

Emerging trends in taxonomy research and evolutionary systematics of fish fauna of North-East India

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ABSTRACT

The importance of taxonomy and systematics lies not only in making the information on diversity of organisms accessible, but also in planning for their conservation and sustainable use. Present taxonomy study involves understanding of inter-basin connections in the past, and drainage basin concept in case of freshwater fishes, tectonic setup of a particular region. Naming and availability of species should strictly conform to the Code. Molecular approaches have become useful in phylogenetic analyses, but the real taxonomy should not be decimated. North-East India is rich in fish diversity due to various factors. However, the diversity is still in the discovery survey state. Phylogenetic studies of the fishes with the prevailing concepts would come out with interesting results.

Key words: Basin, Fish, Morphology, Species, Taxonomy

Taxonomy is the science of finding, describing and naming organisms, also known as alpha- taxonomy. This science is supported by institutions holding collections of these organisms, with relevant data, carefully curated in Natural History Museums, Herbaria and Botanical Gardens. To formulate effective and appropriate measures to protect and preserve biodiversity, an accurate understanding of alpha-level taxonomy is very much essential (Kottelat, 1995). Alpha-taxonomy focuses more on the species end of that spectrum, i.e., classifying organisms into species-groups, and classifying those into genera, rather than determining the higher-level relationships between families or orders. It is the most elementary discipline and inclusive part of biology. Organisms cannot be discussed or treated in a scientific way until some clarification of its taxonomic status has been achieved. In other words it makes the diversity accessible to other biological disciplines and remains the basis for further study (Wilson, 2000).

Systematics, on the other hand, deals with the relationships between taxa, especially at the higher levels. It is the study of the diversity of organisms and their relationships in order to understand the evolutionary history of life. Biological classification is based on systematic studies. It might seem an ivory-tower discipline which has nothing to do with the lives of ordinary people. The importance of taxonomy and systematics lies not only in making the information on diversity of organisms accessible to other biological disciplines, but also in planning for their protection and conservation. Thus, both taxonomy and systematics have

their part in the protection of the environment. It was rightly pointed out by Nelson (1994) that systematists could play a leading role in protecting diversity.

Why taxonomy is neglected ?

We may have some idea on why taxonomy is neglected from Shunsuke's (2005) report of his conversation with the famous taxonomist, Ernst Mayer in October 1994. When asked why people think taxonomy as descriptive and not a science, Mayer answered that in science, the facts first have to be explored without which theories can not be put forward. In order to get facts, findings have to be described. So, the descriptive stage is the beginning in everything or in every science. Mayer also puts the reason to the decline in taxonomy to be due to the immense biological diversity. We have millions and millions and millions of species. Works on basic cellular processes, say about how certain molecules go through membranes, it is applicable to a very vast realm of life. Thus, it will interest an enormous number of different people. There is a great deal more glamour in working on things that have a very wide application in biology. If somebody works out the taxonomy of some rather obscure genus of insects, it would be only of interest to the people who are interested in that genus of insects.

Here, attention may be drawn to Rainboth's (1996) statement: "correct species identification is the basic starting point for any type of biological study, particularly one on wild populations. For research on ecology and applied ecology, important components of fishery science, it is important that each name applies to only a single species and that each species is known by a single name".

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However, it is unfortunate that important taxonomic findings during the course of phylogenetic analysis have been forced by editorial policies of high impact journals either to ignore their own taxonomic results or to treat them marginally by including them in online appendices (Wiens *et al.* 2004).

Drainage basin concept

In case of freshwater ecosystem, the present concept is that fishes are distributed in a particular river basin unless these are introduced in other water bodies. Their congeners in an entirely separated different basin are now proved to be different species. Various revisional studies of some species which were regarded 'highly variable and widely distributed forms' have now been shown to be aggregates of distinct, often not even related species (Ferraris and Runge, 1999; Ng, 2003; Chakrabarty and Ng, 2005; Ng and Kottelat, 2000; Linthoingambi and Vishwanath, 2007; Vishwanath and Linthoingambi, 2007a, 2007b; Vishwanath and Darshan, 2007). The affinity and interrelationships of species have been related with longitudinal river valleys, inter-basin connections, geological history etc.

