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**Ranvijay Singh**  
Assistant Professor  
Department of Zoology,  
R.P.G. College, Jamuhai  
Jaunpur, Uttar Pradesh, India

**Manoj Kumar**  
Research Scholar Fish Biology  
lab, Department of Zoology,  
Tilak Dhari College, Jaunpur,  
Uttar Pradesh, India

## Comparative taxonomy and toxicity study of freshwater species *Macrobrachium rosenbergii* and teleost fish in the river Ganga & River Sai

**Ranvijay Singh and Manoj Kumar**

### Abstract

A current study investigating the comparative taxonomy and toxicity of the prawn *Macrobrachium rosenbergii* and teleost fish in the River Ganga & River Sai highlight relevant information on the general biology of the giant freshwater prawn (*M. rosenbergii*), its aquaculture, the biodiversity of Ganga River fish, and studies on aquatic species toxicity. one would combine taxonomic information on *M. rosenbergii* and select teleost species with toxicity data from relevant studies on river environments. Freshwater Prawn (*Macrobrachium rosenbergii*): Classify it as a palaemonid freshwater prawn and note its presence in the Indo-Pacific region, including India. River Ganga and Sai existing studies on fish and prawn toxicity in these or similar river systems in India, as direct toxicity studies of *M. rosenbergii* alongside teleosts. Potential Pollutants Mention relevant industrial, agricultural, or municipal pollutants that could affect aquatic life in these rivers, which would be key for toxicity assessments. Species Sensitivity: Analyze the different toxicological sensitivities between the prawn and fish species under study to specific pollutants, which can differ significantly between invertebrates and vertebrates. Environmental Impact Discuss the broader implications for the biodiversity and human health in the region district the importance of understanding the ecological health of major Indian rivers like the Ganga and Sai, focusing on key aquatic species such as the giant freshwater prawn (*M. rosenbergii*) and native teleost fish. Detail the study's aim to compare the taxonomy and differential susceptibility to common environmental toxicants between *M. rosenbergii* and select teleost fish inhabiting these rivers. Briefly describe the sampling strategy, taxonomic identification of species, and the specific ecotoxicological assays that would be used. Predict findings regarding variations in physiological responses and overall tolerance to pollutants between the prawn and fish, noting potential differential vulnerability. Emphasize how these findings would contribute to better environmental monitoring, fisheries management, and conservation strategies for these vital freshwater ecosystems. The research paper focused on how various heavy metals affect a common teleost fish, *Amblypharyngodon mola*, and other freshwater species, a common theme in Indian studies like those found on the National Digital Library of India. Heavy metals contaminate the river, posing risks to both fish and human health, with fish acting as bio-accumulators. Studies are actively conducted to investigate the morphology and biology of various species and their potential to serve as biological indicators for metal pollution

**Keywords:** Comparative taxonomy, *Macrobrachium rosenbergii*, teleost fish, river Ganga, river Sai, freshwater prawn toxicity, heavy metal contamination, aquatic biodiversity, ecotoxicology

### 1. Introduction

Aquaculture has been due to trial-and-error method. Aquaculture is thought to have began when man noticed fish that involved land. Ling (1971) <sup>[13]</sup> wrote that aquaculture began in China and the carp was the first fish to be cultured. Aquaculture means organized culture of aquatic organisms like fish, shrimps, frogs, Mussels, oysters, cuttle fish, squids' crabs and prawns etc. And many species of useful hydrophytes and algae. Aquaculture has emerged as one of the most promising industries in the world with considerable growth potential and expected to contribute around a quarter of the global fishery harvest by the end of 20<sup>th</sup> century (Alagh, 1991) <sup>[2]</sup>. Fresh water prawn farming forms around 5% of the global aquaculture production of shrimps and prawn.

In our country the promotion of culture of prawns in scientific line is being taken up as a priority sector development to utilize nearly 1.6-million-hectare water areas present in the form of ponds and tanks. (Culture practices made during last few years indicated that the monoculture of all the three *Macrobrachium* spp. (*M. rosenbergii*) may not be done alone only but they can also be. The taxonomy of the fresh water prawn *Macrobrachium* has been very confusing due to the great morphological plasticity of this group showing considerable

**Correspondence**  
**Ranvijay Singh**  
Assistant Professor  
Department of Zoology,  
R.P.G. College, Jamuhai  
Jaunpur, Uttar Pradesh, India

intra-specific variations and overshadowing affinities between the related species.

