

Taxonomy matters

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Freshwater biodiversity is in a state of crisis¹, with populations declining by 76% (twice as terrestrial and marine) over a forty-year period², as a result of habitat loss, pollution, alien species and overharvest. Today, one of the most important human-induced stressors on riverine ecosystems is the global boom in construction of hydropower dams, which has resulted in change in water levels and the loss of system connectivity²⁻⁵.

Studies on the link between dams, freshwater biodiversity and riverine fisheries in the developing world have largely focused on the Mekong⁶⁻⁸ and Yangtze^{9,10} river systems. Similar studies are lacking in regions such as India, where many small and large dams are being planned and implemented across major river systems⁴. In a recent paper¹¹, the environment flow requirements of River Sone, a 784 km long southern tributary of the Ganges was assessed, and the downstream impacts of Indrapuri barrage on fisheries were quantified using time-series data (1949–1953; 2010–2012). The results of the paper¹¹ not only provide quantitative data on impacts on damming and reduced environmental flows on aquatic biodiversity, but are also important as they contain species-specific information that can help inform conservation assessments (like the IUCN Red List of Threatened SpeciesTM), as well as in developing and implementing on-ground conservation action plans. However, several taxonomic issues in the fish checklist (see table 1 of Joshi *et al.*¹¹) undermine the true importance of the paper¹¹, and its conservation implications.

The science of taxonomy and systematics is in flux, constantly updated with new insights on the phylogenetic relationships between organisms, and the discovery of new species. As a result, old identification keys based solely on the ranges of morphometric and meristic characters, for example, head length and head depth in proportion to body length, lateral and transverse scale rows counts, etc. are subject to change, as more information on the inter- and intra-specific variations becomes clear with the application of molecular species delimitation. Further, most old identification keys fail to identify newly described species.

Therefore, integrated taxonomic practices, which employ both morphological and molecular methods, are more reliable for accurate identifications.

A serious issue with recent Indian ichthyological literature, especially concerning taxonomy, is that the authors uncritically rely on earlier data without any assessment of either their source or reliability¹²⁻¹⁴. This leads to the presentation of old and often incompatible information, and errors are thus propagated over long periods of time¹⁵. This is especially more alarming for systematics and taxonomy, where authors are interested only in producing a checklist of species and propagate outdated and erroneous taxonomy, creating confusion on the true identity of the species targeted for conservation action. It is this concern that encouraged us to write a response to the paper by Joshi *et al.*¹¹, and provide updated taxonomy that can help supplement their results. We are concerned mainly by the improper taxonomical details mentioned in the paper¹¹, including misidentifications, incorrect species names and spellings, erroneous species authorities and placement of species under wrong family. While dealing with taxonomic issues and identities in the paper¹¹, we mainly focus on recent reviews and phylogenetic works published in peer-reviewed journals and avoid old taxonomic compilations (especially books) from India, as recent studies have substantially challenged previous understanding. Although the use of 'databases' (e.g. FishBase, Catalog of Fishes) is suggested, we would like to caution readers to use them with the understanding (and caveat) that they do not undergo peer review.

Before discussing some of the major taxonomic issues in the paper¹¹, we would like to make a note on the literature sources used by the authors. Joshi *et al.*¹¹ mention that fishes were identified according to two books^{16,17}, one of which¹⁶ is widely used by researchers to identify South Asian fishes. However, we would like to caution that this book is in no way an authentic taxonomic source of Indian freshwater fishes, but merely a compilation of (now outdated) information. While it is not incorrect to use this

as one of the references for taxonomic identification, it should in all cases be supplemented with updated literature (especially taxonomic papers) on South Asian freshwater fishes published in various peer-reviewed scientific journals. Likewise, the second database that the authors use, FishBase¹⁸, is again in no way an 'updated' taxonomic source of information, and therefore should be supplemented by information from taxonomic databases such as the Catalog of Fishes¹⁹. Although FishBase uses the Catalog of Fishes as its taxonomic source, the former often carries outdated information, while the latter is continuously updated.

Although we have provided the corrections to the list of fish species provided by Joshi *et al.*¹¹ in Table 1, we wish to explain some of the taxonomic issues in detail as most of these errors recur in ichthyological papers published from India. The report of *Clarias batrachus* from India is likely to be wrong. The taxonomy of this species was recently clarified, and its type locality was fixed to Java (Indonesia) by designating a neotype, because *C. batrachus* (as known earlier) was a species complex²⁰. The name *C. magur*, a fish described from the Ganges was available from India, and was resurrected²⁰. Therefore, the fish that occurs in the Ganges and widely recorded in the 'Indian ichthyological literature' as *C. batrachus* is in fact *C. magur*, which has a restricted distribution in Nepal, northern India and Bangladesh²⁰.

