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Additional Report and Taxonomic Description of Common Pike Conger *Muraenesox bagio* (Hamilton, 1822) from Dholai Fishing Harbour, Gujarat, Northwest Coast of India

Borichangar R. V [a*], Parmar J. N. [a], Bharda S. K. [b] and Kotadiya D. P. [c]

[a] Department of Fisheries Resource Management, College of Fisheries Science, K.U., Navsari, 396 450, India.
[b] Department of Fisheries Resource Management, ICAR-Central Institute of Fisheries Education, Mumbai 400 066, India.
[c] Department of Fisheries Extension, Economics and Statistics, College of Fisheries Science, Navsari, 396 450, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author BRV designed the experiment. Author PJN collected specimens and gathered data. Author BSK wrote the paper. Authors BRV and KDP proofread the manuscript and analysed the data. All authors read and approved the final manuscript.

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**Corresponding author: E-mail: rvb@kamdhenuuni.edu.in;*

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ABSTRACT

Muraenesox bagio was identified and described from Dholai fishing harbour on the Gujarat coast, northwest coast of India, marking the first recorded occurrence of this species in the region. *Muraenesox bagio*, a member of the family Muraenosocidae, shares significant morphological and genetic similarities with its closely related species, *Muraenesox cinereus*. This report confirms the presence of *Muraenesox bagio* along the northwest coast of India and provides a comprehensive account of its taxonomy and detailed morphological descriptions.

Keywords: Dholai fishing harbour; Muraenosocidae; Muraenesox bagio.

1. INTRODUCTION

Fish account for more than 50% of total vertebrate species in the world. Fricke et al. [1] reported a staggering global count of 61,628 fish species. India, recognized for its rich fish biodiversity, hosts 2,860 finfish species [2]. The west coast of India has rich coastal geography, which includes bays, river estuaries, shores varying from muddy bottoms to rocky shores, and the famous mudbanks of Kerala. The west coast represents a little less than 50% of the total ichthyofaunal biodiversity of India. The state of Gujarat alone contributes 426 species, representing approximately 15% of the nation's total fish biodiversity [3].

There are about 106 orders globally, and the order Anguilliformes holds a significant position, encompassing 26 families, 278 genera, and 1900 species [1]. Whereas in India, a study conducted by the Central Marine Fisheries Research Institute (CMFRI) identified 11 families, including 53 genera and 105 species of eels [3]. Family Muraenosocidae is one of the important families in the order Anguilliformes. There are six genera of the family Muraenosocidae reported worldwide, viz., *Congresox*, *Cynoponticus*, *Gavialiceps*, *Muraenesox*, *Oxyconger, and Sauromuraenesox,* out of which four are reported from India. Three species from Genus *Muraenesox* are reported globally, and two are reported from India [2].

Recognizing the limitations in current taxonomic studies the difficulty in distinguishing species based on morphological analysis, and the poorly studied taxonomy of eels underline the existence of numerous unrecorded species, emphasising the necessity for a nuanced understanding of these elusive organisms.

In the current investigation, the estimation of phylogenetic relationships was undertaken as a supplementary step aimed at exploring the evolutionary history of the species. Evolutionary studies can provide strong evidence supporting the relationships between different species and their evolutionary history. Molecular data may reveal genetic variability that is not apparent through traditional morphological observation. Because of the abundance of sequence data available in public gene data banks, the use of phylogenetic analysis in taxonomy has grown in importance [4]. The conservative nature of fish mitochondrial genomes makes them valuable for constructing phylogenetic trees and understanding evolutionary relationships among different fish species [5]. Mitochondrial genomes were inherited maternally, so recombination was very rare and replacement was faster than nuclear DNA [6]. As a consequence, mitochondrial markers have emerged as the most common inference target for molecular phylogeny of fish species. Previous research has shown that mitochondrial genome rearrangement can provide important insights into species evolution and origin [7,8].

Dholai is a minor fishing harbour located on the Arabian Sea coast of the south Gujarat region. The majority of the vessels registered on the harbour are mechanized trawlers [9]. During the survey on identifying rare fish species from the northwest coast of India, *Muraenesox bagio* was identified from a trawler boat on Dholai fishing harbour. The objective of this study was to identify and give detailed taxonomic and morphological descriptions along with a phylogenetic tree.

