

ORIGINAL ARTICLE

Odonata (Dragonfly and Damselfly) diversity of Howrah District, West Bengal, India

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ABSTRACT

A continuous survey was carried out on order Odonata (Dragonfly and Damselfly) of Howrah District, West Bengal, India as no previous exclusive study of District was available. We present a list of 54 Odonata species from this District which contains 35 species of Dragonflies (Anisoptera) from 4 families and 19 species of Damselflies (Zygoptera) from 3 families. Among 54 Odonata species four species are newly recorded from the area, viz., *Macrogomphus annulatus* (Selys, 1854), *Orthetrum luzonicum* (Brauer, 1868), *Mortonagrion aborense* Laidlaw, 1914 and *Lestes viridulus* Rambur, 1842. The most dominant family is Libellulidae followed by Coenagrionidae, Aeshnidae and Gomphidae, Lestidae, Platycnemididae and Macromiidae.

Key words: Anisoptera, Zygoptera, Libellulidae, Coenagrionidae, Aeshnidae.

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INTRODUCTION:

Odonata, an order of most ancient, medium to large sized flying insects, includes dragonflies and damselflies [1]. They are commonly found in forest, range land, crop lands, grass lands, near streams and rivers and are one of the leading groups of aquatic and terrestrial insects [2]. Being primarily aquatic, their biology is closely allied to specific aquatic habitats [3]. Dragonflies and damselflies have been widely used as indicators of environmental quality in aquatic ecological units [4]. Odonata play a key role in the food web as predators both as larvae and as adults [5]. From all over the world approximately 6000 species and subspecies to 630 genera in 28 families are identified [6]. In 3 volumes of Fauna of British India 536 species of Odonates has been mentioned from British India by Fraser [7, 8, 9]. India represented by 499 species and subspecies of Odonata among 139 genera in 17 families [10]. Afterward 499 species, 488 species documented from India [11, 12]. Selys was the pioneer worker and first reported about Odonata from Kolkata [13] and afterward several workers studied on diverse fields of Odonatatology from Kolkata. In the middle of 1970 Mitra *et al.* documented 22 species of Odonates from Kolkata [14]. After that Ram *et al.* worked on Kolkata and surroundings and they were able to recorded 50 species [15]. However Mitra further documented 44 species of Odonata from Kolkata [16]. With the using of 48 species recorded from Kolkata and Howrah Srivastava & Sinha reported 178 Odonata species from West Bengal soon after Gupta *et al.* documented 58 species from Kolkata [17, 18]. Ultimately Mitra documented in general 65 species from Kolkata and Howrah [19]. Last of all from Kolkata and surrounding (Howrah and Hoogly) 53 species were recorded by Dawn however 80 species were listed by him using the previous literatures [20]. The present study carried out to document Odonata diversity of entire Howrah district.

MATERIAL AND METHODS

Study Area

Howrah is a small district (467 km²) of the West Bengal situated southern part of this state (Figure 1). The Howrah district located between 22°48' N and 22°12' N latitudes and between 88°23' E and 87°50' E

longitudes. Rupnarayan River and Bhagirathi-Hooghly River boundary are the west and east borderline of this district whereas Bally canal and Damodar River are situated at the north-east and north-west boundary. Annual average rainfall is 1461 millimeter and temperature varies between 9-42°C.

