

Fish-Parasite Sentinel System-An Emerging Integrated Biomonitoring Tool in the Offing

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Traditionally, parasites have been considered as detrimental to humans and other biological organisms' because they cause immense damage to their hosts in which they take refuge. This was the general perception about parasites among the public and medical practitioners up to the last quarter of the 20th century, nevertheless, such perception has changed in recent times due to revelation of their relevance in various ecological processes. The term 'parasite' or 'parasitism' is in common usage in various fields (like economy and politics) and is generally used satirically to represent the condition of a person or company as 'a life of large income without work'. In other words, these tiny creatures are considered as idle fellows surviving at the cost of their host. With such narrative about parasite in the third quarter of 20th century, there was hardly any chance for them to be considered for new emerging studies, such as ecology, ecotoxicology and habitat management. The debate about the status of parasite in the ecological web could be interesting if all the parties including parasite, host and nature are asked to comment about the status of parasite.

Keeping in view the curious nature of host-parasite association, one would expect interesting conversation between the parasite (here John) and host (here Jimmy) about the status of neglected but an important creature of biosphere:

John to Jimmy: I'm known to be most cruel and unusual creature of the mother earth; yet few know I'm the most important asset for the biological and ecological system.

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Jimmy to John: Who will trust you? You are the one who is responsible for morbidity and killing of organisms; still, I believe, you are a necessary evil for the biological system.

The so-called ‘Cheaters, Suckers and Grudgers’ have recently become compliment-givers as world celebrities and leaders are now being credited with the name of newly discovered parasites that shows that biologists have acknowledged the importance of parasites in the web of life. In 2016, Barack Obama, former president of the US, was given a compliment when the turtle parasite, *Baraktrema obamai*, was named after him, which according to Thomas Platt (an American parasitologist) reflects the positive features of Barak Obama coinciding with the turtle parasite. The bottom line is that these tiny creatures have many beneficial features, which include the assessment of environmental quality, healing of diseases, understanding ecological principles and other miscellaneous roles.

As parasite is an integral part of disease triangle, it is imperative to unravel the relevance of these amazing creatures in the assessment of environmental health. Parasitism is a common occurrence and the interaction of parasites with the environmental stress is a complex one. Various studies have shown that environmental deterioration affects community structure of parasites. Parasites can be used to assess the environment health due to their important features, which other organisms seldom possess. For example, parasites are cosmopolitan in distribution, are long-lived and able to responds to the environmental alteration through their effect and accumulation properties. There are two ways by which parasites can be used as bioindicators: they can be used as an effect indicator, or they can be used as accumulation indicator. Knowing the importance of parasites and their fish hosts in the ecological milieu, ‘Host-Parasite Indicator System’ was tested across three lentic water bodies (Manasbal Lake, Dal Lake and Anchar Lake) of North West Himalaya showing clear eutrophic/pollution gradient. The overarching aim of the study was to provide empirical evidence in favour of fish parasites along with their fish hosts as ecological indicators in the stressed aquatic ecosystem and to highlight the ecological significance of fish parasites. The important health attributes including infection descriptors and other parameters were taken into consideration to analyze the effectiveness of this integrated sentinel system. Prior to field investigation, working hypothesis was developed to test the effectiveness of ‘Host-Parasite’ system as a biomonitoring tool. It was presumed that parasite diversity and infection pattern of fish helminth parasites will show sharp increase from least eutrophic lake conditions to the eutrophic conditions and furthermore it was predicted that there could be decrease in these parameters when conditions change from eutrophic to hypereutrophic condition. It was further hypothesized that fish collected from hypereutrophic lake will show more deterioration in health parameters than fish collected from least eutrophic lake.

In the first field experiment component community and infra community of helminth parasites of fish was tested for impact assessment study. The findings from the five year study depict that parasitic worms, especially endoparasites seem to be influenced by heavy nutrient enrichment as more percentage of infection was observed in the highly polluted lake than in least polluted lake. For example, average infection recorded in fish was more than 25% in Anchar lake, while as it was 20% in Dal Lake and less than 15% in Manabal lake. There was also numerical dominance

of parasite worms in the eutrophic lake, although in few species of fish less parasite density was observed. All these results reveal that parasite diversity and infection altered across pollution gradient which confirm our hypothesis. There could be two reasons for these findings: firstly the enhanced eutrophication could increase the density of intermediate host of parasites and secondly increased level of eutrophication may change the feeding behaviour of fish and thus fish becomes safe refuge for these tiny creatures.

In the second field experiment individual parasite species were tested as an effect indicator to assess how these tiny creatures behave under different pollution condition. The results show promising response of individual parasite species, especially *Diplozoon kashmirensis* and *Adenoscolex oreini* towards altered water quality. The infection burden on gills of fish was more in hypereutrophic lake than in least eutrophic lake, thus indicating that these miniature creatures enjoy their life in more polluted environmental conditions. The distribution of these smart sentinel ectoparasites also showed marked variation in the infection level on different gill arches that reflected the impact of external environment.

In the third field experiment, both parasite and fish host were used as combined indicator system tested under different environmental conditions to check its feasibility as an integrated bio-monitoring tool. Interestingly the model of using integrated host-parasite sentinel system worked very well as compared to the situation when only tiny parasites were used as an effect indicators. The health indicators of fish also reflected marked variation across the altered water quality, and gonadosomatic index showed significant negative correlation with prevalence. Overall, the findings from this study reveal that infection indices and health attributes in a battery of host species can provide best model for the determination of the status of environmental health of altered aquatic ecosystems.

Based on the above experiments, three scenarios can be expected when using host-parasite as an indicator system: Firstly, if both host and parasite show alteration in density, physiology and biological indices across pollution gradient, then host-parasite system can be considered as an ideal indicator system. Secondly, if only parasite or host show the above alterations, then host-parasite system can be considered as partial indicator system. Finally if host or parasite show changes in some of the above features, then host-parasite system can be considered as an ambiguous indicator system.

The amazing part of this study is that parasites along with their host have ability to act as ecological signatures of environmental health that will further boost to include them in routine environmental impact assessment (EIA) studies. The study further illustrates how these miniature indicators have transformed from unhygienic agents to ecological indicators. Parasites along with their hosts should be considered as sentinels for environmental monitoring provided we have an idea about the life cycle stages, ecology and accumulation capability of a particular parasite species. The environmental parasitology is a novel area, which will unravel the hidden enigmas in future course of time. With this, we are shifting to the ecosystem approach, a synonym for an integrated or holistic approach. This approach of integrating various aspects is essential because it is generally not known which environmental stress responses or combinations of responses might be affected and

therefore suitable for revealing the effect of environmental stress on parasites as well as their hosts. Long-term surveys are needed to elucidate the impacts of deteriorating environmental quality on the community structure of parasites. We also need to improve methodologies, study design, and modelling procedures.

Host-parasite association has always puzzled biologists from time immemorial. With these new findings, this twin association can entice more amazing roles in future that could benefit humans in many ways. The conventional thinking of host-parasite association has now been seen looked in positive perspective, thanks to current approach of research. In coming decades, researchers may unravel new roles of parasites. Parasites like nematodes have been already tested in space. Although there is lot to convince non-parasitologists about the positive roles of parasite, but I feel parasite itself will have to come forward and say,

“Every Parasite is not Ugly and nuisance Creature”