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Cover: Nile Crocodile *Crocodylus niloticus* regulating body temperature on a warm day. Digital art on Procreate by © Aakanksha Komanduri.

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REVIEW

Taxonomic reassessment of *Ompok hypophthalmus* (Bleeker, 1846) (Actinopterygii: Siluriformes: Siluridae) in Indonesia with global implications

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Abstract: Indonesia harbors exceptional freshwater fish diversity, yet taxonomic uncertainty persists for several economically important species, including *Ompok hypophthalmus*. This study provides a critical assessment of the morphological and molecular identification of *O. hypophthalmus* in Indonesia by analyzing published literature and publicly available mitochondrial DNA sequence data retrieved from resources such as NCBI. Morphological revisions by Ng (2003) recognized three distinct taxa within the *O. hypophthalmus* complex (*O. hypophthalmus*, *O. rhadinurus*, and *O. urbaini*), yet subsequent studies have frequently applied species names inconsistently, particularly in Sumatra. Analysis of available cytochrome c oxidase subunit I (COI) and cytochrome b (Cyt b) sequences reveals substantial genetic structuring among river populations, suggesting historical misidentification and possible cryptic diversity. Limited sequence availability and incomplete geographic coverage preclude definitive conclusions regarding species boundaries in some river systems. This study highlights the urgent need for integrative taxonomy, i.e., combining morphology, standardized DNA barcoding, and expanded sampling to resolve species identities and to support effective fisheries management and conservation planning in Indonesian freshwater ecosystems.

Keywords: C oxidase subunit (coi), cryptic diversity, DNA barcoding, fish diversity conservation, mitochondrial dna, morphological identification, molecular taxonomy, river system, species.

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Author contribution: All authors contributed substantially to the conception, design, data collection, analysis, and interpretation of results. All authors participated in drafting and critically revising the manuscript, approved the final version for submission, and agreed to be accountable for all aspects of the work.

INTRODUCTION

Indonesia is home to 4,970 documented fish species, accounting for approximately 15% of the world's fish diversity (Reid et al. 2013; Reis et al. 2016). According to FAO assessments between the late 1990s and 2003, the number of recorded fish species in Indonesia increased by approximately 300. Despite this growth, the global total of fish species rose by over 11,000, reducing Indonesia's proportional share from approximately 25% in 2003 to about 15% by 2016. Of these, approximately 1,258 species represent about 10% of the world's freshwater fish diversity (Gustiano et al. 2021). Dudgeon (2000) estimated that around 1,700 freshwater species are found in Indonesia (Dudgeon 2000). Regarding endemism, 19.5% of the fish species are unique to the region (Gustiano et al. 2021). Among the main Indonesian Islands, Sulawesi boasts the highest number of endemic species, with about 76% of the species on the island being native (Partasasmita et al. 2015). The limited increase in newly documented species and the decline in Indonesia's percentage of global species raise important conservation questions.

Catfishes belonging to the genus *Ompok* (La Cepede) are species within the Siluridae family, commonly found in lentic and lotic systems across southeastern and southern Asia. According to Bornbusch (1995), the genus is paraphyletic, comprised of four distinct clades: group of *O. hypophthalmus* (Bleeker, 1846), group *of O. bimaculatus* (Bloch, 1794), group of *O. eugeneiatus* (Vaillant, 1893), and group of *O. leiacanthus* (Bornbusch, 1995). The group of *O. hypophthalmus* is characterized by cartilaginous plates supporting the mandibular barbels. These plates possess two posterior extensions, in contrast to other conditions where the plates are underdeveloped, exhibit a single dorsolateral extension, or appear elongated and hourglass-shaped without extensions. The term "selais fish" is a local vernacular name used in Sumatra and Kalimantan to refer to several morphologically similar silurid catfishes, primarily within the genus *Ompok*. The non-specific use of this term has contributed to taxonomic ambiguity in both ecological and molecular studies.

The rapid advancement of molecular technology worldwide has significantly enhanced the identification of new species, as highlighted by Kalyankar et al. (2012), Bachry et al. (2019), Patil et al. (2023), and Sontakke et al. (2023). Studies focusing on systematics and evolutionary genetics, including taxonomy and phylogeny, have played a crucial role in documenting genetic resources. The use of DNA barcoding for quick and precise species identification is essential for enhancing fish diversity initiatives (Hubert et al. 2015; Tiknaik et al. 2019). In Indonesia, this method has not been widely adopted, with conventional, taxonomy-based species identification still being the predominant approach.

