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A Preliminary Study on Odonata Diversity in Three Diverse Landscapes of Cachar District, Assam, India

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ABSTRACT

Odonates are valuable as indicators of aquatic and terrestrial ecosystem health and also play a vital role as prey and predator to maintain the balance of trophic levels of food chain. Diversity and distribution of different species of Odonata and physico-chemical properties of water of their habitat in the rural (RA), urban (UA) and tea garden (TG) area of Cachar district of Assam was investigated. A total of fourteen (14) species (larva and adult) were recorded from the three areas. Six species were recorded in RA, four species in TG and six species in UA. Two species *Ischnura aurora aurora* and *Agriocnemis pygmaea pygmaea* were recorded common in TG and UA. In TG presence of only two tolerant families indicated that the water quality of the area is polluted. In RA, presence of Aeshnidae indicated relatively better condition of water quality.

Keywords: “Odonata”, “diversity” , “water quality”, “habitat”

INTRODUCTION

Fresh water species throughout the world depend on clean, pure and healthy water for their survival. [1] Although knowledge of freshwater biodiversity is improving [2], large gaps remain, particularly among invertebrates and especially in tropics where data deficient species is greater (50 to 75% data deficient)[3] . It is generally difficult to assess invertebrate diversity as they are often small, cryptic, and seasonal, making even Red List assessments difficult without considerable resources[4]. Till now studies confirmed that Odonata are the only insect group for which a representative assessment of conservation status has been completed and analysed. Having appeared 300 million years ago Odonates are declining worldwide due to the loss and deterioration of their habitat[5].

Dragonflies and damselflies are one of the most common insects found near water bodies. The order Odonata is divided into three suborders, Anisoptera (dragonflies), Zygoptera (damselflies) and Anisozygoptera. The suborder Anisozygoptera is a living fossil, have two species. One of them *Epiophlebia laidlawi* is known from Darjeeling, North Bengal, India. Dragonflies and damselflies can easily be distinguished in the field. Odonates are known as ecological indicators of any freshwater ecosystem because they are very selective and sensitive about their breeding habitat [6]. In the invertebrate world, odonates always attract the human beings for their variety of colour, powerful flight and extraordinary sense of vision. The adults are terrestrial and larvae are aquatic. They are valuable as indicators of aquatic and terrestrial ecosystem health and also play a vital role as prey and predator to maintain the balance of trophic levels of food chain and also useful in the control of mosquitoes which pass on diseases to human beings[7].

In India 3 suborders,17 families, 139 genera, and 499 species and subspecies of odonates are known.[8] The bioindicator species i.e odonata represent an accurate reflection of the habitats’ and biota’s condition. They are very sensitive species to changes caused to their habitat, especially lakes and flooded drainage areas[9]. The

use of fertilizers and chemicals is responsible for the decline of biodiversity in simplified agricultural systems. In aquatic environment, Odonata species are more sensitive to environmental changes in the water [10].

This is the first study on Odonata of Barak valley, Assam although a number of studies are in record from North Eastern India [11-14]. The sites chosen for the study have been categorized into three areas namely rural, urban and tea garden area. As these sites are unique in respect to their environment it is thought that a wide array of Odonata larvae and adult will be explored from these areas. This preliminary study will give an idea of the distribution of different species in the respective areas. Further an attempt also has been made to study relationship of their occurrence with water quality of the particular sites and their role as bioindicator.

MATERIALS AND METHODS

In this study, three different ponds were selected from rural area (RA) , urban area (UA) and tea garden area(TG) of Cachar district of Assam. The rural area is Irongmara village, urban area is the city Silchar and Sillicoorie tea estate is the tea garden. Water samples were collected during January to March,2013 from the selected sites. Then Water temperature (WT), Transparency(TR), Electrical Conductivity (EC), pH, Free CO2, Dissolved oxygen (DO), Total alkalinity (TA), Phosphate(PO_4^{2-}) and Nitrate (NO_3^-) were estimated by standard methods[15]. Air temperature (AT) was also recorded during collection.

Larvae of Odonata were collected from each site by a circular net (mesh size 60μm) by disturbing the vegetation for one minute [16]. A sample is constituted by three such drags. Insects were sorted and kept in 70% ethyl alcohol immediately. Odonata adults were collected with the help of a sweep net (35cm dia. and 70cm ht.) by slowly walking around the water bodies [12]. Digital camera (Nikon Coolpix,Model-3300) was used to trap the images of adults. Odonates were later identified with the help of standard keys [17-24] under advanced stereozoom Microscope (Olympus Magnus MSZ-TR, No.7OT 0820).