A species called 'Salmophasia clupeoides' (mentioned in table 1 of Joshi *et al.*¹¹) never existed. *Cyprinus clupeoides* Bloch 1795, was a synonym of *Salmostoma clupeoides*. However, since the name *Cyprinus clupeoides* Bloch 1795, was preoccupied with *Cyprinus clupeoides* Pallas 1776, Kottelat²¹ replaced *Salmostoma clupeoides* with another available name *Salmostoma balookee* (Sykes, 1839). The genus *Salmophasia* was resurrected only in 1998 (ref. 22), which means that the species came under *Salmophasia*, after the name was changed to *Salmostoma balookee*. Following the most recent literature²³, the species should be listed as *Salmostoma balookee*. Unfortunately, many papers in the

Table 1. Correct taxonomic status, identification and spelling for fish species listed in Joshi *et al.*¹¹

Taxonomic status in Joshi <i>et al.</i> ¹¹	Correct taxonomic status, authority, identification and spelling
<i>Catla catla</i> (Hamilton, 1822)	<i>Gibelion catla</i> (Hamilton, 1822)
<i>Puntius conchonius</i> (Hamilton, 1822)	<i>Pethia conchonius</i> (Hamilton, 1822)
<i>Puntius ticto</i> (Hamilton, 1822)	<i>Pethia ticto</i> (Hamilton, 1822)
<i>Puntius sarana sarana</i> (Hamilton, 1822)	<i>Systemus sarana</i> (Hamilton, 1822)
<i>Salmophasia bacaila</i> (Hamilton, 1822)	<i>Salmostoma bacaila</i> (Hamilton, 1822)
<i>Salmophasia boopis</i> (Day, 1874)	<i>Salmostoma boopis</i> (Day, 1874)
' <i>Salmophasia clupeioides</i> ' (Bloch, 1795)	<i>Salmostoma balookee</i> (Sykes, 1839)
<i>Aspidoparia morar</i> (Hamilton, 1822)	<i>Cabdio morar</i> (Hamilton, 1822)
<i>Parluciosoma daniconius</i> (Hamilton, 1822)	<i>Rasbora daniconius</i> (Hamilton, 1822)
<i>Esomus danricus</i> (Hamilton, 1822)	<i>Esomus danrica</i> (Hamilton, 1822)
<i>Laubuca laubuca</i> (Hamilton, 1822)	<i>Laubuka laubuca</i> (Hamilton, 1822)
<i>Barilius barna</i> (Hamilton, 1822)	<i>Opsarius barna</i> (Hamilton, 1822)
' <i>Psylorhynchus balitora</i> ' (Hamilton, 1822)	<i>Psilorhynchus balitora</i> (Hamilton, 1822)
' <i>Lepodocephalichthys guntea</i> ' (Hamilton, 1822)	<i>Lepidocephalichthys guntea</i> (Hamilton, 1822)
Subfamily – Botiinae	Family – Botiidae
Subfamily – Botiinae: <i>Pangio pangia</i> (Hamilton, 1822)	Family – Cobitidae: <i>Pangio pangia</i> (Hamilton, 1822)
Family – Balitoridae	Family – Nemacheilidae
<i>Nemacheilus scaturigina</i> (McClelland, 1839)	<i>Schistura scaturigina</i> (McClelland, 1839)
<i>Nemacheilus denisoni</i> (Day, 1867)	<i>Schistura denisoni</i> (Day, 1867)
<i>Sperata aor</i> (Sykes, 1839)	<i>Sperata aor</i> (Hamilton, 1822)
<i>Sperata seenghala</i> (Hamilton, 1822)	<i>Sperata seenghala</i> (Sykes, 1839)
<i>Clarias batrachus</i> (Linnaeus, 1758)	<i>Clarias magur</i> (Hamilton, 1822)
<i>Neotropius atherinoides</i> (Bloch, 1794)	<i>Pachypterus atherinoides</i> (Bloch, 1794)
<i>Colisa fasciata</i> Bloch and Schneider, 1801	<i>Trichogaster fasciata</i> (Bloch & Schneider, 1801)
<i>Channa striatus</i> (Bloch, 1793)	<i>Channa striata</i> (Bloch, 1793)
<i>Channa punctatus</i> (Bloch, 1793)	<i>Channa punctata</i> (Bloch, 1793)
<i>Channa orientalis</i> (Hamilton, 1822)*	<i>Channa gachua</i> (Hamilton, 1822)
<i>Tetraodon cutcutia</i> (Hamilton, 1822)	<i>Leiodon cutcutia</i> (Hamilton, 1822)

*Wrong attribution; this should be *Channa orientalis* Bloch and Schneider, 1801.

Indian ichthyological literature still refer to the old name *clupeioides*, when it does not exist anymore.

Joshi *et al.*¹¹ attribute *Channa orientalis* to Hamilton, 1822, when the correct species authority is Bloch and Schneider, 1801. In addition, *C. orientalis* is endemic to Sri Lanka²⁴ and records of this species from India refer to the *C. gachua* complex²⁵. Because the study area of Joshi *et al.*¹¹ is a tributary of the Ganges, we suspect that the authors are referring to (possibly topotypic) *C. gachua*²⁵.

