

An integrative taxonomic approach to the systematics of the genus *Pampus*

In capture fisheries management, fish populations play a critical role in deciding management units employed. Projects like FishPopTrace have been employed in Europe, facilitating use of genetic data and morphological markers, including otoliths for this purpose. Multispecies, multi-gear fisheries landing closely resembling species mixes found in a common ecosystem or fishing ground is widespread in the Indian EEZ. Pomfrets are a low-volume, high value marine fishery in India and an important targeted fishery resource in the Indian Ocean region. However, the taxonomy of the genus *Pampus* has remained complex till date, with literature indicating several cryptic species leading to misidentification and nomenclature issues. This has serious ramifications for traceability concerns in seafood trade and supply chains as well to address sustainability concerns while preparing species specific fisheries management plans. A recent study involving an integrative taxonomic approach with conventional taxonomy tools as well as genetic data and otolith structure, has helped to clarify the taxonomic status of the genus *Pampus* in the Indian EEZ and the new findings with a global outlook is summarized below.

¹Roul, S. K., Jeena, N. S., Rajan Kumar, Vinoth Kumar, R., Shikha Rahangdale, Rahuman, S., Ghosh, S., Rohit, P. and Gopalakrishnan, A. 2021. Postulating the modality of integrative taxonomy in describing the cryptic congener *Pampus griseus* (Cuvier) and systematics of the genus *Pampus* (Perciformes: Stromateidae). | *Frontiers in Marine Science*, 8: 778422. doi:10.3389/fmars.2021.778422

The genus *Pampus* (Family: Stromateidae) commonly known as pomfret, is widespread in the Indo-West Pacific. They are considered as one of the most valuable and popular tablefish that form commercial targeted fisheries in its native ranges including India. The taxonomy of this genus has been uncertain as the similarity in external morphological traits among pomfrets poses problems in correct identification, leading to much controversy regarding species classification, nomenclature, and numerous erroneous GenBank records. Most studies have focused either on either their physical diagnostic characteristics or their

genetics, and a review compiling these features was not available.

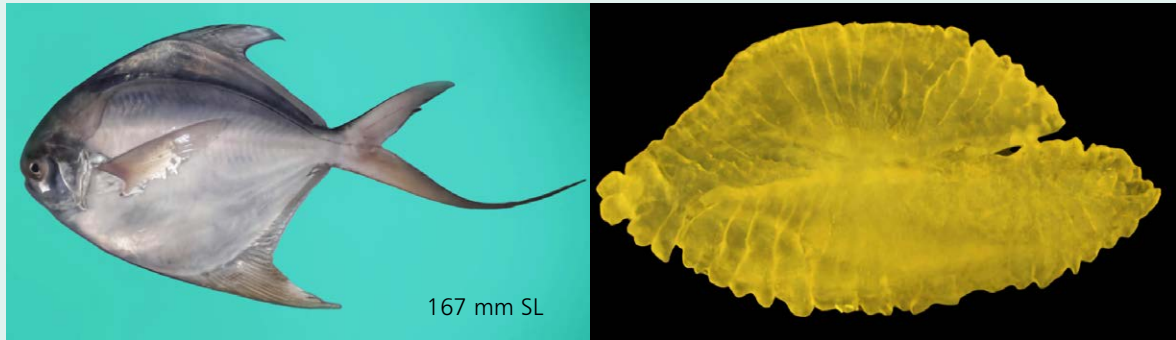
Species forms the bedrock of biology, and is defined by a scientific name that includes its genus and species names. The genus defines the category of the organism at the lowest level. The latest global reports indicate the presence of the following seven valid species in the genus *Pampus* viz. *Pampus argenteus*, *P. minor*, *P. punctatissimus*, *P. chinensis*, *P. cinereus*, *P. candidus*, and *Pampus* sp. Previous genetic studies on pomfrets from India indicated the presence of two putative species viz. *P. candidus* from the Arabian Sea and another

cryptic species *Pampus* sp. from the Bay of Bengal (BOB) and confirmed that *P. candidus* so far treated as *P. argenteus* in India is the most common species in Indian waters. *Pampus argenteus* is endemic to the western Pacific Oceans and is entirely absent along the Indian coastline (Divya et al., 2019).

Recently, a study by team from ICAR-Central Marine Fisheries Research Institute (CMFRI) has led to new informations regarding the taxonomy of this genus by using an integrative taxonomic approach that combines morphology and genetics of ample number of fresh pomfrets of available

Pampus griseus

This species has so far been erroneously ascribed as *Pampus argenteus*. Adults (>167 mm Standard Length SL) of *Pampus griseus* move in large schools and inhabit shallow waters of diverse bottoms (sandy, silty, rocky and turbid). Juveniles (~ 140 mm SL) are found in depth gradients of 3-30 m and adults mostly in 30-70 m depths. It has restricted distribution in the Bay of Bengal (East Coast of India, Bangladesh, and Myanmar) and Southeast Asia (Thailand, Vietnam, and Malaysia). The proposed English name Bengal Silver Pomfret was given because its type locality was Bay of Bengal, and its forms the major component of pomfret fishery in the region.



