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Abundance and Diversity of Odonates in Different Habitats of Barpeta District, Assam, India

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Abstract

A total of 45 species of Odonata including 29 species under 3 families of Anisoptera and 16 species under 3 families of Zygoptera were recorded in four different types of habitats in Barpeta district of Assam during two years (2012 and 2013) of survey. 38 species were recorded from habitats near ponds and rivers, 39 from near beels and 41 species were recorded from open tracts of land. 7 species were recorded from three different types of habitats; 3 species were recorded from two types and 4 species were recorded from two habitat types. 32 species were recorded in all the four habitat types. The most abundant Anisopteran species in ponds was Diplacodes trivalis; in beels and rivers it was Rhyothemis variegate variegate, and Pantala flavescens was most abundant in open tracts. Among the Zygopteran species the most abundant was Ceriagrion coromandelianum in all the habitats. Shannon-Weiner index (H') was 3.323 in ponds , followed by 3.310 in open tracts of land, 3.243 in rivers and 3.305 in Beels or lakes. Margalef's richness (D_{Mg}) index was found to be 6.47 in open tracts; 6.36 in river banks 6.12 in beels and 5.65 in ponds. The Jaccard's similarity index (C_j) was 0.88 between beel and river and 0.80 between pond and open tracts.

Keywords: Odonata, Anisoptera, Zygoptera, Habitat.

Introduction

Dragonflies and damselflies are insects which are very ancient and belong to the order Odonata. They are predatory insects and active during daytime[1]. The larvae are aquatic while the adults are aerial. The order Odonata are divided into three groups, *viz.* damselflies (Zygoptera), Anisozygoptera and dragonflies (Anisoptera)[2]. Odonates breed and are commonly found near aquatic bodies. During the breeding season, adult males generally establish territories along wetlands, and sexually mature and receptive females visit territories held by males. Their breeding habitats include both flowing and stagnant water bodies. Odonates have specific habitat requirements. They are also sensitive to changes in landscape and are reliable indicators of wetland health[3]. The rural areas have higher species richness as compared to urban areas[4].

Studies on Odonate diversity in the North Eastern part of India are very few. Lahiri[5] reported a total of 33 odonate species from Assam, Arunachal Pradesh, Manipur and Mizoram of North Eastern India. Mitra[6] described the geographical distribution and zoogeography of 148 species from the state of Meghalaya. Seven species were recorded from various study sites at the Gauhati University campus[7]. Majumder, *et al.*[8] reported 10 species of Odonata which accounted for 32.25% species richness in urban lakes of Tripura. Devi, *et al.*[9] studied the aquatic insect diversity of Loktak Lake, Manipur and found that Odonata represented by two families *viz.* Libellulidae and Coenagrionidae.

Material and Methods

Study area: The present investigation was carried out in the district of Barpeta of Assam, India. The Barpeta district extends from 26°45' to 26°49' North latitude and 90°45' to 90°15' East latitude. It is a riverine plain forming a part of the Lower Brahmaputra valley. The District is surrounded by the Bhutan Hills and Bagsa District in the North, Nalbari District in the East, Kamrup and Goalpara district in the South and Bongaigaon and Chirang District in the west. The general Topography of Barpeta District varies from low-lying plains to highland having small-hillocks. The river Brahmaputra and eight tributaries form the main river system of the district. More over there are a large number of lakes (locally called Beels), ponds and fisheries which are habitat of odonates along with other aquatic organisms. The climate of the region is tropical monsoon type. The summer season is form March to May, followed by rainy season from June to September and cool winter from October to February.

Sampling: Adult odonates were sampled for a period of two years (2012 and 2013) in five different types of habitats across the study area. Sampling of adult odonates was done on days with fine weather conditions in all the seasons and in all the habitats by moving along a transect.

