Sains Malaysiana 54(3)(2025): 621-627
http://doi.org/10.17576/jsm-2025-5403-01

First Record of *Upeneus heterospinus* Uiblein & Pavlov, 2019, Varied-Spine Goatfish (Syngnathiformes, Mullidae) from Terengganu, Malaysia, in the Southern Part of South China Sea

(Rekod Pertama *Upeneus heterospinus* Uiblein & Pavlov, 2019, Ikan Biji Nangka (Syngnathiformes, Mullidae) dari Terengganu, Malaysia, di Bahagian Selatan Laut China Selatan)

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Received: 18 September 2024/Accepted: 26 November 2024

ABSTRACT

This is the first record of the varied-spine goatfish, *Upeneus heterospinus* Uiblein & Pavlov, 2019, in Malaysia. In March 2023, a single *U. heterospinus* specimen (70 mm standard length) was captured in Setiu Wetlands, Terengganu, Malaysia, in the southern part of South China Sea. *Upeneus heterospinus* has been recorded in southern Indonesia, Singapore, the Gulf of Thailand, Vietnam, the central Philippines, southern China, Taiwan, and Japan, but has not previously documented in Malaysian waters. Detailed morphometric and meristic specimen data are herein presented.

Keywords: Geographic distribution; goatfish; mangrove; Mullidae; Setiu Wetlands

ABSTRAK

Ini merupakan rekod pertama bagi spesies ikan biji nangka, *Upeneus heterospinus* Uiblein & Pavlov, 2019, di Malaysia. Pada Mac 2023, satu spesimen *U. heterospinus* (70 mm panjang piawai) telah berjaya ditangkap di kawasan estuari Tanah Bencah Setiu, Terengganu, Malaysia, yang terletak di selatan Laut China Selatan. *Upeneus heterospinus* telah direkodkan di selatan Indonesia, Singapura, Teluk Thailand, Vietnam, Filipina Tengah, Selatan China, Taiwan dan Jepun tetapi belum pernah didokumentasi di perairan Malaysia. Data morfometrik dan meristik spesimen *U. heterospinus* diterangkan secara terperinci dalam kertas ini.

Kata kunci: Ikan biji Nangka; Mullidae; paya bakau; taburan geografi; Tanah Bencah Setiu

INTRODUCTION

Six genera and roughly 100 species worldwide have been identified in the family Mullidae (Fricke, Eschmeyer & Fong 2023). Members of this family live on coral reefs, in brackish and marine environments, usually on sandy or muddy bottoms. Their considerable degree of morphological variety is one of their defining characteristics (Golani & Galil 1991; Stepien, Randall & Rosenblatt 1994). Mullids inhabit a wide range of environments, from the tropics to the subtropics and even temperate zones, including the Black Sea, the Mediterranean, the Pacific, the Atlantic, and the southern and eastern parts of Australia and New Zealand (Ben-Tuvia 1986; Uiblein 2007). Often referred to as goatfishes, mullids possess two hyoid barbels that can move independently. These barbels are equipped with chemical receptors, enabling the fish to sense sand or holes in the reef, which allows them to locate and feed on crustaceans residing on the ocean floor (Nash et al. 2022). Recent taxonomic revisions in the Eschmeyer's Catalog of Fishes (Fricke, Eschmeyer & Fong 2023) have placed the family Mullidae in order Syngnathiformes.

Of the 100 species in this family, up to 50 validated species have been reported in the genus *Upeneus* Cuvier, 1829 (Froese & Pauly 2023), with 11 species currently

recorded by Malaysia Biodiversity Information System in Malaysia (MyBIS 2024). Nevertheless, no specimens of *U. heterospinus* have been reported from Malaysia to date. Recent field surveys in the Setiu Wetlands have yielded a new record of the mullid species, *Upeneus heterospinus.* This species has previously been recorded from southern Indonesia in the Eastern Indian Ocean to Singapore, the Gulf of Thailand, Vietnam, the Philippines, China, Taiwan, and Japan in the Western Pacific Ocean (Uiblein et al. 2019). *Upeneus heterospinus* is characterized by the presence of seven or eight dorsal-fin spines and can be distinguished from its congeners by the coloration of barbels, the presence of a mid-lateral body stripe, pigmentation patterns in preserved condition, the number of gills rakers and pectoral-fin rays, and body proportions (Uiblein et al. 2019). In this study, a single specimen of *U. heterospinus* was reported as the first confirmed record of the species from Malaysian waters.

