

SCIENCE AND CULTURE

JOURNAL LISTED IN THOMSON REUTERS MASTER LIST
 JOURNAL LISTED IN THE UGC - CARE LIST 'GROUP-A'
 INDEXED IN UK-BASED CAB ABSTRACTS

Special Issue on
Fisheries of River Ganga Under Changing Climate
 On the Occasion of 75th Glorious Years
 for Nation Building in Inland Fisheries

Eighty Eighth Year of Publication

IN THIS ISSUE

Editorial: Fisheries of River Ganga Under Changing Climate

Present Status of Ganges River Dolphin and Strategies towards Conservation of Aquatic Biodiversity

Plankton Diversity and Ecology of River Ganga

Status and Distribution of Periphyton Community in River Ganga

Status of Benthic Molluscs as Pollution Bioindicators in River Ganga

Impact of Climate Change on River Ganga: Recent Status and Mitigation

Microplastics Pollution in Ganga: Present Status and Future Need

River Ranching Programmes of Indigenous Fish Species of River Ganga and their Benefits

Livelihood Status and Socio-Economic Condition of Fishers of River Ganga

Advancement in Fish Migratory Behavior Study through Tagging: An Overview

Nobel Prizes: 2022



Guest Editors:
 Basanta Kumar Das
 Amiya K. Sahoo



Indian Science News Association
 ESTABLISHED 1935

Regd. No. R/N 5093/57

SCIENCE AND CULTURE

NOVEMBER-DECEMBER 2022/ VOLUME 88/NO. 11-12

A JOURNAL OF NATURAL AND CULTURAL SCIENCES

PUBLISHED BY THE
**INDIAN SCIENCE
NEWS ASSOCIATION**

EDITORIAL BOARD

Professor Sudhendu Mandal Editor-in-Chief

Professor Avijit Banerji

Dr. Satyabrata Chakrabarti

Professor Syamal Chakrabarti

Professor Manas Chakrabarty

Dr. Sabyasachi Chattopadhyay

Professor Arnab Rai Choudhuri

Dr. Amit Krishna De

Professor Prabir Kumar Saha

Dr. T. V. Venkateswaran

COLLABORATORS

Amiya Kumar Bagchi (Kolkata)	Punam Kakkar (Lucknow)
Kelvin Brown (Australia)	Deepak Kumar (New Delhi)
D. P. Chattopadhyaya (Kolkata)	Abhijit Lahiri (New Delhi)
A. D. Choudhuri (Kolkata)	Monoj K. Patairiya (New Delhi)
Mrinal K. Dewanjee (USA)	B.K. Pattnaik (Kanpur)
R. Gadagkar (Bangaluru)	V. Ravichandran (Kolkata)
Ajoy Ghatak (New Delhi)	Amit Roy (Kolkata)
Irfan Habib (New Delhi)	Satyesh Chandra Roy (Kolkata)
Amiya K. Hati (Kolkata)	Nimai Chandra Saha (Burdwan)
Mridul Hazarika (Guwahati)	Rajinder Singh (Germany)
S. Kailas (Mumbai)	Srinivasan Srikanthan (Chennai)

EDITORIAL

Fisheries of River Ganga under Changing Climate
— Basanta Kumar Das and
Amiya K. Sahoo ... 367

ARTICLE

Present Status of Ganges River Dolphin and
Strategies towards Conservation of Aquatic
Biodiversity

— Basanta Kumar Das, Sandeep Behera,
Supriti Bayen and Hena Chakraborty ... 370

Plankton Diversity and Ecology of River Ganga

— Trupti Rani Mohanty, Nitish Kumar
Tiwari, Basanta Kumar Das and
Suman Kumari ... 379

Status and Distribution of Periphyton

Community in River Ganga

— Trupti Rani Mohanty, Nitish Kumar
Tiwari, Basanta Kumar Das and
Mitesh Hiradas Ramteke ... 385

Status of Benthic Molluscs as Pollution

Bioindicators in River Ganga

— Shreya Roy, Basanta Kumar Das
and Sourav Kundu ... 388

Impact of Climate Change on River Ganga:

