Assessment of diversity of Odonata fauna in selected sites of Purba Barddhaman district, West Bengal, India

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Abstract: Purba-Bardhaman, a newly emerged district of West Bengal was surveyed for listing its odonate diversity. The district is located in southern West Bengal, and two major rivers, Damodar and Ajay, run through it. It also has a lot of small rivers, perineal and seasonal water bodies, grasslands, marshes, and agricultural fields, making it a great place for odonates. Five different sites of the district were surveyed by direct search and opportunistic sighting methods for a period of two years (March 2021 to February 2023) and odonate diversity was listed. We have found a total of 47 species belonging to 35 genera and six families from this district. The most diverse family was Libellulidae, with 24 species. A few major findings from this study were Macrogomphus montanus, Platygomphus dolabratus, Lathrecista asiatica, Libellula indica, and Agriocnemis kalinga. This is the first systematic study of odonates from this district, and it illustrates the value of this densely populated district for further exploration due to its high agricultural fertility.

Keywords: Agricultural land, Ajay River, Anisoptera, Damodar River, Gangetic plane, riverbed, seasonal pool, Zygoptera.

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Author contributions: SM did the field work, data collection, preservation of samples, analysis, and manuscript writing. RM helped in manuscript preparation and supervised the work.

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INTRODUCTION

The amphibiotic order Odonata, including dragonflies and damselflies, attracts a lot of attention due to the vibrant colours and exquisite flight patterns (Andrew et al. 2008). They are predominantly found in tropical subtropical and oriental regions, although a small number of species have also been found in the temperate zone, specifically in Japan and China (Kalkman et al. 2008) and are found in close proximity of freshwater body, including streams, lakes, marshes, or transient stagnant rainfall pools. They are hemimetabolous insects that go through three life cycle stages: a brief egg stage (a few weeks), the longest larval stage (-ranging from months to year) (Stoks & Córdoba-Aguilar 2012), and finally reaching adulthood. Odonata larvae are aquatic and must go through several moults stages (e.g., 10 moults) before becoming terrestrial flying adults (Stoks & Córdoba-Aguilar 2012; Tiple et al. 2012) and their crucial role is notified in the food web and ecosystem as predators (both nymphs and adults). Odonates are considered as excellent model for studying insect evolution and ecology due to their phenotype and ecological diversity (Tiple & Koparde 2015; Bybee et al. 2016) and reliable bioindicators (Tiple et al. 2013; Siddika et al. 2017).

Globally, 6,406 species in 693 genera of odonates have been reported (Paulson & Schorr 2023) of which, 498 species and 27 subspecies in 154 genera and 18 families are known from India (Babu 2019; Tiple et al. 2022). By recording approximately 22 species from Kolkata, Selys (1891) launched the study of Odonata in West Bengal and subsequently, Mitra (2002) reported 56 species from the District, Howrah and Kolkata. Srivastava & Sinha (1993) documented 178 species in West Bengal, (Srivastava 1993). Recent studies on the Odonata fauna of Purna Medinipur by Payra & Tiple (2019) and Pandhi et al. (2019) recorded 49 and 45 species, respectively. Dwari & Mondal (2018) documented 17 species from the agricultural fields of the Howrah district and 63 Odonata species were reported from the industrial areas of Paschim Barddhaman district, by Nayak & Roy (2016, 2021). Paschim Medinipur was explored by Jana et al. (2021) and 19 species of damselflies were recorded. Odonata diversity of Chinsurah, Baidyabati and Purbasthali were documented by Ghosh (2022) with the finding of 40 species. Latest updated checklist of odonates of West Bengal consists of 240 species from 114 genera (Dawn 2021, 2022).

MATERIALS AND METHODS

Study area

Burdwan district was bifurcated into two districts Purba and Paschim Barddhaman on 7 April 2017. These two districts are topographically different. Paschim Barddhaman is predominantly arid region with dry deciduous forests, patchy grasslands and two major rivers Damodar and Ajay, whereas Purba Barddhaman extends towards the Gangetic delta, which is more humid and dominated by flat alluvial plainslands. Purba Barddhaman lies almost in the middle of southern West Bengal, consisting of several perennial freshwater bodies, adjacent to major rivers like the Ajay, Damodar, and Ganges and small streams like Khari, Kunur, Banka, Kana Damodar to name a few. Bibliographic data on odonata species implies no such comprehensive record or published checklist from Purba Barddhaman district (all the information were collected from www.purbabardhaman.nic.in.).

