Integrated taxonomy, conservation and sustainable development: Multiple facets of biodiversity

Teena Jayakumar, T.K[1], T.T. Ajith Kumar[1], Mahender Singh[1], Vindhya Mohindra[1], Rajeev K. Singh[1], Rajesh Dayal[1], J.K. Jena[2] and Kuldeep K. Lal[1]*

1. ICAR-National Bureau of Fish Genetic Resources, Canal Ring Road, P.O. Dilkusha, Lucknow - 226 002, India; 2. Indian Council of Agricultural Research, Krishi Anusandhan Bhawan-II, Pusa, New Delhi – 110002, India.
**Email kuldeepklal@gmail.com*

Promotion of the sustainable use of biodiversity is of greater importance for maintaining biodiversity in the present decade. Justifiably, the CBD (Convention on Biological Diversity) focuses on an "ecosystem approach to the conservation and sustainable use of biodiversity" as a framework for action, in which all the goods and services provided by biodiversity are considered. Consequently, as a signatory to the United Nations Convention on Biological Diversity, India enacted the *Biological Diversity Act, 2002* to regulate access to and use of its biological resources and mandate approval from the National Biodiversity Authority and to inform the State Biodiversity authorities towards access and judicious utilisation of biological resources. That way, the United Nations declared 2011-2020 as 'Decade on Biodiversity' to support and promote the implementation of the objectives of the Strategic Plan for Biodiversity and the Aichi Biodiversity Targets for significantly reducing biodiversity loss. Sustainable Development Goals (SDG) such as SDG 12 (Sustainable consumption and production) and SDG 14 (Life below water) established by the United Nations, during 2015 have also adopted the global path towards sustainable development for the next 15 years. To achieving the targets of CBD and SDG, cataloguing faunal diversity is essential so as to promote and enhance the ecosystem function for the sustainable development of mankind.

Exploratory surveys to document faunal and floral diversity are the foundation of biodiversity science, which have led to the inventorisation of new species / distributional records, thus supplementing the existing knowledge on total species richness of the region. Taxonomy, which deals with the discovery, description, naming and classification of biodiversity on the Earth along with their phylogenetic relationships, is the basis of biodiversity science (Dar et al. 2012). The advent of molecular methods for species differentiation and delimitation, have revolutionised conventional taxonomy in which it is complemented with information generated from these methods. Thus, integrative taxonomy involving molecular and conventional approaches have led to the unravelling of many cryptic and overlooked species. Taxonomy bestows distribution and biological information, which is crucial for the comprehensive policy making, effective planning and decision making in environmental management. Such work is essential for the fundamental understanding of biodiversity, its documentation, conservation and sustainable use. The integration of the science of taxonomy, ecology and conservation is required to meet the current challenges on global biodiversity.

Realising the existing impediments to taxonomy such as shortage of trained manpower, taxonomic gaps in several biota, lack of monographic and revisionary studies, the Global Taxonomic Initiative has been initiated under the aegis of the CBD for making a global inventory of biodiversity on Earth to assist conservation and management of biodiversity (Convention on Biological Diversity, 2006; Narendran 2008; Dar et al. 2012). Furthermore, capacity building, integrative taxonomic approaches, trans-disciplinary research, assessment of conservation status of species, allocation of adequate funds, easier access to literature and specimens, collaborative online databases and international linkages with researchers are also required for improving the prospects of biodiversity inventory in India. At this significant juncture, the Government of India has initiated mission mode programs such as the Deep Sea and Biodiversity Missions for exploration, mapping and conservation of biodiversity.

Fishes constitute more than half of all vertebrates, with well over 35,768 valid species (Fricke et al. 2021). Fishes known from the fresh and marine waters of India comprises

Figure 1. Number of fish species described worldwide during 2001 - 2020 (Source: Fricke et al 2020).

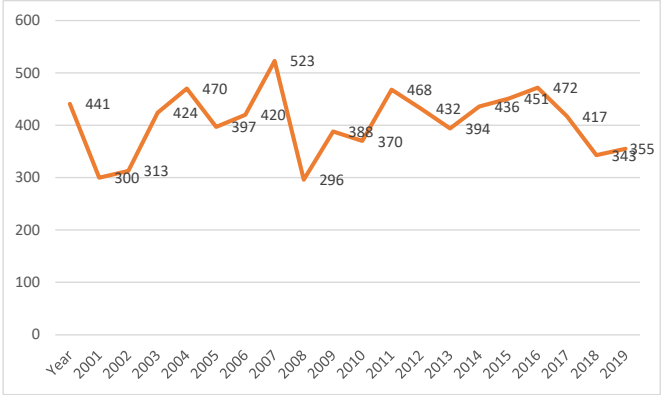


Figure 2. New species and new distributional records of fishes described in India during 2010 - 2019 (Source: Chandra et al. 2020).