2. MATERIALS AND METHODS

The specimen of *Muraenesox bagio* was collected from Dholai fishing harbor (20º73'' N, 72º89” E, Fig. 1). It was brought to the College of Fisheries Science, Navsari, where morphometrics and meristic characters were recorded, linear correlation was applied and photographs were taken. FAO species

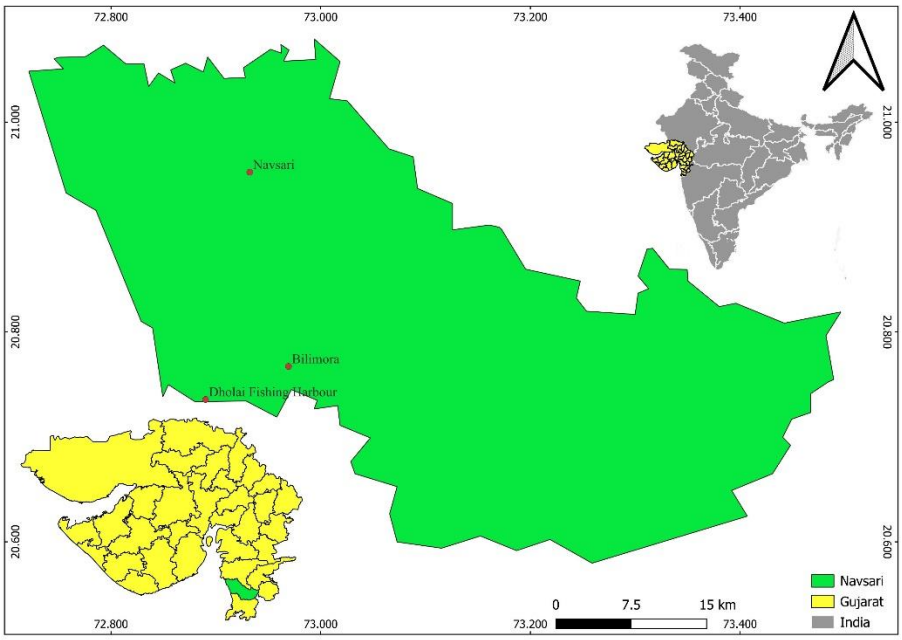

Fig. 1. Location of Dholai Fishing Harbour, Gujarat
(Source: QGIS 3.32.0)

Table 1. List of 10 Anguilliformes species used for phylogenetic relationship

Family	Species	Length (bp)	Accession No.
Muraenesocidae	*Muraenesox bagio*	18,247	NC 013614.1
	Muraenesox cinereus	17,673	MT 571331.1
	Cynoponticus ferox	17,822	NC 013617.1
Congridae	*Xenomystax congroides*	17,897	NC 082754.1
	Xenomystax atrarius	17,821	NC 082557.1
Anguillidae	*Anguilla interioris*	16,713	NC 006539.1
	Anguilla bicolor bicolor	16,700	NC 006534.1
Nettastomatidae	*Venefica procera*	17,899	OP056970.2
	Leptocephalus sp	18,037	NC 013615.1
	Hoplunnis punctata	17,828	NC 013623.1

identification sheets [10] were used for identification. The specimen was submitted to the Aquatic Biodiversity Museum, College of Fisheries Science where it was preserved in 10% formalin solution (Accession No: A 3.1.1.2). Another specimen of *M. cinereus* was also collected for comparison (Accession No: A 3.1.1.1).

In the present study, 10 complete Anguilliformes mitochondrial genomes from 4 families were downloaded from GenBank for phylogenetic studies (Table 1). Evolutionary analyses were performed in MEGA11 software [11] using the Maximum Likelihood method after multiple sequence alignment (clusterW). The evolutionary history was inferred by using the Maximum Likelihood method and the Tamura-Nei model [12]. The tree with the highest log likelihood (-97394.43) is shown.

3. RESULTS

3.1 Taxonomical Description

Kingdom: Animalia

Phylum: Chordata

Subphylum: Vertebrata

Infraphylum: Gnathostomata

Parvphylum: Osteichthyes

Gigaclass: Actinopterygii

Superclass: Actinopteri

Class: Teleostei

Order: Anguilliformes

Family: Muraenosocidae

Genus: Muraenesox

Species: *M. Bagio*

According to the Interim Register of Marine and Nonmarine Genera [13], Kaup provided the original description of the family Muraenosocidae in 1859. The species from the genera *Muraenesox* were initially known as *Muraenosox* and *Muraenisox*, and these names were revised by McClelland in 1844. The name for *Muraenesox bagio* (Hamilton, 1822) was previously misspelled as *Muraenesox baggio* (Hamilton, 1822). Additionally, the earlier synonym for *Muraenesox cinereus* (Forsskål, 1775) was *Muraenesox arabicus* (Bloch & Schneider, 1801).

