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Caption: Large Indian Civet *Viverra zibetha*, Tricoloured Munia *Lonchura malacca* and *Hoya wightii* (Medium—pencil crayon on watercolour paper) © Supriya Samanta.

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COMMUNICATION

Dragonflies and Damselflies (Insecta: Odonata) of Aryanad Grama Panchayat, Kerala, India

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Abstract: A year-long study to document the diversity and seasonality of odonates was conducted at Aryanad Grama Panchayat, Thiruvananthapuram district, Kerala, southern India. A total of 93 species (56 dragonflies and 37 damselflies) belonging to 12 families were recorded. Twenty-four species of odonates recorded are endemic to the Western Ghats, three to peninsular India and one to India. Small streams showed the highest species richness, hosting 69 species and ponds the lowest with 59 species. Species richness showed a peak during the southwest monsoon season and a dip in winter. The study highlights the importance of biodiversity documentation at regional level.

Keywords: Endemic, seasonality, southern India, species richness, Western Ghats.

ഇന്ത്യയിലെ തെക്കൻ സംസ്ഥാനമായ കേരളത്തിൽ, തിരുവനന്തപുരം ജില്ലയിലെ ആര്യനാട് പഞ്ചായത്തിൽ തുമ്പികളുടെ വൈവിധ്യവും കാലികമായ മാറ്റങ്ങളും ഒരു വർഷത്തേക്ക് പഠനവിധേയമാക്കി. 12 കുടുംബങ്ങളിലായി 93 ഇനം തുമ്പികളെ (56 ഇനം കല്ലൻതുമ്പികൾ, 37 ഇനം സൂചിത്തുമ്പികൾ) ഈ പഠനത്തിൽ കണ്ടെത്താനായി. ഇതിൽ 24 ഇനം പശ്ചിമഘട്ടത്തിലും, മൂന്നിനം ഇന്ത്യൻ ഉപദ്വീപിലും, ഒരിനം ഇന്ത്യയിലും സ്ഥാനീയമായി കാണപ്പെടുന്നവയാണ്. ചെറിയ അരുവികളിലായിരുന്ന തുമ്പികളുടെ വൈവിധ്യം ഏറ്റവും കൂടുതൽ. ഇവിടങ്ങളിൽ നിന്നും 69 ഇനം തുമ്പികളെ കണ്ടെത്താനായി. വൈവിധ്യം ഏറ്റവും കുറഞ്ഞ ആവാസവ്യവസ്ഥകളായ കുളങ്ങളിൽ 59 ഇനം തുമ്പികളെയാണ് കണ്ടെത്താൻ കഴിഞ്ഞത്. കാലവർഷം തുടങ്ങുന്ന സമയത്ത് തുമ്പികളുടെ വൈവിധ്യം മൂർദ്ധന്യത്തിൽ എത്തുകയും ശൈത്യകാലത്ത് ഏറ്റവും കുറഞ്ഞു കാണപ്പെടുകയും ചെയ്തു. ഇന്ത്യയിൽ പ്രാദേശികതലത്തിൽ കൂടുതൽ ജൈവവൈവിധ്യ പഠനങ്ങൾ നടത്തേണ്ടതുണ്ട് എന്ന് ഈ പഠനം വിളിച്ചോതുന്നു.

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Author contributions: RC carried out the fieldwork and analysed the data. AVC designed the study, helped with the fieldwork and prepared the manuscript.

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INTRODUCTION

Protected areas are the cornerstones of global biodiversity conservation efforts. India has established a network of protected areas covering approximately 4.8% of its geographical area, but it is impossible to bring the entire range of biodiversity under this network (Mathur & Sinha 2008). It is therefore, imperative that we take measures to document and conserve biodiversity outside protected areas. Under the Biological Diversity Act of 2002, the Grama Panchayats in India are mandated to form Biodiversity Management Committees (BMCs) for the documentation, conservation and sustainable use of bioresources. Kerala is the first state in India to form BMCs in all its local bodies (Kerala State Biodiversity Board 2021). However, the documentation of insect biodiversity is incomplete in most of the People's Biodiversity Registers (PBRs) prepared by the BMCs.

