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11. Macrobrachium Lamarrei: A Jack of all Trades

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Abstract:

Macrobrachium lamarrei is a highly abundant aquatic prawn species (freshwater), is rather an understudied organism. Interestingly, it is semi-transparent in appearance. Fundamental studies on this organism have indicated its capability as an excellent model for research on ecotoxicology, neurobehavioral biology, developmental biology, ecology and climate change. Separately, it has an impact on the food security aspects. Through this article we want to highlight this species for further valuable research and believe this species is a substantially important species in the spotlight.

11.1 Introduction:

Macrobrachium lamarrei (Arthropoda: Crustacea: Decapoda), is a freshwater species (Figure 11.a) that is abundant in various types of freshwater bodies, like ponds, rivers, lakes etc. It has an average length of 3.5 cm.

The body is distinctly divided into cephalothorax and abdomen. The species is already established as a delicacy in different parts of the Indian subcontinent and has an optimum occurrence as a native species.

It must be noted that the species is on an important stratum of the food chain. In addition, prawns are very importantly taken into account due its participation in crustacean food security aspects.

Bose et al., (2021) recently elucidated the commercial role and food security traits of M. lamarrei and the indicated that this highly occurring species can have a positive impact on the economically weaker rural population regarding getting protein rich food in an affordable price.

Figure 11.a: *Macrobrachium lamarrei* (Photograph taken by Chayan Munshi)

Several researchers consider prawns and shrimps as an excellent model organism under the phylum Arthropoda as these crustaceans can be used very significantly in ecosystem-based research, precisely in aquatic climate change research, aquatic ecology, and evolutionary biological research. In this article we are elucidating *Macrobrachium lamarrei* as one model aquatic invertebrate which is can be used effectively in the diverse biological research.

11.2 General Biology of *Macrobrachium Lamarrei*:

Sharma and Subba (2005) calculated the fecundity of eggs in *M. lamarrei* in terms of total number of eggs per weight of the female. This species has a big range of fecundity (69-143 eggs per female), depending on the season and body length (Hussain and Manohar, 2016). The high fecundity rate of the species led to an easy availability throughout the year. Ovigerous or berried prawns carry their eggs in the ventral portion of their abdomen. The eggs remain attached with the pleopods by a gelatinous substance. Dinakaran et al., (2013) described the event of fertilisation in *M. idella idella,* which is similar to *M. lamarrei.* The sperms from the spermatophores fertilise the ova in the thorax (ova are released from the ovary, situated in the thoracic region). Fertilised eggs are further placed within the pleopods and are incubated there. The development of the eggs occurs in the pleopods and finally females release larvae directly in the water (Figure 11.b). The hatching temperature strictly ranges from 24^{o} C to 30^{o} C; however, the ideal temperature is 27^{o} C. Fertilised eggs are deep green in colour and with the advancement of the development the colour of the eggs fades out and finally turns transparent. The shape of the fertilised eggs is elliptical and in the last stage it becomes ovoid (as it possesses the larvae inside). Newly fertilised eggs have huge yolk content. With the progress of the development, the yolk area decreases (Rashid et al., 2013).

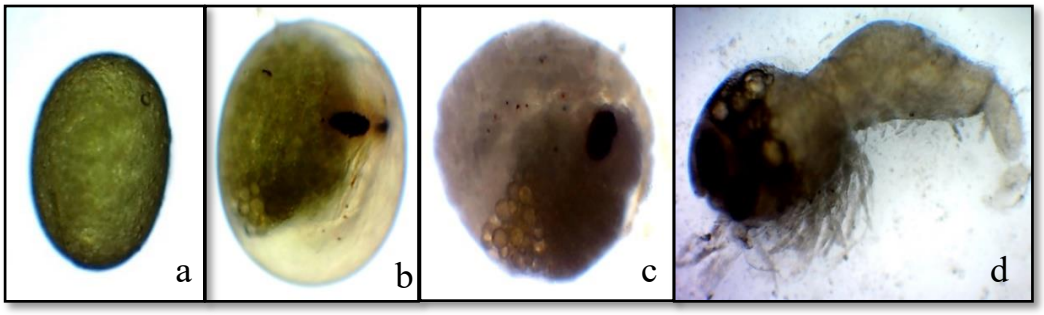

Figure 11.b: Sequential egg development stages in *Macrobrachium lamarrei* (a) non eyed stage; (b) two eyed stages; (c) larva containing stage; (d) larva

11.3 Advantages of The Semi-Transparent Appearance:

Semi-transparent species are considered to be great for visual tracking of the internal systems, as external observation can be done easily. Visual imaging is very prone to experimental artefacts and the experiments can help to find accurate and reliable information as well. Investigations conducted on live cells has gained acceleration in the last decade.