Purba Barddhaman district is encircled by six distinct districts: Murshidabad and Birbhum are located in the north, Nadia covers the east, and south is bounded by Hooghly and a portion of Bankura, and the west side by Paschim barddhaman. The district covers an area of approximately 5,432.69 Km² and is located between 23°53’-22°56’ N and 88°25’-87°56’ E (purbabardhaman.nic.in). Annual rainfall ranges from 1,200 to 1,400 mm (Ruidas et al. 2021).

Five different sites (Image 1), which covers a significant part of the district and the district bordering areas, were surveyed for the study of Odonata distribution and abundance. The details of each site are described in the Table. 1.

Sampling, Documentation, and Identification

Extensive field work was carried out from March 2021, to catalogue the diversity, distribution patterns of odonates in various niches and habitats at bordering areas of adjacent districts by potent described methodology.

The survey of odonate fauna was carried out throughout the year from March 2021 to February 2023. Data was gathered between 0700 h and 1400 h. Each of the sites were visited at least once in each month (2–5 hours of observation on each day). Each of the sampling area covered at least 1.5 km² (150 ha) of land or more. Among each of the study sites there were multiple small patches which were surveyed separately and samples were collected using proper labels (e.g., Site 1, pond 1 near XX village or river) and photographs of each of

...
Distribution of Odonata in Purba Barddhaman

Mukherjee & Mandal


those sites were taken along with co-ordinates using Angle Cam software. The sampling was conducted using the line transect approach (Burnham et al. 1980) and the opportunistic sighting method. For line transect method the lines were of a length of 0.5 to 1 km and number of lines varied from 2–5 in each site according to habitat and accessibility. Walking with uniform speed was used to cover the whole transect line, and all Odonata species on either side of the line were recorded. Photographs taken from a variety of viewpoints were used for documentation. Canon 80D and Nikon D500 cameras were used for taking photographs of individual sightings in field and collected samples. Collected photographic data as well as samples (both dry and wet) were assembled, and specified into monsoon, post monsoon, and pre-monsoon season. Odonate identification was primarily performed in the field with field identification guide, previous literatures describing Odonata species, and websites such as www.indianodonata.org and (Fraser 1933a,b, 1936; Subramanian 2009). Some of the species which were difficult to identify instantly, so the cryptic specimens were captured by insect net. The damselflies were preserved in 70% alcohol in 5 ml plastic vials, and the dragonflies were collected in butter paper envelopes for further dry preservation. Dragonfly specimens were stretched with the help of insect pin to display all the key characters for identification. Identification was done with the help of taxonomic keys (Fraser 1933). Taxonomy and systematic arrangements were followed by Subramanian & Babu (2017).

Table 1. A brief description of selected study sites along with the co-ordinates and habitat types.

<table>
<thead>
<tr>
<th>Site</th>
<th>Latitude(N)</th>
<th>Longitude (E)</th>
<th>Sub-sites</th>
<th>Habitat types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site 1: Katwa</td>
<td>23.6404°</td>
<td>88.1299°</td>
<td>Ajay river bank, Bank of Ganges near Neyachar</td>
<td>Grasslands, river bank, few seasonal and few perennial waterbodies, dry deciduous forest patches</td>
</tr>
<tr>
<td>Site 2: Bhatar</td>
<td>23.4191°</td>
<td>87.9163°</td>
<td>Bhatar village, Karjana pakhralay</td>
<td>Seasonal marshes and water puddles, seven perennial ponds with low to moderate hydrophyte population, paddy fields, mango groves, Khori River bank and surrounding grasslands.</td>
</tr>
<tr>
<td>Site 3: Bardhaman</td>
<td>23.2324°</td>
<td>87.8615°</td>
<td>Bardhaman University campus, Agricultural University campus, Bhutkhala, Damodar bank and DVC canal areas at Paila-Srirampur, Hatiyimul, Barshul, Rathatal</td>
<td>Dry deciduous forest patches with high canopy and moderate understory, more than 15 perennial ponds with low to moderate hydrophyte population, seasonal pools and marshes, bamboo groves, Damodar River bank, DVC canal bank and surrounding areas</td>
</tr>
<tr>
<td>Site 4: Aushgram</td>
<td>23.5256°</td>
<td>87.6630°</td>
<td>Uttar Ramnagar, Gopalpur, Ullaspur, Maliyara, Malacha Ajay river bank and surrounding areas</td>
<td>Bamboo groves, paddy fields, 11 different perennial ponds, Ajay River bank, dry deciduous forest patches, shrubland areas near Ajay River and two different irrigation canals.</td>
</tr>
<tr>
<td>Site 5: Jamalpur</td>
<td>23.0736°</td>
<td>87.8918°</td>
<td>Dadpur, Sarangpur</td>
<td>DVC canal banks (dense patches of mixed trees with thick understory), Damodar River banks, grasslands, seasonal puddles, four different perennial ponds.</td>
</tr>
</tbody>
</table>

