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Aquatic insect diversity and distribution in Maguri Beel and Khamti Guali Beel wetlands, Upper Brahmaputra Basin, Assam, India

Innifa Hasan, Diksha Rabha and Dip Jyoti Haloi*

Department of Zoology, Handique Girls' College, Panbazar, Guwahati 781001, Assam, India.
Email: diphaloi1979@gmail.com

ABSTRACT: The investigation revealed the presence of a total of 16 species of aquatic insects in Maguri Beel and Khamti Guali Beel, two freshwater ecosystems, in Assam, India. The distribution and diversity of species present in the two wetlands with an account of physico-chemical water analysis and macrophyte distribution are discussed. Variation in the diversity indices of both the wetlands, illustrated key differences in diversity and distribution of aquatic insects in Maguri and Khamti Guali Beel.

KEY WORDS: Aquatic ecosystems, physico-chemical water analysis, macrophytes, diversity indices

INTRODUCTION

Insects, occupying a dominant position as the largest group in the animal kingdom, are the most conspicuous forms of life in the aquatic ecosystem (Sharma and Agrawal, 2012). Aquatic insects in particular serve as excellent bioindicators and are essential for the proper functioning of an aquatic ecosystem. By virtue of their taxonomic diversity, varied abundance and tropical significance, aquatic insects can be found in almost every type of aquatic habitat throughout the world such as lakes, ponds, rivers, torrential streams, coastal water and estuaries, highly saline pools, groundwater, acid peat swamps, hot springs and even pools of crude oil seeping from the ground (Yule and Sen, 2004). Aquatic insect communities can vary greatly within and among habitats and these communities play significant roles within the freshwater ecosystems through the cycling of nutrients or through their overall contribution to secondary production. Intriguing in structure and biology, some of these insects are of significant importance to public health as well as aquaculture of inland waters. In consequence, aquatic insects are considered model organisms among the freshwater animal taxa, because of their high abundance, high birth rate coupled with short generation time, large biomass and rapid colonization of freshwater habitats for studying and analyzing the structure and functioning of inland water systems (Sharma and Agrawal, 2012).

Inland waters, particularly freshwaters, cover less than one per cent of the Earth's surface area; however, they are known to harbour 10 per cent of known fauna, of which 60 per cent comprise of aquatic insects. This diversity is represented by 12

* Author for correspondence

orders of living aquatic insects, of which, the following species have larvae which are aquatic and adults which are terrestrial in nature: mayflies (Ephemeroptera), dragonflies and damselflies (Odonata), stoneflies (Plecoptera), alderflies (Megaloptera), lacewings (Neuroptera), flies (Diptera), caddisflies (Trichoptera), moths (Lepidoptera) and wasps (Hymenoptera). Aquatic beetles (Coleoptera) and bugs (Hemiptera) larval or nymphal and adult stages are fully aquatic (Subramanian and Sivaramakrishnan, 2007). Thus life cycle stages play a major role in the occupancy of water habitats by insects. Trichoptera, Ephemeroptera, and Plecoptera are pollution-sensitive insect orders that are widely utilised in aquatic insect biomonitoring projects. Given that these taxa are often intolerant, many bio monitoring programmes believe species diversity to be more vulnerable to stress than total number of taxa (Abhijna *et al.* 2013). Along with biomonitoring, aquatic insect biodiversity provides a variety of additional services like as food for many fish species, nutrient retention, litter decomposition, and noxious weed management, and many more.

Global estimates suggest that around 45,000 of aquatic insect species are derived from the fauna of North America, Australia, Asia and Europe of which around 5,000 species are estimated to inhabit inland wetlands of India. These 5,000 aquatic species of India are predominantly represented by mayflies (Ephemeroptera), dragonflies (Odonata), and caddisflies (Trichoptera) (Subramanian and Sivaramakrishnan, 2007). The northeast India bio-geographic zone holds much significance as it represents the transition zone between the Indian, Indo-Malay and Indo-Chinese bio geographic regions as well as the point of confluence of Himalayan mountains and peninsular India (Barman and Gupta, 2015). Despite this and the fact that the north-eastern region of India has been identified as a biodiversity hotspot by the World Conservation Monitoring Centre (WCMC, 1998), the aquatic insect fauna has been poorly documented compared to the studies conducted in peninsular India (Choudhury and Gupta, 2015). The Brahmaputra drainage system of the Northeast India is one of the largest river systems in the world. Aside from 47 major tributaries, the river basin has around 3000 flood plain lakes known locally as Beels (Biswas, 2014). One such freshwater ecosystem is Maguri Beel, one of the major wetlands of the upper Brahmaputra basin, situated in the Tinsukia district of Assam. This wetland is located on the outskirts of the Dibru- Saikhowa National Park and is a part of Dibru- Saikhowa Important Bird Area (Kardong *et al.,*2020). Another freshwater ecosystem is the Khamti Guali Beel located in the ‘buffer zone’ of the Dibru- Saikhowa Biosphere Reserve (DSBR). This research is intended to shed light on the current biodiversity in these areas, as well as how biotic and abiotic characteristics influence the distribution of aquatic insects.