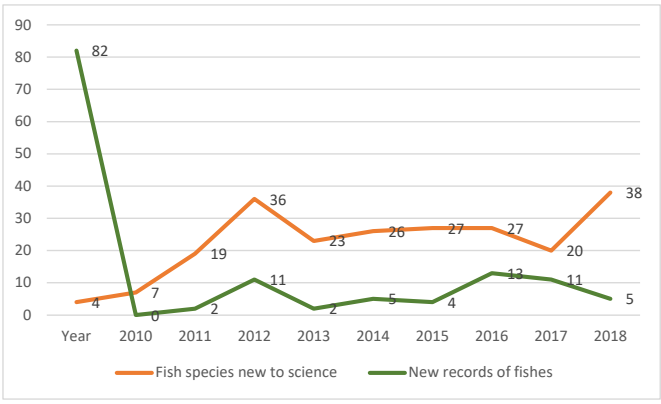


Table 1. Details about the new species and new records of fin and shell fishes described by ICAR-NBFGR during 2015-2020.

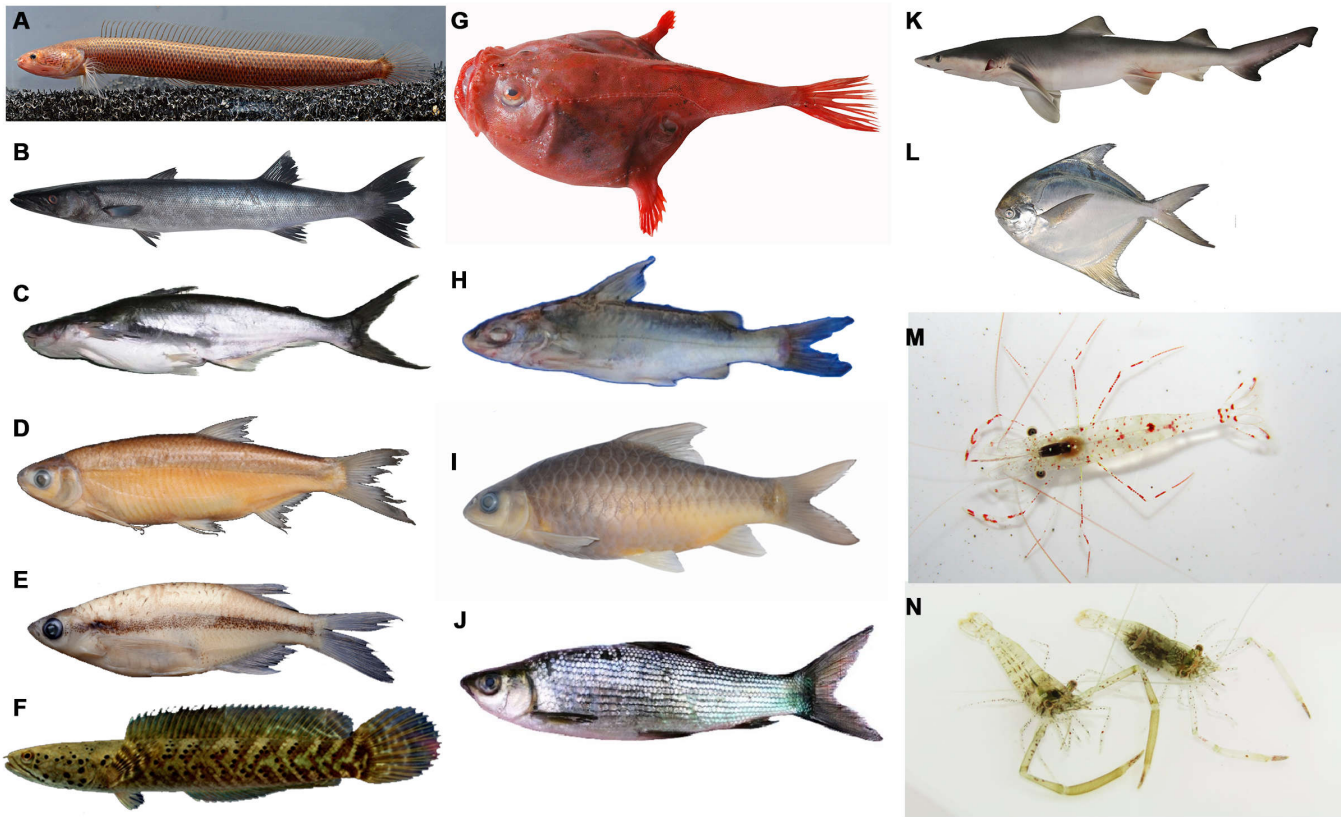
New species	Family	Place of collection	Habitat	Publication
Finfishes				
Aenigmachanna mahabali Kumar, et.al., 2019 (Fig 3.a)	Channidae	Thiruvalla, Kottayam, Kerala	Freshwater	Zootaxa, 2019
Sphyraena arabiansis Abdussamad & Retheesh, 2015 (Fig 3.b)	Sphyraenidae	Cochin Fisheries Harbour, Kerala	Marine water	Indian J. Fisheries, 2015
Pangasius silasi Dwivedi, et. al, 2017 (Fig 3.c)	Pangasiidae	Krishna River at Nagarjuna-Sagar Dam, Guntur District, Andhra Pradesh	Freshwater	Hydrobiologia, 2017
Cabdio crassus Lalramliana, Samuel Lalronuga and Mahender Singh, 2019 (Fig 3.d)	Cyprinidae	Kaladan River of Mizoram	Freshwater	Zootaxa, 2019
Laubuka parafasciata Lalramliana, Vanlalhlimpuia and Singh, 2017 (Fig 3.e)	Cyprinidae	Sala River, a tributary of Kaladan River, in the vicinity of Lungpuk, Siaha District, Mizoram	Freshwater	Zootaxa, 2017
Channa stiktos Lalramliana, Lalro-nunga, S. and Singh, M. 2018 (Fig 3.f)	Channidae	Tiau River, Kaladan River drainage, Mizoram	Freshwater	Vertebrate zoology, 2018
Chaunax multilepis Ho, Meleppura & Bineesh 2016 (Fig 3.g)	Chaunacidae	Kollam, Kerala, Arabian Sea	Marine water	Zootaxa 2016
Rita bakalu Lal, Dwivedi and Singh 2017 (Fig 3.h)	Bagridae	Pranhita River, Bejjur, Godavari river system, Telangana, India	Freshwater	Hydrobiologia 2017
Neolissochilus kaladanensis Lalram-liana, Lalronunga, Kumar and Singh, 2019 (Fig 3.i)	Cyprinidae	Kaladan River in the vicinity of Kawlchaw Village, Mizoram	Freshwater	Mitochondrial DNA, 2019
