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# The diversity of aquatic insects in Assam, North-East India: A Review

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## Abstract

India is one of the world's mega-biodiversity hotspot nations. A class of arthropods known as aquatic insects can be found on or on the surface of lacustrine or riverine ecosystems where they complete their life cycle in water bodies. Eight main insect orders live their whole lives in the freshwater habitat. The functioning of aquatic ecosystems is greatly influenced by aquatic insects. A significant diversity of aquatic insects, which is indicative of the strength and abundance of the aquatic ecosystem, may be found in the north-eastern section of India and various parts of Assam. In most of the research sites, it was discovered from the entire study that insects from the orders Odonata, Hemiptera, and Coleoptera were most prevalent, followed by those from the orders Diptera and Ephemeroptera. The studied locations are discovered to have the least amount of insects from the Orders Plecoptera, Trichoptera, Hymenoptera, and Collembola. In Northeast India and several parts of Assam, there were no records of aquatic insects from the Orders Neuroptera/Megaloptera and Lepidoptera.

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**Introduction**

Water is the most important natural resource that ecosystems supply. Nearly all living things on earth would be unable to survive for an extended length of time without water. Ponds, lakes, springs, streams, rivers, wetlands, reservoirs, and ditches are examples of aquatic ecosystems (Borkataki *et al.*, 2018). A wide variety of aquatic creatures inhabit freshwater habitats. A class of arthropods known as aquatic insects can be found on or on the surface of lacustrine or riverine ecosystems where they complete their life cycle in water bodies. According to Hasan *et al.* (2016), eight main insect orders live their whole lives in the freshwater habitat.

Less than 1% of the surface of the Earth is covered by inland waterways, however these waters are home to 10% of all known animal species, of which 60% are aquatic insects. Today, there are around 100,000 species that have been described in this variety. As a result of the taxonomic gap favoring insects, which is likely underrated, we calculate that there may be more than 200,000 species of aquatic insects, accounting for 80% of the variety of aquatic animals. Most aquatic insects live in water as eggs and larvae before dispersing to terrestrial environments as adults. Aquatic insects spend one or more phases of their life cycles in the water. They have significant ecological functions as principal consumers, detritivores, predators, and pollinators in both aquatic and terrestrial environments. Although freshwaters have been generally ignored as a hotspot of diversification, despite their disproportionate contribution to global biodiversity, the ecology of many groups is widely investigated due to their roles as bioindicators or disease vectors (Dijkstra *et al.*, 2014).

Aquatic insects are an arbitrary collection of insects that live in an aquatic or semi-aquatic environment at some point in their lives (Crespo, 2011).Aquatic insects play an important part in the functioning of aquatic ecosystems. They are essential clusters of invertebrates in the aquatic ecology, where they influence food webs. They are the primary nutritive fauna of fish during the larval stage.

Aquatic insects are a taxonomically varied, ecologically significant, and fascinating collection of creatures found in Lentic fresh water systems. They are recognised to play an important role in nutrient processing and cycling since they are classified as shredders, filter feeders, deposit collectors, and predators (Susmita *et al.*, 2013). Insects that have evolved to aquatic habitats are subjected to a wide range of physical and chemical circumstances that differ from those found in terrestrial settings, affecting their physiology and behaviour (Denny, 1993; Vogel, 1994). Sensory systems are obviously damaged, especially as insects, like other invertebrates, rely on chemoreception as their primary sensory modality (Hildebrand and Shepard, 1997).

There are many distinct types of aquatic insects since practically any sort of freshwater environment habitat, from puddles to rivers to lakes, including both Lentic and Lotic habitats, may be home to diverse aquatic insect species. They are the dominant group of aquatic habitats' benthic, limnetic, and littoral fauna. The diversity of insects in lentic water tends to grow as nutrients rise.

Aquatic insects are frequently effective indicators since they may be found in practically any type of environment and many of them are habitat specialists (Choudhary and Ahi, 2015).

