INNOVATIVE ENERGY TECHNOLOGY SYSTEMS AND ENVIRONMENTAL
CONCERNS: A SUSTAINABLE APPROACH
ISBN: 978-93-84144-81-4

EPT (Ephemeroptera, Plecoptera and Trichoptera: Insecta) Technique for Biomonitoring of Selected Fresh Water Ecosystem (Wullar Lake and Dal Lake) of Kashmir Himalaya

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Abstract

Biological monitoring or biomonitoring is the use of biological responses to assess changes in the environment, generally changes due to anthropogenic activities. Biomonitoring involves the use of indicators, indicator species or indicator communities. Generally benthic macroinvertebrates, fish or algae are used. Certain aquatic plants have also been used as indicator species for pollutants including nutrient enrichment. Jammu and Kashmir, the northern most state of India with the climate subtropical in Jammu and temperate in Kashmir. There has been a serious concern about the decline in water quality in the streams and lakes of Kashmir Himalaya because of encouragement, inflow of different heavy metals, sewage and other chemical wastes from municipal origins and by heavy flow of tourists, pollution from sediment and pesticide runoff from farms, residential areas and by construction of dams. Among the various lakes in Kashmir Himalaya, Dal Lake and Anchar lake are highly polluted ones. Government spent a lot of money to control pollution in these lakes but all in vain. The present investigation is derived from statistically and scientifically defensible monitoring designs. The best way to identify measurement parameters that can serve as vital sign of ecosystems, and define the limits of their variation, is through long term biomonitoring. The resulting data sets are analysed to provide the basis for defining limits of variation or diagnosing ecosystem impairment.

1. Introduction

Aquatic ecosystem worldwide are being severely altered or destroyed at a rate greater than that at any other times in human history and far faster than they are being restored. Dal Lake ecosystem (Lat. 340–6′ N, 740-45′ E, alt. 1583m) situated in the heart of Srinagar, the summer capital of Jammu & Kashmir and Wullar Lake (Lat. 34.16° N, 74.33° E, alt. 1580 m), the largest fresh water ecosystem of Asia and some 52 kms away from the capital of Jammu and Kashmir. Both these lakes are under tremendous anthropogenic pressure since more than three decades. The uniqueness of these lakes is that two lakh people live within these lakes itself in various islands (hamlets) besides houseboats and doonga boats. The myriad ways in which people use the lake, along with the numerous pollutant-generating activities have stressed the lake ecosystem in diverse ways. Over enrichment and excessive plant production is probably the most common as an estimated load of 12.30x106 m3 of liquid waste with 18.17 tons and 25 tons of Phosphorus and inorganic nitrogen is enriching lake annually (Kundangar *et al.*

2003). Despite the fact, number of restoration plans by National and International agencies viz., Srinagar Master plan of 1971, Lake Area Master Plan by Stein (1972), Enex Consortium Report (Enex,1978), Dal lake Development Report by Riddle (1985), ODA (1989) Project Report under NLCP (1997) and Project Report of AHEC Roorke (2000), there has been no significant improvement in Dal lake environment but the lake conditions as a whole continue to deteriorate at an alarming rate thereby threatening the very existence of the lake beside posing serious health hazard to the people living within and around the lake.

The traditional water quality monitoring approach has been to collect stream water samples and analyze them in a laboratory for suspected physical and chemical pollutants. Unfortunately, because sampling and analysis are expensive and because concentrations of pollutants vary greatly with time and location, physical and chemical monitoring alone often cannot detect nonpoint source pollution problems. A biological approach to water quality monitoring, biomonitoring incorporates the use of stream organisms themselves as a basis for pollution detection. Europeans first adopted this strategy in the early 1900s to identify organic pollution in large rivers. In the United States, the use of stream organisms as biological indicators or "sentinels" has become widespread only over the last two decades. Several agencies including the Environmental Protection Agency (EPA), the Natural Resources Conservation Service (NRCS), and the U.S. Geological Survey (USGS) now employ biologists whose main task is to implement biomonitoring in streams and rivers across the country. The underlying concept of biomonitoring is simple: certain types of stream animals occur or thrive only under. certain water quality conditions. When conditions change, such as when a stream receives significant nonpoint source runoff, the abundance and distribution of animals in the affected site change as well.

2. Results and Discussions

The present investigation has been started in the July 2014, in a project sponsored by Department of Science and Technology, India. This paper is based on some previous work and survey and samplings of two months under the current project. Some descriptions about Ephemeroptera, Plecoptera and Trichoptera will be discussed as:

Ephemeroptera: These are aquatic insects whose immature stages (nymphs) usually havetwo or three tails (caudal filaments), flattened or fingerlike gills on the abdomen, and one claw at the end of each leg. Nymphs may be strongly flattened or more cylindrical. Adults are terrestrial, meaning they live on land.

