

First Specimen-based Records of Redfin Emperor *Monotaxis heterodon* (Perciformes: Lethrinidae) from Japan, with New Diagnostic Characters Applicable to Identification of Preserved Specimens

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Twenty-four specimens (184.6–243.6 mm in standard length) of *Monotaxis* Anonymous [Bennett], 1830, collected from the Ryukyu Islands, southern Japan, were identified as *M. heterodon* (Bleeker, 1854) (Perciformes: Lethrinidae). Although a widely distributed Indo-West Pacific species, all previous records from Japanese waters have been based solely on photographs, the present specimens therefore representing the first specimen-based records of *M. heterodon* from Japan. A detailed comparison between *M. heterodon* and its only congener, *M. grandoculis* (Forsskål, 1775), from which it has previously been distinguished primarily by scale rows below the lateral line and fresh or live coloration, revealed new diagnostic characters, most of which are applicable to preserved specimens. In addition to previously recognized characters, the two species can be distinguished by mid-dorsal snout profile in adults (concave vs. straight), snout length (excluding lips) [8.9–11.1 (mean 9.9) % of SL vs. 10.3–12.1 (11.2) % SL], spinous anal-fin base length [4.6–5.9 (5.0) % of SL vs. 3.9–4.9 (4.4) % SL], a distinct black blotch above the pupil (absent vs. present), a dark brown stripe across the post interorbital region in preserved specimens (present vs. absent), and preserved coloration of the pectoral-fin base inner surface (blackish brown vs. light brown).

Key Words: *Monotaxis grandoculis*, morphology, description, distribution, Ryukyu Islands.

Introduction

The emperor fish genus *Monotaxis* Anonymous [Bennett], 1830 is characterized by the following combination of characters: 10 dorsal-fin soft rays; 9 anal-fin soft rays; 14 pectoral-fin rays; 44–47 pored lateral-line scales; cheek covered with scales; inner surface of pectoral-fin base scaled; and molariform teeth on lateral aspect of lower jaw (Carpenter and Allen 1989; this study). The genus currently includes two valid species (Randall 2005; Fricke et al. 2021), *Monotaxis grandoculis* (Forsskål, 1775) and *Monotaxis heterodon* (Bleeker, 1854), although the latter has previously been regarded as a junior synonym of the former because of their similarity in overall body appearance (Carpenter and Allen 1989).

During a taxonomic study on *Monotaxis*, 24 specimens (184.6–243.6 mm in standard length), collected from the Ryukyu Islands, southern Japan, were identified as *M. heterodon*. Although a widely distributed Indo-West Pacific species (Randall 2005; Yoshino 2008; Allen and Erdmann 2012; Fricke et al. 2014, 2019, 2021), specimen-based records of *M. heterodon* have not been reported from Japanese waters (previous Japanese records based only on photographs). In addition, a directed comparison of specimens of *M. het-*

erodon with those of *M. grandoculis* (16 specimens, 161.4–244.2 mm in standard length) revealed new characters separating the species. A detailed description of *M. heterodon*, based on the Japanese specimens, is provided herein, together with a revised diagnosis for the species.

Materials and Methods

Counts and measurements generally followed Carpenter and Allen (1989). Transverse scale rows above the lateral line were counted downwards posteriorly from the base of the fifth dorsal-fin spine (small truncated scale on dorsal and anal fin base counted as one). Measurements were made to the nearest 0.1 mm, with calipers. Standard length is abbreviated as SL. Curatorial procedures followed Motomura and Ishikawa (2013). Institutional codes follow Sabaj (2020). The following specimens of *M. grandoculis* (16 specimens, 161.4–244.2 mm SL, all from the Ryukyu Islands, southern Japan) were examined for comparative purposes: KAUM–I. 82083, 162.8 mm SL, KAUM–I. 116327, 184.6 mm SL, KAUM–I. 128576, 161.4 mm SL, Amami-oshima island, Amami Islands, Kagoshima Prefecture; KAUM–I. 46014, 185.5 mm SL, KAUM–I. 55077, 230.9 mm SL, Yoron-jima island, Amami Islands, Kagoshima Prefecture; URM–P 1382,

197.2 mm SL, URM-P 34769, 215.3 mm SL, URM-P 38673, 244.2 mm SL, URM-P 38674, 226.4 mm SL, URM-P 39573, 198.2 mm SL, URM-P 39718, 207.3 mm SL, URM-P 39719, 213.1 mm SL, URM-P 39721, 206.4 mm SL, URM-P 40061, 233.6 mm SL, URM-P 40099, 211.7 mm SL, URM-P 40309, 212.2 mm SL, Okinawa-jima island, Okinawa Islands, Okinawa Prefecture.

