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Distribution and community structure of aquatic entomofauna in Dheer Beel under Chakrashila complex of Chakrashila Wildlife Sanctuary Assam, Northeast India

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Abstract
Insects represent the most abundant and varied category of living organisms found on our planet. Aquatic insects play a pivotal role in freshwater ecosystems, contributing significantly to the biodiversity and ecological balance of these habitats. Present study was conducted to collect data on the distribution and species composition of aquatic insect community in Dheer beel under Chakrashila complex of Chakrashila Wildlife Sanctuary. A total of 525 individual insects were collected during the study period. Among these, 28 insect species were identified, belonging to 3 different orders and 14 families. Coleoptera, consisting of 12 species, were observed belonging to 4 families Dytiscidae, Hydrophilidae, Gyrinidae, and Noteridae. Hemiptera, on the other hand, were represented by 12 species belonging to 7 families Belostomatidea, Notonectidae, Nepidae, Hydrometridae, Gerridae, Micronectidae, and Veliidae. Lastly, Odonata included 4 species from 3 families Coenagrionidae, Platycnemididae, and Libellulidae. Both Hemiptera and coleoptera exhibited the equal and highest number of recorded species, followed by Odonata, indicating a rich variety of these insect groups in the wetland environment. The dominance of Hemiptera and Coleoptera insects suggests a relatively less polluted ecosystem in Dheer Beel. Diversity indices, such as Simpson's index, Shannon-H index, and Margalef's index, indicated a stable and balanced habitat with high biotic diversity and pollution-free water quality in Dheer Beel.

Keywords: Aqutic Insects, Chakrashila Wildlife Sanctuary**,** Dheer Beel, Diversity indices

Introduction

Insects represent the most abundant and varied category of living organisms found on our planet. Aquatic insects play a pivotal role in freshwater ecosystems, contributing significantly to the biodiversity and ecological balance of these habitats. Their unique adaptations to aquatic environments and diverse life histories make them fascinating subjects for study.

Aquatic insects are a category of insects that reside in water either throughout their entire lifespan or during specific stages of their life cycle. They constitute a relatively small fraction, approximately 3%, of the overall insect diversity (Cheng, 1976) [12]. Freshwater consists of diverse habitat which includes lakes, rivers, springs, wetlands, reservoirs, ponds and ditches (Wetzel, 2001) [40]. Globally, various freshwater ecosystems support a rich diversity of approximately 45,000 insect species (Balaram, 2005) [3]. In the case of India, diverse inland wetlands within the country are home to an estimated count of 5,000 distinct types of aquatic insects (Jaiswal,2013) [21].

Aquatic insects provide a vital ecological role in keeping freshwater ecosystems functioning properly (Subhashini *et al*.,2008) [37]. They form an important component of the food chain and energy flow pathways and comprise of a high proportion of biomass in freshwater. Freshwater habitats globally witnessing higher levels of human disturbance (Saunders *et al*., 2002) [30] and cause changes in the occurrence, diversity and abundance of aquatic insects and consequently decrease the availability of less tolerable species (Rosenbergand Resh, 1993) [29].

Aquatic insects serve as an effective indicator of the biological well-being of an ecosystem they are more vulnerable and sensitive to pollution. While certain species are susceptible to disturbances and heavily polluted water, others can tolerate such conditions (Merritt and Cumminis, 1996) [27]. Therefore, aquatic insects are valuable in evaluating water quality and are regarded as environmental managers and decision-makers. They gives an idea for maintaining the overall health of water bodies Ephemeroptera, Plecoptera, and Trichoptera are very much sensitive to pollution due to which they commonly used as indicators of pollutants in aquatic bodies (Giesy *et al*., 1990) [15].which, in turn affects the distribution of benthic organism(Imoobe and Oboli, 2003) [20].Mandeville, (2002) [24] stated that only physicochemical parameters of a water body was insufficient to indicate its status, it would be more reliable to detect the adverse impact on its aquatic organisms.

Although studies are there on the diversity of winter avifauna and diversity of fish in Dheer Beel (Sinha *et al*., 2015; Nag *et al*., 2017) [35] [28] there is no documentary evidences of study on aquatic insect community. Present study was conducted to collect data on the ecological distribution and community structure of aquatic insect in Dheer beel.