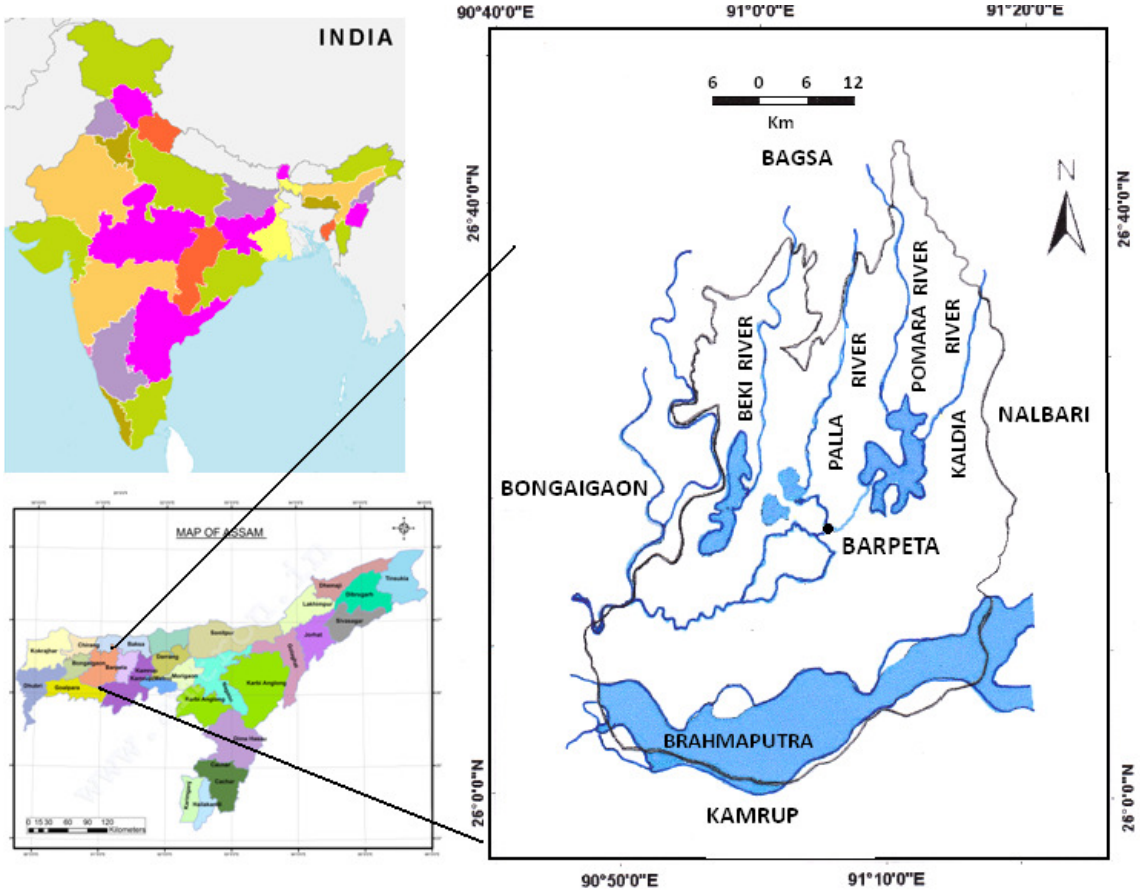

Figure-1
Map showing Barpeta district with major rivers

This method has been widely used for quantitative sampling of Odonates[10-13]. The species were identified using various literatures[2,3,14-18]. The abundance is determined by the number of individual encountered during visual surveys along transects. The total number of individuals of each species encountered during the two years of sampling period (January, 2012 to December, 2013) is used for comparing their abundance.

The different types of habitat which were surveyed included –
Ponds: In the present study, both aquaculture ponds (man managed) and natural ponds which have less human interferences are included in this category. Some of the ponds were permanent or filled with water all the year round while few others dried up during the dry seasons.

(b) **Beels:** Lakes, which are referred herein as beels are large bodies of standing water occupying distinct basins[19]. These wetlands occur in natural depressions and normally fed by streams and rivers.

(c) **River banks:** These sites were adjacent to flowing rivers.

