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COMMUNICATION

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AQUATIC AND SEMI AQUATIC HEMIPTERA COMMUNITY OF SONEBEEL, THE LARGEST WETLAND OF ASSAM, NORTHEASTERN INDIA

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Abstract: Aquatic and semiaquatic Hemiptera bugs play significant ecological roles, and they are important indicators and pest control agents. Little information is currently available concerning its populations in southern Assam. This study assessed hemipterans in four sites of Sonebeel, the largest wetland in Assam (3458.12 ha at full storage level), situated in Karimganj District. The major inflow and outflow of the wetland are the rivers Singla and Kachua, respectively (the Kachua drains into the Kushiara River). Samples were trapped with pond nets and were seasonally recorded. This study recorded a total of 28 species of aquatic and semiaquatic hemipterans belonging to 20 genera under nine families. Population, geographical and environmental data (e.g., rainfall) were used to assess the relative abundance of species, species richness and different diversity indices, and species distribution.

Keywords: Distribution, diversity, Gerromorpha, Nepomorpha, relative abundance, richness, wetland.

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Author Contribution: AS has done the field work, laboratory work and preparation of the manuscript. SG has supervised the whole work and preparation of the manuscript.

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INTRODUCTION

Human disturbance can damage freshwater habitats and introduce biotic pressures including over-exploitation, water pollution, flow modification, degradation of habitat and invasion by exotic species (Dudgeon et al. 2006). These escalating threats have led to a global crisis in loss of freshwater biodiversity (Vorosmarty et al. 2010), which is especially serious in wetlands (Strayer & Dudgeon 2010). In India, for example, wetlands are under stress due to rapid urbanization, industrialization and agricultural intensification (Bassi et al. 2014) and freshwater systems are experiencing greater and more rapid declines in biodiversity compared to other terrestrial ecosystems (Sala et al. 2000).

Aquatic insects serve as ecological indicators of environmental change. Among aquatic insects, bugs of the order Hemiptera, suborder Heteroptera, occupy a prominent position, with approximately 4,000 known species (Dudgeon 1999) broadly classified into infraorders Nepomorpha and Gerromorpha (Bouchard 2009). These bugs play significant ecological roles as both predators and prey, and many are important biocontrol agents. Their varying tolerance to pollution and environmental change also makes them useful as indicator species. Studies of aquatic and semiaquatic Hemiptera in most regions of Assam are still at the exploratory stage (Tordoff et al. 2012). Against this backdrop we selected Sonebeel, the largest (3458.12ha at full storage level) wetland of Assam for

studies of Hemiptera communities. Located in the Indo-Burma Biodiversity Hotspot, this wetland has an important role in conservation of local biodiversity as it provides habitats for many herbivores, carnivores and insectivores, including vulnerable and threatened avifauna. According to Chakravarty et al. (2015), Lesser Adjutant and Pallas's Fish Eagle (vulnerable) and Black-headed Ibis (threatened) were recorded in Sonebeel. This wetland also acts as the primary source of livelihood for local human inhabitants. This study provides an inventory of aquatic and semiaquatic Hemiptera communities in Sonebeel, and provides assessments of seasonal variations in species richness, diversity indices, relative abundance and dominance status.

METHODS

The Sonebeel (3458.12ha, 12.5km long and 3.9km wide with a shoreline of 35.4km) is situated in Karimganj District (Fig. 1). The catchment area of the wetland has ravines, slopes and hilly terrains. The soil type is loamy, sandy or gravelly in the plains and fine-grained sandstones in the hilly region. It is surrounded by hills on its west and east shorelines. The major inflow and outflow of this wetland are the rivers Singla and Kachua, respectively. For the current study four sites were selected, namely, Site 1 Debodwar (24.702°N–92.453°E), Site 2 Anandapur (24.682°N–92.452°E), Site 3 Chamala (24.676°N–92.422°E) and Site 4 Phakugram (24.677°N–92.424°E). Data were recorded seasonally,