India is one of the world's Mega-Biodiversity hotspot nations. Assam, Arunachal Pradesh, Meghalaya, Mizoram, Manipur, Nagaland, Tripura, and Sikkim comprise India's North-Eastern region (NER). Although the World Conservation Monitoring Centre designated India's northeastern area as a biodiversity hotspot, the water insect fauna of this region is little researched. In comparison to research on the variety of aquatic insects in peninsular India, there are less in North-east India (Choudhury and Gupta, 2015).

Assam is a state in northeastern India located south of the eastern Himalayas and along the Brahmaputra and Barak River basins. Assam has a total land area of 78,438km2 (30,285 sq mi). Assam has a high biodiversity, with varied geography and diverse

plants. Assam's entire estimated wetland area is 764372 hectares, accounting for around 9.74 percent of the geographical area (Sharma, 2017). The valley of the rivers Brahmaputra and Barak, with its numerous fresh water lakes (locally known as Beel) or ox-bow lakes (era suti), streams, rivers, ponds, tanks, marshy tracts and seasonally flooded plains, and hundreds of riverine sandbars and islands, is a major habitat for a variety of aquatic insects.

The current study aims to examine the relative abundance of insects in various microhabitats of the study site Assam and the North Eastern States of India. (i) Determine the richness and distribution of insects in different microhabitats; (ii) Study stream habitat types; and (iii) Determine the insect's ecological importance. Keeping in mind the unique and distinctive features of insects, the current survey intended to outline certain characteristics of insect variety found in Assam and North-East India, as there was a little known published checklist of insect diversity up to this point. This information does not only provide unique and distinctive features of insects, but it will also likely provide insight into the insect species richness of Assam and North East India for the first time: knowledge that is vital for management and conservation.

*Aquatic Insect Types*

One of the most important qualities of an aquatic ecosystem is its capacity to sustain its stability in terms of aquatic biodiversity (Vinson and Hawkins, 1998). Aquatic insects are those that spend portion of their life cycle close to water, either dwelling beneath the surface or skimming around on top of it. Aquatic insects are classified into the following taxonomic orders:

a. Collembola-springtails (from springs and spring ponds).
b. Ephemeroptera, which includes mayflies (found in lakes and streams).
c. Odonata-damselflies and dragonflies (lakes and streams)
d. Plecoptera - stone flies (streams).
e. Hemiptera (true bugs) (lake and stream margins).
f. Neuroptera/Megaloptera - the dobsonflies, alderflies, and spongillaflies, which are sponge parasites (mostly in streams).
g. Trichoptera are the caddisflies that live in lakes and streams.
h. Lepidoptera, which includes butterflies and moths (aquatic catterpillars).
i. Coleoptera (beetles in lakes and streams).
j. Hymenoptera - diving wasps (terrestrial, aquatic insect parasites).
k. Diptera are genuine flies that live in all aquatic settings.

*Collembola*

Springtails are tiny insects that have existed for a very long period. This is one of the earliest insect orders, having fossils dating back to the Devonian period around 345 million years ago. Collembola are odd-looking small insects that can be found in great numbers bouncing around on the surface of the water when there is vegetation or organic debris, such as leaves washed up on the coast. These insects have evolved a leaping gear made up of a furcula and tenaculum that allows them to leap their own length repeatedly.

*Ephemeroptera*

Mayflies are widely known among fly fishermen because they are a favourite diet of trout when they emerge as adults. The majority of their lives are spent as nymphs, which can live for several years under water before emerging as adults to mate and lay eggs in a matter of hours or days. The order gets its name from the "ephemeral" aspect of the adult life of the insects. Mayflies are the only insects known to moult after developing wings. They emerge from the water in a winged form called a subimago, which moults back to the adult form.