Monotaxis heterodon (Bleeker, 1854)

[English name: Redfin Emperor; new standard Japanese name: Kagutsuchi-yokoshima-kurodai]

(Figs 1, 3, 4A, C, E; Tables 1, 2)

Pagrus heterodon Bleeker, 1854: 54 (type locality: Sindangole, Halmahera, Indonesia).

Monotaxis grandoculis (not of Forsskål): Hiyama 1943: 449, fig. 31 (Micronesia); Randall et al. 1996: 204, unnumbered fig. (in part; Coral Sea); Sato 1997: 358, unnumbered figs (in part; Kerama Islands, Okinawa, Japan; Saipan); Mansor et al. 1998: 186, fig. 236 (South China Sea); Carpenter 2001: pl. XVII, fig. 144 (Enewetak, Marshall Islands); Kuitert and Debelius 2006: 424, unnumbered figs [in part; locality unknown (Indonesia, Maldives, or Australia)].

Monotaxis heterodon: Randall 2005: 281, unnumbered figs (Satonda, Indonesia; Marshall Islands); Allen and Erdmann 2012: 502, unnumbered figs (Philippines; Indonesia; Papua New Guinea); Yoshino 2008: 195, unnumbered fig. (Sesoko-jima island, Okinawa Prefecture, Japan); Fricke et al. 2014: 94 (Madang, Papua New Guinea); Fricke et al. 2019: 173 (New Ireland, Papua New Guinea); Shimose 2021: 117, unnumbered fig. (Okinawa Prefecture, Japan); Zhao et al. 2021: 321, fig. 1 (Mischief Reef, Spratly Islands, South China Sea).

Material examined. 24 specimens (184.6–243.6 mm SL), all from the southern Ryukyu Islands, Japan: KAUM-I. 88394, 215.0 mm SL, between Amami and Yaeyama islands, 17 May 2016, Y. Sakurai (obtained at fish market in Okinawa-jima island: detail locality unknown); URM-P 33254, 234.6 mm SL, Okinawa-jima island, 30 November 1994, Y. Sakurai et al.; URM-P 33447, 207.2 mm SL, URM-P 33448, 198.4 mm SL, URM-P 33449, 203.4 mm SL, Okinawa-jima island, 24 December 1994, M. Kume et al.; URM-P 34768, 189.1 mm SL, Okinawa-jima island, 25 November 1995, H. Yoshigou and M. Sekine; URM-P 38159, 197.4 mm SL, Okinawa-jima island, 16 June 1996, N. Fujioka; URM-P 38170, 224.1 mm SL, URM-P 38171, 230.4 mm SL, Okinawa-jima island, 18 June 1997, N. Fujioka; URM-P 38211, 219.2 mm SL, Okinawa-jima island, 4 July 1997, N. Fujioka; URM-P 38287, 191.8 mm SL, Okinawa-jima island, 1 August 1997, N. Fujioka; URM-P 38473, 191.5 mm SL, Okinawa-jima island, 22 August 1997, N. Fujioka; URM-P 39150, 235.6 mm SL, URM-P 39151, 227.3 mm SL, Okinawa-jima island, 27 October 1997, N. Fujioka; URM-P 39640, 220.4 mm SL, URM-P 39641, 231.8 mm SL, URM-P 39642, 224.8 mm SL, Okinawa-jima island, 18 December 1998, N. Fujioka et al.; URM-P 39717, 226.7 mm SL, Okinawa-jima island, 13 February 1999, N. Fujioka; URM-P

39731, 212.0 mm SL, Okinawa-jima island, 12 March 1999, N. Fujioka et al.; URM-P 39977, 232.2 mm SL, Okinawa-jima island, 30 April 1999, N. Fujioka; URM-P 40070, 236.2 mm SL, Okinawa-jima island, 15 July 1999, N. Fujioka; URM-P 40102, 218.0 mm SL, Okinawa-jima island, 5 August 1999, N. Fujioka et al.; URM-P 40307, 184.6 mm SL, Okinawa-jima island, 22 November 1999, N. Fujioka; URM-P 43626, 243.6 mm SL, Okinawa-jima island, 8 November 1999, K. Shimada.

