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Use of Aquatic Insects in Water quality assessment of Ponds around two Cement Factories of Assam, India

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Abstract

Present study was carried out using aquatic insects as bio monitors in a few ponds located near Badarpur and Bokajan cement factories, Assam, North East India. Study revealed presence of aquatic insect order Hemiptera, two families (Gerridae and Notonectidae) and three species (Anisops sp. , Gerris sp. and Buenoa sp.) from the ponds located around Cement factory, Badarpur. Anisops sp. was found eudominant in all the ponds except pond 1 where Gerris sp. was eudominant. Ponds (pond 5 and 6) located around Bokajan Cement Factory revealed presence of two aquatic insect orders (Hemiptera and Odonata), five families (Notonectidae, Gerridae, Nepidae, Coenagrionidae and Libellulidae) and eight species (Gerris sp., Anisops sp., Limnometra sp., Ranatra sp., Pseudogrion sp., Ischnura sp., Libellula sp., Sympetrum sp.). In Pond 5, Gerris sp. was found eudominant . In Pond 6, Anisops sp. was found eudominant. In each of the five ponds diversity index (Shannon H' Log Base 10) values were found less than 1 where as signal values were found less than 5.5. Study reported low diversity and occurrence of only tolerant group of aquatic insects in the aquatic systems around the cement factories confirming the fact that aquatic insects are good indicator of water quality.

Keywords: Aquatic insects, bio monitor, cement factory, water quality.

Introduction

Water is one of the most indispensable resources and is the elixir of life. Water constitutes about 70% of the body weight of almost all living organism[1]. Fresh water has a great role in sustenance of life of human beings, other organisms of the environment and maintaining the balance of nature. Water resources are being used by human being for various purposes like agriculture, industries, hydropower, fisheries and recreational uses[2]. Freshwater is a very limited resource and makes up less than 2.8% of the water supply and water is a wonderful chemical medium which has unique properties of dissolving and carrying in suspension, huge varieties of chemicals. Thus it gets contaminated easily and if water is fecally polluted it spreads diseases in consumers to a great number of peoples[3]. Due to tremendous development of industry and agriculture, the water ecosystem has become perceptibly altered in several respects in recent years and as such they are exposed to all local disturbances regardless of where they occur[4]. The impurities may be suspended particles, colloidal materials and may also be dissolved cationic and anionic substances. Man-made activities, like industrial, domestic, agriculture etc. are the main sources of water pollution. The cement industry is one of two primary industrial producers of carbon dioxide (CO_2), creating up to 5% of worldwide man-made emissions of this gas, of which 50% is from the chemical process and 40% from burning fuel[5]. The carbon dioxide (CO_2) produced for the manufacture of one ton of structural concrete (using ~14% cement) is estimated at 410 kg/m3 (~180 kg/tonne @ density of 2.3 g/cm^3) (reduced to 290 kg/m3 with 30% fly ash replacement of cement)[6]. The CO_2 emission from the concrete production is directly proportional to the cement content used in the concrete mix; 900 kg of CO_2 are emitted for the fabrication of every ton of cement[7]. Surface runoff and release of pollutants from cement industries through improper drainage system are the main contributing factors towards contamination of water bodies. Fly ash and red mud containing alkaline oxides, non-metallic oxides and alarming amount of trace and toxic elements and generate various kinds of skin diseases when it is mixes with water[8]. Aquatic insects comprise a taxonomically diverse and ecologically important and interesting group of animals in lentic fresh water systems. They are known to play a very significant role in the processing and cycling of nutrients as they belong to several specialized feeding groups such as shredders, filter feeders, deposit collectors and predators[9]. In spite of their importance as bio-monitors, bio-indicators, predators and bio-control agents, conservationists are far from able to enlist all species under threat. Although insect biodiversity in India amounts to about 10,8,276 species[10], studies conducted on the bio monitoring of water bodies using aquatic insects as bio indicators and ecology of aquatic insects, especially in the lentic systems have so far remained relatively few[11-13]. Taking all these factors into account, in this paper an attempt has been made to understand how occurrence of sensitive and tolerant species of aquatic insects reflect status of water quality of ponds which receive cement factory effluents.