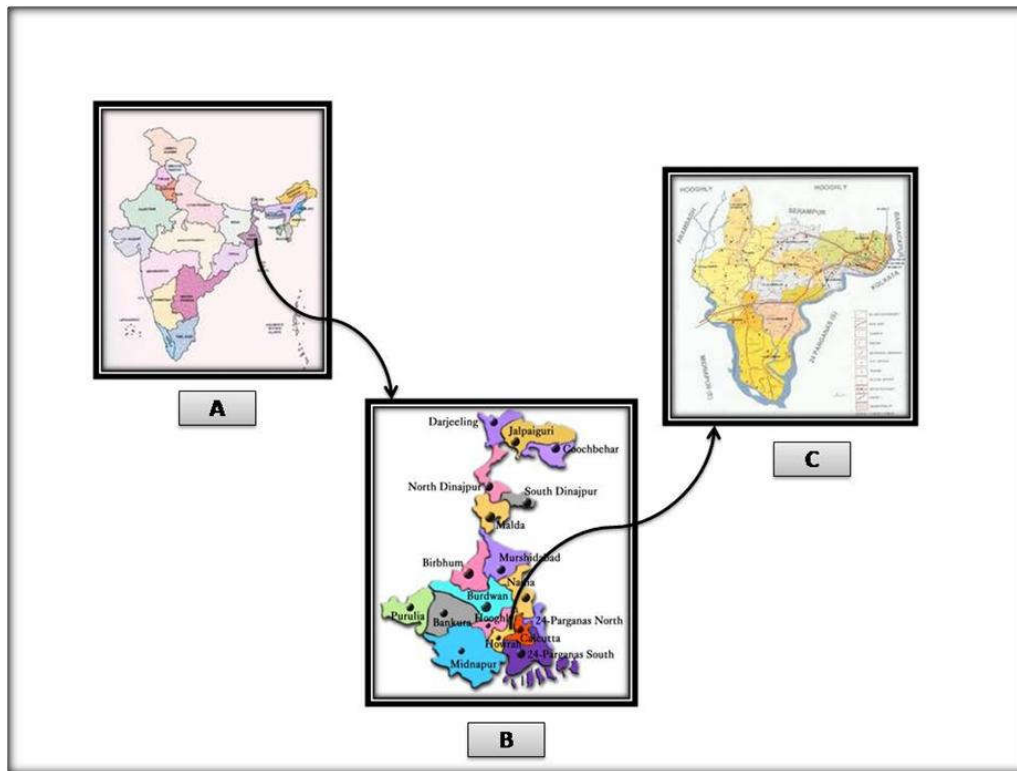


Fig. 1 Study area [India (A), West Bengal (B), Howrah District (C)]

Sampling techniques and species identification

District Howrah was assessed for Odonata diversity during April, 2012 to August, 2017 through various transect methods. In this method 4 permanent 300 m line transects was setup in each block (15) of this district for line transects. The different natural habitats within the study area are also represented (Figure 2). By using these transects walked once a month to follow Pollard Walk Method for documenting the odonates [21, 22]. Ponds and lakes were surveyed through belt transect methods. A slow 180 degree visual sweep was carrying out during walking through transects. Documentation were done throughout the year and data were collected according to three major seasons viz., summer (March to May), monsoon (June to October), and post monsoon (November to February). Collection of samples was avoided to the extent possible. Generally photographic documentation was done. Photographs were taken using Cannon EOS 550D with 18-55 mm lens. Identification of Odonata species was done with the help of these authentic literatures [7, 8, 9, 19, 23, 24, 25]. Systematic arrangement and the taxonomy followed in the checklist from Subramanian [24, 26] and common names after Nair [25].

Data analysis:

Data analyses were performed by PAST software Version 3.02 [27]

a. Measurement of diversity

The type of diversity used here is α -diversity which is the diversity of species within a community or habitat. The diversity index was calculated by using the Shannon – Wiener diversity index [28]

$$\text{Diversity index} = H = - \sum P_i \ln P_i, \text{ where } P_i = S / N$$

S = number of individuals of one species

N = total number of all individuals in the sample

\ln = logarithm to base e

b. Measurement of species richness

Margalef's index was used as a simple measure of species richness [29]

$$\text{Margalef's index} = (S - 1) / \ln N$$

S = total number of species

N = total number of individuals in the sample

\ln = natural logarithm

c. Dominance and Simpson Index

$D = \sum (n_i/n)^2$ where n_i is number of individuals of taxon i .

Dominance = 1-Simpson index. Ranges from 0 (all taxa are equally present) to 1 (one taxon dominates the community completely).

