays 9; the first pectoral-fin ray not isolated; and entire luminous loop on lateral body surface very thin, almost circular and without zigzags. The likelihood of the distribution pattern of small areas of luminous tissue on the head being diagnostic for each species of *Grammatostomias* is briefly considered. *Grammatostomias circularis* has previously been recorded only from the Atlantic, the present specimen representing the first record of the species from the Pacific Ocean, and first record of a species of *Grammatostomias* from Japan.

**Key Words:** Bonin Islands, luminous loop, luminous tissue, Melanostomiinae, mesopelagic fish, Northwest Pacific.

## Introduction

The scaleless dragonfish included in the genus *Grammatostomias* Goode and Bean, 1896, belonging to the subfamily Melanostomiinae (Teleostei: Stomiiformes: Stomiidae), is separable from other genera in the subfamily by the following combination of characters: premaxilla and dentary with a few long fang-like teeth; lower jaw not strongly curved upwardly; vomerine teeth absent; palatine with teeth; first and second basibranchials with teeth; dorsal and anal fin origins in almost the same vertical plane; pectoral fin present; pelvic fin situated ventrally on the body; chin barbel slender, without branches, expanded parts or terminal bulb; suborbital photophore very small; luminous line or loop present on the lateral body surface; and ovoid luminous bodies present on some anterior pectoral-fin rays (Goode and Bean 1896; Beebe and Crane 1939; Morrow 1959; Morrow and Gibbs 1964). *Grammatostomias* comprises four valid species, mainly distributed in mesopelagic or bathypelagic zones of the Atlantic Ocean (e.g., Beebe and Crane 1939; Morrow and Gibbs 1964; Prokofiev 2014; Villarins et al. 2022), although *G. dentatus* Goode and Bean, 1896 has also been recorded from the Indian and Pacific Oceans (Gibbs and Barnett 1990; Fricke et al. 2011).

During a research cruise around the Ogasawara Islands (Bonin Islands), Japan conducted by the T/S *Oshoro-maru* (Hokkaido University) in 2010 (see Tatsuta et al. 2014 for cruise details), a single specimen of *Grammatostomias* was captured between depths of 40–780 m by beam trawl. The specimen, identified as *G. circularis* Morrow, 1959, a species previously recorded only from the Atlantic Ocean, represents the first record of the species from the Pacific Ocean. It is described in detail, and the diagnostic significance of distributional patterns of small luminous tissue areas on the head is briefly considered.

## Materials and Methods

The present specimen is deposited in the Hokkaido University Museum, Hakodate (HUMZ). Methods for counts and measurements mainly followed those of Gibbs et al. (1983), all measurements being made to the nearest 0.1 mm with digital calipers. Interorbital width was measured as the narrowest width of the interorbital area, and caudal peduncle length from the end of the anal-fin base to the mid-base of caudal fin. Standard length is abbreviated as SL. Dorsal- and anal-fin rays, and vertebrae were counted from an x-ray radiograph. Terminology of the main photophores on the head and body follows Aizawa (2002): preorbital photophore (PO); suborbital photophore (SUO); postorbital photophore (PTO); opercular photophores (OP); photophores in entire ventral row from anterior end of isthmus to caudal peduncle (IC: IP + PV + VAV + AC); photophores in ventral row from anterior end of isthmus to vertical line at pectoral-fin origin (IP); photophores in ventral row between vertical lines at pectoral- and pelvic-fin origins (PV); photophores

in ventral row between vertical lines at pelvic- and anal-fin origins (VAV); photophores in ventral row behind last photophore of VAV series (AC); all large photophores in lateral row (OA: OV + VAL); photophores in lateral row from opercular edge to vertical line at pelvic-fin origin (OV); photophores in lateral row between vertical line at pelvic-fin origin and end of large photophores of OA series (VAL). The publication date of Goode and Bean's (1896) original description of *Grammatostomias* and *G. denatus* is regarded as 1896, following Cohen (1963).