(d) **Open land stretch:** Sites like agricultural and farm lands which have no permanent water body like ponds, beels or river at least within a range of 200m or more from the transect laid and surveyed are referred herein as open tracts. Some of these sites were plain and covered with shrubs, bushes or tall trees. Agricultural lands like paddy fields, vegetable cultivation or farm lands with plantation are included in this category. Some of these open land stretches remained filled with water during rainy season. As such they also serve as breeding sites for many species of odonates.

Data Analysis: Margalef's richness (D_{Mg}) index is used here to determine species richness. If '*S*' is the number of species recorded and '*N*' is the total number of individuals in the sample, the indices are calculated as follows:

$$D_{\mathrm{Mg}} = \frac{(S-1)}{\ln N}$$

The Shannon-Weiner index (Shannon and Weaver, 1949) is used here to calculate the diversity of species in different habitats. The Shannon-Weiner index (H′) is given by the formula as follows:

$$\mathrm{H}'' = \sum_{i=1}^{s} \mathrm{p_i} \ln \mathrm{p_i}$$

where's' is the number of species, and 'p_i' is the proportion of individuals of each species belonging to the 'i'th species of the

total number of individuals. The negative of this sum is taken as the index. The higher the index, the higher is the species diversity.

Jaccard's index (C_j) was used to calculate the similarity of odonate species between two habitats among the different types of habitats studied. It is given by the following relation:

$$C_j = \frac{a}{a + b + c}$$

Where, 'a' is the total number of species observed in both the habitats, 'b' is the number of species found in the first habitat type but not in the second and 'c' is the number of species found in the second habitat type but not in the first.

Results and Discussion

Abundance: A total of 45 species were recorded during the study (table-1). The suborder Anisoptera is represented by 3 families and 29 species and the suborder Zygoptera by 3 families and 16 species. 38 species were recorded from habitats near ponds and rivers, 39 from near beels and 41 species were recorded from open tracts of land. Ponds are the most abundant habitat with 699 individuals (504 Anisopteran and 195 Zygopteran), followed by beels with 488 individuals (365 Anisopteran and 123 Zygopteran), open tracts of land with 484 (305 Anisopteran and 179 Zygopteran) and rivers with 337 (272 Anisopteran and 65 Zygopteran individuals) was the least abundant.

Six species viz. *Stylogomphus inglisi*, *Acisoma panorpoides*, *Libellago lineata*, *Aciagrion hisopa*, *Ceriagrion olivaceum* and *Mortonagrion aborense* were found to be present in three different types of habitats. Three species viz., *Gynacantha bainbriggei*, *Brachydiplax farinose* and *Orthetrum pruinosum neglectum* were recorded from two different types of habitats. A total of four species viz., *Paragomphus lineatus*, *Lestes praemorsus*, *Aciagrion pallidum* and *Enallagma parvum* were found only in one particular habitat type. Other 32 species were recorded in all the habitat types. The most abundant Anisopteran species were *Diplacodes trivalis* (in ponds), *Rhyothemis variegate variegate* (in beels and rivers), and *Pantala flavescens* (in open tracts). Among the Zygopteran species the most abundant was *Ceriagrion coromandelianum* in all the habitats.

The distribution and abundance of zygoptera species were most affected by reeds[20]. However, anisoptera species were most affected by shade. The findings herein suggest that open tracts of land, which had only few shady trees, are preferred by zygopteran species of which 14 species were recorded therein. Moreover in addition to shade, perching places are also important in determining the distribution of odonate species. It was found that perch density and variety did not affect dragonfly abundance, but shade alone reduces dragonfly habitat selection[21].The results also indicate that ponds are habitated by all the Anisopteran species except the species *Stylogomphus inglisi* of family Gomphidae. This species is however abundantly found along river banks. The open tracts of land are the habitats which seems to be most preferred by the zygopterans since all the species encountered were present here, whereas five zygopteran species were not found in ponds or rivers and three were absent in beels. It may be for the fact that damselflies prefer shallow water with emergent vegetation into which they oviposit endophytically[22, 23].