Simpson index 1-D. Measures 'evenness' of the community from 0 to 1. Dominance and Simpson indices are often used interchangeably.

d. Species Accumulation Curve

Species accumulation curve is a move towards by plotting the cumulative number of species recorded against the sampling years (2012-2017). From the year 2012, the species accumulation curve of whole district sampled individually, increased from 2012 to 2016 sampling through the number of new records added slowly but after 2016 number of new records were same in 2017.

e. PCA (Principle Component Analysis) and PCO (Principle Coordinates Analysis)

Principal components analysis (PCA) finds hypothetical variables (components) accounting for as much as possible of the variance in your multivariate data [30, 31]. Two variables were choosing based on higher variance and eigenvalue scale. Density was plotted as component 1 and frequency was plotted on component 2.

RESULT

A total of 54 species of Odonata (Table1) belonging to 35 species were from sub order Anisoptera (Dragonflies) and 19 species were from sub order Zygoptera (Damselflies) were recorded from the district Howrah, West Bengal, India. 35 species of sub order Anisoptera belonging to the families Aeshnidae, Gomphidae, Libellulidae and Macromiidae. In case of sub order Zygoptera 19 species were recorded belonging to the families Coenagrionidae, Lestidae and Platycnemididae (Figure 3). Species composition was highest in the family Libellulidae 27 (50%) followed by the family Coenagrionidae 13 (24.07%), Aeshnidae 4 (7.40%), Gomphidae 3 (5.55%), Lestidae 3 (5.55%), Platycnemididae 3 (5.55%) and Macromiidae 1 (1.85%) (Figure 4). Species accumulation curve is represented in the figure 5. Measurements of diversity related indices are represents in the table 2. Principal component analysis (PCA) of odonates of Howrah district, West Bengal based on Density and Frequency data (these two variables are taken based on higher Variance and Eigenvalue scale) are presented in figure 6. On both the cases, X axis (component 1) i.e. Density and on the Y axis (component 2) i.e. Frequencies are plotted which show similarities between different species. Observed odonates were photographed by Canon EOS 550 D with EFS 18-55 mm lens represented in the figure 7- figure 10.

