



Proceedings of  
**National Conference on Research Development in Fisheries**  
**NCRDF-2019**

November 07<sup>th</sup> - 08<sup>th</sup>, 2019

**Editors**  
**Abha Mishra, Sandhya**

**Co-editor**  
**S. Maji**

Department of Zoology  
Babasaheb Bhimrao Ambedkar University,  
Lucknow-226025, India



*Proceedings of*  
**National Conference on Research Development in Fisheries**

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**S. Maji**



**Organized by**

Department of Zoology  
Babasaheb Bhimrao Ambedkar University,  
Lucknow-226025, India

Citation: Mishra A., Sandya and Maji S. (2019). **Proceedings of National Conference on Research Development in Fisheries** (NCRDF -2019). Dept. of Zoology, BBAU, Lucknow, U.P., India

Published by:  
Dr. Abha Mishra  
Email: [drabhamishra@gmail.com](mailto:drabhamishra@gmail.com)

Department of Zoology  
Babasaheb Bhimrao Ambedkar University, Lucknow

ISBN: 978-93-5396-043-8

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**Prof. Sanjay Singh**  
Vice Chancellor

### MESSAGE

I am delighted to know that the Department of Zoology, BBAU, Lucknow is organizing a National Conference on the **“Research Development in Fisheries (NCRDF-2019)”** on 7<sup>th</sup>-8<sup>th</sup> of November, 2019 and publishing a Souvenir on this occasion.

The proposed title of the conference is the need of the hour. Hence, the deliberations and discourse will undoubtedly help the fisheries and its allied sectors for further growth. I anticipate that the outcome of the conference will help the participants indeed to take up the new challenges in the field of fisheries.

On behalf of University, I extend a hearty welcome to all the delegates. I also congratulate the organizers for their untiring efforts towards organizing this event.

  
(Sanjay Singh)

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**Professor Rana Pratap Singh, Ph.D.**  
website : [www.ranapratap.in](http://www.ranapratap.in)

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लखनऊ-226 025, भारत  
Raebareilly Road, Vidya Vihar  
Lucknow-226 025, UP, India  
ईमेल / email : [cceseditor@gmail.com](mailto:cceseditor@gmail.com)  
[dr.ranapratap59@gmail.com](mailto:dr.ranapratap59@gmail.com)  
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Dated : 7-11-19

### MESSAGE

I am very fortunate to know that Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow is organizing a National Conference on the Research Development in Fisheries (NCRDF-2019) during Nov. 7-8, 2019.

The subject of the conference is going to be very helpful for the researchers of the concerned area as it comprises vast categories of topics from the various fields of fisheries. So, all the participants will get a vibrant platform to discuss and explore the recent advancements in fisheries which will be certainly useful in their research career.

I, on behalf of BBAU, Lucknow extend a warm welcome to all the delegates and participants joining to from across the country. I also congratulate the organizers and wish them all the best for successful organizing of NCRDF-2019.

  
(Rana Pratap Singh)

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**BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY**  
(A Central University)  
**Vidya Vihar, Rae Bareli Road, Lucknow-226025**

Prof. D. R. Modi  
Dean,  
School of Life Sciences

Contact No: 9935720995  
Email Id: drmodi@bbau.ac.in

MESSAGE

I am very happy to learn that Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow is organizing a National Conference on the Research Development in Fisheries (NCRDF-2019) during 7-8<sup>th</sup> November, 2019.

I hope that a large number of experts as well as young researchers from various fields of fisheries will participate in this national event. I strongly believe that this event will provide a vibrant platform to discuss the recent advancements and future scope in the field of fisheries. Hence, all the participants will get immense benefit from the conference.

On behalf of School of Life Sciences, BBAU, Lucknow. I extend a very cordial welcome to all the delegates and wish the conference all success.

(Prof. D. R. Modi)  
सकायाध्यक्ष / Dean  
जीव विज्ञान अध्ययन विद्यापीठ / School of Life Sciences  
बाबासाहेब भीमराव अम्बेडकर विश्वविद्यालय  
Babasaheb Bhimrao Ambedkar University  
लखनऊ / Lucknow-226025

Dr. V. Elangovan  
Head(i/c)  
Department of Zoology  
School of Life Sciences

Contact No: +91-9235565647  
+91-8318277304

Email Id: elango70@yahoo.com

## Message

Dear Friends and Delegates,

Warm and happy greeting to all, it is my immense pleasure to welcome delegates and invited speaker in the “**National Conference on Research Development in Fisheries**” (NCRDF 2019) which is being organized on 7<sup>th</sup> & 8<sup>th</sup> November, 2019 by the Department of Zoology. It will provide a common platform for biologists to understand the current complexities in the field of fisheries. This conference may venture to continue the latest research and development. It may also endeavour the tradition of interactions of young and expert researchers at national level.

I wish this national conference all the success and a gainful experience to all the participants.



(V. Elangovan)

DEPARTMENT OF ZOOLOGY  
BBAU, Lucknow-226025



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**(A Central University)**  
**Vidya Vihar, Rae Bareli Road, Lucknow-226025**

### MESSAGE

From the desk of **Organizing Secretary** \_\_\_\_\_

Dear participants,

Warm greeting!!!

On behalf of **Organizing Secretary**, it is our pleasure to welcome all the participants to the **National Conference on Research Development in Fisheries (NCRDF-2019)**. We extend our heartiest gratitude to all the eminent scientists coming from the various prestigious academia. We look forward to hear valuable deliberations that could enrich the knowledge of researchers. We have tried to cover the wide aspects about fisheries research development under six major themes. We hope that all the participants will be benefited by the conference.

Further, we have arranged award for best oral and poster performance, in each research scholars, post-graduation and graduations categories. We, firmly believe that new interdisciplinary research concepts will form with our integrated efforts that will contribute towards advancement in different fields of fisheries and its allied sectors. We, thank each and every one of you who are contributing to the success of the conference and looking forward to seeing you all soon.

**Dr. Sandhya**  
Assistant professor,  
Department of Zoology,  
BBAU, Lucknow  
Contact No: +91-9305008071  
Email Id: drsandhya@bbau.ac.in

**Dr. Abha Mishra**  
Assistant professor,  
Department of Zoology,  
BBAU, Lucknow  
Contact No: +91-9450710387  
Email Id: abhamishra@bbau.ac.in



बाबासाहेब भीमराव अम्बेडकर विश्वविद्यालय  
(केन्द्रीय विश्वविद्यालय)  
विद्याविहार, रायबरेली रोड, लखनऊ- 226025

**BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY**  
(A Central University)  
Vidya Vihar, Rae Bareli Road, Lucknow-226025

From the desk of **Joint-Organizing Secretary** \_\_\_\_\_

Dear Delegates,

As the joint-organizing secretary, we would like to welcome you all to the “**National Conference on Research Development in Fisheries**” (NCRDF-2019). This program is scheduled on 7<sup>th</sup> – 8<sup>th</sup> November, 2019. I hope that this program will provide a unique and important platform to bring various scientists, researchers and students under one roof to discuss the upcoming challenges and development in the field of fisheries. With the objective of undertaking research on basic and applied aspect of fish farming and aquaculture, I anticipate that this type of conference will be highly beneficial to our learning bodies.

Due to lack of time, we could not accommodate all requests for oral presentations, though there are 33 oral and 54 poster presentations.

Sincerely, we thank to all sponsors who have extended their hands to make this meet a success. We are indebted by the valuable suggestions and innovative ideas put forward on this small platform.

Dr.V. Elangovan  
Associate professor,  
Department of Zoology,  
BBAU, Lucknow  
Contact No: +91-9235565647  
Email Id: elango70@yahoo.com

Dr. Venkatesh Kumar R  
Assistant professor,  
Department of Zoology,  
BBAU, Lucknow  
Contact No: +91-9838616937  
Email Id: drvenkateshkumar@yahoo.com



# National Conference on Research Development in Fisheries (NCRDF-2019)

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## PREFACE

India is one of the leaders for production as well as consumption of fish and fish related products. About 60 million people depend on both inland and marine pisciculture in India. With the context of climate change, pollution in water, population burst the discussion on recent research and development in fishery is the need of hour for preparation of blue print for our future research and awareness among future generations. With this thought the National Conference on Research Development in Fisheries (NCRDF-2019) has been organized at Department of Zoology, Babasaheb Bhimrao Ambedkar University during 7<sup>th</sup> to 8<sup>th</sup> November, 2019. Subsequently the fruitful discussion of the conference has been compiled as a proceeding for proper documentation and awareness. We are happy to announce that a proceeding is being successfully published with ISBN number (978-93-5396-043-8). The proceedings contain all abstracts of papers presented by eminent scientists, researchers and students across the country with their innovative thoughts and research findings.

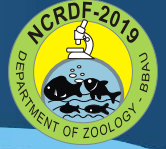
We thankfully acknowledge the paper contributors, sponsors, University administration for this publication. We also express our sincere gratitude to our advisors for this work. Hope, it will help the working force in the field of fishery for a comprehensive growth on fish production and its overall development.

Abha Mishra  
Sandhya  
Sutanu Maji



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## INDUCED BREEDING OF FISH: NEUROENDOCRINE BASIS FOR AN INTEGRATIVE APPROACH

**K. P. Joy**

INSA Emeritus Scientist

Department of Biotechnology, Cochin University of Science and Technology,  
Kochi-682022, Kerala

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Induction of breeding by hormone treatment is an integral part of fish culture practices all over the world. The method is popularly known as 'hypophysation' since the whole pituitary extract or pituitary-based hormones like gonadotropin is centrally involved (first generation technique). A surge in pituitary luteinizing hormone (LH) is the key mechanism underlying ovulation or spermiation leading to spawning. The placenta-derived human chorionic gonadotropin (hCG) is a major alternative to LH still commonly used due to its long acting potential and easy availability. With the understanding of the hypothalamic mechanisms involved in the LH surge, gonadotropin-releasing hormone (GnRH, a decapeptide) and dopamine 2 receptor blockers have found applications in artificial breeding programs. This method popularly known as 'Linpe' method was developed in the 1980s, as improvements on the first generation methods. Spawning agents like Ovaprim are now preferred to LH or hCG preparation due to specific advantages. Kiss peptin molecules have been discovered recently in fish as regulating GnRH secretion in the hypothalamus. Efforts should be made to integrate Kiss peptin-based technology on induced breeding. Since 1950s, arginine vasotocin (AVT), a neurohypophysial peptide hormone (octapeptide) has been shown to induce spawning and oviposition initiation in fish. Recent studies in our laboratory have demonstrated the ovulation-inducing potential of AVT promising further technological improvements. The role of pheromones in the initiation of spawning activity is known in some species but a pheromone-based technical application needs intensive research. An integrative approach of these methodological interventions may prove breeding operations cheaper and less labor-intensive.



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## SUSTAINABLE FISHERIES AND AQUACULTURE: STATUS AND WAY FORWARD

**W.S. Lakra**

NABARD Chair

ICAR CMFRI, Mumbai

Email : [wslakra@gmail.com](mailto:wslakra@gmail.com)

Fisheries and aquaculture play a pivotal role in food and nutritional security of the global population. India is the second largest producer of fish in the world after China contributing more than 6% of global fish production. The total fish production of India during 2017-18 was 12.8 million tons with a contribution of approximately 9.2 million tons from inland sector and 3.6 million tons from marine respectively. Since capture fisheries is more or less stabilized except from reservoirs, the future potential mainly lies with aquaculture. In recent years, there has been a focus on diversification both in terms of species and culture system. The country has now developed package of practices for more than 20 fish species. The culture of *Pangasianodon hypophthalmus* and exotic shrimp, *Litopenaeus vannamei* has created great excitement attracting farmers and entrepreneurs across the country. Inland fisheries, reservoirs and freshwater aquaculture are the pillars of growth besides flood plain lakes and wetlands, irrigation canals, saline and water logged areas. Shrimp farming has been a major activity in coastal states during the past thirty years especially with regard to *Penaeus monodon*. The recent development in brackish water aquaculture and sea cage farming provide a new paradigm of fish production in maritime states. A major breakthrough in recent years has been the use of underground saline water for shrimp and fish farming is Haryana and Punjab providing employment to rural youth with great economic benefits. The ornamental fish industry is also growing very fast with huge potential for export and domestic markets. Cold water fish culture and fisheries is a still a sleeping giant and has enormous potential in the hilly region. New research in basic disciplines such as genetics, biotechnology, health management and nutrition has significantly contributed in recent years to enhance aquaculture production and conserve genetic diversity. Conservation of genetic diversity is critical to aquaculture development and ecological balance. The country has vast genetic resources of more than 2500 fish species. The bounty of marine biodiversity which is exploited from 2.02 million



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km<sup>2</sup> of the Exclusive Economic Zone (EEZ) of India constitutes one of the largest heritage resources of the country. The major challenges of the Indian fisheries sector are low productivity and production in reservoirs, diversification of aquaculture species and systems, exotic fish species, water pollution and scarcity, quality seed and feed, climate change, marketing and quality human resources. The Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India has recently launched an umbrella scheme “Blue Revolution” and the Government also announced Pradhan Mantri Matsya Sampada Yojana in 2019 towards holistic development and management of Indian fisheries. The aim of blue revolution scheme is to increase the fish production and productivity by 8 percent annual growth rate and to reach 15 million tons mark by 2020. The progresses in key areas of inland and marine fisheries along with issues of sustainability are discussed in this presentation.



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## DEVELOPMENT OF CULTURE BASED MARINE FISHERY: AN IMMINENT NEED TO THE PROGRESS OF INDIAN ECONOMY

**Ramalingam Kirubakaran**  
Retd. Scientist-G & Head  
Marine Biotechnology Group  
National Institute of Ocean Technology  
(Ministry of Earth Sciences, Government of India)  
Pallikaranai 600100, CHENNAI 600100  
E-mail id: [kirubagar@gmail.com](mailto:kirubagar@gmail.com)

Aquaculture is one of the fast growing sectors of Indian economy demonstrating a faster growth rate of 7% in the past 5 years. Among various agricultural products, fishery products pre dominantly touched to an appreciable amount of Rs. 48,000 crore in the fiscal year of 2018-19. In spite of meeting present nutritional requirements and food security of the nation, it also currently alleviates problem of employment of over 14.5 million people either directly or indirectly. While we claim proudly as the second largest fish producer of the world, it should also be noticed that 50% of production is achieved through culture based methods using inland water bodies. Meanwhile we should remember that our vast marine water area covering coastline of over 7500 KM and Exclusive Economic Zone of approximately 2.172 million sq. km. remains underutilized. Although capture based marine fishery is challenged with major issues, like impact of climate change on marine biodiversity, restriction of fishing activity of our fisherfolk during frequent cyclonic weather conditions, legislative regulation of fishing along east and west coasts, development of mariculture sector through culture based technologies still remains as a viable and imminent option to enhance Indian economy at present. In this regard, culture based production through coastal and offshore cages; deployment of artificial reef, emplacement of artificial reef, etc. should be explored in near future immediately.



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## **P450 AROMATASE AS A BIOMARKER FOR ENDOCRINE DISRUPTION IN THE CATFISH *HETEROPNEUSTES FOSSILIS***

**Radha Chaube**

Department of Zoology, Institute of Science, Banaras Hindu University, Varanasi -221005

Estrogens are female hormone essential for the normal sexual development and maintenance of the female secondary sexual characteristics. Estrogens are C-18 steroids which are formed by aromatization of C-19 androgens catalyzed by an aromatase enzyme complex comprising a nicotinamide adenine nucleotide phosphate (NADP)- dependent cytochrome P450 reductase and monooxygenase cytochrome P450 aromatase (P<sub>450</sub> aromatase). In tetrapods, including human and cartilaginous fishes, there is a single gene that codes for P<sub>450</sub>arom. In contrast to tetrapods most teleosts have two P450 aromatase genes (*cyp19a1a* and *cyp19a1b*) which are preferentially expressed in ovary and brain, respectively. In the catfish *Heteropneustes fossilis* we have cloned and characterized two forms of aromatase, the brain type (*cyp19a1b*) and ovarian type (*cyp19a1a*). Recently, it has been shown that many chemicals in the aquatic environment are responsible for altering the expression of aromatase under both *in vitro* and *in vivo* conditions. In teleosts, brain aromatase activity is up to 1000 times that in mammals, fish may be especially susceptible to negative effects from environmental endocrine disrupting chemicals (EDCs) that impact aromatase activity. In the present talk, my focus will be on the impact of various pollutants (heavy metals, alkyphenols, chlorophenols) on the expression pattern of aromatase gene in the brain and ovary of *H. fossilis*.



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## AQUACULTURE IN NE INDIA WITH SPECIAL REFERENCE TO ASSAM, PRESENT STATUS, CHALLENGES AND WAY FORWARD

**Bibha Chetia Borah**

Principal Scientist & Centre In charge  
Fisheries Research Centre, Assam Agricultural University,  
Jorhat-785013, Assam, India  
Email id: [drbchetia@yahoo.com](mailto:drbchetia@yahoo.com)

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The North East Region of India, comprised of eight land locked states viz. Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim covers a total of 2.62 lakh sq.km area that accounts for 7.97% of total land area of the country and inhabited by around 4% of the country's population (as per Census 2011). With 90-100% fish eating population in component states, there is substantial demand for fish in the region in both fresh and processed form. In addition to demand, the region possesses unique potential in terms of resource availability and fish biodiversity (422 species, 62.81%, of the country's total) for developing aquaculture as a major sector for economic growth. Although there is steady growth in the sector, several inherent factors including annual devastating flood, heavy rainfall, low pH of soil and water, low temperature during winter etc. have been debarring the region from harnessing the full potentiality. This paper discusses the major challenges faced including the climate change related impact and the way forward encompassing the technological intervention while addressing the specific environmental issues and available resource mobilization to revamp the aquaculture sector as one of the major contributors to the socio economy of the region.



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## XENOBIOTICS: THREATS TO FISH HEALTH

**Banalata Mohanty**

Department of Zoology, University of Allahabad, Prayagraj

Email id: [banalata.mohanty@gmail.com](mailto:banalata.mohanty@gmail.com)

There is growing acknowledgement of adverse effects of low level exposure of the environmental chemicals, otherwise termed as xenobiotics on human health as well as on health of wild life. Xenobiotics are the chemicals of the natural world and/or synthesized in the laboratories/factories interfere with the biological signaling system. Some xenobiotics interfere with the hormones/hormonal signals that resulted in disruption of endocrine functions and are known as endocrine disrupting chemicals (EDCs). The research on toxicological evaluation of EDC has burgeoned during the last decades. The research outcomes on adverse effects of EDCs at low exposure levels are profoundly challenging to traditional toxicological risk assessment which mostly concentrated on lethal consequences of high-dose exposure. Aquatic species are more vulnerable to exposure of various toxic agents including heavy metals in their environment. Many industries discharge chromium to the aquatic bodies along with effluents making the fish susceptible to their exposure. Our studies were focussed on exploring the endocrine disrupting potential of hexavalent chromium on fish. Our studies have demonstrated that environmentally realistic exposure to hexavalent chromium can compromise general health of the fish to affect behaviour, stress homeostasis by interrupting the hypothalamic-interrenal axis as well as can affect the reproductive efficiency of fish by impairing pituitary-gonadal axis. Immediate effect on the survival of fish though not reflected, persistence low level exposure to this heavy metal may have hazardous impact on fish population. Fish being one of major protein diet for human beings, the human health is no doubt at risk on consumption of such fish.



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## MONOGENEAN PARASITES OF FRESH WATER FISHES IN INDIA: A REVIEW

**Hridaya Shanker Singh**

Department of Zoology

C. C. Singh University Meerut (U.P.), 250004, India

Studies about biodiversity of helminthes (excluding Monogeneans) in India were started from the middle of 20<sup>th</sup> century by helminthologists who came to this country on medical or military deputation from foreign lands. As regard biodiversity studies related to Indian Monogeneans is concerned, it also started w.e.f., 1940s by workers like - Chauhan, Thapar, Jain, Unnithan, Gupta (SP), Gupta (NK), Agarwal (GP), Ramalingam, Tripathi, Gussev etc. Recently, Pandey and Agrawal compiled a comprehensive account of known species of Monogeneans from India which is estimated to be about 300, which is far from complete. Indian subcontinent is blessed with five major river systems of India viz., Ganga, Brahmaputra, Indus, East coast and West coast river systems. These rivers are long and are further fed strengthened by many large and important tributaries. Moreover, many small seasonal and perennial rivers also use to contribute to these river systems separately. The investigator is actively engaged in the study of freshwater monogeneans since 1980. The present study reveals that about 35.45% fishes have so far been investigated for monogenean infection in general and still 74% are remaining that are not screened. Helminth parasites, particularly monogeneans leads greater losses on account of having direct life cycle, which can be completed easily in a closed system of fish culture. If we stick to one host one parasite rule, there exists a very big gap as far as state of our knowledge related to biodiversity of freshwater monogeneans are concerned. It is clear from the present review that much remains to be done about this group within India with newer tools including molecular studies.