During the morphological observations of *M. bagio*, several morphometric parameters and meristic characters were recorded, and linear correlation was applied. A list of morphometric parameters is presented in Table 2. The total length of the specimen was 192 cm and the eviscerated weight was 9120 g; according to sources [2], the maximum length of this species is around 200 cm, and the sex and maturity of the specimen could not be identified as it was gutted by a fisherman onboard the boat before landing.

3.2 Species Description

Elongated body, conical-shaped head, mouth extending well beyond eyes (Fig. 2); head length 16.18% of total length. Jaws are very large, with 3 longitudinal rows of teeth on both jaws (Fig. 2). 25-26 large canine teeth, which are laterally compressed with basal bulges at the front and behind. 7-8 large canine teeth at the tip of the lower jaw that fits into the snout when the mouth is closed. With small gill openings, the gill arches are smooth without gill rakers and feature large gill filaments on the gill arches. The dorsal fin and anal fins are continuous with the caudal fin and create a pointed caudal fin. Dorsal fin with 200-210 soft rays. Very well-developed pectoral fins with 24-26 soft rays that extend beyond the origin of the dorsal fin. The anal fin has 165-170 rays. The dorsal fin originates behind the operculum, whereas the anal fin originates from the latter half of the body. There are around 120 lateral line pores present on the whole lateral line; out of 120, 35 pores are present before anal opening. Lateral line pores have small tails, giving it a look that of a comet. The head width and snout length are equal (around 4% of total length). The upper jaw is slightly more extended (7.83% of total length) than the lower jaw (6.85% of total length) to accommodate the lower jaw's large canine teeth.

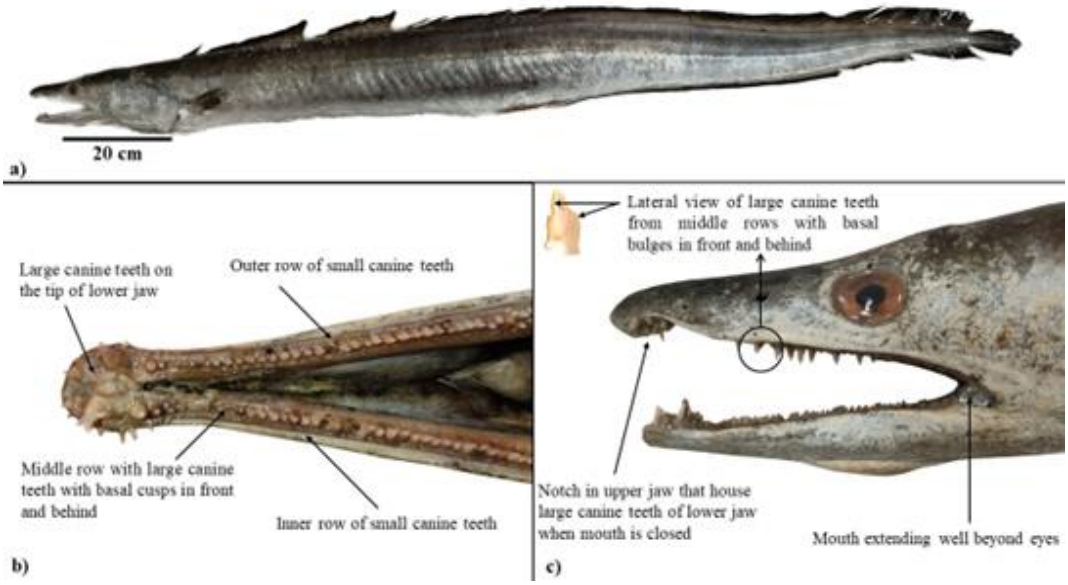

Fig. 2. a) Lateral view of *Muraenesox bagio* b) Top view of lower jaw c) lateral view of head