The ecological and taxonomical studies of an aquatic ecosystem have got importance since several biological and physio-chemical factors affects the morphology of aquatic organism (Kanauija, 1994, 2001) <sup>[8]</sup> Planktons plays an important role in transferring energy from one trophic level to next trophic level ultimately leading to fish production in water. Phytoplankton play an important role in maintaining water quality by affecting nutrients concentration, light, oxygen level and bacteria. Toxicology is the field of science that half us understanding the harmful effects of chemicals, environmental contaminants on aquatic organism, such as the effects of pesticides on the health of fish. Toxicity of the pesticides refers to the effects that a poisonous substance. Brief exposure to some chemicals may have little effects on fish, whereas longer exposure may cause harm. Fish and fishery products have been widely recommended for the study of fresh & marine water pollution because of its consumption by a large population in coastal areas. Organization for Economic Cooperation and Development (OECD) has also recommended the use of fish as an environmental indicator. Fishes shows much higher concentration of pollutants compared with those in the surrounding waters, which leads to much cheaper analysis with less efforts for sample preparation. In order to meet the international standard, it is widely suggested that seafood (fish food) consuming and exporting countries should monitor their products for nutritional and pollutant metals contents. The toxicity study is fundamental to find out toxicants limit and safe concentration of pollutants, so that there will be least amount of harm to aquatic fauna in the near future. Among the numerous aspects of toxicity studies, the bioassay constitutes one of the most regularly used methods in aquatic environmental studies with appropriate organisms. The need of determining the toxicity of substances to commercially aquatic forms at the lower level of the food chain has been valuable and accepted for water quality management. Several studies have been performed in assessing the toxicity of pesticide to the aquatic biota especially fresh water teleost fish.

The demand for prawn in world market as expected to be doubled in the next few years from the present level of 8,10,000 tonnes. In this context, India has played a major role in the world market to maximize and improve the economy of the fishery bulk in rural areas. The systematic research on *Macrobrachium* culture in India began from 1957 at central Inland fisheries Research Institution, Cuttack (CIFA) with the first trial on *M. Malcolmsonii*.

In tropical countries like India where there is increasing protein demands fish acts as a cheap source of animal protein. It is known for its protein value, high contents of essentials minerals and for being low saturation fat. We are living in a technological era where technologies make our lives easier. After Green Revolution during sixties especially in India pesticides as knight armors for crops (Srivastava and Singh 2014) <sup>[22]</sup>. India ranks second in aquaculture and third in fisheries production fresh water consists 55% of total fish production. Fishing in India is a major industry employing 14.5 million people. According to the National Developmental Boards (NDB) the fisheries generates export earnings of 334.41 billion. In general, pesticides are used very extensively in agriculture, forestry, public health and veterinary practices are gaining immense importance due to their ability to control weeds and aquatic snails (Gagnaire *et al.*, 2004; Jain *et al.*, 2005 Mushtapha,

2008; Naeem *et al.*, 2010; Abu-Darwish *et al.*, 2011) <sup>[6, 7, 14, 1]</sup>.

## 2. Literature Review

In India the giant prawn *M. Rosenbergii*, the Gangetic prawn *M. Gangeticum* and the Godavari giant prawn the species of high commercial value. The Ganga River is said to be the most holy river in the country and is regarded as purifier of the human body and their sin. Millions of people of the country and abroad take a dip into the holy river in every season and on sacred occasions. Besides the river water is used for drinking, washing, bathing and recreational purposes. It is considered to be the most potent freshwater fishery resources of the country.

Lakshmi Narayan (1959) <sup>[12]</sup>: The first published record on the Ganga River was probably that of who studied the phytoplankton of the water. In subsequent years Pahwa and Mehrotra studied the fluctuation of the plankton population in the stretch of the river from Kanpur to Raajmahal about certain hydrological features. This was further strengthened by the studies of Singh, *et al.*, 1983 <sup>[13]</sup> and Singh and Srivastava, (1988) <sup>[21]</sup>.

Jhingran, (2003) <sup>[23]</sup>: Unfortunately, the whole stretch of the river is posing a unique, challenge to the ecologists of the country. Hydrological studies of Indian waters are mostly restricted to the surface waters of small ponds and tanks and the observation recorded are based on the year-round assessment of the water quality. The significant contribution on record is those of Sinha, 1969 <sup>[19]</sup>.