MATERIALS AND METHODS

The field work is carried out on the two freshwater bodies in Tinsukia district, Assam. The freshwater ecosystems taken under study are Maguri Beel and Khamti Guali Beel. The Maguri Motapung Beel is a wetland lake located near the Dibru- Saikhowa National Park and Motapung Village of Tinsukia district of Assam (situated between 27°34’49.92"N to 27°34’34.98"N and 95°21’7.68"E to 95°24’11.39"E, with an altitude of 96.1m above sea level and area of 119ha). This wetland is lake-like with static water formed by inundation of low-lying lands during flooding, with water trapped even after floodwaters recede. Another freshwater ecosystem is that of the Khamti Guali Beel that connects the Maguri Beel to the River Dibru. It is situated between 27º34’23.4"N to 27º34’26.0"N and 95°20’27.4"E to 95°20’53.8"E. It is located at an altitude of 97.4m above sea level and covers an area of 11ha. Three stations were visited on both the study locations twice a month during the day.

The current study was conducted over a five-month period, from January 2023 to May 2023 (pre-monsoon). Water and insect samples were taken from both bodies of water from the 3 sampling sites. As many aquatic insects migrate to deeper water during the late hours of the day, habitat sampling of the insects and water was conducted during the early hours of the day (6am - 9am). Aquatic insects were gathered from locations using the ‘Kick’ approach (Brittain, 1974), which involved disturbing

Table 1. Different species of aquatic insects in Maguri Beel (M) and Khamti Guali Beel (K)

No.	Order	Family	Species	No.	
				M	K
1.	Hemiptera	Belostomatidae	*Diplonychus annulatus*	05	04
2.			*D.rusticus*	12	09
3.		Nepidae	*Ranatra filiformes*	15	
4.			*Laccotrephes sp.*	07	
5.	Coleoptera	Dytiscidae	*Laccophilus sp.*	19	10
6.		Hydrophilidae	*Hydrophilus sp.*	04	
7.	Odonata	Libellulidae	*Urothemis signata*	23	17
8.			*Tramea basilaris*	08	03
9.			*Trithemis sp.*	04	
10.		Macromiidae	*Macromia sp.*	03	05
11.		Gomphidae	*Paragomphus sp.*	14	09
12.			*Macrogomphus sp.*	19	
13.			*Ictinogomphus sp.*	16	14
14.		Aeshnidae	*Anax guttatus*	11	12
15.	Diptera	Culicidae	*Culex sp.*	06	07
16.			*Aedes sp.*	07	08
Total				173	98

the plant and dragging a net over it for a unit period. A sample was made up of three such drags. Three replicate samples were collected, after which the insects were separated, numbered, and stored in 70 per cent ethyl alcohol. They were later identified using advanced dissection or stereo zoom microscope (10X or above) with the help of standard keys and identified using taxonomic literature (Bouchard, 2004).

Water samples were obtained from a depth of (at least) 40cm using a 1.5 litre plastic jar. Water samples were collected and stored in clean stoppered plastic bottles for later testing. Physico-chemical parameters of water such as air temperature (AT), water temperature (WT), and pH of water sample were analyzed using a mercury bulb thermometer, pH meter (Model: pH Digital meter) and TDS with TDS digital meter respectively. Dissolved oxygen (DO), free carbon dioxide (CO_2), calcium, magnesium, total hardness, and chloride of water sample were analyzed by standard titrimetric methods (APHA, 2017). Aquatic macrophyte species, present in the area were collected and documented to construct herbarium. Species diversity indices of the collected aquatic insects such as Shannon–Wiener diversity index (1949), Simpson's Index of Diversity, Pielou's Evenness Index (Pielou, 1966), Margalef's Index (Margalef, 1958), and Berger-Parker (Berger and Parker, 1970) indices were computed to study and understand the biotic community of each area.