Materials and methods

The study was conducted for a period of one year from June,2022 to May,2023 in the Dheer beel situated in the Dhuburi district, Assam with geographical position 26.282°N, 90.380°E. It is characterized as a floodplain wetland, covering an area of 689 ha and has connections with the river Brahmaputra through an 11km long channel (Barik *et al*., 2007) [5]. On its north-western side is

Chakrashila Wildlife Sanctuary. Most of the beel is clear, with floating vegetation, *Eichhornia sp.*, scattered over the lake (Sinha *et al*., 2015) [35]. The depth of the beel is varies according to the season with an average depth of 10m. For the sampling purposes the Beel was divided into five zone-central, north, south, east & west

Insects were collected by kick method (Brittain, 1974) [11]. The circular net with a diameter of 50 cm frame (250µm mesh size) attached to the bamboo handle was used during the sampling of aquatic insect. The insects were sampled by submerging the net and dragging it through the water column. Three such drags constituted the sample. The sampling time at each zone was 5min. The samples were then sorted by placing them in white tray and transferred to fresh 70% alcohol and were changed with fresh 70% alcohol after 24 hours. The insects were identified and photographed using Labomed stereo zoom microscope with the help of standard keys. (Bal and Basu, 1994; Biswas and Mukhopadyaya, 1995; Subramanian & Sivakrishnan, 2007). [1, 2, 9, 10, 38]

The statistical analyses were carried out using MS Excel 2007 and PAST software (version 4.03). The dominance status of insects was determined using Engelmann's scale (Engelmann, 1978) [14].

Results

A total of 525 individual insects were collected during the study period. Among these, 28 insect species were identified, belonging to 3 different orders and 14 families. Coleoptera, consisting of 12 species, were observed belonging to 4 families Dytiscidae, Hydrophilidae, Gyrinidae, and Noteridae. Hemiptera, on the other hand, were represented by 12 species belonging to 7 families Belostomatidea, Notonectidae, Nepidae, Hydrometridae, Gerridae, Micronectidae, and Veliidae. Lastly, Odonata included 4 species from 3 families Coenagrionidae, Platycnemididae, and Libellulidae.

According to the Engelmann's scale the study revealed thatout of 28 species of Insects collected 4 species of insects that are *Lethocerusindicus, Cybistertripunctatus asiaticus, Hydrometragreeniand Cybisterventralis*were classified as Subrecedent. Another 11 species of insects namely*Laccotrephesruber, Cercotmetuspilipes, Hygrotussp, Copelatussp, Sternolophus rufipes, Hydrovatussp, Helochares sp, Hydrophilus olivaceus, Dineutus spinosus, Ischnura heterosticta* and *Canthydrussp*were categorized as Recedent. Additionally, 11 species of insects namely*Diplonychusannulatus, Enitharessp, Ranatrafiliformis, Gerrissp, Micronecta ludibunda, Microveliasp, Laccophilussp, Amphiopssp, Ischnura aurora, Calicnemia miles and Tholymis tillarga*were Subdominant. 2 species of insects namely *Diplonychusrusticus* and*Aquarius adelaidis* held the Dominant status. No species were recorded as Eudominant in the study area.

In winter season, the values of the Diversity indices are as follows- Dominance_D is 0.056, Shimpson D is 0.943, Shannon H is 3.072, Evenness is 0.771, Margalef index is 4.897, and Berger-parker index is 0.117. In the pre-monsoon season, these values undergo minor changes- Dominance_D increases to 0.062, Shimpson D decreases to 0.937, Shannon H decreases to 3.006, Evenness decreases to 0.721, Margalef index decreases to 4.801, and Berger-Parker index increases to 0.144.

Table 1: Insect species of Dheer beel

Order	Family	Species
Hemiptera	Belostomatidea	*Lethocerus indicus* Lepeletier & servile
		Diplonychus rusticus Fabricius
		Diplonychus annulatus Fabricius
	Notonectidae	*Enithares sp.*
	Nepidae	*Laccotrephes ruber* Linnaeus
		Cercotmetus pilipes Dallas
		Ranatra filiformis Fabricius
	Hydrometridae	*Hydrometra greeni* Kirkaldy
	Gerridae	*Aquarius adelaidis* Dohrn
		Gerrissp.
	Micronectidae	*Micronecta ludibunda* Breddin
	Veliidae	*Microvelia sp.*
Coleoptera	Dytiscidae	*Cybister tripunctatus asiaticus* Regimbart
		Cybister ventralis Sharp
		Laccophilus sp.
		Hygrotus sp.
		Copelatus sp.
		Hydrovatus sp.
	Hydrophilidae	*Sternolophus rufipes*Fabricius
		Helochares sp.
		Amphiops sp.
		*Hydrophilus olivaceus*Fabricius
	Gyrinidae	*Dineutus spinosus* Fabricius
	Noteridae	*Canthydrus sp.*
Odonata	Coenagrionidae	*Ischnura aurora* Brawer
		Ischnura heterosticta Burmeister
	Platycnemididae	*Calicnemia miles*Laidlaw
	Libellulidae	*Tholymis tillarga*Fabricius