MATERIALS AND METHODS

A single specimen of *U. heterospinus* was collected from Setiu Wetlands, Malaysia (Figure 1) in March 2023 during exploratory sampling to characterize the ichthyofauna of the Setiu Wetlands. The specimen was caught in a seine net in the Setiu Wetlands estuary (5°40'04.8"N, 102°44'06.0"E). Upon collection, the specimen was photographed in fresh color. The sex indeterminate specimen was then fixed in 10% formalin and preserved for long-term storage in 70% ethanol. The voucher specimen was deposited in the fish reference collection of the South China Sea Repository and Reference Centre, Institute of Oceanography and Environment, Universiti Malaysia Terengganu, Malaysia, under the catalogue number UMTF 10723.

The specimen was measured using vernier calipers to an accuracy of 0.1 millimeters (mm). The standard length (SL) was denoted in millimeters (mm), whilst other measurements were shown as a proportion of the standard length. The morphological measurements and identification terms adhere to the conventions outlined by both Uiblein and Heemstra (2010) and Uiblein et al. (2019) in their descriptions of the species. The distribution data for the species (Figure 2) were collected and referenced from multiple sources, such as the Global Biodiversity Information Facility (https://www.gbif.org/), Eschmeyer's Catalogue of Fishes (https://www.calacademy.org/scientists/projects/eschmeyers-catalog-of-fishes), FishBase (https://www.fishbase.se/search.php), and Malaysian fish identification books.

Utilizing the conventional CTAB (cetyl trimethylammonium bromide) extraction method (Winnepenninckx, Backeljau & Wachter 1993), genomic DNA was extracted from the specimen to confirm the initial morphological analysis. The genomic DNA was then stored at a temperature of -20 ºC until further use. DNA purity and concentration were measured using a microvolume UV spectrophotometer (Quawell Q300, Quawell, California). After that, PCR amplification was performed using universal teleost primers by Ward et al. (2005); FishF2-5'-TCGACTAATCATAAAGATATCGGCAC-3' (forward) and FishR2-5'-ACTTCAGGGTGACCGAAGAATCAGAA-3' (reverse).

The PCR thermal cycling profiles applied were as specified by Zainal Abidin et al. (2021). We included a negative control in the PCR analysis preparation process to ensure the reliability and accuracy of the PCR results. The amplified PCR products were detected using 1.7% agarose gel electrophoresis, followed by purification. The purified amplicons were subjected to bidirectional Sanger sequencing by Apical Scientific Sdn. Bhd., a commercial service provider. The sequencing was performed utilizing the ABI PRISM 3730XL automated sequencer and the ABI PRISM BigDye terminator cycle sequencing kit v3.1, both manufactured by Applied Biosystems (Foster City, CA, USA). The mtDNA COI sequence obtained from the current specimen was submitted to GenBank with the accession number OR859580 for future comparative analysis.

RESULTS AND DISCUSSION

Taxonomy; Class Actinopterygii; Order Syngnathiformes; Family Mullidae; Genus *Upeneus* Cuvier, 1829; *Upeneus heterospinus* Uiblein & Pavlov, 2019

New records. MALAYSIA – Terengganu • Setiu Wetlands; 5°40'04.8"N, 102°44'06.0"E; 12.III. 2023; Kasim NS leg.; seine net; GenBank: OR859580; 1 specimen in ethanol; 70 mm SL; UMTF 10723.

Diagnosis Dorsal fin spines VIII, gill rakers 24, lateral-line scales 30, pectoral-fin 14, and absence of dark pigmentation in the area of the first dorsal-fin tip (Table 1). These following combination of diagnostic characters was aligned with the description by Uiblein et al. (2019) for *Upeneus heterospinus*: dorsal fins VIII + 9 (first spine minute); pectoral fins 14; gill rakers 8 + 16 = 24; lateral-line scales 30; when fresh, head and body dorsally brown mottled, ventrally white, with many red blotches; upper lobe of caudal fin with 5 brown bars, lower caudal-fin lobe with 6 dark-brown bars; bars on both lobes of pupil width, interrupted by pale, partly hyaline interspaces of similar width; barbels entirely yellow; a single pale brown mid-lateral body stripe of pupil width from snout tip through eye to caudal-fin base; first dorsal fin with 4 pale-red stripes, fin-tip area not darker pigmented; second dorsal fin with 4 brown well-separated stripes with hyaline interspaces; pectoral fins hyaline, pelvic and anal fins weakly pigmented and partly hyaline.