RESULTS AND DISCUSSION

The physicochemical parameters of the water at Maguri Beel and Khamti Guali Beel indicated no marked differences for the water parameters.

Although the physiochemical analysis revealed only minor variations, particularly in dissolved oxygen, chloride, and calcium concentrations, these factors collectively impacted aquatic insect diversity and distribution in both the ecosystems. Dissolved oxygen (DO) is one of the most essential parameters for indicating water quality and determining the distribution of diverse aquatic insect groups (Wahizatul *et al.,* 2011). In the investigation, the dissolved oxygen in Maguri Beel and Khamti Guali Beel was 12 mgL^{-1} and 10.9 mgL^{-1} respectively (Fig. 2). The dissolved oxygen was observed to be less in Khamti Guali Beel compared to Maguri Beel, which might be due to polluted water and eutrophication. This could be correlated to the lesser diversity and abundance of species reported in Khamti Guali Beel in comparison to its counterpart, Maguri Beel.

Chloride concentration, which can be attributed to the dissolution of salt deposits, discharges of effluents from chemical industries, oil well operations, sewage discharges, and many more pollutants, was found to be 12.43 mgL^{-1} and 14.67 mgL^{-1} in Maguri Beel and Khamti Guali Beel respectively, with values for Khamti Guali Beel being higher representing increase chloride levels in water. Furthermore, the Calcium concentration was also higher in Khamti Guali Beel with a value of 20 mgL^{-1} as opposed to 15.7 mgL^{-1} in Maguri Beel (Fig. 1)**.**

Four species of macrophytes were found in the two water bodies. 1) Submerged suspended, perennial *Ceratophyllum demersum* belonging to Cerratophyllaceae family; 2) Free floating, annual *Pistia stratiotes*belonging to Araceae; 3) Free floating, perennial *Eichhornia crassipes* belonging to Pontedariaceae and 4) Emergent anchored, perennial *Alternanthera philoxeroides* belonging to Amaranthaceae.

A total of 16 aquatic insect species were recorded belonging to four orders (Hemiptera, Coleoptera, Odonata, and Diptera). Order Odonata represents the highest number of species (8) followed by order Hemiptera (4) and other orders such as Coleoptera and Diptera (2 each). Plecoptera and Tricoptera, two significant water insect species, were completely absent from the study area. In contrast, the orders Hemiptera, Coleoptera, Odonata, and Diptera had a great species richness and abundance of insects (Table 1).

In Maguri Beel there were Odonata (50%), Hemiptera (25%), Diptera (13%) and Coleoptera (12%). In Khamti Guali Beel it was Odonata (55%), Hemiptera (18%), Diptera (18%), and Coleoptera (9%). Maguri Beel displayed a higher diversity of species and abundance, with 16 species from nine families and a total of 173 insects. The species diversity in Khamti Guali Beel was restricted, with 11 species from seven families, among the 98 total insects collected. Insects collected throughout each month of January, February, March, April, and May, only four species were observed, from both aquatic environments during the five months. These species were *Diplonychus rusticus* (Hemiptera), *Laccophilus sp.* (Coleoptera), *Urothemis signata* (Odonata), and *Culex sp.* (Diptera).

The values of Shannon diversity at the two water ecosystems of Maguri Beel and Khamti Guali Beel are 2.61461 and 2.292607 respectively, which were in the normal range of 1.5-3.5 (Türkmen and Kazanci, 2010). The slightly higher index value of Maguri Beel indicates a greater diversity of species found. In other terms, higher values of H' is a representative of more diverse communities in the ecosystem. The Simpson index of diversity (1-D) values for Maguri and Khamti Guali Beel were 0.92324 and 0.89943, respectively. This result was comparable to Shannon index values, with higher values for Maguri Beel suggesting greater sample diversity. In this scenario, this index indicates the likelihood that two individuals chosen at random from a sample will belong to different species, and so may be used to calculate dominance. The Pielou's diversity index (e) value for Maguri Beel is 0.943, whereas Khamti Guali Beel has a rating of 0.956. The values fall within the proper range of 0 to 1, with values closer to 1 suggesting that individuals are dispersed equally, implying that the species of aquatic insects in Khamti Guali Beel are scattered more evenly than in Maguri Beel**.** The Margalef