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## ASSESSMENT OF GENETIC VARIABILITY, SPECIES DELINEATION AND PHYLOGENETIC KINSHIP OF FOUR CHANNID SPECIES OF INDIAN SUBCONTINENT

**Iqbal Parwez\*, Mustafa. A. Kamal, Arif Ahmad and Subuhi Abidi**

Department of Zoology, Aligarh Muslim University, Aligarh 202 002, India

\*Currently at Baba Ghulam Shah Badshah University, Rajouri 185234 (J&K)

Email id: [iparwez2002@gmail.com](mailto:iparwez2002@gmail.com)

The declining population of fish species which has been the area of great concern amongst the fishery scientists has necessitated evolving robust conservation strategies which include all the measures necessary for checking and reversing this declining trend. A comprehensive remedial plan to check this alarming decline in biodiversity is the need of hour. These strategies ensure sustainability and diversity of species which also help to improve the likelihood of maintaining minimal viable populations of rare and endangered species. One of the mega biodiversity zones, Indian subcontinent abounds with nearly 2500 fish species and some of which are showing an alarming decline. Snakehead Channid fishes distributed in Asian and African countries are represented by 30 species of which 27 are confined to Asian countries, 10 in Indian subcontinent and 4 ubiquitously distributed all across the country which are *C. punctatus*, *C. gachua*, *C. marulius* and *C. striatus*. The fish constitute an important component of capture and culture fishery of India and are showing a steady decline in their wild population. Molecular characterizations of these four Channid species to uncover inter- and intraspecies genetic diversity, their phylogenetic relationship and identification of unique species specific molecular marker(s) by RAPD Fingerprinting have been undertaken. Primers from OPA and OPB Kits were used to obtain the RAPD band profile of each species. Twelve primers gave fairly good amplification and reproducible band profile. Some selected primers generated species specific band for one, two or three species. However, OPA 12 was the only primer that clearly delineated all the four species in the same gel by generating characteristic species specific band and species specific profile. The genetic similarity (GS) values for most of the primers ranged between 0.83 to 1.0. The maximum and minimum values of Shannon's Information index (I) is 0.344 and 0.115 for *C. punctatus* by primer OPA 4 and OPB 12 respectively. The polymorphic band contents of different species with selected primers showed a wide range from 14.2 % with OPA 20 for *C. striatus* to 57.1% with OPA 19 for *C. punctatus*. The above data clearly suggested that *C. punctatus* showed the highest degree of genetic variability and *C. marulius* the minimum which also corresponded to recorded decline index of these two species. Based on the above baseline data, the effective strategies for the conservation of these species will be devised.



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## INLAND OPEN WATER FISHERIES AND CLIMATE: VULNERABILITY AND ADAPTATION OPTIONS

**U.K. Sarkar, A. P. Sharma, M. Naskar, G. Karnataka, K. D. Joshi and M.K. Das**

ICAR-Central Inland Fisheries Research Institute

Barrackpore, Kolkata 700120,

Email id: [usarkar1@rediffmail.com](mailto:usarkar1@rediffmail.com)

Climate change is recognized as one of the major environmental challenges affecting ecosystems, societies and economies worldwide. Nearly 700 million rural people in India directly depend on climate sensitive sectors like agriculture and fisheries and natural resources for their subsistence and livelihoods. The multiple benefits that inland fisheries and aquaculture provide for food security and poverty alleviation are presently threatened by climate change. Climate variability in India manifested by sea level rise, increased incidence of flood, drought, tropical cyclones, erratic rainfall and increasing water stress will impact the eco system goods and services derived from inland water bodies. The impacts are already evident in India as manifested by altered geographic distribution, breeding period, biodiversity and physiological behaviour of inland fishes. It is therefore imperative to think of the vulnerability and adaptation strategies of the sector in dealing with the impacts of climate variability. While the inland fisheries sector cannot do much to mitigate climate change, it could contribute to reduce the impact by following effective adaptation measures based on the vulnerability assessments. The primary challenge therefore, of the fisheries and aquaculture sector in the context of climate change is sufficient to ensure food supply with nutritional, improve livelihood options and ensure ecosystem safety. Addressing these concerns require evolving an adaptive mechanism and implementing it across all stake holders of inland fisheries at the state and national level. ICAR-CIFRI's research in the area has developed a frame work for assessing the vulnerability of the inland fisheries sector to climate change. Different adaptive options in response to flood, drought, cyclones, erratic rainfall and water stress has been evolved for climate resilient and sustainable fisheries. However, it is important to understand that climate change adaptation in the inland fisheries sector has to be considered in the broader context of other environmental and social changes. There is therefore a need for integrated assessment of different changes impacting water resources and environment at multiple scales instead of focusing merely on climate change. Future research need to focus on i) improving the vulnerability assessment methods and developing vulnerability maps for the inland fisheries sector in India ii)develop adaptation options for inland fisheries which can be upgraded as new knowledge emerges iii)improve education and communication within the inland fisheries industry and with other stake holders about climate change and adaptation policies iv)building up the adaptive capacity of people at local level in India through livelihood diversification.



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## ZEBRAFISH AS A MODEL SYSTEM FOR DISEASE BIOLOGY AND DRUG DISCOVERY

**Dibyendu Banerjee\* and Khushboo Sinha**

Division of Cancer Biology and Molecular & Structural Biology,  
CSIR-Central Drug Research Institute, Sector 10, Janakipuram Extension, Sitapur Road, Lucknow-  
226031, UP, India

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Zebrafish is a widely used model system to study human physiology and human diseases. There are marked similarities in morphogenesis between human and zebrafish embryonic development. Therefore, it is a very good model system to study the development of the human embryo. Genes and gene pathways are highly conserved that control vertebrate embryonic development. In the genome-wide ENU screens, many developmental processes are assayed in the 1- day old zebrafish embryo. Mutations affecting blood cell development, coloration patterning, head/tail axis formation and vascular patterning can be studied easily. Zebrafish produces 100-200 offspring per week. Their bodies are transparent and ideal for imaging studies. Robust transgenic technology is available and the model is prone to spontaneous and chemically induced tumors and therefore a good model for cancer biology. Strengths of the Zebrafish Model for Cancer Research include the newly developed CRISPRcas9 genome editing technology. High-throughput *in vivo* small molecule screens based on phenotype make the zebrafish model a very useful tool for drug screening.



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## NITRIC OXIDE (NO) AS POTENT STEROIDOGENIC AND FOLLICULOGENIC FACTOR IN FISH

**Bechan Lal and Vinay Kumar Singh**

Department of Zoology, Fish Endocrinology Laboratory, Institute of Science,  
Banaras Hindu University, Varanasi, India

Nitric oxide is well known gaseous signaling molecule affecting varieties of physiology including reproduction in vertebrates. Further, development of induced breeding technique has certainly augmented the fish production by providing huge amount of good quality of fish seed. The hormonal preparation used in this technique takes-care of terminal events of reproduction in gravid fishes. However, attempts are still on for the search of some formulation to produce gravid brood fishes with high fecundity. The present study was undertaken with the aim to examine for potentiality of nitric oxide as potent gonado-stimulatory, as some of our earlier studies had pointed its potentiality. For this, a NO donor, sodium nitroprusside (SNP) and NOS inhibitor, N-nitro-L-arginine methyl ester (L-NAME) were injected during the two reproductive phases of reproductive cycle of the *Clarias batrachus*. During the late-quiescence phase, high dose of L-NAME lowered the levels of NO, testosterone, 17 $\beta$ -estradiol and vitellogenin in serum & ovary and activities of 5-ene-3 $\beta$ -hydroxysteroid dehydrogenases and 17 $\beta$ -hydroxysteroid dehydrogenases in the ovary, whereas higher dose of SNP increased these parameters. L-NAME also decreased oocytes-I but increased perinucleolar oocytes in the ovary, while SNP raised the number of advanced oocytes (oocytes-I and II) than the perinucleolar oocytes as compared to the control ovary. During the mid-recrudescence phase, both doses of SNP increased NO, testosterone, 17 $\beta$ -estradiol and vitellogenin levels in serum and ovary; however, L-NAME decreased their contents. The activities of ovarian 3 $\beta$ -HSD and 17 $\beta$ -HSD were also augmented by the SNP. However, L-NAME suppressed their activities. The SNP-treated ovaries were populated by secondary and tertiary stage oocytes, while L-NAME-treated ovary exhibited more perinucleolar oocytes and oocytes-I and rare advanced oocytes. Expression of endothelial NOS (eNOS), inducible NOS (iNOS) and neuronal NOS (nNOS) was augmented by the SNP and declined by L-NAME treatments when compared with the control group. The study, thus, provides distinct evidence of NO-stimulated steroidogenesis, vitellogenesis and folliculogenesis in fish and thereby as a potent candidate to help producing gravid fishes.



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## FROGS PREY OR PREDATORS IN A POND ECOSYSTEM: AN IGNORED BUT IMPORTANT ISSUE FOR COMMERCIAL FISH PONDS

**Krishan Kumar Sharma**

Former Vice Chancellor, Maharshi Dayanand Saraswati University, Ajmer-305023, Rajasthan

[kksmds@gmail.com](mailto:kksmds@gmail.com)

Fish Farming is an age old activity and in practice from ancient times. The concept of composite fish culture was developed by ICAR in late seventies under a coordinated composite fish culture project. This comprises the culture of 3 indigenous species of fish viz. rohu, catla and mrigal and 3 exotic fish i.e silver carp, grass carp and common carp, keeping in view their different food habit and habitat. This practice has been very well accepted by many farmers in India for pond fisheries. Ponds provide an excellent habitat for many aquatic plants and animals. The successful fish culture requires many basic practices such as ploughing of pond, addition of manure, stocking of fish seed etc. but eradication of unwanted aquatic plants and animals is equally important. Frogs and toads (anurans) breed during monsoon and spawn can be observed during this season. Tadpoles hatch out of eggs within 72 hours in most cases and many fish ponds are full of various developmental stages of these anurans. Commercial fish ponds provide suitable habitat, excellent breeding conditions and abundant food for most anuran species. Most tadpoles complete metamorphosis within a month but in species like skipper frogs (*Euphlyctis cyanophlyctis*) may remain tadpoles as a result of over wintering. There is always competition between tadpoles and fishes particularly during early stages of development. Often adult frogs and large size tadpoles eat fish seed and fingerlings in a rearing pond. There are also reports about larger size fish feeding on tadpoles and spawns. Not only adult frogs but tadpoles are often problematic for producers of small fish, such as bait and ornamental species. Many farmers are reporting to their respective Government fisheries Departments that their commercial fish ponds are facing serious threats from frogs and toads. Frog traps near light source at night and fencing around fingerling rearing ponds may protect fingerling rearing ponds from predation by frogs.



## RELEVANCE OF FISH IN THE STUDY OF ENVIRONMENTAL GENOMICS

**Sunil P. Trivedi**

Environmental Toxicology & Bioremediation Laboratory (ETBL),  
Department of Zoology, University of Lucknow, Lucknow-226007.

Email: [trivedi\\_sp@lkouniv.ac.in](mailto:trivedi_sp@lkouniv.ac.in); [sat060523@gmail.com](mailto:sat060523@gmail.com)

Habitat specific Environmental Management Plans (EMPs) are now becoming the need of the hour. For habitat restoration and their conservation regular environmental monitoring is routinely employed. Instead of routine physico-chemical monitoring of polluted aquatic habitats, bio-monitoring through sentinel organisms may be useful in pin pointing the source, effect and fate of the pollutants. Monitoring of stressed aquatic habitats with molecular biomarkers gives more insight with precision and elaboration. In fact, sentinel organisms like fishes are worst hit against environmental toxicants. These xenobiotics generate free radicals/ Reactive Oxygen Species (ROS) in fishes and thus subject them to oxidative stress. This stress can be precisely measured by the estimation of activities of antioxidants, *viz* SOD, CAT (Superoxide dismutase, Catalase) etc. However, long prevalence of oxidative stress results in physiological, biochemical, cellular and molecular disturbances. This becomes responsible for genotoxicity. Some of the most widely applied and validated methods in assessment of genotoxicity in fishes include, CAT or Chromosomal aberration test as cytotoxic end markers, MNT or Micronucleus test as an index for chromosomal damage, Single cell gel electrophoresis (SCGE) or Comet assay for detecting alteration in DNA organization, activities of oxidative stress marker enzymes, SOD, CAT, and GR etc. for assessment of extent of Reactive Oxygen species (ROS) and expression and quantification of certain marker genes, *viz*, *p53* for DNA damage and repair, *bax*, *bcl2*, *apaf1*, *casp3* for apoptosis or programmed cell death, *nox*, *gsr*, *sod*, and *cat* for assessment of oxidative stress against toxicants. Fish are relevant enough for studying organism-environment interface in aquatic regimes. Further, on account of their wide geographical distribution, trophic position, lifestyles, speciation, well resolved and broadly accepted evolutionary history, possession of a consistent number of chromosomes in most species, broad genome sizes varying between 0.32 and 133 billion base pairs and inhabitation in widely different habitats, fish represent the organisms of choice for environmental genomics.



### ENDOCRINE REGULATION OF OBESITY IN ZEBRAFISH

**Sathyamoorthy S & Rohit Seth**

Department of Zoology

Guru Ghasidas Vishwavidyalaya

Bilaspur (CG) 495009

Obesity has emerged as a worldwide epidemic and according to the World Health Organization, an estimated 310 million people worldwide are obese; there is a strong association between obesity and various adverse health consequences, including atherosclerosis, hypertension, type 2 diabetes and certain types of cancer. As vertebrates, zebrafish possess many structural similarities with humans and have been used to model various human diseases and may serve as a good model for research on the normal and dysfunctional regulation of appetite. In search of major food intake regulating factors that have been linked to abnormal feeding behavior in mammals we are investigating neural and endocrine signals regulating food intake in zebrafish.

Zebrafish have two isoforms of adiponectin (adiponectin A, 45% aa identity with human adiponectin, mainly expressed in kidney, and adiponectin B, 65% aa identity with human adiponectin, mainly expressed in liver and brain). Adiponectin B liver expression decreases following fasting (Nishio *et al.*, 2008), suggesting that adiponectin has a role in the regulation of metabolism in zebrafish. Our work in rodents suggested that amylin (AMN) in combination with leptin (LEP) can lower the blood pressure and obesity in rats (Seth *et al.*, 2011, 2012). The clinical studies with amylin agonists have shown that they could also be useful for weight loss (Boyle *et al.*, 2017). Amylin is suggested to be involved in the regulation of food intake in fish. Similarly, AgRP: Agouti-related peptide; CART: cocaine- and amphetamine-regulated transcript; CCK: cholecystokinin; GLP: glucagon-like peptide; NPY: neuropeptide Y; POMC: proopiomelanocortin; PYY: peptide YY are found to be regulating food intake in the zebrafish. Westermarck *et al.*, 2002, presented a report in which it is suggested that all these peptides encode a protein precursor with around 45% aa similarity with the human protein. Presenting all these evidences justify the use of zebrafish as a model of obesity. LEP mediated regulation of food intake gets messed up in obese individuals who develop a condition termed as LEP resistance. In a recently published work we reported that one possibility to augment LEP responsiveness is co-administration of LEP with amylin (AMN). AMN is a 37 amino-acid peptide co-secreted with insulin. AMN acts by binding to area postrema in hind brain. Binding of AMN increases cGMP formation in area postrema and subfornical organ. This cGMP acts as an excitatory second messenger in the area postrema and appears to be critical for AMN induced anorexia. The weight loss induced by AMN+LEP treatment preserves the lean mass associated with increased proopiomelanocortin (POMC) gene expression in the arcuate nucleus (ARC) and is not accompanied by a compensatory decline in metabolic rate. Although, AMN+LEP combination treatment resulted in a chronic negative energy balance, it prevented the compensatory decline in metabolic rate and fat oxidation that was evident with paired rats. We are creating a diet induced obese model in Zebrafish and will study the potential mechanisms affecting LEP resistance. In future we plan on studying in details responses of both the hunger and satiety centers controlling food intake in zebrafish.



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## ACCUMULATION XENOBIOTICS AND HEAVY METALS IN THE RIVERINE SYSTEM: EVALUATION OF THEIR IMPACT ON FISH SPECIES

**Bechan Sharma**

Department of Biochemistry, University of Allahabad, Allahabad 211002, UP, India;

Email: sharmabi@yahoo.com

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Sangam is a place containing union of two giant rivers Ganges and Yamuna in Allahabad. These rivers have been receiving both the domestic and the industrial effluents in India since long. The present paper deals with the chemical analysis of riverine water, sediment and muscles of two fish species procured from different catchment areas of these rivers to estimate the presence and accumulation of heavy metals (Cu, Cr, Cd, Pb, Zn) and organochlorine pesticides in the riverine water, sediment, and tissues of two cat fish species, *Channa punctatus* (*C. punctatus*) and *Clarias batrachus*. The results indicated highest content of Zn followed by other metals tested in water; Cd being the minimum. Almost similar trend was observed in the sediment as well as the tissues of the fish species. The pesticides (DDT and DDD) residues were found to be present maximally in sediment followed by fish tissues and water. The impact of carbofuran, an organocarbamate pesticide, was also evaluated on the levels of certain biomolecular indices in the rat and results indicated significant alterations from the control values.. The presence of heavy metals and the pesticide residues in water, sediment and the fish tissues suggested the need to devise strategies to stop mixing of these chemicals in the water of Yamuna and Ganges so as to avoid prospective health hazards to users of water from these rivers in and around Sangam areas.

### NMR BASED PRECLINICAL METABOLOMICS FOR RAPID SCREENING OF THERAPEUTIC EFFICACY AND SAFETY

Dinesh Kumar\*

Centre of Biomedical Research (CBMR), SGPGIMS, Lucknow-226014, dineshcbmr@gmail.com

It is important to assess the chronic or short term effects of pharmaceutical products before recommending their use in clinical settings for disease management. Metabonomics is an analytical approach to metabolism and involves quantitative and comparative analysis of low-molecular-weight metabolites in body fluids or cellular/tissues extracts. Owing to its ability to reveal disease-specific metabolic

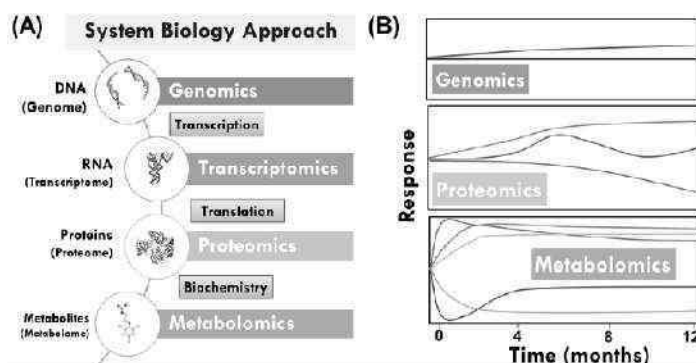


Fig. (A) Schematic depiction of system biology approach showing metabolomics is an “omics” technique that is situated downstream of genomics, transcriptomics, and proteomics. (B) The response time of different biological parameters altering under a pathophysiological condition.

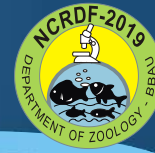
patterns or metabolic changes produced in response to a therapeutic intervention; it is gaining widespread applications virtually in all aspects of biomedical and pharmaceutical research including preclinical/clinical trials for evaluating therapeutic efficacy/safety of promising drug candidates either alone or in conjunction with other omics tools such as genomics, transcriptomics and proteomics. Pre-clinical metabolomics studies are typically performed on biofluids (such as urine, blood plasma/serum and tissue extracts) obtained from normal, diseased and treated animal (mainly rat/mice) models of particular disease or toxicity and at the end of treatment period. The metabolic profiling capabilities of nuclear magnetic resonance (NMR) spectroscopy with pattern recognition methods have successfully been applied for identifying diagnostic panel of biomarkers, evaluating drug efficacy/safety, screening toxicity and disease mechanism. Particularly, the interest in applying NMR-based metabolomics for the assessment of therapeutic efficacy and safety is increasing among drug researchers and drug regulators owing to its non-destructive, non-selective and minimal sample preparation requirement.