Dragonflies and damselflies, which together form the insect Order Odonata are considered as important components of freshwater ecosystems as well as good indicators of ecosystem health because of their amphibious life history, relatively short generation time, high trophic position and diversity (Corbet 1993; Clark & Samways 1996). Biodiversity of insects is threatened worldwide (Sánchez-Bayo & Wyckhuys 2019) and one in 10 species of dragonflies and damselflies is threatened with extinction (Clausnitzer et al. 2009). This global decline of insect populations is feared to cause a catastrophic collapse of earth's ecosystems (May 2010). The endemic species of odonates have a narrow distribution across the Western Ghats, occurring in only small patches of suitable habitats (Subramanian et al. 2011; Koparde et al. 2014). Aryanad (8.556–8.677 ^{0}N & 77.071–77.224 ^{0}E) is an agricultural village under the foothills of Agasthyamalai of southern Western Ghats in Thiruvananthapuram district, Kerala (Figure 1). The predominant crops grown here are coconut, rubber, banana, and vegetables (Government of Kerala 2021). Aryanad lies adjacent to the Peppara Wildlife Sanctuary and the Karamana River that originates in the Western Ghats flows through the village.

MATERIALS AND METHODS

Four ponds (with area less than 30 m^2), three small streams (with width approximately 0.5 m), five large streams (with width approximately 2 m) and the Karamana River having a width of approximately 6 m were selected in Aryanad Grama Panchayat for sampling odonates (Image 1). Each habitat was visited once every month from 1 December 2019 to 30 November 2020. Visual encounter surveys (VES) were done to

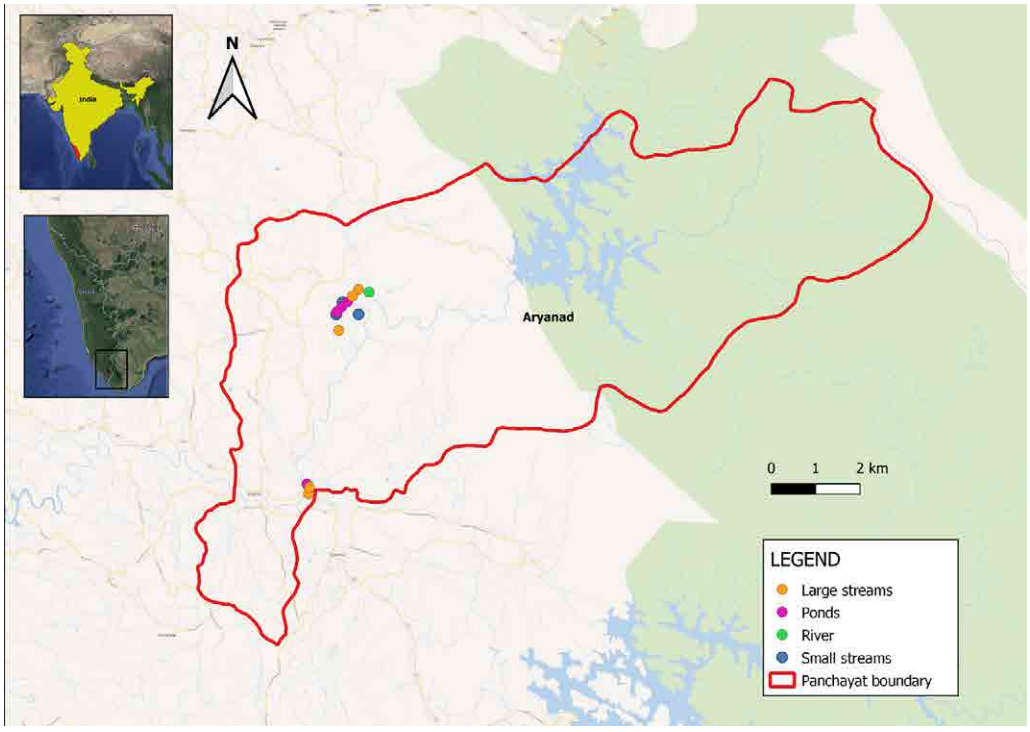

Figure 1. Map of Aryanad showing sampling sites.

document the odonates, where the observer walked along the edge of each waterbody for 20 minutes and recorded all the odonate species encountered. All the field visits were made between 0900 h and 1100 h. The odonates were photographed using a Nikon Z6 mirror-less camera and Nikon 105 mm macro lens. The individual odonates were identified to the species level referring to taxonomic monographs (Fraser 1933, 1934, 1936) and field guides (Subramanian 2005, 2009; Kiran & Raju 2013). A checklist was prepared using systematic arrangement and taxonomy according to Kalkman et al. 2020. The study period was divided into four seasons for data analysis—winter (December–February), summer (March–May), south-west monsoon (June–August), and north-east monsoon (September–November).