Table - 1: List of Odonta (Dragonfly and Damselfly) fauna of Howrah district (West Bengal, India) during 2012 to 2017

Sl No.	Common name	Scientific name	Status
Suborder : Anisoptera			
Family: Aeshnidae			
1	Blue-Tailed Green Darner	<i>Anax guttatus</i> (Burmeister, 1839)	C
2	Rusty Darner	<i>Anaciaeschna jaspidea</i> (Burmeister, 1839)	R
3		<i>Gynacantha</i> sp.	U
4	Brown darner	<i>Gynacantha dravida</i> Lieftinck, 1960	R
Family: Gomphidae			
5	Common Clubtail	<i>Ictinogomphus rapax</i> (Rambur, 1842)	VC
6	Deccan Bowtail	<i>Macrogomphus annulatus</i> (Selys, 1854)	R
7	Common Hooktail	<i>Paragomphus lineatus</i> (Selys, 1850)	R
Family: Libellulidae			
8	Trumpet Tail	<i>Acisoma panorpoides</i> (Rambur, 1842)	VC
9	Scarlet Marsh Hawk	<i>Aethriamanta brevipennis</i> (Rambur, 1842)	VC
10	Rufous-Backed Marsh Hawk	<i>Brachydiplax chalybea</i> (Brauer, 1868)	VC
11	Little Blue Marsh Hawk	<i>Brachydiplax sobrina</i> (Rambur, 1842)	VC
12	Emerald Flanked Marsh Hawk	<i>Brachydiplax farinosa</i> (Krüger, 1902)	C
13	Ditch Jewel	<i>Brachythemis contaminata</i> (Fabricius, 1793)	VC
14	Granite Ghost	<i>Bradinyopyga geminata</i> (Rambur, 1842)	C
15	Rudy Marsh Skimmer	<i>Crocothemis servilia</i> (Drury, 1773)	VC
16	Ground Skimmer	<i>Diplocodes trivialis</i> (Rambur, 1842)	VC
17	Asiatic Bloodtail	<i>Lathrecista asiatica</i> (Fabricius, 1798)	U

18	Estuarine Skimmer	<i>Macrodiplax cora</i> (Brauer, 1867)	C
19	Fulvous Forest Skimmer	<i>Neurothemis fulvia</i> (Drury, 1773)	VC
20	Pied Paddy Skimmer	<i>Neurothemis tullia</i> (Drury, 1773)	VC
21	Tri Coloured Marsh Hawk	<i>Orthetrum luzonicum</i> (Brauer, 1868)	R
22	Crimson Tailed Marsh Hawk	<i>Orthetrum pruinosum</i> (Burmeister, 1839)	C
23	Green Marsh Hawk	<i>Orthetrum sabina</i> (Drury, 1770)	VC
24	Wandering Glider	<i>Pantala flavescens</i> (Fabricius, 1798)	VC
25	Yellow Tailed Ashy Skimmer	<i>Potamarcha congener</i> (Rambur, 1842)	VC
26	Rufous Marsh Glider	<i>Rhodothemis rufa</i> (Rambur, 1842)	VC
27	Common Picture Wing	<i>Rhyothemis variegata</i> (Linnaeus, 1763)	VC
28	Red Marsh Trotter	<i>Tramea basilaris</i> (Palisot de Beauvois, 1807)	C
29	Black Marsh Trotter	<i>Tramea limbata</i> (Desjardins, 1832)	U
30	Crimson Marsh Glider	<i>Trithemis aurora</i> (Burmeister, 1839)	C
31	Long Legged Marsh Glider	<i>Trithemis pallidinervis</i> (Kirby, 1889)	VC
32	Coral-Tailed Cloud Wing	<i>Tholymis tillarga</i> (Fabricius, 1798)	VC
33	Greater Crimson Glider	<i>Urothemis signata</i> (Rambur, 1842)	VC
34	Brown Dusky Hawk	<i>Zyxomma petiolatum</i> Rambur, 1842	VC
Family: Macromiidae			
35	Common torrent hawk	<i>Epopthalmia vittata</i> Burmeister, 1839	U
Suborder: Zygoptera			
Family: Coenagrionidae			
36	Indian Hooded Dartlet	<i>Agriocnemis kalinga</i> Nair and Subramanian, 2015	VC
37	Milky Dartlet	<i>Agriocnemis lacteola</i> Selys, 1877	C
38	Pigmy Dartlet	<i>Agriocnemis pygmaea</i> (Rambur, 1842)	VC
39	Orange-Tailed Marsh Dart	<i>Ceriagrion cerinorubellum</i> (Brauer, 1865)	VC
40	Coromandel Marsh Dart	<i>Ceriagrion coromandelianum</i> (Fabricius, 1798)	VC
41	Azure Dartlet	<i>Amphiallagma parvum</i> Selys, 1876	C
42	Golden Dartlet	<i>Ischnura aurora</i> (Brauer, 1865)	VC
43	Senegal Golden Dartlet	<i>Ischnura senegalensis</i> (Rambur, 1842)	VC
44		<i>Mortonagrion aborense</i> Laidlaw, 1914	LC
45	Three-Lined Dart	<i>Pseudagrion decorum</i> (Rambur, 1842)	VC
46	Blue Dart	<i>Pseudagrion microcephalum</i> (Rambur, 1842)	C
47	Saffron-Faced Blue Dart	<i>Pseudagrion rubriceps</i> Selys, 1876	VC
48		<i>Pseudagrion spencei</i> Fraser, 1922	C
Family: Lestidae			
49	Emerald Spreadwing	<i>Lestes elatus</i> Hagen in Selys, 1862	R
50	Brown Spreadwing	<i>Lestes umbrinus</i> Selys, 1891	LC
51	Emerald-Striped Spreadwing	<i>Lestes viridulus</i> Rambur, 1842	R
Family: Platycnemididae			
52	Pied Bush Dart	<i>Pseudocopera ciliata</i> (Selys, 1863)	VC
53	Yellow Bush Dart	<i>Copera marginipes</i> (Rambur, 1842)	U
54	Black Marsh Dart	<i>Onychargia atrocyana</i> (Selys, 1865)	VC