MATERIALS AND METHODS

Molecular analysis

Mitochondrial DNA sequences of *Ompok* species were retrieved from BOLD Systems and GenBank, including 18 COI and five cytochrome b (Cyt b) sequences with verified locality information. Sequence alignment was performed using MUSCLE implemented in MEGA X v10.x, with manual trimming to equal lengths. Genetic distances were calculated using the Kimura 2-parameter (K2P) model. Phylogenetic relationships were inferred using the Neighbor-Joining (NJ) method with 1,000 bootstrap replicates. Species delimitation was preliminarily explored using GMYC and PTP models based on the COI dataset. Only sequences with unambiguous taxonomic annotation and river-level metadata were included in downstream analyses.

RESULTS

The analysis revealed that the distribution of *O. hypophthalmus* in Indonesia is restricted to specific river systems, suggesting a narrower range than previously reported. The findings highlight the importance of accurate species identification and continuous monitoring, as populations may be vulnerable to environmental changes, habitat fragmentation, and anthropogenic disturbances.

Current Status of *O. hypophthalmus* in Indonesia

The distribution of *O. hypophthalmus* in Indonesia appears to be confined to specific river systems, indicating a more restricted range than previously understood. This emphasizes the need for accurate species identification and continuous monitoring to support effective conservation measures. The habitats of these fish may be vulnerable to environmental changes, habitat fragmentation, and anthropogenic activities.

Morphological identification of *Ompok* species in Indonesia

1. In 2003, Ng reviewed the taxonomy and distribution of the *O. hypophthalmus* complex in

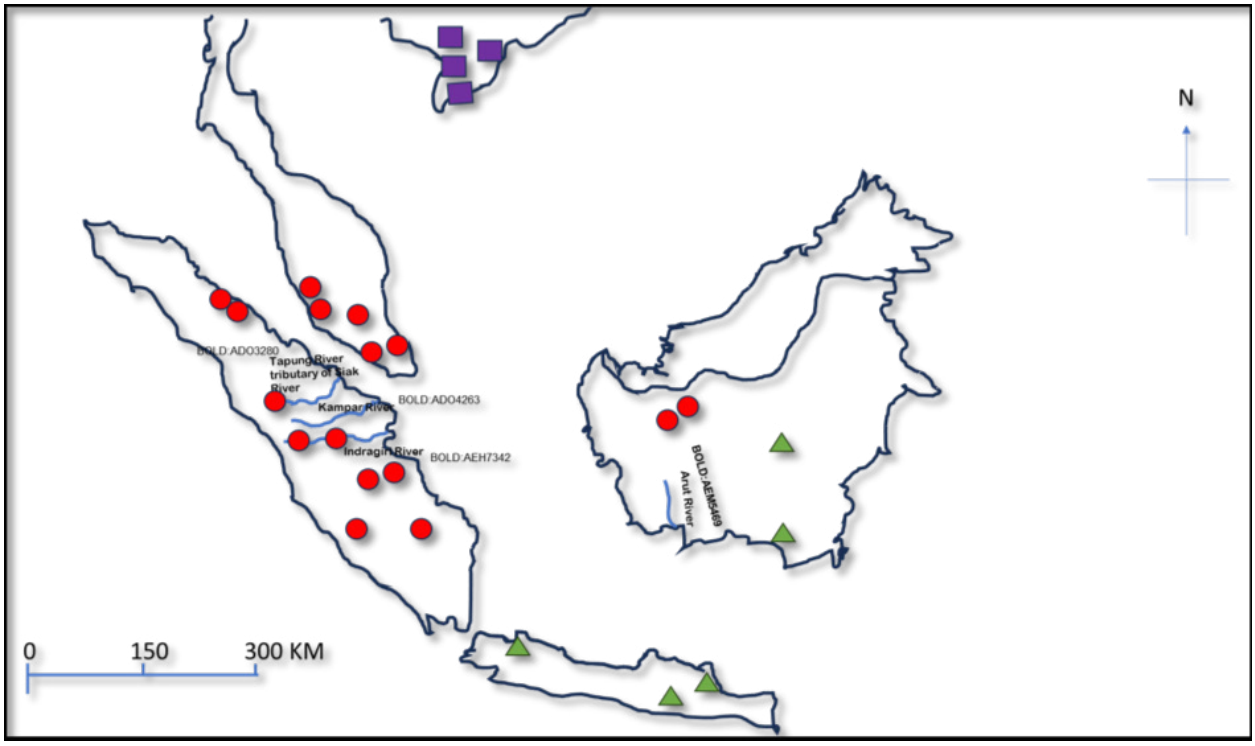

Figure 1. Map of south-east Asia showing distributions according to Ng (2003) of: *Ompok hypophthalmus* ▲, *O. rhadinurus* ●, and *O. urbaini* ■, / indicate rivers.