## Taxonomic Accounts

***Grammatostomias circularis*** Morrow, 1959
[New standard Japanese name: Tsukinowa-hotei-eso]
(Figs 1–5; Tables 1, 2)

*Grammatostomias circularis* Morrow, 1959: 1, unnumbered fig. (original description; type locality: off Puerto Rico, Northwest Atlantic); Morrow and Gibbs 1964: 449, fig. 133 (redescription of holotype); Gibbs 1984: 353, unnumbered fig. (short description; Northeast Atlantic); Lloris et al. 1991: 228 (list; Madeira Islands, Northeast Atlantic); Moore and Boardman 1991: 17 (list; type catalog); Craddock et al. 1992: table 1 (list; Northwest Atlantic); Sutton and Hopkins 1996: table 2 (list; Gulf of Mexico, Northwest Atlantic); Vinnichenko 1997: table 2 (list; Corner Rise Seamounts, Northwest Atlantic); McEachran and Fechhelm 1998: 518 (description; Gulf of Mexico, Northwest Atlantic); Harold 2002: 911 (list; central West Atlantic); Moore et al. 2003: 189 (list; Georges Bank, Northwest Atlantic); Judkins and Haedrich 2018: table 3 (list; central East Atlantic); Sutton et al. 2020: 112 (short description; central East Atlantic).

**Material examined.** HUMZ 210834, 131.4 mm SL, west of Haha-jima Island, Ogasawara Islands, Tokyo, Japan, 28°58.2′N, 141°55.2′E–29°21.4′N, 141°56.2′E, between 40–780 m in depth, beam trawl, T/S *Oshoro-maru*, 18–19 December 2010, coll. by K. Nakaya.

**Diagnosis.** Dorsal-fin rays 21; anal-fin rays 23; pectoral-fin rays 9; total vertebrae 56 or 57; PV 18 or 19; first pectoral-fin ray not isolated from other rays; entire luminous loop on lateral body surface very thin, almost circular and without zigzags (Morrow 1959; Morrow and Gibbs 1964; Prokofiev 2014; present study).

**Description.** Counts and proportional measurements (% SL) given in Table 1. Body elongate, laterally compressed (Fig. 1). Head small. Eyes moderate. Two pairs of nostrils anterodorsal to eye. Mouth large, terminal (Fig. 2). Premaxilla and maxilla comprising anterior 2/3 and posterior 1/3 of upper jaw, respectively. Premaxillary teeth in two rows; four and six teeth in inner and outer rows, respectively; first tooth of inner row long, fang-like and fixed; second tooth of inner row very long, fang-like and depressible, extending below ventral margin of lower jaw when mouth closed; third and fourth teeth of inner row long, fang-like and depressible; teeth in outer row small, caniniform and fixed. Maxilla with fixed minute conical teeth. Lower jaw slightly protruding, not bent upwardly. Dentary teeth in two rows; 13 and five teeth in inner and outer rows, respectively; first tooth of inner row very long, fang-like and fixed, extending above dorsal margin of head when mouth closed; second to fifth and eighth teeth in inner row moderately short, caniniform and depressible; sixth, seventh, and ninth to thirteenth teeth in inner row short, caniniform and fixed; teeth in outer row moderately long, caniniform and fixed. Vomer without teeth. Palatine with four short conical teeth, anterior three fixed, posteriormost depressible. First basibranchial with one short fixed tooth; second basibranchial with one long fixed tooth. Third and fourth pharyngobranchials with six and five short depressible caniniform teeth, respectively. Each gill raker tooth-like; 11 rakers on inner aspect of lower

Table 1. Counts and proportional measurements (%SL) of *Grammatostomias circularis*.

| | Present study | Morrow (1959) and Morrow and Gibbs (1964) |
|---|---|---|
| | HUMZ 210834 | Holotype (YPM 3773)* |
| Standard length (mm) | 131.4 | 135.6 |
| Counts | | |
| Dorsal-fin rays | 21 | 21 |
| Anal-fin rays | 23 | 23 |
| Pectoral-fin rays | 9 | 9 |
| Pelvic-fin rays | 7 | 7 or 8 |
| Branchiostegal rays | 10 | 10 |
| Total vertebrae | 57 | 56 |
| IP photophores | 7 | 7 |
| PV photophores | 19 | 18 |
| VAV photophores | 20 | 21 |
| AC photophores | 12 | 13 |
| IC photophores | 58 | 59 |
| OV photophores | 18 | 18 |
| VAL photophores | 21 | 19 or 20 |
| OA photophores | 39 | 37 or 38 |
| Proportional measurements (% SL) | | |
| Head length | 15.7 | 15.6 |
| Body depth behind head | 13.8 | 10.5 |
| Fleshy orbit length | 3.7 | 2.6 |
| Interorbital width | 3.9 | 4.1 |
| Snout length | 3.4 | 3.4 |
| Postorbital organ length | 3.4 | — |
| Upper jaw length | 16.1 | — |
| Lower jaw length | 16.8 | — |
| Predorsal length | 80.1 | 78.3 |
| Preanal length | 80.2 | 78.3 |
| Prepelvic length | 45.5 | 45.8 |
| Pectoral fin length | 10.9 | — |
| Pelvic fin length | 14.8 | — |
| Caudal peduncle length | 3.6 | — |
| Caudal peduncle least depth | 3.0 | — |
| Dorsal-fin base length | 13.8 | 14.6 |
| Anal-fin base length | 18.1 | 17.0 |