Table 2: Dominant status insects in Dheer beel during the study period

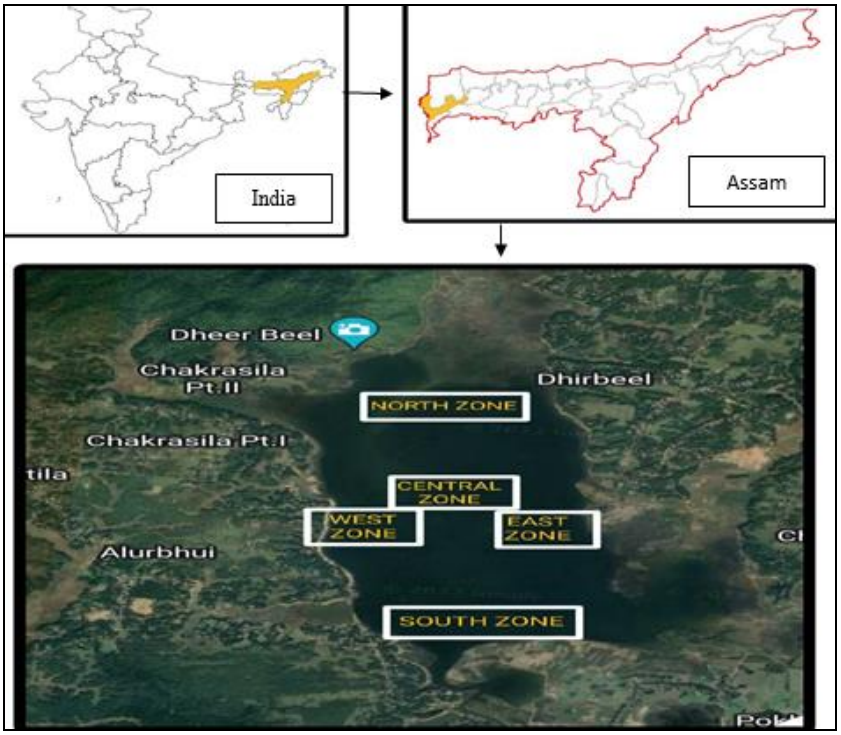
Order	Family	Species	No. of insects	RA%	Dominant status
Hemiptera	Belostomatidea	*Lethocerus indicus* Lepeletier & servile	2	0.38	Subrecedent
		*Diplonychu srusticus*Fabricius	54	10.29	Dominant
		*Diplonychus annulatus*Fabricius	20	3.81	Subdominant
	Notonectidae	*Enitharessp*	18	3.43	Subdominant
	Nepidae	*Laccotrephes ruber* Linnaeus	12	2.29	Recedent
		Cercotmetus pilipes Dallas	8	1.52	Recedent
		Ranatra filiformis Fabricius	21	4	Subdominant
	Hydrometridae	*Hydrometra greeni* Kirkaldy	4	0.76	Subrecedent
	Gerridae	*Aquarius adelaidis* Dohrn	69	13.14	dominant
		Gerris sp.	33	6.29	Subdominant
	Micronectidae	*Micronecta ludibunda* Breddin	19	3.62	Subdominant
	Veliidae	*Microvelia sp.*	23	4.38	Subdominant
Coleoptera	Dytiscidae	*Cybister tripunctatus asiaticus* Regimbart	5	0.95	Subrecedent
		Cybister ventralis Sharp	2	0.38	Subrecedent