Table 2. Morphometric parameters of *Muraenesox bagio*

Sl. No	Morphometrics	cm	% TL*	% SL**	Sr. No	Morphometrics	cm	% TL	% SL
1	Total length	192.8	100.00	108.31	11	Pectoral fin length	10.4	5.39	5.84
2	Standard length	178	92.32	100.00	12	Pectoral fin base	2.6	1.35	1.46
3	Head length	31.2	16.18	17.53	13	Snout length	8.6	4.46	4.83
4	Head width	8.5	4.41	4.78	14	Eye diameter	2.7	1.45	1.57
5	Body depth	5.9	3.06	3.31	15	Pre-orbital length	8.6	4.46	4.83
6	Caudal fin length	3.8	1.97	2.13	16	Post-orbital length	20.4	10.58	11.46
7	Pre-dorsal length	27.8	14.42	15.62	17	Inter orbital width	2.8	1.45	1.57
8	Post-dorsal length	165	85.58	92.70	18	Lower jaw length	13.2	6.85	7.42
9	Pre-anal length	88.2	45.75	49.55	19	Upper jaw length	15.1	7.83	8.48
10	Pre-pectoral length	32.5	16.86	18.26	20	Inter nostril distance	3	1.56	1.69

** Morphometric parameter converted to percentage of total length*

*** Morphometric parameter converted to percentage of standard length*

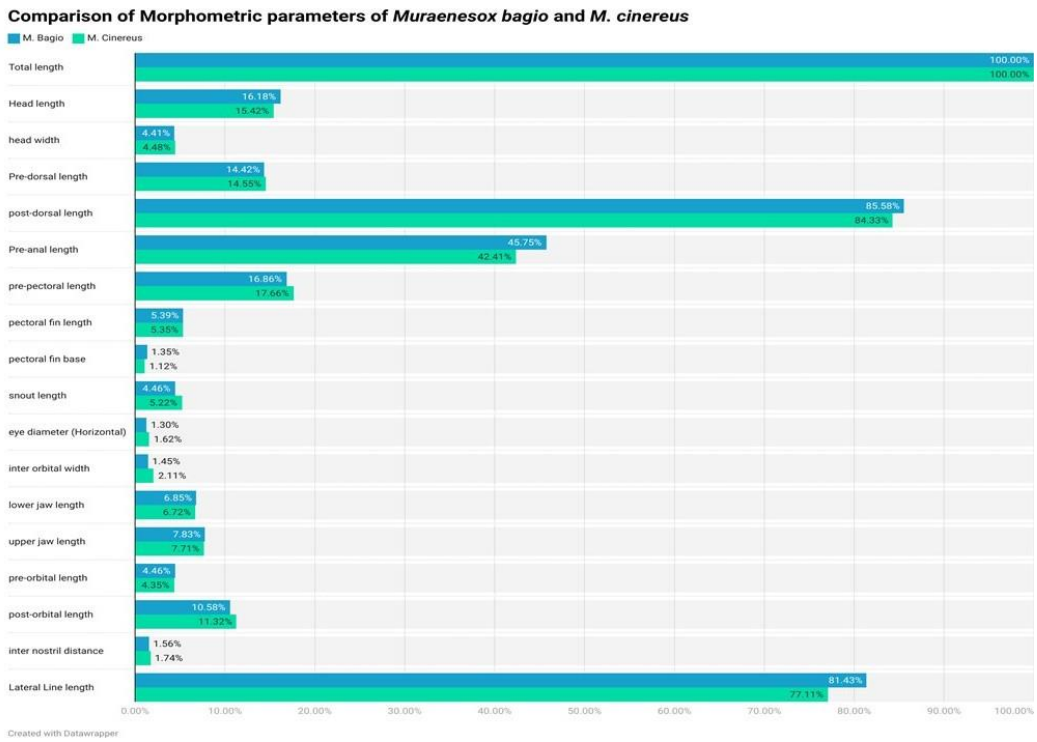

Fig. 3. Comparison of Morphometric parameters of *Muraenesox bagio* and *M. cinereus*

Colouration: Fresh specimens are dark grey on the dorsal side, which gradually decreases to a light silver colour on the ventral side. Dorsal and anal fins have narrow black edges when fully extended.

Sister species found in the study area: There is another species described from this area, *Muraenesox cinereus*, which is very close to this species in terms of morphometric (Fig. 3) and morphological characters. Both species have similar colouration; *M. bagio* is dark grey coloured on the dorsal side, and *M. cinereus* is brown-grey on the dorsal side in fresh condition.