Diversity and similarity index: The Shannon-Weiner index (ponds: $H' = 3.323$; Open tracts of land: $H' = 3.310$; rivers: $H' = 3.243$ and beels or lakes: $H' = 3.205$) as shown in table-2 does not vary much among the different habitats. Species richness or Margalef's richness (D_{Mg}) index was found to be 6.47 in open tracts, 6.36 in river banks and 6.14 in beels. It was found to be lowest in ponds (5.65). The Jaccard's similarity index (C_j) as shown in table-3 was highest (0.88) between beel and river and it was lowest between pond and open tracts of land (0.80).

Some zygopteran species *Libellago lineata*, *Aciagrion hisopa*, *Aciagrion pallidum*, *Ceriagrion olivaceum, Enallagma parvum*, *Mortonagrion aborense* and *Lestes praemorsus* were found to have limited distribution as far as the four different types of habitats are concerned. *Libellago lineata* is a species confined to streams and rivers frequently sits on water plants and overhanging bushes[2], so during the study this species was commonly found near river but also seen rarely near beels and in open tracts of land. *Aciagrion hisopa* is found in puddles in grassland and *Aciagrion pallidum* occurs in small colonies in grasslands much away from water[18]. *Ceriagrion olivaceum* an inhabitant of marshy areas was found in all the habitats except beels, *Enallagma parvum*, which prefers weedy habitats, was recorded in weed covered areas of beels. *Mortonagrion aborense* is commony found in bushes near marshy and so commonly encountered near beels. *Lestes praemorsus* prefers seasonal puddles[18] and so it was recorded only from open tracts of land where puddles are frequent.

The study area may be regarded to have both generalist and habitat specialist species. Most of the species which were found in all the habitats of the study area may be regarded as widespread generalist species. These species were found in the entire lentic ecosystem including open tracts of land where puddles of water are common during rainy seasons. Other species like *Libellago lineata*, *Aciagrion hisopa, Brachydiplax farinosa* and *Tholymis tillarga* which are restricted to a particular habitat may be regarded as habitat specialist[24]. Some habitat specielist species *Stylogomphus inglisi*, *Libellago lineata* and *Tholymis tillarga* were found to be present in more than one type of habitat. This may be due to the type of vegetation present in the area because the change in marginal vegetation has an influence on the change in dragonfly species composition due to species overlap[25].

Table-1
Table showing Odonata species recorded, their abundance, Margalef's richness (D_{Mg}) index and Shannon-Weiner index (H′) in different habitats of the study area

Suborder	Sl. No.	Species	Number of individuals encountered (abundance)			
			Pond	Beel	River	Open tracts
Anisoptera	**Family: Aeshnidae**					
	1.	*Anax guttatus*	18	17	6	2
	2.	*Gynacantha bainbriggei*	1	-	4	
	Family: Gomphidae					
	3.	*Ictinogomphus angulosus*	4	14	15	7
	4.	*Paragomphus lineatus*	-	-	-	2
	5.	*Stylogomphus inglisi*	-	1	5	1
	Family: Libellulidae					
	6.	*Acisoma panorpoides*	1	37	1	-
	7.	*Aethriamanta brevipennis*	10	34	2	7
	8.	*Brachydiplax chalybea*	30	3	10	6
	9.	*Brachydiplax farinosa*	5	-		7
	10.	*Brachydiplax sobrina*	11	1	5	16
	11.	*Brachythemis contaminata*	31	12	22	11
	12.	*Bradinopyga geminata*	4	2	3	6
	13.	*Crocothemis servilia*	43	32	11	9
	14.	*Diplacodes nebulosa*	6	6	1	3
	15.	*Diplacodes trivialis*	45	11	16	33
	16.	*Neurothemis fulvia*	21	20	8	28
	17.	*Neurothemis intermedia intermedia*	7	12	9	10
	18.	*Orthetrum glaucum*	1	4	4	8
	19.	*Orthetrum pruinosum neglectum*	3	2	-	-
	20.	*Orthetrum sabina*	29	23	16	29
	21.	*Pantala flavescens*	34	30	25	37
	22.	*Potamarcha congener*	41	9	26	26
	23.	*Rhodothemis rufa*	3	5	1	1
	24.	*Rhyothemis variegata variegata*	24	39	29	19
	25.	*Tholymis tillarga*	42	9	4	1
	26.	*Tramea basilaris burmeisteri*	28	16	8	25
	27.	*Trithemis pallidinervis*	30	5	28	3
	28.	*Urothemis signata signata*	27	19	12	7
	29.	*Zyxomma petiolatum*	5	2	1	1
Zygoptera	**Family: Lestidae**					
	30.	*Lestes praemorsus*	-	-	-	1
	Family: Chlorocyphidae					
	31.	*Libellago lineata*	-	1	6	10
	Family: Coenagrionidae					
	32.	*Aciagrion hisopa*	-	2	2	2
	33.	*Aciagrion pallidum*	-	-	-	2