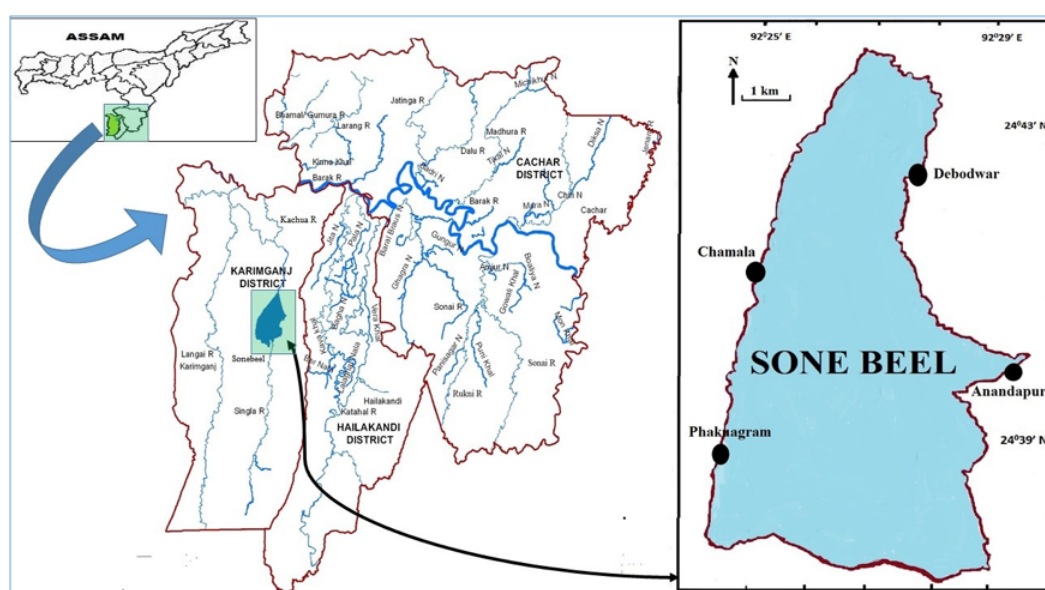


Figure 1. Map of Assam and Barak Valley showing Sonebeel and the four collection sites. (Map not up to scale)

viz, winter (W), premonsoon (PR), monsoon (M) and postmonsoon (PM) during 2012–2014. During collection hemipterans were sampled in triplicates using a bigger pond net (mesh opening: 500µm; diameter: 60cm; depth: 50cm) and a D-net with adjustable handle. Bigger pond net was dragged around the vegetation for one minute. Three such drags constituted a sample (Brittain 1974; Subramanian & Sivaramakrishnan 2007). Aquatic vegetation sampled for insects were searched vigorously for hemipterans. All out search method was employed to collect insects from the substratum when the lake becomes shallow. Samples were preserved in 70% ethanol (Subramanian & Sivaramakrishnan 2007). Identification was carried out by using standard keys (Bal & Basu 1994 a,b; Bouchard 2004; Nieser 2004; Nieser & Chen 2005; Thirumalai 1989, 1994, 1999, 2002; ZSI 2004). Various diversity indices like Shannon Weiner diversity index, Evenness index and Berger-Parker index of dominance were studied using Biodiversity Professional Version 2. Dominance status of the aquatic and semi aquatic Hemiptera were evaluated on the basis of relative abundance using Engelmann's scale (Engelmann 1978). The software Biodiversity Pro was also used to study the individual-based rarefaction curves, accumulation curve of the study sites. Community-level analysis of the four habitats using single linkage cluster analysis based on Bray-Curtis similarity was also performed using this package. Monthly Rainfall data were collected from the meteorological centre of Regional Agricultural Research Station (RARS), Akbarpur, Karimganj District, Assam.

RESULTS AND DISCUSSION

An inventory of the aquatic and semi aquatic Hemiptera of Sonebeel along with their relative abundance in the four sites is listed in Table 1. The study recorded a total of nine aquatic and semi aquatic Hemiptera families, 20 genera and 28 species belonging to infra-order Nepomorpha and Gerromorpha from the four sites of Sonebeel (Table 1; Appendix 1). Throughout the collection, Site 3 recorded with the highest number of 23 species. Among all seasons the highest number of species, genera and families of Hemiptera were recorded in monsoon 2014. Gerridae was represented by seven species followed by Corixidae and Notonectidae by nine species each. Highest number of species and genera was recorded during monsoon 2013 in Site 2, while the highest number of families was recorded during monsoon 2014 in Site 4 (Fig. 2). Das & Gupta (2012), recorded 14 species belonging to 11 genera