According to short, (2004) <sup>[17]</sup>; colouration of specimens differs distinctly. *M. rosenbergii* of other habitat differs in shape, size of the body, rostrum, number of teeth, shape of lamina and extension of pereopods. Overall morphological differences are caused by conditions of surrounding area such as water temp, DO, free CO<sub>2</sub> and availability of food. Thus, the present form Somewhat differs from already known forms of *M. rosenbergii*. Author redescribed *M. rosenbergii* at river Ganga Varanasi and found many differences due to climatic conditions of surrounding water. Sarkar, Uttam & Pathak (2012) <sup>[16]</sup> The Ganges is the longest river in India and the fifth longest in the globe. It is also the biggest river in India. Although a vast number of research on fish ecology and systematics have been carried out, the primary purpose of these studies has been to enhance fisheries, the variety of fish and the patterns of their distribution in the Ganges have never been fully addressed from a conservation standpoint.

Kumar, Vinay & Sahu, & Singh (2020) <sup>[11]</sup> In this article, an attempt has been made to look at the many surfactants that may contribute cause toxicity in the human body, especially when ingested through water. The drinking water is the subject of this article. In (2019) before to the commencement of the monsoon season, 10 sites were chosen to measure metals, other physicochemical properties, and surfactant concentration in the river's flowing stream. The analysis's findings showed that other parameter values were noticeably enhanced in addition to the concentration of surfactants.

Kumar, M., & Singh S. K., (2022) <sup>[9]</sup> Studied the harmful effects of pesticides on aquatic life such as fishes. Toxicity of pesticides refers to effects that poisonous substances. The work has been carried out to study the lethal concentration of pesticides on fresh water fishes. Pesticides have direct contacts with surface of fresh water fishes. Finally change the different physiological disorder of aquatic organism (fishes).

Pawan Kumar, Kumar, R., Thakur, K. (2023) <sup>[15]</sup> The present study confirms aquatic animals are very precious to humans because they provide food sources. In order to satisfy the growing demand for food over the past few decades, there has been a significant rise in the widespread application of pesticides. Surface runoff transports pesticide residues into the aquatic environment, where they pose a threat to the plants and animals that live there. The rise in the human population is accompanied by an accompanying rise in the toxicity of pesticides. The toxicity of pesticides causes damage to the aquatic food chain by decreasing the amount of oxygen that is dissolved in water bodies and contaminating the water.

Kumar Manoj., & Singh S. K., (2024) <sup>[10]</sup> The present study confirms that DDT in high concentrations has effects on *Labeo rohita* fingerlings affecting growth parameter, skin, scales, gill structure, ethological and morphological changes. Which thereby could cause toxicity effects on its survivability. Toxicity evaluation LC<sub>50</sub> values and behavioral change in the fish are particularly sensitive marker of pesticides toxicity. The fish's overall health is affected by the pesticides. For this reason, DDT use must be regulated the pesticides runoff from agricultural fields can deteriorate fish health and significantly reduce fish and aquatic organism productivity of water bodies.

3. Material and Methods

Prawn feeds mainly on algae mass and other aquatic weeds. It occasionally feeds on small aquatic animals such as copepods, snails, debris of the bottom. Mostly prawn feeds on both phyto and zooplankton. It feeds mostly at night, being more active at dawn and dusk than at any other time. The monthly collection of Prawns from all the sites were made during the period between June and December. The samples were preserved in 5% Formalin and transported to the laboratory. which include preparing ponds with hideouts, acclimatizing and stocking post-larvae or juveniles at appropriate densities, and feeding with formulated or fermented feeds containing ingredients like soybean, fish meal, and cassava starch residue. The culture cycle typically

involves a nursery phase and an on-growing phase, with management of water quality and prawn growth parameters such as survival, growth rate, and feed conversion. The total length of the individual specimen of all the groups from tip of the rostrum to the tip of the telson was recorded to the nearest mm, species wise and sex-wise. Occurrence of Prawns in fresh water bodies of Jammu is documented by Dutta, 1970 <sup>[24]</sup>. The Indian River prawn, with respect to its larval development, fishery and biology has been studied in some detail by Qureshi *et al.*, 1990 <sup>[25]</sup>; Character for differentiating the young ones of important table prawns of Indian fresh water habitats.