Recent Status and Mitigation

— Basanta Kumar Das, Supriti Bayen,
Sunita Prasad and Uttam Kumar Sarkar ... 397

Microplastic Pollution in Ganga: Present

Status and Future Need

— Dhruva Jyoti Sarkar, Soma Das Sarkar,
Santhana Kumar V., Sourav Kundu and
Basanta Kumar Das ... 400

River Ranching Programmes of Indigenous Fish

Species of River Ganga and Their Benefits

— Basanta Kumar Das, Himanshu
Sekhar Swain, Supriti Bayen, Mitesh
Hiradas Ramteke, Subhadeep Das Gupta
and Nitish Kumar Tiwari ... 406

Contd. next page.



Indian Science News Association

MEMBERS OF THE COUNCIL

President

Dr. K. Muraleedharan

Vice-Presidents

Professor S. K. Talapatra
Professor (Mrs.) Julie Banerji
Professor Bikas K. Chakrabarti
Professor Dhruvajyoti Chattopadhyay
Professor Basab Chaudhuri
Dr. Anil K. Rajvanshi

Honorary Secretaries

Professor Manas Chakrabarty
Dr. Amit Krishna De

Honorary Treasurer

Professor Prabir Kumar Saha

Editor-in-Chief, Science and Culture

Professor Sudhendu Mandal

Members

Professor Avijit Banerji
Shri Prasanta K. Bose
Dr. Manoj Kumar Chakrabarti
Dr. Satyabrata Chakrabarti
Professor Syamal Chakrabarti
Dr. Sabyasachi Chattopadhyay
Dr. (Mrs.) Sumitra Chaudhuri
Dr. Manas Pratim Das
Dr. D. P. Duari
Shri Pathik Guha
Dr. Balaram Majumder
Professor Partha P. Majumder
Shri Sitendu Mandal
Dr. Shankarashis Mukherjee
Professor Sajal Ray
Professor Arnab Rai Choudhuri
Dr. Devaprasanna Sinha
Dr. D. K. Srivastava
Professor (Mrs.) Bani Talapatra
Dr. T.V. Venkateswaran

Livelihood Status and Socio-economic
Condition of Fishers of River Ganga
— *Basanta Kumar Das, Piyashi Debroy,
Aparna Roy, Supriti Bayen and
Hena Chakraborty* ... 410

Advancement in Fish Migratory Behavior
Study Through Tagging: An Overview
— *Akankshya Das,
Amiya Kumar Sahoo
and Basanta Kumar Das* ... 415

RESEARCH COMMUNICATION

Teachings of Yoga Darsana: Assumptions
and Practices
— *Bhumika Kanjilal* ... 422

Comparative Ecomorphology of *Lemna minor*
L. and *Spirodela polyrrhiza* (L.) Schleid
Collected from Municipality Areas of
Malda District
— *Santanu Gupta and Sudipta Kumar Sil* ... 426

REPORT

Nobel Prizes : 2022
Chemistry
— *Manas Chakrabarty* ... 432

Physics
— *B. K. Chatterjee* ... 434

Physiology or Medicine
— *Snehasis Mishra and Syamal Roy* ... 436

Economics
— *Pranab Kumar Chattopadhyay* ... 437

Literature
— *Amrit Sen* ... 439

Peace
— *Sabyasachi Chatterjee* ... 441

NOTES AND NEWS ... 443

Cover: Benthic Molluscan Diversity in Ganga (page 390)