and seven families of Hemiptera insect community in a temple pond of Silcoorie Tea Estate, Cachar, Assam. In a similar study at two ponds of Chatla floodplain of Cachar District, Purkayastha & Gupta (2012) recorded six species belonging to six genera and three families. Further Purkayastha & Gupta (2015) carried out a study at Monabeel, a part of Chatla floodplain ecosystem recorded two more species belonging to an additional family. Choudhury & Gupta (2015), carried out a study in Deeporbeel, the only Ramsar site of Assam, and recorded 17 species of Hemiptera belonging to 13 genera and eight families. Takhelmayum & Gupta (2011) recorded four species belonging to four genera and three families of order Hemiptera from the Phumdis (floating island) of Loktak Lake, Manipur. Further in the Keibul Lamjao National Park, which is a part of Loktak Lake, Takhelmayum & Gupta (2015) recorded two more species in addition to their previous study.

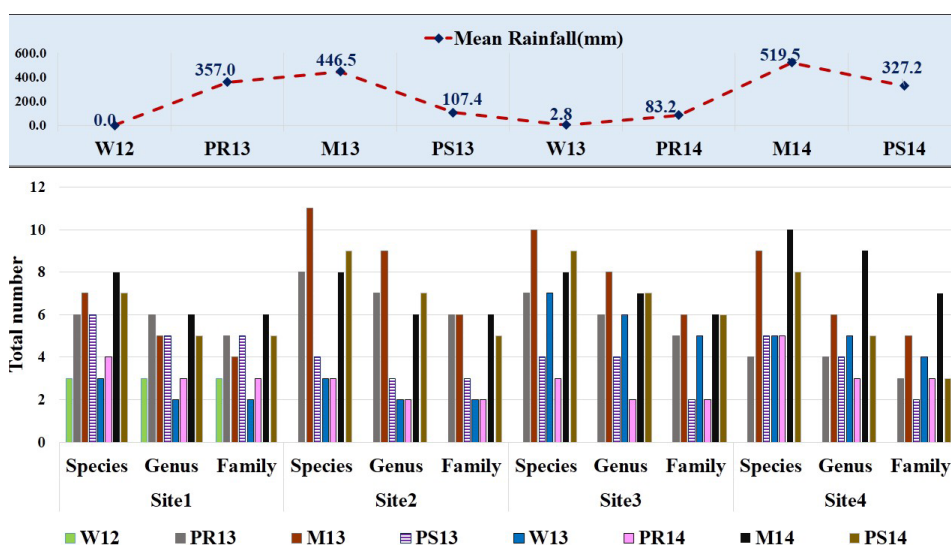
Micronecta scutellaris and *Trepobates* sp. were the eudominant species recorded in Site 1 and Site 3 respectively. Additionally, among the 18 recorded species in Site 1, *Micronecta siva* and *Micronecta ludibunda* were recorded dominant. In Site 2, among the 21 recorded species, *Micronecta scutellaris*, *Micronecta ludibunda* and *Anisops breddini* were the dominant species. In Site 3, *Micronecta scutellaris* was recorded dominant. In Site 4, among the 22 recorded species, *Micronecta siva*, *Micronecta scutellaris* and *Micronecta ludibunda* were recorded dominant (Table 1). Das & Gupta (2012) also reported Family Corixidae and Notonectidae as the eudominant in the temple pond whereas Purkayastha & Gupta (2012) reported family Gerridae to be the eudominant in the two ponds of Chatla floodplain, and Corixidae and Mesoveliidae as the eudominant families in Monabeel (Purkayastha & Gupta 2015). Takhelmayum & Gupta (2011, 2015), reported family Belostomatidae as eudominant in Loktak Lake and Keibul Lamjao National Park of Manipur.