*Odonata*

Odonates are insects that are generally known as dragonflies and damselflies. Because they are all predators, both as nymphs and adults, adults may drastically suppress mosquito populations by scooping them out of the air with their basket-like leg arrangement. Odonate larvae have peculiar mouthparts that stretch to catch food. These are ancient insects that have existed since before the dinosaurs. Some Carboniferous Odonate fossils have wingspans of almost a metre. These insects were the size of several current hawks.

*Plecoptera*

The Plecoptera are known as stoneflies because their nymphs are commonly found beneath the stones of rivers and streams. Stoneflies, another ancient order, love colder, fast-flowing water and are one of the most prevalent orders in the Connecticut River's minor tributary streams. Stonefly nymphs resemble adults only in the absence of wings.

*Hemiptera*

The Hemiptera you find in the river are undoubtedly the insects you should treat with extreme caution since many of them are capable of delivering really severe bites. They range in size from microscopic Watermeasurers in the Hydrometridae family to the enormous Belostomatidae, or Giant Water Bugs, which may reach 7 centimetres or more in length. The majority of aquatic Hemipterans are predators, as evidenced by their raptorial forelegs and piercing mouthparts. The most dangerous of these insects may be a little spherical bug known as a Creeping Water Bug. This bug's bite is unquestionably as unpleasant as a hornet sting, if not more so. Other possible species are Water Scorpions, Backswimmers, Water Boatmen, and Water Striders. All of these insects are abundant in Connecticut, mainly where there is slow-moving water and emergent plants.

*Megaloptera and Neuroptera*

These big insects, sometimes known as alderflies or dobsonflies, are frequently extremely stunning as larvae and adults. The immature form of the dobsonfly is known as a "hellgrammite" by fisherman. These vicious larvae may grow to be nearly three inches long and have powerful mandibles that can give quite a pinch. They are widespread in rocky, fast-moving sections of the river where they seek and consume other aquatic species. Even as adults, they appear intimidating because many of the adult males have severely enlarged jaws. These, on the other hand, are mostly for show and cannot squeeze like the larvae's jaws.

*Trichoptera*

Trichoptera's common name is "Caddisfly," which means "case-bearer." Many of these insects construct measuring containers from of diverse materials found in the river, such as stones, twigs, leaves, or sand. Here's a look at some of the cases you could come across when investigating the river. The average length of these cases is roughly 1.5 centimetres.

*Coleoptera*

The Latin word for "shield-wing" is coleopteran. The front wings of beetles have been transformed into tough shields that protect the rear wings from injury. Flying beetles only utilise their rear wings to fly, with the front wings merely opening to push themselves out of the way. Beetles have more species than any other category of animals or plants on the planet. Approximately 300,000 beetle species have been described to far. The aquatic beetles are extremely varied and fascinating. Predaceous diving beetles, some nearly an inch long, are prevalent in the river. Although these insects are normally harmless to humans, they should be handled with caution because some can inflict painful bites. Whirligig beetles are quite abundant and may often be spotted swimming in big numbers on the surface of calm water. These insects have a fascinating adaption to life on the water's surface. They have developed into "four-eyed" creatures, with one set of eyes above the water.

*Diptera*

It means "two wings" and alludes to truth flies. Aquatic Diptera, particularly those that desire to feed on our blood, are among humanity's least favourite insects. These include the Tabanids (horseflies and deerflies), the Culicids (mosquitoes), and so the Simuliids (biting blackflies). Because many of these insects spread illnesses such as malaria and dengue fever, a great deal of effort has gone into studies to control them. Despite significant advances, flies continue to sicken more people than any other source of disease. Breathing tubes, silken tunnels, and ventral suction cups are some of the unusual adaptations that flies have developed to colonise aquatic habitats.

*Ecological Importance Of Aquatic Insects*

Aquatic insects are common in most freshwater ecosystems and can be quite diverse. They are the food for practically all vertebrate and invertebrate predators in aquatic food webs, and many of them are predators themselves (Hershey *et al.*, 2010).