Key to closely resembling genus of family Muraenosocidae: The species from Genus *Congresox* and *Muraenesox* have jaw teeth in multi-serial rows, and they do not possess conspicuous sensory pores on the head.

Congresox spp.: Large conical teeth in the lower jaw; teeth do not possess basal bulges.

Muraenesox spp.: Large teeth in the lower jaw with prominent basal cusps.

Key to Species identification: *Muraenesox bagio:* Lateral line pores before anal fin 34-35, soft dorsal fin rays before anal fin 47-48. Lateral line around 81% of the total length. Distance between two nostrils is around 10% of head length. Eye diameter (2.8 cm) is 3 times the snout (8.6 cm) length. Upper jaw teeth in the middle row sparsely set (Fig. 4).

Muraenesox cinereus: Lateral line pores before anal fin 40-41, soft dorsal fin rays before anal fin 72-73. Lateral line around 77% of the total length. The distance between two nostrils is around 21% of head length. Eye diameter is 2.3 times (1.4 cm) in snout length (3.4 cm). Upper jaw teeth in the middle row are densely packed. (Fig. 4).

3.3 Phylogenetic Analysis

To further study the evolutionary status of *M. bagio*, four closely related families (including Muraenosocidae) were selected to construct phylogenetic trees (Fig. 5) to analyze species relationships. It clearly shows that *M. cinereus* and *M. bagio* were the closest in the relationship and that these two species form the Muraenosocidae branches and share a common ancestor in recent. The mitochondrial genome structures of *M. cinereus* and *M. bagio* were very similar, but in some places, they differed by gene arrangement [14].

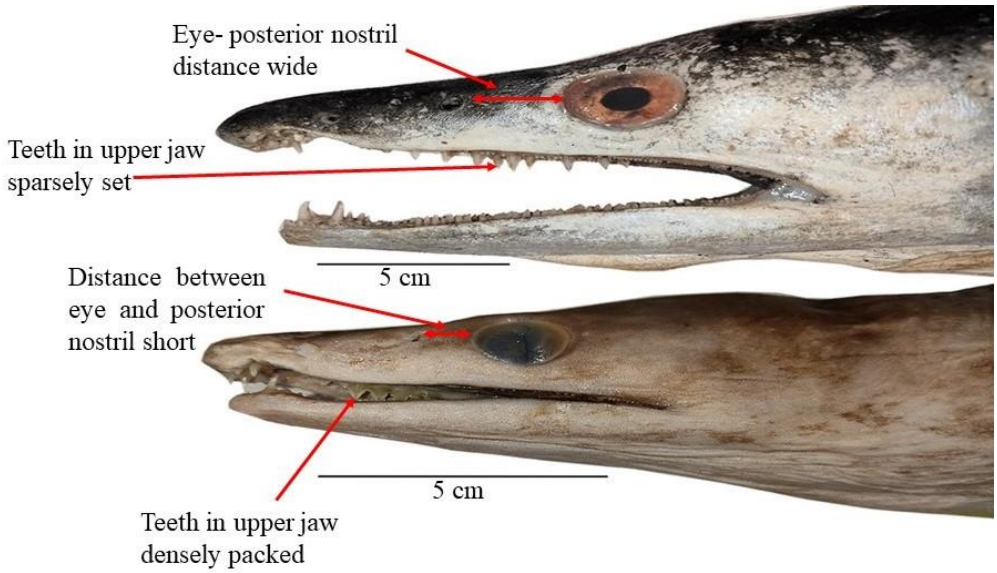

Fig. 4. Lateral View of *Muraenesox bagio* (above) and *M. cinereus* (below)