All species listed under the family Balitoridae in Joshi *et al.*¹¹ are currently under the family Nemacheilidae based on their phylogenetic placement²⁶. This is not just a taxonomic curiosity, but has an ecological significance as well, as the two families have different niches and microhabitats and may therefore react differentially to the changes in water flow (the main focus of the paper by Joshi *et al.*¹¹). Similarly, the recent taxonomic revision of the South Asian barb, previously identified as *Puntius*, into different monophyletic genera²⁷, has led to

the identification of lineages with distinct ecological niches and roles. As a result, presence and absence of certain genera can by itself imply the effect of environmental flow rates.

In taxonomy, certain names can change because of the revealing of an earlier reference or precedence and grammatical gender of the genus when the species is transferred from one genus to another. We have provided such nomenclatural changes in Table 1. However, what we are more concerned about is the propagation of spelling errors like '*Psylorhynchus balitora*' and '*Lepodocephalichthys guntea*' that are present in Joshi *et al.*¹¹. In the taxonomic literature, such errors can create unnecessary synonyms, and lead to confusion for future workers.

While we understand that taxonomy is in flux, maintaining currently accepted taxonomy helps in maintaining integrity and creating some order in the chaos. In this electronic age, most taxonomic references on Indian freshwater fishes are available for free download. Our critique on the taxonomy of fishes listed by Joshi

*et al.*¹¹ in no way undermines the valuable information and analysis provided by the authors, but is only meant to inform improved utilization of their data. The information that we have provided in Table 1 and some of the notes discussed above should be used as a supplement to the results compiled by Joshi *et al.*¹¹, so as to better inform practical conservation planning and action. We also suggest that authors working on environmental impact assessment related studies that provide species checklists should seek help from expert taxonomists, while editors of journals publishing such papers should also seek the services of taxonomists as one of the reviewers, so as to avoid taxonomic inaccuracies propagating in the scientific peer-reviewed literature.

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Pervasive incursion of extremism in academic fields

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Using extremism to defend or oppose any issue has been practised in almost all social, political and to some extent in administrative areas since some years. But the recent trend shows that it has made incursion (intrusion?) in the scientific field as well. The National Green Tribunal (NGT) is a semi-judicial autonomous organization initiated to protect the environment, forest, greenery, etc. The NGT has given the following verdict on 21 February 2015. The order is: ‘NAGPUR: In a major setback to the Ministry of Environment, Forests and Climate Change (MoEFCC), the principal bench of National Green Tribunal (NGT) at Delhi, on Friday, stayed felling of trees for all linear projects like roads, canal, power lines passing through forests in the country even if they have been granted Stage 1 clearance. The five-judge principal bench of NGT headed by Justice Swatanter Kumar passed an order on a petition filed by Nagpur-based wildlife biologist Milind Pariwakam through his lawyer Ritwick Dutta and stayed felling of trees across the country, along such projects as national highways, power lines, irrigation canals, railways and the

ones carried out by the Government construction agency Central Public Works Department (CPWD).

The order will have a bearing on four-laning of NH7 between Mansar and Khawasa that entails large-scale felling and the case about which is being heard by Nagpur bench of Bombay High Court. The MoEFCC, vide a letter issued to the state governments on 8 August 2014, and subsequently on 15 January 2015, had diluted the guidelines under the Forest Conservation Act (FCA), 1980, stating project proponents could start work on linear projects and fell trees even after getting Stage 1 clearance....’

An old similar case about land allotted for an airport at Navi Mumbai could be recollected. Out of the total 1200 acres of land earmarked for development of Navi Mumbai airport, about 10 acres of land was from wetland area. While granting environmental clearance, the green clearance authority had observed that an area of the same size (10 acres) may be developed as wetland. It is known that wetland and mangroves cannot grow in stationary water. It needs fluctuating water near sea and preferably estuarine

region. Subsequently, the suggestion was removed.

If the above verdict is accepted, it would stop roadway, railways canals and electrical lines. At present, there are some dams which are completed or have reached completion stage. If water from the reservoir and electricity from the power house are to be carried to some locations, this would not be permitted. If an underdeveloped nation like India needs progress, such bans would definitely have a negative impact on development. There has been a recent trend in scientific extremism which says without any reason, logic or science that ‘cutting of trees reduces the amount of rainfall...’. Based on this there is yet another case from Nashik, Maharashtra, where the next Kumbh Mela is to be held during August–September 2015. The local authorities wanted to make roads and space for the yatis. For this, cutting of about 500 trees was required. The local court and the High Court have not permitted this tree cutting. As a result, during the Kumbh Mela, concentration and movement of a large population on a limited area could possibly lead to stampede.