—: No data; * YPM: Yale University, Peabody Museum of Natural History, New Haven.

Fig. 1. Fresh specimen of *Grammatostomias circularis*, HUMZ 210834, 131.4 mm SL, west of Haha-jima Island, Ogasawara Islands, southern Japan.

limb; rakers absent on upper limb.

Dorsal and anal fin origins in almost same vertical plane; rays of both fins covered with skin basally. Anal-fin base longer than dorsal-fin base. Pectoral fin on ventral portion of body; no isolated rays; all rays distally filamentous; first to third rays thickened; interspaces between first to fourth adjacent rays wider than those between fourth to ninth rays. Pelvic fin ventrally on body, short, its distal tip not reaching midpoint between origins of pelvic and anal fins. Caudal fin forked, upper lobe shorter than lower lobe. Adipose fin absent. Chin barbel slender, unbranched, broken distally. Skin smooth, scaleless.

*Photophores*. PO absent. SUO small, on lower margin of eye, slightly behind eye center (Fig. 2). PTO large, elongate. OP three; one posterior to eye, two posterior to postorbital organ. Principal body photophores small, interspaces between each almost equal; each photophore covered by transparent membrane; posteriormost two photophores of VAV and VAL above anal-fin base. Small luminous tissues areas on isthmus, above nostrils, below eye, on anterodorsal part of opercle, and above pectoral- and pelvic-fin bases, absent behind eye and on posterior part of opercle (Fig. 2). Many small luminous tissue areas scattered on body. Single very thin luminous loop forming circle on lateral body surface above pectoral fin and IP photophores, ventral portion without zigzags (Fig. 3). Luminous tissue present along each pectoral-fin ray, that on third ray expanded, forming single ovoid luminous body (Fig. 4). Luminous bodies absent on extant portion of chin barbel.

**Color when fresh (based on photograph) (Fig. 1).** Body dark brown. Photophores and small luminous tissue areas on body white. Unpaired fins brown and transparent basally, pale and transparent distally. Pectoral fin brown basally, pale distally. Pelvic fin dark brown.

**Color in alcohol.** Chin barbel pale except for brown basal portion. Photophores and small luminous tissue areas on body and pectoral fin yellowish-white. Luminous circular loop on body pale. Otherwise similar to fresh condition.

**Distribution.** Tropical to subtropical waters in Atlantic Ocean (northwestern, northeastern and eastern regions) (e.g., Morrow 1959; Gibbs 1984; Lloris et al. 1991; Sutton and Hopkins 1996; Vinnichenko 1997; Moore et al. 2003; Judkins and Haedrich 2018); Northwest Pacific Ocean off Ogasawara Islands (present study: Fig. 5). *Grammatostomias circularis* has been collected from depths between 0–802 m (e.g., Morrow 1959; Sutton and Hopkins 1996; Moore et al. 2003; Judkins and Haedrich 2018; Museum of Comparative Zoology, Harvard University 2023a, b) in the Atlantic, and 40–780 m in the Pacific (present study).