	34.	*Agriocnemis lacteola*	23	2	1	14
	35.	*Agriocnemis pygmaea pygmaea*	19	1	4	29
	36.	*Ceriagrion cerinorubellum*	13	15	8	4
	37.	*Ceriagrion coromandelianum*	59	32	23	46
	38.	*Ceriagrion olivaceum*	11	-	1	13
	39.	*Enallagma parvum*	-	4	-	-
	40.	*Ischnura aurora*	13	8	5	16
	41.	*Ischnura forcipata*	9	6	3	7
	42.	*Mortonagrion aborense*	8	18	-	15
	43.	*Onychargia atrocyana*	9	18	4	8
	44.	*Pseudagrion microcephalum*	17	7	4	3
	45.	*Pseudagrion rubriceps*	14	9	4	9
TOTAL			699	488	337	484
H′			3.323	3.205	3.243	3.310
D_{Mg}			5.65	6.14	6.36	6.47

Table-2
Table showing Jaccard's similarity index (C_j)

	POND	BEEL	RIVER	OT
POND	1	0.83	0.85	8.80
BEEL	0.83	1	0.88	0.82
RIVER	0.85	0.88	1	8.84
OT	8.80	0.82	8.84	1

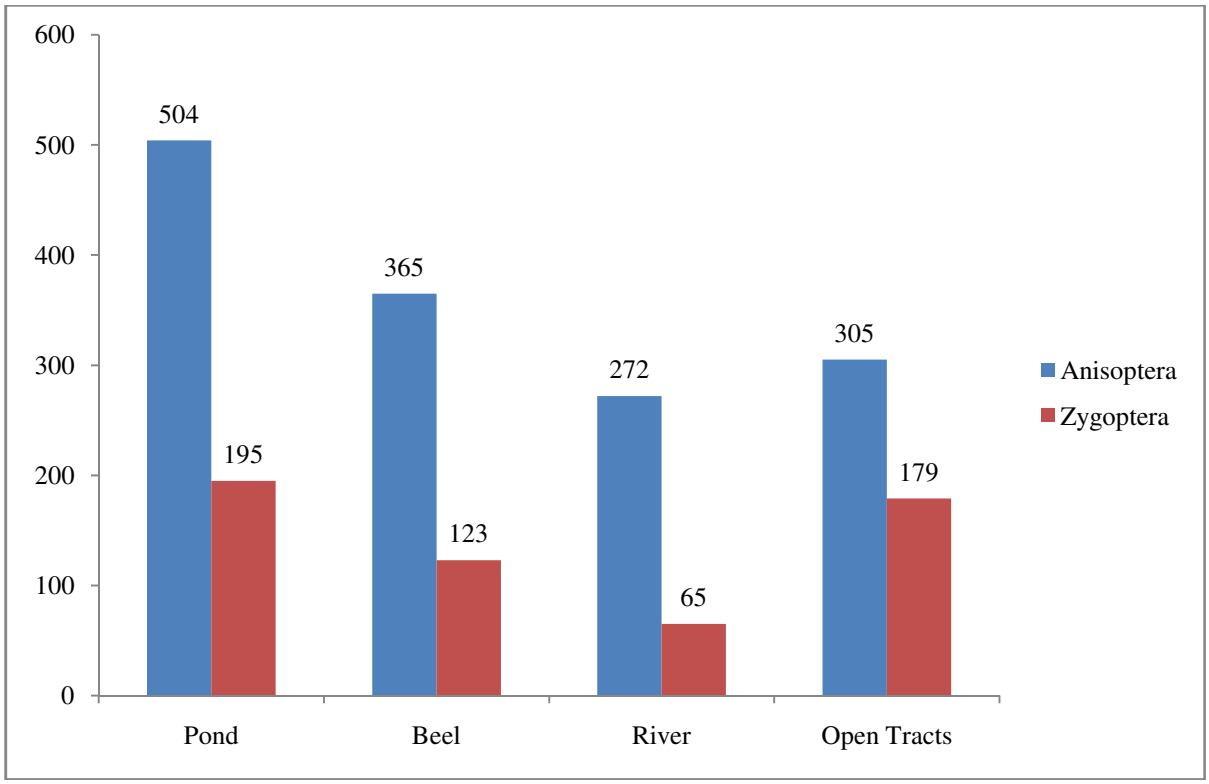

Figure-2
Bar diagram showing Anisopteran and Zygopteran abundance in different habitats

Lowest species richness both in terms of Margalef's richness (D_{Mg}) in case of ponds may be for the fact that most of the ponds are very near to human dwellings where interferrences may be high. (D_{Mg}) was highest in open tracts. Ponds mostly consist of mobile and habitat generalist species.

Conclusion

The results of the investigation indicate that Barpeta district of Assam, India has a rich diversity of Odonata population. The water bodies present in this region are suitable habitats for this fascinating group of insect. The species richness was found to be highest in open tracts of land and lowest in ponds. Further investigations are necessary for utilizing this group of insect as indicator species for the management of various water bodies in the study area.