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## TOXICITY ANALYSIS OF THE COAL WASHERY EFFLUENT USING FISH BIOASSAY

**Huma Vaseem, V. K Singh, M.P. Singh**

\*Department of Zoology, Aligarh Muslim University, India

@Centre of Biotechnology, University of Allahabad, India

#C.M.P College, University of Allahabad, India

In India, coal is the major source of energy. Due to its easy availability and low price, the use of coal has increased several folds. Mining, washing and processing of coals generate huge amount of chemicals and dust which cause environmental pollution. During washing and processing of coal, large amount of coal washery effluents (CWE) is produced from washery plants which contain suspended particles, different chemicals, detergents and many toxic metals. CWE is released directly into the different water bodies including rivers which cause serious water pollution. Besides, creating environmental damage these pollutants also affects the health of water biota. This study is subjected to evaluate the toxicity of coal washery effluent (CWE) and its impact on aquatic organisms. The CWE was collected from coal washery of the BCCL (Bharat coking coal limited), Jharkhand, India. Different physicochemical parameters (BOD, dissolved CO<sub>2</sub>, total solids, total dissolved solids, hardness, acidity, turbidity and others) of the effluent were analysed using the methods of APHA (1998). Concentration of different metals (Pb, Cd, Ni, Mg, Zn, As, Al, Fe, and Cu) were also estimated in effluent sample using ICP-MS (Inductively Coupled Plasma Mass Spectrometry). All the above mentioned physicochemical parameters and concentration of different metals in the effluent were found to be much above than their safe limits (EPA 2003) making the effluent very toxic. To evaluate the effect of CWE on aquatic organisms, fish *Channa punctatus* was exposed to CWE. Different stress markers like metal accumulation, metallothionein concentration, activity of antioxidant enzymes like SOD, catalase, GSH, GPX, Lipid peroxidation were measured in the gill and liver of CWE exposed fish. Level of estrogen, testosterone and NO was also evaluated and significant alterations were observed in these parameters due to toxic effect of CWE. Structural changes in histological sections of liver and gill were also noticed in fish exposed to CWE. Hence this study showed altering effects of CWE on the fish physiology.



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## PHOTOPERIOD ALTERS REPRODUCTIVE RESPONSES OF ZEBRAFISH, *DANIO RERIO*

Suneeta Yadav\* and Maya Yadav#

\*Central University of Jharkhand

#Dr. S.P.M. Govt Degree College Bhadohi

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Zebrafish (*Danio rerio*) is a good model for research work as its maintenance is easy and cost effective and also its reproductive rate is very high. Moreover, it is vertebrate model and human is also vertebrate. Studies in many fields including rhythm research and chronobiology are successful and put significant results. Reports regarding light duration and light dark cycle are very rare. Earlier results show that it has more active in constant light compare to constant dark. But study of reproduction in response to different light durations is not yet reported. So, I planned to study reproductive behaviour with respect to different light durations. For the study, Zebrafish were divided into four groups each having 8 animals- LL (exposed to 24 hr light continuously), LD 16:8 (exposed to 16 hr light in 24 hr), LD 12:12 (exposed to 12 hr light in 24 hr ) and DD (exposed to 0 hr light continuously i.e. 24 hr dark). Results shows that the groups receiving 24 hr and 16 hr light were more active both physically and reproductively compare to 12 hr group. On the other hand DD group is less active that 12 hr group. The findings indicate that light durations may alter reproductive responses and behaviour in Zebrafish. The present study is innovative and need more extensive study regarding different parameters.



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## STATUS OF AQUATIC BIODIVERSITY IN BANGLADESH

**Binay Kumar Chakraborty**

Researcher and Consultant

Visiting Professor, Bangladesh Agricultural University

Former Project Director, Department of Fisheries, Bangladesh

Data and information sources are used from the direct interview with individual, publication of the Department of Fisheries (DoF) and related non-published grey literature. The country has an inland water area of about 45,000 km<sup>2</sup> and about 710 km long coastal belt. Fisheries sector contributes 3.57% to the national GDP, 25.30% to the agricultural GDP and more than 2.0% to the total export earnings. The total production was 4.277 m.mt fish in 2017-2018 whereas inland open water (capture) contributes 28.45% and inland closed water (culture) contributes 56.24% to total production. Overall growth rate of total production in 2017-18 is 3.44%. This sector is contributing significantly in food security through providing safe and quality animal protein; about 60% animal protein in daily dietary requirement comes from fish. About 11% of total population is engaged with this sector on full and part time basis for their livelihoods. Bangladesh is blessed with huge open water resources with a wide range of enriched aquatic diversity, comprising almost 260 freshwater fish species and other aquatic lives. But due to decline and degradation of wetland resources, the stock of inland capture fisheries has been reduced remarkably. In recent years, the fisheries sector is faced with challenges posed by numerous natural and anthropogenic causes such as climate change, natural disaster, environmental pollution, industrialization, overfishing, using destructive fishing gears, pesticide and agrochemicals. As a result, commercial important 07 species were Extinct, 16 species were critically endangered, 31 species were endangered, 48 species were vulnerable status, 67 species of fish assessed as lower risk, 91 species as not threatened position from biodiversity view point. For the development of biodiversity, healthy ecosystem and safety food, improved biological management technology of fish sanctuary, beel nursery, fingerlings stocking, fish habitat rehabilitation, breeding ground conservation and pen culture, and Fish Regulation Act-1950 and jatka conservation for *Hilsha* production is to be developed to restrict the decline of resources and enhance production and number of population.



### SPAWNING PERIODICITY OF NILE TILAPIA, *OREOCHROMIS NILOTICUS* (LINNAEUS, 1758) INHABITING A LAKE IN BANGALORE

**Shubha, M. and S. Ravichandra Reddy\***

Department of Zoology, BMS College for Women, Basavanagudi, Bangalore 560004

\*Professor of Fishery (Retd.), Department of Zoology, Bangalore University,  
Bangalore 560056

Corresponding author: [shubhabhat21@gmail.com](mailto:shubhabhat21@gmail.com)

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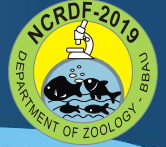
Unauthorized introduction of African Cichlid *O. niloticus* into India has occurred in late 1970s. Since then, it has been found to inhabit rivers, reservoirs and lakes. Although majority of tilapia production systems in African are pond based, considering its success the fish farmers in Bangalore have introduced *O. niloticus* in the Lakes. *O. niloticus* has not only become the dominant species, but also has harmed the diversity of native fish fauna. This paper provides information on spawning periodicity of *O. niloticus* inhabiting Hebbal Lake, Bangalore. Sampling of *O. niloticus* was carried out in the lake every month successfully for twelve months. Fish of various sizes were selected randomly from the catch. Over 360 females ranging in size from 7.5cm to 40.5cm (TL) were examined. Fishes were excised and size at first maturity was determined. Fecundity of the species was established by counting of eggs. GSI was also calculated. Length at first maturity in females averaged 11.6 cm while in males it was 13.1 cm suggesting females mature in smaller size than males. Fecundity ranged from 845 to 7543 eggs/female. Mean GSI values varied significantly among different months (ANOVA,  $p < 0.001$ ). Peaks of GSI values were observed during February, March, July, August and September which means females can breed more than once in an annual cycle. The occurrence of high percentage (> 40%) of mature (phase III) and ripe individuals (phase IV) in February, March, July, August and September suggests that these months represent the peak reproductive period of fish. Mouth brooding in fish ensured greater survival and eggs to attain juvenile stage. These reproductive characteristics of the species may have competitive advantage over native species.



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## TWO NEW SPECIES OF THE TREMATODE PARASITE OF THE GENUS, *BUCEPHALOPSIS* (DIESING, 1855) NICOLL, 1914 FROM FRESHWATER FISHES OF VARANASI, INDIA

Sabhyata, Pankaj Tandon, M.K. Sinha and Shashi Prabha Agrawal

Department of Zoology, D.A.V. College, Kanpur

Email: [dr.sabhyatasingh@gmail.com](mailto:dr.sabhyatasingh@gmail.com)

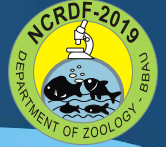
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During extensive survey for the study of trematode parasites of freshwater fishes of Varanasi, eight specimens of bucephalid worms were recovered from the intestine of two species of fishes. Fishes were obtained from river Ganga and Varuna at Varanasi in the month of March. Both trematode parasites belong to the genus *Bucephalopsis*. Four specimens of the *Bucephalopsisguptai* sp. nov. were collected from a freshwater fish, *Eutropichthyesvacha* (Ham.) having elongate body and sucker like rhynchus and absence of receptaculumseminis. Another new parasite species is *Bucephalopsisvinodae*. Also four specimens of this form were collected from the intestine of a freshwater fish, *Silundiaganetica* (Ham.) and it is having elongate and slender body, extension of uterus not beyond the ovary, testis and ovary in the middle third of the body. Presence of uterine coils in between the testis, having smooth body and the position of intestine above the ovary partly overlapping it and longer cirrus sac in relation to body length.



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## A NEW TREMATODE *HAPLORCHOIDES JAIRAJPURII* SP. NOV. FROM A FRESH WATER FISH, *CLUPISOMA GARUA* (HAM.) FROM VARANASI, INDIA.

**Sabhyata, Pankaj Tandon and M.K. Sinha**

Department of Zoology, D.A-V. College, Kanpur

Email : [dr.sabhyatasingh@gmail.com](mailto:dr.sabhyatasingh@gmail.com)

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Present paper reports a new species of trematode parasite from a freshwater fish, *Clupisomagarua* (Ham.) obtained from Chaukaghat fish market at Varanasi. The present species can be distinguished by the presence of oesophagus, posterior extension of caeca, nonconfluent nature and anterior commencement of vitelline follicles and posterior extension of vesiculaseminalis from other known species. The present form belongs to the genus, *Haplorchoides*, Chen, 1949. The new species *Haplorchoides jairajpurii* differs from all the known species of this genus except in having inter caecal ventrogenital sac from *H. takree*, *H. macronis*, *H. brahmputrensis*, *H. seenghali*, *H. pearsoni*, *H. mehrai*, *H. kherai*, *H. srivastavai*, *H. rajghatii*, *H. hardayali*, *H. mystusi*, and *H. dayali*. *Haplorchoides jairajpurii* sp. nov. also differs from *H. piscicola*, *H. gomtiensis*, *H. macronis* in having receptaculumlatero-dorsal to ovary instead of either anterior or posterior to it, from *H. silundi* and *H. ritai* in the posterior extension of vitelline follicles a little behind the testis, from *H. attenuatum* in the commencement of vitelline follicles from the posterior level of vesiculaseminalis instead of hind end of receptaculumseminis and from *H. gangeticus* in the presence of oesophagus and posterior extension of caeca anterior to posterior level of testis.



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## ROLE OF THYROID HORMONE IN IMMUNOMODULATION OF CELLS OF SPLEEN AND HEAD KIDNEY IN FRESHWATER TELEOST, *CHANNA PUNCTATUS*

Shaily Gupta and Manish Kumar Tripathi\*

Department of Zoology, School of Life Sciences, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, India

\* Corresponding author mail [manish10aug@gmail.com](mailto:manish10aug@gmail.com)

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Thyroid is an important endocrine organ and is the first endocrine gland to develop in the embryo. Thyroid hormone role is known for differentiation, growth and metabolism. However, role of thyroid hormone is scarcely verified in immunity. Aim of current work was to evaluate the effect of exogenous thyroxin on innate and cell mediated immune responses of *Channa punctatus*. Fishes were divided into control and experimental groups and thyroxin injections (5 and 10 $\mu$ g/g body weight for 10 days) were given to experimental fishes. Following the completion of experiment, fishes were mildly anaesthetized and spleen and head kidney were isolated aseptically. Single cell suspension was prepared from each tissue and various immune parameters like macrophage phagocytosis, superoxide production, nitrite release and lymphocyte proliferation were assessed. Thyroxin treatment resulted in increase in macrophage phagocytosis while superoxide production was unchanged. Nitrite release by cells of spleen and head kidney was significantly increased after thyroxin treatment when compared with control animals. Proliferation of lymphocytes from spleen and head kidney was also enhanced and this enhancement was more pronounced when mitogens were used. It was concluded that thyroxin is involved in modulation of some immune responses in *Channa punctatus*.



### **STUDIES ON SPAWNING BEHAVIOR OF INDIAN HILL TROUT (*BARILIUS BENDELISIS*) IN CLOSED RE-CIRCULATORY CAPTIVE AQUARIUM CONDITIONS**

**S.G.S. Zaidi\*, A.K. Pande and A.K. Singh**

Ex. Sr. Scientist (Aquaculture) ICAR- Directorate of Cold water Fisheries Research Bhimtal-  
263136, Uttarakhand

Email id: [sgszaidi@hotmail.com](mailto:sgszaidi@hotmail.com)

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Spawning behaviour, sexual dimorphism, dominance courtship behaviour during spawning time in Indian hill trout (*Barilius bendelisis*) have been studied in a re-circulatory glass aquarium tank. The glass tank was having dimension of 150x80x70cm with water holding capacity of 700 L. The tank was equipped with indigenously designed PVC pipe under-gravel filtration system that was operated by a power head water pump with pumping capacity of 3500 l water per hour. About 12-18 cm thick layer of coarse gravel size 4-6 mm were spread over the pipe filter which acts as a biological filtration medium to eliminate toxic ammonia from the water and trap suspended particles to make crystal clear water condition in closed re-circulatory aquarium. Ten numbers of mature males having length of 110-165 mm; weighting 13.6-18.4 g where 16 female (length 80-122 mm weight 6-12 g) were maintained for breeding purpose. Water temperature were maintained within range of 18-22°C by immersion glass 300 watts thermostat heaters. Brood stock were fed with wet feed containing 30-40% protein 2-3 times a day. Male and female both attained full sexual maturity in closed re-circulatory aquarium condition. During breeding season, sexual dimorphism characters were well developed in male fish. Very prominent breeding tubercles on snout region and numerous elongated spine-like structures called uncini on body scales of male were observed. Tubercles are multi cellular epidermal structures that often support a conical keratin cap. The function of these breeding tubercles is still not clear but it is believed to facilitating contact between individuals during spawning. This is the first observation at ICAR- DCFR Bhimtal that Indian hill trout have nesting behaviour during breeding period. Usually dominant male establish its breeding territories and dig nest pits on the gravel surface to attract females. In the breeding tank, 4-5 numbers of breeding nest pits were observed during breeding season. The



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dominant male shows higher level of aggressive behavior to maintain their territory and breeding nest. Dominant male usually fight when other male approaches towards the nesting pit by quivering and butting against the other rival males during courtship. In this butting, the male bumped the female physically with its forehead. Dominant male usually circles next to a female. Erection of the dorsal fins and the anal fin by the male fish were observed during courtship period. The male frequently vibrates its anal fin and with this act male try to burrow the fertilized eggs deep inside the spawning pit. After spawning is over, parents do not guard their nest thus showing no parental care for their offspring. The aim of the present study revealed that development of prominent breeding tubercles could be related to male dominance with the courtship and mating behavior. Furthermore, females were found to be selective in preferring the dominant males to improve their progeny.



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## OBSERVATIONS ON DEVELOPMENTAL ABNORMALITIES IN EMBRYOS AND HATCHLINGS OF BLACK MAHSEER *NAZIRITOR CHELYNOIDES* (MC CLELLAND)

**S.G.S. Zaidi and A.K. Singh**

Ex. Sr. Scientist (Aquaculture),

ICAR- Directorate of Cold water Fisheries Research Bhimtal-263136, Uttarakhand

Email:sgszaidi@hotmail.com

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A very characteristic suite of developmental defects/abnormalities in developing embryos showing conjoined two heads with single body twins, yolk sac edema, spinal curvature (lordosis or scoliosis) and reduction in the size of hatchlings, and other presumptive abnormalities were observed in a coldwater stream fish Black mahseer *Tor chelionoides*. These abnormalities were found in one of the breeding batches of eggs when they were collected after natural spawning in closed re-circulatory aquarium conditions. Total number of 38 deformed embryos and hatchlings were segregated from the collected batch of eggs. Out of these, three embryos were conjoined twins with two distinguished head and one fused single body that survived for eight days. Similarly we found that six hatchlings were having twisted spinal cord. Some of the hatchlings have abnormal yolk sac and deformities in head and tail region. None of abnormal hatchling was able to survive for more than 10 days. Numbers of environmental factors responsible for inducing deformities in fish embryo or larvae have been considered for future corrections. These abnormalities are considered primarily the impact of environmental variables and also some nutritional deficiency in parent fish. Exact reasons for the occurrence of such abnormalities are being worked out. Such fish teratology characters have been reported in adult specimens of some cold water rivers and streams fishes. Nevertheless, there are no available records of teratology studies on early developmental stages of cold water fishes. These observations suggest some further information on early developmental stages of fish teratology studies.



### FIRST RECORD OF MULTIPLE TIMES NATURAL SPAWNING OF GOLDEN MAHSEER, *TOR PUTITORA* (HAMILTON) WITH SAME BROOD STOCKS IN A CLOSED RE-CIRCULATORY AQUARIUM

***S.G.S. Zaidi\* and A.K. Singh***

Ex. Sr. Scientist (Aquaculture), ICAR- Directorate of Cold water Fisheries Research

Bhimal-263136, Uttarakhand

Email id: [sgszaidi@hotmail.com](mailto:sgszaidi@hotmail.com)

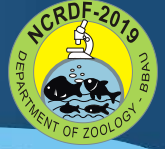
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Golden mahseer, *Tor putitora* (Hamilton) is one of the largest freshwater fish found in the foot hills of Indian Himalayan Rivers. The fish is one of the best sport fish for anglers. Due to indiscriminate fishing its population is continuously decreasing in its natural habitat. This species has been categorized as an 'endangered' species in the IUCN red list. Six numbers of brood stock in ratio of 1:2 (F: M) with average weight of 1200 and 750 g respectively were kept in wall aquarium tank that has dimension of 130x120x95 cm with water holding capacity of about 950 litre. Aquarium tank was equipped with indigenously made perforated PVC pipe under gravel filter that was covered by 15-18 thick sand gravel of 3-5 mm size. Filter was operated by a 3500 l per hour pumping capacity of power head water pump. Water filtration system acts as a biological filtration system to eliminate toxic ammonia from the system and at the same time trapping suspended particles from water thus maintaining crystal clear water in aquarium. Water temperature were maintained within range of 18-22<sup>o</sup>C by immersion glass 300 watts thermostat heaters. Brood stocks were fed with feed containing 30-40% protein and occasionally goat heart liver 2-3 times a day. Male and female both attained full sexual maturity in closed re-circulatory aquarium condition. Mature male develop small tubercles on operculum region and observed in oozing condition throughout the year. First natural spawning was observed on 26<sup>th</sup> February 2017 followed by four successive natural spawning on 8th April, 12 July, 2nd August and 12th November 2017 by same brood stock within one calendar year, without use of any hormone in captive aquarium conditions. This was the first reported observation that Golden mahseer can be able to attain full sexual maturity in a 1000 liter re-circulatory aquarium tank and naturally spawned multiple times within a span of one year. In controlled conditions its breeding period is possible to extend throughout the year. Spawning behavior and breeding habits were closely observed and recorded in camera. During spawning ritual after 2 to 3 hours of chasing by males, female releases eggs inside the deep layer of



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gravel that were simultaneously fertilised by males releasing milt. Fertilized eggs were collected from the aquarium gravel and hatched in indigenously designed floating incubation trays placed in a closed re-circulatory incubation cum hatching glass tank. Hatchlings and fry were raised on wet feed made with simple ingredients of poultry eggs, wheat flour, vegetable oil, mineral mix and binder, properly cooked in microwave oven. Seeds were successfully reared in the aquarium and FRP tanks. Water quality parameters were analyzed and found optimum during the rearing of brood stock, incubation of eggs and rearing of fry. This study was an attempt to help in standardizing a protocol for natural breeding of golden mahseer in controlled conditions. Best management practices of brood stock in controlled condition will certainly help in mass scale seed production which in turn will help in conservation and rehabilitation of the fish.



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## ORGANIZATION OF SENSORY ORGANS IN FLAT FISH (*CYNOGLOSSUS CYNOGLOSSUS*)

**Urbee Banerjee and Samiran Ghosh\***

Department of Zoology

Bethune College, 181, Bidhan Sarani, Kolkata 700006

\*Email id: [itssamiranghosh@gmail.com](mailto:itssamiranghosh@gmail.com)

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Flat fish (*Cynoglossus cynoglossus*) has the most extreme asymmetric body morphology of vertebrates. In many species eyes lie on one side of head by migration during metamorphosis. Protrusible eyes are one of the most adapting features to live in the benthic environment. Other sense organs are olfactory apparatus, inner ear, lateral line, taste bud and electroreceptor organs, also contribute to adapt for lateral life. Asymmetrical shape and lateralized behaviour of flat fish are of source for fascination to study sensory organs, how to adapt lateral life. Histological studies were conducted. Eyes are large and round with a flattened corneal surface and chiefly no eyelids. Olfactory chambers are situated on the ocular side of the head. Three otolith chambers and Cristae ampullaris are distinct. Neuromast comprises the sensory hair cells interspersed with supporting cell, covered by Cupula. Taste buds are found on elevated epidermal hillocks. Electroreceptor organs are innervated numerous spinal neurons. Many fine calibre axons from the electric nerves are observed. For adapting unique mode of life, advancement of sensory organs contributes in the successful passage through evolution.



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## VIRAL HEPATITIS AND FISH: INSIGHT INTO THEIR EVOLUTIONARY LINK AND POSSIBLE SIGNIFICANCE

Milan Surjit

Virology laboratory, Translational Health Science and Technology Institute,  
3<sup>rd</sup> Milestone, Faridabad Gurgaon Expressway, Faridabad -121001, Haryana, India.