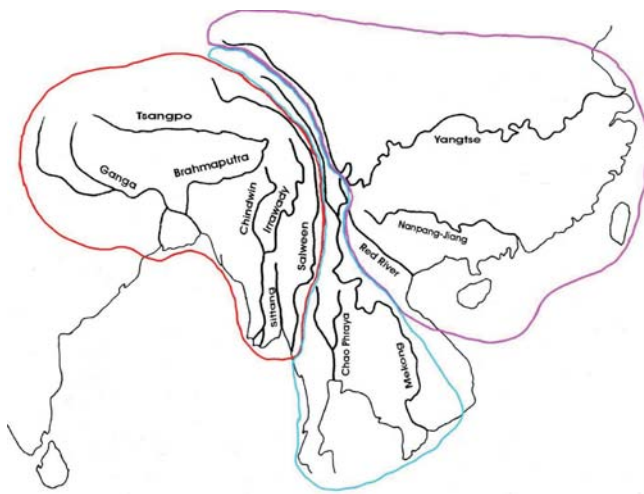


Fig 1. Subregions of fish fauna in Asia

The Asian fish fauna may be divided into three subregions (Fig. 1). 1. South Asian, consisting of Irrawaddy, Brahmaputra, Ganges and Indus basins and Peninsular India; 2. South-East Asian-Mekong, Chao Phraya, Mae Khlong basins, Malay Peninsula, S.E. Thailand to S.W. Kampuchia and 3. East Asian-Red River, Nanpang-Jiang, Yangtze and Taiwan (Kottelat, 1989).

Inter-basin connections

To trace the evolutionary history of fishes in a drainage basin, we need to understand the inter-basin connections of the past. At a time between post-Oligocene and present, the upper Irrawaddy was connected to the Sittoung, the Tsangpo to the Chindwin and lower Irrawaddy and the upper Salween with Irrawaddy.

The present fish fauna supports some of his conclusions and contradicts others (Kottelat, 1989). Distribution of many genera, viz. *Osteobrama* in Chindwin-Irrawaddy and Salween explains the concept. Various other evolution and distribution of taxa and their phylogeny need extensive study.

Sampling size

Hundreds of species probably still await discovery for obvious reasons, sampling of the habitats of rapids can be difficult and dangerous, and they are under-sampled in most countries (Kottelat and Whitten, 1996). Many species were considered to be widely distributed and the morphological differences between species of two different drainage systems were once regarded as variable forms of one species.

Earlier fish taxonomy was often based on a limited sample sizes and poorly preserved specimens. Failing to interpret the reason for observed variability: ontogenic, geographic, intra or interspecific; taxonomists conservatively concluded for intraspecific variability (Ng and Kottelat, 2000).

The so called 'catch-all cyprinid genus' *Puntius* and the catfish genus *Glyptothorax* which is referred to as 'taxonomic wastebasket' are suspected to be polyphyletic. The same is with the catfish genus *Akysis*. This is because the species of these genera have been poorly studied due to their poor representation in museum collections and their lack of market value. The difficulty of using morphometric measurements in diagnosing species of some genera is a problem that is encountered very often. The only solution to which would be to examine a large series of specimens.

Type designation

The most appropriate thing to do in the light of all these problems is to compare the holotypes of the nominal species. For some of the species whose holotypes were never designated and whose original descriptions are rather subtle, it has become inevitable to designate a lectotype in order to stabilize their taxonomy, and serve stability and universality to nomenclature, by referring to the International Code of Zoological Nomenclature (Code). For example when a case of misidentification of species is involved, under Article 70.3 of the Code, an author now has the option to select which species is best suited as type species, either the species originally cited (Article 70.3.1) or the species actually involved but misidentified (Article 70.3.2).

The history of oriental fresh water ichthyology starts with Hamilton's (1822) work on the Fishes of the Ganges. However, Hamilton's species create some difficulties to modern ichthyologists as there are no types for any of them. Most descriptions are very short and many have no illustrations. Some authors claim that they are unidentifiable.

The descriptions of fishes by Gray (1830-1835) are based on the drawings of Major General Hardwick's drawings.

However, the code (1999) states that for every species and subspecies, a name bearing type (holotype, syntypes,

lectotype or neotype should be fixed. For those taxa established before 2000, name bearing types should be fixed from the type series. If no name-bearing type is believed to be extant, a neotype may be fixed (Art. 72.2). A proposal of a new nominal species-group taxon after 1999 must include the fixation of a holotype or syntypes (Art. 72.3).