Classification of *Macrobrachium rosenbergii*

Kingdom - Animalia  
Phylum - Arthropoda  
Class - Malacostraca  
Order- Decapoda  
Family - Palaemonidae  
Genus- Macrobrachium  
Species - rosenbergii

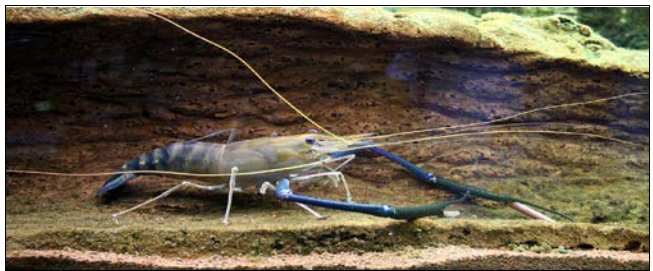
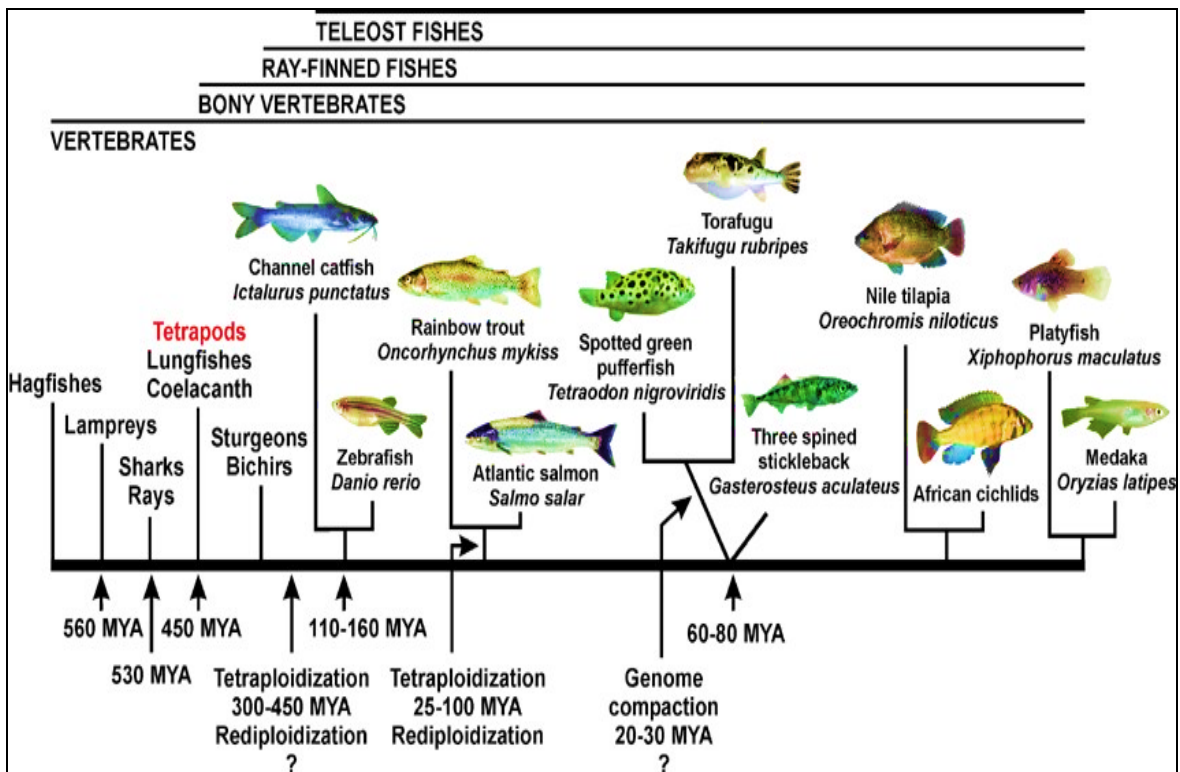


Fig 1: *Macrobrachium rosenbergii*

Classification of teleost fish.

|             |                |
|-------------|----------------|
| Kingdom:    | Animalia       |
| Phylum:     | Chordata       |
| Class:      | Actinopterygii |
| Infraclass: | Teleostei      |
| Division:   | Teleostei      |