Each year, viral hepatitis causes approximately 1.3 million deaths worldwide. The disease is caused by a diverse group of unrelated viruses that include Hepatitis A, Hepatitis B, Hepatitis C, Hepatitis delta and Hepatitis E virus. Infection with Hepatitis B and Hepatitis C viruses predominantly lead to cirrhosis and hepatocellular carcinoma, culminating in death in many cases (~1.25 million deaths annually). Approximately 5% of HBV infected people are also infected with hepatitis delta virus (HDV). Hepatitis A and Hepatitis E infection usually causes acute hepatitis, which may escalate to liver failure and death (~50,000 deaths annually). Some of these viruses also cause epidemic outbreaks, resulting in loss of man-hours and huge economic burden. Therefore, hepatitis viruses are major threats to human health and wealth. Effective control of viral hepatitis is dependent on:(a) development of specific prophylactic and therapeutic strategies (b) thorough understanding of the origin of the causative agents so as to trace their evolutionary journey and predict their future course of action. Interestingly, recent high throughput metagenomic sequencing studies traced the origin of human HBV to fish, mediated by the Bluegill hepadna virus (BGHBV). Similarly, HAV and HEV have homologues in fish, in the form of non-pathogenic viruses. Further, Shellfish are a major source for both HAV and HEV infection. It is believed that the non-pathogenic viruses from fishes crossed the species barrier, acquired virulent characteristics and became pathogenic in human and many other higher animal hosts during the natural course of evolution. Detailed understanding of the evolutionary journey of these viruses will allow us to predict their future path and possibly avoid future epidemics



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## .SEASONALITY - A POINTER TO THE LEVEL OF VULNERABILITY OF CESTODE PARASITES IN FRESH WATER FISHES OF MEERUT REGION

**Bindu Sharma and Deepika\***

Department of Zoology, Chaudhary Charan Singh University, Meerut-250004

\*[deepika21111993@gmail.com](mailto:deepika21111993@gmail.com)

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Cestodes are monophyletic parasitic tapeworms belonging to phylum Platyhelminthes that pose a zoonotic health risk. They complete their complex life cycle into one or more intermediate hosts and a definitive host. In fishes, larval and juvenile cestode stages are found in internal organs or muscles, and the adult stages in the intestine or sometimes in body cavity. Fish cestodes may decelerate the growth and lead to adhesions that disturb the host metabolism and reduce prolificacy thus, effecting the fish culture production and hence economy of nation. In the present study, freshwater fishes of species *Channa punctatus*, *Heteropneustes fossilis*, *Mastambulul armatus* and *Labeo rohita* were collected from different water reservoirs of Meerut district during summer, winter and monsoon season from August 2018 to July 2019. We observed high prevalence of cestode infection in summer season followed by winter season whereas infection was low in monsoon season. The results of present study clearly indicated that environmental factors, breeding pattern and feeding habitat influence the seasonality of parasitic infection either directly or indirectly.



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## SEASONAL CHANGES IN INNATE AND CELL MEDIATED IMMUNE RESPONSES IN FRESH WATER TELEOST, *CHANNA PUNCTATUS*

**Ajay Kumar Bhardwaj, Rakesh Kumar Chandra and Manish Kumar Tripathi\***

Department of Zoology, School of Life Sciences, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, India

\* Corresponding author mail [manish10aug@gmail.com](mailto:manish10aug@gmail.com)

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Fishes are the phylogenically primitive vertebrate group and include many species having great ecological and economic significance. Fishes are the first group which have both innate and adaptive immune mechanism, hence, crucial model for understanding immune mechanisms. In the present study we tried to understand seasonal variation in innate and cell mediated immune responses in a freshwater teleost, *Channa punctatus*. Animals were mildly anaesthetised and the blood was collected aseptically in heparinized vials. Leucocytes were isolated and used to study superoxide anion production (through nitroblue tetrazolium reduction assay) and nitrite release. Cell mediated immunity was assessed by studying mitogen induced lymphocyte proliferation. Lymphocytes were isolated through density gradient centrifugation of whole blood. Results obtained showed that nitrite release was significantly differed in different months. Superoxide production by leucocytes was also changed in different months. Mitogen induced lymphocyte proliferation was higher in winter and decreased in summer. Thus, data revealed that seasonal variation in immune responses provide optimum defence repertoire which is of adaptive in nature. *Channa punctatus* is a seasonal breeder and in seasonally breeding animals physiological processes are critical in determining energy balance between reproduction and immunity.



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## STUDY OF OMICS TECHNOLOGY IN AQUACULTURE

**Brij Bharti**

Defence Institute of Physiology and Allied Science, DRDO, Delhi

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The term “Omics” mention to collective technologies used to explore the roles, relationship and action of the various types of molecules that make up the cells of an organism. All modern technologies like genomics, transcriptomics, proteomics and metabolomics are covered under omics head. Omics technology provides the tools to look at the differences in DNA, RNA, proteins, and other cellular molecules between species and among individuals of a species. These types of molecular profiles can vary with cell or tissue exposure to chemicals or drugs and thus have potential use in toxicological assessments. Omics experiments can often be conducted in high-throughput assays that produce tremendous amounts of data on the functional and/or structural alterations within the cell. Proteomics is the study of all the expressed proteins of an organism or cell type. Proteomics technology provides a powerful set of tools for the study of functional genomics. Metabolomics comprises the measurement of low molecular weight endogenous metabolites and can provide an overview of the metabolic status of a biological system. Data generated from genomics, transcriptomics, metabolomics can be linked together through bioinformatics to generate a landscape of events occurring within a given organism. Omics technology is being used in a number of applications in the fisheries and aquaculture sector such as unraveling the mechanisms of disease and stress tolerance, selection of disease resistant varieties, fish disease diagnosis, vaccine development, species identification for fish food authentication, post-harvest value addition and many more.



### CYPERMETHRIN INDUCED DEVELOPMENTAL TOXICITY AND OXIDATIVE STRESS IN EARLY LIFE STAGES OF ZEBRAFISH

**Archisman Mahapatra<sup>1</sup>, Priya Gupta<sup>1</sup>, Richa Sahwal<sup>2</sup> and Rahul Kumar Singh<sup>1\*</sup>**

<sup>1</sup>Department of Zoology, Banaras Hindu University, Varanasi 221005, India

<sup>2</sup>SRM Institute of Science and Technology, Kattankulathur - 603203

\*Corresponding Author Email: [rks.rna@gmail.com](mailto:rks.rna@gmail.com)

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Cypermethrin, a type II pyrethroid insecticide, is widely used throughout the world in controlling pests of both indoor and outdoor systems. As a consequence, Cypermethrin is now one of the most common toxicants in freshwater aquatic systems. Although it was reported in adult rodents, that cypermethrin causes neurotoxic effect but little is known regarding the developmental toxicity in early life stages of aquatic animals. Hence, the present study was undertaken to explore the potential developmental toxicity of cypermethrin in zebrafish embryos. At 4-h post fertilization (hpf), zebrafish embryos were exposed to different concentrations of cypermethrin for 96h. Various morphological abnormalities like body curvature, and edema was observed at highest concentration. Antioxidative enzyme activities i.e., lipid peroxidation, superoxide dismutase and catalase of zebrafish larvae were significantly increased in dose dependent manner. Further, the toxic effect of cypermethrin on larvae was observed by acridine orange (AO) staining and their intensity signals were quantified. The result demonstrated that Cypermethrin has the potential to induce oxidative stress as well as developmental toxicity in zebrafish larvae. This study further suggests zebrafish as a good model to study the developmental toxicity caused by environmental contaminants.



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## STATUS, THREATS AND POLICIES TO PROMOTE AND CONSERVE ICTHYOFAUNA CULTURE IN UTTAR PRADESH, INDIA

**Khursid A Khan\*, Ruchi Badola and Ainul Husaain**

Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, India

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The Uttar Pradesh is flood plain zone having a rich diversity of rivers, ponds, and reservoirs. Due to the presence of these resources, the state consists of rich fish fauna. More importantly, the rivers of the state, particularly Ganga and Yamuna, are known as original abode of most of the valuable inland fish species, including major Indian carps. Chitla (*Chitla chitla*) is the state fish of Uttar Pradesh, along with Chitla 126 indigenous fish species belonging to 26 families and 74 genera reported from the major rivers of Uttar Pradesh. Due to anthropogenic activity and greediness to harvest more fishes, the diversity of the fishes is found to be decreasing day by day. The other major threats to the ichthyofauna are water pollution, destructive fishing methods, introduction to exotic species, habitat alteration, sand mining, and climate change. The state and central government have different policies to promote and conserve the ichthyofauna in the state. Some significant policies are The United Province Fisheries Act, Fisheries Development Policy, Integrated Development and Management of Fisheries, Encouragement of Fisheries in Rural Areas, Fish Seeds, Production and Distribution, Development of Fisheries in Reservoirs, Welfare Programme for Fisherman Communities.



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## EFFECT OF GnRH ANTAGONIST ON TESTICULAR GROWTH AND MATURATION IN THE FRESHWATER CATFISH, *CLARIAS BATRACHUS*

**Ankur Singh<sup>1</sup>, Ishwar S. Parhar<sup>2</sup>, Robert P. Millar<sup>3</sup> and Bechan Lal<sup>1</sup>**

<sup>1</sup>Fish Endocrinology Laboratory, Department of Zoology, Institute of Science,  
Banaras Hindu University, Varanasi, India.

<sup>2</sup>Brain Research Institute School of Medicine and Health Sciences,  
Monash University, Sunway Campus, Malaysia

<sup>3</sup>Centre for Neuroendocrinology, Department of Immunology, University of Pretoria, Pretoria.

\*lalbhu@yahoo.co.in

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Classically, hypothalamic gonadotropin-releasing hormone (GnRH) was considered to influence the gonadal activities through pituitary gland secretion of gonadotropins. However, recently several studies have changed this notion. The existence of GnRH has also been reported in the non-hypothalamic tissues of vertebrates. Similarly, growth hormone (GH) is not only a hypophyseal hormone but is also present in non-pituitary tissues. The present study provides evidence of cellular presence of GnRH1 and GH in the testis of catfish, which varies with the changing testicular status. Further, treatment of GnRH antagonist during the reproductively active phase induced down-regulation of testicular growth and development and circulating testosterone. Western blot of the important steroidogenic proteins also revealed lowered expression. The *in vitro* treatment of testicular fragments also reduced testosterone secretion. Our findings indicate that GnRH1 is present in the testis and its suppression impairs the testicular growth and maturation.



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## TOXIC EFFECTS OF HEAVY METAL ON FRESH WATER FISHES

**Manoj kumar**

Department of Zoology  
D.V.College, ORAI, JALAUN

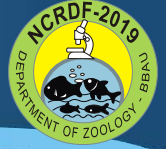
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Increase in industrialization currently is underway, but immediate hazard to mankind, domestic animal, fish and wild life through its wastes is unpredictable. The discharge of untreated or partially treated industrial effluents containing trace metal in to the water bodies, especially river, prevail in aquatic bodies and get bio-accumulated along the food chain. Bio magnification of these heavy metals along the food chain occurs leading to various health hazards to both human and other living organism. Edible fish present in aquatic bodies form an important group of organism as heavy metal once accumulated in fish tissue could act as potential carrier of metal ion along the food chain. The need for industry to install a waste treatment plant with a view to treat waste before being discharged in to the streams to keep the discharge within limits is highly required.



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## STUDY OF GONADO-SOMATIC INDEX (GSI) OF MALE AND FEMALE *CHANNA STRIATUS* (BLOCH, 1793) IN TARAIBELT AREA OF LAKHIMPUR KHERI

**Kailash Chandra Yadav**

Department of Zoology

School of Basic and Applied Sciences,

Maharaja Agrasen University,

Kalujhanda, Baddi, Solan, Himachal Pradesh

\*Email. [Kailashyadav447210@gmail.com](mailto:Kailashyadav447210@gmail.com)

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Snakehead fishes of family Channidae play an important role in fish biodiversity with 32 total species. *Channa striatus* is an important fish of this family. It is very useful and economic important fish used as food, game, ornamental and pest controller fish in different regions. This is a native of Indian subcontinent, found in India, China, Pakistan, Srilanka, Bangladesh, Nepal, Vietnam and Malaysia etc. The culture production and conservation by aquaculture have much important for present scenario because the population of *Channa striata* fish species decline by several anthropogenic activities due to destruction of their natural habitats and over fishing. The reproductive biology has the important part of gonado-somatic Index for the aquaculture production. It is direct effect to survival growth breeding mechanism and their technology formation. Present study provides the basic idea for the Gonad-somatic index that expressed the relative change in gonadal weight to the percentage of body weight. The present study indicates the *Channa striatus* GSI in around Lakhimpur area (Uttar Pradesh) India, during study period from January to June. GSI have increased with gonadal development and maturation of this fish. GSI value was minimum at January during pre spawning period was  $0.274 \pm 0.014$  and maximum at peak maturation period during June  $4.32 \pm 0.24$  in female and in male GSI is  $0.138 \pm 0.026$  minimum and  $0.230 \pm 0.018$  maximum.



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## DEVELOPING RAPID, SENSITIVE AND HIGH THROUGHPUT, KIT FOR DETECTION OF ANDROGENS AND ANTI-ANDROGENS IN WATER

**Gunjan Dagar and Gargi Bagchi**

Amity Institute of Biotechnology, Amity University Haryana

Endocrine disruptive chemicals (EDCs) interfere with the hormonal balance of the body, in humans and wildlife. These disruptions can cause severe birth defects and developmental disorders. Specific health problems attributed to EDCs include a range of reproductive disorders, early puberty, brain and behavioral problems, impaired immune functions, and various types of cancers. EDCs such as drugs, pesticides, plastics, pollutants, often find their way into water bodies. These cause serious health deterioration in fishes and other aquatic organisms. Globally, there is an attempt to identify and screen these chemicals so that their toxic effects can be monitored. The US-EPA and European countries have now included mandatory tests for estimating levels of EDCs in water. In India, heavy pollution in rivers and other water bodies warrants a need for performing routine tests for checking the presence of EDCs. However, currently, no such tests are mandatory or proposed. We have developed two different reporter cell lines in our laboratory that can detect androgens/antiandrogens in water with very high (picomolar) sensitivity. These include two different reporter genes, namely, Luciferase and SEAP, downstream of the androgen response element and coactivator genes to enhance the readout. The Luciferase cell line exhibits 178-fold increase in comparison to control whereas the SEAP cell line exhibits 119-fold increase when exposed to 10 nM Testosterone. At 1 pM concentration changes observed with the Luciferase and SEAP reporter systems are 16 folds and 6 folds respectively. Also, we have developed a protocol by which water from different sources can be tested using these two cell lines to indicate the concentration of androgens or antiandrogens present in it.



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## TOXICOLOGICAL EFFECTS OF HEAVY METALS ON FISHES OF SARYU RIVER, (GOLWAGHAT) DISTT-BAHRAICH

**Dilip Kumar Yadav**

Kisan P.G. College, Bahraich (U.P.)

E-mail: [dileepzool.80@gmail.com](mailto:dileepzool.80@gmail.com)

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Sewage water is directly drained in to the Saryu river. The untreated sewage water have many heavy metal like Zn, Cd, Cr, Pb etc. These heavy metal enters in to the fish body by mainly three ways-through gills, through body surface and through digestive tract. Among these heavy metals the deposition of Pb and Cd was found to be greater in the cypriniformes fishes when compared to other fishes. It is also called 'common carps' and is the most edible fishes. The main effect of lead (Pb) is change in the physiological and behavioural, growth rate, mortality rate and reproduction. It also causes the death of fishes. The concentration of heavy metal increases in their body by the process of 'biomagnifications' as fishes are the top consumer of the aquatic ecosystem.



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## EXOTIC FISHES AFFECTED OUR ECOLOGY AND ECONOMY: INDIAN CONTEXT

**Shipra Chowdhary**

Department of Zoology, Dr. R. P M Degree College (Affiliated by Lucknow University)

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Exotic fishes are most noteworthy threat to our aquatic ecosystem. They are affecting our natural ecosystem as well as economy. Most of the exotic species introductions have caused irrevocable damage to the aquatic biodiversity. In early time exotic species are introduced into the Indian water for the improvement of fish potential to increase our economy, sport fishing and for increasing the diversity in fish aquarium. But later on exotic species become a curse. It captured our diversity by increasing its number enormously in short period of time and our trade also affected vigorously. It is marked that on-line trading could be a powerful route for the introduction of exotic species in India. Reports are available regarding the presence of exotic ornamental fishes in Indian rivers.



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## MACROPHAGE: A DOUBLE EDGED SWORD TO CONTRIBUTE INTO PATHOLOGY DURING HEMOTOXICITY IN FISHES

**Sooram Banesh, Anvita Srivastava, Rohitas Deshmukh and Vishal Trivedi<sup>1#</sup>**

<sup>1</sup>Malaria Research Group, Department of Biosciences and Bioengineering, Indian Institute of Technology-Guwahati, Guwahati-781039, Assam, India.

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Fishes are aquatic organism and they are been exposed to the different types of heavy metals present in water as an impurities or industrial wastage. Heavy metal toxicity in fishes are associated with hemotoxicity, tissue damage, organ dysfunction and reduction in reproductive capacity. During hemotoxicity, RBC releases Hb, MetHb and other products to create a pro-inflammatory microenvironment. The pro-inflammatory microenvironment is known to show toxicity to various cells and tissues such as RBCs, endothelial cells, kidney, liver and brain. These pro-oxidant molecules especially heme is present in abundant quantity around the macrophages. But, then also macrophages are viable for a longer period of time as compared to other cells. Stimulation of macrophages with TLR ligand secretes heme polymerization activity (HPA) in the supernatant. Secretion is specific to LPS stimulation and ROS generated inside the macrophages regulates the secretion of HPA. The HPA is proteinaceous in nature and requires hydrogen peroxide for catalyzing heme polymerization. Heme polymerization protects macrophages from heme toxicity. We further explored whether the macrophages are functionally active or not. The macrophages expos



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## MICROSPORIDIOSIS IN ZEBRAFISH

**Mukta Mayee Kumbhar**

Department of Life Sciences, Rama Devi Women's University, Bhubaneswar-751022, Odisha

[Email-muktamayee@gmail.com](mailto:Email-muktamayee@gmail.com)

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Microsporidia are a group of highly reduced parasitic fungi found in vertebrates and invertebrates. Among vertebrates they are most prevalent in fish and mammals. The zebrafish, *Danio rerio*, is now one of the most important vertebrate models in biomedical research and can be naturally infected with two microsporidia. There are two species of microsporidia that can infect the zebrafish *viz.* *Pseudoloma neurophilia* and *Pleistophora hyphessobryconis*. These microsporidian spores are released from fish in various manners *viz.* through the urine, feces, and also released in spawned eggs which provide a strong evidence of maternal transmission. They also infect the central nervous system and muscle and also cause skeletal deformities in fish. About 100 species of microsporidia have been reported to infect other agriculturally relevant fish, such as salmon and rainbow smelt and sometimes they play a major role in the decline of entire fishery industry. Zebrafish also provides an excellent platform for investigating various basic and applied research topics pertaining to microsporidia in vertebrates. Further, research is required to evaluate the possible approaches to control method for microsporidia in both the laboratory and field conditions.



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## CLIMATIC CHANGE AND THEIR EFFECT ON INDIAN BIODIVERSITY

**Pradeep Kumar\***

\*Department of Zoology, S.G.N. Govt. P.G. College, Muhammadabad Gohana,

Mau, 276403, (U.P.) India

Email: [pkumar\\_gpu@yahoo.co.in](mailto:pkumar_gpu@yahoo.co.in)

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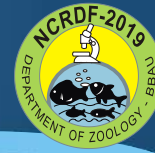
Biodiversity is the incredible variety of living things in nature and how they interact with each other. Therefore, each organism contributes to the biodiversity, functioning and beauty of the earth. It is a very complex and is often explained as the variety and variability of genes, different species, and ecosystems on the earth planets. The biodiversity is a multitude form of life within each ecosystem. These ecosystems are now at risk as a result of human developmental activities. India has a rich biodiversity which covering ten biogeographically zones such as Trans-Himalayan, Himalayan, Semi-arid zone, Western Ghats, Indian desert, Deccan Peninsula, Gengetic Plain, North-East India, Coasts and Islands. In India's wide range of climatic and topographical features has resulted in a high level of ecosystem biodiversity encompassing forests, grasslands, wetlands, deserts, coastal and marine ecosystems, each with a unique assemblage of species. This diversity generates economic value for human societies in different ways and it has been a source of revenue from extractable products which obtained from individual species. Climate is one of the most important factors on the earth which controlling growth, developments, abundance, survival and distribution of different species as well as regulating natural ecosystems in a variety of ways. The climatic changes are one of the most important global environmental challenges which affect all the natural ecosystems of the earth. The effect of climate change on the natural system may be diverse, such as change in the timing of phenological events of plants, changes in species abundance and range, shifts in habitat. According to prevailing extinction theory, the larger and more specialized species are likely to be lost due to the habitat destruction. This is a special risk factor for different species which are very sensitive to climate change and more likely to be at risk of extinction. On the earth human activities cause major role in the sustainable development of the biodiversity.



