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DIVERSITY OF ODONATA IN THE URBAN ECOSYSTEM OF HABIGANJ, BANGLADESH

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ABSTRACT: Dragonflies and damselflies are collectively known as odonates under the insect order Odonata. This group of insects is sensitive to environmental changes; therefore, acts as an ecological indicator. Field-based investigation on their diversity, abundance, and status is crucial to assess the ecological condition of any given landscape. Therefore, this study was carried out in an urban area of Habiganj Sadar Upazila between March 2020 and February 2021. Opportunistic surveys across different habitat types of two selected sites were followed for data collection. From the study, a total of 42 species of Odonata under 29 genera, 7 families, and 2 suborders have been recorded. Suborder Anisoptera contained the highest number of species (n=25), and Libellulidae was the dominant family (n=21) among 7 families. From the recorded species, 11 species were very common, 10 species were common, 6 species were uncommon, and 14 species were rare. Shannon-Wiener diversity index showed site A and the rainy season having the highest diversity (H′ = 3.1475 and H′ = 3.1119, respectively) of odonates. This preliminary study will provide information for future conservation steps for this charismatic insect group in the study area.

Key Words: Anisoptera, Zygoptera, Diversity, Habitat, Season.

INTRODUCTION

Bangladesh is a South Asian country, part of the Indo-Burma biodiversity hotspot, and hosts an enormous area of wetland habitats, which include ponds, rivers, freshwater lakes, marshes, and extensive mangrove swamps. Moreover, monsoon creates many temporary water reservoirs. During monsoon, most of the paddy fields and irrigation channels remain water filled for more than three months. In terms of geographic location and diverse range of water bodies, Bangladesh harbors a rich diversity of Odonata fauna (Chowdhury and Mohiuddin 2011; Tuhin and Khan 2018). Dragonflies and damselflies are collectively called Odonata, which are considered as earliest winged insects, as they evolved long back in the Permian period (Kalkman *et al.* 2008; Tuhin and Khan 2018).

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They are distributed in all the continents except Antarctica (Mitra 2002; Trueman 2007; Nasiruddin and Barua 2018). Yet, 6338 species of Odonata belonging to 693 genera have been recorded from all over the world (Schorr and Paulson 2020). Odonates considered as the most colorful and attractive among other insects on earth, and because of their comparatively large size, they are easily noticeable while pursuing their prey near water bodies such as ponds and temporary pools (Thorp and Rogers 2011; Tiple *et al.* 2013). They are paleopterous and amphibiotic invertebrates that depend on freshwater bodies for most of their lifetime (Trueman 2007; Tiple *et al.* 2013). Females lay eggs on water and submerged plants, and the nymphal development occurs underwater (Hornung and Rice 2003; Tuhin and Khan 2018). Their nymphs are highly predaceous and respire through gills (Andrew *et al.* 2008). From the perspective of ecology, odonates are very important for both aquatic and terrestrial habitats and play an important role as predators in wetland and terrestrial food chains (Tiple 2020). In addition, their adults and nymphs are food sources for birds, lizards, and frogs. In some countries adult dragonflies are taken as food by people (Basher *et al.* 2014). In spite of their higher distribution in diverse ecological niches, they are sensitive to the alteration of their habitats. This makes them ideal for ecological indicators of the status of freshwater ecosystems (Brown 1991; Martin and Maynou 2016). Odonates are also broadly studied in evolutionary and ecological research (Córdoba and Aguilar 2008). To investigate the impact of environmental warming and climate change, odonates have been used as models because of their ability to adapt in temperate climates and also because for their tropical evolutionary history (Nesemann 2011; Payra *et al.* 2014). They are providing a very crucial role in controlling epidemic diseases like malaria, dengue, and filariasis as their nymphs feed on mosquito larvae (Mitra 2002; Payra *et al.* 2014).