Because of their abundance, high birth rate with short generation time, enormous biomass, and quick colonisation of freshwater environments, aquatic insects may be regarded model species in analysing the structure and functioning of the freshwater ecosystem. Aquatic insects are situated near water for much of their life cycle; any change in their population size and composition at a given period and location may signal a change in water quality. They also serve as an indication of aquatic ecosystem trophic structure, water quality, and eutrophication (Varma and Pratap, 2006).

Aquatic insects are an essential component of the aquatic ecology, and they require both ecological and economic value. Predators like Dytiscus serve to maintain the balance of organisms and hence the food available in the freshwater ecosystem by reducing the number of other invertebrates. The odonate larvae employ Anopheles larvae as an energy source in their diet, therefore keeping control over their population numbers, which are responsible for the spread of epidemic illnesses such as malaria (Mitra, 2002). Chironomid larvae are an important source of food for fish and ducks (Cibrowski and Corkum, 2003). Dipteran flies are the most important arthropod disease vectors in humans and other animals. Malaria, for example, may be a major cause of sickness in many tropical nations. An estimated 500,000 cases of malaria are transmitted each year by 70 Anopheles mosquito species. A single mosquito, *Aedesaegypti*, transmits yellow fever. Dengue fever is spread by the yellow-fever mosquito and *Aedesalbopictus*.

Hemipterans are the initial food source for a variety of wild and cultivable fishes, making them useful predators. They are also occasionally pests in man-made nursery ponds for fish culture, where they prey on juvenile fish. Certain insect families may also be used for biological control of mosquito larvae (Ohba and Nakasuji, 2006; Saha *et al.*, 2007). These insects are eaten and appreciated in many cultures. Mayfly naiads are an important food source for fish and other aquatic species. Anglers frequently use mayflies as bait or tie "flies" that mimic imagos and subimagos. Other aquatic species rely on the larvae for sustenance.

Plecoptera are utilised in evolutionary studies and as biogeographical markers. Plecoptera (stoneflies) are a feeding source for many game fish. They have been employed in the sport of fly fishing for hundreds of years, and fisherman are well-versed in them. Trichopterans eat trash, which helps to clean the freshwater habitat in which they reside while also providing food for fish. Trichoptera larvae, pupae, and adults also play an important role in the organic phenomena, and they have been widely employed as models for "flies" by trout fishing aficionados. Caddisflies are economically significant as pests, but they also play an essential role in the trophic dynamics and energy flow of aquatic ecosystems.

**Results**

*Diversity of aquatic insects in Northeast India*

The north-eastern area of India, which includes the states of Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland, and Sikkim, is unusual in having a profusion of habitats with varied biota and a high level of endemism. The water insect fauna of this region of India is understudied. Several studies have been undertaken to investigate the aquatic variety in various sections of India's North Eastern Region.

Loktak Lake is one of the greatest bodies of water in Manipur. In a preliminary examination of aquatic insect diversity and water quality at Loktak Lake, Manipur, one of the Ramsar sites, six orders and fifteen families were discovered, with the order Hemiptera having the largest number of aquatic insects. Belostomatidae and Corixidae were the most prevalent families (Devi *et al.*, 2013).

In a study conducted in the Phumids (Floating island)Phumdi Live (PL), Phumdi Mixed (PM), and Phumdi Dry (PD) areas of Manipur's Loktak Lake, the PL and PM areas were represented by two orders of insects, Hemiptera and Odonata, while the PD area was insect-free (Takhelmayumand Gupta, 2011).

Similarly, 3 orders, 9 families, 12 genera, and 18 species of aquatic insects were discovered and documented in a research done in the lower river Moirang in Manipur. Diplonychusrusticus was discovered to be the area's eudominant species, followed by five subdominant and six recedent species (Takhelmayum *et al.*, 2012).

In an inventory conducted to examine Tripura's urban fresh water lakes, 2159 individuals from 30 species from 23 groups, 15 families, and 4 orders were recorded. The majority of the individuals documented, 1191 individuals representing 30 species, came from the vegetation-rich Maharaja BirBikram College, while the minority, 215 individuals, came from the vegetation-poor Laminarayan Bari Lake. Insects from the orders Hemiptera and Odonata had the highest species richness, followed by Coleoptera and Diptera (Majumder *et al.*, 2013).