Shellfishes				
Periclimenella agattii Bharathi et al 2019 (Fig 3.m)	Palaemonidae	Agatti Island, Lakshadweep	Marine water	Zootaxa, 2019
Urocaridella arabianensis S. Akash et. al., 2020 (Fig 3.n)	Palaemonidae	Agatti Island, Lakshadweep	Marine water	Zootaxa, 2020
Re-description/ re-discovery				
Labeo rajasthanicus Lal, Datta and Majumdar, 1970 (Fig 3.j)	Cyprinidae	Jaismund Lake in western Rajasthan region.	Freshwater	Indian J. Fisheries, 2015
Lamiopsis temminckii (Muller and Henle, 1839) (Fig 3.k)	Carcharhinidae	Newferry wharf, Sasson dock and Satpati fisheries harbour Maharashtra coast	Marine water	Zootaxa, 2016
Pampus candidus (Cuvier, 1833) (Fig 3.l)	Stromateidae	Bay of Bengal and Arabian Sea	Marine water	Zoological studies, 2019
New distributional records				
Finfishes				
Bathymyrus simus Smith, 1965	Congridae	Nagapattinam (Tamil Nadu) and Digha (West Bengal) landing centres	Marine water	Thalassas, 2019
Cypselurus opisthopus (Bleeker, 1865)	Exocoetidae	Vizhinjam, Kerala	Marine water	Journal of Ichthyology, 2019
Leptojulis lambdastigma Randall and Ferraris, 1981	Labridae	ChidiyaTapu, Andaman	Marine water	JMBAI, 2020
Shellfishes				
Thor hainanensis Xu and Li 2014	Thoridae	Agatti Island, Lakshadweep	Marine water	Zootaxa, 2019
Lysmata hochi Baeza and Anker, 2008	Lysmatidae	Agatti Island, Lakshadweep	Marine water	Zootaxa, 2020
Association				
Argeiopsis inhacae Kensley, 1974 with *Stenophus hispidus* (Olivier, 1811)	Bopyridae	Agatti Island, Lakshadweep	Marine water	Current Science, 2019