Table 1: Odonata species collected from Site 1(Rural area), Site 2 (Tea garden area) , Site 3(Urban area)

Suborder	Family	Specie	Present in Sites
Zygoptera	Coenagrionidae	*Pseudagrion* sp.(larva)	Site 1
Anisoptera	Libellulidae	*Tholymis tillarga*	Site 1
Anisoptera	Libellulidae	Pantala flavescens	Site 1
Anisoptera	Libellulidae	*Urothemis signata signata*	Site 1
Anisoptera	Libellulidae	*Diplacodes trivialis*	Site 1
Anisoptera	Aeshnidea	*Gynacantha dravida*	Site 1
Anisoptera	Libellulidae	*Tramea sp.*	Site 2
Anisoptera	Libellulidae	*Orthetrum sabina sabina*	Site 2
Zygoptera	Coenagrionidae	*Agriocnemis pygmaea pygmaea*	Site 2, Site 3
Zygoptera	Coenagrionidae	*Ischnura aurora aurora*	Site 2, Site 3
Zygoptera	Coenagrionidae	*Ischnurasp. (larva)*	Site 3
Zygoptera	Platycnemididae	*Copera marginipes*	Site 3
Anisoptera	Libellulidae	*Brachythemis contaminata*	Site 3
Anisoptera	Libellulidae	*Crocothemis servilia servilia*	Site 3

Table 2: Physico-chemical properties of water (mean± SD) of pond of rural area (RA) in four different visits

Parameter	1st	2nd	3rd	4th
AT(°C)	21±1	22.33±1.15	26 ±1	31±1
Trans. (cm)	21.33±9.27	22±9.00	21.67±8.42	21.33±9.27
pH	5.97±14.69	6.71±5.64	7.39±8.25	6.88±4.03
WT(°C)	23.43±7.69	20.77±9.25	22.1± 7.91	22.1± 7.91
EC(µScm $^{-1}$)	151.97±60.36	126.33±46.65	153.3±58.03	232.67±89.02
FCO2(mg/l)	15.77±6.88	9.53±1.88	6.97±2.91	6.42± 2.64
DO(mg/l)	6.56±5.50	7.87±5.56	11.86±0.04	10.59±3.17
TA(mg/l)	80.66±33.00	87±38.18	69±28.46	92±58.69
PO4(mg/l)	3.72±0.51	2.09±2.03	1.52±1.32	1.30±1.32
NO3(mg/l)	0.48±0.07	0.51±0.06	0.31±0.07	0.47±0.20

Table 3: Physico chemical properties of water (mean±S.D) of pond of tea garden area (TG) in four different visits

Parameter	1st	2nd	3rd	4th
AT(°C)	21.67 ±1.15	21.67 ±1.15	25.33 ±2.52	30.33 ±1.15
Trans.	16.17± 7.18	15.67± 6.00	31.33± 14.3	29 ±4.49
pH	6.06 ±8.03	6.8 ±0.87	6.30 ±5.06	7.11 ±3.60
WT(°C)	16.58 ±7.86	24.27 ±11.6	29.33± 2.64	23.39± 4.50
EC(µScm $^{-1}$)	75.93 ±26.94	53.43± 18.73	190.2± 5.80	219.33 ±101.4
FCO2(mg/l)	13.02± 4.91	10.08± 3.66	21.63 ±10.04	22.37 ±8.54
DO(mg/l)	9.09± 3.60	9.09 ±3.88	13.03 ±5.36	12.0 ±3.93
TA(mg/l)	34 ±12.76	35 ±15.72	45.67 ±18.20	40.33 ±12.58
PO4(mg/l)	1.58±1.41	1.47±1.37	1.18±1.28	0.39±0.35
NO3(mg/l)	0.39± 0.05	0.35 ±0.04	0.28± 0.07	0.24±0.05

Table 4: Physico- chemical properties of water (mean± SD) of pond of urban area (UA) in four different visits