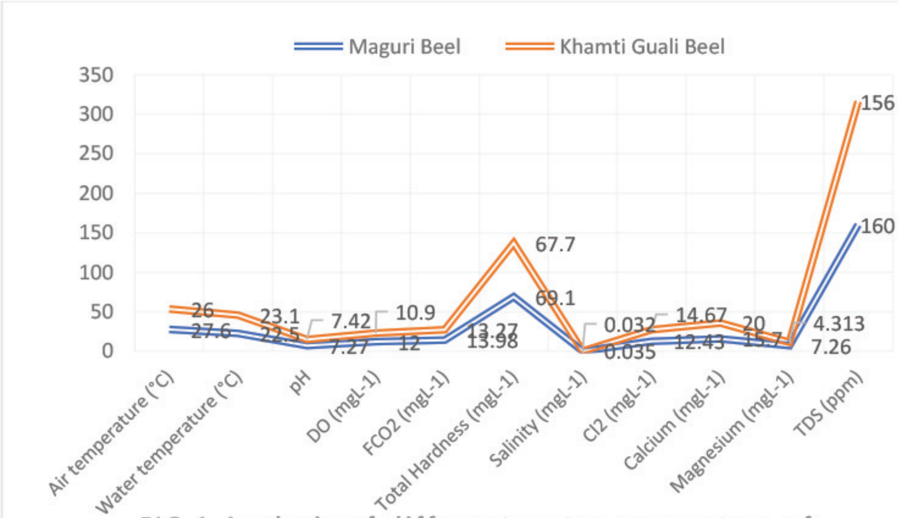

FIG.1 Analysis of different water parameters of Maguri Beel & Khamti Guali Beel.

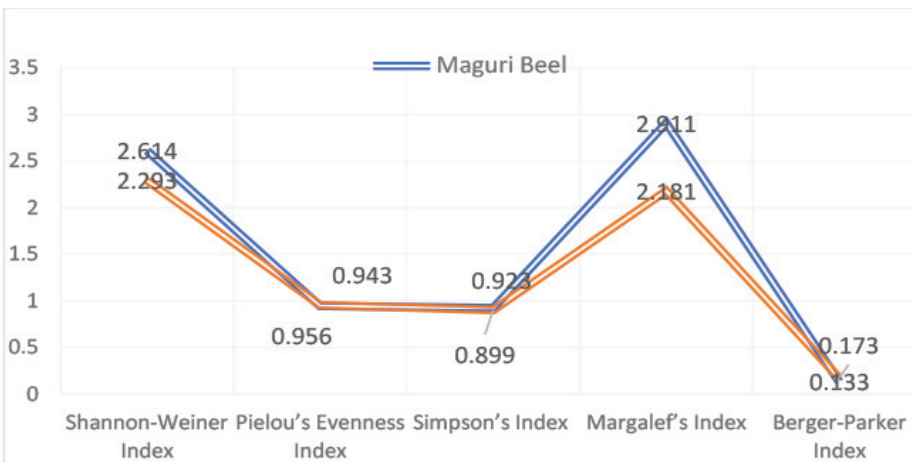

Fig. 2 Different diversity indices at Maguri Beel and Khamti Guali Beel

diversity index shows variation depending on the number of species, that is, the richness or variety of taxa/species/types present in an assemblage or community. It thus has a different purpose of usage from other indices. However, it showed similar results with the other indices as the vales for Maguri Beel was higher (2.911) than that of Khamti Guali Beel (2.181) with moderately polluted waters in both ecosystems. Finally, the Berger-Parker index of dominance value for the dominant species *Urothemi signata,* which was the most abundant species in both locations, was found to be 0.1329 in Maguri Beel and 0.1735 in Khamti Guali Beel. This index expresses the proportional importance of the most abundant type (Fig. 2). The results of the different diversity indices that were used to examine the community structure of both water ecosystems show that the Khamti Guali Beel's aquatic fauna is more evenly distributed and contains more dominant taxa, while the Maguri Beel's aquatic insect fauna is more diverse, richer, and distinct in terms of taxa.