Diagnosis. A species of *Monotaxis* with the following combination of characters: scale rows below lateral line 13 or 14; mid-dorsal snout profile concave; snout short, its length (excluding lips) 8.9–11.1% (mean 9.9%) of SL; spinous anal-fin base long, its length 4.6–5.9% (5.0%) of SL; both lips reddish-gray; distinct black blotch absent; 2 vertical narrow white bands on lateral surface of body (usually indistinct in preserved specimens over ca. 185 mm SL), width of each band including 1 or 2 longitudinal scale rows; black blotches on soft-rayed bases of dorsal and anal fins absent; all fins red or yellowish-red; dark brown stripe across occipital region in preserved specimens; and inner surface of pectoral-fin base blackish-brown in preserved specimens.

Description. Counts and measurements given in Tables 1 and 2. Body slightly compressed, deepest at base of third dorsal-fin spine. Dorsal profile of head and body generally elevated from snout tip to base of third spine of dorsal fin (concave above middle of snout), thereafter gradually decreasing to uppermost point of caudal-fin base. Ventral profile decreasing from lower-jaw tip to pelvic-fin origin, thereafter gradually rising to lowermost point of caudal-fin base. Eye and pupil round. Anterior and posterior nostrils close to each other, former with membranous tube; both located before anterior margin of eye. Both lips thick. Posterior tip of maxilla reaching to vertical through anterior margin of pupil. Gill rakers short, knob-like. Teeth on both jaws conical anteriorly, molariform laterally. Body completely covered with stout ctenoid scales, not extending onto fin bases, except for caudal fin. Head partially covered with stout scales, anterior margin of scaled area reaching to level with through posterior margin of eyes in dorsal view. Snout and suborbital region naked. Lateral line complete, extending from posterior tip of opercle to caudal-fin base. Cheek and inner surface of pectoral fin covered with scales. Pelvic fin with axillary scale.

Dorsal-fin origin above uppermost point of pectoral-fin base; end of dorsal-fin base reaching posteriorly to vertical through end of anal-fin base. Lowermost point of pectoral-fin base below base of second dorsal-fin spine. Posterior tip of pectoral fin slightly pointed, reaching to below between bases of 10th dorsal-fin spine and first dorsal-fin soft ray. Pelvic-fin origin below lowermost point of pectoral-fin base. Posterior tip of depressed pelvic fin reaching to anus. Anal-fin origin below between bases of 9th and 10th dorsal-fin spines. Caudal fin forked, upper and lower tips rounded.

Coloration. *Fresh condition* (Fig. 1A). Body brown dorsally, brownish-gray ventrally, with two faint pale white bands on lateral surface; anterior and posterior bands extending from base of third dorsal-fin spine and first dorsal-fin soft ray, respectively, to middle of body through lateral

Table 1. Counts and proportional measurements (expressed as percentages of standard length) of specimens of *Monotaxis* from the Ryukyu Islands, southern Japan.

	<i>Monotaxis heterodon</i>		<i>Monotaxis grandoculis</i>	
	n=24		n=16	
Standard length (SL; mm)	184.6–243.6		161.4–244.2	
Counts		Modes		Modes
Dorsal-fin rays	X, 9–10	X, 10	X, 10	X, 10
Anal-fin rays	III, 9	III, 9	III, 9	III, 9
Pectoral-fin rays	14	14	14	14
Pelvic-fin rays	I, 5	I, 5	I, 5	I, 5
Lateral-line scales	45–47 ^a	46	45–47 ^f	46
Upper gill rakers	3–6	5	2–6	6
Lower gill rakers	4–6 ^b	5	3–5	4
Scale rows above lateral line	5 ^c	5	5 ^d	5
Scale rows below lateral line	13–14 ^d	14	15–16 ^e	15
Measurements (% of SL)		Means		Means
Body depth	40.2–46.2	42.8	39.0–42.9	41.2
Head length	30.6–34.8	32.7	32.3–34.1 ^h	33.1
Snout length (excluding lips)	8.9–10.6	9.9	10.3–12.1	11.2
Snout length	10.2–13.8	12.0	12.1–14.2	13.3
Cheek height	15.0–17.7	16.1	11.9–17.4	15.6
Eye length	9.9–11.9	10.6	10.0–11.7	10.8
Pectoral-fin length	31.1–35.9	33.1	32.1–35.8	33.8
Pelvic-fin length	25.9–30.3 ^e	28.6	23.0–32.5 ^f	29.0
Caudal-peduncle length	15.4–19.0	17.1	16.4–18.8	17.8
Dorsal-fin base length	47.6–51.4	49.0	47.3–50.7	49.3
Spinous dorsal-fin base length	28.5–31.9	30.1	27.3–30.8	29.3
Soft dorsal-fin base length	17.4–19.6	18.6	18.4–21.1	19.3
Anal-fin base length	19.7–21.4	20.7	19.9–22.3	20.7
Spinous anal-fin base length	4.6–5.9	5.0	3.9–4.9	4.4
Soft anal-fin base length	13.2–16.0	14.9	14.3–16.3	15.2
Preorbital width	9.3–13.1	10.3	10.1–13.1	11.0