Uiblein et al. (2019) included most of the proportional measurements in the diagnostic characters for the species. The morphometric measurements of the specimen fall within the range observed by Uiblein et al. (2019) except for several characters, *viz*., maximum barbel width and caudal-fin length (Table 1). Such minor differences are

FIGURE 1. Fresh specimen of *Upeneus heterospinus,* UMTF 10723, 70 mm standard length, Setiu Wetlands, Terengganu, Malaysia

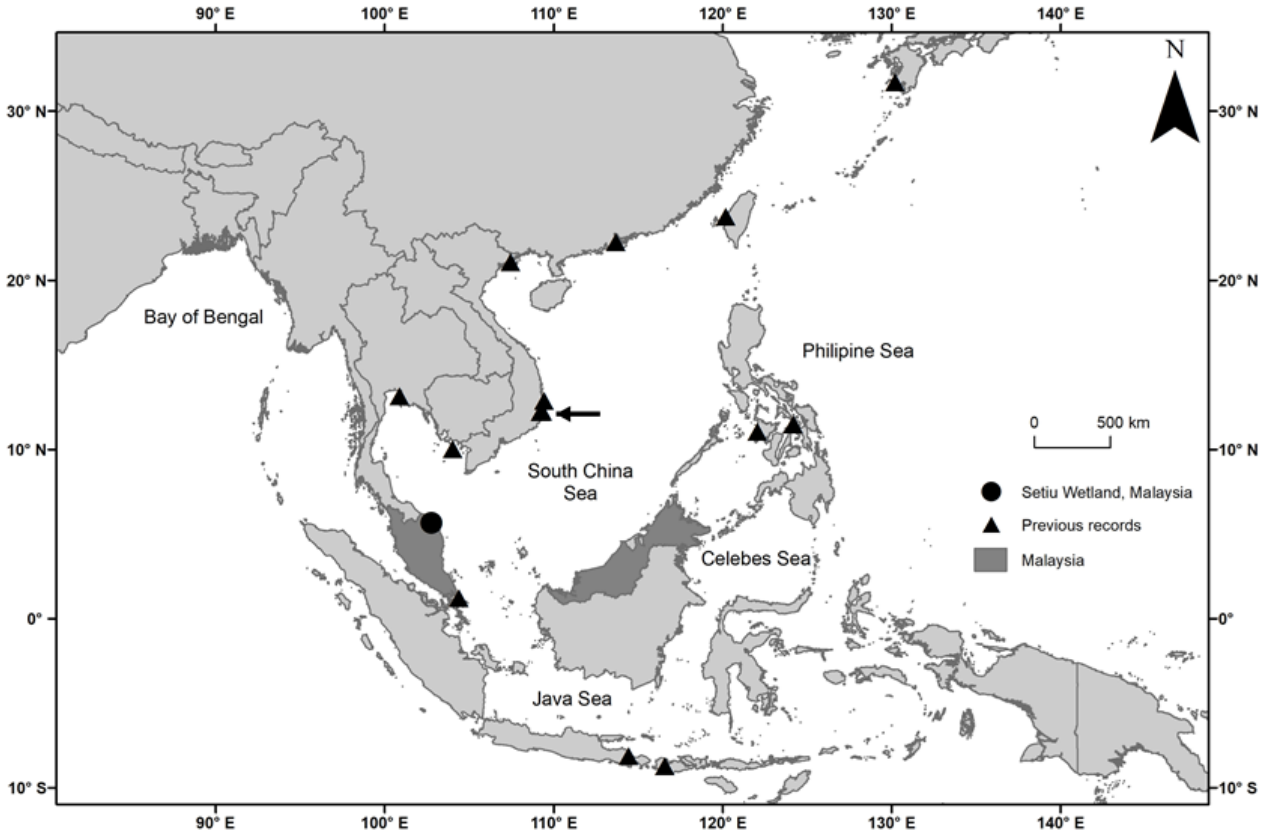

FIGURE 2. Collecting sites of previous records of *Upeneus heterospinus* (Uiblein et al. 2019; triangles) and new record from Malaysia (circle). Arrow indicates the type locality

TABLE 1. Morphometric measurements and meristic counts obtained from adult specimens (> 65 mm standard length) of *Upeneus heterospinus*