Parameter	1st	2nd	3rd	4th
AT(°C)	20.33± 1.15	23.67 ±2.08	24.33 ±3.51	27± 2
Trans.(cm)	65.33± 30.07	61.67 ±22.34	60.33± 20.08	55.33± 16.16
pH	5.69±25.13	6.79±12.96	6.88±8.60	6.95±8.56
WT(°C)	20.43±25.73	26.03±16.78	29.4±9.71	31.77±8.03
EC(µScm $^{-1}$)	137.5±49.86	120.93±50.26	153.47±59.70	173.27±60.17
FCO2(mg/l)	14.48±5.66	8.62±2.09	7.52±2.76	6.78±2.26
DO(mg/l)	10.12±4.33	10.59±4.43	12.89±4.91	10.50±2.98
TA(mg/l)	74.67±31.23	73.67±30.01	70.67±23.13	70.33±21.40
PO4(mg/l)	0.62±1.07	0.39±0.35	1.07±1.10	0.45±0.39
NO3(mg/l)	0.31±0.01	0.31±0.03	0.28±0.05	0.31±0.02

RESULTS AND DISCUSSION

Invertebrates possess the capacity of responding to environmental perturbation at different levels of organization and serve as bioindicators of pollution[25,. 26, 27,28]. For the investigation of the impact of global warming and climate change, order Odonata can be considered as ideal taxa[29,30]. High diversity of tropical odonates is due to high diversity of fresh water habitats in tropical forests [31].

Odonata diversity and distribution

The life history of order Odonata is closely linked with water bodies. They use a wide range of flowing and stagnant water bodies. Even though most species of odonates are highly specific to a habitat, some have adapted to urban areas and made use of man-made water bodies. Habitat specificity has an important bearing on the distribution and ecology of odonates. Some species use specialized habitats for their survival. However a large number of endemic odonates are threatened due to large scale habitat destruction[12].

A total of fourteen (14) species (larva and adult) were recorded from the three areas. Six species were recorded in RA, four species in TG and six species in UA. Two species *Ischnura aurora aurora* and *Agriocnemis pygmaea pygmaea* were recorded common in TG and UA. The species recorded in RA are: *Pseudagrion* sp.larva, *Tholymis tillarga, Pantala flavescens, Urothemis signata signata, Gynacantha dravida, Diplacodes trivialis;* in TA are : *Tramea* sp., *Orthetrum sabina sabina, Agriocnemis pygmaea pygmaea*, *Ischnura aurora aurora;* in UA are: *Agriocnemis pygmaea pygmaea, Ischnura aurora aurora , Ischnura* sp. , *Copera marginipes, Brachythemis contaminata, Crocothemis servilia servilia.*

In RA, one species (larva) of order Zygoptera and five species (adult) of sub order Anisoptera were found, while in TG four species (one larva and three adult) were found. Two species belonged to suborder Zygoptera and two species belonged to sub order Anisoptera. In UA five species belonged to Zygoptera while two were Anisoptera. The Odonata larvae recorded from the different sites are shown with their systematic position in the Table 1 and images are shown in Fig. 1 and Fig. 2.

***Pseudagrion* sp.**

(larva) : Long caudal lamellae, lamellar type, rounded at the apices. Ante-nodal and post-nodal areas are distinct

Tholymis tillarga

(Fabricius): Golden brown fascia extending from node to base of hind wing . Borders of anal loop running on to meet posterior border of wing,apex of loop open.

Pantala flavescens

(Fabricius): Wings hyaline with a narrow apical brown spot limited to the posterior border of wings. Presence of dark reddish brown transverse belt between anterior and posterior lobe of prothorax.

Urothemis signata signata

(Rambur): Apices of wings tipped usually with blackish brown spot in anal area well separated from that in cubital space. abdomen greenish-olivaceous on dorsum

Diplacodes trivialis

(Rambur): Abdomen greenish-yellow with sutures finely black. Thorax and abdomen pruinoised blue.

Gynacantha Dravida

(Lieftinck): Hindwings tipped with dark brown spot in anal area,frons with T-shaped marked on the upper surface of the frons . Pterostigma long and narrow,abdomen at 1-2 segment swollen,segment 3 markedly constricted.

***Tramea* sp.**

(larva) : Long lateral spines on segments 8 and 9. Labial palps with dentation.

Orthetrum sabina sabina

12 antenodal nervures in forewing. thorax pale greenish yellow with numerous bold black stripes, with age becoming dark and a single bold whitish band on each side.

Ariocnemis pygmaea pygmaea

(Rambur): Antehumeral stripes bordered outwardly by a reddish brown or dark violaceous stripe, laterally green. Abdominal segments 1 to 6

Fig. 1: Photographs of the Odonata species recorded during the study in the three sites

with ground colour pale greenish-yellow,terminal segments pink or brick red,marked with black.

Ischnura aurora aurora

(Brauer): At the posterior wing is tipped with greyish black colour. wings hyaline,pterostigma differing in fore and hind wing.