^{a-h} Based on 17, 23, 18, 14, 11, 12, 10 and 15 specimens, respectively

Table 2. Frequency distribution of scale rows below the lateral line of *M. heterodon* and *M. grandoculis*.

		Scale rows below lateral line			
		13	14	15	16
<i>M. heterodon</i>	n=14	1	13		
<i>M. grandoculis</i>	n=10			9	1

line; width of bands relatively narrow, including 1 or 2 longitudinal scale rows. Head brownish-gray, a single yellowish-brown band on middle of nape. Snout tip faint blackish, both lips reddish-gray. Upper and posterior margins of eye reddish-gray and yellowish-brown, respectively. Pupil black, a small faint red blotch above pupil. Upper point of posterior margin of opercle reddish-gray. Spinous portion of dorsal fin reddish-yellow, soft rayed portion red. Pectoral fin red, upper part of fin base widely margined with black, middle portion blackish-gray. Pelvic fin reddish-white anteriorly, white posteriorly. Anal fin whitish-red. Caudal fin ground color red, upper and lower lobes widely margined with yellowish-brown, a few narrow reddish-black streaks along rays (particularly in middle of fin).

Preserved condition (Fig. 1B). Body blackish-brown dor-

sally, light brown ventrally, two faint white bands (in fresh condition) becoming less distinct (not visible in 22 specimens, probably due to long-term preservation). Head light brown with single dark brown stripe across postorbital region. Snout tip faint blackish. Single yellowish-brown band on middle of nape (in fresh condition) usually retained as faint whitish band (not visible in 9 specimens). All fins (except caudal fin) pale brown. Caudal fin yellowish-brown, a few narrow black streaks along rays (particularly in middle of fin). Inner surface of pectoral-fin base blackish-brown.

Distribution. Widely known from the Indo-West Pacific: Seychelles east to southern Japan and New Caledonia (Sato 1997; Randall 2005; Yoshino 2008; Allen and Erdmann 2012; Fricke et al. 2014, 2019, 2021; Zhao et al. 2021; Shimose 2021). In Japanese waters, specimen-based records are known only from Okinawa-jima island, Ryukyu Islands. Photograph-based Japanese records are known only from Okinawa Prefecture, including Sesoko-jima island and the Kerama Islands (Sato 1997; Yoshino 2008; Shimose 2021).

Remarks. Although *M. heterodon* was regarded as a junior synonym of *M. grandoculis* by Carpenter and Allen (1989), Randall (2005) demonstrated differences (color patterns of lips and fins, and width of body stripes) between