Citation of Species names and role of the author's names

There has been a tendency for some taxonomists to credit the authorship for a species different from the authorship of the whole paper. For example, in a paper authored by Singh, Sen, Banareescu and Nalbant (1982), there are descriptions of two genera, viz. *Mesonemacheilus* and *Physoschistura* and two new species. The two generic names are followed by Banareescu and Nalbant, while one species, *M. reticulofasciatus* is followed by Singh and Banareescu and another, *P. elongata* by Sen and Nalbant. Although the paper is authored by four workers, two each of them seem to be responsible for the description. But, nowhere in the main paper, there is any mention that the particular genus or species are described by the authors whose names followed the new names. In another case, there is a description of a new species, *Sisor chennuah* Ng and Lahkar in a paper authored by Ng (2003) who also did not mention the contributions of the workers.

International Code of Zoological Nomenclature (the Code) (1999) in Article 50.1 states that the author of a name is the person who first publishes it (Arts. 8, 11) in a way that satisfies the criteria of availability (Arts. 10 to 20). Article 50.1.1 further states if it is clear from the contents that someone other than the author of the work, is alone responsible for the name other than the actual publication, then the other person is the author of the name. If the identity of that other person is not explicit in the work itself, then the author is deemed to be the person who publishes the work. Thus, to avoid confusion and to keep in conformity of the code, the contribution of the worker, other than the author of the publication has to be explained in the main text of the publication itself.

Taxonomy provides opinions on species boundaries, and on the phylogenetic relationship between species. It provides a stable naming system that in today's jargon is a portal to a huge, if not always easy to access, store of information about a species. It has become inevitable that easy access to museum specimens and libraries to retrieve essential information be made to all, without which it would democratize taxonomy.

Phantom taxonomy

Lack of complete taxonomic knowledge can lead to the production of "phantom taxonomies": those that first appear in online appendices as downloadable documents, in which both the new taxonomy and the authors are difficult to track. "Phantom nomina" (Vences *et al.* 1999) refers to new nomina accidentally published in amateur publications without proper

descriptions and vouchers, while "phantom references" point to references that were quoted as "in press" or "in preparation" but were never published. Unreliable taxonomic information stemming from the need for rapid publication is equally unacceptable (Wheeler *et al.* 2004) given that, in taxonomy, unlike other disciplines, poor science cannot be ignored (Giribet and Wheeler, 2007).

New Code (effective from 1.1.2000)

The revised code which is effective from 1.1.2000 has certain amendments, e.g., obligation to explicitly fix name bearing types for new species-group taxa, method of "publication" employing ink on paper or read-only laser disks deposited in at least five major publicly accessible libraries named in the work itself. The following changes have been made:

1. A new name published after 1999 is available only if indicated as being new: sp. nov. gen. nov or equivalent terms.
2. A new species-group nominal taxon must include the fixation for it of a name-bearing type (a holotype or expressly indicated syntypes).
3. Name bearing preserved specimen/specimens, proposer include a statement naming the collection in which the name-bearing type is or will be deposited.
4. A new genus-group nominal taxon for trace fossils must include the designation of type species.
5. If new family-group name is proposed, adopt generic name as the stem to avoid homonymy.
6. Lectotype designation- accompanied by a statement to the effect that the designation is made with the purpose of clarifying the application of the name to a taxon.
7. In the event of rediscovering a lost holotype, syntype or lectotype, designated neotype will be rejected.
8. If the existing name-bearing type of a species-group taxon is indeterminate, so that the correct application of the name to a particular taxon is doubtful (*nomen dubidum*), an author should request the Commission to set it aside and designate a neotype.
9. A work will be treated as published only if the durable, unaltered copies (i.e., on read-only laser disks) have been deposited in at least five major publicly accessible libraries named in the work itself.
10. For purposes of zoological nomenclature, the following kinds of material are treated as unpublished:
 - a. electronically distributed text or illustrations
 - b. downloaded copies or printouts of such material
 - c. abstracts of papers, posters, lectures, etc., issues to participants at congress, symposia and other meetings but not otherwise published.
 - d. Offprints distributed after 1999 in advance of the date of publication specified in the work of which the offprint forms part.