[VC: Very Common (>50), C: Common (20-50), U: Uncommon (5-20), LC: Locally Common (Common in particular area), R: Rare (<5)]

Table 2: Measurements of diversity related indices

SL. No.	Diversity related indices	Calculated result
1	Taxa_S	54
2	Simpson_1-D	0.9744
3	Dominance_D	0.0255
4	Shannon_H	3.765
5	Evenness_e^H/S	0.7996
6	Margalef	6.783

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Figure 2: Habitats of Odonates in Howrah District, West Bengal, India A) Amta 2 Block B) Shyampur II Block C) Udaynarayanpur Block D) Bagnan I Block E) Domjur Block F) Panchla Block G) Shyampur I Block D) Uluberia I Block E) Sankrail Block

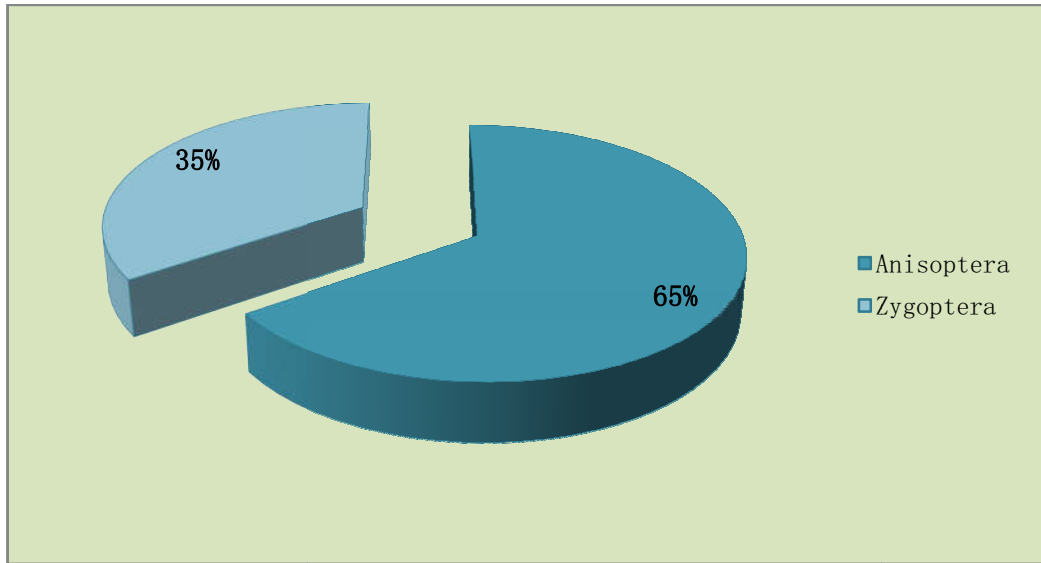


Fig 3: Sub order wise graphical representation of Odonata species

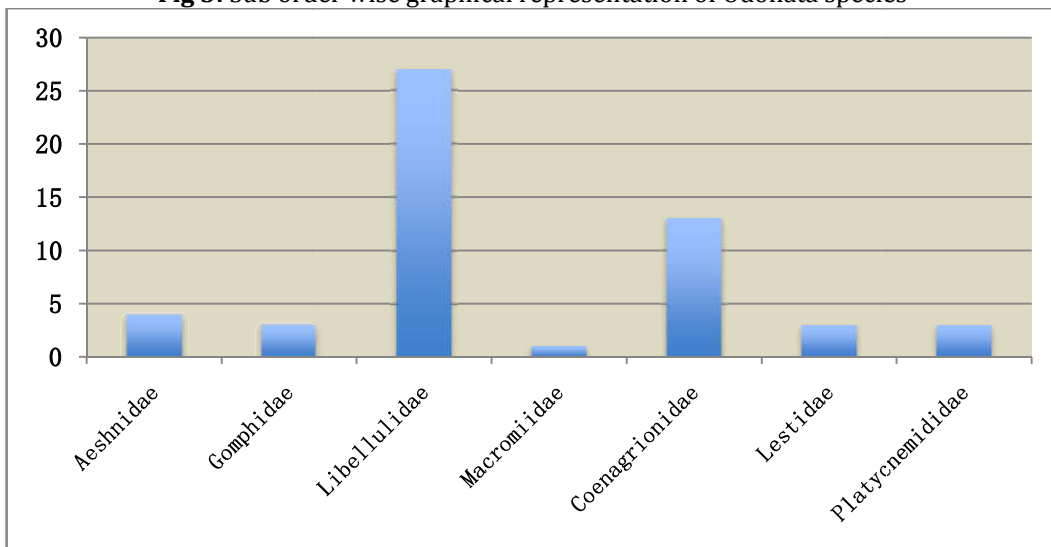


Fig 4: Family wise graphical representation of Odonata species

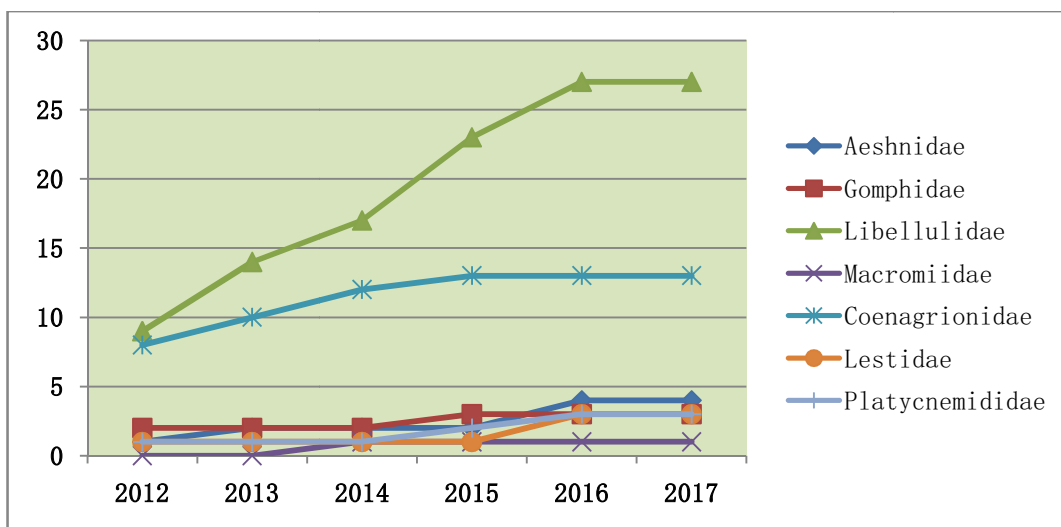


Fig 5: Graphical representation of cumulative number of species collected against the sampling years (2012-2017).