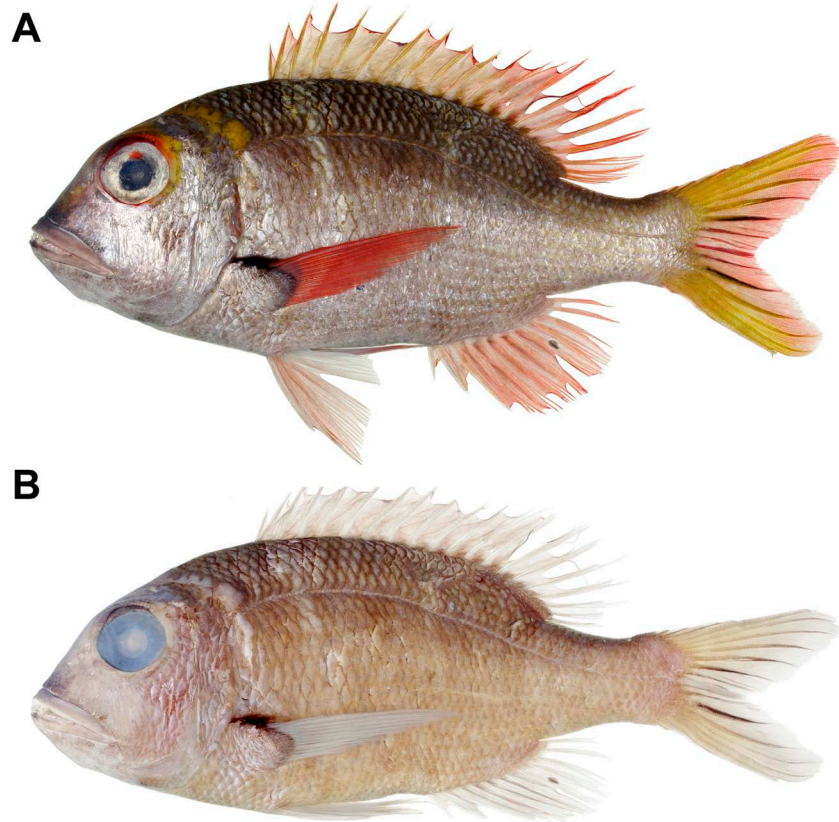


Fig. 1. Fresh (A) and preserved (B) specimen of *Monotaxis heterodon* (KAUM-I. 88394, 215.0 mm SL) from Ryukyu Islands, Japan.



Fig. 2. Fresh (A) and preserved (B) specimen of *Monotaxis grandoculis* (KAUM-I. 46014, 185.5 mm SL) from Yoron-jima island, Amami Islands, Japan.

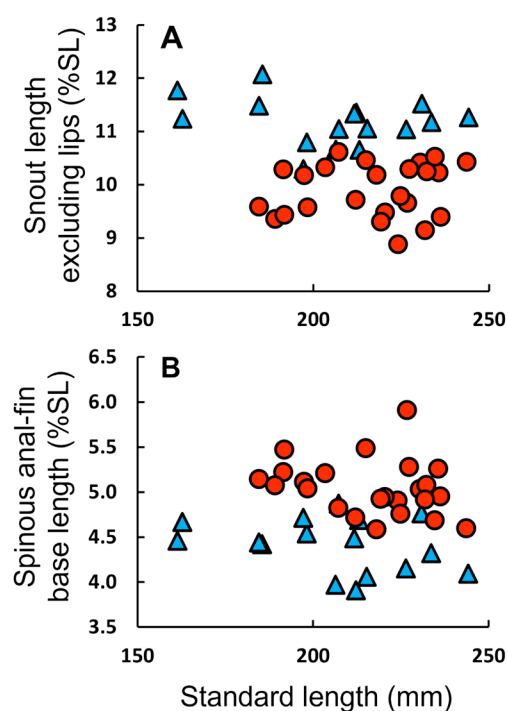


Fig. 3. Relationships of (A) snout length (excluding lips) (% of SL) and (B) spinous anal-fin base length (% of SL) to SL (mm) in *M. heterodon* (red circles) and *M. grandoculis* (blue triangles).

the two species and resurrected the former as a valid species. The present specimens agreed closely with *M. heterodon* [sensu Randall (2005) and Allen and Erdmann (2012)] in having scale rows below the lateral line 12.5 (vs. 13.5 in *M. grandoculis*), reddish lips (vs. yellowish), relatively narrow vertical white bands on the lateral surface of the body (width including 1 or 2 longitudinal scale rows) (vs. broad, including 3 or 4 longitudinal scale rows), and all fins red or yellowish-red (vs. dark brown or dusky red), and lacking black blotches on the soft-rayed bases of the dorsal and anal fins [vs. some blotches on soft-rayed bases (between membranes) of fins] (Figs 1, 2). Zhao et al. (2021) analyzed the COI sequences of *M. heterodon* and *M. grandoculis*, and detected two monophyletic clades that differed by 8.71% sequence divergence.

