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Diversity of Aquatic Insects in Relation to the Physico-chemical Parameters of the Selected Water Bodies from Punjab, India

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ABSTRACT

Diversity of aquatic insects in relation to the physicochemical parameters of the two selected ponds of Bathinda region was studied from December, 2021 to May, 2022. A total of 430 individuals of aquatic insects belonging to five orders were collected and identified (upto genus level). More number of insects was recorded from the pond I as compared to pond II. Number of physical and chemical parameters such as temperature, pH, transparency, total alkalinity, water salinity, dissolved oxygen, total hardness, calcium, magnesium, free carbon dioxide, chloride, ammonium nitrogen and orthophosphate levels were also studied to demonstrate the quality of water.

Key words : *Aquatic Insects, Water quality, Punjab*

Introduction

Aquatic ecosystems are rich in the diversity of aquatic organisms. Anthropogenic activities such as pollution from agricultural fields, industries and houses, overexploitation of species and introduction of exotic species etc. continually polluted the aquatic ecosystem which results in the decline or destruction of the diversity of water life. Water bodies have economical, ecological and aesthetic value. Man also depended on these bodies for various resources such as medicines, food and other business purposes including fishing and the travel industry.

Hence, to keep up with the equilibrium of nature and to proceed with the accessibility of resources for coming generation, it is important to secure and conserve the aquatic diversity. Insects are also a part of these aquatic ecosystems called Aquatic insects, have ecological and economical values.These hexapodslive or spend only one or two stages of their life cycle in the water (Pennak, 1978). Analysis of aquatic insects is an important tool for the scientific study due to theease of keeping them in research laboratories, easy availability and speedy rate of their multiplication. Entomology gained man's attention since ancient time due to their coloured body, diversity, behavior and medicinal values of their products (Kaur *et al.,* 2015; Kaur *et al.,* 2018; Kaur *et al.,* 2020; Kaur *et al.,* 2022). They are also useful in studying the ecology, evolution, of the water body, population growth, genetics etc. Aquatic insects are very sensitive towards the level of pollution (Merritt *et al.,* 2008). These tiny forms belonging to the order Ephemeroptera, Odonata, Plecoptera and Trichoptera are restricted tothe aquatic ecosystem in their immature form. The huge number of water in-

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sects of the order Coleoptera, Diptera and Hemiptera spend only one stage of their life cycle in the aquatic habitat (egg, larva/nymph, or adult) (Kaur *et al.,* 2020).

Water insects and their larvae are unavoidable for many important reasons as play role in maintaining the stability of an aquatic ecosystem (Vinson and Hawkins, 1998; Sharma *et al.,* 2004), help in nutrients recycling (Uniyal, 1998), act as a food for fishes, feed on the dead parts of plants that shed off from the land plants into water body thereby help to clean the water body, also act as vectors through which pathogenic forms are transmitted to humans and animals (Foil, 1998; Chae *et al.,* 2000), oxygenates the bottom etc. In some countries such as Thailand, Mexico and Philippines, man consume aquatic insects as a food because they are rich in protein, amino acids, carbohydrates, fat, vitamins and trace elements (Xiaoming *et al.,* 2010).

It is estimated that less than 4% of the total number of insects complete their entire lives in water (Grosberg *et al.,* 2012). All the species belongs to the order Ephemeroptera, Odonata, Plecoptera and Trichoptera have aquatic stages although these orders have little numerical significance as compared to other large orders such as Coleoptera, Diptera, Hemiptera, Lepidoptera and Hymenoptera, where only a few species are aquatic (Bouchard, 2004). The insect have well-segmented body, which further divisible into three regions head, thorax and abdomen. Adaptation towards the aquatic environment is concerned with respiratory mechanism of insects (Pennak, 1978). Aquatic insects respire via various processes such as by using the mechanism of simple diffusion through their thin integument, from a plastron or physical gill, storage of oxygen in the hemolymphin the form of haemoglobin molecules and by exchanging oxygen from the surface via siphons (Mill, 1974; Barnes, 1980; Graham, 1990; Klowden, 2008; Komolafe and Imoobe, 2020).

The presence or absence of specific order or family of insects depending on whether the waterbody is more or less polluted in which they are residing. Thus, aquatic insects can provide relevant information for assessing water quality and also helps the decisions makers to take accurate and justifiable decisions with regards to condition and quality of water bodies (Arimoro and Ikomi, 2008). Negative effects of low water quality due to anthropogenic activities gain much attention of the researchers allround the globe (Deliz-Quinones, 2005; Mishra *et al.,* 2015). Therefore, the aim of present study was to study the physico-chemical parameters of two selected ponds and their effects on the diversity of aquatic insects.