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## REVIEW ON SOCIO-ECONOMIC DEVELOPMENT OF FRESHWATER FISH IN UTTAR PRADESH

**Brijesh Ranjan**

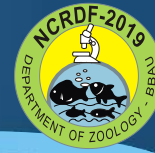
Assistant Professor, Department of Zoology, Dr. Ashok Kumar Samark PG College

Akbarpur, Ambedkar Nagar Uttar Pradesh 224122

Email- [brijeshranjanbhu08@gmail.com](mailto:brijeshranjanbhu08@gmail.com)

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Fish diversity within the fresh water ecosystem has a great importance in terms of the livelihood and the economic importance of the people living around it. Accordingly the relation between the biodiversity and human well-being is interrelated and is being promoted increasingly through the concept of ecosystem services provide by the species. Fishery plays an active role in the socio-economic development of the country, as it is a valuable resource of livelihood for a huge section of economically backward population. It also generates employment, alternate income and stimulates growth of new subsidiary industries. India is one of the mega biodiversity hot spots contributing 11.72% of globe fish biodiversity. Fisheries sector in India has shown outstanding growth and ranks third in the world in total fish production and contributes around 1.07 % of the country's Gross Domestic Products (GDP) and 5.34% of the agricultural GDP. Shrinking resource of agriculture, mounting pressure on land is making us to look for new avenues of producing food and ensure adequate nutrition to the masses. India is one of the 17 mega biodiversity hot spots contributing 60-70% of the world's biological resources. With third position in fisheries and second in aquaculture, the country has high potentials in the sector for rural development, domestic nutritional security, employment generation, gender mainstreaming as well as export earnings, that only few other activities can provide. Uttar Pradesh has vast potential of aquatic bio resources and offers considerable scope of inland fisheries development and aquaculture. State contributes approximately 14.68% of the total national fish diversity and resources are available in the form of 28,500 km of rivers and canals, 1.38 lakh ha of reservoirs and 1.61 lakh ha of ponds and tanks as well as 1.33 lakh ha of floodplain lakes and derelict water.



### INDUCTION OF DNA DAMAGE AND OXIDATIVE STRESS IN VARIOUS TISSUES OF JUVENILE CHANNA PUNCTATUS (BLOCH) AFTER EXPOSURE TO MULTI-WALLED CARBON NANOPARTICLES

**Daoud Ali\***

Department of Zoology, College of Science, King Saud University, Riyadh, Saudi Arabia

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Multi walled carbon nanotubes (MWCNTs) have been increasingly used in industrial applications. There is a little knowledge about the genotoxic potential of MWCNTs (210 nm) on juvenile freshwater fish *Channapunctatus*. In this study, we have evaluated the effects of MWCNTs and assessed toxicological endpoints such as oxidative stress and genotoxicity in an acute exposure assay for 1-5 days. Fish were exposed to 0 (control), sublethal I, sublethal II, and sublethal III for 1-5 days. Fish exposed to higher MWCNTs concentrations showed major changes in oxidative stress markers. An increase in lipid peroxidation (LPO) levels was observed in the gills and kidney of fish exposed to sublethal II with no changes in the antioxidant enzymes activities. In the case of the sublethal III treatment, gills and kidney activation of the enzymatic antioxidant defence occurred, and LPO levels resulted unaltered. The MWCNTs toxicity was also evidenced by the DNA damage in fish lymphocytes, at higher concentrations. In conclusion, acute exposure to sublethal concentrations of MWCNTs is enough to generate deleterious effects on fish, including DNA damage. This study explored the combined use of micronucleus assay and comet assay for *in vivo* laboratory studies using freshwater fish for screening the genotoxic potential of xenobiotics.



### ACUTE TOXICITY OF TRIVALENT AND HEXAVALENT CHROMIUM TO CLIMBING PERCH, *ANABAS TESTUDIENUS*

**Jawaid Akhter, Anirudh Singh and Dina Nath Pandit\***

P.G. Department of Zoology, S.P. Jain College, Sasaram

\*Department of Zoology, VKS University, Ara-802 301

\*Corresponding author email: [panditdina@gmail.com](mailto:panditdina@gmail.com)

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Chromium is highly toxic to both aquatic and soil environment. Aim of the present study was to determine acute effect of chromium trivalent (Cr- III) and hexavalent (Cr-VI) toxicity on climbing perch, *Anabas testudienus* (Bloch). *The work was done using Finney's Probit analysis method.* The 96hr-LC<sub>50</sub> of Cr- III and Cr-VI was determined to be 305.0 and 39.0 mg/l by experimental fishes were exposed in different concentrations. The LC<sub>50</sub> dose was more in Cr(III) in comparison to Cr(VI) as the difference was highly significant. The work showed that acute chromium toxicity is severely affects the fundamental organs which are harmful to fishes in aquatic ecosystem. There is need to control the usage of chromium especially Cr-VI because of its observed toxicity level as Cr(VI) is more dangerous to aquatic organisms that Cr(III).



### EFFECT OF PENTACHLOROPHENOL (PCP) ON HISTOLOGY OF LIVER IN THE INDIAN CATFISH, *HETEROPNEUSTES FOSSILIS*

**Surya Prakash Verma and Sunanda Dubey\***

Department of Zoology, Udai Pratap College, Varanasi-221002 India,

[\\*sunandadubey@rediffmail.com](mailto:sunandadubey@rediffmail.com)

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Pentachlorophenol (PCP) is used globally in the production of plastics, pesticides, wood preservatives, herbicides, cleaning products and is present in sewage effluents. Further it has been reported that PCP is the most important degradation products of complex chlorinated hydrocarbon compounds because of its enhanced resistance towards biodegradation, toxicity, ability to bio accumulate in aquatic organisms, and estrogenicity. Effect of PCP the histological changes in liver of a fresh water fish *Heteropneustes fossilis* was studied. Fish were exposed to 32µg/l/day of sub lethal concentration for a period of 14 and 28 days. The liver of the control fish appears as a continuous mass of hepatic cells. Hepatocytes show cord like pattern interrupted by blood vessels and sinusoids. The cords of hepatocytes are arranged around the central vein. The hepatocytes are large in size, polygonal in shape with spherical centrally located nuclei and have homogenous eosinophilic cytoplasm. The sinusoids are seen as communicating channels occupied by blood cells. After 14 days of exposure of PCP, the hepatocytes became irregular and loosen their polygonal shape and after 28 days some cells exhibited expanded contour. There were many regions in the liver of experimental fish, where cells were highly vacuolated. Many cells have exhibited necrosis. Liver also showed degeneration and disintegration in most cytoplasmic content and lymphatic aggregation. PCP (32µg/l/day) was found to affect the liver tissue adversely and its corresponding impact may effect on reproductive organs.



### EVALUATION OF REPRODUCTIVE TOXICITY INDUCED BY HERBICIDE PRETILACHLOR IN FRESH WATER FISH *CLARIAS BATRACHUS* (LINN.)

**Sushant Kumar Verma\* and Rakesh Soni**

Department of Zoology, Guru Ghasidas Vishwavidyalaya

Bilaspur, Chattisgarh (India)

Email: [vermasushant2008@gmail.com](mailto:vermasushant2008@gmail.com)

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Herbicide pretilachlor is most frequently used in paddy fields for the control of annual weeds. It is widely present in aquatic environment and causes detrimental effects on fishes. Very few works have been done so far to evaluate the toxicity induced by pretilachlor in fishes. Therefore present study was carried out in *Clarias batrachus* to evaluate the reproductive toxicity caused by it. Male and female fishes were exposed to different predefined sub lethal concentrations of pretilachlor for 30, 45 and 60 days. After the exposure the reproductive toxicity caused by pretilachlor was evaluated by analysing plasma sex steroid profile, plasma vitellogenin concentration and gonadal aromatase activity in both male and female fishes. A significant increase in plasma 17- $\beta$  estradiol (E2) was noted in male fishes however plasma E2 in females was not affected. Plasma concentrations of testosterone were significantly decreased in both male and female fishes. In male plasma vitellogenin (VTG) and gonadal aromatase activity was increased; however no such changes were seen in pretilachlor exposed females. The findings demonstrated that herbicide pretilachlor act as endocrine disruptor in fishes and may adversely affect the normal process of reproduction in fishes.



### ATTENUATIVE EFFECTS OF SOME ANTIOXIDANTS AGAINST CHLORPYRIFOS INDUCED TOXICITY IN *HETEROPNEUSTES FOSSILIS*

**Abhisweta Singh and Abha Mishra\***

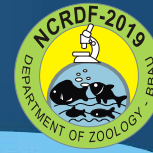
Department of Zoology

Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

\*drabhamishra@gmail.com

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Chlorpyrifos (CPF), an organophosphorous pesticide, banned in most of the European countries, continues to be a part of the Indian agriculture practices. It is an acetylcholinesterase inhibitor, the excessive use of which leads to contamination of water bodies via a surface runoff. The present study was performed to understand the attenuative effect of the two major anti-oxidants, curcumin and ascorbic-acid, on tissue architecture and important energy source compounds such as glycogen and protein against CPF exposure to freshwater catfish, *Heteropneustes fossilis*, for 72h. Glycogen and protein are vital for normal growth, metabolism and reproductive events. CPF induced not only the histopathological alterations in tissues such as liver, kidney, gill, stomach and intestine but also decreased the glycogen and protein content in some of the major tissues. However, in the present study, different combinations of curcumin and ascorbic acid was found to attenuate (reduce) the toxic effects of CPF significantly. The study suggested that incorporation of curcumin and ascorbic acid in CPF contaminated water can help in restoring normal tissue architecture and also biochemical content in tissues of fish.



### EFFECT OF ORGANOPHOSPHOROUS PESTICIDE, TRIAZOPHOS, ON IMMUNE RESPONSES OF SPLEEN AND HEAD KIDNEY IN FRESH WATER TELEOST, *CHANNA PUNCTATUS*

**Rakesh Kumar Chandra, Ajay Kumar Bhardwaj and Manish Kumar Tripathi\***

Department of Zoology, School of Life Sciences, Guru Ghasidas Vishwavidyalaya (A Central University), Bilaspur, India

\* Corresponding author mail [manish10aug@gmail.com](mailto:manish10aug@gmail.com)

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Fishes are considered the first group of vertebrates having both innate and adaptive immune system. Triazophos is an Organophosphorous pesticide which is used to control pests indoor and outdoor. However, significant amount of triazophos reaches to the aquatic system through various routes like run-off, leaching and spray-drift effluent from factories. Present study was designed to investigate the effect of triazophos on different innate and cell mediated immune functions in *Channa punctatus*. LC<sub>50</sub> for 96 h exposure was calculated to evaluate the toxicity of triazophos. Fishes were exposed to 1/10 of LC<sub>50</sub> for 10 and 20 days. Following the completion of experiment, fishes were mildly anaesthetized and spleen and head kidney were isolated aseptically. Single cell suspension was prepared from each tissue and super oxide formation by cells from both the tissues were analysed by nitro-blue tetrazolium assay. Nitrite assay was also performed to evaluate the production of nitric oxide. Lymphocytes were separated through density gradient centrifugation and were subjected to proliferation assay. Mitogen induced proliferation was also assessed using concanavalin A and lipopolysaccharide. Findings of this study demonstrated that superoxide production by immune cells was reduced when the fishes were exposed to the triazophos. Proliferation of lymphocyte was also found to be significantly decreased in treated animals. It was concluded the pesticide targets the immune system and suppresses the immune functions in fishes and the effect was more prominent when exposure time was prolonged.



### COMPARATIVE EFFECTS OF 4-NONYLPHENOL ON THE TESTICULAR STRUCTURE AND FUNCTION OF CATFISHES: *HETEROPNEUSTES FOSSILIS* AND *CLARIAS BATRACHUS*

Suman<sup>1</sup>, Radha Chaube<sup>2</sup> and Gautam Geeta J.<sup>1</sup>

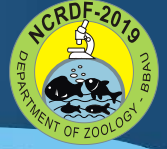
<sup>1</sup>Zoology Department, Mahila Mahavidyalaya, Banaras Hindu University, Varanasi-221005,

<sup>2</sup>Department of Zoology, Institute of Science, Banaras Hindu University, Varanasi-221005,

Email:geeta2713@gmail.com, [chauberadha@rediffmail.com](mailto:chauberadha@rediffmail.com)

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The 4-Nonyl phenol (4-NP) is widely used as non-ionic surfactants pervasive in industrial effluents and in aquatic environment. It is a persistent and ubiquitous xenoestrogen with endocrine-disrupting activities, and is present in varying concentrations in wastewater, ground water, treated drinking water and sediments. This study was aimed to investigate the effects of low (64µg/L) and high dose (160µg/L) of 4-NP on the structure and function of testes of two catfishes *H. fossilis* and *C. batrachus*. Methodology included histopathological assessment, sperm count and viability test of spermatozoa. Sexually mature male *H. fossilis* and *C. batrachus* were exposed to low and high doses of 4-NP for 60 days and testes were sampled after 30, 45 and 60 days of duration. The main histological changes observed in the structure of testes of both *H. fossilis* and *C. batrachus* were disintegration of interlobular connective tissues, clumping of spermatids, fibrosis of interstitial tissue, necrosis of spermatozoa, disintegration of cyst, vacuolization and abnormal distribution of spermatogonia. The severity of effects increased with time and dose. Significant dose dependent decrease was observed in the total number of viable spermatozoa and increase in mortality of spermatozoa was seen in both catfishes ( $p < 0.05$ ). There was no significant species variation between the effects of 4-NP in the structure and function of testes of both the fishes. These results therefore substantiate that exposure to waterborne 4-NP can modulate the normal histology of testes and viability of spermatozoa.



## FUNCTIONAL INTERACTION BETWEEN VASOTOCIN AND CORTICOSTEROIDS IN THE CATFISH *HETEROPNEUSTES FOSSILIS*

**Varsha Singh<sup>\*</sup>, Radha Chaube<sup>2</sup> and K.P. Joy<sup>3</sup>**

<sup>\*</sup>Department of Zoology, Kalindi College, University of Delhi, Delhi-110008

<sup>2</sup>Department of Zoology, Banaras Hindu University, Varanasi-221005

<sup>3</sup>Department of Biotechnology, CUSAT, Kochi 682022

[\\*varshabhu@gmail.com](mailto:*varshabhu@gmail.com)

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Oocytes of marine and catadromous fishes undergo a unique process of hydration associated with oocyte maturation (meiosis resumption), which is thought to have important physiological and ecological implications. Oocyte hydration in many teleost fish is induced *in vitro* by 17, 20-dihydroxy-4-pregnen-3-one and cortisol. It is also known that corticosteroid levels are elevated during oocyte maturation suggesting strongly that corticosteroids play a role in ovarian functions. In teleosts, the main corticosteroid is cortisol. It is possible that cortisol participates in the control of oocyte hydration and is probably involved in other periovulatory ovarian functions. Oocytes of the freshwater catfish *Heteropneustes fossilis* undergo hydration (about a maximum of 23% increase in water content) during meiotic maturation *in vitro*, induced with human chorionic gonadotropin (hCG) or VT. Since both VT and cortisol are involved in osmoregulation (water balance and ion exchange) in fishes and also in oocyte maturation and hydration, it is possible that there may be some functional interaction between these two. Further, neurohypophysial peptides VT and isotocin (IT) have been shown to modulate the secretion of ovarian steroids during the prespawning and spawning phases of the reproductive cycle of *H. fossilis*. The present study intends to understand the functional interaction between vasotocin and corticosteroids for which both *in vitro* and *in vivo* studies were performed in prespawning and spawning phases of the reproductive cycle of the catfish. *In vitro* studies with VT, IT and hCG significantly increased ovarian cortisol and corticosterone in both the reproductive phases, VT showing the maximal effect, followed by IT. *In vivo*, vasotocin and hCG significantly increased the cortisol and corticosterone in all the tissues studied (plasma, kidney and ovary). The physiological significance of the interaction needs to be investigated in future studies.



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## EFFECTS OF STRESS ON REPRODUCTION OF *HETEROPNEUSTES FOSSILIS*

**Anil Kumar and Abha Mishra\***

\*Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

\*drabhamishra@gmail.com

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In nature fishes experience a variety of adverse conditions which challenge them for their survival. These adverse conditions may be the chemicals, habitat changes, pollution of water by heavy metals, industrial effluent, culture practices like handling or stocking of fishes etc. Any to water quality changes, fish experiences stress. Oxidative stress in fishes is caused by the heavy metals which while being metabolised generate reactive oxygen species (ROS) including free radicals, super oxides, singlet oxygen etc. These ROS damage various cellular components including the biological membranes, ultimately leading to cell death. Generally, there occurs a balance between ROS and antioxidants to avoid any damage caused by the ROS but when water gets polluted, the fish experiences oxidative stress. Stress is a normal survival incidence if it occurs acutely. However, if the fish is exposed to the stressors chronically, the fish shows abnormal symptoms; the fish-health starts deteriorating, growth ceases, mortality rate increases, fecundity and reproductive abilities get reduced ultimately reducing the yield. During a stress, various chemical cascade begins in the fish body to counteract the effects caused by the stressors. Hormones like catecholamines (adrenaline and noradrenaline) from chromaffin cells of the pronephros are secreted with the induction of the hypothalamus. Another hormone from adrenal cortex, cortisol is also secreted and their plasma levels increase many folds. If the stress exists for longer durations, these hormones cause worsening of the body leading to the reduced immunity power, susceptibility to infections and reduced yield.



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## NATURAL WOUND HEALING POTENTIAL IN *CHANNA PUNCTATUS*

**Devika Srivastava, Vandana Singh, Venkatesh Kumar R\***

Department of Zoology, Babasaheb Bhimrao Ambedkar University,  
Vidya Vihar, Raibareli Road, Lucknow, Uttar Pradesh 226025

\*Email id: [drvenkateshkumarr@gmail.com](mailto:drvenkateshkumarr@gmail.com)

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Fishes are always prone to cutaneous injury such as abrasions, laceration, etc. which is one of the main reasons for infections in fishes. The current study was aimed to investigate the wound healing capacity in *Channa punctate* by silk fibroin hydrogel and vancomycin drug. Initially, Fishes were lacerated at the caudal region and were divided into three groups. The first group of fishes was treated with silk fibroin hydrogel to heal their wounds. The second group of fishes was treated with silk fibroin hydrogel loaded with drug vancomycin, and the third group was control. The experimental groups were treated with silk fibroin hydrogel and vancomycin drug up to seven days and observed that that control group was recovered quickly as wound healing in this group occurred faster than the treated groups. Further, it was also found that the wound area of treated groups was increased despite the using silk hydrogel and vancomycin drug. The results of this study showed clearly that natural wound healing potential is enhanced in the untreated group of *Channa punctatus* when compared to treated groups. In this regard, future studies will help us to know the reasons for the current scenario.



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## ANTIOXIDANT EFFECT OF CURCUMIN AGAINST STRESS ENZYME IN FRESHWATER CATFISH (*HETEROPNEUSTES FOSSILIS*)

**Pooja Pandey<sup>1</sup> and Abha Mishra<sup>1</sup>**

Department of Zoology<sup>1</sup>, School of Life Sciences,

Babasaheb Bhimrao Ambedkar University (A Central University), Lucknow-226025

Email: [drabhamishra@gmail.com](mailto:drabhamishra@gmail.com)

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The aim of this study was to determine protective effects of curcumin on oxidant/antioxidant parameters in freshwater catfish. For acclimatization fishes were kept to normal lab temperature with suitable environment for 3 days after that these wild catch fish kept with curcumin (bioactive chemical of turmeric) treatment for 1, 5 and 21 day. The same fish, also extended for one week without curcumin treatment, with 0.001% curcumin dosage. Catalase (CAT), lipid peroxidase (LPO) and peroxidase (POD) activities were monitored in liver, kidney and gills as well as muscles which were collected at the end of the experiment. Treatment with curcumin works as antioxidant agent by significantly decreasing the levels of catalase (CAT), lipid peroxidase (LPO) and peroxidase (POD) activity in the tissues. In conclusion, this study demonstrated that curcumin significantly decrease the oxidative stress in cat fish ( $P < 0.05$ ), depending on dose and duration of curcumin.



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## ANALYSES OF THE GOMTI RIVER WATER PHYSICAL QUALITY IN UTTAR PRADESH REGION

**Kiran Das and Sandhya Bharti\***

\*Department of Zoology, Babasheb Bhimrao Ambedkar University, Lucknow

Email: [drsandhya@bbau.ac.in](mailto:drsandhya@bbau.ac.in) , [sandhyabharti54@gmail.com](mailto:sandhyabharti54@gmail.com),

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The Gomti River is one of the major tributaries of holy Ganga River. A few decade before it was considered as black nala in Uttar Pradesh (U.P). As a result, many effluent treatment plants were implemented to treat the river water. However, the status of the Gomti river water is retaining as such in certain plain areas of U.P. Therefore, efforts were made to do survey of different regional areas along the banks of the Gomti River in order to identify and record the various pollution causing contributors. During the month of March - April 2019 one survey was conducted near Pilibhit and Rudrapur (U.P) along the Gomti River to observe the water physical status. It was observed that the surface of Gomti river water was covered with green algae. Further, the river water was odorless also. The reason could be due to presence of lots of Hindu worship places near these cities which prohibit people to pollute the Gomti river water in their vicinity. The study will be beneficial in implementation the 'Gomti river water cleanness campaign'.