### Toxicity Test of Fresh Water Teleost Fish

The acute toxicity of fresh water species was evaluated by exposing the fish to the chemical in stainless steel tanks with static water inside a glasshouse. Following a 96-hour observation period, the concentration of cypermethrin were determined. The cypermethrin concentration in the water exhibited a rapidly rise during the first 24-hour period subsequent to its administration. Subsequently, throughout the subsequent three-day period, the concentration steadily declined, with the rate of decrease being directly related to the initial application rate. Each tank had a total of four fish, while the water level was around 32 centimeters in depth. The water temperature exhibited a range between 24 and 27 degrees Celsius. Fish did not experience mortality when the cypermethrin concentration reached a maximum of 1.8 pg/litre. However, complete fish mortality occurred when the concentration exceeded around 6 pg/litre.

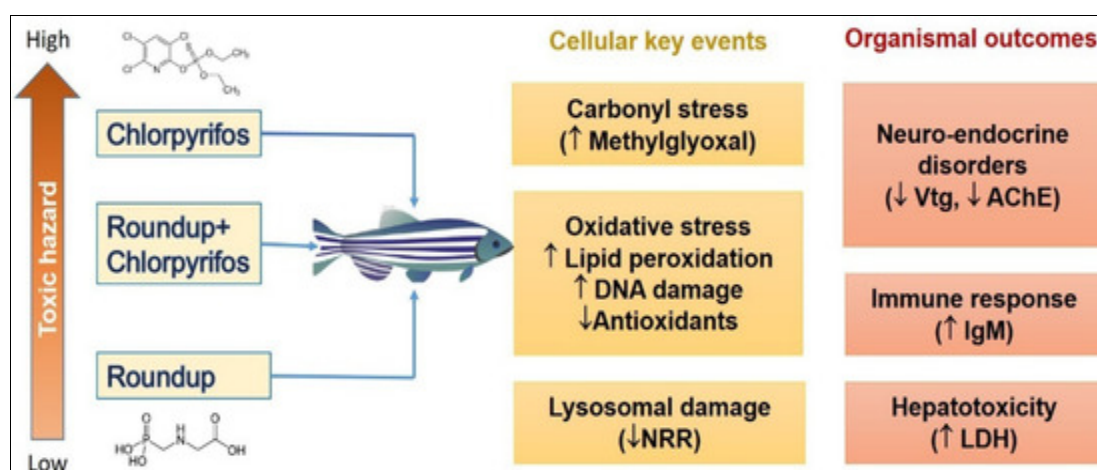
It is a short-term disclosure to toxicants to determine the concentration of a chemical or toxicant effect on the test organism under controlled laboratory condition. Toxicity tests were conducted in accordance with standard methods (APHA, 1992) [3]. The death of the aquatic organism is the most distinguishable response to find out the lethality test or LC<sub>50</sub> concentration of test. The fish were undernourished for 24 hours prior to their use in experiments as suggest by storage to avoid any interference in the toxicity of pesticides by excretory products. After the addition of the toxicants in to the test tank with 12 liters of water having twenty-two fish, mortality was recorded after 24, 24, 72, and 96 hours. Percent mortality was calculated and the values were transferred in to probit scale. Probit analysis was carried out as suggested by Finney (1971) [5]. The acute toxic effect of BHC on gills, liver, stomach and intestinal tract of fresh water teleost fish have shown pathological changes after exposure to a sublethal (2.0 ppm) and a lethal (3.8 ppm) concentration of the toxicant for 24 and 96 h. Damage to the different cells, tissues was more pronounced in a lethal concentration of the chemical and increased time of treatment. The gills exhibited greater damage compared with the liver, stomach and intestinal tract. Swelling of the

secondary lamellae leading to the detachment of the epithelium from the pillar-cell system and its partial degeneration with loss of rigidity of the pillar cell system and hypertrophy in the lamellar channels were the major changes. In the liver, the tissue showed prominent splitting due to the widening of the sinusoids. The cells lost their shape, size and the membrane were ruptured, the cytoplasm became granulated and necrosis was evident. Degeneration of the epithelium shrinkage and atrophy in the tunica propria and vacuolation in different layers of the stomach and intestine tract were also observed.