	Present study	Uiblein et al. (2019): Table 9)
	UMTF 10723	*n* = 101
Standard length (mm)	70	65-152
Morphometric characteristics (% of standard length)		
Body depth at first dorsal-fin origin	26	22-26
Body depth at anal-fin origin	21	18-22
Half body depth at first dorsal-fin origin	21	18-22
Half body depth at anal-fin origin	16	15-17t
Caudal-peduncle depth	11	9.2-11
Caudal-peduncle width	4.3	3.5-5.0
Maximum head depth	22	19-23
Head depth through eye	17	15-18
Suborbital depth	10	8.3-11
Interorbital length	7.6	7.2-9.2
Head length	27	27-31
Snout length	10	9.7-13
Postorbital length	11	10-13
Orbit length	7.1	5.9-8.3
Orbit depth	5.7	4.9-7.4
Upper-jaw length	10	9.4-13
Lower-jaw length	8.9	8.9-12
Snout width	10	7.1-11
Barbel length	17	16-20
Maximum barbel width	1.4	0.8-1.2
First pre-dorsal length	36	34-39
Second pre-dorsal length	60	60-67
Interdorsal distance	16	13-17
Caudal-peduncle length	26	22-26
Pre-anal length	63	61-68
Pre-pelvic length	30	30-35
Pre-pectoral length	29	28-33
Second dorsal-fin depth	23	19-23
Pelvic-fin depth	24	22-26
Pectoral-fin depth	18	15-18
Length of first dorsal-fin base	14	13-17
Length of second dorsal-fin base	13	12-16
Caudal-fin length	24	27-32
Length of anal-fin base	10	10-13
Anal-fin height	15	15-19
Pelvic-fin length	20	19-23
Pectoral-fin length	20	19-22

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Pectoral-fin width	4.3	3.4-4.7
First dorsal-fin height	21	18-23
Second dorsal-fin height	17	16-20
Meristic characteristics		
Dorsal-fin spines	8	7 or 8
Pectoral-fin rays	14	13-15
Rudimentary gill rakers on upper limb	4	2-4
Developed gill rakers on upper limb	4	2-4
Developed gill rakers on lower limb	12	11-14
Rudimentary gill rakers on lower limb	4	3-6
Total gill rakers on upper limb	8	4-6
Total gill rakers on lower limb	16	15-18
Total gill rakers	24	21-24
Scales along lateral line	30	28-30
Colour pattern		
Bars on upper caudal-fin lobe	5	0-6
Bars on lower caudal-fin lobe	6	0-6
Bars on both caudal-fin lobes	11	0-12

regarded here as intraspecific differences. Although Uiblein et al. (2019) pointed out that statistical analyses based on meristic and morphometric values among putative members are necessary for precise identification of the targeted *margarethae* species group, comparative analysis are not available for this study. However, the important characters, including VIII dorsal-fin spines (unique within the species group) and fresh coloration, and the close proximity to previously recorded localities (such as Singapore) of the present specimen strongly support the present identification as a new record. This species is grouped under *margarethae* group due to sharing the same color characteristics as well as the counts of pectoral-fin rays, gill-rakers, and lateral-line scales, both in fresh and preserved specimens. However, it deviates from the norm by having a pattern of alternating occurrences of 7 or 8 dorsal-fin spines, rather than entirely 8 (Uiblein et al. 2019). Initially, *U. heterospinus* was misidentified as *U. tragula* Richardson, 1846 due to similarities in pattern and color characteristics. This is not unexpected as species in the *margarethae* group share similarities with the *tragula* group in meristic, morphometric and color characteristics (Uiblein et al. 2016).

This specimen marks the first documentation of *U. heterospinus* in the Setiu Wetlands of Terengganu, Malaysia. According to Uiblein et al. (2019), this species is prevalent in the Western Pacific, ranging from southern Indonesia to Singapore, across the central Philippines, up to the Gulf of Thailand, Vietnam, southern China, Taiwan, and southern Japan, as reported by FishBase (Froese & Pauly 2023). It could also be native to Malaysian waters. Given that this species has been recorded in the waters of neighboring countries, it is plausible that it could also be found in Malaysia. This significant finding is the first recorded presence of *U. heterospinus* in Malaysian waters, approximately 500 km from the nearest known population in Singapore (Figure 2). This newly recorded species of mullid fish adds to the total number of species in the family Mullidae identified in Malaysian waters, bringing the count to 28, with 12 documented under the genus *Upeneus*. This accounts for 28% of all identified mullid species, currently at a total of 107 (Fricke, Eschmeyer & Fong 2023). Additionally, documenting this record contributes to the establishment of a fish checklist for Malaysian waters, which is crucial for long-term monitoring. This is particularly important for detecting changes in global climate trends and potential threats over time, even for species that are currently deemed stable (Mohamad, Rahmat & Mohd 2022; Oliver et al. 2021). Moreover, each documented species enhances the overall understanding of biodiversity within the region. This is essential for developing accurate taxonomic checklists, understanding ecosystem composition, and identifying biodiversity hotspots that may require conservation (Graham et al. 2017; Lo Brutto 2023). Maintaining inventories of all species, including those not currently threatened, strengthens