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## STUDY OF POLLUTION IMPACT ON GANGA RIVER SYSTEM IN UTTER PRADESH REGION

**Chetan Singh and Sandhya Bharti<sup>1</sup>**

<sup>1</sup>Department of Zoology, Babasheb Bhimrao Ambedkar University, Lucknow Utter Pradesh Email:  
[drsandhya@bbau.ac.in](mailto:drsandhya@bbau.ac.in) , [sandhyabharti54@gmail.com](mailto:sandhyabharti54@gmail.com)

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The Ganga River has a total stretch of about 8,047 km (2,525 km in Utter Pradesh). It is considered as 'holy' river in India. However, now it is known as one of the most contaminated river in the world. Nearly over 1.3 billion litres of sewage waste water per day is dumped into the Ganag River. The various industries in cities like Kanpur, Varanasi and Prayagraj that are situated on the banks of the Ganga River have led to tremendous deterioration of the river water. During the survey to Kanpur it was observed that Jajmau area has maximum small drains which are directly connected to river Ganga. Though, water treatment plants have been setup at “Ganga barrage” to treat the sewage water prior its dumping into Ganga. Still, the effluent form during sewage processing generate huge amount of waste effluent which further is drained into the same Ganga River. In Varanasi, body cremations at Manikanika Ghat are directly dumped into river Ganga which pollutes the water. In Prayagraj also at the Sangam, Ganga River gets contaminated with heavy loads of ritual waste and religious wastes.



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## EFFECT OF STRESS ON PROTEIN METABOLISM AND GENE ACTIVATION

**Bulbul Ali and Abha Mishra\***

Department of Zoology

Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

\*drabhamishra@gmail.com

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Due to environmental stress like chemical, thermal, hypoxia etc. fishes brings a generalized physiological response to survive in that drastic environment as in other vertebrates. These stresses negatively affect the growth, reproduction, metabolism, osmoregulation and immune ability of fishes. The physiological response to the stress hypothalamic-pituitary-internal (HPI) gets activated and immediate release of catecholamine hormones like epinephrine and norepinephrine that culminate the production and release of corticoids like glucocorticoids in blood plasma and muscles. This specific response to the stressors one of the response is a change in protein metabolism and the gene activation. Pituitary-adrenal axis plays a key role in regulating the protein metabolism. In Fishes repeated acute stress and chronic situations adversely affect the organism's growth. Due to the alteration in protein metabolism the body weight is depressed particularly in skeletal muscles because the protein accretion is a primary importance to growth. Glucocorticoids are an important mediator of the metabolic response to stress. The elevation of glucocorticoids is caused by stress but the role of glucocorticoids to regulate the protein metabolism is less known. Therefore, efforts will be made to analyse toxic effect of chemical like sodium dexamethasone (NaDOC) at cellular level on fish.



### **NICKEL SULPHATE INDUCED EFFECTS: HISTOTOXICITY, OXIDATIVE STRESS, APOPTOSIS AND ON GENE EXPRESSION IN THE CATFISH HETEROPNEUSTES FOSSILIS**

**Sandhya Sharma and Radha Chaube\***

Department of Zoology, Institute of Science, Banaras Hindu University, Varanasi-221005

\*Email id: [chauberadha@rediffmail.com](mailto:chauberadha@rediffmail.com), [ssmesandhya@gmail.com](mailto:ssmesandhya@gmail.com)

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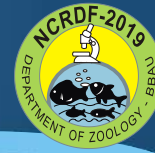
Water pollution is generally associated with heavy industrialization and dense population, one of the major ecological problems. In aquatic ecosystem, heavy metals are considered as the most important pollutants and detectable in the critical amounts. These metals can effectively influence the vital operations and reproduction of fish; weaken the immune system, and induce pathological changes. In the present study, nickel sulphate exposure to catfish causes impaired gonad development and leads to developmental toxicity. In the present study we investigated sub lethal effects of nickel sulphate in the catfish *Heteropneustes fossilis*. Female catfish were selected from reproductive phases of the reproductive cycle. The catfishes were exposed with nickel sulphate of concentrations 0.1 mg/L 0.2 mg/L and 0.5 mg/L for 3 and 7 days. Ovary was dissected out and stored in buffered formalin, RNA later as per requirement of experiment. Histological approach, oxidative stress, tunnel assay and quantitative-PCR methodology were used to achieve present objectives. Exposure to nickel sulphate produced histopathological changes in the ovary. histopathological as well as oxidative stress effects in the catfish. Examined anti-oxidative stress enzyme activities include superoxide dismutase (SOD), catalase (CAT) and lipid peroxides (LPO) results from the biochemical assay indicated significantly higher ( $P < 0.05$ ) levels of a lipid peroxidation product exposed catfish compared to the control. All enzymes showed significantly higher activities in nickel sulphate-exposed catfish compared to the control.



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## EFFECT OF TOXICANTS ON THE FISHES OF U.P. AND BIHAR

**Lavi Jaiswal**

Department of Zoology, Mahila P.G. College,

Bahraich (U.P.)

E-mail: [labbabrh95@gmail.com](mailto:labbabrh95@gmail.com)

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The study compares the a etiology of pansteatitis in the fresh water fishes of U.P. and Bihar. Where untreated waste materials drained in the fresh water reservoir it produces many harmful effects. Macroscopic and microscopic pathology, age determination, analysis of stomach content, fatty acid and stable isotopes explain the high prevalence of pansteatitis in several species of fresh water edible fishes. Excessive sewage drainage in aquatic bodies may cause eutrophication which affects the intrinsic drivers of many other diseases which might ultimately affect fishes. It may also affect health of human as fishes are consumed by humans.



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## ORNAMENTAL FISH CULTURE A SMALL SCALE AQUA BUSINESS IN INDIA

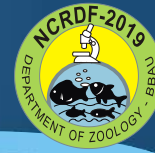
**Upendra Kumar Meena and Sandhya Bharti**<sup>1</sup>

<sup>1</sup>Department of Zoology, Babasheb Bhimrao Ambedkar University, Lucknow

Email: [drsandhya@bbau.ac.in](mailto:drsandhya@bbau.ac.in) , [sandhyabharti54@gmail.com](mailto:sandhyabharti54@gmail.com),

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The objective of ornamental fish was initially oriented toward ecstatic pleasure. However, now this trade is expanded. About 600 decorative fish species are reported worldwide from numerous aquatic environments. This technique involves production of ornamental fishes in pools holding less than 1000 liter water or in used refrigerator/ fridge containers with 100-200 litre capacity. The pools are setup using used flex or silpaulin sheets. They are constructed at elevated area or at a higher terrain so as to facilitate water exchange by gravity. At weekly interval 20 % of bottom water is exchanged and this water is used for irrigating plants. This integrated farming approach saves land, water, energy, money expenses and increase production. The pools for fish culture can also be erected on roof top of house employing wooden frames or at backyard using bricks/laterite stones. Similarly used flex banners or sheets can be used for culturing ornamental fishes as a backyard activity or on roof top of concrete houses.



## REGULATION OF PIGMENTATION IN FISH MELANOPHORES

**Poonam and Sandhya Bharti<sup>1</sup>**

<sup>1</sup>Department of Zoology, Babasheb Bhimrao Ambedkar University, Lucknow

Email: sandhyabharti54@gmail.com

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influences the skin color. It is well known that during any kind of stress such as fasting, new habitat low pH, high temperature, UV ray's exposure etc. its synthesis increases. The  $\alpha$ -MSH is a corticotropic hormone. There are certain vital receptors belonging to  $\alpha$ -MSH. One of its receptors is melanocortin - 1-receptor (MC1R) which is responsible for either melanin dispersal or aggregation under the effect of other messenger molecules in fishes. The sequence of MC1R is found to be highly conserved in all the vertebrates. The certain chemical modifiers that are involved in cAMP pathway during melanogenesis are PDE4, rolipram, 3-isobutyl-1-methyl xanthin (IMBX) which are known to increase dispersal of melanosome. Other molecules such as agrp involve in melanogenesis is also found to play an important role in fasting. Thus, agrp also control appetite. Hence, the effect of lipolysis, glucose, lactate, sodium ion, calcium ion, thyroid hormone, insulin, HCl and some other chemicals like Nocodazole, IBMX, Colchicine, Vinca alkaloids, Epothilones can be studied to understand its role on dispersion and aggregation of chromatophore under the c



### SEASONAL CHANGES IN LEVELS OF HORMONES IN THE CATFISH *HETEROPNUESTES FOSSILIS*, IN FOREBRAIN REGIONS DURING DIFFERENT REPRODUCTIVE PHASES

**Surabhi Mishra and Radha Chaube\***

Department of Zoology and Fisheries Science, Dolphin PG College of Science and Agriculture, Chunnikalan, Punjab, mishra.surabhi021@gmail.com, Department of Zoology, Institute of Science, Banaras Hindu University, Varanasi -221005, India.

\*Corresponding author: chauberadha@rediffmail.com, radhachaubey72@gmail.com

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It is now established that the brain synthesizes steroids *de novo* from cholesterol through mechanisms at least partly independent of peripheral steroidogenic glands. These steroids called neurosteroids accumulate within the brain of several mammals, avian, amphibian and teleost species. The content of these steroids are almost constant even after removal of peripheral steroid sources. In the present study, progestins (pregnenolone, progesterone, and 17-OH-progesterone) and cortisol were measured in hypothalamus and telencephalon brain regions of both male and female catfish *Heteropnuestes fossilis*, throughout their reproductive phases, using ELISA. Our study showed that, the level of pregnenolone, progesterone and 17-OH progesterone decreased significantly from the resting to post-spawning season in both hypothalamus and telencephalon. The levels were highest in forebrain in non-breeding season and lowest in preparatory phase. Cortisol level were highest in forebrain; highest level was observed during preparatory phase in both the sexes. There was significant variation in levels of testosterone and estradiol-17 $\beta$  level throughout their reproductive cycle. Lowest concentration level was observed in telencephalon during prespawning phase in both the sexes. Thus, present study suggests that catfish brain is involved in biosynthesis of steroids seasonally and these steroids may play an important role in regulating brain functions, which can be correlated with reproductive behaviour and brain region-specific functions such as neuroprotection, plasticity and neurogenesis, which need further investigation in the catfish.



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## EFFECT OF PHOTOPERIOD AND TEMPERATURE ON GROWTH HORMONE EXPRESSION IN OVARY AND OVARIAN RECRUDESCENCE IN THE FRESHWATER CATFISH, *CLARIAS BATRACHUS*

**Priya Gupta, Ankur Singh and Bechan Lal\***

Department of Zoology, Banaras Hindu University, Varanasi 221005, India

\*Corresponding Author E-mail: [lalbhu@yahoo.co.in](mailto:lalbhu@yahoo.co.in)

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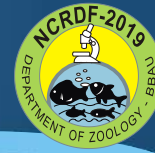
Photoperiod and temperature are well-known to play an important role in regulating reproductive cycle of many vertebrates. The altered photoperiod and temperature activate the brain-pituitary-gonad (BPG) axis and act as the crucial factors for gonadal recrudescence. Growth hormone, the adenohipophyseal peptide hormone of about 191-199 a.a. and having molecular weight of 21-23 kDa, has been reported from hypophysis and variety of non-hypophyseal tissues and has predominant role in regulation of somatic and gonadal growth & development in vertebrates, including fishes. Therefore, the present study was undertaken to investigate whether the altered photoperiod and temperature can change the expression of GH in the ovary, one of the non-hypophyseal tissue of the freshwater catfish, *Clarias batrachus*. The catfish were exposed to different photo-thermal regimes during quiescent phase for one month and the expression of GH was analyzed along with changes in ovarian activities. Gonadosomatic Index (GSI) and  $17\beta$ -estradiol level in long photoperiod and high temperature exposed catfish were appreciably highest, and also GH immunoreactivity in this exposed condition was found to be highest in granulosa cells of ovarian follicles. While low temperature have decreased GH expression significantly and arrested the ovarian activities. Thus, through this study it may be concluded that photoperiod and temperature both affect GH expression and thereby gonadal recrudescence in fish.



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## ISOLATION AND IDENTIFICATION OF FUNGI FROM GILL AND SKIN OF *CLARIAS BATRACHUS* L.

**Vijay Kumar Yadav<sup>1</sup>, H D Bhartiya<sup>2</sup>, Mukesh shrivastava<sup>3</sup>, T K Sharma<sup>2</sup> Divya Walia<sup>1</sup> and Sunny Kant<sup>1</sup>**

<sup>1</sup>Department of Zoology, Bipin Bihari College, Jhansi. 284001

<sup>2</sup>Department of Botany, Bipin Bihari College, Jhansi, 284001

<sup>3</sup>Department of Chemistry, Bipin Bihari College, Jhansi 284001

Email [vijaybetwa@gmail.com](mailto:vijaybetwa@gmail.com)

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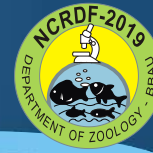
Microbiological analyses have been carried out from infected fish samples obtained from fish market for isolation and identification of fungi in infected regions. The infected fish samples with open wound and ulcerative growth found on caudal region and gills of *Clarias batrachus* were collected. Extract was prepared from the infected part of fish. Serial dilutions of each sample upto 1: 1000 have been prepared and were streaked over Potato Dextrose Agar (PDA) and the petriplates were incubated at 28°C. After purification of culture, microscopic study was carried out. The fungi isolated from the infected fish samples includes *Aspergillus flavus*, *A. terreus*, *A. fumigatus*, *Alternaria alternata*, *Curvularia lunata*, *Penicillium chrysogenum*, *Cladosporium sphaerospermum*, *Rhizopus stolonifer* and *Sepedonium sp.*. In the present study, it was found that almost 50% of the fish studied were infected with genus *Aspergillus* and thus, it can be concluded that *Aspergillus* sp. is most dominant fungus among all the fungal genera to cause fish diseases.



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## PYRIMIDINE: UNIQUE MOLECULE WITH DIVERSE BIOLOGICAL ACTIVITIES

**Huda Khan<sup>1</sup>, Abha Mishra<sup>2</sup> and Jyoti Pandey<sup>1\*</sup>**

<sup>1</sup>Department of Chemistry, <sup>2</sup>Department of Zoology, Babasaheb Bhimrao Ambedkar University (A Central University) Vidya Vihar, Rae Bareli Road, Lucknow-226025 (U.P.)

\*Corresponding author email: [drjyotibbau@gmail.com](mailto:drjyotibbau@gmail.com)

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Pyrimidine is a heterocyclic aromatic organic compound similar to benzene and pyridine, containing two nitrogen atoms at positions 1 and 3 of the six-membered ring. The pyrimidine ring system has wide occurrence in nature. Synthesis of bioactive annulated pyrimidine derivatives are the most significant molecule in heterocyclic chemistry because these compounds have proved to be very attractive and useful for the design of new molecular frameworks of potential drugs with varying pharmacological activities. The most abundant naturally occurring pyrimidine are uracil (2, 4-dihydroxy pyrimidine), cytosine (2-hydroxy-4-amino pyrimidine), and thymine (2, 4-dihydroxy-5-methyl pyrimidine). The first two are found predominantly in RNA, while the latter two are found predominantly in DNA.



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## ADAPTATION OF RESPIRATORY ORGANS FOR AMPHIBIOUS LIFE OF MUD SKIPPER (*PSEUDAPOCRYPTUS ELONGATUS*)

**Anusha Banerjee and Samiran Ghosh**

Department of Zoology

Bethune College, 181, Bidhan Sarani, Kolkata - 700006

Email id: [itssamiranghosh@gmail.com](mailto:itssamiranghosh@gmail.com)

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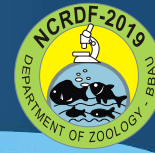
Fish evolved through diverse air breathing organs independently among all phylogenetic lineages. Air breathing fishes embarked into the land. Mudskippers are distinct among them. Due to the advancement of respiratory system, circulatory system has to follow the path of advancement so as to accommodate the blood heading to and from the air breathing respiratory surfaces. However, studies on mudskippers have not shown any significant amount of gross anatomical changes of cardio-respiratory system while in transition from aquatic to amphibious life. In the present study on gill, suprabranchial organ and opercular chamber of *Pseudapocryptus elongatus*, histological organization of these organs were characterized. Four pairs of gill arches supported by bony skeleton were associated striated muscles. Gill lamellae are smaller and opercular chamber was larger. Holobranch gill filaments were distinct. Lamellar sinusoids were narrow, highly vascular spaces delineated by pillar cells. Suprabranchial organ was consists of three layers of tunica externa, submucosa and tunica interna. Double circulation in vertebrates initially evolved as a means of reducing oxygen loss to hypoxic surrounding in which air breathing probably evolved. Location of gas exchange surface with in mouth and small size may be the advantage to invade land in some extent without restructuring cardiovascular system.



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## UTILIZATION OF MULBERRY AND NON-MULBERRY SILKWORM PUPAE OILS IN MEAL AS AN ALTERNATIVE SOURCE OF OMEGA-3 FATTY ACIDS IN THE DIET OF FISH

**Param Dev and Neetu Singh**

Department of Zoology, Babasaheb Bhimrao Ambedkar University (A Central University) Vidya Vihar Raebareli Road Lucknow-226025

Email: [parampcs@gmail.com](mailto:parampcs@gmail.com)

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Mulberry and non-mulberry namely tasar, eri and muga silkworm pupae oils can effectively reduce triglycerides, improve the blood quality and the environment within the blood vessel, effectively soften the blood vessels, lower blood pressure, prevent arteriosclerosis and thrombosis. Therefore, utilization of pupae oils as valuable resources for feeding in fishes is a better way to reduce the environmental impact of silk industry. Mulberry and non mulberry silkworm pupae oils meal is an unsaturated fat-rich feed ingredient of animal origin with a high nutritional value. After the GCMS analysis of mulberry and non mulberry silkworm pupae oils having compound namely alpha linolenic acid (ALA) which is a omega-3 fatty acids, linoleic acid, oleic acid, palmitic acid and stearic acid. The ALA is present in the silkworm pupae oils is used to prevent a variety of diseases such as cardiovascular complication, hypertension, inflammatory and auto immune disorder, depression and certain disrupted neurological functions. This is because it could synthesize eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in the body by a series of chain elongation and desaturation.



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## SCENARIO OF INDIAN ORNAMENTAL FISHERIES

**Jaya Devi<sup>1</sup> and Balwant Singh<sup>2</sup>**

Department of Life Science, Babasaheb Bhimrao Ambedkar University,  
Lucknow-226025 (UP) India

Department of Zoology, B. P. P. G. College Narayanpur- Maskanwa, Gonda-271305

Email id: [jayadevi1642@gmail.com](mailto:jayadevi1642@gmail.com); [balwantsingh1642@gmail.com](mailto:balwantsingh1642@gmail.com)

Ornamental fishes are also known as living jewels. There are more than 30,000 fish species reported around the world, of this about 800 belong to ornamental fishes. Most of the ornamental fishes survive in freshwater. They come under eight closely related families namely, Anabantidae, Callichthyidae, Characidae, Cichlidae, Cobitidae, Cyprinodontidae, Cyprinidae and Poeciliidae. India has great potentials in ornamental fish production due to the presence of rich biodiversity of species, favourable climatic conditions and availability of cheap labour. Kerala, Tamil Nadu and West Bengal mainly practice ornamental fish farming in India. The ornamental species are categorized into indigenous (*Botia lohachata*, *Chandra nama*, *Labeo nandina*, *Notopterus notopterus*, *Colisa lalia*, *Puntius conchonius* etc.) and exotic (*Betta splendens*, *Labeo bicolor*, *Paracheirodon innesi*, *Pterophyllum scalare*, *Symphysodon discus* etc.). Availability of a vast number of native species has contributed significantly to the development of ornamental fish industry in the country. North-eastern states, West Bengal, Kerala and Tamil Nadu are blessed with potential indigenous species. About 90% of native species (85% are from northeast India) are collected and reared to meet export demand. Presently, nearly about 100 native species are reared as aquarium fish. There is also a great demand for exotic species due to its colour, shape and appearance. More than 300 exotic species are covered in the ornamental fish trade, but a greater demand for this still exists. About 200 species are bred in India. 90% of India exports go from Kolkata followed by 8% from Mumbai and 2% from Chennai. Ornamental fishes of India are contributing about 1% of the total ornamental fish trade. These fishes are exported in 69.26 tons, having the value of Rupees 566.66 crores in 2014-15. On an average, an Annual growth rate of about 11% has been recorded during the period 1995 to 2014.