In Arunachal Pradesh, a research was undertaken at the Namdapha National Park, where 10 species of water insects from the subfamilies of Dytiscidae were recorded (Ghosh, 2018). A research in the DiyungTheip watershed, located in Tenga valley, West Kameng District of Arunachal Pradesh, found aquatic insects belonging to seven orders, thirteen families, and nine species (DasandBordoloi, 2012).

A research on the diversity and ecology of Plecoptera larvae was conducted in two tiny streams in Shillong, Meghalaya, North-east India, Wahdienglieng and Umrisa, where species from three families and eight genera were reported (Marweinand Gupta, 2021). Simillary, In the study of aquatic and semi-aquatic Hemiptera in the Jaifftia Hills and East Khasi Hills Districts of Meghalaya, 16 species belonging to 16 genera under 7 families were identified, including 6 new records from the state: Cereotmetuspilipes Dallas (Family: Nepidae); Diplonyehusrustieus (Fabricius) (Family: Belostomatidae); Gestroiella(Lyngdoh, 2010).

*Diversity of aquatic insects in different regions of Assam*

India is one of the world's 17 Mega biodiverse countries, accounting for 7-8% of all documented species. Assam is a component unit of the Eastern Himalayan Biodiversity Region and one of the country's two biodiversity "hot spots." Assam is a state in northeastern India that is south of the eastern Himalayas, along the Brahmaputra and Barak rivers. Assam's state is split into 34 administrative districts. In Assam, the diversity of aquatic insects has been examined more thoroughly than in other north-eastern Indian states. Various research conducted in various locations of Assam are highlighted below-

A study of aquatic insect variety was undertaken in Cachar district, Assam, in two ponds - Urban pond (UP) and Jalinga pond (JP), where 5 orders, 17 families, and 29 species from UP and 3 orders, 8 families, and 17 species from JP were documented over two separate seasons. The major species recorded were Aphelonectasp, Cloeonsp, and Micronectasp (Dalai and Gupta, 2016). A research was conducted on the variety and density of aquatic insect communities in two urban temple ponds in Silchar, Assam, Northeast India: Radhamadhavakhra pond and Mandirdighi pond. A total of 22 aquatic insect taxa were identified, including 13 from Radhamadhavakhra pond and 18 from Mandirdighi pond. In both ponds, 9 taxa were determined to be frequent (Dalai and Gupta, 2014). A research on the richness of aquatic insect populations was conducted in three ponds in Guwahati. This investigation identified 25 distinct species from 6 orders and 13 families. Hemiptera has the most species (15), followed by Coleoptera (4), and other orders such as Odonata (2 species), Hymenoptera (1 species), Ephemeroptera (1 species), and Diptera (2 species). In the current study, the order Hemiptera was determined to be the most varied and plentiful in the pond (Hasan *et al.*, 2016).

A seasonal research was done on the aquatic insect community of the Brahmaputra River at three locations in the Dibrugarh region near the DibruSaikhowa National Park: Balijanghat (BS1), Oakland (BS2), and Maijanghat (BS3). The study identified four orders, ten families, twelve genera, and twelve species of aquatic insects. The order Hemiptera had the highest density across all sites and seasons. Seasonal fluctuations in water environmental factors were found to be mild (Gogoi and Gupta, 2017).

In the study of aquatic insect diversity in three permanent water bodies in kaliabor, Nagaon district, Assam, 28 species of aquatic insects belonging to 6 orders and 18 families were recorded. According to the study, the order Hemiptera has the most species (9 families and 15 genera). Coleoptera (three families and four genera), Odonata (two families and four genera). Diptera (two families, two genera) During this effort, Ephemeroptera (1 family, two genera) and Hymenoptera (1 family, one genus) were seen (Mahanta *et al*., 2018).