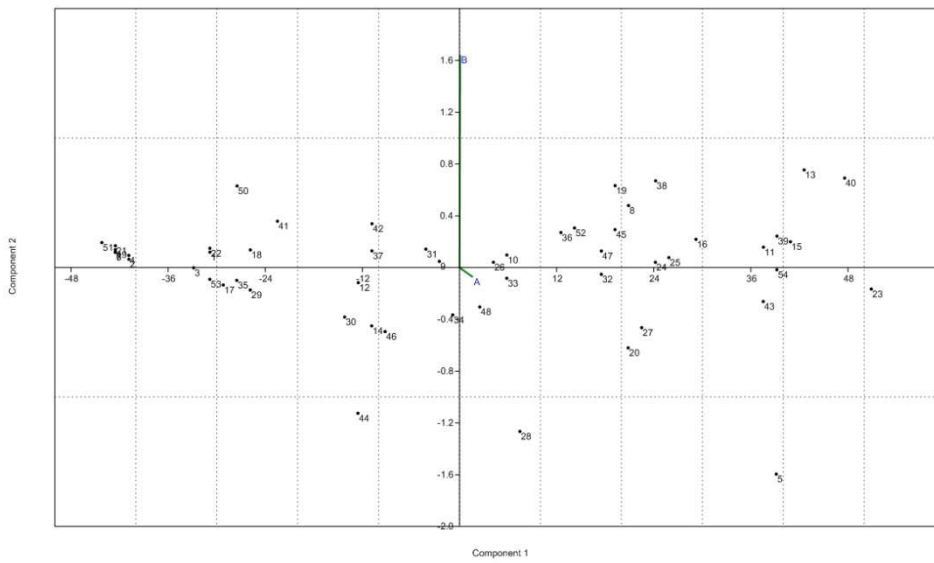


Fig 6: PCA (Principle component analysis) of species of Mantids created through PAST software. (Used characters: Number of individuals, density and frequency).



Figure 7: A) *Anax guttatus* B) *Anaciaeschna jaspidea* C) *Gynacantha* sp. D) *Gynacantha dravida* E) *Ictinogomphus rapax* F) *Macrogomphus annulatus* G) *Paragomphus lineatus* H) *Acisoma panorpoides* (Male) I) *Acisoma panorpoides* (Female) J) *Aethriamanta brevipennis* K) *Brachydiplax chalybea* L) *Brachydiplax sobrina* (Male) M) *Brachydiplax sobrina* (Female) N) *Brachythemis contaminata* (Male) O) *Brachythemis contaminata* (Female) P) *Bradinopyga geminata*



Figure 8: A) *Crocothemis servilia* (Male) B) *Crocothemis servilia* (Female) C) *Diplocodes trivialis* (Male) D) *Diplocodes trivialis* (Female) E) *Lathrecista asiatica* F) *Macrodiplax cora* G) *Neurothemis fulvia* (Male) H) *Neurothemis fulvia* (Female) I) *Neurothemis tullia* (Male) J) *Neurothemis tullia* (Female) K) *Orthetrum luzonicum* L) *Orthetrum pruinosum* M) *Orthetrum sabina* N) *Pantala flavescens* O) *Potamarcha congener* P) *Rhodothemis rufa*

DISCUSSION

The results collected so far clearly indicate that the overall diversity of odonates in this district is quite good as in Howrah major forests and protected areas are absent and density of human population is high. Four species viz. *Macrogomphus annulatus* (Selys, 1854), *Orthetrum luzonicum* (Brauer, 1868), *Mortonagrion aborense* Laidlaw, 1914 and *Lestes viridulus* Rambur, 1842 were recorded for the first time from this District. *Lestes viridulus* were the first time reported from this District as well as South West Bengal. *Macrogomphus annulatus* and *Orthetrum luzonicum* were previously recorded only from Asansol - Durgapur region of South West Bengal [32]. *Mortonagrion aborense* was previously recorded only from coastal region of South West Bengal [33]. *Trithemis aurora* Burmeister (1839) was first time recorded by Srivastava and Sinha and reported from Kolkata and Surroundings by Dawn [17, 20]. *Macrogomphus annulatus* and *Gynacantha dravida* are Data Deficient (DD) species according to IUCN (ver) as well as Rare (R) species of this District. *Lestes umbrinus* Selys, 1891 is another Data Deficient (DD) species, locally common in this district. *Mortonagrion aborense* is an uncommon species on the basis of whole district but

locally common in Bagnan I, Amta I and Amta II blocks. Status of *Agriocnemis kalinga* is Not Evaluated (NE) by IUCN (ver) though it is a Very Common (VC) species of this District.