11. Not to displace a name which has been used as valid by at least 10 authors in 25 publications during last 50 years.
12. Maintain particular spelling, even if formed from grammatically incorrect stems.
13. If type species fixation is found based on misidentification, a type actually involved may be fixed.
14. Name used for higher group name, even if found later than the name of subordinate taxon, name is not to be displaced.
15. Commission is empowered to safeguard list of names in major taxonomic fields.

Phylogeny (Greek: phylon = tribe and genesis = origin)

Phylogeny is the evolutionary history of a species or group of related species. Phylogeny is the study of the history: the origin, the lines of evolution in a group of organisms and evolution of higher taxa. Traditionally, the phylogenetic studies have been based on morphology, especially the skeleton, which is the only complete organ system available for detailed comparison with fossils (Greenwood *et al.*, 1966). However, with availability of both primitive and advanced teleosts, approaches other than the morphological study may be taken up for the investigation of their interrelationship. We should not imagine that, the full informational content of the teleostean morphology has been extracted. It will take a long time to extract such informational content (Greenwood *et al.* 1966). Osteological character provides valuable data as it does not fluctuate physiologically, rhythmically or seasonally throughout the post-embryonic life of the fish (Jayaram and Anuradha, 2003).

Importance and the reliability of the osteological study as a tool and basis for phylogenetic studies have been felt by various workers throughout the world. McClelland (1842) was a pioneer worker. Later Regan (1911); Greenwood *et al.* (1966); Roberts (1973); Kobayakawa (1992); Mo (1991); Bornbusch (1991); Chen and Lundberg (1995); Banarescu and Nalbant (1995); de Pinna (1996); and most recently Zhou and Zhou (2005) contributed in the subject.

Even within the realm of osteology, only a small superficial portion has so far been accomplished. There are so many portions left to be studied. We doubt if more than the external anatomy of 95% of the species of living teleosts has been examined, and for many families, there has so far been little or no deeper study.

In India, the importance of osteology in fish taxonomy and phylogenetic research were also conceived by earlier Indian workers, viz. Bimachar (1933); Jayaram and Bimachar (1967); Mahajan (1966); Gauba (1966); Tilak (1963). Most recent osteology work is that of Shantakumar and Vishwanath (2006); Vishwanath and Shantakumar (2007).

Molecular approach

The increasing demand for phylogenetic patterns has

resulted in a sharp rise in molecular phylogenetic analyses and concomitant reduction in traditional taxonomic works. Although studies of phylogeny are commonly cited as evidence of active taxonomic research, 'real' taxonomy has been decimated (Wheeler, 2004).

The value of molecular data in phylogenetic reconstruction is undeniable. Today, molecular markers are increasingly used to study population differentiation, and most biologists can do this. Indeed, for any taxonomic issue with medical or economic consequences, it is inconceivable that molecular techniques would not be applied. Similarly, biologists who might have previously looked to taxonomists to provide a phylogeny of a group are finding it increasingly easy to do it themselves as sequencing becomes cheaper and more widely available. DNA sequence data play an essential role in the reconstruction of evolutionary relationships among organisms, resulting in insights in genetic affinities that may confirm or conflict with traditional taxonomy.

Taxonomists are often criticized for failing to act together as a community, not least in nature. However, the almost universal, voluntary adherence to the current codes of nomenclature is arguably one of the strongest examples of international scientific cooperation. The success of the International Commission for Zoological Nomenclature in facilitating this cooperation over many years makes it the right organization to spearhead a universal system for the registration of zoological names. The commission appeals to all taxonomists to support this project and to engage in the consultation needed to design the best system. We also appeal to all biologists, whose work depends on taxonomy, to throw their weight and influence behind this initiative.

These days systematics is greatly influenced by data derived from DNA from nuclei, mitochondria and chloroplasts. This is sometimes known as molecular systematics which is becoming increasingly more common, perhaps at the expense of traditional taxonomy (Wheeler, 2004).

Evolutionary Systematics of Fish Fauna of North-East India

North-East India has as many as 296 fish species under 111 genera and 36 families (Vishwanath *et al.* 2007). The fauna of the region is still in the discovery survey state and very little work has been done on the evolutionary systematics. Although fish exploration started with the work of Hamilton (1822) and continued upto 1940's by Dr S.L. Hora and his team, there has been a long gap in the work. Only in late 80's, the study started again. With the implementation of United States Science Foundation funded All Catfish Species Inventory project, involving many scientists around the world in 2003, scientists from outside the country have also explored catfishes from North East India. Active inventory of ornamental fishes are also in progress.