Figure 1. Field site: Panel (a) shows the geographical location of PurbaBarddhaman district within India (shown as red dot). Panel (b) shows the centralised position of PurbaBarddhaman district in southern part of West Bengal (the boundary of the district is filled in red). Panel (c) shows the geographical location of five field sites. The sites are namely site 1 Katwa and surroundings, site 2 Bhatar, Karjana and surroundings, site 3 Bardhaman town and surroundings, site 4 Ausgram and surroundings, site 5 Jamalpur, Raina and surroundings.
RESULTS

The data from all of the sites revealed a total of 47 species, 35 genera, and six families. The sites chosen contained 32 species under the suborder Anisoptera and 15 species under the suborder Zygoptera. The Libellulidae family was found to be the most abundant (24 species). Together with the Libellulidae, other families were also found, including Coenagrionidae (11 species), Gomphidae (5 species), Aeshnidae (3 species), Platycnemididae (3 species), and Chlorocyphidae (1 species). The detailed record of the species along with its occurrence in different seasons and in different sites is listed in Table 1.

**Suborder Zygoptera Selys, 1854**  
**Family Chlorocyphidae Cowley, 1937**  
**Libellago indica** Fraser, 1928  
Labrum dark brownish-yellow, abdomen 14–16 mm, black in colour with yellow markings on the sides of segments and broad mid-dorsal black stripes, differentiating it from *Libellago lineata*. Brown eyes. Black prethorax with citron yellow markings. Black thoracic segments with citron or greenish yellow markings. Legs are black, wings are hyaline, and the bases of all have a little amber tinge. Forewing’s apical black patch is noticeably longer (See Image 4d).
Family Coenagrionidae Kirby, 1890
*Agriocnemis kalinga* Nair & Subramanian, 2014

A small damselfly, possibly the smallest described from India to date, with an abdomen measuring about 13–14 mm and a hindwing measuring 8–11 mm. The superior anal appendages are longer than the inferior ones, and the male’s tergum 2 is marked with a distinctive cobra hood-like pattern. The ground colour is bright yellow with black on the dorsum, yellow pterostigma, with a bright yellow tip. The males on the other hand are dark green coloured with a black line running through the dorsal side of the abdomen. The anal appendages on occasions appeared yellow or orangish-yellow and the thorax also had black line markings (Image 4a).

Suborder Anisoptera Selys, 1854
Family Gomphidae Rambur, 142
*Platygomphus dolabratus* Selys, 1854

Abdomen is about 41 mm. Bright yellow labium, labrum, and face. Fronts are completely yellow; vertex is black with a sizable yellow mark behind the ocelli; and the occiput is a bright yellow. Bottle-green eyes. Prothorax...
is black on dorsum, sides yellow. Thorax is yellow with black markings. Wings hyaline that occasionally have a slight yellow hue. Legs are yellow with black markings. Anal appendages have a black border and are yellow or yellowish-brown in colour (Image 2e).

**Macrogomphus montanus** Selys, 1869

Length of abdomen, 45 mm. Black head with yellow markings. Labrum has two oval basal patches, as does the entire labium. Brown colored occiput. Unmarked prothorax is black in colour. Stripes are visible on the black thorax. Widely yellow sides with two neatly marked black lateral sutures. Hyaline, palely enfumed, brown wings with a tight reticulation. Blackish-brown legs. Black abdomen with yellow markings. The apical half of the divaricate, point-tipped anal appendages are thick at the base (Image 2a,b,c,d).