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## WATER QUALITY FOR THE MANAGEMENT OF POND FISH CULTURE

**Balwant Singh<sup>1</sup>, Amrit Kumar<sup>2</sup> and Ram Prakash<sup>1</sup>**

<sup>1</sup>Department of Zoology, B.P.G. College Narayanpur-Maskanwa, Gonda-271305 (UP)

<sup>2</sup>Department of Zoology, S.M.D.P.G. College Jangal Belhar, Santkabir Nagar-272270 (UP)

Email id: [balwantsingh1642@gmail.com](mailto:balwantsingh1642@gmail.com), [amritkumar1642@gmail.com](mailto:amritkumar1642@gmail.com)

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The optimum fish production is totally dependent on the physical, chemical and biological qualities of water to most of the extent. Hence, successful pond management requires an understanding of water quality. Water quality is determined by variables like temperature, transparency, turbidity, water colour, carbon dioxide, pH, alkalinity, hardness, unionised ammonia, nitrite, nitrate, primary productivity, BOD, plankton population etc. The water quality management principles in fish culture have been reviewed to make aware the fish culturist and environmentalist about the important water quality factors that influence health of a pond and are required in optimum values to increase the fish yields to meet the growing demands of present day scenario of the world. Because the food resources are in a state of depletion and the population pressure is increasing on these resources. Therefore, there is the need to ensure that, these environmental factors are properly managed and regulated for good survival and optimum growth of fish.



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## FISH DIVERSITY OF LUCKNOW DISTRICT (UTTAR PRADESH), INDIA

**Pinky Rao, Shraddha Suman, Shalini Gautam, Komal Singh, Vikrant Tomar, Jyotsana**

**Anand, Kumari Preeti and Manoj Kumar**

M.Sc. Zoology, Department of Zoology,  
Babasaheb Bhimrao Ambedkar University, Lucknow

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Lucknow a capital of Uttar Pradesh. It has vast potential of fish faunal diversity and offers considerable scope of inland fisheries development, aquaculture activities in rural for most of the local fisherman. In order to establish fish faunal diversity of Lucknow a preliminary, data have been collected with the help of local fish farmers and market survey. Various lentic and lotic water bodies of different locations have been observed. During the study period, 83 fish species belonging to 58 Genera, 21 Families and 8 Orders have been identified. Cypriniformes was found the dominated Order with 56 species (68%), followed by Perciformes 9 species (11%) and Clupeiformes 6 species (7%). The present study showed that Lucknow possesses rich fish diversity but proper conservation measures are required to maintain sustainability and richness of the species diversity of the district.



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## ILLEGAL, UNREPORTED AND UNREGULATED (IUU) FISHING

**Shivani Singh, Rafiq , Abhilasha, Priya, Sayma, Poonam Pal and Jyoti**

Department of Zoology, BBA University Lucknow (U.P).

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Illegal, unreported and unregulated fishing is a global concern which is bothering regional, national and international governments all over the world. In addition to this it has hampered local farmers also. IUU remain unreported therefore it manipulates the original data base of local fish biodiversity of any region. People use this mode to earn by illegal ways. It impacts the local fisheries and vulnerable species. Fishes being a rich nutritional value, known protein source and also a considerable source of secondary income get explicated in national and international market. Therefore, several legal barriers and strict steps have been formulated by both national and international agencies to protect the threatened and endangered fish species and their illegal trading.



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## ROLE OF WOMEN IN FISHERIES SECTOR

**Trapti chauhan, Anuradha Verma, Premlata, Vijay kumar, Rohit kumar Gautam and Almeen  
Nisha**

Department of Zoology, BBA university Lucknow (U.P).

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In India, women constitute around 48.20% of the total population and comprise one third of the labour force. It is estimated that there are 5.4 million people fully engaged in fisheries activities, and in this population, 3.8 million are fishermen and 1.6 million are fisherwomen. Women traders had less access to social and economic resources profitable markets and high value fish, which resulted in lower income. These gender inequalities are linked to lower women fish traders. Women's have to take care of child and household responsibilities, hence traditionally, fisheries have been associated with men. Their prime focus was primarily on capture fisheries However, nowadays women also perform diverse unpaid task such as mending net, collecting bait, preparing food for fisheries, and keeping accounts which are unacknowledged or undercounted as employment. In addition, women's gleaning of invertebrates and near shore fishing is largely undervalued and almost invisible in management plans and fisheries statistics. Keeping this facts in view, the National bank of agriculture and rural development (NABARD) has launched a number of programs to improve the socioeconomic status of women in the fisheries sectors with a focus on providing credit support through self help groups ( SHGs ) of 14, 313 SHGs, 11,072 SHGS formed by women. Many of the fish cathing, feeding, maintenance etc. accessories and equipments are nowadays are synthesize in industrial where lots of women are ncreasingly employed. In India 25,000 young girls from the state of kerala work in shrimps factories for several months every year.



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## UTTARAKHAND FISHERIES

**Manjulendra Kumar, Shubham Kumar Lal, Akash Mishra, Dhananjay Singh, Satyawan**

**Singh and Devansh Dugtal**

Department of Zoology

Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

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Uttarakhand formerly known as 'Uttaranchal' is situated in the northern part of India. The population of the state primarily depends on agriculture for livelihood. The state has a large variety of fish species and various types of water sources both natural and manmade. Fisheries resources of Uttarakhand are comprises of fast flowing rivers and their tributaries. The state of Uttarakhand is blessed with plenty of natural beauty, including ice covered Himalayan peaks and center of beauty is many freshwater streams and snow fed river all along the landscape. The head water of the holy river Ganges such as Alaknanda and Bhagirathi rivers take origin from Gharwal. Himalayan and other major tributaries like Ramganga and Kali river drain along Kumaon region of Uttarakhand. Fish species associated these river are well documented by many researches since 1882 onwards, from Atkinson (1882) to Badola (2009). Based on these literature, this region has about 125 fish species collected mostly from Gharwal, Himalaya and Kumaon regions. There are several important game fishes reported from this regions such as: mahseer, goonch, murrells and snow trout etc. For meeting the demands of huge population and raising fish farming as the occupation this region has fetched the production of fish and their seeds in tones and lakhs respectively. Numerous beneficial schemes has been provided by fisheries department uttarakhand for boosting fish farming as a occupation even for small farmers.



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## COMPOSITION AND DIVERSITY IN LUCKNOW FISH MARKETS

**Anirudh Tiwari and Ananya Singh**

Department of Zoology

Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

Lucknow despite being land locked city is blessed with vast potential of aquatic bio resources such as river Gomti. She has a stretch of 940 km and contribute 7.39 billion cubic meter of water per year to main river Ganga. She exhibit potential genetic and vivid faunal diversity and after vast scope of inland fisheries development. In order to study fish diversity and customer preference, a preliminary data have been collected from three main fish markets of Lucknow. Fishes in the market are collected from Gomti river as well as borught from different state such as Andhra Pradesh, Orissa and West Bengal and many parts of Lucknow division like Unnao Baharaich and Barabanki. During the study period of one month 30 fish species belonging to 27 genera and 16 families have been identified. Cypriniformes was found to be dominant order with 6 species. It may be due to it's better adaptibility in this particular area, better taste, high nutritional content. It is also rich in isoleucine, leucine and tryptophan amino acids and vitamin B<sub>12</sub> and A. Besides these, it has several health benefits like having anti-inflammatory properties, immunity booster and gastrointestinal health.



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## WASTE WATER (SEWAGE-FED) AQUACULTURE

**Alok Ranjan and Shreya Jaiswal**

Department of Zoology

Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

Water is now highly contaminated with various sources of effluents. However, fish production needs lots of water. Therefore, concept of reusing the waste water after proper treatment is growing. Among them, one of the reuse is done by treatment of sewage waste water. Sewage fed aquaculture is a unique system that has unique advantage in developed tropical countries. It act as major source of nutrient for aquaculture. A large number of people derived their livelihood from sewage fed aquaculture using the principle of system ecology and applying it through ecological engineering. A subject of sewage fed aquaculture is reviewed in terms of sources, chemical nature, diversity pattern, cycling practices, and production of potential for aquaculture. Generally major carps are mostly reffered as source for aquaculture for Rohu, Catla, Mangur etc. That help the rural people to grade-up their poverty line. Advantage of sewage fed aquaculture is-low input cost and high production. The sewage waste water is treated with physical, chemical and biological methods. It reduce pollution load of river and aquatic ecosystem. It uses the waste recycling process and maintain the good environment around the urban area.



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## CONTRIBUTION OF EDUCATION AND RESEARCH INSTITUTE IN FISHERIES AND HELPING FISH FARMERS

**Utkarsh Chauhan, Sunita Sharma, Ashendra Pratap Singh and Km Kusum Gautam**

Department of Zoology, BBA University Lucknow (U.P).

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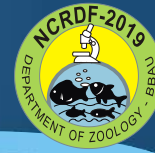
India is one among the biodiversity hotspot in the world and possesses approximately 9.5% of fish genetic resources. Aquaculture resources in India include 2.36 million ha of ponds and tanks 0.798 million ha of flood plain lakes, 195210 km of river canals, 2.907 million ha of reservoirs could be utilized for aquaculture purposes. Imparting fisheries education to peoples from local town to major cities could led to more understanding of fisheries science. Further, after studing fisheries subject the farmers could take up the fish farming as their livelihood and improve the production of fish. In India there are so many fisheries research and educational centers. Their main aim is to not only engage in research and educational area but they also make local people aware about fish biodiversity and their conservation methods. They also help in dragging lagging behind communities to provide ample skill and tools so that they can earn their livelihood as well as may contribute in Nation welfare. Fisheries sector not only contribute in livelihood earning but this has a strong solution to get rid of malnutrition related diseases.



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## DISEASE IN AQUACULTURE, THEIR DIAGNOSIS AND HEALTH MANAGEMENT

**Malay Tripathi**

Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj

Email id: [mt7081444748@gmail.com](mailto:mt7081444748@gmail.com)

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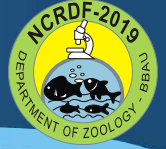
The survival and growth rate of fish under culture depends upon fish diseases. These fish diseases often lead to great economic losses to fish farmers. To reduce such losses, it is very important to take precautions to prevent fish diseases and reduce pathogen levels in water bodies. It is also important to improve water quality and to take certain steps for the natural resistance of the fish stock. Regular monitoring of fish health is an effective way to identify diseases. Disease diagnosis can be basically divided into two types: presumptive diagnosis and confirmatory diagnosis. Disease diagnosis is carried out by study of gross and clinical signs, analysis of clinical biochemistry and environmental parameters, necropsy examination and bright field microscopy or isolation of pathogen. Incorrect diagnosis can lead to ineffective or inappropriate control measures, which may be even more costly. There are multiple recent diagnoses available in aquaculture for disease diagnosis at different levels. Ponds should be dried before starting the culture to get successful grow-out culture. Very good quality of water should be maintained throughout the culture. Disease-free stock should be used from good genetic scale of broodstock. There should be regular monitoring of proper destruction and disposal of infected as well as dead animals. Animals must be handled with good care to avoid unwanted stress. Regulations are required to prevent transfer of pathogens from one host population to another. All these measures will help us improve our overall production and improve the quality of aquatic life as a whole.



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## ROLE OF HOMOEOPATHY IN AQUACULTURE

**Aarushi Dubey**

Pt. Jawaharlal Nehru State Homoeopathic Medical College and Hospital, Lakhanpur,  
Kanpur-208024

Email Id: [aarushidubey18@gmail.com](mailto:aarushidubey18@gmail.com)

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Generation of undesirable side effects due to misuse of powerful drugs (steroids, antibiotics, disinfectants) has inspired the development of aquacultural homoeopathy. It has been found experimentally that the use of homoeopathy in various nations across the globe has helped in obtaining beneficial effects on growth, survival, hepatosomatic index, development of muscle fibres and lipid content in muscle in case of freshwater fishes. Homoeopathy has also been employed to improve the culture of economically important marine species of molluscs, fish and shrimp. Various homoeopathic medicines such as *Passiflora incarnata*, *Valeriana officinalis*, *Ignatia amara*, *Zincum*, *Phosphoric acid*, *Silicea terra*, *Calcium sulphuricum*, *Hepar sulphuris*, *Ferrum phosphoricum*, *Magnesium phosphoricum*, *Mercurius solubilis* were used in the treatment of freshwater organisms (Nile Tilapia: *Oreochromis niloticus*; Pacu: *Piaractus mesopotamicus*), Molluscs (Catarina scallop: *Argopecten Ventricosus*; Horse-mussel: *Modiolus capax*; American oyster: *Crassostrea virginica*; Kumamoto oyster: *Crassostrea sikamea*; Geoduck clam: *Panopea globosa*; Octopus: *Octopus bimaculoides*), Crustaceans (White shrimp: *Litopenaus vannamei*). Homoeopathy has been so far successfully applied in biochemical, zootechnic, genomic and transcriptomic parameters in fish, molluscs and crustaceans. It is found to be effective against epizotic pathogenic bacteria in the hatchery, in increasing haemocyte count, stimulation of growth rate, enhancement of immunity of organisms, increase in the reproductive potential of organisms, improvement of quality of oocytes and decreasing the use of harmful medication and chemical compounds.



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## AQUARIUM MANAGEMENT

**Arya Arun Kumar, Riya Diwedi and Anjali Singh**

Department of Horticulture, BBA University Lucknow U.P

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Aquarium keeping hobby increasing at a steady pace in the last 20 years. After cats and dogs, the most popular pet is now the freshwater fish. The maintenance of fish aquariums is a very difficult task itself. Whenever you have to clean up your aquarium or you have to feed, you have to do a lot of things. Then also keeping fish as pets is much less demanding than taking care of other animals. The maintenance of fish aquariums requires regular maintenance in the form of water parameter testing, changing part of the aquarium water, feeding the fish, maintaining the temperature, lights of aquarium etc. It may happen easy way by keeping the system in automatic mode or in the form of water recleaning and recirculating form. In this way regularly fish will get their required oxygen amount as well as cleaned water in the cost of little management. In our approach, the water temperature control, lighting of aquarium environment, feeding of fishes, draining and infilling of aquarium tank are all will automatically controlled by a software embedded in an intelligent controller to avoid water infections and fish diseases problems.



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## AQUARIUM CONSTRUCTION AND ITS MANAGEMENT

**Prashansa Devi, Harsh Kumar and Yogesh Verma**

Bachelor of Vocational Course (Floriculture and Landscape Gardening)

Department of Horticulture

Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

Email id: [vermayogesh2100@gmail.com](mailto:vermayogesh2100@gmail.com) , [hs1700294@gmail.com](mailto:hs1700294@gmail.com)

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Aquarium is generally a water container with at least one transparent wall for display of inhabitants. This may include any kind of aquatic organism that has some ornamental or economic significance. Commonly ornamental fish of varied colour and vivid fins are favorite residents of aquarium. Aquarium may also have different type of fish with compatible nature along with corals and echinoderms. Aquariums business is also flourishing among different fish trades. With the basic infrastructure one can design very attractive aquariums. Aquarium management is just like a onetime investment business. With the increasing information and technology, simple type of aquarium is now being replaced with fancy and differently designed one. Aquarium represents a versatile combination of inhabiting aquabiota in microenvironment. Aquarium applications also extended from interior decorative to ornamental, corporate industry as well as meditational, stress suppressor. Now a day, aquarium significance further expands to research, education and conservation practices. In the present paper, we provide information about basic aquarium design, preparation, testing of it for durability, capacity etc. Paper will also cover basic points of its management and look after.



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## AQUARIUM FILTERS AND DEVICES

**Saurabh Verma, Shantul Shukla and Vaibhav Soni**

Bachelor of Vocational Course (Floriculture and Landscape Gardening)

Department of Horticulture

Babasaheb Bhimrao Ambedkar University, Lucknow-226025, India

Email Id: [Saurabhverma6855@gmail.com](mailto:Saurabhverma6855@gmail.com)

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An aquarium is of any size having at least one transparent side in which aquatic plants or animals are kept and displayed. Fish caretaker use aquaria to keep fish, invertebrates, amphibians, aquatic reptiles such as turtles, and aquatic plants. Aquarium filters are very necessary components of both freshwater and marine aquaria. Aquarium filters remove physical and soluble chemical waste products from aquaria, simplify maintenance.

Aquarium filters are required to support life as aquaria are relatively small, closed volumes of water compared to the natural environment. Animals, typically fish, kept in fish tanks produce waste from excrement and respiration. Another source of waste is uneaten food or plants and fish which have died. These waste products collected in the aquarium and made water toxic not fit to lead a healthy life contaminate the water. As the degree of contamination rises, the risk to the health of the aquaria increases and removal of the contamination becomes critical. Filtration is a standard method used for the maintenance of healthy aquaria.



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## Recommendations from National Conference on Research Development in Fisheries

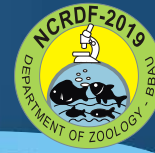
1. Induced breeding of fish is an interplay between brain-pituitary and gonadal axis. An integrated approach required to resolve complicated oocyte maturation arrest in fish breeding. The KISSPEPTIN, vasotocin, GnRH and corticosteroids role still needed more exploration. Nitric oxide has also shown folliculogenesis and steroidogenesis in the same direction. Different fish breeding behaviour to understand fish reproduction discussed in detail.
2. The fish cope up to adverse conditions with the help of specialised organs help us to understand fish diversity and its need. Induction of DNA damage and oxidative stress with anthropogenic reasons well addressed in the conference.
3. The conference had detailed discussion on fish biodiversity and its socio-economic status within India as well as outside of nation. Conference emphasised on to enrich production and biodiversity applied socio-eco-friendly technology. As fish biodiversity threat, we had common member frogs. It acts as prey or predators in a pond ecosystem.
4. Marine fishery as an imminent need for the progress of Indian economy emphasised on fish aggregating devices (FAD).
5. The fish culture with limited water sources like recirculatory captive aquarium recommended. Different design of aquarium, its assembly and management discussed for ornamental fish.
6. The relevance of fish in the study of environmental toxins (effluents to the riverine system), genomics, proteomics with nickel sulphate, pretilachlor (herbicide), PCP (pentachlorophenol), organophosphorous pesticide, hexa and trivalent chromium etc discussed. It suggested as P450 aromatase used as a biomarker for endocrine disrupter.
7. Papers on seasonal fluctuation in innate and cell-mediated immune responses and reproduction (steroid hormones) in teleost presented. Emphasised that immunity and breeding in fish are not constant throughout the year. The thyroid hormone plays an essential role in immune modulation.
8. Different fish parasites helminth, fungal their seasonal and species variation also represents current changing environmental conditions strategies to tolerate against the unfavourable conditions. Macrophage may play an important tool in fish disease curation.
9. The conference presented status, threats and policies to promote and conserve Ichthyofauna. It is required to maintain a sustainable fishery and aquaculture growth. Exotic fish regulation in a planned way will provide native fish conservation.
10. Fish emerged as a conventional experimental animal model to study different physiological mechanism as obesity, the evolutionary role of fish as a parasite reservoir as hepatitis virus was in fish but nonpathogenic. It may emerge as a tool for disease biology and drug release pathway.
11. Aquaculture not only giving food substitute but also provide secondary income by its waste recycling in a profitable manner or one can say “noting is waste in aquaculture”. It helps in women empowerment.



# National Conference on Research Development in Fisheries

(NCRDF-2019)

November 07<sup>th</sup> - 08<sup>th</sup>, 2019



## Summary Report

of

**National Conference on Research Development in Fisheries (NCRDF-2019),**

**Department of Zoology, BBAU**

The Department of Zoology, Babasaheb Bhimrao Ambedkar University has organized 2 days National Conference on Research Development in Fisheries (NCRDF-2019) from 7<sup>th</sup> to 8<sup>th</sup> November, 2019. The event was conducted in the Conference Hall (Old Administrative Building) of BBAU. The Organizing Secretaries of NCRDF-2019 were Dr Abha Mishra and Dr Sandhya, Assistant Professors, Department of Zoology, BBAU.

The Conference was inaugurated by the Hon'ble Vice Chancellor Prof. Sanjay Singh, BBAU on 7<sup>th</sup> November, 2019 who was also the Patron of the NCRDF-2019. The Chief Guest of the NCRDF-2019 was Dr. V.P. Mishra (Director, UP-CST) and the Guest of Honor was Prof. K.P. Joy (INSA fellow, CUSAT, Kochi). The dais was also shared by Prof. D. R. Modi (Director NCRDF, Dean SLSc), Dr. V. Elangovan (Chairperson NCRDF, Head <sup>(i/c)</sup>, Dept Zoology), Dr. Venkatesh Kumar R. (Joint Organizing Secretary, NCRDF), and Dr. Sandhya (Organizing Secretary, NCRDF). Dr Sandhya briefed about the relevance and significance of NCRDF during inaugural ceremony, and other eminent speakers also endorsed the need of fish and fisheries conference in the light of current scenario to get enormous opportunities of employment and a tool against malnutrition and secondary earning by recycling of fish waste. Vote of thanks delivered by Dr. Venkatesh Kumar R.