Before we proceed to evolutionary systematics, we must

be aware of the various factors responsible for the present fish distribution in the region.

Plate tectonics and Fish phylogeny

Plate tectonics and fish phylogeny are two fields of very active researches in which major new hypotheses can still be expected at any time (Kottelat, 1989). We are only beginning to understand the complexity of the evolution of the continents and all proposed phylogenies are likely to suffer modifications. Ibotombi (1993) wrote that rifting and stretching of the crustal layer (lithosphere) of the present Manipur, possibly initiated sometime towards the close of Mesozoic era (upper cretaceous). The Manipur valley was probably evolved as a result of the passive rifting of the continental margins, i.e., sinking of a former plateau. Thus it is probable that the present Imphal river (Chindwin drainage) has a reverse course and it probably joined the Barak (Brahmaputra drainage) resulting in the present distribution of fish species common to both the systems.

Hora (1949) put forward 'Satpura hypothesis' to explain the dispersal of specialized fishes evolved in the mountains of Yunnan and Indo-China to Peninsular India. The hypothesis is based on the concept of Darlington (1957) that South-East Asia is 'centre of origin' of Ostariophysi. Both Satpura hypothesis and centre of origin theory have been negated as there is no geological support. Both were based on the concept of continental stability. The present concept is that continents do move. Beaufort (1951) and Mani (1974) considered the disjunction pattern of distribution of fishes of North-East India and South India as the remnants of an older wider distribution and not of recent origin. This disjunction is probably due to the extinction due to the Cretaceous to Eocene Deccan volcanism (Sarasin, 1910).

Plate reconstructions (Fig. 2) based on palaeomagnetic data suggest that the Indian plate attained a very high speed ($18\text{--}20\text{ cm yr}^{-1}$ during the late Cretaceous period) subsequent to its breakup from Gondwanaland, and then slowed to $\sim 5\text{ cm yr}^{-1}$ after the continental collision with Asia 50 myr ago. The Australian and African plates moved comparatively less distance and at much lower speeds while Antarctica remained almost stationary. This mobility makes India unique among the fragments of Gondwanaland. Thickness of the lithospheric root was important in determining their speed. Shear-wave receiver function technique revealed that while other plates had thicknesses of 180–300 km, Indian lithosphere was only about 100 km thick. Thus, it resulted in fastest movement and the resultant Himalayan orogeny (Kumar *et al.* 2007).

Reasons for Diversity

The region has rich fish diversity. The diversity is attributed to many reasons, viz. the geomorphology, consisting of hills, plateaus and valleys, resulting in the occurrence of a variety of torrential hill streams, rivers, lakes

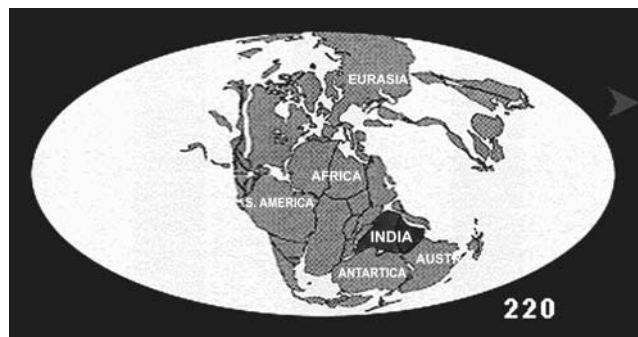


Fig 2. Tectonic set-up of continents 220 MY ago

and swamps; the drainage pattern which include the Ganga-Brahmaputra, Koladyne and Chindwin-Irrawady systems. Another important factor is the tectonic setting in the Indo-China subregion caused by collision of Indian, Chinese and Burmese plates, resulting in the formation of the mighty Himalayas and Indo-Burman ranges.

North East India forms part of two of the 34 biodiversity hotspots listed by Conservation International, they are: the Himalaya and Indo-Burma (Roach, 2005). The Himalaya is the home of the world's highest mountains and deepest gorges. The mountains rise abruptly, resulting in a diversity of ecosystems. The Indo-Burma, also called Indochina bioregion includes portions from eastern India to Vietnam. The whole of Arunachal Pradesh and Assam, north of the Brahmaputra, and Sikkim belongs to the Himalaya while Mizoram, Assam south of the Brahmaputra, Meghalaya, Nagaland and Manipur belong to the Indo-Burma. Kottelat and Whitten's (1996) map of freshwater biodiversity hotspot also covers areas of NE India.