They have also become adapted to urban habitats and started to use man-made water bodies (Andrew *et al.* 2008; Tiple 2020). But nowadays, urban wetlands are also under high pressure due to human activities such as degradation and pollution of wetlands on a global scale. Odonates dwelling in urban wetlands are at great risk. So, examining such wetlands may offer an indication of the level of local reduction in community for this wetland-dependent being (Koparde *et al.* 2019). Very few studies have been carried out so far to document the odonate fauna of the Bangladesh. According to Khan (2015), 108 species have been recorded so far from the country, but in recent years some species have been added to the odonate fauna of Bangladesh. Experts believe much more species are yet to be discover from the country which might exceed 150 species of odonates (Habib *et al.* 2016). There were no previous studies regarding diversity of odonates that had been done in Habiganj Sadar.

Therefore, this study was conducted to know the diversity of odonates in this human-dominated landscape of north-eastern region of the country.

MATERIAL AND METHODS

Study area: The study was carried out at Habiganj Sadar Upazila of Habiganj district. Habiganj Sadar comprises 214.22 square kilometers and is situated on the bank of the Khowai River. Along with human settlements, it has some green spaces such as homestead gardens, parks, canals, lakes, ponds, grasslands, and agricultural fields. The average annual rainfall of Habiganj is 157.5mm, with the wettest month being July (413.18mm) and the driest month being January (1.93 mm) and the average annual humidity is 67.39% (Rishan and Fagun 2019). Two sites were selected based on habitat quality for the study purpose. Site A (24.3753°N to 91.4108°E) is the Brindaban College Quarter area, which includes ponds, meadow fields with some temporary pools, and bushy areas. On the other hand, site B (24.3836°N to 91.4155°E) is the North Shaymoli area, which includes ponds (mostly polluted due to sewage discharges) and fewer open spaces with congested human settlements. Most of the bank areas of ponds were shady due to large trees (Fig. 1).

Data Collection: The study was carried out between March 2020 and February 2021. Data was collected once a month from each site between 10 am and 2 pm by walking opportunistically through all the possible odonate habitats of the study sites (Payra and Tiple 2019). Different identification keys of the specimen, such as wing venation, patterns of thorax and abdomen, shape of anal appendages (Tuhin and Khan 2018) were sharply photographed by using a DSLR camera (Canon 700D with 55-250mm zoom lens). Further, species were identified with the help of taxonomic keys provided by Fraser (1933, 1934, 1936), Asahina (1967), and Mitra (2002). The study period was divided into three seasons: summer (March-June), rainy (July-October), and winter (November-February). Observation status was determined on the basis of encounter: very common (more than 100 sightings), common (50-100 sightings), uncommon (15-50 sightings), rare (2-15 sightings), and very rare (less than 2 sightings) (Tiple and Koparde 2015). Shannon-Wienner diversity index was followed to determine seasonal and site-wise diversity. The formula is

$H' = -\sum (p_i \ln p_i)$ Where, p_i= Proportion of the community= Number of individuals of one population/ total individual of the community.

RESULTS AND DISCUSSION

Species Richness: A Total of 42 species of Odonata under 29 genera, 7 families, and 2 suborders (Anisoptera and Zygoptera) have been recorded from