southeastern Asia, clarifying the identities of *O. hypophthalmus*, *O. urbaini*, and describing a new species, *O. rhadinurus*. The study synonymized *O. macronema* with *O. hypophthalmus* and validated *O. urbaini* as a distinct species, previously misclassified. It also delineated the geographical distributions of these species: *O. hypophthalmus* is found primarily in Java and southern Borneo, *O. urbaini* in Indo-China river systems, and *O. rhadinurus* in Sumatra, Borneo, and the Malay Peninsula. Key morphological differences, such as head width, caudal peduncle depth, and the number of anal-fin rays, were instrumental in distinguishing these species. Ng's findings are illustrated in Figure 1. Despite these clarifications, several subsequent studies appear to have misidentified *O. urbaini* and *O. rhadinurus* as *O. hypophthalmus*.

2. In a biodiversity study conducted in Buaya Lake and the Indragiri River basin in Sumatra, 22 fish species were identified across both habitats. The lake served as a spawning and nursery ground, supporting younger specimens likely originating from the Indragiri River. Among the identified species, *O. hypophthalmus* was reported from the river channel (Nofrizal et al. 2023).

3. Further research on the reproductive biology of *O. hypophthalmus* in the Kampar Kiri River floodplain revealed five stages of gonad maturity, confirming the species as a total spawner and iteroparous (Sjafei et al. 2008). Simanjuntak (2008) examined fecundity, maturity, and spawning patterns of *O. hypophthalmus* and *Clarias macrocephalus* in the same region (Simanjuntak et al. 2008).

4. Elvyra et al. (2010) studied the gonadal maturity, fecundity, and conservation needs of *O. hypophthalmus* in the Kampar River, emphasizing the ecological importance of this species, locally known as 'ikan lais' (Elvyra et al. 2010).

5. Eddy & Gema (2019) reported *O. hypophthalmus* from the Arut–Kumai peat waters; notably, *O. rhadinurus*, which Ng (2003) reported from parts of Borneo, was not mentioned in that study, raising the possibility of misidentification.

6. In the Siak River, *O. rhadinurus* was identified by the original authors in fish catches, highlighting the continued taxonomic challenges in distinguishing these species (Budy et al. 2023).

7. A year-long study in the Mahakam River, East Kalimantan, documented the presence of *O. hypophthalmus* and *O. miostoma* among six catfish species sampled across four locations (Jusmaldi et al. 2018).

Table 1. COI gene sequence details of *Ompok hypophthalmus* available in BOLD and NCBI databases.

Listed species	BIN ID	Sample ID / NCBI ID	Location	Name of scientist who generated sequences
O. hypophthalmus	BOLD:AEM5469	MZ634369, MZ634366, MZ634368, MZ634372, MZ634367, MZ634371, MZ634373, MZ634370, MZ634374	Arut River, Central Kalimantan, Indonesia	Kasayev, T. & Arisuryanti, T.
	BOLD:ADO3280	MH732890, MH732889, MH732891, MH732887	Tapung River	Elvyra, R.
	BOLD:AEH7342	MK473379, MK473378, MK473377, MH732888	Indragiri River	Elvyra, R.
	BOLD:ADO4263	MH732886	Kampar River	Elvyra, R.

Molecular identification and DNA barcoding evidence

As of late 2024, only 18 COI gene sequences and five cytochrome b (Cyt b) sequences of *O. hypophthalmus* have been submitted to the BOLD and NCBI databases. These sequences were contributed primarily by two research groups led by Elvyra R. and Kasayev T. (Refer to Table 1).

1. A study by Kasayev & Arisuryanti (2022) analyzed nine COI sequences of selais fish from the Arut River in Central Kalimantan, suggesting their identity as *O. hypophthalmus* (Kasayev & Arisuryanti, 2022). These findings revealed up to 3.6% nucleotide divergence among COI sequences, indicating substantial genetic structuring and raising uncertainty regarding conspecificity.