RESULTS AND DISCUSSION

A total of 93 species of odonates (56 dragonflies and 37 damselflies) from 12 families were recorded from Aryanad Grama Panchayat (Table 1, Images 2–6). This accounts for more than half (53%) of the odonate species recorded from the state of Kerala till date (Society for Odonate Studies 2021). In comparable studies, only 82 species of odonates were recorded from Thattekkad Bird Sanctuary (Varghese et al. 2014) and 48 from Chinnar Wildlife Sanctuary (Adarsh et al. 2015). The high odonate diversity documented from Aryanad Grama Panchayat is probably due to the diverse habitats it sustains and its proximity to forests including those of Peppara Wildlife Sanctuary. Out of the 93 species recorded from Aryanad, 24 are endemic to the Western Ghats, three to Peninsular India and one to India. Small streams had the highest species count and ponds the least (Figure 2). The species richness showed a peak during the south-west monsoon when 90 species were recorded and a dip in winter, when only 30 species could be seen (Figure 3).

The records of the following species are significant considering their endemicity, rarity and threat status (Subramanian et al. 2018; IUCN 2021):

***Protosticta sanguinostigma* Fraser, 1922**

This species, easily identified by the reddish brown equatorial band in its eyes and the peculiar shape of anal appendages is categorized as 'Vulnerable' by the International Union for Conservation of Nature and Natural Resources (IUCN) in its Red List of Threatened Species. It was recorded only from the lotic habitats of Aryanad and was unrecorded during winter.

***Calocypha laidlawi* (Fraser, 1924)**

This small damselfly brightly coloured with sky blue, black and vermilion is the only extant species of the genus. It is endemic to the southern Western Ghats and has so far been recorded only from a few locations in Kerala and Karnataka. It was recorded from all three lotic habitat types of Aryanad Grama Panchayat and was sighted in all the seasons. An extensive search of literature and websites failed to produce even a single photograph of the female of this species. Hence, this is most probably the first photographic record of the female from the wild (Image 7). It remains a 'Data Deficient' species in the IUCN Red List.

***Elattoneura souteri* (Fraser, 1924)**

This damselfly coloured brightly with red and black is a 'Data Deficient' species in the IUCN Red List and has so far been recorded only from a few locations in Kerala and Karnataka. It was recorded from all three lotic habitat types of Aryanad and could not be seen in winter.

***Esme longistyla* Fraser, 1931**

This species was identified referring to characters like complete anal bridge vein, blue annules on abdomen, blue stripes on legs and structure of anal appendages. Even though it is classified as a 'Least Concern' species in the IUCN Red List, only very scarce reports of this species exist from Kerala and Karnataka. In Aryanad, it was recorded from both small and large streams. It could not be seen in winter.

***Melanoneura bilineata* Fraser, 1922**

This rare and relatively large damselfly species is the sole representative of the genus and has so far been recorded only from a few locations in Kerala and Karnataka. It is coloured blue and black and can be distinguished by the absence of the anal bridge vein in its wings. This species, classified as 'Near Threatened' in the IUCN Red List was recorded from Aryanad in all four seasons. It could be seen only in the small streams and hence appears to show high habitat specificity.

***Burmagomphus laidlawi* Fraser, 1924**

This medium-sized clubtail dragonfly has till now been recorded only from montane forest streams of Kerala, Karnataka and Tamil Nadu. It can be easily separated from other clubtail species by the structure of its anal appendages. It was recorded only during the southwest monsoon season and could be seen only in large streams. Hence, this species is highly seasonal and has specific habitat requirements. It remains a 'Data

Table 1. Checklist of Odonata recorded from Aryanad Grama Panchayat, Kerala, southern India.
Endemicity: EN WG—Endemic to the Western Ghats | EN P—Endemic to peninsular India | EN I—Endemic to India.
IUCN Red list status: NE—Not Evaluated | DD—Data Deficient | LC—Least Concern | NT—Near Threatened | VU—Vulnerable.
Habitats: P—Ponds | SS—Small streams | LS—Large streams | R—River.
Seasons: M1—Southwest Monsoon | M2—Northeast Monsoon | W—Winter | S—Summer.