After exposing fish to log2 concentrations of toxicant (0.001, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, and 0.008ppm) for 96 hours and calculating the percent mortality from the cumulative mortality, the LC<sub>50</sub> values were obtained using the graphical method of Dragsted. The LC<sub>50</sub> is derived from the C50 value of deaths. Using the following finny dragsted formula, we can get the LC<sub>50</sub>:

$$\log LC_{50} = \log A + \frac{50-a}{b-a} \times \log 2$$

The most frequent diseases and symptoms are mild local symptoms from dermal contamination of fishes. Systemic intoxication from high doses or ingestion manifest as a result neurological symptoms on fishes such as (tremors, fasciculations, seizures and coma) and gastrointestinal symptoms (nausea, gastrointestinal irritation, and vomiting). toxic that presented as a suspected organophosphate poisoning on fresh water teleost fish. The fish spent one week in the lab, during which time they were given groundnut cake every day a week to help them adjust to the new environment. The fish were kept in an aquarium with a constant temperature of 28° 1°C duration of this study. Following the advice of Doudoroff *et al.*, (1951) [26], the current study's experiments are carried out in stationary water. Before each estimate, the fish were fasted for 24 hours to remove the impact of food. Holding capacity affects the metabolism of xenobiotics in fishes.



### 4. Results and Discussion

*Macrobrachium rosenbergii* is collected from River Ganga Varanasi. Body dark coloured, rostrum, long (1.25-1.35 times close in young males of 23.4-25.2 mm times close with tip distinctly extending beyond distal end of scaphocerite) but extending up to antennular peduncle. Teeth closely spaced to distal half of rostrum armed with 7-

13 teeth. Scaphocerite stout, 0.56-0.58 times close length 2.16-2.28 times of maximum breath, lamina somewhat rounded from broadest point to anterior margin. Anterior margin produced much forward at inner angles, lateral margin slightly concave. Third maxilliped with ultimate segment reaching up to antennal peduncle, ultimate parallel to penultimate, 0.75 as long as penultimate. M. rosenbergii

larvae was observed during the first hours upon altering the salinity to 0 and 4. Total mortality occurred at 72 h in the salinity of 40. In Test 1 (96 h), the best survival was shown with salinities between 16 and 24, with a maximum of 46.7% in 20 and 24. Giant.

- First pereopod, somewhat cylindrical extending up to sphalerite up to proximal to carpus. Carpus 2.20-2.29 times chela length, 1.22-1.23 times Merus length, a row of long setae presents along inner margin of ischium and basis.
- Second and third pereopods are similar in shape equal in size, large spines, spinules and few scattered rather long stiff setae present on all segments respectively.
- While fourth and fifth pereopods are entirely dactylus extending beyond sphalerite, large spines, spinules and few scattered, rather long stiff setae present in all segments; 15, 16 ventral spines distributed along the length of propodus; Merus 0.84-1.02 times, 2.28-2.42 times longer than ischium.

Identification of the species *M. rosenbergii* (Deman, 1879) <sup>[27]</sup> is supported by the MDA i.e. analysis of the large morphometric data set of the species group indicates distinct species. Similarities of present form to *M. rosenbergii*, stands taxonomic problems. Some additional important distinguishing characters have been identified during present study including colour, habitat, physio-chemical and biological parameters. These affected the morphology of organism.)

Results of various experiments shows that acute toxicity test was found in Fresh water fish species in adults. In Fresh water fish adult  $LC_0$  was found 0.5  $\mu$ l/l,  $LC_{50}$  was found 0.7  $\mu$ l/l and  $LC_{100}$  was found 0.9  $\mu$ l/l concentration of cypermethrin (Table). In Fresh water fish adult  $LC_0$  was found 0.4  $\mu$ l/l,  $LC_{50}$  was found 0.6  $\mu$ l/l and  $LC_{100}$  was found 0.9  $\mu$ l/l concentration of cypermethrin (Table). Data shows that adult of *C. gachua* is more sensitive to cypermethrin than adult of Fresh water fish whereas the  $LC_{100}$  remains the same (0.9  $\mu$ l/l). It was also observed that the acute toxicity of  $LC_{50}$  and  $LC_{100}$  were found different in both adult fish. Acute test for a long period has been a major component in a toxicity testing. In which acute chemical toxicity is determined as a 96 hour.  $LC_{50}$  value however the environmental implication of death of individuals after short term exposure to high concentration is questionable. In contrast to this our results shows Cypermethrin is very toxic even at lower concentration 0.07  $\mu$ l/l for 96 hr.  $LC_{50}$  in Fresh water fish adult and 0.06  $\mu$ l/l in Fresh water fish adult. Lethality in the present study is compared with few earlier published studies that exist but that  $LC_{50}$  for all species exceeded this concentration. Toxicity test provides a measurement of the toxicity of cobalt to given species under specific conditions (pH, Temperature,  $O_2$  &  $CO_2$ ) etc. Aquatic organism is continuously being exposed to various heavy metals especially Cobalt in the environment. The medium lethal concentration ( $LC_{50}$ ) for 24, 48, 72, and 96 hours were found, as were 0.004412, 0.004058, 0.003725 and 0.003558. The lower concentration limit (L.C.L) for 24, 48, 72, and 96 hours were found, as were 0.004401, 0.004051, 0.003719 and 0.003549. The upper concentration limit (U.C.L) for 24, 48, 72, and 96 hours were found, as were 0.004423, 0.004062, 0.003729 and 0.003563. The mortality of fresh water fish decreased with decreasing concentration of heavy metal