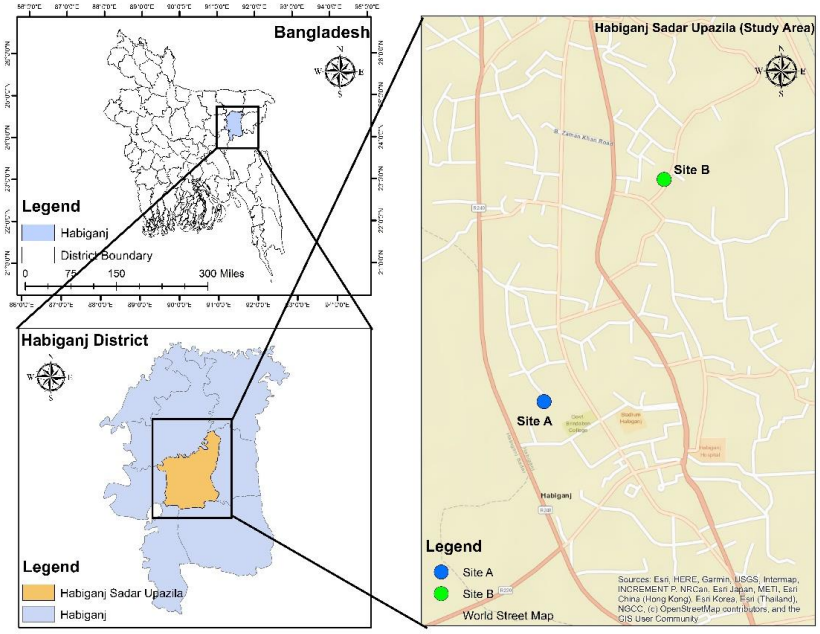

Figure 1. Study area map

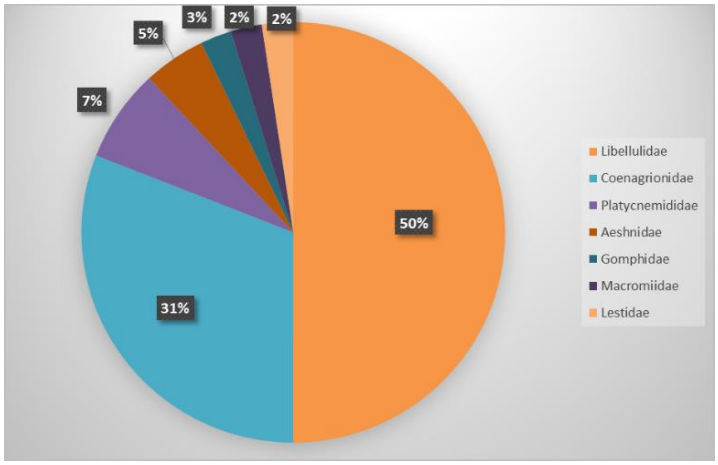

Figure 2. Family-wise percentage of odonate species

the study area (Table.1). Anisoptera contained 25 species under 19 genera and 4 families and Zygoptera contained 17 species under 10 genera and 3 families. Libellulidae was the most dominant family with 50% (21 species) of the total species count followed by Coenagrionidae (31%), Platycnemididae (7%), Aeshnidae (5%), Gomphidae (3%), Macromiidae (2%), and Lestidae (2%) (Fig. 2).

Among 29 genera, Agriocnemis was the most dominant genus with 4 species. Next, Ischnura and Neurothemis contained 3 species in each, whereas Ceriagrion, Pseudagrion, Brachydiplax, Orthetrum, and Diplacodes contained 2 species in each, and the rest of the genera contained only one species in each. According to observation status, 11 species were very common, 10 species were common, 6 species were uncommon, 14 species were rare, and 1 species was very rare (Table 1).

