

Aquatic Insects for Biomonitoring Freshwater Ecosystems: A Report

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Abstract: Aquatic insects may be considered model organisms in analyzing the structure and function of the freshwater ecosystem because of their high abundance, high birth rate with short generation time, large biomass and rapid colonization of freshwater habitats. Aquatic insects are the major groups of arthropods that spend some parts of their life cycle in the water. Class Insect has many potential representatives that can be used as environmental bioindicators, among which are from the Coleoptera, Diptera, Lepidoptera, Hymenoptera. Water insects or aquatic beetles are biological indicators. The use of bioindicators is essential for environmental monitoring. This study deals with the diversity and importance of aquatic beetles in the freshwater ecosystem and their role in water quality assessment as pollution indicators.

Keywords: Ecosystem, Diversity, Insect, Indicator, Pollution, Freshwater.

1. Introduction

Water is one among the prime necessities of life required for growth and activity of all living beings on globe. Only a small amount of water that occurs in fresh water rivers, streams, lakes and tanks is available for the terrestrial life. Insects are the most diverse group of organisms in freshwater. There are about 7, 51,000 known species of insects, which is about three-fourth known species of plants and animals on the planet. These are also the only invertebrates that can fly [1]. Even though a majority of the insect species lives in freshwater environments, such as swamps, ponds, lakes, springs, streams and rivers, these are called aquatic insects. There are about 45,000 species of insects, known to inhabit diverse freshwater ecosystems. Less than 3% of all species of insects have aquatic stages in some freshwater biotopes, insects may comprise over 95% of the total individual or species of macroinvertebrates.

They play important ecological roles in keeping freshwater ecosystems functioning properly. They are best indicators for Bio assessment and the abiotic environment of the water body directly affect in the distribution, population density and diversity of the fresh water insects. Insects are especially of great significance for fisheries that they themselves act as food of bottom feeder fishes. Water beetles are very integral part of the biotic component of any water body or wetland. Water beetles are very integral parts of the biotic component of any water bodies or wetlands.

Water Beetle is common name for any of numerous aquatic beetles including the true or diving water beetles, the whirligig beetles, and the water scavenger beetles. There are approximately 2000 species of true water beetles native to land areas throughout the world. The hardened elytra, or using covers, which are usually grooved in the female & smooth in the male form a cavity above the body proper. The Beetles rise periodically to the surface of the water to draw a fresh supply of air in to the elytra cavity.

2. Types of Aquatic Insects

Aquatic insects include following taxonomic orders:

- (i) Collembola - the springtails (springs and spring ponds).
- (ii) Ephemeroptera - the mayflies (lakes and streams).
- (iii) Odonata - the dragonflies and damselflies (lakes and streams).
- (iv) Plecoptera - the stone flies (streams).
- (v) Hemiptera - the true bugs (lake and stream margin).
- (vi) Neuroptera/Megaloptera - the dobsonflies, alderflies, and spongillafly, parasitic on sponges (mainly streams).
- (vii) Trichoptera - the caddisflies (lakes and streams).
- (viii) Lepidoptera - the butterflies and moths (aquatic caterpillar).
- (ix) Coleoptera - the beetles (lakes and streams).
- (x) Hymenoptera - diving wasps (terrestrial, parasitic on aquatic insects).
- (xi) Diptera - the true flies (all aquatic habitats).

3. Life Cycle

Aquatic insects are a major group of arthropods which at least one stage of their life cycle occurs in water. Most of them live in water in primary stages that followed by terrestrial adult (e.g., Ephemeroptera, Odonata, Plecoptera, Trichoptera and Megaloptera). Semi aquatic insect are only associated with aquatic and semi aquatic vegetation, the water's surface, or the margins of water habitats [2]. Water beetle is adapted to live in water. There are few water species that live in the intertidal zone. Some species of water beetles have aquatic larvae and terrestrial adults.

4. Importance as Vector

These insects play an important role for transmission of some human and animal diseases. Some species of aquatic insect are medically important vectors that transmit diseases such as malaria, dengue, filariasis, yellow fever, and some other main parvoviruses. Furthermore few numbers of them have a painful bite that cause dermatological effect on human and animal host. Some of them act as a host of trematods

such as dragonfly and damselfly [3]. In some countries dragonfly are considered as a threat to the poultry industry because they transmit a parasitic flatworm of *Prosthogonimus* spp.[4].

5. Importance in Food Web, Nutrient Cycle and Diversity

Aquatic insects may be considered model organisms in analyzing the structure and function of the freshwater ecosystem because of their high abundance, high birth rate with short generation time, large biomass and rapid colonization of freshwater habitats. They play an important role in ecosystem functioning *viz.* nutrient cycling, primary production, decomposition and materials translocation. Different functional feeding groups of aquatic insects such as shredders, scrapers, filter feeders and predators are important links in nutrient recycling. Insects serve as food for fish, amphibians, and water birds. Aquatic insects primarily process wood and leaf litter reaching the wetland from the surrounding landscape. Nutrients processed by aquatic insects are further degraded into absorbable form by fungal and bacterial action. Plants in the riparian zone absorb this nutrient soup transported through the wetlands.