## 5. Conclusion

Migration, increase of catchment and decrease of inland water resources. The sex ration also has been observed during the years 2009-10 at both sites. Males were recorded 68-77% during months of June and July while females were recorded 89% in the month of September while minimum (15-23%) in the month of September and July respectively. As regards food and feeding habits it mostly feed upon organic detritus, mudded sand, crustaceans, aquatic plant portions, diatoms, algae and planktons etc. They have been reported carnivorous as well as omnivorous in food habits due to the dominance of detritus, bottom mud and sand present in the gut of *Macrobrachium* species.

According to the present work, Sai River water quality state is gradually declining, as many workers have also noted. The entrance of sewage and other wastes at various stations in Sai River must therefore be effectively checked. It is necessary to inform agricultural crop growers about the negative consequences of using chemicals in the local agricultural areas. An integrated effort from many disciplines is needed to restore the Sai River ecology because it is a vital supply for many city residents. It is therefore necessary to take the water quality of this river seriously and to safeguard, maintain, and preserve such crucial water resources because the health risk and prosperity of the local population in this area are closely tied to the functioning Sai River ecology. Heavy metals support biological production in freshwater habitats however the extent varies from metal to metal. The freshwater teleost fish were exposed to pesticides and heavy metals toxicity in the current investigations. Standard techniques were used to analyses the pesticides & heavy metals toxicity on fish, and probit analysis was used to calculate the  $LC_{50}$  for each time period of 24, 48, 72, and 96 hours. As the dose and duration of exposure to the pesticides & heavy metals toxicity on fish during the fatal toxicity investigation, fish mortality also increased dramatically. The purpose of this test was to get preliminary data on the toxicity of zinc to the freshwater edible fish.

## References

1. Abu-Darwish MS, Al-Fraihat AH, Al-Dalain SYA, Afifi FU, Al-Tabbal JA. Determination of essential oils and heavy metals accumulation in *Salvia officinalis* cultivated in three intra-row spacings in Ash-Shoubak, Jordan. International Journal of Agriculture and Biology. 2011;13:981-985.
2. Alagh AYK. Perspective planning for aquaculture in India. In: Singh VRP, Srivastava HC, editors. Aquaculture Productivity. New Delhi: Oxford and IBH Publishing Co.; 1991. p. 34-42.
3. American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater. 18th ed. Washington, D.C.: American Public Health Association, American Water Works Association, Water Environment Federation; 1992.
4. Borane VR. Histopathological impact of Dimethoate on the kidney of freshwater fish *Garra mullya* (Sykes). International Journal of Life Science Scientific Research. 2016;2(4):451-453.
5. Finney DJ. Probit Analysis. Cambridge: Cambridge University Press; 1971. p. 333.
6. Gagnaire B, Thomas-Guyon H, Renault T. *In vitro* effects of cadmium and chromium on Pacific oyster