The available data on the fishes of North East India is far from complete. This was due to lack of extensive survey work in this area, particularly in the interiors of hills because of difficult topography, inaccessibility and lack of proper language communication. In the past few years, researchers in the region have made extensive surveys of the water bodies and have added more species names to the list of fishes and added a new dimension on the fish study. Changes have taken place in the nomenclature, concepts of taxa and scheme of classification of fishes. With the publication of the result of extensive surveys of fishes in the Indo-Chinese region, great changes have also taken place in the concept of the origin and evolution of freshwater fishes of the region. Thus, students and researchers find difficulty in consulting books on fish fauna published long ago.

History of Ichthyology

Since the pioneering work of Hamilton (1822), about 70 research papers have been published and as many as 139 species of fishes have been described new from the region.

Fish genera endemic to the region

The Indochina bioregion including North East India is characteristic in having certain endemic genera of fishes, viz. *Aborichthys* Chaudhuri, *Akysis* Blyth, *Amblyceps* Blyth, *Badis* Hamilton, *Bangana* Hamilton, *Chaca* Gray, *Chaudhuria* Annandale, *Conta* Hora, *Erethistes* Muller and Troschel, *Erethistoides* Hora, *Exostoma* Blyth, *Meyersglanis* Hora and Silas, *Olyra* McClelland, *Parachiloglanis* Wu, *Pareuchiloglanis* Regan, *Pseudecheneis* Blyth, *Pseudoexostoma* Chu, *Pseudolaguvia* Misra, *Psilorhynchus* McClelland and *Semiplotus* Bleeker, *Sisor* Hamilton.

Advanced Fish Taxonomy

Fish systematics has taken a new turn with the understanding of plate tectonics and continental drift and rejection of the theory of continental stability. Ichthyologists have been looking into the geographical history, river basin formations and early fossil appearances for correlation with the origin of fish and their evolution in time and space. With

the new concept, scientists are concerned in detailed inventory, cataloguing and conservation of fish germplasm.

Early workers had access to a very few and poorly preserved specimens. With the new concept, various workers (Kottelat, 1996; Kottelat and Lim, 1993, 1995; Ng and Dodson, 1999; Ng and Kottelat, 2000) re-examined 'highly variable' widely distributed species and concluded that they were in fact aggregates of distinct, often not even closely related species.

Many other species have emerged new in this way, viz. *Gagata gasauyuh* (Roberts and Ferraris, 1998), *Badis chittagongis*, *B. ferrarisi* and *B. kanabos*, *Mystus falcarius* (Chakraborty and Ng, 2005), *Sisor chennuah* (Ng and Lahkar, 2003), *Pseudolaguvia ferula* (Ng, 2005a), *P. inornata* and *P. muricata* (Ng, 2005a), *Gogangra laevis* (Ng, 2005b), *Batasio spilurus* (Ng, 2006), *Pseudecheneis crassicauda* and *P. serracula* (Ng and Edds, 2005), *Amblyceps arunachalensis* and *A. apangi* (Nath and Dey, 1986), *Psilorhynchoides*