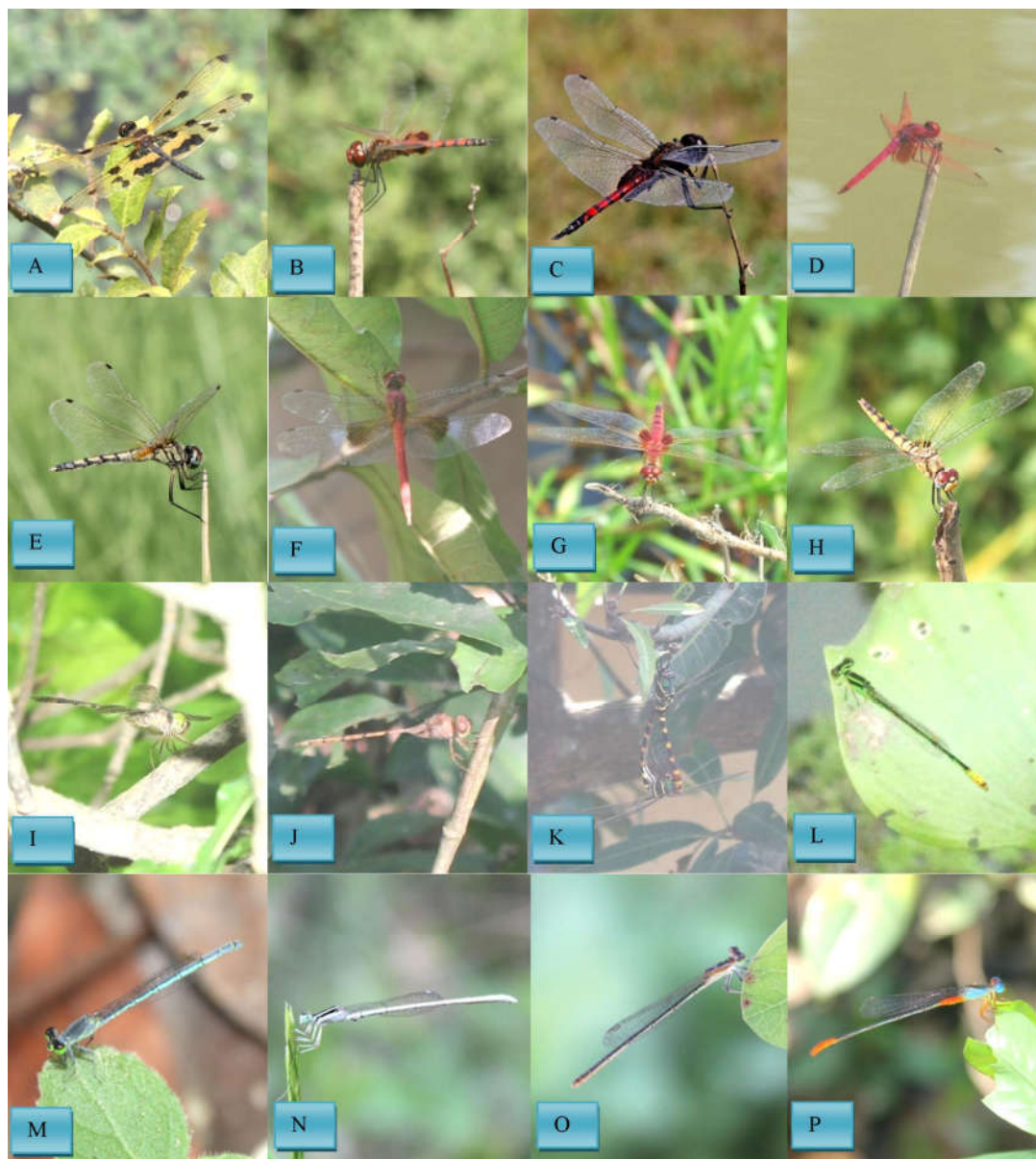


Figure 9: A) *Rhyothemis variegata* (Male) B) *Tramea basilaris* C) *Tramea limbata* D) *Trithemis aurora* E) *Trithemis pallidinervis* F) *Tholymis tillarga* (Male) G) *Urothemis signata* (Male) H) *Urothemis signata* (Female) I) *Zyxomma petiolatum* (Male) J) *Zyxomma petiolatum* (Female) K) Copula of *Epophthalmia vittata* L) *Agriocnemis kalinga* (Male) M) *Agriocnemis kalinga* (Female) N) *Agriocnemis lacteola* O) *Agriocnemis pygmaea* P) *Ceriagrion cerinorubellum*

Rests of species are Least Concern (LC) by IUCN (Ver.) but Rare (R) species of study area were *Anaciaeschna jaspidea*, *Paragomphus lineatus*, *Orthetrum luzonicum*, *Lestes elatus* and *Lestes viridulus*. One species of genus *Gynacantha* was also recorded which does not identified in species level due to poor quality of picture. *Gynacantha bayadera* was documented from south West Bengal [34]. Uncommon (U) species of this District were *Gynacantha* sp., *Lathrecista asiatica*, *Tramea limbata*, *Epophthalmia vittata*, *Mortonagrion aborensis* and *Copera marginipes*. The studies reveal that high species richness and evenness and low dominance at study area. The biodiversity (diversity index, species richness and evenness) of Odonata fauna in Howrah district, West Bengal is mainly due to the presence of many water bodies as water plays an important role for the early stages of odonates and also presence of bushy

vegetation which are important suppliers of food materials of adult odonates. PCA analysis shows that species with similar distributional pattern are come into the same coordinate. Species accumulation curve is represented in the fig 5. The species accumulation curve of whole district sampled individually increased from 2013 to 2016 sampling through the number of new records added slowly but after 2016 number of new records were same in 2017. Rapid development, human colonization and industrialization are the potential causes of declining Odonata species richness, diversity and abundance in this district.