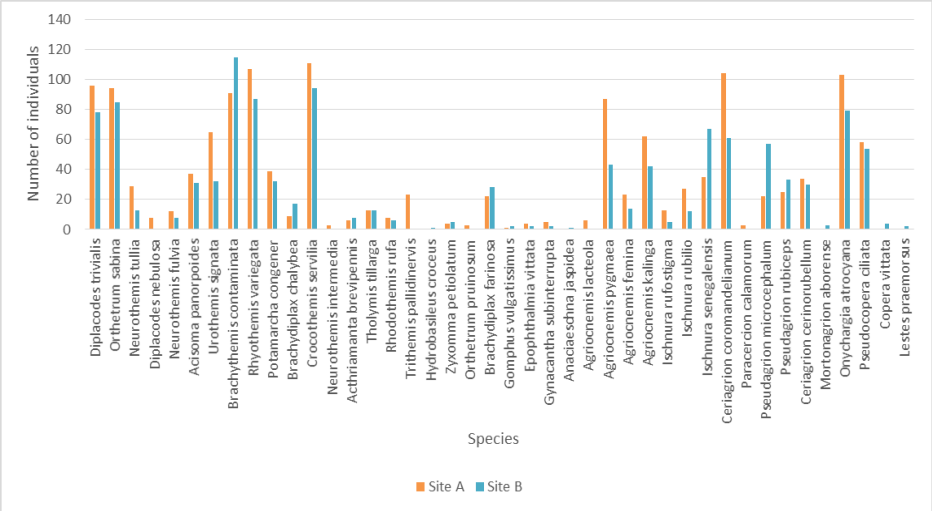

Figure 3. Site-wise abundance of odonates

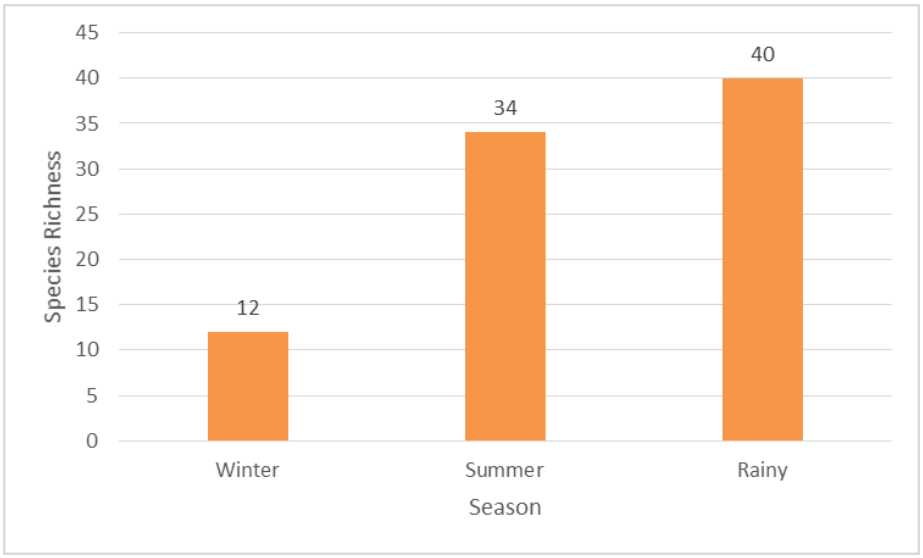

Figure 4. Season-wise species richness of odonates

Spatio-temporal variation: The Shannon-Weinner diversity index revealed site A had the highest diversity (H′ =3.1475; 39 species) over site B (H′ =2.9854; 36 species). Site A also contained a higher number of species (39) than site B (36). In site A, *Crocothemis servilia* was most dominant (n=111), while in site B, *Brachythemis contaminata* was most dominant (n=115) (Fig. 3). There were some site-specific species, such as *Neurothemis intermedia, Orthetrum pruinosum, Trithemis pallidinervis, Agriocnemis lacteola,* and *Paracercion calamorum* were restricted to site A, whereas *Anaciaeschna jaspidea, Mortonagrion aborense, Copera vittata,* and *Lestes praemorsus* were only found from site B. The Shannon-Weinner diversity index also showed the highest odonate diversity in the rainy season (H′ =3.1119), followed by summer (H′ =3.0019), and winter (H′ =1.9753). In rainy season, highest number of species was observed (40), followed by summer (34), and winter (12) (Fig. 4). There were some season-specific species, such as *Trithemis pallidinervis, Anaciaeschna jaspidea, Paracercion calamorum, Pseudagrion microcephalum* were only found in winter period, while *Orthetrum pruinosum, Hydrobasileus croceus, Zyxomma petiolatum, Gynacantha subinterrupta* were found only in rainy season. However, eight species (*Epophthalmia vittata, Crocothemis servilia, Brachythemis contaminata, Orthetrum Sabina, Ceriagrion coromandelianum, Agriocnemis pygmaea, Onychargia atrocyana,* and *Pseudocopera ciliata*) were commonly found in all three seasons.