This can help to provide an insight into the working methodologies of certain cell-based metabolic processes. Fluorescent protein and synthetic fluorophore technology have aided quite a bit in this kind of experiment. Live-cell imaging has become an important tool in the case of biological advancement. Similarly, working on live animals has also become an integral part of biological research. This is more facilitated when the research is going on in a transparent or semi-transparent organism. To be precise, methodologies in the case of visual live imaging become easier with the help of semi-transparent species as one will be able to observe the flow of fluorescent and luminescent stains within the organism with appropriate scientific devices.

Examination of the species becomes simple when the researcher wishes to observe into a specific behavioural trait and the underlying internal physiology in the organism. This has proven to be helpful in numerous fields like developmental biology, pharmacology, and several other biomedical research disciplinary areas. Technical success lies in the circumstance when imaging experiments can be conducted successfully in a healthy and functioning environment.

Macrobrachium lamarrei can be very helpful in the case where the ongoing research is about administering a certain stimulus to observe the behavioural and physiological changes in the organism. Internal components tracking is easy with fluorescence or bioluminescence. Although there can be some complications about sufficient spatial and temporal resolution and also importantly toxicity should not be induced, the overall observation process becomes very easy and convenient. As the entire process is facilitated in the presence of a semi-transparent species like *Macrobrachium lamarrei,* it is advisable that this be used for further research in several biological fields.

11.4 Toxicological Aspects:

Increasing anthropogenic activities have become a serious threat to the ecosystem due to release of contaminants in the environment. These contaminants include hazardous synthetic chemicals and natural contaminants like heavy metals, pesticides, microplastics etc. In particular, aquatic ecosystems are being heavily exposed to such pollutants and the resident organisms are being affected. Acute toxicity can affect the physiology of the organisms and eventually causes death. However, low, non-lethal concentration with a chronic exposure can led to several physiological threats.

Ecotoxicology has evolved as one of the most important spheres in biology. Behavioural toxicity is one of the most significant areas in this field that can help to assess behavioural alterations and underlying neurological disorders in organisms, due to several toxic hazards. It has been found in a series of experiments that arsenic trioxide can stimulate repetitive grooming in *Macrobrachium lamarrei,* a freshwater prawn species (Munshi and Bhattacharya, 2020).

Grooming is already established as a behavioural marker of neurological stress in animals (Kalueff et al., 2016). It can be predicted with this experiment that repetition in the grooming behaviour can indicate neurotoxicity by arsenic and induce autism spectrum disorder within a short period of time as well (Munshi et al., 2021). A comparative ethogram study of *M. lamarrei* in both arsenic contaminated and uncontaminated study strongly indicate behavioural alterations (Figure 11.c).