Year	Worker	No of sp. described	Year	Worker	No of sp. described
1822	F. Hamilton	(17)	1991	J. Vierke	(1)
1835	J.E. Gray	(1)	1993	W. Vishwanath	(1)
1839	J. McClelland	(5)	1994	N. Sen and B.K. Biswas	(1)
1842	J. McClelland	(8)	1995	W. Vish. and W. Manojkumar	(1)
1845	J. McClelland	(1)	1998	L. Kosygin and W. Vish.	(1)
1849	J. Muller and F.H.Troschel	(1)	2000	L. Arunkumar	(6)
1867	R.L. Playfair	(1)	2000	P. Musikasinthorn	(1)
1912	B.L. Chaudhuri	(3)		W. Vishwanath and Kosygin	(2)
1913	B.L. Chaudhuri	(3)		Menon, Rema Devi and Vish.	(1)
1921	S.L. Hora	(9)	2001	K. Selim and W. Vsh.	(1)
1923	S.L. Hora	(1)	2002	S. Kullander and R. Britz	(3)
1925	S.L. Hora	(1)		W. Vishwanath, Manojkumar and Selim	(2)
1935	Hora and Mukerji	(1)	2004	W. Vishwanath and L. Juliana	(4)
	S.L. Hora	(1)		W. Vishwanath and K. Shanta	(2)
	A.G.K. Menon	(1)		W. Vishwanath and K. Nebeshwar	(1)
1936	S.L. Hora	(1)		Ng and Lahkar	(1)
1937	E. Ahl	(1)		H.H. Ng and D.R. Edds	(1)
1950	S.L. Hora	(1)	2005	H.H. Ng and Edds	(2)
1954	A.G.K. Menon	(1)		H.H. Ng	(4)
1966	K.C. Jayaram	(1)		W. Vishwanath and M. Shantakr	(1)
1968	P. Bararescu and T. Nalbant	(1)		W. Vishwanath and K. Nebeshwar	(1)
1972	G.M. Yazdani	(1)	2006	H.H. Ng	(4)
1975	G.M. Yazdani and Talukdar	(1)		W. Vishwanath and A. Darshan	(1)
1982	A. Singh and P. Banarescu	(1)		W. Vishwanath and K. Nebeshwar	(1)
	N. Sen and T. Nalbant	(1)	1999	L. Arunkumar	(1)
1984	R.P. Barman	(1)		W. Vishwanath and L. Kosygin	(1)
1986	W. Vishwanath and H. Tombi	(1)	2005	H.H. Ng	(1)
1987	A.G.K. Menon	(6)		W. Vishwanath and I. Linthoingambi	(1)
	A.K. Datta, RP Barman and KC Jayaram	(1)		W. Vishwanath and H. Joyshree	(1)
1988	L. Arunkumar	(2)		W. Vishwanath and K. Shanta	(1)
	W. Vish and Ch. Sarojnalini	(1)		W. Vishwanath and A. Darshan	(1)
1989	P. Nath and S.C. Dey	(2)	2007	W. Vishwanath and I. Linthoingambi	(7)
1990	W. Vish and K. Nebeshwar	(1)		W. Vishwanath and H. Joyshree	(1)
				W. Vishwanath and A. Darshan	(2)
				K. Nebeshwar, K. Bagra and D.N. Das	(1)
				M. Kottelat <i>et al.</i>	(1)