Species ranking for both Whittaker plot and K-dominance plot is based on relative abundance (RA) of individual species. The species ranking sequence in the present study is *Micronecta scutellaris* (RA 30.35%) followed by *Micronecta ludibunda* (RA 21.87%). Next in the sequence are *Micronecta siva*, *Trepobates* sp., *Anisops breddini*, *Nychia Sappho* and *Micronecta haliploides*. The eudominant and dominant species recorded in the system were all semi-tolerant, belonging to the families Micronectidae, Notonectidae, and Gerridae. Thus, the Sonebeel is predicted to be disturbed to some extent.

The Whittaker plot (Magurran 2003) shows the

Table 1. Inventory of aquatic and semiaquatic Hemiptera along with their relative abundance (RA%) and dominance status (DS) (Engelmann's scale, 1978) in the four study sites of Sonebeel

Infraorder	Families	Species recorded	Site 1		Site 2		Site 3		Site 4	
			RA	DS	RA	DS	RA	DS	RA	DS
Nepomorpha	Micronectidae	<i>Micronecta siva</i> (Kirkaldy, 1897)	15.37	D	7.33	SD	3.44	SD	16.90	D
		<i>Micronecta halipoides</i> (Horvath, 1904)	3.55	SD	5.23	SD	1.08	R	2.46	R
		<i>Micronecta scutellaris</i> (Stål, 1858)	41.22	E	25.60	D	29.89	D	29.23	D
		<i>Micronecta ludibunda</i> (Bredin, 1905)	22.13	D	29.39	D	6.67	SD	13.38	D
		<i>Synptonecta issa</i> (Distant, 1910)	0	-	0	-	0	-	4.23	SD
	Nepidae	<i>Ranatra varipes</i> (Stal, 1861)	3.38	SD	0.32	SR	0.22	SR	0.70	SR
		<i>Ranatra gracilis</i> (Dallas, 1850)	0.17	SR	0.08	SR	0.43	SR	0	-
		<i>Ranatra longipes</i> (Stal, 1861)	0	-	0	-	0.22	SR	0	-
	Notonectidae	<i>Anisops breddini</i> (Kirkaldy, 1901)	1.35	R	12.16	D	2.58	R	4.23	SD
		<i>Anisops kuroiwa</i> (Matsumura, 1915)	0	-	0	-	0	-	0.35	SR
		<i>Nychia sappho</i> (Kirkaldy, 1901)	2.53	R	6.20	SD	2.37	R	2.82	R
		<i>Anisops niveus</i> (Fabricius, 1775)	0.51	SR	2.42	R	1.51	R	2.82	R
		<i>Enithares mandalayensis</i> (Distant, 1910)	0	-	0	-	0.22	SR	0	-
	Belostomatidae	<i>Diplonychus molestus</i> (Dufour, 1863)	0.51	SR	0.48	SR	0	-	0	-
		<i>Diplonychus rusticus</i> (Fabricius, 1781)	0.51	SR	0.16	DR	0.65	SR	3.17	R
	Helotrephidae	<i>Tiphotrephes indicus</i> (Distant, 1910)	0	-	0.08	SR	0.22	SR	0	-
	Pleidae	<i>Paraplea frontalis</i> (Fieber, 1844)	0.51	SR	0	-	0.86	SR	0.70	SR
		<i>Paraplea liturata</i> (Fieber, 1844)	0	-	0.32	SR	1.08	R	2.46	R
Gerronomorpha	Gerridae	<i>Trepobates</i> sp.	2.87	R	1.37	R	32.04	E	2.82	R
		<i>Rhagadotarsus anomalus</i> (Bredin, 1905)	0	-	0	-	1.51	R	0.35	SR
		<i>Aquarius adelaidis</i> (Dohrn, 1860)	0	-	2.98	R	4.73	SD	3.87	SD
		<i>Gerris adelaidis</i> (Dohrn, 1960)	2.70	R	3.78	SD	2.37	R	1.76	R
		<i>Neboandelus</i> sp. (Distant, 1910)	0	-	0	-	0	-	0.35	SR
		<i>Limnogonous nitidus</i> (Mayr, 1865)	0	-	0	-	4.52	SD	0	-
		<i>Neogerris parvulus</i> (Stal, 1859)	0	-	0.6	SR	0	-	1.41	R
	Mesoveliidae	<i>Mesovelia vittigera</i> (Horvath 1895)	1.69	R	1.0	R	2.15	R	3.17	R
	Veliidae	<i>Microvelia</i> sp.	0.51	SR	0.2	SR	1.08	R	1.06	R
		<i>Pseudovelia lundbladi</i>	0.34	SR	0.2	SR	0.22	SR	0	-
		<i>Baptista</i> sp.	0.17	SR	0.1	SR	0		1.76	R