At a study of the richness of aquatic insect communities at ten Deeporbeel sites, the sole Ramsar site in Assam, located on the southern bank of the Brahmaputra, 31 species from 18 families and five orders were identified. The order Hemiptera has 17 species and 8 families, making it the greatest order in terms of aquatic insect diversity, followed by the order Coleoptera, which has 7 species and 5 families (Choudhury and Gupta, 2015). The study on the insect resources of KaplaBeel in the Barpeta District indicated the presence of a varied insect species in the wetland. A total of 34 insect species were identified, including 5 Coleoptera families with 20 genera, 6 Hemiptera families with 8 genera, 2 Odonata families with 2 genera, 2 Diptera families with 2 genera, and 1 Ephemeroptera family with 2 genera. Coleoptera were the most numerous, followed by Hemiptera, Odonata, Diptera, and Ephemeroptera. The order Coleoptera accounted for 59% of all known aquatic insect species, Hemiptera 23%, and Diptera, Ephemeroptera, and Odonata 2% each (Barman and Baruah, 2015).

The research was conducted out at Bakuamari stream, Chakrashila Wildlife Sanctuary, Assam, North East India, in the Kokrajhar district. The investigation discovered the existence of 21 aquatic bug species from 14 families and 7 orders. Hemiptera ranked first, followed by Coleoptera and Ephemeroptera (Barman and Gupta, 2015).

A research on the aquatic insect fauna of Majuli River Island was undertaken at Majuli, the world's biggest riverine island, where 48 aquatic insect species belonging to 6 orders and 20 families were recorded. Odonata was shown to be the most prevalent order (47.92%) with the most species (23) followed by Coleoptera and Hemiptera (18.75% abundance with 9 species each). Only a few aquatic insect species (6.25%, 3), Tricoptera (4.17%, 2), and Diptera (4.17%, 2) were registered (Borkataki *et al*., 2018).

Checklist of aquatic insect fauna on Assam's Majuli river island in 2016-17 (Borkataki *et al*., 2018).

| Order | Sub order | Family | Scientific name | Habitat |
|---|---|---|---|---|
| Odonata (23 species) | Anisoptera | Libellulidae (15 species) | *Brachythemis contaminata* Fabricius, 1793) | Aquatic naiads are found in bodies of water with thick, floating, and submerged vegetation/seasonal natural streams/periodically controlled streams. Adults live in a semi-aquatic environment. |
| | | | *Crocothemis servilia servilia* (Drury, 1773) | |
| | | | *Rhyothemis variegate* (Linnaeus, 1763) | |
| | | | *Urothemis signata* (Rambur, 1842) | |
| | | | *Pantala flavescens* (Fabricius, 1798) | |
| | | | *Aethriamanta brevipennis* (Rambur, 1842) | |
| | | | *Orthetrum sabina* (Drury, 1770) | |
| | | | *Orthetrum pruinosum* (Burmeister, 1839) | |
| | | | *Orthetrum brunneum* (Fonscolombe, 1837) | |
| | | | *Brachydiplax chalybea* (Brauer, 1839) | |