Trichoptera: Caddisfly immature (larvae) are caterpillar-like with fleshy (whitish) abdomens, a dark brown head and thorax, and three pairs of well developed legs close to the head. The last abdominal segment bears a pair of fleshy appendages with hooks. Larvae may build and live within cases made from wood, leaf fragments, or inorganic materials such as fine sand, or they may be free living. Adults are terrestrial and resemble small moths. Some noteworthy contributions to this fauna by current author include Parey *et al.* 2013, Parey and Saini 2103, Parey and Saini 2012abc, Saini and Parey, 2012, Parey *et al.* 2012, Saini and Parey, 2011.

Plecoptera: Stonefly nymphs often are confused with mayflies; they differ in that they always have two caudal filaments (never three), usually lack abdominal gills (some have fingerlike gills on the thorax, or midsection, at the base of each leg), and have two claws at the end of each leg Like mayflies, most stonefly nymphs are flattened. Adults are terrestrial

2.1 How Are EPT useful in Biomonitoring?

Typically, EPT are sampled from streams using dip nets or kick screens for qualitative collections or quadrat samplers such as a Surber or Hess sampler for more precise, quantitative collections. After collection, the samples are examined either in the field or in the laboratory. The invertebrates are removed from stones and organic debris, identified as belonging to a particular taxonomic group, and counted. Once counted, invertebrates can be compared to samples taken in the same stream but at different times, such as before and after a suspected pollutant has entered a stream. They also can be compared to samples taken from two or more streams at approximately the same time, such as from a stream suspected of receiving a pollutant and a nearby undisturbed reference stream. Invertebrates may be quantified by species richness (number of unique types of invertebrates present in a sample), abundance (total number of invertebrates in a sample), relative abundance (number of invertebrates in the sample from one species relative to another), and species diversity (distribution of total individuals across species in the sample). One very popular biomonitoring metric is the “EPT” index. This is a measure of the total number of species within the three most pollution-sensitive aquatic insect orders:

Ephemeroptera (mayflies),
Plecoptera (stoneflies), and
Trichoptera (caddisflies).

This index assumes that streams showing high EPT richness are less likely to be polluted than are streams showing relatively low EPT richness in the same region

2.2 Importance of Reference Streams

Because streams differ by many natural factors besides nonpoint source pollution, it is critical to establish a baseline or reference condition upon which differences or changes in water quality resulting from pollution can be judged. Water chemistry (e.g., whether streams drain chalky limestone or more dense sandstone rocks), the nature of the stream bottom and its slope, flow regimes, amount of light, temperature, and other watershed features can greatly affect invertebrate communities independent of human influences. For example, benthic research on undisturbed forested watersheds from four different ecoregions of the southeastern United States (Blue Ridge, Southwestern Appalachians, Piedmont, and Coastal Plains) revealed that streams from different ecoregions can show large, natural differences in invertebrate communities. Total invertebrate and EPT richness often may be higher in upland streams of the Blue Ridge or Southwest Appalachians than in lowland Piedmont or Coastal Plains streams. This demonstrates that stream invertebrates can vary geographically according to differences in natural watershed attributes, and measures such as the EPT index are useful in recording such natural variation. Thus, some measure of reference conditions that incorporates natural variation must be established if biomonitoring is useful in pinpointing changes resulting from nonpoint source impacts in streams.

3. Conclusion

Water quality is a major issue in India and particularly in Kashmir Himalaya which is blessed by Nature with a large number of fresh water lakes in India. The use of Ephemeroptera, Plecoptera and Trichoptera for monitoring water quality has a long history in some of the countries, but does not exist in Kashmir Himalaya or least work has been done in India. Some research, teaching, and public policy development regarding these techniques is being carried out in countries such as Indonesia and Vietnam. In addition, a recently established regional network, the Aquatic Entomological Society of East Asia (Bae 2001), is proving useful for sharing and exchanging information on biodiversity and biomonitoring. Throughout most of Asia, very few species are identifiable in their benthic larval forms, so that current biomonitoring protocols are usually based on family-level or genus-level identifications. More refined analyses, based on species level identifications, would be preferable (Lenat and Resh 2001). However, this remains a goal for the future as larval– adult associations (eg by rearing larvae to adults and/or by DNA analyses, where larvae are unidentifiable to the species level, but adults are identifiable) and larval identifications at the species level are accomplished. As species of larvae are described, tolerance values can be calculated from the physicochemical data acquired from their habitats. Obstacles to the introduction of biomonitoring techniques and improvement of water quality include lack of knowledge of the macroinvertebrate fauna in Kashmir Himalaya and scarcity of equipment and literature. The present research project will form baseline information for future researchers and for policy makers for conserving the fragile aquatic ecosystems of Kashmir region.

4. Acknowledgment

The author is thankful to Department of Science and Technology (DST), New Delhi for providing the grant under fast track young scientist project with sanction order no. SB/YS/LS-312/2013.

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Fig. 1: Collection method of EPT larvae in Dal Lake.

Fig. 2: Algal bloom because of eutrophication in Dal Lake.