**Figure 2.** Temporal and spatial variations in total number of species, genera and families of Hemiptera in the four sites of Sonebeel. Seasonal variations in mean rainfall (mm) is represented graphically by line. (W12= winter2012; PR13= Premonsoon2013; M13= Monsoon2013; PS13= Postmonsoon2013; W13= Winter2013; PR14= Premonsoon2014; M14= Monsoon2014; PS14= Postmonsoon 2014)

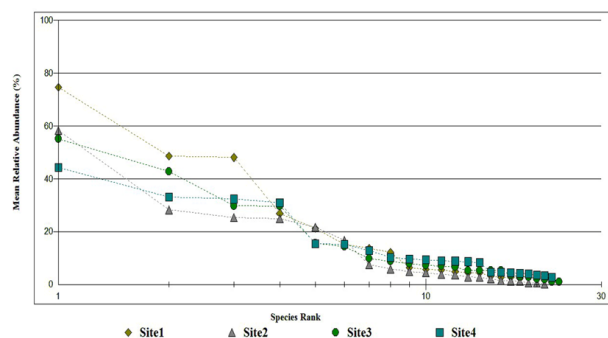


Figure 3. Whittaker plot showing the rank based abundance results of the aquatic and semiaquatic hemipterans in the four sites of Sonebeel

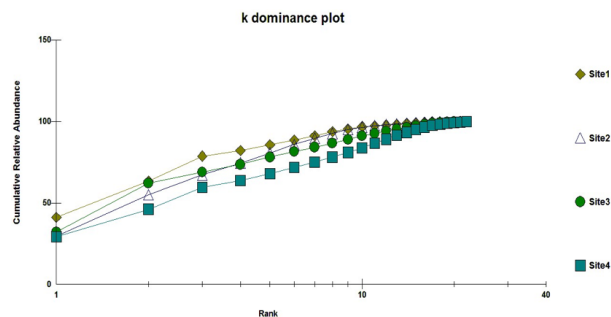


Figure 4. K-dominance graph showing cumulative relative abundance of the aquatic and semi aquatic hemipterans in the four sites of Sonebeel

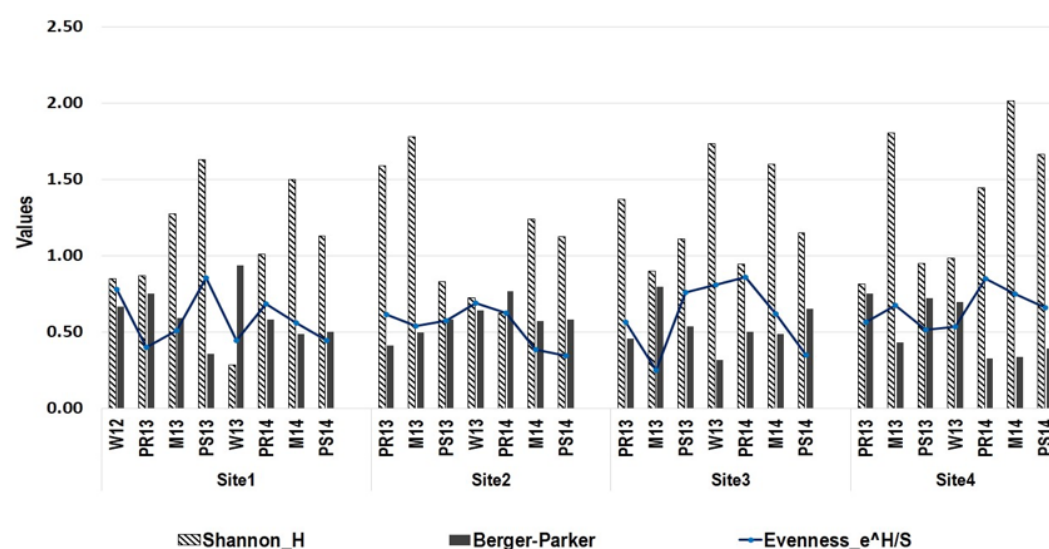


Figure 5. Spatial and temporal variation in Shannon Weiner diversity index, Evenness index, and Berger-Parker index of dominance in the four Sites of Sonebeel (W12 = winter2012; PR13 = Premonsoon2013; M13 = Monsoon2013; PS13 = Postmonsoon2013; W13 = Winter2013; PR14 = Premonsoon2014; M14 = Monsoon2014; PS14 = Postmonsoon 2014)