of 3,439 valid species constituting around 10 percent of the total number of fish species of the world (Chandra et al. 2020). During 2020, 355 new species of fishes have been discovered worldwide (Fricke et al. 2021) (Figure 1) and 38 new species of fishes in India during 2019 (Chandra et al. 2020) (Figure 2). Nevertheless, it is expected that thousands of species await discovery both in Indian and internationals contexts. The global taxonomy initiative of the CBD, is an important milestone, as through this the convention of parties recognised that taxonomy is important for management of genetic resources for alleviating hunger. Nations advocated that there is an urgent need to build capacity and repositories to strengthen the documentation of genetic diversity. Unless there are strong initiatives in this direction, many species might undergo unrecognised extinction. Examples are provided by the focussed explorations from the ICAR-National Bureau of Fish Genetic Resources (NBFGR), an organisation from India, mandated for cataloguing of genetic resources of the country and which carries out research on systematic accounts, distributional records and reports with surveys and inventories of fresh and marine water fin and shell fishes, providing fundamental knowledge on the distribution and abundance of ichthyodiversity. These cover exploratory surveys of various ecosystems ranging from fauna of deep sea to the high-altitude regions of the Himalaya, falling under diverse biogeographic zones and unexplored regions of the country, including North-eastern India, Western Ghats, Lakshadweep and Andaman and Nicobar Islands towards cataloguing faunal and floral diversity. These efforts by a single institute, ICAR-NBFGR, have resulted in reports and publication of 14 new fish species and 6 new distribution records during the small period of 2015 to 2020 (Table 1). Of these 14 species, 11 are new to science and first discoveries and descriptions; three species are rediscoveries, which were reported elsewhere but not considered as valid by science due to lack of evidence or specimens (Figure 3). These species were rediscovered, re-described, validated and their original names are resurrected (Table 1) and thus such rediscoveries are equivalent to new species discoveries. New distributional records for six species previously unknown from Indian waters constituting of previously known species but discovered in a new distributional range have been documented. The research used integrated taxonomy in most of cases to reach the conclusion, complementing morphology with molecular tools.

Asia is rich in biodiversity. There is an opportunity for many countries to join hands in capacity building and documenting the unknown treasure of genetic resources. This is also important from the viewpoint of the Nagoya protocol, as nations have sovereign rights over their genetic resources, however, to stake claim the precise data and knowledge of genetic resources under their respective national jurisdictions is very important.

Considering various threats to biodiversity, new knowledge of existing species and discovery of new species and their ensuing study is strongly warranted for conservation and sustaining biodiversity for the future, since degradation of habitat and unsustainable fishing practices as well as their illegal collection are contributory factors for dwindling populations in natural habitats. Conservation of diversity is contingent on the number of taxa in an area, distribution and their taxonomic relationship, and uses biodiversity inventory provided by taxonomy for deciding and planning conservation strategies (Giangrande, 2003). Systematic taxonomic surveys

Figure 3. New fin and shellfish species described by ICAR-NBFGR during 2015 - 2020.



along with well-maintained collections and catalogues are also a prerequisite for the conservation. Besides, identification, categorisation of endangered, threatened and vulnerable fish species and studies on their biology also aids in conservation. Therefore, conservation of biodiversity is central as other than providing goods and services, which are necessary for human survival, it is also concomitant with providing livelihoods and improving the socio-economic conditions of local people, contributing to sustainable development and poverty alleviation. Many of the new discoveries could aid in future as value-added biological/biotechnological resource-materials besides providing new species for aquaculture diversification and utilisation for ornamental trade.

Description of new species and at the same time their evaluation and mainstreaming so that the pathway of harmonising conservation and livelihoods through aquaculture and ornamental trade is established. This is carried out though implementing the concept of Live Fish Germplasm Resource Centres for prioritised species (NBFGR, 2016). For example, Pangasius silasi, a new species, reveals a healthy nutritional profile, with good PUFA contents and broodstock development of the species is under progress at Nagarjuna Sagar dam, Telengana, to promote the species for inland aquaculture in the near future (NBFGR, 2019). Likewise, captive propagation technologies are also underway to develop ornamental shrimps described from Lakshadweep islands recently for sustainable aquarium trade and conservation, besides promotion of livelihood to the islanders (Anonymous, 2020). Thus, holistic, and sustainable development of coastal communities without compromising the biodiversity is the need of the hour.

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