Materials and Methods

Description of Sampling Locations: The study was carried out on twonatural village ponds; Pond 1 is named for Gurusar and Pond 2 for Bhagiwander near Gurudwara sahib. These ponds are permanent, close to the residential houses thus, used for the drainage of sewage and run off from the surrounding areas. The study was carried in two distinct seasons; the winter season is from December, 2021 to Feburary, 2022 while the summer season is from March, 2022 to May, 2022.

Water samples were collected from all three stations after the interval of 15 days. To observe the seasonal variations in aquatic insects, physico-chemical characteristics were investigated such as water and air temperature, pH, dissolved oxygen, free carbon dioxide, hardness, total alkalinity, transparency, nitrate, and phosphate from September, 2021 to February, 2022. Each physico-chemical parameter was evaluated for six times and the average has been considered as the final value. Some parameters were monitored on the spot, while others, the sample bottles were brought to the laboratory for further analysis.

Collection and Identification of the Aquatic insects: In the present study, collection and identification of various types of aquatic insects belonging to different orders was observed. Insects were collected during the morning time from 6.00 am to 8.30 am and evening time from 5.00 pm to 8.00 pm in summer while in the morning from 7.00 am to 9.00 am and evening from 4.00 pm to 6.00 pm in winters. The collection of aquatic insects was done from one square meter of the area with the help of square-meshed cloth (0.50 mm) in the 70% alcoholic grade for further study. After that, these were sorted on the morphological basis and kept in 10 ml or 15 ml vials. A label having the name of collector, date, location, collection site was glued on each vial along with name of specimen after identification. Preservation was done in 70% alcohol and Glycerine (3:1 ratio). Large insects by dry preservation like pinning and stretching. Morphological identification of aquatic insects has been done under separate magnification of stereo zoom microscope and compared

the characters with relevant literature. Detailed descriptions of orders and genus are avoided, as these are present in the relevant literature. Identification was done with the help of relevant literature from various online and offline sources like Hemiptera (Julka, 1977), Coleoptera (Vazirani, 1977), Ephemeroptera (Chopra, 1927), Diptera (Hossain *et al.*, 2004) and Odonata (Mc-Cafferty, 1981).

Results and Discussion

Divesity of Aquatic insects : In the present study, both ponds have been compared for the insect diversity (No of individuals and genus) and physico-chemical water parameters. Overall, there are 5 orders (Hemiptera, Coleoptera, Diptera, Odonata and Ephemeroptera), 11 (*Anisops* sp., *Micronect* sp., *Microvelia* sp., *Mesovelia* sp., *Berosus* sp., *Sternolophus* sp, *Chrionomous* sp., *Culex* sp., *Pantala* sp., *Acisoma* sp. and *Beatis* sp.) genus has been reported. During summer season, in pond I, there are total 4 orders, 9 genus with 271 individuals of aquatic insects has been reported, while in pond II, 3 orders, 6 genus with 92 individuals of aquatic insects has been found. In winter season, pond I with 4 orders, 8 genus and 76 individuals, however in pond II, 3 orders and 5 genus with 86 individuals has been reported. Overall, more insect diversity has been seen in pond I as compared to pond II during the summer season. Number of aquatic insects collected is prominent during the summer season in both ponds than winter season. Order Hemiptera represented with 4 genus followed by Coleoptera (2 genus), Diptera (2 genus), Odonata (2) genus and Ephemeroptera (1 genus) in both studied ponds. Pond I showed higher insects diversity with 9 genus than pond II with only 6 genus reported during summer season. Both ponds showed less diversity during the winter season as in pond I, 8 genus whilein pond II only 5 genus were observed. During summer season, Pond I Hemiptera (4)> Coleoptera (2)= Diptera (2)= Odonata (2)> Ephemeroptera (1), Pond II Hemiptera (4)> Diptera (2) >Coleoptera (1). During winter season, Pond I Hemiptera (4)> Coleoptera (2)= Odonata (1)= Ephemeroptera (1), Pond II Hemiptera (3)> Diptera (1) >Coleoptera (1) (Table 1 and 2 & Fig. 1 and 2.). Eventually, Pond I was rich in aquatic insect's diversity than Pond II.

Physico-chemical water parameters: There was total 13 physico-chemical water parameters have been studied in two ponds during summer and winter season (Table 3, 4 & Fig. 3, 4). There were major changes has been observed in both ponds in both seasons. Overall, during the winter season, Total hardness, Calcium, Magnesium, Free CO_2, Chlorides, pH values are higher in both ponds inthe summer season except Transparency and Tempera-

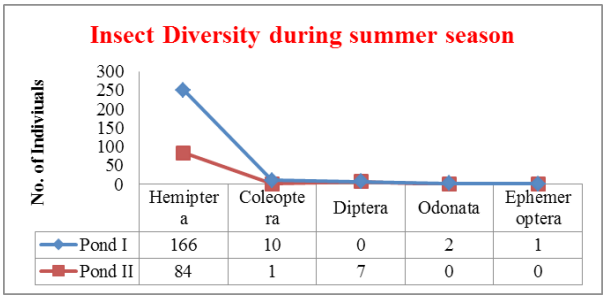

Fig. 1. Comparison of Insect diversity of pond I and Pond II during summer season.