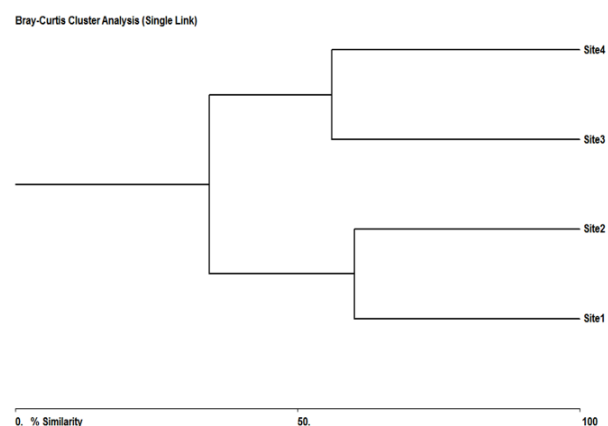


Figure 6. Bray-Curtis Single linkage cluster analysis of the four sites of Sonebeel

species abundance curve (Fig. 3) where species are plotted in sequence from most to least abundant along the horizontal axis with respect to their relative abundance on the vertical axis. This also facilitated comparison among the four sites of the wetland. The four sites showed similar shallower slopes inferring higher evenness of the aquatic and semi aquatic Hemiptera species. If imaginary straight line is considered passing through the first and last point of the respective graph, Site 1 shows the highest and Site 4 shows the lowest evenness. Site 2 and Site 3 also show similar result. The k-dominance plot (Fig. 4) shows cumulative relative abundance of the aquatic and semi aquatic hemipterans in the four sites in relation to species rank. The plot lines show similar pattern which is not much elevated inferring a diverse assemblage in the four study sites of