comprehensive ecological research. As a side note, marine fish records in Malaysia have added another species to the database, bringing the total number of species to 1,620 (MyBIS 2024).

Upeneus heterospinus, similar to other species within the genus *Upeneus*, operates at the trophic level as a benthic forager, consuming benthic invertebrates found within the sediment. This feeding behavior indirectly aids in regulating the populations of these benthic organisms, thereby contributing to the overall balance of benthic communities (Krishna, Panchakshari & Prabhavathi 2015). Furthermore, as a bottom-dweller, it plays a role in sediment turnover and nutrient cycling. This bioturbation process can improve sediment oxygenation, which in turn benefits other benthic organisms and the overall health of the habitat (Baranov, Lewandowski & Krause 2016; Sturdivant, Díaz & Cutter 2012). This species is occasionally found on sandy or muddy bottoms (Uiblein et al. 2019). Notably, this particular specimen of *U. heterospinus* was captured using a beach seine net in a muddy seagrass bed area, near the river mouth opposite Pulau Sutung in the Setiu Wetlands, Setiu, Terengganu. These seagrass beds play an important role in adding organic matter to coastal ecosystems through bacterial and fungal intermediaries (Canuel, Freeman & Wakeham 1997; Jones et al. 2003) and may enhance the diversity of fish communities in the Setiu Wetlands. Given that this wetland encompasses a multihabitat ecosystem, we anticipate that additional species records will be documented, particularly in unexplored sites.

ACKNOWLEDGEMENTS

This work was supported by the 'Ministry of Natural Resources and Environmental Sustainability (NRES)' under National Conservation Trust Fund for Natural Resources (NCTF) under grant no. NRECC/NCTF/2021/53478. We thank Mr. Mohd Nasir bin Mohamad for producing the distribution map. We also thank the collection teams of the expeditions: Ms. Nur Ilham Syahadah Mohd Yusoff and Mr. Raja Ahmad Raja Deman as well as the entire staff of the Faculty of Fisheries and Food Science and the South China Sea Repository and Reference Centre for their valuable research assistance. We also express our special thanks to our reviewers and academic editor.

REFERENCES

Baranov, V., Lewandowski, J. & Krause, S. 2016. Bioturbation enhances the aerobic respiration of lake sediments in warming lakes. *Biology Letters* 12(8): 20160448.

Ben-Tuvia, A. 1986. Mullidae. In *Smiths' Sea Fishes,* edited by Smith, M.M. & Heemstra, P.C. Berlin, Germany: Springer-Verlag. pp. 610-613.

Canuel, E.A., Freeman, K.H. & Wakeham, S.G. 1997. Isotopic compositions of lipid biomarker compounds in estuarine plants and surface sediments. *Limnology and Oceanography* 42(7): 1570-1583. https://doi.org/10.4319/lo.1997.42.7.1570

Fricke, R., Eschmeyer, W.N. & Fong, J.D. 2023. Species by family/subfamily. http://researcharchive.calacademy.org/research/ichthyology/catalog/SpeciesByFamily.asp (Accessed on 10th October 2023).

Froese, R. & Pauly, D. 2023. FishBase. www.fishbase.org. (Accessed on 10th September 2024).

Golani, D. & Galil, B. 1991. Trophic relationships of colonizing and indigenous goatfishes (Mullidae) in the eastern Mediterranean with special emphasis on decapod crustaceans. *Hydrobiology* 218(1): 27-33. https://doi.org/10.1007/BF00006415

Graham, N.R., Gruner, D.S., Lim, J.Y. & Gillespie, R.G. 2017. Island ecology and evolution: Challenges in the Anthropocene. *Environmental Conservation* 44(4): 323-335. doi:10.1017/S0376892917000315

Jones, A.B., O'Donohue, M.J.O., Udy, J. & Dennison, W.C. 2003. Assessing ecological impacts of shrimp and sewage effluent: Biological indicators with standard water quality analyses. *Estuarine, Coastal and Shelf Science* 52: 91-109. https://doi.org/10.1006/ecss.2000.0729

Krishna, P.V., Panchakshari, V. & Prabhavathi, K. 2015. Food and feeding habits of goat fish *Upeneus sulphureus* from Nizampatnam Coast, Andhra Pradesh, India. *International Journal of Advanced Research* 3(11): 1066-1070.