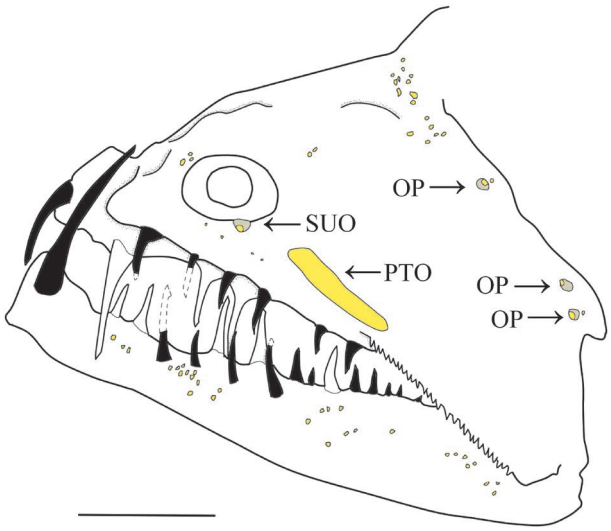


Fig. 2. Lateral view of head of *Grammatostomias circularis*, HUMZ 210834, 131.4 mm SL. Black and white teeth on premaxilla and dentary indicate fixed and depressible teeth, respectively. Arrows indicate main photophores. Small yellow dots indicate small luminous tissue areas. Dotted line indicates broken part of teeth. Abbreviations: SUO, suborbital photophore; PTO, postorbital photophore; OP, opercular photophore. Scale bar indicates 5 mm.

**Remarks.** The genus *Grammatostomias* includes four valid species: *G. circularis*, *G. dentatus*, *G. flagellibarba* Holt and Byrne, 1910, and *G. ovatus* Prokofiev, 2014 (Prokofiev 2014; Villarins et al. 2022). The present specimen clearly differs from *G. dentatus*, *G. flagellibarba*, and *G. ovatus* in the shape of the luminous loop on the lateral body surface (loop a thin circle without zigzags in the former vs. a streak-like line in *G. dentatus*, ventrally thickened elongate loop with

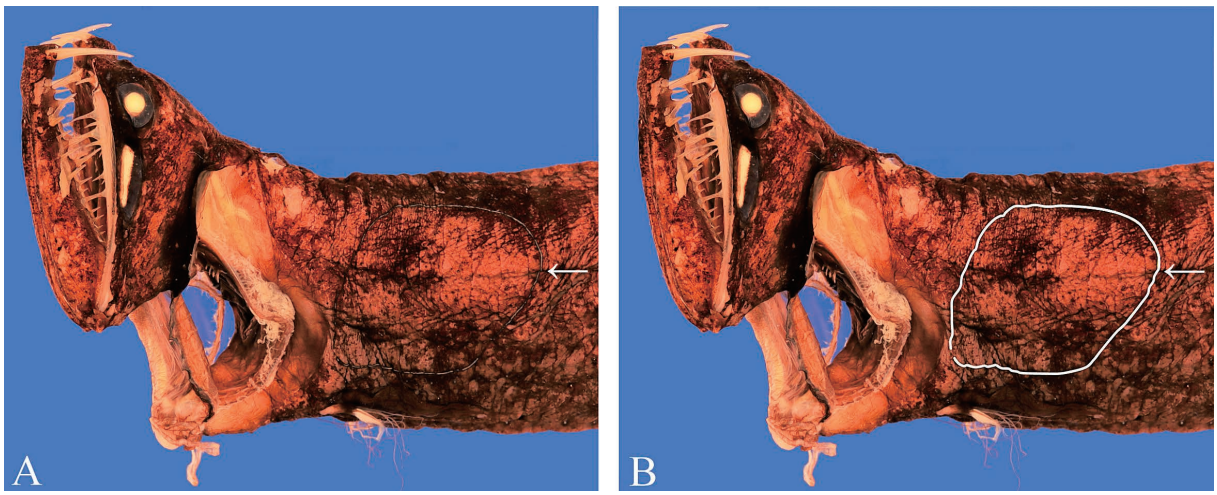


Fig. 3. Lateral view of head and anterior part of body of preserved specimen of *Grammatostomias circularis*, HUMZ 210834, 131.4 mm SL (A, B). Arrows indicate luminous loop on lateral body surface. Loop outlined in white in (B), not outlined in (A).