Table 1. Diversity of Aquatic insects In Pond I and Pond II during summer season

Order	Genus	Pond I (no. of Indiviuals)	Pond II (no. of Indiviuals)
Hemiptera	1. *Anisops* sp.	+ (50)	+ (0)
	2. *Micronecta* sp.	+ (28)	+ (17)
	3. *Microvelia*sp.	+ (65)	+ (55)
	4. *Mesovelia* sp.	+ (23)	+ (12)
Coleoptera	1. *Berosus* sp.	+ (5)	-(0)
	2. *Sternolophus* sp.	+ (5)	+ (1)
Diptera	1. *Chrionomous* sp.	- (0)	+ (5)
	2. *Culex* sp.	- (0)	+ (2)
Odonata	1. *Pantala* sp.	+ (1)	-(0)
	2. *Acisoma* sp.	+ (1)	-(0)
Ephemeroptera	1. *Beatis*sp	+ (1)	-(0)
Total	11 (Genus)	9 Genus (179 Indiviuals)	6 Genus (92 Indiviuals)

*(+/- shows the presence or absence of genus)

Table 2. Diversity of Aquatic insects In Pond I and Pond II during Winter season.

Order	Genus	Pond I (no. of Indiviuals	Pond II
Hemiptera	1. *Anisops* sp.	+ (25)	+ (0)
	2. *Micronecta* sp.	+ (15)	+ (17)
	3. *Microvelia*sp.	+ (10)	+ (55)
	4. *Mesovelia* sp.	+ (22)	+ (12)
Coleoptera	1. *Berosus* sp.	+ (2)	-(0)
	2. *Sternolophus* sp.	+ (1)	+ (1)
Diptera	1. *Chrionomous* sp.	- (0)	+ (1)
	2. *Culex* sp.	- (0)	- (0)
Odonata	1. *Pantala* sp.	+ (1)	-(0)
	2. *Acisoma* sp.	- (0)	-(0)
Ephemeroptera	1. *Beatis*sp	+ (1)	-(0)
Total	11 (Genus)	4 Genus (77Indiviuals)	3 Genus (86Indiviuals)

*(+/- shows the presence or absence of genus)

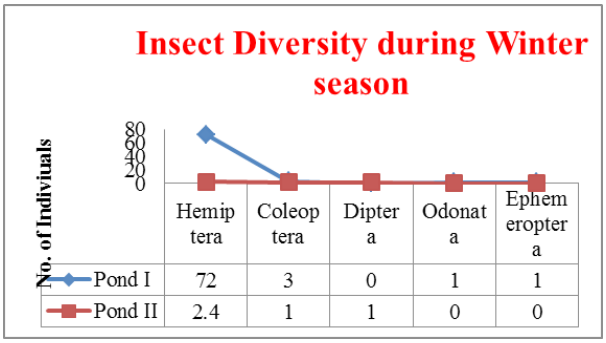

Fig. 2. Comparison of Insect diversity of pond I and II winter season.

ture, while orthophosphate and ammonia nitrogen are observed equal. Pond I and Pond II showed some major difference in summer season as DO, Transparency, Temperature values are higher in pond I than pond II while, Total hardness, Calcium, Magnesium, Free CO_2, Chlorides, pH values are higher in Pond II. A similar difference has been observed in winter season in both selected ponds. Resultantly, Pond I was less pollutedas compared to the Pond II in the form of physico-chemical water parameters.

Relationship of aquatic insect's diversity with Physico-chemical water parameters: The distribution of aquatic insects in a particular water ecosystem directly or indirectly linked with the environmental conditions (Mandape and Kamdi, 2022). The sensitive species residing in water body can be eliminated or gradually become tolerant species inhabiting and grow in abundance by establishing their colonies. In the present study, Pond I was much abundant in aquatic insects diversity thus represent the good ecologically health than pond II. The high number of individuals in pond I was due to the

Table 3. Comparison of Physico-chemical parameters of Pond I and Pond II during summer season