Pampus griseus

Otolith of *Pampus griseus*

species (*P. candidus*, *P. chinensis*, *Pampus* sp.) from various locations along the east coast (Bay of Bengal) and the west coast (Arabian Sea) sampled between 2019 to 2020. Along with these specimens from the Marine Biodiversity Referral Museum of ICAR-CMFRI and digital images of *Pampus* from the Museum National D'histoire Naturelle were also examined. Since traditional taxonomic tools cannot provide a stand-alone platform to solve the taxonomic perplexity of pomfrets, an integrative taxonomic approach was adopted here. The study aimed to establish the identity of the cryptic congener in the Bay of Bengal, re-evaluation of *Pampus* spp. of the Indo-West Pacific for phylogenetic resolution, revision of the systematics and preparation of field identification key for all seven valid species in the genus *Pampus*. Here, traditional taxonomic tools viz. Morphology, multivariate analysis, gill raker shape,

sagittal otolith morphology, vertebral count, morphology of transverse occipital canal of the lateral line, and fishery information were integrated with molecular data for all the species fished along the Indian coast, and compared with global literature and database for inference.

In this study, the cryptic and valid species *Stromateus griseus* Cuvier and Valenciennes, 1833 is resurrected from the synonymy and redescribed as *Pampus griseus* based on specimens from the Bay of Bengal, confirmed by molecular analyses that indicated a limited distribution of the species to the region. Phylogeny of the genus was reconstructed, integrating COI barcodes and concatenated mitochondrial gene sequence data (1822 nucleotides) generated from the available species. The phylograms reconstructed on the concatenated data produced a highly supported clade for the *P. cinereus* complex (*P.*

griseus, *P. cinereus*, and *P. candidus*) that share similar features. The clustering of the three sister species indicated a convergent evolution characterized by the elongation of dorsal, caudal and anal fin, a common character of the three (Yin *et al.*, 2019). The tree topology discriminated each species into separate clades with no common haplotypes. There were also two sister lineages i. e., Indian and Pacific Ocean lineages in *P. chinensis* that may be due to the climate-related vicariant events during glacial epochs and the effect of the Indo-Pacific Barrier.

Multivariate analysis has been widely used in species identification and discrimination. The multivariate analysis isolated the *P. griseus* from its counterparts. The morphometric variable like caudal peduncle length (CPL), pre-dorsal distance (PDD), pectoral fin length (PFL), and eye diameter (ED) were important

Pampus candidus

The proposed English name is Indian Silver Pomfret. One of the predominant species in the Indian Ocean it was originally described as *Stromateus candidus* Cuvier and Valenciennes (1833) from Indian waters, and later synonymized with *Pampus argenteus*. It was redescribed as a valid species by Divya *et al.* (2019) based on fish samples from Arabian Sea and Bay of Bengal, and a lectotype was designated, as type specimens were absent.



Pampus candidus

Otolith of *Pampus candidus*

morphometric measurements capable of separating *P. candidus* and *P. griseus*. Marginal overlap was observed in the two groups which suggested their cryptic nature that led to its misidentification as single species (*P. candidus*) till date.

Otoliths are depicted to have high morphological variability with particular characteristics across species and genera and at times considered as species-specific characteristics in taxonomy. Comparison of sagittal otolith morphology of seven valid species of *Pampus* including *P. griseus*, *P. candidus* and *P. chinensis* from Indian waters and four species from Chinese waters revealed that the overall gross morphology of sagittal otolith of *P. griseus* is more similar to *P. candidus*, *P. cinereus*, *P. chinensis*, and *P. punctatissimus* than others. This character has lesser taxonomic utility to differentiate between closely

resembling species, when used alone. The study also suggested that the long and thin fins should not be considered when identifying the species as it gets damaged easily from fishing operations.

The present study covered the entire Indian coastline and suggested that the three species that are sympatric in the Indian Ocean vary in range of distribution and abundance; *P. chinensis* is more widespread compared to *P. candidus* found in the Arabian Sea and certain areas of the BOB, while *P. griseus* is exclusively found in the BOB. It is interesting to note that although both species occur in Tamil Nadu, only *P. griseus* has been traced from the fishing ports of the type locality and adjacent regions. The study adds identification markers or diagnostic features (*viz.* re-description) of the pomfret *Pampus griseus* and proposed a new English

name 'Bengal Silver Pomfret' due to its restricted geographical distribution in the BOB. The genetic data of the *Pampus* spp. from the GenBank (a database containing diagnostic DNA sequences of all organisms) was also corrected. The authors also suggest some new English names for certain species such as 'Indian Silver Pomfret' for *Pampus candidus* as it is the dominant pomfret species in the Indian Ocean, and 'Japanese Silver Pomfret' for *Pampus punctatissimus* given its original description comes from the Japanese waters.

Collection of species-specific information is vital for long-term sustainable fishery management plans and inaccurate identification of fish species or use of ambiguous names in landing reports will lead to undesired consequences. Precise information on species forms the basis for international trade,

Pampus chinensis

A commercially important species, the stock of *P. chinensis* in the Arabian Sea (Indian Ocean) is forming a distinct lineage from the Pacific Ocean. The species is distributed in the Arabian Sea, Bay of Bengal, East and South China Sea and coastal areas of Malaysia in Southeast Asia.



Pampus chinensis

Otolith of *Pampus chinensis*

consumer safety, biodiversity research and prevention of fraudulence. *Pampus candidus* misidentified as *P. argenteus*, formed a regular export commodity from various ports in India. Present study affirmed that *Pampus argenteus* is completely absent in the Indian Ocean and primarily distributed in the Western Pacific only. DNA-based approaches can be successfully applied as an alternative tool for

seafood authentication, even on partially or fully processed fishes when important morphological characters are lost. The authors have summarized the diagnostic characteristics, reviewed the systematics of genus and provided an easy field identification key based on a combination of features. This study has opened various doors to studies related to pomfrets¹. Further, studies like this can have potential

impact on the management of the highly valuable pomfret fisheries, addressing associated seafood trade and traceability concerns in export markets as the species can be identified with complete accuracy.

References

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