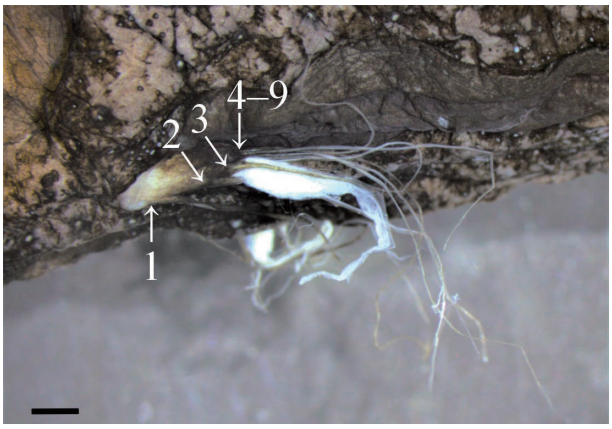


Fig. 4. Lateral view of pectoral fin of preserved specimen of *Grammatostomias circularis*, HUMZ 210834, 131.4 mm SL. Numbers and arrows indicate pectoral-fin rays and their respective bases. Scale bar indicates 1 mm.

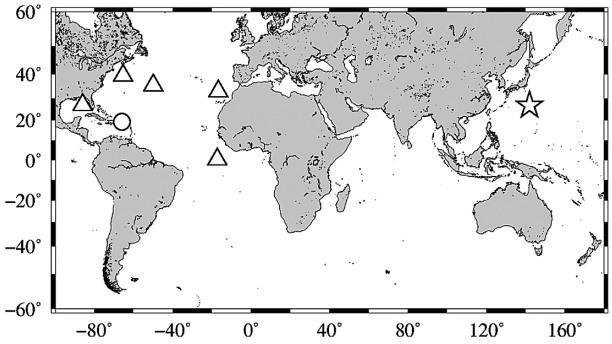


Fig. 5. Map showing records of *Grammatostomias circularis*. Star, circle and triangles indicate present Pacific record, type locality (Morrow 1959) and other Atlantic records (Llois et al. 1991; Sutton and Hopkins 1996; Vinnichenko 1997; Moore et al. 2003; Judkins and Haedrich 2018), respectively. Detail localities of Atlantic records from Moore et al. (2003) and Judkins and Haedrich (2018) given in Museum of Comparative Zoology, Harvard University (2023a, b), respectively.

zigzags in *G. flagellibarba*, and ovoid loop in *G. ovatus*) (Goode and Bean 1896; Holt and Byrne 1910; Parr 1927; Regan and Trewavas 1930; Beebe 1932; Beebe and Crane 1939; Morrow and Gibbs 1964; Swinney 1988; Prokofiev 2014; Villarins et al. 2022; Fig. 3, Table 2). Additionally, the present specimen differed from *G. dentatus* in having nine pectoral-fin rays (vs. five in *G. dentatus*), and from *G. ovatus* in having 21 dorsal- and 23 anal-fin rays, and no isolated pectoral-fin rays (vs. 18, 20 and first pectoral-fin ray isolated in *G. ovatus*) (Regan and Trewavas 1930; Parr 1927; Beebe and Crane 1939; Morrow 1959; Morrow and Gibbs 1964; Prokofiev 2014; Villarins et al. 2022; Table 2). Overall, the present specimen conformed to the original and subsequent descriptions of *G. circularis* (see Morrow 1959; Morrow and Gibbs 1964; McEachran and Fechhelm 1998). However, the total vertebral and photophore numbers of the former differed from those of the holotype of *G. circularis* (total vertebrae 57 in present specimen vs. 56 in holotype, and PV, VAV, AC, IC, VAL and OA 19, 20, 12, 58, 21 and 39, respectively vs. 18, 21, 13, 59, 19 or 20, and 37 or 38) (Morrow 1959; Morrow and Gibbs 1964; Table 1). However, such differences, being of similar order to those in congeneric species (e.g., PV 15 or 16, VAV 20–22, AC 12 or 13, OV 15–17 and VAL 21 or 22 in *G. dentatus*; see Morrow and Gibbs 1964), were considered to represent intraspecific variation only, thereby justifying the present identification of the present specimen as *Grammatostomias circularis*.