Some of the aquatic insects are responsible for breaking down the dead leaves and plant parts that fall on the water surface. This material provides the base of the food chain in some aquatic environments. Some of them filter suspended particles in water and cause light to reach the bottom of streams where algae grow. Another kind of aquatic insects mix soft sediment of bottom while searching for food and this makes bottom appropriate for organisms and this phenomenon is due to oxygen enrichment of the bottom. Additionally, predator-aquatic insects reduce the numbers of other invertebrates and help keep a balance among different organisms and food reservoir [1]. In addition to this significant ecosystem function, aquatic insects are also a primary source of food for fishes and amphibians.

Chironomid larvae are an important food source for fish and waterfowls [5]. Chironomid species diversity and their sensitivity to eutrophic conditions have been used to create trophic classification of lakes into oligotrophic, mesotrophic and eutrophic [6-8]. Dipteran flies are the most important arthropod vectors of disease in humans and other animals. For example, malaria is a major cause of illness in many tropical countries. About 70 species of *Anopheles* mosquito transmit an estimated 500,000 cases of malaria every year. Yellow fever is transmitted by single mosquito, *Aedes aegypti*. Dengue or break bone fever is transmitted by *Aedes aegypti* and *A. albopictus*.

Aquatic biodiversity is one of the most essential characteristics of aquatic ecosystem for maintaining its stability. Aquatic ecosystems are under increasing pressure from various kinds of disturbances. This situation threatens both aquatic living resources and human population. Biodiversity loss in freshwater ecosystems is an increasing phenomenon, mainly due to human activities [9]. The main causes are the habitat destruction and defragmentation, exotic species introduction and global climate change

impacts [10]. Removal or loss of aquatic insects can cause negative effects in the eco-systems stability and diversity.

Odonates are characterized as an excellent habitat indicator of present and past (long term) environmental conditions in aquatic habitats [11-12]. Dipterans are the most ubiquitous of the entire macrobenthic invertebrate group in tropics. Aquatic Hemiptera have an intermediate place in the food chain, apart from being eaten, are often important predators too [13]. Order Coleoptera, or beetles, is represented by some 3, 50,000 known species [14], but recent estimates suggest that there are hundreds of thousands or even millions of species which are not described. There are about 18,000 species of aquatic coleopteran present on the earth at present. Aquatic coleopterans are highly diverse and distributed to nearly 30 families. The water beetles show wide diversity of colour, form and life pattern [15]. Stone flies represent a very important component of ponds both as biomass and diversity. They are prey for the other macrovertebrates and fishes, including those of economic importance. Plecoptera is a sensitive order of aquatic insects and restricted to habitats where there is a little human interference, clear water, and high dissolved oxygen content. Trichoptera are important processors of organic matter, collectively known as functional feeding groups (FFG) of animals, they display the full array of feeding modes [16].

6. Important Bioindicator

Some aquatic insects are used as an indicator of water contamination. Water quality is evaluated by comparing the number of tolerant species (some midge larva) to the number of intolerant species (Ephemeroptera, Plecoptera, and Trichoptera orders, [1]. Furthermore some of these insects are used in toxicological researches in primary stages [2]. Aquatic insects are found in a wide variety of aquatic habitats from pond, spring, stream to rivers which are different in salinity, pH and other characteristics.

Apart from medical importance of aquatic insects, they play an important role in the ecosystem. Aquatic beetles are biological indicators. The use of bioindicators is essential for environmental monitoring. The characteristics of a bioindicator are richness and diversity species, easy handling, ecological faithfulness, fragility to small environmental changes and good organism responses. Class Insect has many potential representatives that can be used as environmental bioindicators, among which are from the Coleoptera, Diptera, Lepidoptera, Hymenoptera. Aquatic beetles are a diverse group and are excellent indicators of habitat quality, age and naturalness. They are indicators of ecological diversity and habitat characteristics as they meet most of the criteria generally accepted in the selection of indicator taxa. Today these fragile ecosystems are under threat due to intensive anthropogenic influence in the century in response to a variety of factors particularly agricultural intensification and associated drainage of wetlands and increases in diffuse pollution leading to eutrophication.

They are indicators of ecological diversity and habitat characteristics [17-18] as they meet most of the criteria generally accepted in the selection of indicator taxa. The

beetles are especially useful in certain habitats as peat bogs, coastal and saline lagoons, wood and wetland ponds, etc. There is a great deal of papers discussing how to use several methods for estimating the species richness for a wide range of taxonomic groups. The mayfly naiads are an important source of food for fish and other aquatic wildlife. Anglers often use mayflies as bait, or tie “flies” that are made to resemble images and subimagos. The larvae are important as food for other aquatic organisms.

Plecoptera have been used as biogeographical indicators and in evolutionary research. Plecoptera (stoneflies) are a source of food for many game fishes. They have been used for centuries in the sport of fly fishing, and fishermen have good knowledge of them.

Trichopterans feed on debris, cleaning the freshwater ecosystem in which they live besides being an important source of food for fish. Trichoptera larvae, pupae and adults also form an important link in the food chain and they have also been used extensively by trout fishing enthusiasts as models for “flies”.

7. Conclusion

Aquatic insects play an important role for transmission of human and animal diseases. These insects also are important for biological control. Therefore ecological study on aquatic insects can provide information about ecology of insects in an area for any decision making. Conservation of natural resources and biodiversity has become urgent issues in recent years for attaining an environmentally sustainable future. While a lack of data has historically excluded the use of many taxa as possible indicators. Growing number of studies on the habitats and distributional pattern of certain insects is making their use increasingly suitable. The improvement and development of existing and new biomonitoring tools using aquatic insects are a major effort among aquatic entomologists.

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