While the physicochemical properties of both water ecosystems were quite comparable, with just minor

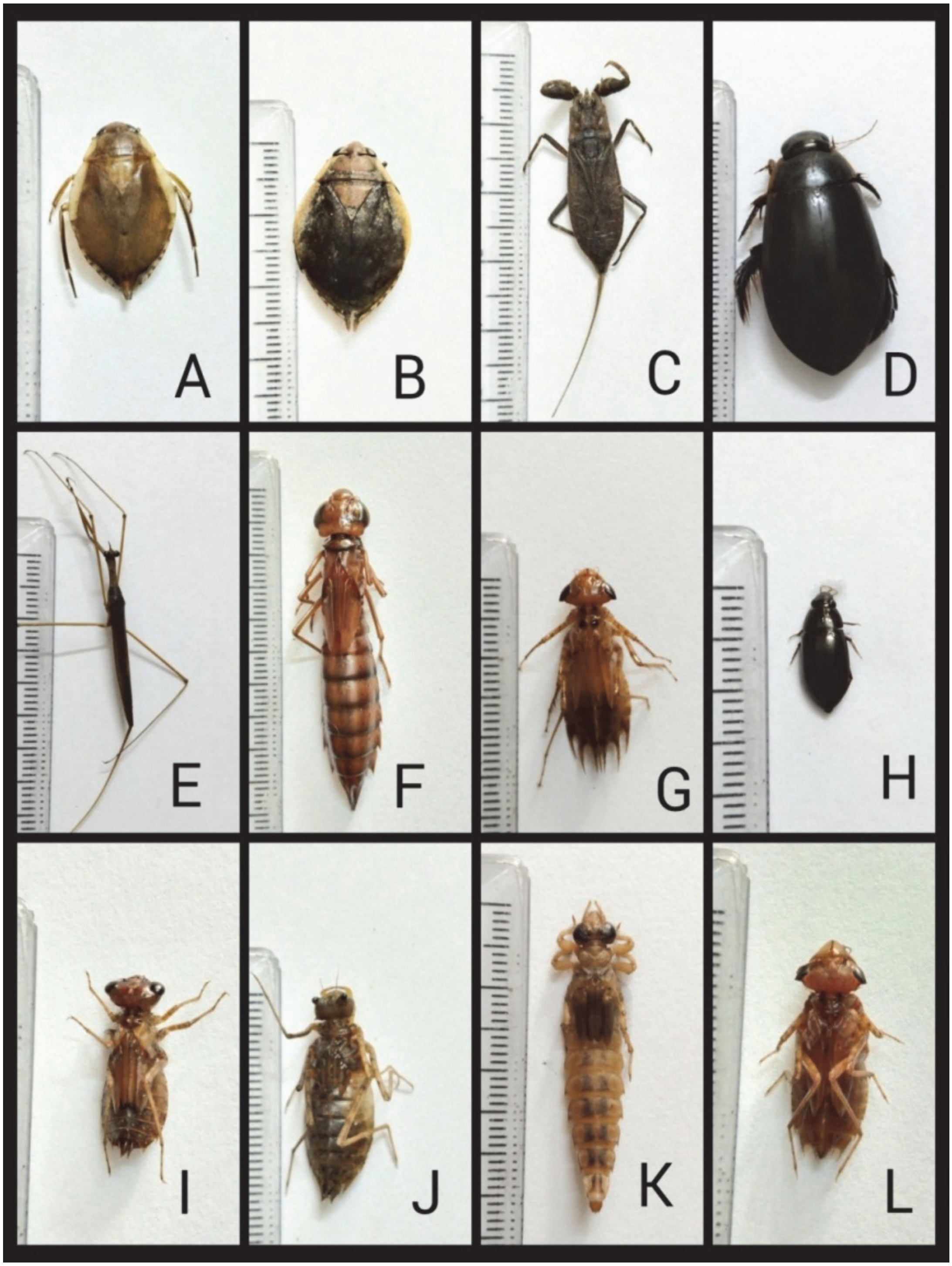

Fig. 3 Aquatic insects collected from study sites: A. *Diplonychus rusticus,* B. *Diplonychus annulatus*, C. *Laccotrephes sp.,* D. *Laccophilus sp.,* E. *Ranatra filiformes*, F. *Anax guttatus*, G. *Tramea basilaris*, H. *Hydrophilus* sp., I. *Trithemis sp.,* J. *Macromia* sp., K. *Paragomphus sp.,* L. *Urothemis signata* *(Scales in the photographs are expressed in Centimeters)*

changes in some parameters (DO, calcium, and chloride concentrations), the specific conditions in Maguri Beel may have provided for a more conducive environment for the existence of a broader range of aquatic insects. The diversity indices corroborate the conclusion that Maguri Beel harbors a richer variety of aquatic insect populations compared to Khamti Guali Beel, which has a more uniform distribution of its relatively fewer species.