		Laccophilus sp.	23	4.38	Subdominant
		Hygrotus sp.	16	3.05	Recedent
		Copelatus sp.	7	1.33	Recedent
		Hydrovatus sp.	13	2.48	Recedent
	Hydrophilidae	*Sternolophus rufipes* Fabricius	13	2.48	Recedent
		Helochares sp.	8	1.52	Recedent
		Amphiops sp.	30	5.71	Subdominant
		Hydrophilus olivaceus Fabricius	6	1.14	Recedent
	Gyrinidae	*Dineutus spinosus* Fabricius	12	2.29	Recedent
	Noteridae	*Canthydrus sp.*	14	2.67	Recedent
Odonata	Coenagrionidae	*Ischnura aurora* Brawer	21	4	Subdominant
		Ischnura heterosticta Burmeister	12	2.29	Recedent
	Platycnemididae	*Calicnemia miles* Laidlaw	23	4.38	Subdominant
	Libellulidae	*Tholymis tillarga* Fabricius	37	7.04	Subdominant

RA<1%= Subrecedent, 1.1-3.1%= Recedent, 3.2-10%=Subdominant, 10.1-31.6%=Dominant and >31.7%= Eudominan

Table 3: Diversity Indices of insects during the study period.

Diversity Index	winter	Pre-monsoon
Dominance_D	0.056	0.062
Simpson_1-D	0.943	0.937
Shannon_H	3.072	3.006
Evenness_e^H/S	0.771	0.721
Shannon_HMargalef	4.897	4.801
Berger-Parker	0.117	0.144