There were six technical sessions which included Invited lectures of eminent scholars, oral and poster presentations covering broad themes of NCRDF-2019 such as Aquatic ecology and conservation, Physiology and adaptation, Toxicology and remediation, Reproduction and endocrinology, Culture practice and disease management and Morphology, anatomy and Behaviour. The conference was graced by scientists and eminent personalities from across the nation and abroad. Total number of invited speakers was eleven. They have come from different parts of India. A total of 141 participants attended the conference, and 75 abstracts were received. In addition, 30-40 in-house participants were



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also contributor in the conference. Each session was conducted by a Coordinator, Chair, Co-chair, and Rapporteur.

I<sup>st</sup> day, 7<sup>th</sup> November 2019, started at 8 a.m. with the breakfast and technical session had two tea break and one lunch break. I<sup>st</sup> day technical session wind-up at 6 p.m. followed by high-tea with Gazal-E-Sandhya (Cultural evening) and dinner up to 9.30 pm.

II<sup>nd</sup> day, 8<sup>th</sup> November 2019, started with breakfast at 8 a.m. followed by technical session with same breaks as on I<sup>st</sup> day. The NCRDF-2019 ended with valedictory function.

NCRDF-2019 also provided platform for competition on oral/poster presentation among students (research scholars, M.Sc., B.Sc.) and the winners were awarded at Valedictory function.

Meanwhile organizers also collected duly filled feedback forms from delegates and found their suggestions regarding NCRDF-2019. All of them were satisfied/very satisfied with conference lectures, content, schedule and local hospitality (venue, transportation, food, stay). Among suggestions adherence with session time, annual conduction of conference, inclusion of fish farmers/entrepreneur/hawker/vendor and also request to organize workshop to recycle the fish waste was included. Delegates expressed their keen interest and appraise the interior decoration of venue by fish scales done by M.Sc. III<sup>rd</sup> Sem students of Dept Zoology.

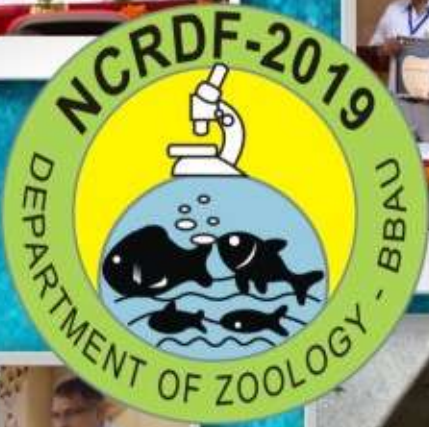
The valedictory function was organized in the presence of Prof. R.P. Singh (Dean Academic Affairs, BBAU), Prof. R.B. Ram (Dean, S.Ag.S.T.), Prof. D.R. Modi (Director NCRDF, Dean S.L.Sc), Dr. V. Elangovan (Chairperson NCRDF, Head<sup>(ivc)</sup>, Dept Zoology), Dr. Venkatesh Kumar R. (Joint-Organizing Secretary NCRDF-2019) and Dr Abha Mishra (Organizing Secretary NCRDF-2019). Detailed report of NCRDF was read by Dr. Venkatesh Kumar R. NCRDF-2019 was successfully completed with the hearty vote of thanks from the Organizing Secretary, Dr. Abha Mishra.



# National Conference on Research Development in Fisheries



NCRDF-2019  
November 07<sup>th</sup> - 08<sup>th</sup>, 2019

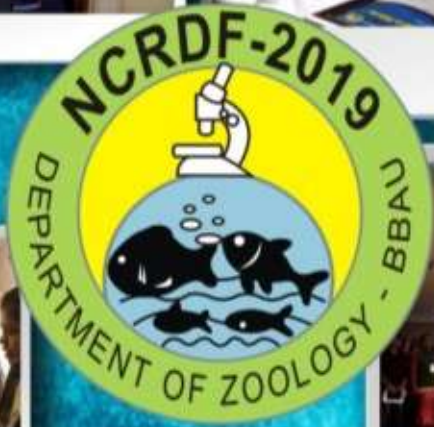




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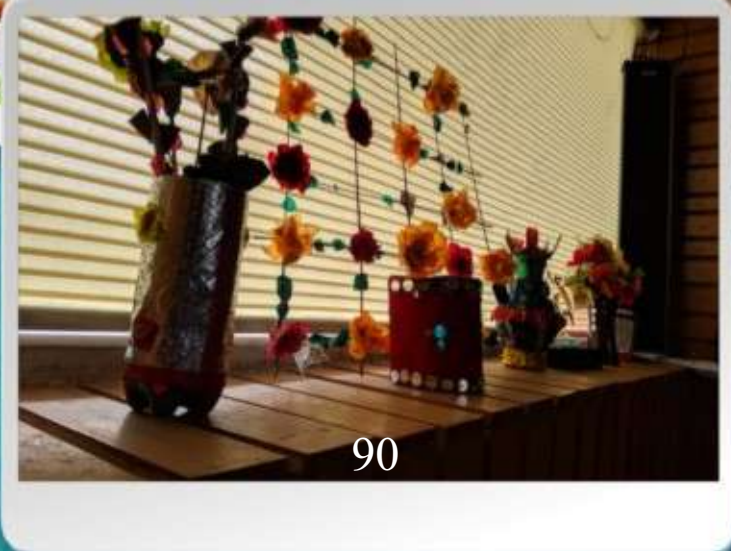
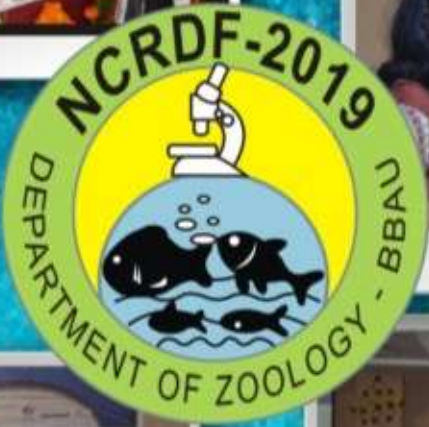




# National Conference on Research Development in Fisheries



NCRDF-2019  
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# Media coverage

## बाबासाहब भीमराव अम्बेडकर विश्वविद्यालय, लखनऊ में मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन

लखनऊ। बाबासाहब भीमराव अम्बेडकर विश्वविद्यालय, लखनऊ के जंतुविज्ञान विभाग द्वारा मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन (एन.सी.आर.डी.एफ.) का आयोजन किया गया। जिसमें मत्स्य क्षेत्र में शोध कर रहे, देश विदेश से आये सैकड़ों वैज्ञानिकों ने हिस्सा लिया। इस राष्ट्रीय सम्मेलन की आयोजन सचिव प्रोफेसर डा. आभा मिश्रा व डा. सन्ध्या ने इस पूरे आयोजन की जानकारी देते हुये बताया कि यह सम्मेलन बी.बी.ए.यू. के पुराने प्रशासनिक भवन के सभागार में आयोजित किया गया। सम्मेलन का उद्घाटन बी.बी.ए.यू. के कुलपति डा. संजय सिंह द्वारा किया गया। अपने उद्घाटन वक्तव्य में बोलते हुये कुलपति डा. सिंह ने कहा कि वर्तमान में जिस तरह खाद्यान्न संकट बढ़ रहा है उसका दहाते हुये ऐसे सम्मेलनों की अत्यन्त आवश्यकता है। आयोजन के मुख्य अतिथि विज्ञान और प्रौद्योगिकी परिषद, उत्तर प्रदेश के



### मैगिस्टर एक्ट के आरोपी को जगदाम पुलिस ने किया गिरफ्तार

जगदाम पुलिस ने मैगिस्टर एक्ट के आरोपी को गिरफ्तार किया है।

### चंद दिनों में ही गर्हों में तब्दील हुआ मार्ग

चंद दिनों में ही गर्हों में तब्दील हुआ मार्ग।



मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन

November 21, 2019



prakash prabhaw news बाबासाहब भीमराव अम्बेडकर विश्वविद्यालय, लखनऊ में मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन में बाबासाहब भीमराव अम्बेडकर विश्वविद्यालय, लखनऊ में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन का आयोजन किया गया।

## मछली स्वास्थ्यवर्धक भोजन ही नहीं बल्कि अपशिष्ट को पुनःप्रयोग कर महिला सशक्तिकरण भी उपलब्ध कराती है : शोध

November 21, 2019 • टैक्सिडोप टूटे प्रकृतियों

लखनऊ। बाबासाहब भीमराव अम्बेडकर विश्वविद्यालय लखनऊ के जंतुविज्ञान विभाग द्वारा मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन (एन.सी.आर.डी.एफ.) का आयोजन किया गया। जिसमें मत्स्य क्षेत्र में शोध कर रहे, देश विदेश से आये सैकड़ों वैज्ञानिकों ने हिस्सा लिया। इस राष्ट्रीय सम्मेलन की आयोजन सचिव प्रोफेसर डा. आभा मिश्रा व डा. सन्ध्या ने इस पूरे आयोजन की जानकारी देते हुये बताया कि यह सम्मेलन बी.बी.ए.यू. के पुराने प्रशासनिक भवन के सभागार में आयोजित किया गया। सम्मेलन का उद्घाटन बी.बी.ए.यू. के कुलपति डा. संजय सिंह द्वारा किया गया। अपने उद्घाटन वक्तव्य में बोलते हुये कुलपति डा. सिंह ने कहा कि वर्तमान में जिस तरह खाद्यान्न संकट बढ़ रहा है उसका दहाते हुये ऐसे सम्मेलनों की अत्यन्त आवश्यकता है। आयोजन के मुख्य अतिथि विज्ञान और प्रौद्योगिकी परिषद, उत्तर प्रदेश के



अम्बेडकर विश्वविद्यालय में हुआ दो दिवस राष्ट्रीय सम्मेलन

November 22, 2019 • Journal News • Leave A Comment

लखनऊ(जनसंघ) बाबासाहब भीमराव अम्बेडकर विश्वविद्यालय, लखनऊ के जंतुविज्ञान विभाग द्वारा मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन (एन.सी.आर.डी.एफ.) का आयोजन किया गया। जिसमें मत्स्य क्षेत्र में शोध कर रहे, देश विदेश से आये सैकड़ों वैज्ञानिकों ने हिस्सा लिया। इस राष्ट्रीय सम्मेलन की आयोजन सचिव प्रोफेसर डा. आभा मिश्रा व डा. सन्ध्या ने इस पूरे आयोजन की जानकारी देते हुये बताया कि यह सम्मेलन बी.बी.ए.यू. के पुराने प्रशासनिक भवन के सभागार में आयोजित किया गया।

## बीबीएयू में मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन का आयोजन

मछली स्वास्थ्यवर्धक भोजन ही नहीं बल्कि अपशिष्ट को पुनःप्रयोग कर महिला सशक्तिकरण भी उपलब्ध कराती है मत्स्य क्षेत्र



लखनऊ। बाबासाहब भीमराव अम्बेडकर विश्वविद्यालय लखनऊ के जंतुविज्ञान विभाग द्वारा मत्स्य क्षेत्र में शोध पर दो दिवसीय राष्ट्रीय सम्मेलन (एन.सी.आर.डी.एफ.) का आयोजन किया गया। जिसमें मत्स्य क्षेत्र में शोध कर रहे, देश विदेश से आये सैकड़ों वैज्ञानिकों ने हिस्सा लिया। इस राष्ट्रीय सम्मेलन की आयोजन सचिव प्रोफेसर डा. आभा मिश्रा व डा. सन्ध्या ने इस पूरे आयोजन की जानकारी देते हुये बताया कि यह सम्मेलन बी.बी.ए.यू. के पुराने प्रशासनिक भवन के सभागार में आयोजित किया गया। सम्मेलन का उद्घाटन बी.बी.ए.यू. के कुलपति डा. संजय सिंह द्वारा किया गया। अपने उद्घाटन वक्तव्य में बोलते हुये कुलपति डा. सिंह ने कहा कि वर्तमान में जिस तरह खाद्यान्न संकट बढ़ रहा है उसका दहाते हुये ऐसे सम्मेलनों की अत्यन्त आवश्यकता है। आयोजन के मुख्य अतिथि विज्ञान और प्रौद्योगिकी परिषद, उत्तर प्रदेश के



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## Indian National Science Academy

The Indian National Science Academy was established in January 1935 with the object of promoting science in India and harnessing scientific knowledge for the cause of humanity and national welfare. The foundation of the Academy, earlier known as the National Institute of Sciences of India (NISI), was the outcome of joint endeavours of several organizations and individuals and the Indian Science Congress Association (ISCA) playing a leading role in this regard. The name of the National Institute of Sciences of India was changed to the Indian National Science Academy (INSA) in February 1970.

### Objectives:

- Promotion of scientific knowledge in India including its practical application to problems of national welfare.
- Coordination among Scientific Academies, Societies, Institutions, Government Scientific Departments and Services.
- To act as a body of scientists of eminence for the promotion and safeguarding of the interests of scientists in India and to present internationally the scientific work done in the country.
- To act through properly constituted National Committees, in which other learned academies and societies may be associated, for undertaking scientific work of national and international importance which the Academy may be called upon to perform by the public and by the Government.
- To publish such proceedings, journals, memoirs and other publications as may be found desirable.
- To promote and maintain liaison between Science and Humanities.
- To secure and manage funds and endowments for the promotion of Science.
- To perform all other acts that may assist in, or be necessary for the fulfilment of the above-mentioned objectives of the Academy.



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**Science and Engineering Research Board**  
Established through an Act of Parliament: SERB Act 2008  
Department of Science & Technology, Government of India

One of the most notable developments in the S&T sector in the XI Plan has been the setting up of the Science and Engineering Research Board (SERB) through an Act of Parliament, viz. the Science and Engineering Research Board Act, 2008. Promoting basic research in Science and Engineering and to provide financial assistance to persons engaged in such research, academic institutions, research and development laboratories, industrial concerns and other agencies for such research and for matters connected therewith or incidental thereto are the primary and distinctive mandate of the Board.

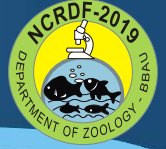
SERB aims to build up best management systems which would match the best global practices in the area of promotion and funding of basic research.



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वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद

Council of Scientific & Industrial Research

विज्ञान एवं प्रौद्योगिकी मंत्रालय, भारत सरकार

Ministry of Science & Technology, Govt. of India

The Council of Scientific & Industrial Research (CSIR), known for its cutting edge R&D knowledgebase in diverse S&T areas, is a contemporary R&D organization. Having a pan-India presence, CSIR has a dynamic network of 38 national laboratories, 39 outreach centers, 3 Innovation Complexes and 5 units. CSIR's R&D expertise and experience is embodied in about 4600 active scientists supported by about 8000 scientific and technical personnel.

CSIR covers a wide spectrum of science and technology from radio and space physics, oceanography, geophysics, chemicals, drugs, genomics, biotechnology and nanotechnology to mining, aeronautics, instrumentation, environmental engineering and information technology. It provides significant technological intervention in many areas with regard to societal efforts which include environment, health, drinking water, food, housing, energy, farm and non-farm sectors. Further, CSIR's role in S&T human resource development is noteworthy.

CSIR has pursued cutting edge science and advanced knowledge frontiers. The scientific staff of CSIR only constitute about 3-4% of India's scientific manpower but they contribute to 10% of India's scientific outputs. In 2012, CSIR published 5007 papers in SCI Journals with an average impact factor per paper as 2.673. In 2013, CSIR published 5086 papers in SCI journals with an average impact factor per paper as 2.868.

CSIR has operational zed desired mechanisms to boost entrepreneurship, which could lead to enhanced creation and commercialization of radical and disruptive innovations, underpinning the development of new economic sectors.

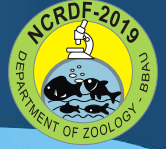
CSIR has put in place CSIR@80: Vision & Strategy 2022 New CSIR for New India. CSIR's mission is "to build a new CSIR for a new India" and CSIR's vision is to "Pursue science which strives for global impact, the technology that enables innovation-driven industry and nurtures trans-disciplinary leadership thereby catalyzing inclusive economic development for the people of India".



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भारतीय कृषि अनुसंधान परिषद  
Indian Council of Agricultural Research  
(Ministry of Agriculture and Farmers Welfare)

The Indian Council of Agricultural Research (ICAR) is an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture and Farmers Welfare, Government of India. Formerly known as Imperial Council of Agricultural Research, it was **established on 16 July 1929** as a registered society under the Societies Registration Act, 1860 in pursuance of the report of the Royal Commission on Agriculture. The ICAR has its headquarters at New Delhi.

The Council is the apex body for co-coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. With **101 ICAR institutes** and **71 agricultural universities** spread across the country this is one of the largest national agricultural systems in the world. The ICAR has played a pioneering role in ushering Green Revolution and subsequent developments in agriculture in India through its research and technology development that has enabled the country to increase the production of **food grains by 5.4 times, horticultural crops by 10.1 times, fish by 15.2 times, milk 9.7 times and eggs 48.1 times since 1951 to 2017**, thus making a visible impact on the national food and nutritional security. It has played a major role in promoting excellence in higher education in agriculture. It is engaged in cutting edge areas of science and technology development and its scientists are internationally acknowledged in their fields.



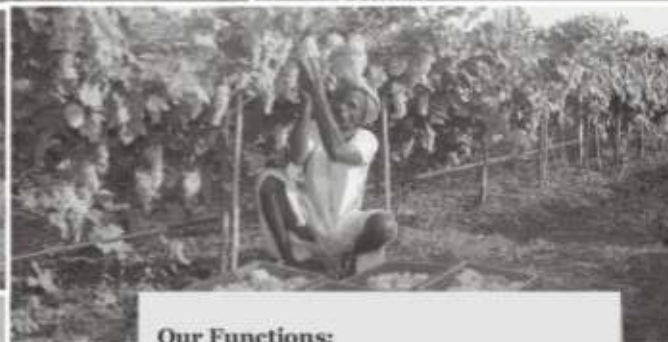
# National Conference on Research Development in Fisheries

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## National Bank for Agriculture and Rural Development



**Our Mission:** Promotion of sustainable and equitable agriculture and rural prosperity through effective credit support, related services, institution development and other innovative initiatives.

- Research and Development on matters of importance pertaining to agriculture, agricultural operations and rural development including the provision of training and research facilities.
- Consultancy services related to Agriculture & Rural Development through subsidiary (NABCONS).

### Our Functions:

- Provide Credit/Refinance for production credit and investment credit to eligible banks and financing institutions.
- Development functions undertaken through Farm Sector Promotion Fund (FSPF), Financial Inclusion Fund (FIF), Watershed Development Fund (WDF), Tribal Development Fund (TDF), Rural Infrastructure Development Fund (RIDF), etc.
- Supervisory functions in respect of Cooperative Banks and Regional Rural Banks.

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[www.nabard.org](http://www.nabard.org)

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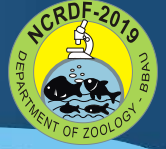
Taking Rural India >> Forward



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## LAB LINE TRADERS

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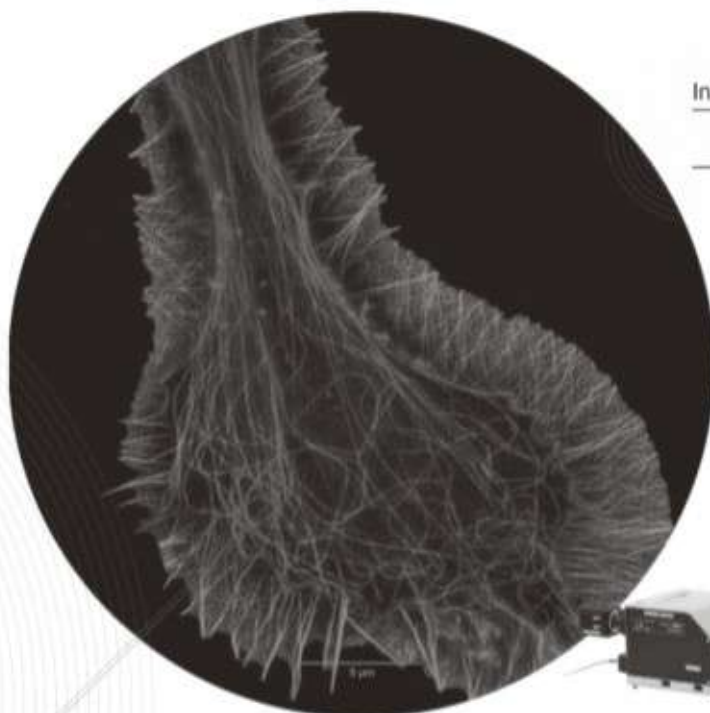
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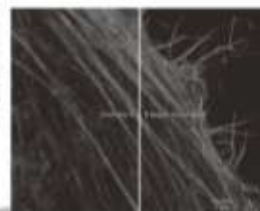
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# National Conference on Research Development in Fisheries (NCRDF-2019)

November 07<sup>th</sup> - 08<sup>th</sup>, 2019



## AQUA World

Contact Person: Indra Mani Raja  
24B, Bogh Makka, Raja Baazar Lucknow - 226003,  
Uttar Pradesh, India +91-8048428707  
<https://www.indiamart.com/aqua-world-lucknow/>





ISBN: 978-93-5396-043-8