2. The 18 COI sequences available in the BOLD database are categorized into four Barcode Index Numbers (BINs), each corresponding to a distinct river system: the Arut, the Tapung, the Indragiri, and the Kampar Rivers (Refer to Figure 1 & Table 1).

3. Elvyra et al. (2020) assigned Cyt b sequences to *O. hypophthalmus* based primarily on morphological identification, as comparative Cyt b reference sequences for confirmed *O. hypophthalmus* were not available at the time. Consequently, these assignments should be interpreted cautiously (Elvyra et al., 2020).

4. Arisuryanti et al. (2020) investigated genetic variation in selais fish from the Arut River by analyzing polymorphisms in the partial 16S mitochondrial gene. Their findings revealed intra-population genetic variation and suggested that the selais fish represents a single species, although its specific taxonomic name remains unresolved.

This growing body of molecular evidence underscores notable genetic diversity among populations currently identified as *O. hypophthalmus* and highlights the importance of integrating molecular tools with morphological analyses for accurate species identification.

DISCUSSION

Reassessment of the distribution of *O. hypophthalmus*

This section synthesizes evidence from both morphological taxonomy and molecular barcoding to reassess the reported distribution of *O. hypophthalmus* in Indonesia. Both morphological and molecular approaches complement each other, and each has inherent strengths and limitations. The following synthesis summarizes the reassessment of *O. hypophthalmus* distribution in Indonesia.

Morphological status of *O. hypophthalmus* in Indonesia

1. Ng (2003) provided a comprehensive morphological revision of the *O. hypophthalmus* species complex, recognizing *O. hypophthalmus*, *O. urbaini*, and describing *O. rhadinurus* as a new species. Clear diagnostic characters and geographically structured distributions were established; however, these revisions have not been consistently applied in subsequent Indonesian studies.

2. Following Ng's (2003) revision, several studies from Indonesia did not consistently apply the revised diagnostic criteria and continued to report *O. hypophthalmus* in regions where *O. rhadinurus* was expected.

3. Several studies conducted in the Kampar River have investigated reproductive biology and gonadal development of specimens identified as *O. hypophthalmus* (Simanjuntak et al. 2008; Sjafei et al. 2008; Elvyra et al. 2010). Ng (2003) did not report *O. hypophthalmus* from the Kampar River based on morphological evidence.

4. Most subsequent studies focused on ecological or fisheries-related aspects rather than taxonomic validation, and only a limited number explicitly referenced Ng's (2003) revision (Akbar et al. 2020; Nofrizal et al. 2023).

5. In 2023, Budy and Isnaniah mentioned that the *O. rhadinurus* species was observed in Benayah Village,

Table 2. Distance matrix within and between the BIN ID. (Values outside parentheses represent maximum K2P distance (%), while values in parentheses represent mean distance).

BIN ID	BOLD:AEM5469	BOLD:ADO3280	BOLD:AEH7342	BOLD:ADO4263
BOLD:AEM5469	0 (0)			
BOLD:ADO3280	4.55 (1.9)	0.17 (0.09)		
BOLD:AEH7342	4.03 (1.66)	1.61 (0.89)	0	
BOLD:ADO4263	16.57 (3.27)	15.53 (6.09)	16.16 (6.29)	0