Material and Methods

Aquatic insects were collected by kick method[14,15] from four aquatic ecosystems (pond 1, pond 2, pond 3 and pond 4) located

near Badarpur Cement factory, Barak Valley, Assam and two aquatic ecosystems (pond 5 and pond 6) located near Bokajan Cement factory, Brahmaputra Valley, Assam (figure 1). All the collections were made in monthly intervals for the period of six months from October 2010 to March 2011.

Collected insects were sorted immediately and preserved in 70% ethyl alcohol. Later those were identified using Dewinter Advance Stereozoom Microscope with the help of standard keys[16-23]. SIGNAL (Stream Invertebrate Grade Number – Average Level) values for each of the six ponds were found out using standard methods[24]. Dominance statuses of various insect species were described on the basis of relative abundance following Engelmann's scale[25]. Diversity indices like Shannon diversity index values, evenness index values, Berger- Parker dominance values were calculated as well as Cluster analysis and PCA were worked out using the package Biodiversity Professional Version 2 for Windows, 2007.

Results and Discussion

Ponds (pond 1, pond 2, pond 3 and pond 4) located around Badarpur Cement Factory revealed the presence of single aquatic insect order (Hemiptera), two families (Gerridae and Notonectidae) and three species (*Anisops* sp. *, Gerris* sp. *and Buenoa* sp.). *Anisops* sp. and *Gerris* sp. were recorded from each of the four ponds studied where as *Buenoa* sp. was absent in pond 1. *Anisops* sp. was found eudominant in all the ponds except pond 1 where *Gerris* sp. was found eudominant (table 1). The abundance of *Anisops* sp. could be due to the fact that they produce haemoglobin in large modified fat-body cells within its abdomen and this haemoglobin act as supplementary oxygen [21]. Pond 5 and pond 6, the ponds located around Bokajan Cement Factory revealed only two orders (Hemiptera and Odonata), five aquatic insect families (Notonectidae , Gerridae, Nepidae, Coenagrionidae and Libellulidae) and eight species (*Gerris* sp., *Anisops* sp., *Limnometra* sp., *Ranatra* sp., *Pseudogrion* sp., *Ischnura* sp., *Libellula* sp., *Sympetrum* sp.) were recorded. In pond 5, *Gerris* sp. was found eudominant where as *Pseudogrion* sp. and *Libellula* sp. were found dominant and subdominant respectively. In pond 6, *Anisops* sp. was found eudominant. *Ranatra* sp., *Libellula* sp. and *Sympetrum* sp. were found dominant (table 2). In each of the six ponds studied Shannon Wiener diversity index (Shannon $H^{/}$) value was found to range from 0.29 (pond 1) - 0.76 (pond 6). Evenness index was found to range from 0.78 (pond 5) - 0.96 (pond 1). Berger parker index of dominance was found to range from 0.33(pond 6) - 0.64 (pond -5) (table 3). Cluster analysis revealed similarity of all four ponds reported from Badarpur area where as pond 5 and pond 6 were found dissimilar from all the other ponds and from each other too (figure 2). This fact was supported by Principal component analysis (PCA) too where pond 1 to 4 were found to occupy same axis where as pond 5 and pond 6 were found to occupy different axes (figure 3). Each of the five ponds studied, reported signal value less than 5.5 (score ranging from 0-5.5 suggests pollution, above 5.5 -7 suggest toxic pollution and above 7 indicate good water quality) (table 4) which indicate moderately polluted nature of water[26]. Shannon diversity index value less than one also indicated perturbed nature of water body[27]. This disturbed nature of the ecosystems located in the cement factory campus was due to release of effluent from the cement factory which directly mad their way to the ecosystems in the immediate vicinity. A study on the environmental impact of cement production on biodiversity in Nigeria revealed that the natural vegetation and crops were damaged which lead wildlife species to emigrate[28].