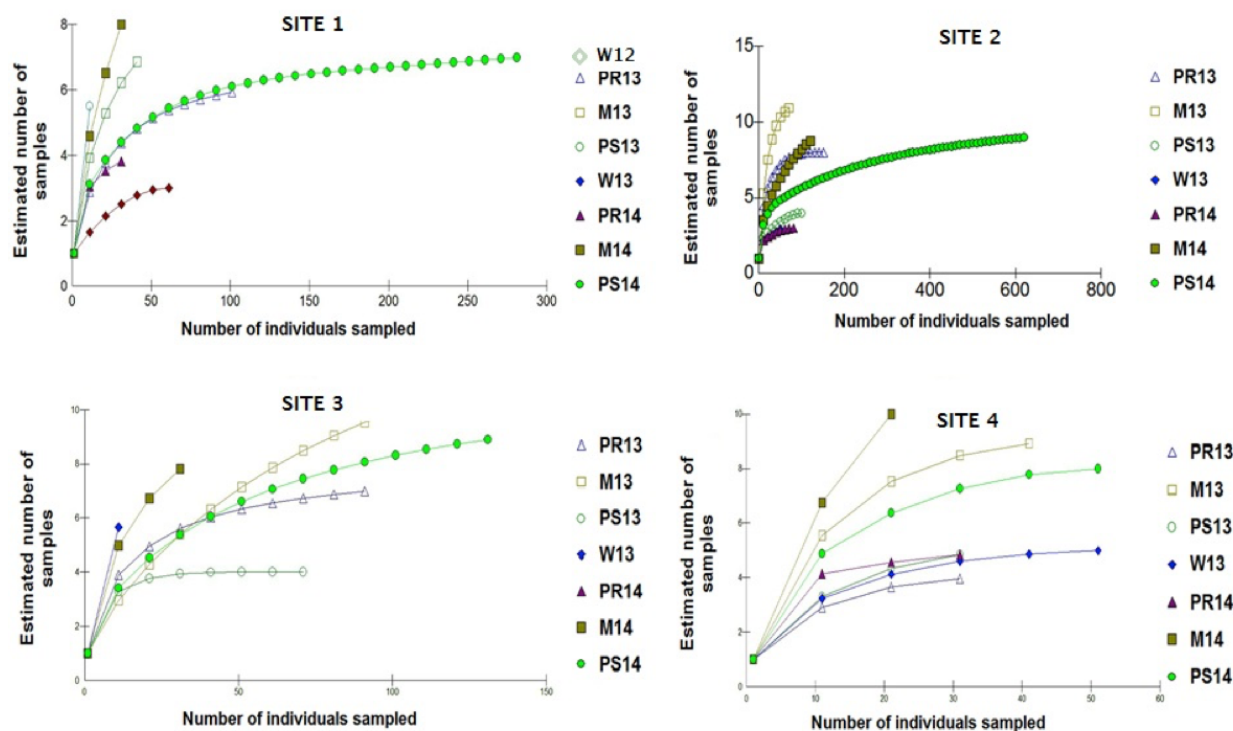


Figure 7. Sample based rarefaction curves in relation to sample size of four study sites during different seasons. (W12 = winter2012; PR13 = Premonsoon2013; M13 = Monsoon2013; PS13 = Postmonsoon2013; W13 = Winter2013; PR14 = Premonsoon2014; M14 = Monsoon2014; PR14 = Postmonsoon 2014)

the wetland (Magurran 2003).

The Shannon (H') values of the four sites ranged from 0.28 in Site 1 during winter 2013 to 2.02 in Site 4 during monsoon 2014 inferring poor to moderate water quality of the system in different sites in different seasons (Wilhm 1970) (Fig. 5). Evenness index in the four sites ranged from 0.25–0.86. Thus diversity is found higher in Site 4 with lower dominance.

Bray-Curtis similarity index (Fig. 6) based on different species and their population of each sites shows highest similarity of Site 1 and Site 2 (60%) forming a pair. Site 3 and Site 4 formed a separate pair with 56% of similarity. Highest similarity of Site 1 with Site 2 is due to the presence of common species in these two sites which might be attributed to the fact that the two sites are in the same direction of the lake.

Sample-based Rarefaction curves are shown (Fig. 7) in relation to the sample sizes of the four study sites of the wetland. Rarefaction is used to compare the estimated number of species in relation to the number of individuals sampled (Magurran 2003). The curves during winters were poorly produced and their confidence intervals were found overlapping other curves. During pre-monsoon 2013 and 2014 the curves were short but a gentle curve was formed where species diversity

was less but number of individual was higher inferring complete sampling. In monsoon 2013 and 2014, the curve showed rapid rise inferring chances of getting more species. On the other hand, curves produced during post-monsoon of 2013 and 2014 showed different pattern. During post-monsoon 2013, curve of Site 1 inferred incomplete sampling while curves of rest of the sites inferred complete effort. In post-monsoon 2014, all the four sites produced most satisfied curves inferring the statistically highest richness of the aquatic and semi aquatic hemipterans in the system. This might be due to the fact that in this season the rainfall was optimum after the highest shower during monsoon 2014. The whole system retained sufficient water providing a uniform suitable condition for dispersion of insects during postmonsoon. Thus along with the increase in number of species their evenness in dispersion was also found higher contributing completeness in collection effort.

CONCLUSIONS

This is the first documentation of aquatic and semiaquatic Hemiptera species in Sonebeel, Assam,

where high population number and species variety has indicated good habitat suitability. The number of species, genera and families recorded were highest during wet seasons. Due to population pressure and various anthropogenic activities, this pristine system is under stress. Increase in land use for residences, agricultural practices, brick industry, siltation, and excessive fishing are well-known threats to the wetland. These impacts are reflected in this study, and there is an urgent need for conservation.

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Appendix 1. Species images from the study area: 1 - *Diplonychus rusticus*; 2 - *Mesovelgia vittigera*; 3 - *Micronecta haliploides*; 4 - *Neogerris parvulus*; 5 - *Tiphotrephes indicus*



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