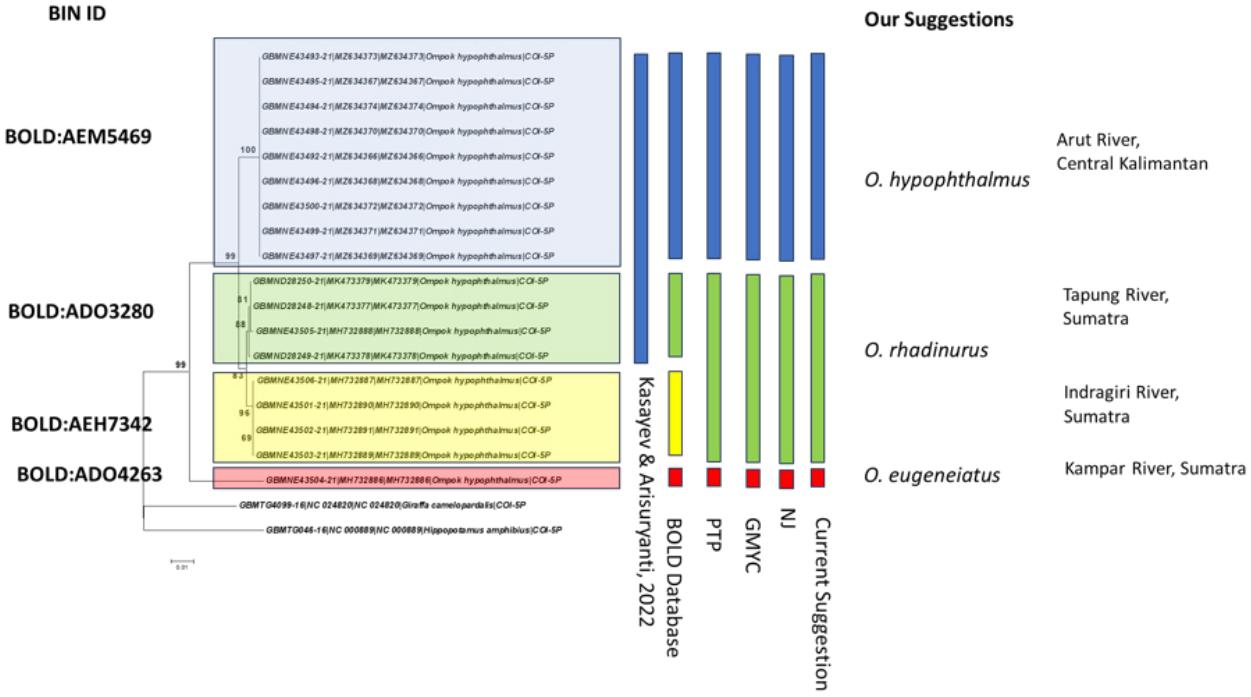

Figure 2. Phylogenetic tree relationships inferred using NJ, GMYC, PTP based on COI sequences; bootstrap values >50% are shown.

Pusako District, Siak Regency (Budy et al. 2023).

Molecular identification status of *O. hypophthalmus*

1. Elvyra et al. (2020) investigated the molecular characteristics and phylogenetic relationships of silurid catfishes from the Kampar River in Indonesia, focusing on the cytochrome b gene. They found four species, including *Kryptopterus limpok*, *O. eugeneiatus*, *O. hypophthalmus*, and *Phalacronotus apogon* (Elvyra et al. 2020).

2. A study by Kasayev & Arisuryanti (2022) mentioned selais fish from the Arut River in central Kalimantan, confirming their identity as *O. hypophthalmus*. In the same study, COI sequences from specimens collected in the Indragiri River were assigned to *O. hypophthalmus*; based on Ng's (2003) morphological framework and observed genetic divergence exceeding 3%, these assignments remain uncertain. This level of divergence suggests the possibility of taxonomic misidentification or cryptic diversity; additional integrative analyses are required before proposing taxonomic speciation (Kasayev & Arisuryanti 2022).

3. Arisuryanti et al. (2020) investigated 16S genetic variation in selais fish from the Arut River; the precise taxonomic identity of these specimens remained unresolved.

Proposed reassessment of *Ompok* species distributions in Indonesian Rivers

Based on the synthesis of available morphological and molecular evidence, the following interpretations are proposed:

Kampar River

1. Available morphological and Cyt b data suggest the presence of at least two silurid taxa in the Kampar River (*O. eugeneiatus* and specimens currently identified

as *O. hypophthalmus*). The absence of comparative COI data prevents definitive confirmation of species identity.

Indragiri & Tapung Rivers

2. Based on Ng's (2003) morphological revision and available COI divergence values, specimens from the Indragiri and Tapung Rivers are more consistent with *O. rhadinurus* than *O. hypophthalmus*. Nevertheless, additional integrative sampling is required to confirm this reassignment.

CONCLUSION

This study highlights persistent taxonomic inconsistencies in the identification of *O. hypophthalmus* in Indonesia. While molecular data reveal clear genetic structuring among river populations, current evidence is insufficient to fully resolve species boundaries across all regions. Integrative taxonomy combining standardized morphological assessment and expanded DNA barcoding is essential before definitive biogeographic conclusions can be drawn. Accurate species identification is critical for fisheries management, conservation planning, and preventing the perpetuation of taxonomic confusion in Indonesian freshwater fishes. Accurate taxonomic recognition of *O. hypophthalmus* is critical for fisheries management and conservation assessments, as historical misidentifications may have influenced stock evaluation, biodiversity estimates, and regional Red List assessments across its reported distribution. The conclusions of this study are limited to a small number of publicly available sequences, uneven geographic sampling, and the lack of integrated morphological examination of sequenced specimens.

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