	Species	Endemicity	IUCN Red List status	Habitats recorded from	Seasons recorded in
	Zygoptera (Damselflies)				
	Family: Lestidae				
1	*Lestes elatus* Hagen in Selys, 1862		LC	P, SS	M1
2	*Lestes praemorsus* Hagen in Selys, 1862		LC	P	M1, M2
	Family: Platystictidae				
3	*Protosticta gravelyi* Laidlaw, 1915	EN WG	LC	P, SS, LS, R	M1, M2, W, S
4	*Protosticta sanguinostigma* Fraser, 1922	EN WG	VU	SS, LS, R	M1, M2, S
	Family: Calopterygidae				
5	*Neurobasis chinensis* (Linnaeus, 1758)		LC	SS, LS, R	M1, M2, W, S
6	*Vestalis apicalis* Selys, 1873		LC	P, SS, LS, R	M1, M2, W, S
7	*Vestalis gracilis* (Rambur, 1842)		LC	P, SS, LS, R	M1, M2, S
8	*Vestalis submontana* Fraser, 1934	EN WG	NE	P, SS, LS, R	M1, M2, S
	Family: Chlorocyphidae				
9	*Calocypha laidlawi* (Fraser, 1924)	EN WG	DD	SS, LS, R	M1, M2, W, S
10	*Heliocypha bisignata* (Hagen in Selys, 1853)	EN P	LC	SS, LS, R	M1, M2, W, S
11	*Libellago indica* (Fraser, 1928)	EN P	NE	SS, LS, R	M1, M2, W, S
	Family: Euphaeidae				
12	*Dysphaea ethela* Fraser, 1924	EN P	LC	SS, LS, R	M1, M2, S
13	*Euphaea fraseri* (Laidlaw, 1920)	EN WG	LC	SS, LS	M1, M2, S
	Family: Platycnemididae				
14	*Caconeura risi*(Fraser, 1931)	EN WG	DD	P, SS, LS	M1, M2, W, S
15	*Copera marginipes* (Rambur, 1842)		LC	P, SS, LS, R	M1, M2, W, S
16	*Copera vittata* (Selys, 1863)		LC	P, SS, LS, R	M1, M2, W, S
17	*Elattoneura souteri* (Fraser, 1924)	EN WG	DD	SS, LS, R	M1, M2, S
18	*Elattoneura tetrica* (Laidlaw, 1917)	EN WG	LC	SS, LS, R	M1, M2, S
19	*Esme longistyla* Fraser, 1931	EN WG	LC	SS, LS	M1, M2, S
20	*Melanoneura bilineata* Fraser, 1922	EN WG	NT	SS	M1, M2, W, S
21	*Onychargia atrocyana* Selys, 1865		LC	P, SS	M1, M2, S
22	*Prodasineura verticalis* (Selys, 1860)		LC	P, SS, LS, R	M1, M2, W, S
	Family: Coenagrionidae				
23	*Aciagrion occidentale* Laidlaw, 1919		LC	LS, R	M1, M2, S
24	*Agriocnemis pieris* Laidlaw, 1919		LC	P, SS, LS, R	M1, M2, W, S
25	*Agriocnemis pygmaea* (Rambur, 1842)		LC	P	M1, M2
26	*Agriocnemis splendidissima* Laidlaw, 1919		LC	P, R	M1, M2
27	*Archibasis oscillans* (Selys, 1877)		LC	SS, LS, R	M1, M2, S
28	*Ceriagrion cerinorubellum* (Brauer, 1865)		LC	P	M1, M2, W, S
29	*Ceriagrion coromandelianum* (Fabricius, 1798)		LC	P	M1, M2
30	*Ceriagrion rubiae* Laidlaw, 1916		LC	LS, R	M1, S
31	*Ischnura rubilio* Selys, 1876		NE	P, R	M1, M2
32	*Ischnura senegalensis* (Rambur, 1842)		LC	P	M2, S
33	*Pseudagrion decorum* (Rambur, 1842)		LC	P, LS, R	M1, S