Diplonychus, Laccophilus, Urothemis, Macromia, Tramea, Anax, Paragomphus, Macrogomphus, Culex, and *Aedes* were among the species studied in this study for the two water bodies under inquiry (Fig. 3). In this study, 16 species were identified from two separate aquatic environments, and the number of species and abundance differed across the two pools. The dominance of the orders Odonata and Hemiptera indicates that the water bodies are ecologically healthy. Despite anthropogenic perturbations, the Maguri Beel ecosystem remains rich and diversified, according to this study. Khamti Guali Beel, on the other hand, demonstrated evenness in taxonomic distribution based on the numerous diversity indices. As a result, a monitoring strategy and the use of a number of diversity and biotic indices could shed light on the state of health of a water ecosystem and influence public attitudes and policies towards water body conservation in both protected and unprotected regions.

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REFERENCES

Abhijna U.G., Ratheesh R. and Kumar A.B. (2013) Distribution and diversity of aquatic insects of Vellayani lake in Kerala. Journal of Environmental Biology 34(3): 605–611.

APHA (2017) Standard Methods for the Examination of Water and Wastewater (23rd ed.). American Public Health Association, Washington DC.

Barman B. and Gupta S. (2015) Aquatic insects as bio-indicator of water quality-A study on Bakuamari stream, Chakras hila Wildlife Sanctuary, Assam, North East India. Journal of Entomology and Zoology Studies 3(3): 178–186.

Berger W.H. and Parker F.L. (1970) Diversity of planktonic foraminifera in deep-sea sediments. Science 168(3937): 1345–1347.

Biswas S.P. (2014) An Overview on the threats of aquatic ecosystem in Upper Brahmaputra Basin. In: Rivers for Life—Proceedings of the International Symposium on River Biodiversity: Ganges-Brahmaputra-Meghna River System, Patna, India: IUCN. 45–53pp.

Bouchard R. (2004) Aquatic invertebrates. Guide to aquatic invertebrates of the Upper Midwest. Water Resources Center, University of Minnesota, St Paul, MN., USA. pp9–33.

Brittian Johne (1974) Studies on the lentic Ephemeropterea and Plecoptera of southern Norway. Nork entomologist tidsskrift 21: 135–154.

Choudhury D. and Gupta S. (2015) Aquatic insect community of Deepor Beel (Ramsar site), Assam, India. Journal of Entomology and Zoology Studies 3(1): 182–192.

Kardong D., Puzari M. and Sonow J. (2020) Diversity of freshwater mollusc in Maguri Beel, Tinsukia District in Assam, India. International Journal of Current Research 8: 29169–29176

Margalef R. (1958) Information theory in ecology. University of Louisville. Systems Science Institute, Louisville, Kentucky. General Systems Bulletin 3: 36–71.

Pielou E.C. (1966) The measurement of diversity in different types of biological collections. Journal of theoretical biology 13: 131–144.

Shannon C.E. and Weaver W. (1949) The mathematical theory of communication. University of Illinois. Urbana 13:.1–138.

Sharma R.K. and Agrawal N. (2012) Faunal diversity of aquatic insects in Surha Tal of District-Ballia (UP), India. Journal of Applied and Natural Science 4(1): 60–64. doi:10.31018/jans.v4i1.223.

Simpson E.H. (1949) Measurement of diversity. Nature 163(4148): 688–688.

Subramanian K.A. and Sivaramakrishnan K.G. (2007.) Aquatic Insects of India-A Field Guide. Ashoka Trust for Ecology and Environment (ATREE), Bangalore, India. 62pp.

Türkmen G. and Kazanci N. (2010) Applications of various biodiversity indices to benthic macroinvertebrate assemblages in streams of a national park in Turkey. Review of hydrobiology 3(2): 111–125.

Wahizatul A.A., Long S.H. and Ahmad A. (2011) Composition and distribution of aquatic insect communities in relation to water quality in two freshwater streams of Hulu Terengganu, Terengganu. Journal of Sustainability Science and Management 6:148–155.

WCMC F.B. (1998) Freshwater Biodiversity: A Preliminary Global Assessment. A document prepared for the 4th Meeting of the Conference of the Practices to the Convention of Biological Diversity. *World Conservation Monitoring Centre*. WCMC Biodiversity Series No. 8, Press, Cambridge, UK. vii + 104 pp + 14 Maps.

Yule C.M. and Sen Y.H. (2004) Freshwater Invertebrates of the Malaysian Region. Academy of Sciences Malaysia. 861pp.

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