**Members of the Advisory Committee
of
Indian Science News Association**

Professor Padmanabham Balaram	Bengaluru
Professor D. Balasubramanian	Hyderabad
Professor Basudeb Barman	Kolkata
Professor Ashoke Nath Basu	Kolkata
Dr. Balaram Bhargava	New Delhi
Professor Uday Bandyopadhyay	Kolkata
Professor Sonali Chakravarti Banerjee	Kolkata
Dr. Srivari Chandrasekharan	New Delhi
Dr. Purnendu Chatterjee	Kolkata
Professor Suranjan Das	Kolkata
Dr. Rajesh S. Gokhale	New Delhi
Dr. K. Kasturirangan	Bengaluru
Dr. Shekhar C. Mande	New Delhi
Dr. R. A. Mashelkar	New Delhi
Professor Goverdhan Mehta	Hyderabad
Dr. Trilochan Mohapatra	New Delhi
Dr. Nakul Parashar	New Delhi
Professor Ashoke Sen	Allahabad
Dr. Bikash Chandra Sinha	Kolkata
Professor M. S. Swaminathan	Chennai

**SCIENCE & CULTURE
ADVERTISEMENT
RATE**

	Single Insertion	
	(Full Page)	(Half Page)
COVER (Back)	Rs. 20,000/-	×
COVER (Front Inside)	Rs. 15,000/-	×
COVER (Back Inside)	Rs. 15,000/-	×
OTHER PAGES	Rs. 10,000/-	×

N.B. : For colour or any other special types of advertisement—rates may be negotiated.

A discount of 20% for insertions in all issues in a year and of 15% for atleast three insertions will be allowed.

TO OUR READERS

Your appreciation of the journal makes us bold to suppose that some of your friends would also like to read **SCIENCE AND CULTURE**, the premier scientific bi-monthly of India devoted to the publication of the progress in pure and applied sciences. The Indian Science News Association has been conducting the journal for 88 years with the editorial co-operation of eminent scientists of India with the object of promoting and diffusing knowledge laying special stress on the progress of scientific studies here and abroad, and advocating methodical application of science to problems of national regeneration.

Editorial correspondence should be sent to the Editor-in-Chief, *Science and Culture*, 92, Acharya Prafulla Chandra Road, Kolkata-700 009, E-mail: editorial.scienceandculture@gmail.com / chiefeditorscienceandculture@gmail.com Manuscripts prepared in accordance with the Instruction to Authors should be submitted through e-mail.

Correspondence relating to subscription, advertisement and other matters should be addressed to the **Honorary Secretary, Indian Science News Association, 92, Acharya Prafulla Chandra Road, Kolkata - 700 009, Phone: 2350-2224. E-mail : editorial.scienceandculture@gmail.com Website: scienceandculture-isna.org**

MEMBERSHIP FEE

Life Member (India)	Rs.5,000.00*+
Life Member (Foreign)	\$ 600.00
Ordinary Member (without journal)	Rs. 100.00
Ordinary Member (with journal)	Rs. 500.00

ANNUAL SUBSCRIPTION

Inland (Institution)	Rs. 2,500.00
Foreign	U.S.\$ 125.00
Inland (Individual)	Rs. 400.00
Foreign (Individual)	US.\$ 60.00
Single Copy (Inland)	Rs. 125.00
Single Copy (Foreign)	\$ 20.00

* Entitles to receive *Science and Culture* for 15 years
+ Rs. 1000/- towards the cost of delivery of the journal for 5 years