Although the above-mentioned characters are useful for distinguishing between *M. heterodon* and *M. grandoculis* (reconfirmed in this study), they are restricted to fresh specimens (except for black blotches on the dorsal and anal fins) and/or small individuals [e.g., white bands on the lateral body surface usually indistinct in large preserved specimens (>ca. 185 mm SL) in both species; Figs 1, 2]. However, the present study disclosed new diagnostic characters which can be used for preserved specimens, as well as large individuals, as follows: mid-dorsal profile of snout concave (except in juveniles: see Randall 2005; Yoshino 2008; Allen and Erdmann 2012) (vs. straight; Figs 1, 2); snout short, its length (excluding lips) 8.9–11.1 (mean 9.9) % of SL [vs. 10.3–12.1 (11.2) % SL; Fig. 3A]; spinous anal-fin base long, its length 4.6–5.9 (5.0) % of SL [vs. 3.9–4.9 (4.4) % SL; Fig. 3B]; a distinct black blotch above pupil absent (vs. single black blotch

present-note, both species with a small red blotch above pupil in fresh specimens; Fig. 4A, B); a dark brown stripe across occipital region in preserved specimens (vs. occipital stripe absent; Fig. 4C, D); and inner surface of pectoral-fin base blackish-brown in preserved specimens (vs. light brown; Fig. 4E, F). Randall (2005) and Allen and Erdmann (2012) described the counts of scale rows below the lateral line of *M. grandoculis* and *M. heterodon* as 13.5 and 12.5 (equivalent to 14 and 13 in counting method in this study), respectively. The counts of the present specimens were 15 or 16 in *M. grandoculis* and 13 or 14 in *M. heterodon* (Table 1). Although the range of the scale counts slightly overlapped, the modal values still differed between the two species (Table 2).

Monotaxis heterodon has previously been recorded from Japanese waters by Yoshino (2008) and Shimose (2021), based only on photographs from Okinawa Prefecture. Sato (1997) published an underwater photograph of a juvenile fish as *M. grandoculis* from the Kerama Islands and the photographed fish was re-identified here as *M. heterodon* based on two longitudinal black stripes on the lateral surface of the body (diagnosis of juveniles of *M. heterodon*; Randall 2005). Therefore, the present Ryukyu Islands specimens represent the first specimen-based records of *M. heterodon* from Japan.

Hiyama (1943) reported *M. grandoculis* from Micronesia and proposed the new Japanese name “Dokudai” (meaning “venomous sea bream”) for the species. Hiyama’s (1943) *M. grandoculis* was reidentified here as *M. heterodon*, having a concave snout, no black blotches above the pupil, and a yellowish caudal fin based on figure. Subsequently, Matsubara (1955) apparently overlooked Hiyama (1943) and proposed the Japanese name “Yokoshima-kurodai” for *M. grandoculis*, based on a single juvenile specimen (85 mm total length) which reported by Fowler (1946) from the Ryukyu Islands. The identity of Fowler’s (1946) specimen was confirmed here as *M. grandoculis* (based on his description, viz., having olive brown band from interorbital through eye to lower margin of cheek) (such a band absent in juveniles of *M. heterodon*; Randall 2005; Yoshino 2008; Allen and Erdmann 2012).

Recently, “Yokoshima-kurodai” has been widely used in papers that have treated fishes belonging to *Monotaxis* (e.g., Carpenter and Allen 1989; Sato 1997), whereas “Dokudai” has been rarely used (e.g., Baba 1983; Wu et al. 1999) since its proposal by Hiyama (1943). In addition, Hiyama’s (1943) “Dokudai” was superseded by Matsubara’s (1955) “Yokoshima-kurodai” (although both were considered to represent *M. grandoculis* at that time). In his review of Japanese lethrinids, Shimada (2000, 2002, 2013) followed Matsubara (1955) and used “Yokoshima-kurodai” as the standard Japanese name for both *M. grandoculis* and the genus *Monotaxis*. We also follow Matsubara’s (1955) and Shimada’s (2000, 2002, 2013) treatment, and suppress “Dokudai” to avoid further confusion. The new standard Japanese name “Kagutsuchi-yokoshima-kurodai” was therefore proposed for *M. heterodon*, based on KAUM-I. 88394, “Kagutsuchi” is the god of fire in Japanese mythology, and is associated with the reddish fins of this species.