Khan (2015) reported 76 odonata species from north-eastern region of Bangladesh and the present study found 42 species which is more than half of species recorded from north-eastern region. This indicates potential of an urban area to hold of these ecologically important insects. In this study, suborder Anisoptera found to contain more species than suborder Zygoptera. This dominance of Anisoptera over Zygoptera also supported by Pahari *et al.* (2019), who argued this is due to Anisoptera having higher dispersal ability, a wide level of habitat preferences, and a higher tolerance level than Zygoptera.

Table 1. Odonate species recorded from the study area between March 2020 and February 2021

Suborder	Family	Scientific Name	Common Name	OS
Anisoptera	Libellulidae	*Diplacodes trivialis*	Blue Ground Skimmer	VC
		Orthetrum sabina	Green Marsh Hawk	VC
		Neurothemis tullia	Pied Paddy Skimmer	UC
		Diplacodes nebulosa	Black Tipped Ground Skimmer	R
		Neurothemis fulvia	Fulvous Forest Skimmer	UC
		Acisoma panorpoides	Trumpet Tail	C
		Urothemis signata	Greater Crimson Glider	VC
		Brachythemis contaminata	Ditch Jewel	VC

Suborder	Family	Scientific Name	Common Name	OS
		Rhyothemis variegata	Common Picturewing	VC
		Potamarcha congener	Yellow Tailed Asy Skimmer	C
		Brachydiplax chalybea	Rufous Backed Marsh Hawk	UC
		Crocothemis servilia	Scarlet Skimmer	VC
		Neurothemis intermedia	Paddyfield Parasol	R
		Acthriamanta brevipennis	Scarlet Marsh Hawk	C
		Tholymis tillarga	Coral Tailed Cloudwing	C
		Rhodothemis rufa	Rufous Marsh Glider	R
		Trithemis pallidinervis	Long Legged Marsh Glider	UC
		Hydrobasileus croceus	Amber Winged Marsh Glider	VR
		Zyxomma petiolatum	Brown Dusk Hawk	R
		Orthetrum pruinosum	Crimson Tailed Marsh Hawk	R
		Brachydiplax farinosa	Black Tailed Dasher	C
	Gomphidae	*Gomphus vulgatissimus*	Common Clubtail	R
	Macromiidae	*Epophthalmia vittata*	Common Torrent Hawk	R
	Aeshnidae	*Gynacantha subinterrupta*	Dingy Dusk Hawk	R
Anisoptera	Aeshinidae	Anaciaeschna jaspidea	Rusty Darner	R
Zygoptera	Coenagrionidae	*Agriocnemis lacteola*	Milky Darlet	R
		Agriocnemis pygmaea	Pygmy Darlet	VC
		Agriocnemis femina	Pruinosed Darlet	C
		Agriocnemis kalinga	Indian Hooded Darlet	VC
		Ischnura rufostigma	Not Available	UC
		Ischnura rubilio	Western Golden Darlet	UC
		Ischnura senegalensis	Senegal Golden Darlet	C
		Ceriagrion coromandelianum	Coromandel Marsh Dart	VC
		Paracercion calamorum	Dusky Lily-squatter	R
		Pseudagrion microcephalum	Blue River-damsel	C
		Pseudagrion rubiceps	Saffron-faced Blue Dart	C
		Ceriagrion cerinorubellum	Orange-tailed Marsh Dart	C
		Mortonagrion aborense	Not Available	R
	Platycnemididae	*Onychargia atrocyana*	Black Marsh Dart	VC
		Pseudocopera ciliata	Pied Bush Dart	VC
		Copera vittata	Blue Bush Dart	R
	Lestidae	*Lestes praemorsus*	Scalloped Spreadwing	R

(Note: OS- Observation status, VC- Very Common, C- Common, UC- Uncommon, R- Rare)