Map1: Location Map of Dheer beel

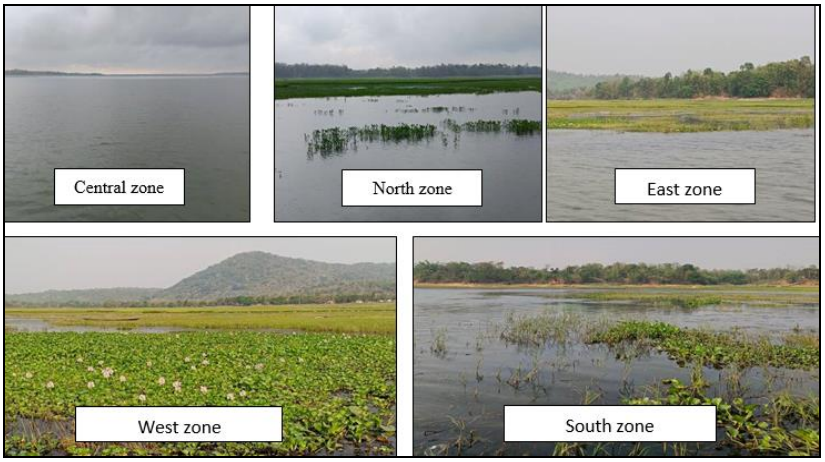


Plate1: Sampling zones

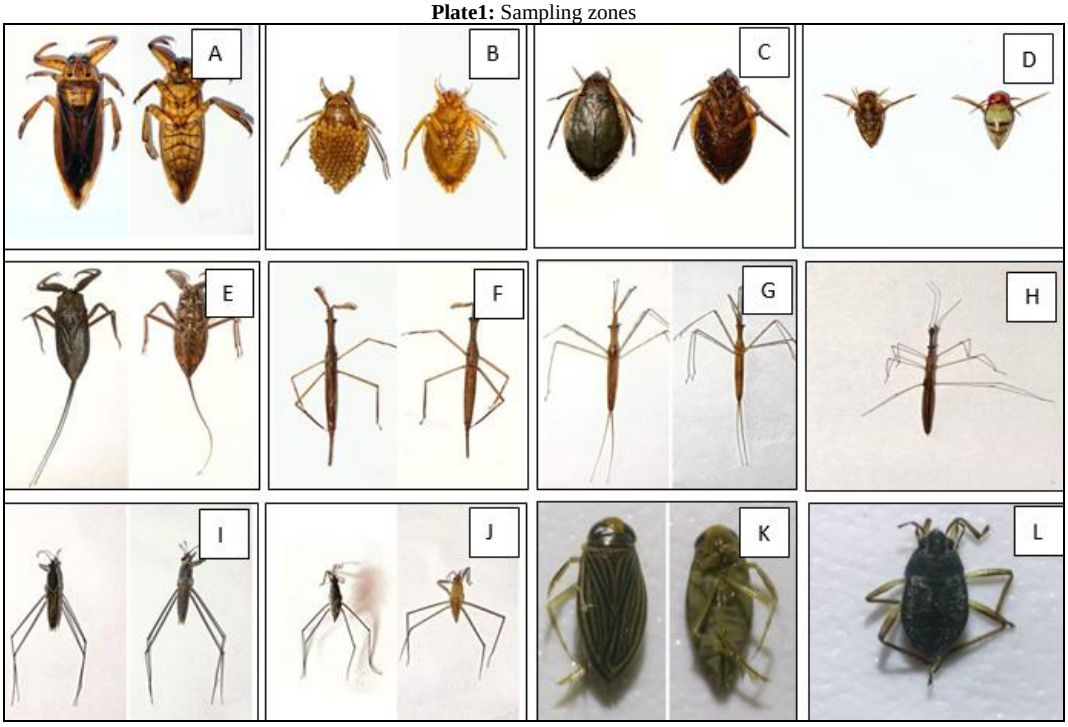


Plate 2: Hemipteran species of Dheer beeel. (A. *Lethocerus indicus* B. *Diplonychus rusticus* C. *Diplonychus annulatus* D. *Enithares sp.* E. *Laccotrephes ruber* F. *Cercotmetus pilipes* G. *Ranatra filiformis* H. *Hydrometra greeni* I.*Aquarius adelaidis* J. *Gerris sp.* K. *Micronecta ludibunda* L. *Microvelia sp.*)

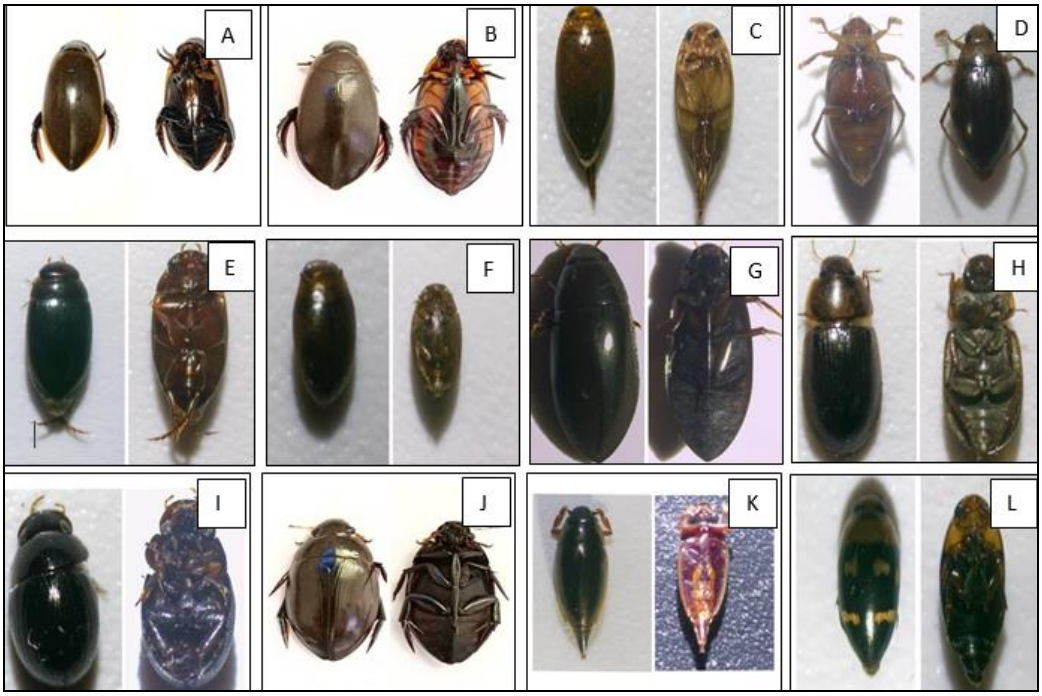


Plate 3: Coleopteran species of Dheer beel. (A. *Cybister tripunctatus asiaticus* B.*Cybister ventralis* C.*Laccophilus sp.* D.*Hygrotus sp.* E.*Copelatus sp.*F.*Hydrovatus sp*. G.*Sternolophus rufipes* H. *Helochares sp*. I. *Amphiops sp.* J.*Hydrophilus olivaceus* K.*Dineutus spinosus* L.*Canthydrussp.*)