Past Special Issues

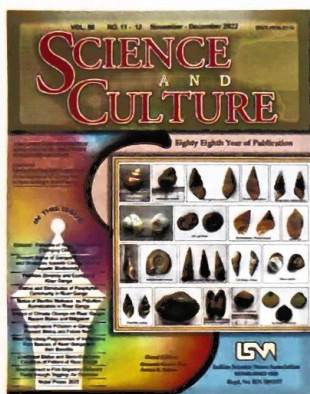
- **Fisheries of the Holy Ganga River** (September-October 2022)
- **Climate Crisis in India : Issues and Concerns** (January-February 2020)
- **A Quantum Jump in Computation** (May-June 2019)
- **How Bose Statistics Changed Our Understanding of Matter** (January-February 2019)
- **Meghnad Saha and the World of Plasmas** (November-December 2018)
- **Cooperative Learning and Social Games : Kolkata Restaurant Problems** (January-February 2018)
- **J. C. Bose, Bose Institute and Scientific Legacy** (November-December 2017)
- **International Year of Light 2015** (November-December 2015)
- **Nuclear Chemistry Research : Past, Present and Future** (September-October 2015)
- **Communicating Science Through Science Museums, Science Centres and Planetaria towards Developing a Culture of Science** (November-December 2013)
- **Atomic Energy in National Development** (January-February 2013)
- **CSIR-NML on the March** (November-December 2012)
- **CSIR-CSIO : Instrumental in Scientific-eco System Measurements** (September-October 2012)
- **A Journey from Plant Physiology to Plant Biology** (May-June 2012)
- **New Science of Synthetic and Systems Biology** (March-April 2012)
- **Impact of CSIR-NEIST in the North East Region** (November-December 2011)
- **Recent Trends in Tea Research** (September-October 2011)
- **Emerging Trends in Genomics : Applications in Health and Disease** (January-February 2011)
- **Fifteen years of Econophysics Research** (September-October 2010)
- **Cholera : A Disease that Eludes Technological Advance** (May-June 2010)
- **Geomagnetism and Aeronomy** (July-August 2009)
- **Origin of Species—A Revolutionary Argument** (March-April 2009)
- **Scientific Legacy of Acharya J. C. Bose The Doyen of Indian Science** (November-December 2008)
- **Radio Science** (September-October 2008)
- **Mysteries of the Earth's Interior** (May-June 2008)
- **Natural Products Chemistry** (January-February 2008)
- **Forensic Science in Criminal Justice Delivery System** (November-December 2007)
- **Current Trends in Leishmania Research** (May-June 2007)
- **Unconventional Applications of Physics** (March-April 2007)
- **Water Resources in South Asia : An Assessment of Climate Change – Associated Vulnerabilities and Coping Mechanisms** (July-August 2005)
- **Glass and Ceramic Research in India** (May-June 2005)

SCIENCE AND CULTURE

VOLUME 88 □ NOVEMBER-DECEMBER 2022 □ NOS. 11-12

 EDITORIAL

FISHERIES OF RIVER GANGA UNDER CHANGING CLIMATE



India is bestowed with a variety of open inland water bodies in the form of rivers, wetlands, reservoirs, lakes etc. which serve as an enormous potential source for fisheries production ensuring national food security. Besides, the fisheries sector plays a key role towards uplifting socio economic conditions of poor fishers through their daily family income as artisanal fisheries. Of all these openwater resources, rivers are the hub of aquatic biodiversity sustaining life in the form of flora and fauna. River Ganga sustains unique source of multiple ecosystem services to the mankind since decades. The river not only supports rich indigenous biodiversity including Gangetic Dolphin but also a part of spiritual life of millions witnessed by Maha Khumb Mela and several rituals. Therefore the river Ganga is revered as the holy River of India. However, in the recent years set of factors including river modification, habitat degradation and over exploitation of important commercial fish stocks have become evident. However, with the boom of rise in population, prolific urbanization coupled with industrialization, the river has been under tremendous pressure impacted majorly by anthropogenic vulnerabilities and climate change. In the recent years, climate change has been a major challenge, for the aquatic resources and lives. Unlike terrestrial animals, fishes are susceptible to certain critical environmental parameters modifications, as their population directly depends upon the environment. The variability of life cycle including population recruitment, feeding and predation of fishes depends upon its aquatic environment and its habitat.