	Species	Endemicity	IUCN Red List status	Habitats recorded from	Seasons recorded in
34	*Pseudagrion indicum* Fraser, 1924	EN WG	LC	P, LS, R	M1, M2, S
35	*Pseudagrion malabaricum* Fraser, 1924		LC	LS, R	M1, S
36	*Pseudagrion microcephalum* (Rambur, 1842)		LC	P, SS, LS, R	M1, M2, S
37	*Pseudagrion rubriceps* Selys, 1876		LC	P, SS, LS, R	M1, M2, W, S
	Anisoptera (Dragonflies)				
	Family: Aeshnidae				
38	*Anax immaculifrons* Rambur, 1842		LC	LS, R	M1, M2, S
39	*Gynacantha dravida* Lieftinck, 1960		DD	P, LS, SS, R	M1, M2
	Family: Gomphidae				
40	*Burmagomphus laidlawi* Fraser, 1924	EN WG	DD	LS	M1
41	*Gomphidia kodaguensis* Fraser, 1923	EN WG	DD	P, SS, LS, R	M1, M2, W, S
42	*Heliogomphus promelas* (Selys, 1873)	EN WG	NT	P, SS	M1, M2
43	*Ictinogomphus rapax* (Rambur, 1842)		LC	P, SS, LS, R	M1, M2, W, S
44	*Macrogomphus wynaadicus* Fraser, 1924	EN WG	DD	P, SS, LS, R	M1, M2
45	*Melligomphus acinaces* (Laidlaw, 1922)	EN WG	DD	LS	M1, M2
46	*Merogomphus tamaracherriensis* Fraser, 1931	EN WG	NE	P, SS, LS, R	M1, M2, S
47	*Microgomphus souteri* Fraser, 1924	EN WG	LC	SS, LS, R	M1, M2, S
48	*Nychogomphus striatus* (Fraser, 1924)		DD	P, SS, LS, R	M1, M2
49	*Paragomphus lineatus* (Selys, 1850)		LC	P, SS, LS	M1, M2, W, S
	Family: Macromiidae				
50	*Epophthalmia frontalis* Selys, 1871		LC	LS, R	M1, M2, S
51	*Epophthalmia vittata* Burmeister, 1839		LC	LS, R	M1, M2
52	*Macromia bellicosa* Fraser, 1924	EN WG	LC	SS, LS, R	M1
53	*Macromia cingulata* Rambur, 1842	EN WG	LC	SS, LS	M1, S
54	*Macromia flavocolorata* Fraser, 1922		LC	SS, LS, R	M1, M2, S
55	*Macromia ida* Fraser, 1924	EN WG	LC	R	M1
56	*Macromia irata* Fraser, 1924	EN WG	LC	SS, LS	S
	Family: Libellulidae				
57	*Acisoma panorpoides* Rambur, 1842		LC	P, SS	M1, M2
58	*Aethriamanta brevipennis* (Rambur, 1842)		LC	P, SS	M1, M2
59	*Brachydiplax chalybea* Brauer, 1868		LC	P, SS, LS, R	M1, M2, W, S
60	*Brachydiplax sobrina* (Rambur, 1842)		LC	P, SS	M1, M2
61	*Brachythemis contaminata* (Fabricius, 1793)		LC	P, SS, LS, R	M1, M2, W, S
62	*Bradinopyga geminata* (Rambur, 1842)		LC	SS	M1, M2
63	*Cratilla lineata* (Brauer, 1878)		LC	SS, LS, R	M1, M2, S
64	*Crocothemis servilia* (Drury, 1773)		LC	P, SS, LS, R	M1, M2, S
65	*Diplacodes trivialis* (Rambur, 1842)		LC	P, SS, LS, R	M1, M2, W, S
66	*Hydrobasileus croceus* (Brauer, 1867)		LC	P, SS, LS, R	M1, M2, S
67	*Hylaeothemis apicalis* Fraser, 1924	EN I	DD	P, SS	M1, M2, S
68	*Lathrecista asiatica* (Fabricius, 1798)		LC	P, SS, LS, R	M1, M2, S
69	*Neurothemis fulvia* (Drury, 1773)		LC	P, SS	M1, M2, S
70	*Neurothemis tullia* (Drury, 1773)		LC	P, SS, LS, R	M1, M2, W, S
71	*Onychothemis testacea* Laidlaw, 1902		LC	LS, R	M1, M2
72	*Orthetrum chrysis* (Selys, 1891)		LC	P, SS, LS, R	M1, M2, W, S
73	*Orthetrum glaucum* (Brauer, 1865)		LC	P, SS, LS, R	M1, M2, W, S