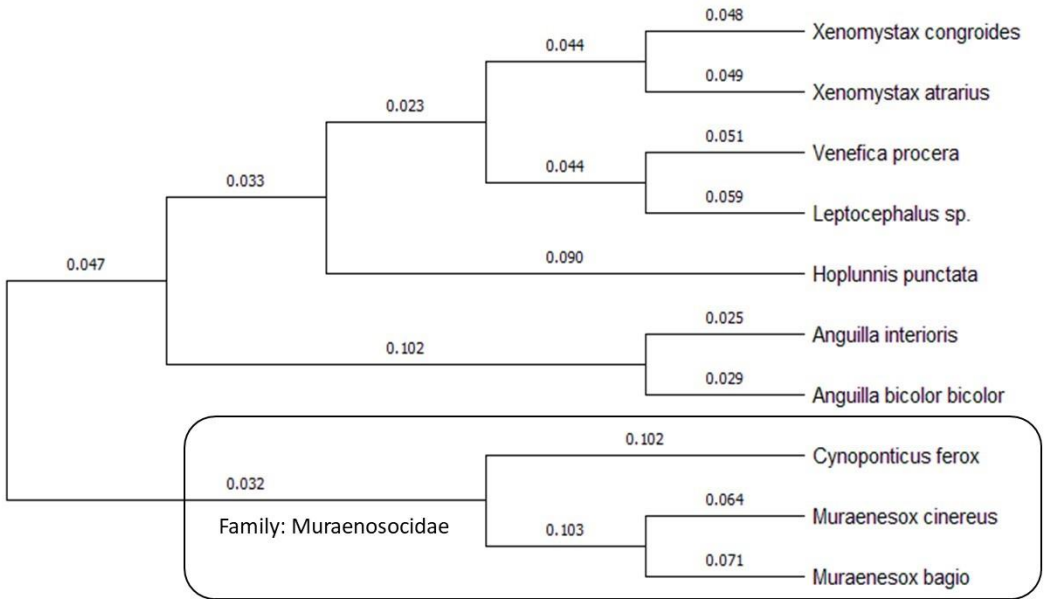

Fig. 5. Phylogenetic analysis based on the nucleotide sequence of a mitogenome
(Source: MEGA11)

4. DISCUSSION

Several checklists on ichthyofaunal biodiversity from various locations along the northwest coast of India have been prepared. While some of these checklists have reported *Muraenesox cinereus*, there have been no reports or taxonomic descriptions of *Muraenesox bagio* [15,16,17,18,19,20,21,22]. The present study provides the first geographical report and the taxonomic descriptions of *M. bagio* from the Gujarat coast, northwest coast of India. The species from the present study (FAO fishing area 51) have been compared with the previous record (Fig. 6) by Lin et al. [23] from Taiwan (FAO fishing area 71), The parameters of both species match with each other and species descriptions also match with original descriptions from Fischer [10] thus proving the species from the current study is indeed *M. bagio*.

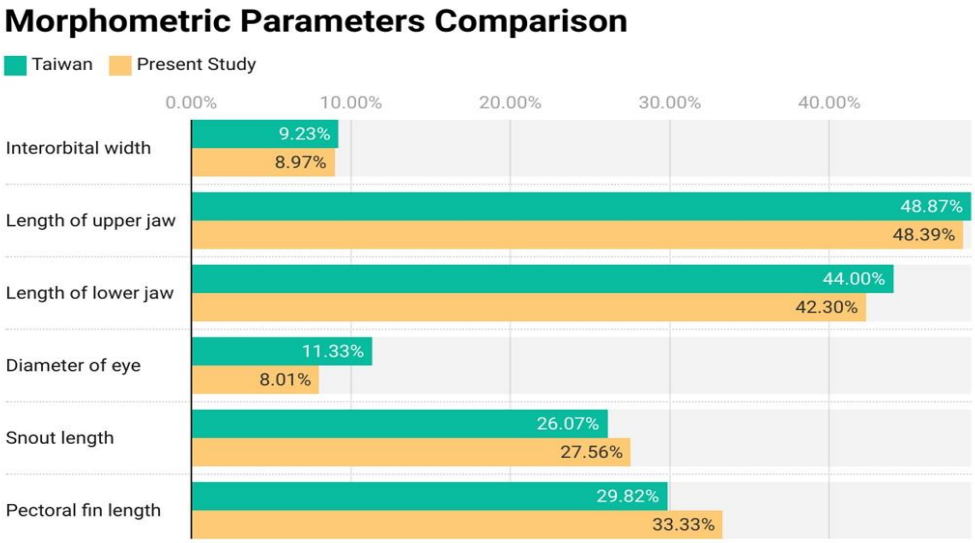

Fig. 6. Comparison of Morphometric parameters between a study carried out in Taiwan (Lin et al. 2013) [23] and the present study

5. CONCLUSION

In conclusion, there has been no known record or taxonomic description of this species being present from the Gujarat, northwest coast of India; this is the first documented record with its taxonomic descriptions. This research extends the geographical range of *M. bagio* to the northwest coast of India.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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