River Ganga after its origin passes through different plains of the country with varied hydrological regime therefore completely modulated by the climate impacts. Migratory keystone fish species of river Ganga viz. Mahseer (*Tor putitora*) and Hilsa (*Tenualosa ilisha*) traverse hundreds of kilometres to complete their life cycle processes. Alteration in any climatological parameters can upset the entire life cycle processes. Variability and changes in climatic factors could disturb the spatial distribution of the wild fish stocks, therefore changing the habitat and recruitment processes. The river Ganga and majority of its tributaries are particularly snow fed originating from the Himalays. Therefore, decrease in snow cover owing to global warming has severely affected the basin hydrology. River flow is a key factor for maintaining physical, chemical and biological structure of a river ecosystem. The nature of flow determines the biotic communities and their interactions with the floodplains. The floodplain wetlands, those are connected to the river Ganga form an important part of riverine habitat for the fish recruitment processes. Reduction of river discharge therefore could severely impact on the indigenous fish recruitments on the other hand, with the rise of sea level, intrusion of salt water in the brackishwater section of river Ganga may also be impinging upon the biodiversity. Moreover, frequent extreme climatic incidences such as severe tropical cyclonic storms and floods in the coastal part of the river have severely impacted on the biodiversity and coastal inhabitants through salt water intrusion in the freshwater stretches of river Ganga therefore changing the fish diversity and recruitment physiology. As per the projection of IPCC 2022, climatic impact on fisheries sectors particularly in coastal parts may relate to increase in sea level, amplify in cyclones, rise in groundwater salinity and water stress areas. Therefore, the impact on estuarine fisheries, an integral part of the river could be the most

impacted sector influenced by the climatic alterations. While, the freshwater sections of the river could be potentially impacted resulting to the decrease in surface water availability and river flows. Majority of the indigenous fishes of river Ganga depend upon the timely rainfall during monsoon, as it triggers the early maturation for a successful recruitment. ICAR-CIFRI, has recorded that an alteration in precipitation in the selected stretches of river Ganga at Prayagraj in Uttar Pradesh over the period of 1979-2009. During this period, the total rainfall declined by 7% in May-August (peak breeding period of fishes like Indian Major Carps in the river). In addition, availability of natural fish spawn in river Ganga has come down to meagre 568 ml at present, as compared to 1500 ml during 1965-69. Moreover, the shift in rainfall patterns has also altered the basic breeding requirements like turbidity and river flow in the river Ganga. The impact could be noticed in the pattern of river water temperature. The rise of annual mean temperature (AMT) of river water by 0.99°C at Haridwar has shown that several warm water fishes like catfishes and carps migrate upstream of the river. In addition to the freshwater and estuarine stretches of the river Ganga, effect of climate change like increase AMT in river water and altered hydrological regime has created added pressure into the floodplain open wetlands of river Ganga. In our recent studies conducted by ICAR-CIFRI, several fishes species

(*Glossogobius giuris*, *Puntius ticto*, *Xenentodon cancila*.) inhabiting in the warm water areas of the river are now recorded in the upstream of the river upto Devprayag. We have recorded the impact of climate change on the breeding phenology of anadromous Hilsa indicating interesting findings such as early maturity and altered spawning behaviour.

Based on our scientific experiences through ongoing and past studies over the decades, we realized that a concerted efforts on gathering and correlating time series data of river Ganga with the climate variability's is need of the hour. In addition, a holistic research efforts including biodiversity, ecosystem services, GIS based mapping of susceptible areas along the river stretch, intensive peoples and community participation and integrating with climatic vulnerability assessment and sensitivity components for the holy river Ganga could reduce the impact of climate change on river ecosystem significantly Therefore adaption strategies may be built on the priority basis with the active participation of Government and different stakeholders to protect the biodiversity including fisheries and Gangetic Dolphin under the changing climate. □

Basanta Kumar Das
Amiya K. Sahoo

Dr. Basanta Kumar Das

Dr. Basanta Kumar Das is currently, Director, ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata

Born in Athilabaj, District Balasore, Odisha on 20 March 1966. Educated at Orissa University of Agriculture and Technology, B.F.Sc. 1988, M.F.Sc. 1991, Ph.D. 1998, Post-Doc at FRS Marine Lab, Aberdeen, Scotland, UK 2006-2007. At present Dr. Das is the President, Inland Fisheries Society of India to date; President, Professional Fisheries Graduates Forum and President, Orissa Fisheries College Alumni Association. Started his career as Scientist, ICAR-National Academy of Agricultural Research Management, Hyderabad, 1994-95; Scientist, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 1995-98; Scientist Sr. Scale, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 1998-2003; Sr. Scientist, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 2003-2009; Principal Scientist, ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, 2009-2016. His main field of research includes Aquaculture & Molecular Immunology, Fish Health Management, Inland Fisheries.