***Ischnura* sp.**

Apical spine absent at the 4th flagellar segment of antennae. Apices of the caudal lamellae sharply pointed, middle portion is broad.

Copera marginipes

Legs flattened, yellow. Abdomen black with yellow stripes on the bottom side, white tip.

Crocothemis servilia servilia

(Drury): thorax bright ferruginous,often blood-red on dorsum during life. wings hyaline,bases of all marked with rich amber yellow.

Brachythemis contaminata

(Fabricius): Prothorax with dark reddish brown transverse stripes.Wings with bright orange fascia from base within 2/3 cells to pterostigma. While in RA and TG in the first two sampling dates Odonata species was not recorded, in the UA Odonata species were recorded in all the four sampling dates. Occurrence of the families Coenagrionidae and Libellulidae across the sites justified their status as the largest families under suborder Zygoptera and Anisoptera, respectively. A study in the River Moirang, Manipur also revealed presence of the two families for 9 months in the system[32].

Physico-chemical parameters of water

The values of different physico-chemical parameters of water of ponds of RA, TG and UA, respectively are shown in table 2, 3 and 4. Seasonal and diurnal variation in physico-chemical properties of water may be related to water use pattern and precipitation[33]. The AT of rural area (RA), tea garden area (TG) and urban area (UA) ranged from 20 to 31°C, 21 to 30° C & 20 to 27°C, respectively. The lowest range of WT recorded in RA might be due to obstruction of sunlight by macrophytes in the pond. The Transparency (TR) of water bodies of RA, TG and UA ranged from 21.3 to 22cm, 15.6 to 13.3cm and 55.3 to 65.3cm respectively (Table 2, 3 and 4). The TR values of UA were found higher than that of others because of the large varieties of macrophytes present in the system that might have adsorbed suspended particles in their roots. The measurement of pH indicates the acidic and basic nature of water. Changes in pH of water may be the result of various biological activities. In the present study, the pH of ponds of RA ranged from 5.95 to 7.39, TG from 6.3 to 7.11 and UA from 5.69 to 6.95. The lowest pH was recorded in UA. Alkaline pH is of importance for proper growth and development of fishes and aquatic organisms. The EC of Site RA, TG and UA ranged from 126.33 to 232.67µScm^{-1}, 53.43 to 219.33µScm^{-1} and 120.93 to 173.27µScm^{-1}. All the three sites had medium conductivity levels as opined by Adeleke[34]. Possible sources of free CO_2 in water are respiration of biota, decomposed organic matter and infiltration through the soil[35]. FCO_2 in RA, TG and UA ranged from 6.42 to 15.77mgl-^{1}, 10.08 to 22.37mgl^{-1}, and 6.78 to 14.48mgl^{-1}, respectively. The highest FCO_2 and EC were recorded in water body of TG. Ranges of DO at RA, TG and UA were 6.56 to11.86 mgl^{-1}; 9.09 to13.03 mgl^{-1} and 10.12 to 12.89 mgl^{-1}, respectively. Very low penetration of sunlight in RA inhibited the process of photosynthesis resulting low DO. At RA, PO_4 ranged from 1.3 to 3.72 mgl^{-1}, at TG 0.39 to 1.58 mgl^{-1} and at UA it was 0.39 to 1.07mgl^{-1}. This agreed with the findings of a study on fishery pond of Chatla floodplain[36]. The ranges of NO_3 at RA, TG and UA were 0.31 to 0.51mgl^{-}1, 0.24 mgl^{-1}to 0.39mgl^{-1} and 0.28mgl^{-1} to 0.31mgl^{-1}, respectively. Biological oxidation of nitrogenous substances is the most important source of NO_3 in a fresh water system.

The identification of Odonata-habitat associations is an essential tool for characterizing the response of dragonflies and damselflies to changes in the environment. Hilshenhoff [37] developed family biotic index which is indicative of tolerance level of benthic arthropod community. The tolerance values range from most sensitive 0 to 10 most tolerant organisms. The tolerance values of Libellulidae and Coenagrionidae are 9 while for Aeshnidae it is 3 [38]. In TG presence of only two tolerant families indicated that the water quality of the area is polluted. In tea garden area use of pesticides might have been

Fig. 2: Photographs of the Odonata species recorded during the study in the three sites

responsible for the disturbed nature. In RA, presence of Aeshnidae indicated relatively better condition of water quality.

This preliminary study gave an idea of the Odonata diversity in three different areas of Cachar district. However a more intensive sampling is required for reducing data deficiency of this area and also for confirming their role as biological indicators.

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