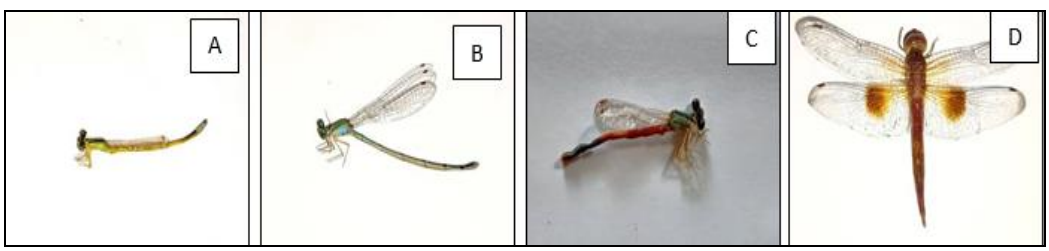


Plate 4: Odonatanspecies of Dheer beel. (A. *Ischnura aurora* B. *Ischnura heterosticta* C. *Calicnemia* miles D. *Tholymis tillarga*)

Discussion

The present study recorded a total of 28 species from three different orders: Hemiptera, Coleoptera, and Odonata. Among these, the order Coleoptera comprised 12 species, belonging to four families: Dytiscidae, Hydrophilidae, Gyrinidae, and Noteridae. The order Hemiptera was represented by 12 species from seven families: Belostomatidea, Notonectidae, Nepidae, Hydrometridae, Gerridae, Micronectidae, and Veliidae. Lastly, the order Odonata included four species from three families: Coenagrionidae, Platycnemididae, and Libellulidae. A total of 525 individual insects were collected during the study period.

The large diversity of Coleoptera and Hemiptera species suggests a rich variety of these insect groups in the Dheer beel. The abundance of these insects depicts a relatively unpolluted environment of the wetland. Similar studies have also been carried out by Mazumder *et al*. (2013). [23] The significant number of Coleoptera and Hemiptera species points to a rich variety of these two insect groups in the Dheer Beel. Similar trend was fund in study of Bandhaw *et al. (*2025) [4], they recoreded 29 taxa out of which Hemiptera represent the most abundant order. Same pattern was also observed by Gogoi & Barman (2019) [16] in the maguri beel of Tinsukia district of Assam. The abundance of Hemipteran and Coleopteran insects in the Dheer Beel indicates a relatively unpolluted wetland environment (Majumder*et al*., 2013, Barman and Baruah 2015) [23] [15]. Therefore, the dominance of Hemiptera and Coleoptera insects in the Dheer Beel indicates a relatively less polluted ecosystem. Similar studies conducted on aquatic insect populations in three permanent ponds of Guwahati by Hasan *et al.* (2016) [19] reported the presence of 25 different species from six orders and 13 families. Barman and Baruah (2018) [6] identified 46 insect species in their study in Kapla beel a freshwater wetland of Barpeta District Assam. Additionally, Gogoi and Gupta (2017) [17] studied the aquatic insect community of River Brahmaputra and recorded a total of 12 genera and 12 species, representing four orders and 10 families. Another study on the biodiversity and population dynamics of aquatic insects was conducted by Thaware, V.H. (2023) [39] at Karadkhed dam, Maharashtra show similar trend of results.

Ephemeroptera, Diptera, Plecoptera and Trichoptera were absent in the studied aquatic water body during the entire study period. Same kind of comprehensive study was done by Siddiky, et. al., (2024) [33] in two ponds at Jahangirnagar University campus, Dhaka. Thhey recorded 18 genera, 15 different families but the major aquatic insect taxa such as Ephemeroptera, Diptera, Plecoptera, and Trichoptera were remarkably absent. Contrarily, species richness and abundance were notably higher among insects of the orders Hemiptera, Odonata, and Coleoptera. Similarly, in the study of Gupta and Narzary (2013) [18] on the aquatic insect community of Phulbari Anua Lake and reported the presence of nine species from nine families and four orders during the study period.

The range of Simpson's index (1949) [34] is from 0 to 1. As per Dash (2003) [13] the value in the range of 0.6 to 0.9 implies settled and stable communities and have high diversity and value near to zero hint that the communities under stress and revealing low diversity. In the present study, the Simpson D value is 0.943 in winter and 0.937 in pre-monsoon. As the value is close to 1, it suggests that the wetland is rich in aquatic insect diversity. The range of Shannon_H (1949) [32] is from 0 to 5. Values less than 1 indicate heavily polluted water bodies, and values in the rangeof 1 to 2 are indication of moderate polluted water bodies while the value above 3 signifies stable water bodies (Stub *et al*., 1970; Mason, 1988) [36, 26]. In the present study of Dheer Beel, Shannon_H is 3.072 in winter and 3.006 in pre-monsoon. The values indicated that the habitat is stable and balanced, along with a high level of biotic diversity. According to Lenat *et al*., (1980) [22] it was expressed that Margalef's index (1968) [25] values above 3 indicate clean conditions, values below 1 indicate severe pollution, and intermediate values suggest moderate pollution. In the present study the value of Margalef's index was 4.897 in winter and 4.801 in pre-monsoon. Thus, the values indicated that the Dheer beel is a pollution free aquatic ecosystem. According to Shah and Pandit, (2013) [31] the higher value of the Berger-Parker dominance index (1970) [8] is indicative of greater diversity. In the present study the value of Berger-Parker dominance index was 0.117 in winter and 0.144 in pre-monsoon.