Dr. Das Developed Linkages with Worldfish, NACA, FAO, GIZ, SAARC, BOBP, IUCN, World Bank, RMIT University, Waterloo University, University of Manitoava, University of Aberdeen, TWAS, MoEF & CC, Ministry of Jalshakti, DoF, NMCG, NFDB, CPCB, CWC, State Fisheries Departments. Guided 25 Ph.D. and 35 Masters students including 2 post Doc and 2 international students. Signed 11 MOU with the Govt. department,



3 MoU for commercial, 7 MoU for consultancy project. 2 MoU for research collaboration and 3 MOU for academic and research collaboration. More than 355 international publications having Citations-6751, h-index – 38, i10 index – 119.

Received Awards/Honours like Jawaharlal Nehru Award for outstanding post graduate research conferred by ICAR 1999; Lal Bahadur Shastri Young Scientist Award conferred by ICAR for the biennium 1999- 2000; Dr. Hiralal Chaudhuri Annual Awards 2001-2002; DBT Overseas Associateship 2005; Krushakbandhu Award by Orissa Krushak Samaj 2011; Dr. M.S. Swaminathan Award for Best Indian Fisheries Scientist by Professional Fisheries Graduates Forum 2011; Krushi Ratna Award from Orissa Krushak Samaj 2016; Eminent Zoologist of the Year Award by Zoological Society of India 2017; Krushak Gourav Award from Orissa Krushak Samaj 2017;

Cashless Award for making ICAR-CIFRI a Cashless Office, ICAR, New Delhi, 2017; Ganesh Chandra Vidyarthi Award for Hindi Journal, Nilanjali, ICAR, New Delhi, 2018; Best annual Report Award of ICAR-CIFRI, ICAR, New Delhi, 2019; Sardar Patel Outstanding ICAR Institution Award-2020 under Large Institute Category, ICAR, New Delhi, 2020; Rafi Ahmed Kidwai Award for Outstanding Research in Agricultural Sciences under Animal & Fisheries Sciences Category, ICAR, New Delhi, 2020; Ganesh Chandra Vidyarthi Appreciation Award for Hindi Journal, Nilanjali, ICAR, New Delhi, 2020; Agri-Food Empowering India awards 2021; Special Felicitation for outstanding and exceptional contribution to the Nation by State Bank of India, 2022. He is a Fellow of the International Society for Environmental Protection (ISEP); Member, Executive Council, India Science Congress Association for the year 2020-2021; Member, The National Academy of Sciences, India.

Dr. Amiya K. Sahoo



Dr. A.K.Sahoo is currently working as Senior Scientist, in Riverine and Estuarine Fisheries Division at ICAR-Central Inland Fisheries Research Institute, Barrackpore. Since more than 10 years, he is working in the area of Ecohydrology under climate change, Environmental flows, River basin approach towards sustainable fisheries and Fish health. Dr. Sahoo has wide working experiences in different rivers including rivers Mahanadi, Ganga, Teesta, Narmada, Cauvery particularly on Impact assessment due to hydropower projects. He has immense contribution towards Conservation of migratory fish species through technical guidance on Fish passess, delineating the migratory path of fish through tagging and fish breeding. The major migratory fish species are under investigations are Hilsa, Mahseer and Trouts. Dr. Sahoo is a

recipient of many awards including Young Scientist Award from AFS, Padmashree S. Ayyappan gold medal award, ZSI Gold Medal, University Gold medal and fellow of JFLS and has more than 90 publications to his credit. He is currently serving as Guest Editor to Frontier's in Marine Biology. Dr. Sahoo represents as Technical member to Expert Appraisal Committee, River Valley Project, MoEFCC and Technical member of Biodiversity ISO certification and Farakka Barrage Authority.

Note by the Editor-in-Chief, Science and Culture: This issue has been sponsored by the ICAR-Central Inland Fisheries Research Institute, Barrackpore, Kolkata.