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Figure-3
Gynacantha bainbriggei

Figure-4
Ictinogomphus angulosus

Figure -5
Stylogomphus inglisi

Figure-6
Acisoma panorpoides (Male)

Figure-7
Aethriamanta brevipennis (Male)

Figure-8
Brachydiplax chalybea

Figure-9
Brachydiplax farinose

Figure -10
Brachydiplax sobrina (Male)

Figure-11
Brachythemis contaminate (Male)

Figure-12
Bradinopyga geminate

Figure-13
Crocothemis servilia (Male)

Figure-14
Diplacodes nebulosa

Figure-15
Diplacodes trivialis

Figure-16
Neurothemis fulvia (Male)

Figure-17
Neurothemis intermedia intermedia

Figure-18
Orthetrum pruinosum neglectum

Figure-19
Orthetrum Sabina

Figure-20
Pantala flavescens

Figure-21
Potamarcha congener (Male)

Figure-22
Rhodothemis rufa

Figure-23
Tholymis tillarga (Male)

Figure-24
Tramea basilaris burmeisteri (Female)

Figure-25
Zyxomma petiolatum

Figure-26
Libellago lineate(Female)

Figure-27
Aciagrion hisopa

Figure-28
Aciagrion pallidum

Figure-29
Agriocnemis femina

Figure-30
Agriocnemis lacteola

Figure-31
Agriocnemis pygmaea

Figure-32
Ceriagrion cerinorubellum

Figure-33
Ceriagrion olivaceum

Figure-34
Enallagma parvum

Figure-35
Ischnura aurora

Figure-36
Ischnura forcipata

Figure-37
Mortonagrion aborense

Figure-38
Onychargia atrocyana (Male)

Figure-39
Pseudagrion rubriceps

Figure-40
Lestes praemorsus

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