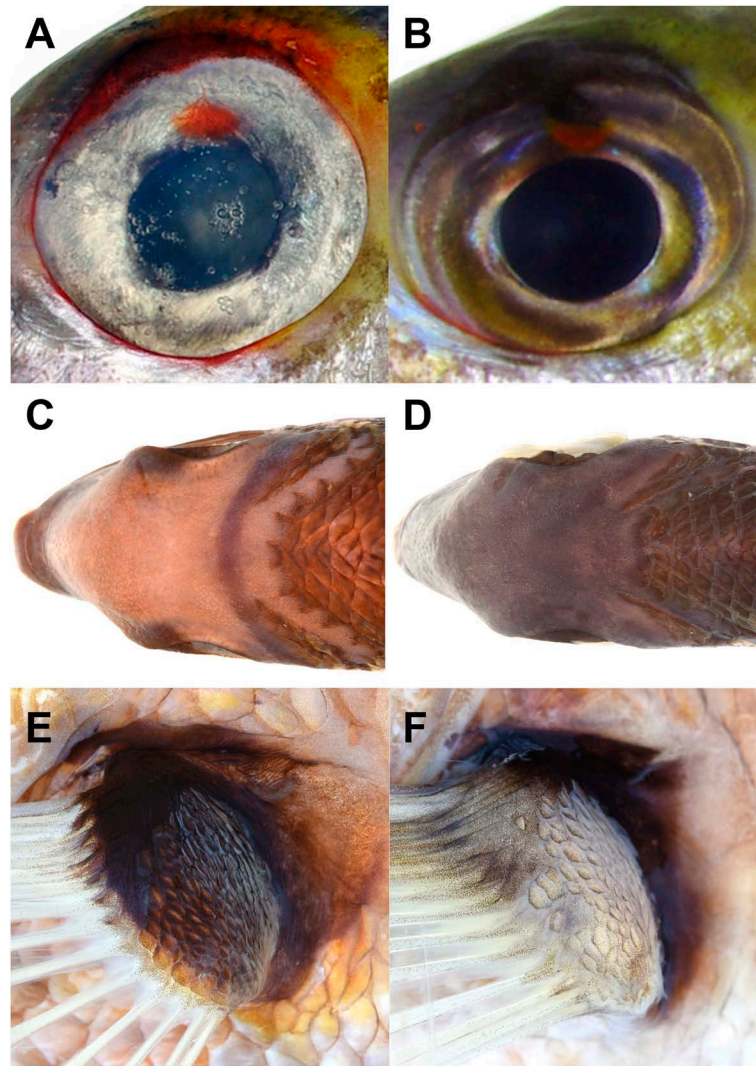


Fig. 4. Eyes (A, B), occipital region (C, D), and inner surface of pectoral-fin base (E, F) of *M. heterodon* (A, C, E) and *M. grandoculis* (B, D, F), showing differences between the two species. A, KAUM-I. 88394, 215.0 mm SL, fresh condition; B, D, F, KAUM-I. 46014, 185.5 mm SL, fresh (B) and preserved (D, F) conditions; C, E, URM-P 34768, 189.1 mm SL, preserved condition.

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References

- Allen, G. R. and Erdmann, M. V. 2012. *Reef Fishes of the East Indies. Vols. 1–3*. Tropical Reef Research, Perth, xiii+1292 pp.
- Baba, K. 1983. [Seafood poisoning (part 2)]. *Hekisui* 16: 6–8. [In Japanese]
- Bleeker, P. 1854. Bijdrage tot de kennis der ichthyologische fauna van Halmaheira (Gilolo). *Natuurkundig Tijdschrift voor Nederlandsch Indië* 6: 49–62.
- Carpenter, K. E. 2001. Lethrinidae, emperors (emperor snappers). Pp. 3004–3050. *In*: Carpenter, K. E. and Niem, V. H. (Eds) *FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific. Vol. 5. Bony Fishes Part 3 (Menidae to Pomacentridae)*. FAO, Rome.
- Carpenter, K. E. and Allen, G. R. 1989. *FAO species catalogue. Vol. 9. Emperor fishes and large-eye breams of the world (family Lethrinidae)*. An annotated and illustrated catalogue of lethrinid species known to date. *FAO Fisheries Synopsis*, No. 125: i–v+1–118, pls 1–8.
- Fowler, H. W. 1946. A collection of fishes obtained in the Riu Kiu Is-