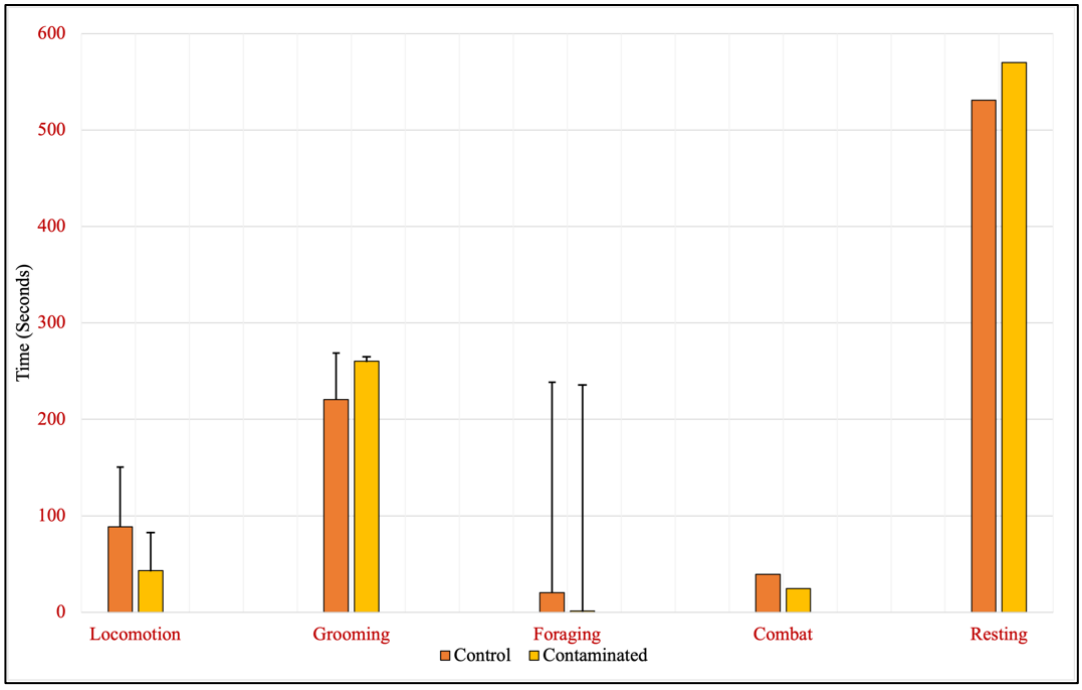

Figure 11.c: Comparative ethogram of *Macrobrachium lamarrei*

As per the prior reports on *Macrobrachium lamarrei*, there is evidence to support that environmental contaminants can induce behavioural alterations in this species (Munshi and Bhattacharya, 2020; Singh, 2014; Verma, 2012; Lodhi et al., 2006; Upadhyay and Shukla, 1986; Murti and Shukla, 1984; Murti and Shukla, 1984) (Figure 11.d). It has been demonstrated in some pilot studies that the change in the aquatic environment leads to immediate behavioural change in this species.

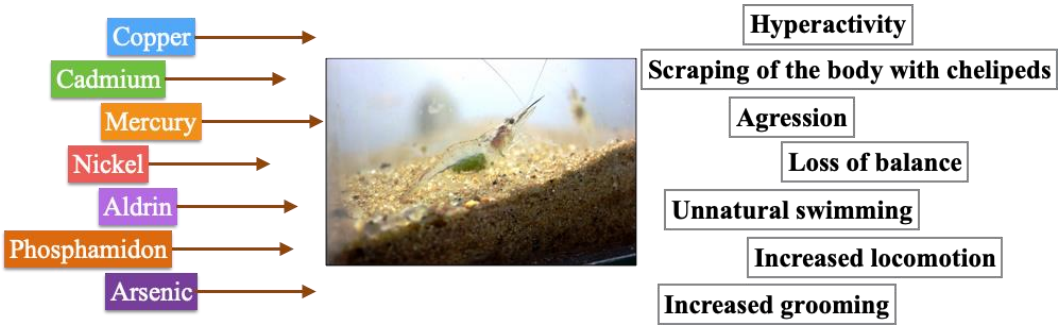

Figure 11.d: Demonstrating the effects of contaminants on (Munshi and Bhattacharya, 2020; Singh, 2014; Verma, 2012; Lodhi et al., 2006; Upadhyay and Shukla, 1986; Murti and Shukla, 1984; Murti and Shukla, 1984)

11.5 Discussion:

Aquatic ecosystems broadly include vast research perspectives, due to the complex biodiversity in several aquatic ecosystems. It is highly believed by biologists that assessment of the effects of environment or climate change in biological system can be done in terms of the analysis of several biological biomarkers. For past few decades, toxicologists have been highly concerned in working with fish (an effective vertebrate model) to understand altered physiology and behaviour due to acute and chronic environmental contaminant exposure.

Since the last few decades, climate change has been a matter of global research and an issue of concern. Global warming, ocean acidification, drought, and environmental pollution are included within this concern. The aquatic ecosystem is directly affected by the impact of climate change. The impact of climate change on aquatic organisms has been studied extensively over the past few years. The effect of climate change on different aquatic organisms can be assessed in terms of behavioural manifestation. There are few organisms in the vast ecosystem of waters, but only few are considered as models to evaluate several biological activities. These models should have certain characteristics like ecological importance, population, sensitivity to the environment and easy to work with.

Fishes are the most common vertebrates used for these kinds of studies. Among the aquatic invertebrates, prawns are considered. Prawns are included as significant models in these studies as they are found in both marine and freshwater ecosystems in different varieties. Therefore, the prawn model can be considered to be important and prominent in the indexing of climate change. Consequently, *Macrobrachium lamarrei* can be considered as an important model to study behavioural plasticity due to climate change. Honey bees are

used very widely among the terrestrial arthropods in neuro-ethological research. Through this article we want to highlight those prawns are most promising models and bioindicators among the aquatic arthropods in biological research. This is because, ecotoxicological, behavioural ecology, neurobehavioral, developmental biology and food security research can be conducted simultaneously with prawn. Precisely, *Macrobrachium lamarrei* is one semi-transparent species that can pose as an exceptional model to study diverse biological phenomena and can contribute to contemporary research work.

11.6 Conflict of Interest:

We declare no conflict of interest.

11.7 Acknowledgement:

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11.8 References:

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