On the other hand, Zygoptera with less dispersal ability may become vulnerable to habitat fragmentation and may need more joined and contiguous habitats for their viability in any given area (Neupane *et al.* 2024). Site a showed higher species diversity than site B because of its diverse habitat types. Structurally complex habitats provide more niches and diverse ways of exploiting the environmental resources, thereby increasing species diversity (Bazzaz 1975). Meadows, bushes, and the presence of temporary pools over the rainy season made it ideal ground for odonates. Moreover, better water quality and less human disturbance in site A were responsible for highest species diversity and species richness. The anthropogenic pressure, habitat structure, and the quality of water affect on the communities of the Odonata (Holtmann *et al.* 2019). Site B was a relatively polluted area, and *Brachythemis contaminata* was most abundantly observed in this site. This species is considered as bioindicator of pollution, as they are abundantly found in polluted areas. *B. contaminata* has higher pollution tolerance and adaptive capability. Nayak and Roy (2016) also observed similar findings in their study. In addition, species that prefer open marshy areas, such as *Trithemis pallidinervis*, *Urothemis signata*, *Neurothemis tullia*, and *Neurothemis intermedia* were less abundant in Site B due to the lack of such habitat types (Fig. 3). Some species were found in meadows, such as *Agriocnemis lacteola, A. pygmaea, Ischnura rufostigma, I. rubilio, Neurothemis tullia,* and *Diplacodes nebulosa*, while some were found near ponds, such as *Brachythemis contaminata, B. chalybea, Acthriamanta brevipennis, Ictinogomphus rapax, Ischnura senegalensis,* and *Pseudagrion microcephalum,* whereas others were found in shady areas, such as *Epophthalmia vittata, Gynacantha subinterrupta, Anaciaeschna jaspidea, Hydrobasileus croceus, Zyxomma petiolatum, Orthetrum pruinosum, Brachydiplax farinose,* and *Lestes praemorsus*. These observations suggest habitat diversification and utilization of different species (Tuhin and Khan 2018).

Odonates depend on water for their larval development. After completion of mating, females lay their eggs on water or submerged water. During the rainy season, rainfall is at its maximum. Thus, creating different water reservoirs, such as temporary pools, which make them ideal for odonates. Moreover, vegetation also increases in rainy season that attracts herbivorous insects upon which odonates feed. All these factors are responsible for the highest diversity of odonates in rainy season (Chowdhury and Mohiuddin 2011). As odonates are ectothermic, they depend on external temperature to remain active. During summer and rainy seasons, the temperature is ambient, thus the diversity was higher in these two seasons, whereas in winter, temperature falls in Bangladesh as well as in Habiganj, and so the diversity was lower. Notably, in this study, species that were observed commonly were lower in number, while species that were observed rarely were higher in number. This indicates fluctuation in the community structure of odonates. The variation can be attributed to habitat

Figure 5. Some of the recorded odonates from the study area.

degradation, decreasing population numbers, or changing environmental factors.

According to Shah and Khan (2020), *Gynacantha subinterrupta, Anaciaeschna jaspidea, Epophthalmia vittata,* and *Hydrobasileus croceus* are nationally rare, and *Diplacodes nebulosa* and *Lestes praemorsus* are nationally uncommon. This suggests the importance of the study area in harboring such crucial species (Fig. 5). Regular region-based surveys are necessary to know abundance fluctuations, species composition, and the local status of a particular group of animals (Tuhin and Khan 2018). Region-based surveys are

also need to assess the conservation status of a species (Khan 2018). IUCN Bangladesh has not done a red list of dragonflies and damselflies yet. Lack of such study is a barrier to understanding of the conservation priorities of odonates.

CONCLUSION

This is the first study to examine odonate diversity in Habiganj Sadar upazila. In total, 42 species under 29 genera and seven families have been recorded, indicating the study area still holds suitable aquatic habitats for odonates. But there also habitat destruction is ongoing. Many ponds and open areas are being filled for the construction of buildings. These activities possess serious threats to odonates. Further broad-based surveys across Habiganj Sadar area could reveal more species.

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