Table-1
Relative abundance and dominance status of aquatic insects of ponds around Badarpur Cement Factory (RA <1 = Subrecedent; 1.1-3.1 = Recedent; 3.2-10% Subdominant; 10.1-31.6 = Dominant and >31.7% = Eudominant)

Aquatic insects from Badarpur			Pond 1		Pond 2		Pond 3		Pond 4	
Order	**Family**	**Species**	**Relative abundance (%)**	**Status of dominance**	**Relative abundance (%)**	**Status of dominance**	**Relative abundance (%)**	**Status of dominance**	**Relative abundance (%)**	**Status of dominance**
Hemiptera	Notonectidae	*Anisops sp.*	61.11	Eudominant	42.11	Eudominant	31.82	Eudominant	18.18	Dominant
		Buenoa sp.	-	-	47.37	Eudominant	59.09	Eudominant	50	Eudominant
	Gerridae	*Gerris sp.*	38.89	Eudominant	10.53	Dominant	9.09	Subdominant	31.82	Eudominant

Table-2
Relative abundance and dominance status of aquatic insects of ponds around Bokajan Cement Factory (RA <1 = Subrecedent; 1.1-3.1 = Recedent; 3.2-10% Subdominant; 10.1-31.6 = Dominant and >31.7% = Eudominant)

Aquatic insects from Bokajan			Pond 5		Pond 6	
Order	**Family**	**Species**	**Relative abundance (%)**	**Status of dominance**	**Relative abundance (%)**	**Status of dominance**
Hemiptera	Notonectidae	*Anisops* sp.	-	-	33.33	Eudominant
	Gerridae	*Gerris* sp.	63.64	Eudominant	-	-
		Limnometra sp.	-	-	5.56	Subdominant
	Nepidae	*Ranatra* sp.	-	-	16.67	Dominant
Odonata	Coenagrionidae	*Pseudogrion* sp.	27.27	Dominant	5.56	Subdominant
		Ischnura sp.	-	-	5.56	Subdominant
	Libellulidae	*Libellula* sp.	9.09	Subdominant	16.67	Dominant
		Sympetrum sp.	-	-	16.67	Dominant

Table-3
Index values for diversity, evenness and Berger parker dominance

	Badarpur				Bokajan	
Indices	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6
Shannon H' Log Base 10.	0.29	0.415	0.388	0.443	0.373	0.757
Evenness Index Shannon J'	0.964	0.869	0.813	0.929	0.783	0.896
Berger-Parker Dominance (d)	0.611	0.474	0.591	0.5	0.636	0.333

Table-4
Signal values for each of the six ponds reported from the study (0-5.5 → pollution, 5.5 -7→ toxic pollution, above 7 → good habitat condition and water quality)

Pond	Signal Value	Pond	Signal Value
Pond 1	2.29	Pond 4	2.29
Pond 2	1.6	Pond 5	1.82
Pond 3	1.6	Pond 6	2.67