| Order | Sub order | Family | Scientific name | Habitat |
|---|---|---|---|---|
| | | | *Brechmorphoga mendax* (Hagen, 1861) | |
| | | | *Neurothemis tullia* (Drury, 1773) | |
| | | | *Neurothemis fulvia* (Drury, 1773) | |
| | | | *Diplacodesne bulosa* (Fabricius, 1793) | |
| | | | *Acisoma panorpoides* (Rambur, 1842) | |
| | | Aeshnidae (1 species) | *Gynacantha dravida* (Lieftinck, 1960) | |
| | Zygoptera | Coenagrionidae (7 species) | *Ischnura aurora* (Brauer, 1865) | Naiads are aquatic organisms found in bodies of water with thick, floating, and submerged vegetation, as well as seasonal natural streams and occasionally controlled streams. Adults live in a semi-aquatic environment. |
| | | | *Ischnura elegans* (Linden, 1820) | |
| | | | *Ceriagrion coromandelianum* (Fabricius, 1798) | |
| | | | *Ceriagrion calamineum* (Lieftinck, 1951) | |
| | | | *Agriocnemis pieris* (Laidlaw, 1919) | |
| | | | *Agriocnemis pygmaea* (Rambur, 1842) | |
| | | | *Aciagrion hisopa* (Sélys, 1876) | |
| Coleoptera (9 species) | Adephaga | Gyrinidae (1 species) | *Dineutus* sp. (Macleay, 1825) | Typically found on the surface of bodies of water with thick, floating, and submerged vegetation/seasonal natural streams. |
| | | Dysticidae (5 species) | *Cybister fimbriolatus* (Say, 1823) | |
| | | | *Cybister* sp. (Curtis, 1827) | |
| | | | *Laccophilus* sp. (Leach, 1815) | |
| | | | *Hydaticus* sp. (Leach, 1817) | |
| | | | *Herophydrus musicus* (Klug, 1834) | |
| | | Hydrophilidae 1 species) | *Hydrophilus* sp. (Geoffroy, 1762) | |
| | | Curculionidae (1 species) | *Bagous* sp. (Germar, 1817) | |
| | | Carabidae (1 Sp) | *Pterostichus* sp. (Bonelli, 1810) | |
| Hemiptera (9 species) | Heteroptera | Belostomatidae (4 species) | *Diplonychus rusticus* (Fabricius, 1871) | Typically found on the surface of bodies of water with thick, floating, and submerged vegetation/seasonal natural streams. |
| | | | *Diplonychus* sp. (Laporte, 1832) | |
| | | | *Lethocerus indicus (Lepeletierand serville,* 1825) | |
| | | | *Lethocerus* sp. (Mayr, 1853) | |
| | | Nepidae (2 species) | *Laccotrephes* sp. (Stål, 1866) | |
| | | | *Ranatra* sp. (Fabricius, 1790) | |
| | | Gerridae (1 species) | *Gerris* sp. (Fabricius, 1794) | |
| | | Notonectidae (1 species) | *Enithares* sp. (Spinola, 1837) | |
| | | Corixidae (1 species) | *Micronecta* sp. (Kirkaldy, 1897) | |
| Ephemeroptera (3 species) | Pannota | Caenidae (1 species) | *Caenis* sp. (Stephens, 1835) | Nymphs and imagos are prevalent in clean water bodies' benthic zones. Adults are terrestrial dwellers with limited lifespans. |
| | Pisciformia | Baetidae (1 species) | *Baetis* sp. (Leach, 1815) | |
| | | Isonychiidae (1 species) | *Isonychia* sp. (Eaton, 1871) | |
| Trichoptera (2 species) | Spicipalpia | Glossosomatidae (1 species) | *Glossosoma* sp. (Curtis, 1834) | |
| | Annulipalpia | Hydropsychidae (1 species) | *Diplectronamodesta* (Banks, 1908) | |
| Diptera (2 species) | Nematocera | Simulidae (1 species) | *Simulium* sp. (Latreille, 1802) | Maggots are often found on the surface of lentic water bodies or in the benthic zone. Adults live on land. |
| | | Chironomidae (1 species) | *Chironomus* sp. (Meigen, 1803) | |