## Discussion

The distributional pattern of small luminous tissue areas on the head is variable among species of *Grammatostomias*, judging from the present specimen and previous descriptions of congeneric species; i.e., arranged in a line below and behind the eye in *G. dentatus*, in a line behind the eye and a cluster posteriorly on the opercle in *G. flagellibarba*, and in a line below the eye and a band posteriorly on the opercle in *G. ovatus* (see Goode and Bean 1896; Holt and

Table 2. Comparison of selected characters of valid species of *Grammatostomias*.

| | *G. circularis* | *G. dentatus* | *G. flagellibarba* | *G. ovatus* |
|---|---|---|---|---|
| Counts | | | | |
| Dorsal-fin rays | 21 | 19–20 | 19–21 | 18 |
| Anal-fin rays | 23 | 23 | 20–24 | 20 |
| Pectoral-fin rays | 9 | 5 | 9–11 | 6–9 |
| Total vertebrae | 56–57 | ca. 50 | 54 | No data |
| PV photophores | 18–19 | 15–16 | 17 | 17–18 |
| First pectoral-fin ray | Not isolated | Not isolated | Not isolated | Isolated |
| Small luminous tissue areas on head | | | | |
| Below eye | Present | Present | Absent | Present |
| Behind eye | Absent | Present | Present | Absent |
| On posterior part of opercle | Absent | Absent | Present | Present |
| Luminous loop or line on lateral body | | | | |
| Shape | Circular | Streak-like line | Elongate | Ovoid |
| Thickened section and zigzags | Absent | Absent | Present | Absent |
| References* | M, M&G, Pre | G&B, B, B&C, M&G | H&B, B&C, M&G | P, V |

* G&B: Goode and Bean (1896); H&B: Holt and Byrne (1910); B: Beebe (1932); B&C: Beebe and Crane (1939); M: Morrow (1959); M&G: Morrow and Gibbs (1964); P: Prokofiev (2014); V: Villarins et al. (2022); Pre: present study.

Byrne 1910; Beebe 1932; Beebe and Crane 1939; Morrow and Gibbs 1964; Prokofiev 2014; Table 2). In contrast, *G. circularis* lacks luminous tissue behind the eye and posteriorly on the opercle (Morrow 1959: unnumbered fig.; Fig. 2). However, the number of specimens examined in previous studies amount to fewer than 10 for each species (e.g., Beebe and Crane 1939; Morrow and Gibbs 1964; Prokofiev 2014). Additionally, it has been shown that the distributional pattern of small luminous tissue areas above the pectoral fin changes with growth (Beebe and Crane 1939; Morrow and Gibbs 1964). Therefore, the diagnostic validity of luminous tissue distribution on the head in *Grammatostomias* species requires further examination of intraspecific variation, based on additional variously-sized specimens.

*Grammatostomias circularis* has been recorded previously only from the Atlantic (e.g., Gibbs 1984; Sutton et al. 2020; Fig. 5). The inclusion of the species in a fish list for New Caledonia by Rivaton et al. (1990) was based on a misidentification of *G. dentatus* (see Fricke et al. 2011). Therefore, the present specimen represents the first record of *G. circularis* from the Pacific region, in addition to the first Japanese record of a species of *Grammatostomias*.

Some stomiid species, such as *Aristostomias tittmanni* Welsh, 1923 and *G. dentatus*, known from the Atlantic are rarely reported from the Indo-Pacific, as well as *G. circularis* (see Gibbs 1984; Mundy 2005; Fricke et al. 2011). Additionally, species having such a distributional pattern are also recognized in other mesopelagic fish groups: e.g., diceratiid *Diceratias pileatus* Uwate, 1979; oneirodid *Dolopichthys danae* Regan, 1926; ophidiid *Thalassobathia pelagica* Cohen, 1963; caristiid *Platyberyx mauli* Kukuev, Parin, and Trunov, 2012 (Pietsch and Randall 1987; Prokofiev and Kukuev 2008; Misawa et al. 2023; Okamoto et al. 2023). These suggest that mesopelagic species currently considered endemic to the Atlantic could also be distributed in the Indo-Pacific.

The new standard Japanese name "Tsukinowa-hotei-eso", based on HUMZ 210834 and referring to the luminous loop on the lateral body surface of the species (Fig. 3), is proposed for *Grammatostomias circularis*.

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## Authors Contributions

Kota Obata: Conceptualization; Funding acquisition; Investigation; Visualization; Writing – original draft. Hisashi Imamura: Supervision; Writing – original draft; Writing – review & editing.

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## Declarations

**Competing interests.** The authors declare no conflicts of interest.

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