Lo Brutto, S. 2023. Zoological checklists: From natural history museums to ecosystems. *Diversity* 15(6): 741. https://doi.org/10.1371/journal.pone.0034539

Mohamad, M.F., Rahmat, S.R. & Mohd, S. 2022. Assessing Malaysia marine fisheries sustainability under climate change pressure: A quintuple helix approach. *Malaysian Journal of Social Sciences and Humanities (MJSSH)* 7(11): e001899. https://doi.org/10.47405/mjssh.v7i11.1899

Malaysia Biodiversity Information System (MyBIS). 2024. Ministry of Natural Resources and Environmental Sustainability, Malaysia Biodiversity Centre & Forest Research Institute, Malaysia. https://www.mybis.gov.my/ (Accessed on 16th June 2024).

Nash, C.M., Lungstrom, L.L., Hughes, L.C. & Westneat, M.W. 2022. Phylogenomics and body shape morphometrics reveal recent diversification in the goatfishes (Syngnatharia: Mullidae). *Molecular Phylogenetics and Evolution* 177: 107616. https://doi.org/10.1101/2022.04.12.488079

Oliver, R.Y., Meyer, C., Ranipeta, A., Winner, K. & Jetz, W. 2021. Global and national trends, gaps, and opportunities in documenting and monitoring species distributions. *PLoS Biology* 19(8): e3001336. https://doi.org/10.1371/journal.pbio.3001336

Stepien, C.A., Randall, J.E. & Rosenblatt, R.H. 1994. Genetic and morphological divergence of a circumtropical complex of goatfishes: *Mulloidichthys vanicolensis, M. dentatus,* and *M. martinicus. Pacific Science* 48(1): 44-56.

Sturdivant, S.K., Diaz, R.J. & Cutter, G.R. 2012. Bioturbation in a declining oxygen environment, *in situ* observations from Wormcam. *PLoS ONE* 7(4): e34539.

Uiblein, F. 2007. Goatfishes (Mullidae) as indicators in tropical and temperate coastal habitat monitoring and management. *Marine Biology Research* 3(5): 275-288. https://doi.org/10.1080/17451000701687129

Uiblein, F. & Heemstra, P.C. 2010. A taxonomic review of the Western Indian Ocean goatfishes of the genus *Upeneus* (Family Mullidae) with descriptions of four new species. *Smithiana Bulletin* 11: 35-71.

Uiblein, F., Gledhill, D.C., Pavlov, D.A., Hoang, T.A. & Shaheen, S. 2019. Three new goatfishes of the genus *Upeneus* (Mullidae) from the Indo-Pacific, with a redescription of colour patterns in *U. margarethae*. *Zootaxa* 4683(2): 151-196. https://doi.org/10.11646/zootaxa.4683.2.1

Uiblein, F., Gouws, G., Gledhill, C. & Stone, K. 2016. Just off the beach: Intrageneric distinctiveness of the bandtail goatfish *Upeneus taeniopterus* (Mullidae) based on a comprehensive alpha taxonomy and barcoding approach. *Marine Biology Research* 12: 675-694. https://doi.org/10.1080/17451000.2016.1190458

Ward, R.D., Zemlak, T.S., Innes, B.H., Last, P.R. & Hebert, P.D. 2005. DNA barcoding Australia's fish species. *Philosophical Transactions of the Royal Society B: Biological Sciences* 360(1462): 1847-1857. https://doi.org/10.1098/rstb.2005.1716

Winnepenninckx, B., Backeljau, T. & De Wachter, R. 1993. Extraction of high molecular weight DNA from molluscs. *Trends in Genetics* 9(12): 407. doi: 10.1016/0168-9525(93)90102-n

Zainal Abidin, D.H., Mohd Nor, S.A., Lavoue, S., A Rahim, M., Jamaludin, N.A. & Mohammed Akib, N.A. 2021. DNA-based taxonomy of a mangrove-associated community of fishes in Southeast Asia. *Scientific Reports* 11(1): 17800. https://doi.org/10.1038/s41598-021-97324-1

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