Conclusion

The present study revealed that Dheer Beel is a rich aquatic system that harbors a diverse array of aquatic insect species. A total of 28 species were identified from the orders Hemiptera, Coleoptera, and Odonata. Hemiptera and Coleoptera comprise of 12 nos. species each followed by Odonata with 3 species. Presnece of Hemiptera and Coleoptera as dominant insects group indicate Dheer Beel as comparitevely less polluted water body. Diversity indices, such as Simpson's index, Shannon-H index, and Margalef's index, indicated a steady habitat with high diverse faunal diversity and non-polluted wetland.

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Reference

1. Bal A, Basu RC. Insecta, Hemiptera, Mesovellidae, Hydrometidal, Velidae and Gerridae. Sate fauna series 5. Fauna of West Bengal, Part- 5, 1994:535-558. Zoological Survey of India.
2. Bal A, Basu RC. Insecta: Hemiptera: Mesovelidae, Hydrometridae, Veliidae and Gerridae. State fauna Series 3: Fauna of West Bengal, Part 5, 1994:511-534. Zoological Survey of India, Culcutta.
3. Balaram P. Insect of tropical streams. Curr. Sci.,2005:89:914.
4. Bandhaw C, Tamang AM, Sharma V. Study of aquatic insect diversity and evaluation of the ecological status of the Sagar Lake. Int J Trop Insect Sci,2025:45:839-862.
5. Barik NK, Gorai BK, Choudhury M. Impact of changes in management regime on fisheries: A temporal case study of Dheer beel in Assam. Agricultural Economic Research review,2007:20(1):87-98.
6. Barman A, Baruah BK. Influence of physico-chemical characteristics of water in seasonal abundance of insects of Kapla Beel, Assam, India. Int. Res. J. Biol. Sci.,2018:7(3):1-8.