**DISCUSSION**

This is the first comprehensive study of odonate diversity to cover a significant portion of the Purba Barddhaman district, though there were some individual sighting reports from a few small pockets and another study that covered Purbasthali, within the district’s territory (Ghosh 2022). We attempted to incorporate various types of habitats in this study, ranging from seasonal pools to perennial rivers, resulting in the listing of 47 species from 35 genera. Our results were in cohesion with the detailed report by Dawn (2022).

It reveals from the results (see Table 2) that the family Aeshnidae is noticed in Site 1, 2, 3, 4 but not in 5; out of which *Anax indicus* (Lieftinck, 1942) appeared to be a more common species and is noticed in Site 1, 2 & 3 site in monsoon period but *Anax guttatus* (Bermeister, 1839) and *Gynacantha* sp. in Site 3 during post monsoon period. *Anax indicus* was found mostly flying over small waterbodies and sometimes hanging from the leaves or branches of mango trees. *Gynacantha* sp. was found in the middle of Barddhaman town near an old house.

Five different species were found under family Gomphidae and among them, *Ictinogomphus rapax* (Rambur, 1842) and *Paragomphus lineatus* (Selys, 1850) were found in all seasons near large waterbodies and canals. *Macrogomphus montanus* (Selys, 1869) was...
only found in Site 3 during monsoon in the shades of shrubby patch with high canopy trees over the shrubby patch. This species was reported only twice from West Bengal before this study (from Kolkata in 2002 and from Paschim Barddhaman in 2021) (Mitra 2002; Nayak & Roy 2021).

![Figure 2. Percentage of odonate diversity from different sites and in different seasons.](image)

The bar graphs in panel (a) shows percentage of odonates found in different field sites. S1, S2, S3, S4, S5 denotes Site 1, 2, 3, 4, 5, respectively. The bar graphs in panel (b) shows percentage of odonates found in different seasons. Each season is denoted by different colour.

These are Bar graphs plotting the respective percentages. The X axis shows locations (panel (a)), and seasons (panel (b)). The Y axis shows the percentage of occurrence of species from different locations and different seasons.

A total of 24 species belonging to Libellulidae family of Anisoptera were recorded from the study areas, making it the most abundant family. *Pantala flavescens* (Fabricius, 1798) and *Urothemis signata* (Rambur, 1842) are available in pre monsoon and monsoon period with *P. flavescens* mostly flying in good numbers at a height near waterbodies, whereas *U. signata* was mostly seen sitting atop small shrubby patches. *Orthetrum sabina* (Drury, 1770) was seen very commonly and across seasons, and on some occasions seen feeding on other Odonata species like *Brachythemis contaminata* (Fabricus, 1793) was often seen sitting on small hydrophytes in small and stagnant waterbodies. It often showed obelisk posture while sitting. *Potamarcha congener* (Rambur, 1842) was often seen sitting on wires or dry bamboo sticks. *Crocothemis servilia* (Drury, 1770) was very commonly found near waterbodies even in the banks of rivers and *Diplacodes trivialis* (Rambur, 1842) was often found sitting on the ground and feeding on mosquitos, mayflies and other small insects. *Brachydiplax sobrina* (Rambur, 1842) was found near waterbodies with loads of hyacinths and shady areas; *Tramea basiliaris* (Palisot
Table 2. List of Odonates found and their seasonal occurrence.