- Crassostrea gigas* (Thunberg) haemocytes. Fish and Shellfish Immunology. 2004;10:502-512.
7. Jain P, Sharma JD, Sohu D, Sharma P. Chemical analysis of drinking water of villages of Sanganer Tehsil, Jaipur district. International Journal of Environmental Science and Technology. 2005;2:373-379.
  8. Kanaujia DR. Studies on the biology of some fish food organisms: The cladoderm. [Thesis]. Jaunpur: Purvanchal University; 1994. 221 p.
  9. Kumar M, Singh SK. Toxicity effect of pesticide on freshwater fishes. International Journal of Food and Nutritional Sciences. 2022 Dec;11(11). ISSN: 2320-7876.
  10. Kumar M, Singh SK. Studies on morphological effect of some pesticides on freshwater fish *Labeo rohita* in Sai River of Jaunpur District, Uttar Pradesh, India. Uttar Pradesh Journal of Zoology. 2024;45(12):189-195. <https://doi.org/10.56557/upjoz/2024/v45i12417>
  11. Kumar V, Sahu P, Singh P, Tiwari M, Pramod. Multivariate statistical approach for the analysis of organic and inorganic pollutant loads in Gomati River at Lucknow City. International Journal of Environmental Research. 2020.
  12. Lakshminarayana JSS. Phytoplankton of the River Ganges. [PhD thesis]. Varanasi: Banaras Hindu University; 1959.
  13. Ling SW. Travel report: Visits to Taiwan and Hong Kong. Rome: FAO; 1971. Report No. FID/71/87. 11 p.
  14. Naeem M, Salam A, Tahir SS, Rauf N. Assessment of the essential elements and toxic heavy metals in hatchery-reared *Oncorhynchus mykiss*. International Journal of Agriculture and Biology. 2010;12:935-938.
  15. Kumar P, Kumar R, Thakur K, *et al.* Impact of pesticides application on aquatic ecosystem and biodiversity: A review. Biology Bulletin of the Russian Academy of Sciences. 2023;50:1362-1375. <https://doi.org/10.1134/S1062359023601386>
  16. Sarkar U, Pathak A, Sinha R, Kuppusamy S, Kathirvelpandian A, Pandey A, *et al.* Freshwater fish biodiversity in the River Ganga (India): Changing pattern, threats and conservation perspectives. Reviews in Fish Biology and Fisheries. 2012;22:251-272. <https://doi.org/10.1007/s11160-011-9218-6>
  17. Short JW. A revision of Australian river prawns *Macrobrachium* (Crustacea: Decapoda: Palaemonidae). Hydrobiologia. 2004. In press.
  18. Singh SR. Observation on the seasonal variation in the water quality of Dah Lake (Ballia). Proceedings of the National Science Academy of India. 1983;53(B11):142-149.
  19. Sinha AB. Investigations on the ecology of Ramgarh Lake, Gorakhpur. [PhD thesis]. Gorakhpur: Gorakhpur University; 1969.
  20. Singh RK. Fluctuations in the composition of zooplankton population in relation to hydrobiological conditions of a reservoir. Journal of Hydrobiology. 1986;2(3):37-42.
  21. Singh SR, Srivastava VK. Variation in water quality of Ganga River between Buxer and Ballia. Pollution Research. 1988;7(3-4):85-92.
  22. Srivastava R, Singh S. Fate of fungicides on fish *Clarias batrachus*: A complete study. Saarbrücken: LAP Lambert Academic Publishing; 2014. 134 p.
  23. Dill S, Eiron N, Gibson D, Gruhl D, Guha R, Jhingran A, Kanungo T, Rajagopalan S, Tomkins A, Tomlin JA, Zien JY. SemTag and Seeker: Bootstrapping the semantic web via automated semantic annotation. In Proceedings of the 12th international conference on World Wide Web 2003 May 20 (pp. 178-186).
  24. Dutta NC. Occurrence of prawns in freshwater bodies of Jammu. Indian J Fish. 1970;17(1):98-102.
  25. Qureshi TA, Mustafa S, Rahman MA, Choudhury SN, Saha SB, *et al.* Studies on the larval development, fishery and biology of the Indian river prawn *Macrobrachium malcolmsonii*. J Inland Fish Soc India. 1990;22(2):45-52.
  26. Jhingran A, Burke TW, Eifel PJ. Definitive radiotherapy for patients with isolated vaginal recurrence of endometrial carcinoma after hysterectomy. International Journal of Radiation Oncology\* Biology\* Physics. 2003 Aug 1;56(5):1366-72.
  27. de Man JG. On some species of the genus *Palaemon* Fabr. with descriptions of two new forms. Notes from the Leyden Museum. 1879 Jan 1;1(3):165-84.