7. Barman A, Baruah BK. Macrophyte preference and aquatic entomofaunal diversity of Kapla beel, a fresh water wetland of Barpeta District of Assam, India. AJST,2015:6:1205-1210.
8. Berger WH, Parker FL. Diversity of planktonic Foraminifera in deep sea sediments. Science,1970:168:1345-1347.
9. Biswas S, Mukhopadhyay P. Insecta: Coleoptera, Hydrophilidae. State fauna Series 5: Fauna of West Bengal, Part 6a. Zoological Survey of India, Calcutta,1995:143-168.
10. Biswas S, Mukhopadhyay P, Saha SK. Insecta: Coleoptera: Adephaga. I Family Dytiscidae. State fauna Series 5: Fauna of West Bengal, Part 6a. Zoological Survey of India, Calcutta,1995a:77-120.
11. Brittain JE. Studies on the Lentic Ephemeroptera and Plecoptera of Southern Norway. Norsk Entomologisk Tidsskriff,1974:21:135-151.
12. Cheng L (Ed). Marine Insects. North Holland, Amsterdam,1976:581.
13. Dash MC. Fundamental of Ecology. 2nd Edition. Tata McGraw-Hill publishing company limited, New Delhi, 2003.
14. Engelmann HD. Zur Dominanzklassifikazierung von Bodenarthropoden. Pedobilogia,1978:18:378-380.
15. Giesy JP, Rose CJ, Craney, Henry MG. Dose relationship forbenthic invertebrate bioassays with toxic sediment and pore water. Environment Toxicology, Chemistry,1990:9:233-248.
16. Gogoi A, Barman A. Distribution of aquatic insects at maguri beel of tinsukia district, Assam, north east India. Ecology Environment and Conservation,2019:25(1):360-364.
17. Gogoi A, Gupta S. Aquatic insect community of River Brahmaputra near Dibru Saikhowa National Park, Assam, North East India. Journal of Entomology and Zoology Studies,2017:5(2):1257-1265.
18. Gupta S, Narzary R. Aquatic insect community of lake, Phulbari anua in Cachar, Assam. Journal of Environmental Biology,2013:34:1019-1025.
19. Hasan I, Haloi DJ, Chetri S, Begum S. Biodiversity of aquatic insect population in three permanent ponds of Guwahati, Assam, India. International Journal of Fisheries and Aquatic Studies,2016:4(6):271-275.
20. Imoobe TOT, Oboli IP. Physical and chemical hydrology of River Jamieson Niger Delta, Nigeria. Bermuda Syria Digest,2003:1:105-119.
21. Jaiswal D. Aquatic Insects of Lakes in and around Hyderbad (Hempitera and Coleoptera). Records of Zoological Survey of India,2013:350:1-51.
22. Lenat DR, Smock LA, Penrose DL, Smock DL, Penrose. Use of benthic macro invertebrates as indicator of environmental quality. In: Douglass LW, Editors. Biological monitoring for environmental effects. Lexington books. Toronto,1980:97-114.
23. Majumder J, Das RK, Majumder P, Ghosh D, Agarwala BK. Aquatic Insect Fauna and Diversity in Urban Fresh Water Lakes of Tripura, Northeast India. Middle-East Journal of Scientific Research,2013:13(1):25-32.
24. Mandaville SM. Benthic Macroinvertebrates in Freshwater - Taxa Tolerance Values, Metrics, and Protocols. Project H - 1. Nova Scotia, Soil and Water Conservation Society of Metro Halifax, 2002.
25. Margalef R. Perspectives in Ecological Theory. University of Chicago Press, Chicago, IL,1968:111.
26. Mason CF. Biology of Fresh Water Pollution. Longman scientific and technical, 1988.
27. Merritt RW, Cumminis KW. An introduction to the Aquatic insects of North America. 3rd edition. Kendall: Hunt publishing Company,1996, 862.
28. Nag R, Singha N, Deka P. A study on the fish diversity of Dheer Beel of Dhubri District of Assam, India. International journal of applied research,2017:3(5):19-26.
29. Rosenberg DM, Resh VH. Introduction to freshwater biomonitoring and benthic macroinvertebrates. Freshwater biomonitoring and benthic macroinvertebrates. Chapman and Hall, New York,1993:1-9.
30. Saunders DL, Meeuwig JJ, Vincent ACJ. Freshwater protected areas: Strategies for Conservation. Conservation Biology,2002:16(1):30-41.
31. Shah JA, Pandit KA. Application of diversity indices to crustacean community of Wular Lake, Kashmir Himalaya. International Journal of Biodiversity and Conservation,2013:5(6):311-316.
32. Shannon CE, Wiener W. The Mathematical Theory of Communication. Urbana, University of Illinois Press,1949:177.
33. Siddiky T, Islam Z, Ratna S, Alim M, Mandal BK. Diversity and abundance of aquatic insects of the natural ponds at the Jahangirnagar University Campus, Dhaka, Bangladesh. J. Entomol.Zool. Stud,2024:12(4):08-17.
34. Simpson EH. Measurement of diversity. Nature,1949:163:688.
35. Sinha A, Talukdar S, Das GC, Sarma PK, Singha H. Diversity of winter avifauna in Dheer beel, Assam, India. Indian BIRDS,2015:10(3&4):99-103.
36. Stub R, Appling JW, Hatstetter AM, Hass IJ. The effect of industrial waste of Memphis and Shelby country on primary planktonic producers. Bioscience,1970:20:905-912.
37. Subhashini S, Kumar LK, Logaswamy K. Insects and aquatic environment. Ecobiology of Aquatic Insects. Edited by Arvind Kumar and Dr. Habhajan Kaur. Daya Publishing House, Delhi-110035,2008:107.
38. Subramanian KA, Sivaramakrishnan KG. Aquatic Insects of India-A field guide. Ashoka Trust for Research in Ecology and Environment (ATREE) Small Grants Programme, 2007.
39. Thaware VH. Study of aquatic insects, their role in improving biodiversity and balancing the food web of a freshwater ecosystem at Karadkhed Dam in Nanded, Maharashtra. Journal of Entomology and Zoology Studies,2023:11(1):173-176.
40. Wetzel RG. Limnology. San Diego, CA, Academic, 3rd ed., 2001.