<table>
<thead>
<tr>
<th>Species</th>
<th>Site of occurrence</th>
<th>Season of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Suborder: Anisoptera</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family: Aeshnidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acisoma panorpoides</td>
<td>Pre-monsoon,</td>
<td></td>
</tr>
<tr>
<td>Rambur, 1842</td>
<td>Monsoon</td>
<td></td>
</tr>
<tr>
<td>Aethriamanta brevipennis</td>
<td>S2, S3</td>
<td></td>
</tr>
<tr>
<td>Rambur, 1842</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brachydiplax chalybea Brauer, 1869</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Brachydiplax farinosa Krüger, 1902</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Brachydiplax sabotino Rambur, 1842</td>
<td>S1, S3, S4</td>
<td></td>
</tr>
<tr>
<td>Brachythemis contaminata Fabricius, 1793</td>
<td>S2, S3, S4, S5</td>
<td></td>
</tr>
<tr>
<td>Bradinopyga geminata Rambur, 1842</td>
<td>S1, S2, S3</td>
<td></td>
</tr>
<tr>
<td>Crocothemis servilia Drury, 1773</td>
<td>S1, S3, S4, S5</td>
<td></td>
</tr>
<tr>
<td>Diplocodes nebulosa Fabricius, 1793</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Diplocodes trivialis Rambur, 1842</td>
<td>S1, S3, S4, S5</td>
<td></td>
</tr>
<tr>
<td>Lathrecista asiatica Fabricius, 1798</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Macrodiplax cora Brauer, 1867</td>
<td>S3, S5</td>
<td></td>
</tr>
<tr>
<td>Neurothemis fulvia Drury, 1773</td>
<td>S2, S3</td>
<td></td>
</tr>
<tr>
<td>Neurothemis tullia Drury, 1773</td>
<td>S3, S4</td>
<td>Pre-monsoon,</td>
</tr>
<tr>
<td>Orthetrum sabino Drury, 1770</td>
<td>S1, S2, S3, S4, S5</td>
<td>Monsoon,</td>
</tr>
<tr>
<td>Pantala flavescens Fabricius, 1798</td>
<td>S1, S2, S3, S4, S5</td>
<td></td>
</tr>
<tr>
<td><strong>Suborder: Zygoptera</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family: Chlorocyphidae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Libellago indica Fraser 1928</td>
<td>S1</td>
<td>Monsoon</td>
</tr>
<tr>
<td><strong>Family: Coenagrionidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agriocnemis pygmaea Rambur, 1842</td>
<td>S3, S4</td>
<td>All season</td>
</tr>
<tr>
<td>Amphiallagia porum Selys, 1876</td>
<td>S3, S2, S3</td>
<td>All season</td>
</tr>
<tr>
<td>Ceragron cerinorubellum (Brauer, 1865)</td>
<td>S3, S5</td>
<td></td>
</tr>
<tr>
<td>Ceragron coromandelianum Fabricius, 1798</td>
<td>S1, S2, S3, S4, S5</td>
<td>Pre-monsoon,</td>
</tr>
<tr>
<td>Ichneura nursei Morton, 1907</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Ichneura rubiella Selys, 1876</td>
<td>S1, S2, S3, S4, S5</td>
<td>Pre-monsoon,</td>
</tr>
<tr>
<td>Ichneura senegalensis Rambur, 1842</td>
<td>S1, S3, S4, S5</td>
<td>All season</td>
</tr>
<tr>
<td>Pseudagron decorum Rambur, 1842</td>
<td>S2, S4</td>
<td>Monsoon,</td>
</tr>
<tr>
<td>Pseudagron microcephulin Rambur, 1842</td>
<td>S5</td>
<td>Post-monsoon</td>
</tr>
<tr>
<td>Pseudagron rubriceps Selys, 1876</td>
<td>S1, S2, S3, S4, S5</td>
<td>Monsoon,</td>
</tr>
<tr>
<td><strong>Family: Platycnemididae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Onychargia atrocyana Selys, 1865</td>
<td>S2, S3, S4</td>
<td>All season</td>
</tr>
<tr>
<td>Copaera marginipes Rambur, 1842</td>
<td>S3</td>
<td></td>
</tr>
<tr>
<td>Pseudocopa ciliata Selys, 1863</td>
<td>S1, S2, S3</td>
<td>All season</td>
</tr>
</tbody>
</table>