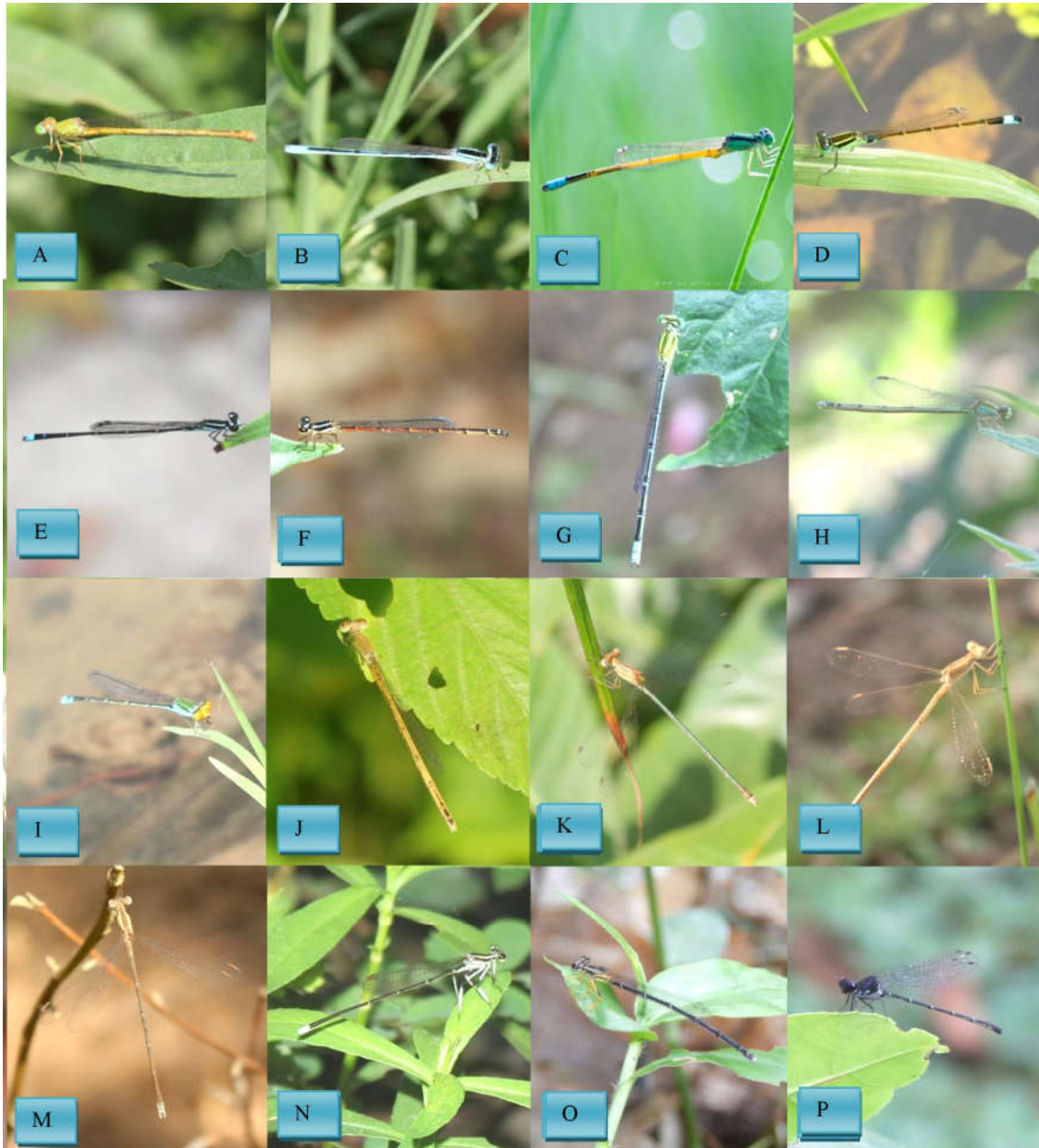


Figure 10: A) *Ceriagrion coromandelianum* B) *Amphiallagma parvum* C) *Ischnura aurora* D) *Ischnura senegalensis* E) *Mortonagrion aborensis* (Male) F) *Mortonagrion aborensis* (Female) G) *Pseudagrion decorum* H) *Pseudagrion microcephalum* I) *Pseudagrion rubriceps* J) *Pseudagrion spencei* K) *Lestes elatus* L) *Lestes umbrinus* M) *Lestes viridulus* N) *Pseudocoperca ciliata* O) *Copera marginipes* P) *Onychargia atrocyana*

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