**Discussion**

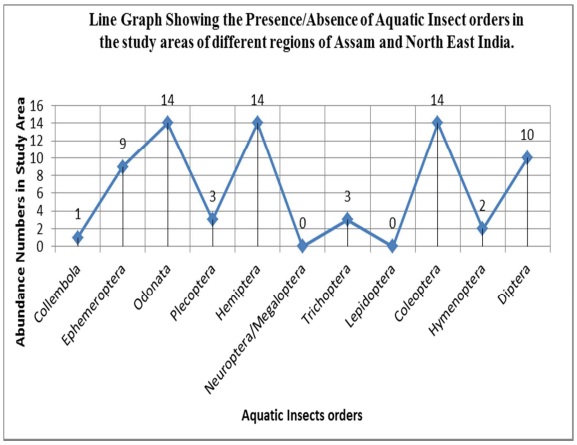
Although the richness of aquatic insects in the North Eastern area is seldom recorded or researched. According to an overall study conducted by several experts and academics in the North Eastern section of India and various parts of Assam, the study area is endowed with a great diversity of aquatic insects, revealing the health and riches of the aquatic environment. Insects belonging to the orders Odonata, Hemiptera, and Coleoptera were found to be common in the majority of the research locations recorded, followed by insects belonging to the orders Diptera and Ephemeroptera. In contrast, insects from the Orders Plecoptera, Trichoptera, Hymenoptera, and Collembola are observed to be the fewest in the research locations. Aquatic insects of the Orders Neuroptera/Megaloptera and Lepidoptera were not found in any of the research locations in Northeast India and other areas of Assam.

Table displaying the presence or absence of Aquatic Insect orders in the research areas of Assam and the North Eastern Regions.

| SL | Study Area (State/ District) | Habitat | Insect Orders | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Collembola | Ephemeroptera | Odonata | Plecoptera | Hemiptera | Neuroptera/ Megaloptera | Trichoptera | Lepidoptera | Coleoptera | Hymenoptera | Diptera |
| 1 | Manipur | Loktak Lake | - | + | + | - | + | - | + | - | + | - | + |
| 2. | Manipur | PhumidsLoktak lake | - | - | + | - | + | - | - | - | - | - | - |
| 3. | Manipur | Moirang River | - | - | + | - | + | - | - | - | + | - | - |
| 4. | Tripura | Fresh Water Lake | - | - | + | - | + | - | - | - | + | - | + |
| 5. | Arunachal Pradesh | DiyungTheip Watershed | - | - | + | + | + | - | - | - | + | - | - |
| 6. | Arunachal Pradesh | Namdapha National Park | - | - | - | - | - | - | - | - | + | - | - |
| 7. | Meghalaya | Streams | - | - | - | + | + | - | - | - | - | - | - |
| 8. | Cachar | Ponds | - | + | + | + | - | - | - | - | + | - | + |
| 9. | Silchar | Ponds | - | - | + | - | + | - | - | - | + | - | + |
| 10. | Guwahati | Ponds | - | + | + | - | + | - | - | - | + | + | + |
| 11. | Dibrugarh | Brahmaputra River | - | + | + | - | + | - | - | - | + | - | - |
| 12. | Nagaon | Water Bodies | - | + | + | - | + | - | - | - | + | + | + |
| 13. | Guwahati | Deeporbeel | - | + | + | - | + | - | - | - | + | - | + |
| 14. | Majuli | River Island | - | + | + | - | + | - | + | - | + | - | + |
| 15. | Barpeta | KaplaBeel | - | + | + | - | + | - | - | - | + | - | + |
| 16. | Kokrajhar | Bakuamari Stream | + | + | + | - | + | - | + | - | + | - | + |
| Total | | | 1 | 9 | 14 | 3 | 14 | 0 | 3 | 0 | 14 | 2 | 10 |

("+" represents the Presence of Aquatic Insects belonging to specific Order)

("-" represents the Absence of Aquatic Insects belonging to specific Order)




**Conclusion**

Aquatic insects are plentiful in most freshwater settings and are frequently diverse. The primary goal of this inquiry or study was thus to increase our understanding of the fact that there is little information on the quantity and variety of aquatic insects in freshwater bodies in Assam. As a result, it is critical to conduct ongoing investigations, censuses, and research activities on the taxonomy and variety of aquatic insects, so that future researchers may use this essential group's knowledge as baseline data for

further study and conservation planning. As a result, a systematic research of the variety of aquatic insects in Assam, North East India, should be conducted.

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