During pre-monsoon and post-monsoon period Acisoma panorpoides (Rambur, 1842) was noticed near ponds with loads of hyacinth and other hydrophytes, with very less open water surface. Bradinopyga geminata (Rambur, 1842) was mostly found inside the Bardhaman town sitting on walls, sometimes well camouflaged. Neurothemis tullia (Drury, 1773) was not so common and was seen in grassy areas near waterbodies on a few occasions. Rhododemis rufa (Rambur, 1842) and Rhyothemis variegata (Linnaeus, 1763) in Site 3, 4,5 and Site 2, 3, 4, respectively. Thalymis tillarga (Fabricus, 1798) was mostly found active during late afternoon and during daytime sitting in the shades. Among suborder Zygoptera, Libellago indica (Fraser, 1928) belonging to Chlorocyphidea family and
**Ischnura senegalensis** species of family Coenagrionidae are recorded of which (Rambur, 1842) were found across seasons very commonly. *Agriocnemis pygmaea* was found mostly in shallow water patches sitting on vegetation. During pre-monsoon and monsoon *Ceriagrion coronandellum* (Fabricus, 1798) and *Ischnura rubillo* (Selys, 1876) were noticed in all sites; whereas during monsoon and post monsoon period *Pseudagrion rubriceps* (Selys, 1876) was often observed guarding its mate or in tandem with the female and in very few occasions laying eggs on submerged twigs. *Pseudagrion decorum* (Rambur, 1842) was found near perennial waterbodies and small seasonal village ponds but *Agriocnemis pygmaea* (Fabricus, 1798) and *Ischnura senegalensis* (Rambur, 1842) was found near Damodar River along with other damselflies with the female and in very few occasions laying eggs on submerged twigs. *Pseudagrion rubriceps* (Selys, 1876) was found mostly in monsoon and monsoon commonly. (Rambur, 1842) were found across seasons very frequently. 

Distribution of Odonata in Purba Barddhaman

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- S. Manigandan, H. Byju & P. Kannan, Pp. 24730–24736

Observations on Indian Skimmer *Rynchops albicollis* Swainson, 1838 (Aves: Charadriiformes: Laridae) breeding colonies in Middle Ganges stretch, India
- Kumar Ankit, Mujahid Ahamad, Vivek Ranjan, Syed Ainul Hussain & Govindan Veeraswami Gopi, Pp. 24737–24745

Avifaunal diversity in urban greenspaces within Cotabato city, Mindanao Island, Philippines
- Joan Rhea Mae L. Baes, Peter Jan D. de Vera, John Paul A. Catipay, Marian Dara T. Tagoon & Elsa May Delima-Baron, Pp. 24746–24751

Waterbird count at Narathali waterbody, Buxa Tiger Reserve in northern Bengal for a decade (2009–2019) with a note on raptors
- Sachin Ranade & Soumya Sundar Chakraborty, Pp. 24752–24759

First confirmed reproduction by a translocated female Siamese Crocodile *Crocodylus siamensis* (Crocodylidae: Crocodylia) with observations of nest attendance and nest-associated fauna

Erode Ground Gecko *Cortadactylus species* (Beddome, 1870) (Squamata: Gekkonidae) from peri-urban common-lands of Coimbatore, India, with comments on habitat associations

Assessment of diversity of Odonata fauna in selected sites of Purba Bardhman district, West Bengal, India
- Sulagna Mukherjee & Rabindranath Mandal, Pp. 24775–24785

A preliminary assessment of butterfly diversity from Mekhliganj town, Cooch Behar District, West Bengal, India
- Abhirup Saha, Prapti Das & Dhiraj Saha, Pp. 24786–24794

Utilization of *Afzelia africana* Sm. ex Pers. (Magnoliopsida: Fabales: Fabaceae) in Nigeria and its implications for conservation

Short Communications

Gastrointestinal parasites of the Indian Flying Fox *Pteropus medius* in Nagpur City: a seasonal study through faecal sample analysis
- Ruchika R. Sangale & Priya Gawande, Pp. 24804–24806

*Plagiochila javanica* (Sw.) Nees & Mont. (Marchantiophyta: Plagiochiaceae) rediscovered from the Western Ghats after 180 years

A new record of genus *Synedrus* Graham, 1956 with description of male of *Synedrus kasparyani* Tselikh, 2013 from India
- Mubashir Rashid & Arvind Kumar, Pp. 24812–24815

Note

*Hunteria zeylanica* (Retz.) Gardner ex Thwaites (Magnoliopsida: Gentianales: Apocynaceae)—new addition and first genus record to the flora of Karnataka
- G. Ramachandra Rao, Pp. 24816–24818