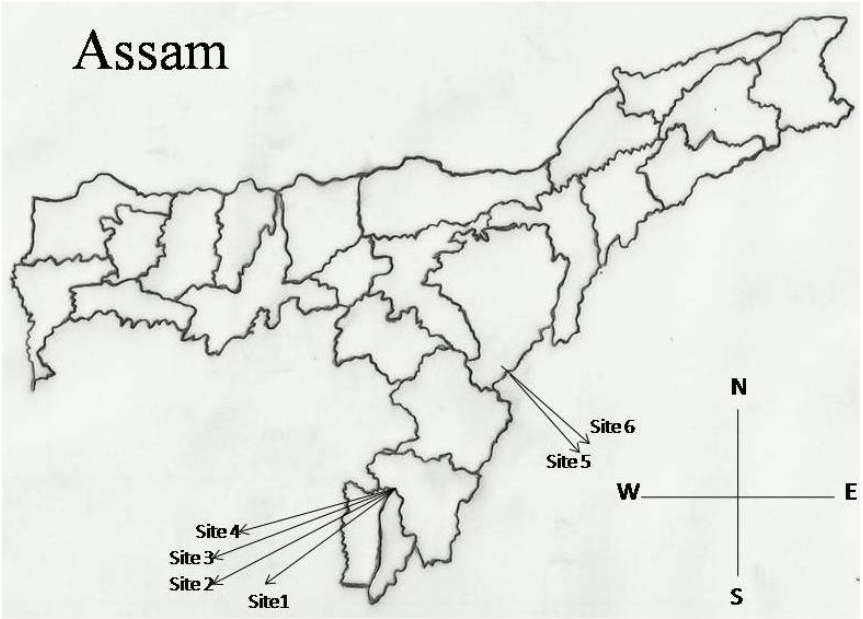

Figure-1
Map of the area studied

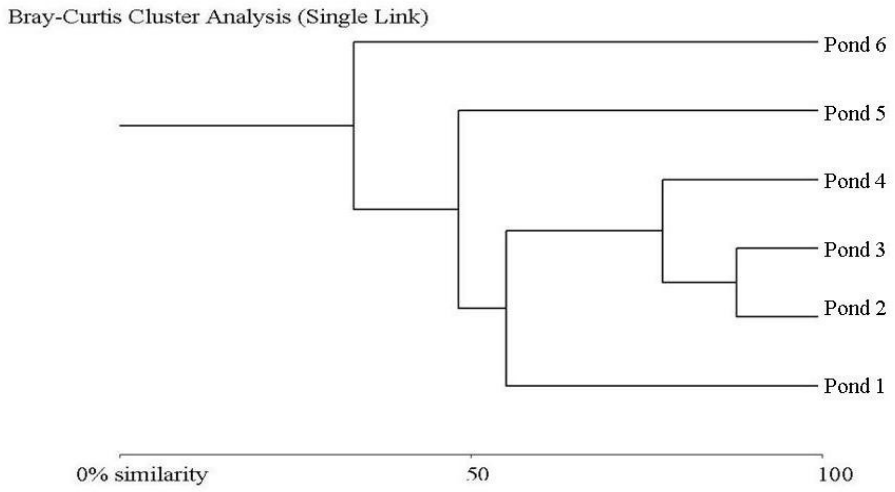

Figure-2
Cluster analysis of the ponds studied

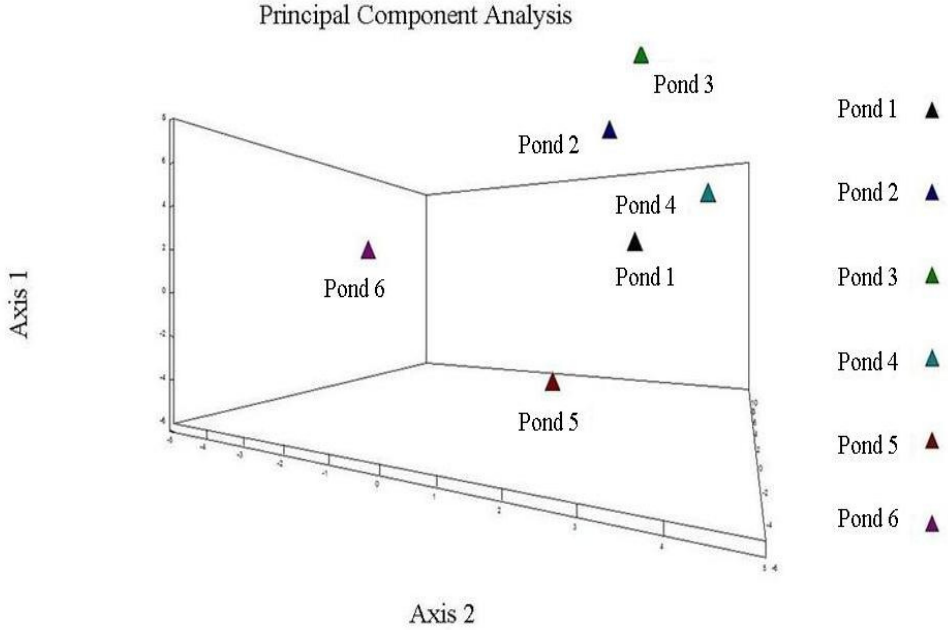

Figure-3
PCA of the ponds studied

Conclusion

Present study reported low diversity and occurrence of only tolerant group of aquatic insects in the aquatic systems around the cement factories confirming the fact that aquatic insects are good indicators of water quality.

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