Physico-chemical Characteristics	Summer season	
	Pond I	Pond II
Temperature(°C)	20 ± 6.2	21.3 ± 5
pH	7.2± 0 less	7.8 ± 0
Transparency (cm)	20.1 ± 0 high	17.2 ± 0
Total alkalinity (mg/l)	9.98 ± 0.23	15.8 ± 0.18
Water salinity (mg/l)	11.6 ± 0.34	15.3 ± 0.12
DO (mg/l)	6.9 ± 0.07 high	5± 0.19
Total hardness (mg/l)	9.4 ± 0.22	11.6 ± 0.44
Calcium (mg/l)	9.3 ± 0.08	8.81 ± 0.17
Magnesium (mg/l)	23 ± 1.94	30 ± 0.47
Free CO_2 (mg/l)	15.8±2.12	17.6±5.72
Chlorides (mg/l)	5.4 ± 0.19	16.82 ± 0.55
Ammonia nitrogen (mg/l)	0.34± 0.002	0.41 ± 0.02
Orthophosphate (mg/l)	0.38 ± 0.003	0.42 ± 0.006

high abundance of tolerant species. In pond II, water parameters were changed to a little extent, which also get adjusted by aquatic insects but by less number of species (Salman *et al.*, 2010). The species belongs to order Odonata prefer to the oxygenated and less contaminated aquatic habitat (Needham *et al.*, 2000). Presence of high population of Dipterans containing water bodies indicates that it is heavily polluted and contains less amount of oxygen (Victor and Onomivbpri, 1996). Order Hemiptera can survive in extremely degraded sites and harsh environment having poor ecological conditions (Sunder Mann *et al.*, 2007). Based on the previous studies, it was found that,the population of aquatic insects belonging to order Ephemreoptera, Odonata and Coleoptera, which prefer to reside in less polluted water, was recorded to be high in number in pond I as compared to pond II. On other hand, members of order Diptera and Hemiptera, which are well flourished in poor water quality, was observed in pond II as compared to the pond I. On comparing the physico-chemical characteristics, pond I have high level of DO and temperature and low levels of other parameters as compared to pond II. These observations clearly indicated that Pond I was considered as the less contaminated than the Pond II. Based on the present observations, the two studied seasons also showed some variation such as summer season showed a little higher diversity of aquatic insect communities than winter was due to some favorable condition and due to high temperature and high DO rates.

Table 4. Comparison of Physico-chemical parameters of Pond I and Pond II during winter season

Physico-chemical Characteristics	Winter season	
	Pond I	Pond II
Temperature (°C)	16.3 ± 1.5	15.3 ± 2.1
pH	7.3 ± 0	7.9 ± 0
Transparency (cm)	15 ± 0	12 ± 0
Total alkalinity (mg/l)	21.5± 1.89	16.9± 0.17
Water salinity (mg/l)	15± 0.2	21± 1.53
DO (mg/l)	6.8 ± 0.67	3 ± 0.06
Total hardness (mg/l)	12.5 ± 0.18	17.6 ± 0.5
Calcium (mg/l)	10. ± 1.82	8.81 ± 1.4
Magnesium (mg/l)	25 ± 1.33	45 ± 1.89
Free CO_2 (mg/l)	20±4.37	22 ±2.28
Chlorides (mg/l)	8 ± 0.17	16± 1.63
Ammonia nitrogen (mg/l)	0.34 ± 0.008	0.41 ± 0.02
Orthophosphate (mg/l)	0.38 ± 0.4	0.42 ± 0.03

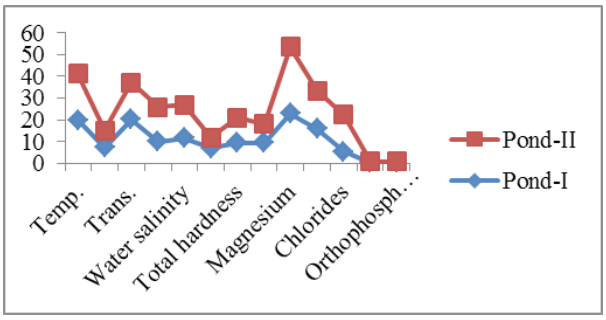

Fig. 3. Recorded changes in the level of different physico-chemical parameters of pond I and Pond II during summer season.

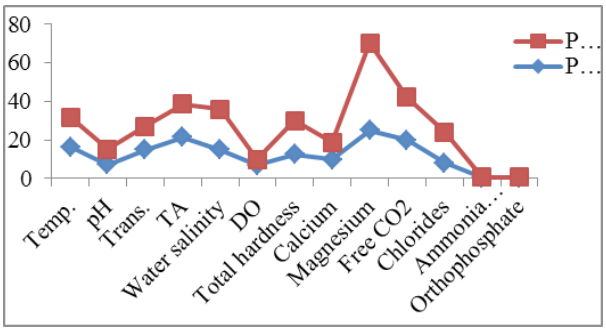

Fig. 4. Recorded changes in the level of different physico-chemical parameters of Pond I and Pond II during winter season.

Conclusion

Overall, in selected water bodies total five orders and 11 genus are reported and relationship of water quality with aquatic insects shows the eutrophic condition of water. This water can be used for some agricultural aspects. Moreover this basic data provides outline for future use of water by taking some serious steps to improve the quality of water.

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