List of fishes (valid names) described from North-East India

Year	Species	Year	Species
1822	<i>Bangana dero</i> , <i>Batasio batasio</i> , <i>B. tengana</i> , <i>Channa barca</i> , <i>Crossochilus latius</i> , <i>Conta conta</i> , <i>Erethistes hara</i> , <i>Eutropichthys vacha</i> , <i>Labeo boga</i> , <i>Labeo pangusia</i> , <i>Nangra nagra</i> , <i>Ompok pabo</i> , <i>Pimelodus rama</i> , <i>Puntius guganio</i> , <i>Raiamas bola</i> , <i>Securicula gora</i> , <i>Schistura savona</i>	1987	<i>Schistura arunachalensis</i> , <i>S. nagaensis</i> , <i>S. sijuensis</i> , <i>S. singhi</i> , <i>S. tirapensis</i> , <i>Neonoemacheilus assamensis</i> , <i>Pterocryptis indica</i>
1835	<i>Balitora brucei</i>	1988	<i>Danio yuensis</i> , <i>Garra manipurensis</i> , <i>Puntius morehensis</i>
1839	<i>Acanthocobitis pavonaceous</i> , <i>Garra nasuta</i> , <i>Labeo dyocheilus</i> , <i>Neolissochilus hexagonolepis</i> , <i>Semiplotus semiplotus</i>	1989	<i>Amblyceps apangi</i> , <i>A. arunachalensis</i>
1842	<i>Exostoma labiatum</i> , <i>Garra annandalei</i> , <i>G. kempi</i> , <i>G. naganensis</i> , <i>Glyptothorax lissorhynchus</i> , <i>G. striatus</i> , <i>Olyra longicauda</i> , <i>Pseudochenes sulcata</i>	1990	<i>Schistura chindwinica</i>
1845	<i>Poropuntius clavatus</i>	1991	<i>Channa bleheri</i>
1849	<i>Erethistes pussilus</i>	1993	<i>Garra litanensis</i>
1867	<i>Channa stewartii</i>	1994	<i>Nangra assamensis</i>
1912	<i>Danio naganensis</i> , <i>Olyra kempi</i> , <i>Schistura manipurensis</i>	1995	<i>Psilorhynchus microphthalmus</i>
1913	<i>Aborichthys kempi</i> , <i>Moringua hodgartii</i> , <i>Mystus dibrugarensis</i>	1998	<i>Garra compressus</i>
1921	<i>Aborichthys elongatus</i> , <i>Barilius dogarsinghi</i> , <i>Devatio acuticephala</i> , <i>Garra abhoyai</i> , <i>Lepidocephalichthys irrorata</i> , <i>Pseudolaguvia shawi</i> , <i>Schistura kangjupkhulensis</i> , <i>S. prashadi</i> , <i>S. sikmaiensis</i>	1999	<i>Homaloptera manipurensis</i> , <i>Myersglanis jayarami</i>
1923	<i>Parachilognanlis hodgarti</i>	2000	<i>Akysis manipurensis</i> , <i>Barilius lairoukensis</i> , <i>Channa aurantimaculata</i> , <i>Chela khujairokensis</i> , <i>Erethistes serratus</i> , <i>Garra elongata</i> , <i>Lepidocephalichthys manipurensis</i> , <i>Macrognathus morehensis</i> , <i>Neonoemacheilus morehensis</i> , <i>Puntius manipurensis</i>
1925	<i>Aborichthys garoensis</i>	2001	<i>Aspidoparia ukhrulensis</i>
1935	<i>Psilorhynchus homaloptera</i> , <i>Schistura devdevi</i> , <i>Schistura inglishi</i>	2002	<i>Badis kanabos</i> , <i>B. blosyrus</i> , <i>B. ferrarisi</i> , <i>Barilus chatrickensis</i> , <i>B. ngawa</i>
1936	<i>Crossocheilus burmanicus</i>	2004	<i>Acantopsis multistigmatus</i> , <i>Badis tuivaiei</i> , <i>Batasio macronotus</i> , <i>Puntius bizonatus</i> , <i>P. ornatus</i> , <i>Rasbora ornatus</i> , <i>Schistura khugae</i> , <i>S. reticulata</i> , <i>Sisor chennuah</i>
1937	<i>Badis assamensis</i>	2005	<i>Erethistoides sicula</i> , <i>Garra nambulica</i> , <i>G. paralissorhynchus</i> , <i>Glyptothorax ventrolinatus</i> , <i>Sisor barakensis</i> , <i>Pseudecheneis crassicauda</i> , <i>P. serracula</i> , <i>Pseudolaguvia ferrula</i> , <i>P. foveolata</i> , <i>P. inornata</i> , <i>P. muricata</i> , <i>Schistura minutus</i> , <i>S. tigrinum</i>
1950	<i>Erethistoides montana</i>	2006	<i>Batasio fasciolotus</i> , <i>B. niger</i> , <i>B. spilurus</i> , <i>Pseudolaguvia ferula</i> , <i>Pterocryptis barakensis</i>
1954	<i>Glyptothorax manipurensis</i>	2007	<i>Exostoma barakensis</i> , <i>Glyptothorax chindwinica</i> , <i>G. granula</i> , <i>G. ngapang</i> , <i>Puntius ater</i> , <i>P. khugae</i> , <i>Pseudocheneis sirenica</i> , <i>P. ukhrulensis</i> , <i>Schistura papulifera</i> , <i>Psilorhynchoides arunachalensis</i>
1966	<i>Pareuchiloglanis kamengensis</i>		
1968	<i>Neoeucirrhichthys maydelli</i>		
1972	<i>Chaudhuria indica</i>		
1975	<i>Puntius shalynius</i>		
1982	<i>Mesonoemacheilus reticulofasciatus</i> , <i>Physoschistura elongata</i>		
1984	<i>Aborichthys tikaderi</i>		
1986	<i>Puntius jayarami</i>		

arunachalensis (Nebeshwar *et al.* 2007), *Pseudecheneis sirenica* and *P. ukhrulensis* (Vishwanath and Darshan, 2007), *Puntius ater* and *P. khugae* (Linthoingambi and Vishwanath, 2007).

In view of the rich fish diversity in the region and their need for categorization under IUCN threat criteria and conservation and to study their phylogeny, we need sincere efforts of scientists who know fish taxonomy. Detailed inventory, correct identification and naming and systematic study using traditional techniques supported by modern tools will solve various problems in fish evolutionary systematic of North-East India.

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