- lands by Captain Ernest R. Tinkham, A.U.S. Proceedings of the Academy of Natural Sciences of Philadelphia 98: 123–218.
- Fricke, R., Allen, G., Amon, D., Andréfouët, S., Chen, W.-J., Kinch, J., Mana, R., Russell, B., Tully, D., and White, W. T. 2019. Checklist of the marine and estuarine fishes of New Ireland Province, Papua New Guinea, western Pacific Ocean, with 810 new records. *Zootaxa* 4588: 1–360.
- Fricke, R., Allen, G., Andréfouët, S., Chen, W.-J., Hamel, M. A., Laboute, P., Mana, Tan, H.-H., and Uyeno, D. 2014. Checklist of the marine and estuarine fishes of Madang District, Papua New Guinea, western Pacific Ocean, with 820 new records. *Zootaxa* 3832: 1–247.
- Fricke, R., Eschmeyer, W. N., and van der Laan R. (Eds) 2021. Eschmeyer's catalog of fishes: genera, species, references. Version 8 September 2021. Available at <http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp> (19 September 2021).
- Hiyama, Y. 1943. Dokudai. Pp. 59–60. In: Nissan Fishery Research Institute Odawara Branch (Ed.) *Research Report on Venomous Fishes of the South Sea*. Nissan Fisheries Research Institute Odawara Branch, Odawara. [In Japanese]
- Kuiter, R. H. and Debelius, H. 2006. *World Atlas of Marine Fishes*. IKAN-Unterwasserarchiv, Frankfurt, 720 pp.
- Mansor, M. I., Kohno, H., Ida, H., Nakamura, H. T., Azman, Z., and Abdullah, S. 1998. *Field Guide to Important Commercial Marine Fishes of the South China Sea*. Marine Fishery Resources Development and Management Department, Southeast Asian Fisheries Development Center, Terengganu, xiii+287 pp.
- Matsubara, K. 1955. *Fish Morphology and Hierarchy. Vol. 1*. Ishizaki-shoten, Tokyo, 789 pp. [In Japanese]
- Motomura, H. and Ishikawa, S. (Eds) 2013. *Fish Collection Building and Procedures Manual. English Edition*. The Kagoshima University Museum, Kagoshima and the Research Institute for Humanity and Nature, Kyoto, 70 pp. Available at http://www.museum.kagoshima-u.ac.jp/staff/motomura/dl_en.html (19 September 2021).
- Randall, J. E. 2005. *Reef and Shore Fishes of the South Pacific: New Caledonia to Tahiti and the Pitcairn Islands*. University of Hawai'i Press, Honolulu, v+707 pp.
- Randall, J. E., Allen, G. R., and Steene, R. C. 1996. *Fishes of the Great Barrier Reef and Coral Sea. Revised and Expanded Edition*. University of Hawai'i Press, Honolulu, xx+557 pp.
- Sabaj, M. H. 2020. Codes for natural history collections in ichthyology and herpetology. *Copeia* 108: 593–669.
- Sato, T. 1997. *Monotaxis grandoculis*. P. 358. In: Okamura, O. and Amaoka, K. (Eds) *Sea Fishes of Japan*. Yamakei Publisher, Tokyo. [In Japanese]
- Shimada, K. 2000. Lethrinidae. Pp. 860–866, 1568–1569. In: Nakabo, T. (Ed.) *Fishes of Japan with Pictorial Keys to the Species. Second Edition*. Tokai University Press, Tokyo. [In Japanese]
- Shimada, K. 2002. Lethrinidae. Pp. 860–866, 1559–1560. In: Nakabo, T. (Ed.) *Fishes of Japan with Pictorial Keys to the Species. English Edition*. Tokai University Press, Tokyo.
- Shimada, K. 2013. Lethrinidae. Pp. 960–968, 2014–2017. In: Nakabo, T. (Ed.) *Fishes of Japan with Pictorial Keys to the Species. 3rd Edition*. Tokai University Press, Hadano. [In Japanese]
- Shimose, T. 2021. *Commercial Fishes and Shellfishes of Okinawa*. Okinawa Times, Naha, 207 pp. [In Japanese]
- Wu, H.-L., Jin, X.-B., and Ni, Y. 1999. *Venomous and Medicinal Fishes in China*. Kouseisha Kouseikaku, Tokyo. xiii+350 pp. [In Japanese]
- Yoshino, Y. 2008. *Sea Fishes of Japan*. Yamakei Publisher, Tokyo. 543 pp. [In Japanese]
- Zhao, Y., Zhou, W., Shan, B., Liu, Y., Yang, C., and Sun, D. 2021. First record of *Monotaxis heterodon* (Actinopterygii: Perciformes: Lethrinidae) from the lagoon waters of Mischief Reef, South China Sea. *Acta Ichthyologica et Piscatoria* 51: 321–325.