	Species	Endemicity	IUCN Red List status	Habitats recorded from	Seasons recorded in
74	*Orthetrum luzonicum* (Brauer, 1868)		LC	P, SS, LS, R	M1, M2, W, S
75	*Orthetrum pruinosum* (Burmeister, 1839)		LC	P, SS, LS, R	M1, M2, W, S
76	*Orthetrum sabina* (Drury, 1770)		LC	P, SS, LS, R	M1, M2, W, S
77	*Palpopleura sexmaculata* (Fabricius, 1787)		LC	SS	M2
78	*Pantala flavescens* (Fabricius, 1798)		LC	P, SS, LS, R	M1, M2, W, S
79	*Potamarcha congener* (Rambur, 1842)		LC	P, SS, LS, R	M1, M2
80	*Rhodothemis rufa* (Rambur, 1842)		LC	P, LS, R	M1, M2, W, S
81	*Rhyothemis triangularis* Kirby, 1889		LC	P	M1, M2, W, S
82	*Rhyothemis variegata* (Linnaeus, 1763)		LC	P, LS, R	M1, M2
83	*Tetrathemis platyptera* Selys, 1878		LC	P, SS	M1, M2, S
84	*Tholymis tillarga* (Fabricius, 1798)		LC	P, LS, R	M1, M2
85	*Tramea limbata* (Desjardins, 1832)		LC	P, LS, R	M1, M2
86	*Trithemis aurora* (Burmeister, 1839)		LC	P, SS, LS, R	M1, M2, W, S
87	*Trithemis festiva* (Rambur, 1842)		LC	P, SS, LS, R	M1, M2, S
88	*Urothemis signata* (Rambur, 1842)		LC	P, SS	M1, M2, S
89	*Zygonyx iris* Selys, 1869		LC	SS, LS, R	M1, M2
90	*Zyxomma petiolatum* Rambur, 1842		LC	P, SS	M1, M2, S
	Genera incertae sedis				
91	*Idionyx gomantakensis* Subramanian, Rangnekar & Naik, 2013	EN WG	NE	SS	M1, S
92	*Idionyx saffronata* Fraser, 1924	EN WG	DD	SS	M1, S
93	*Macromidia donaldi* (Fraser, 1924)		LC	SS, LS, R	M1, M2, S

Deficient' species in the IUCN Red List.

***Nychogomphus striatus* (Fraser, 1924)**

This medium-sized clubtail dragonfly has very few previous records from Kerala and Tamil Nadu. The record from Nepal requires validation. It has peculiar claw-shaped anal appendages that help to distinguish it easily from other clubtail species. It is a 'Data Deficient' species in the IUCN Red List and was recorded from all four habitat types sampled in Aryanad. It could be seen in both southwest monsoon and northeast monsoon seasons.

***Epophthalmia frontalis* Selys, 1871**

Fraser (1924) described *Macromia binocellata* based on a single male specimen collected by C.M. Inglis from Palni hills, Western Ghats. Subsequently, more specimens were obtained from Tamaracherry, Calicut and Walayar in the Western Ghats after which he treated it as *Epophthalmia frontalis malabarensis* (Fraser 1935) and later, as *Epophthalmia frontalis binocellata* (Fraser 1936). According to the last source, within Indian limits, *E. frontalis frontalis* occurs in Assam and *E. frontalis binocellata* is confined to the Western Ghats. The taxon in the Western Ghats is described as a much darker insect compared to its congenerics. Its abdominal segments 4 to 6 have paired isolated sub-basal spots instead of rings. Also, its inferior anal appendage is distinctly longer and curves up between the apices of superiors. According to Lieftinck (1931) and Fraser (1936) *E. frontalis* and *E. vittata* can be separated from each other based on their facial markings, but Asahina (1987) disagrees and states that these markings vary depending on maturity and individuals. A large Macromiid was seen in the large streams and Karamana River in Aryanad, but its markings seem to match more with *E. frontalis frontalis* as described by Fraser (1936) and Asahina (1987). Its terminal abdominal segments, including the anal appendages were predominantly yellow. The inferior anal appendage was longer than the superiors whose apices it covered by curving in. A comparative analysis using the available resources and photographs lets us place the taxon encountered as *Epophthalmia frontalis* (Image 8), but taxonomic resolution beyond this level was impossible without examining specimens. Tiple & Payra (2020) while reporting *E. frontalis* from Central India encountered a similar problem and suggested a taxonomic revision of South and Southeast Asian

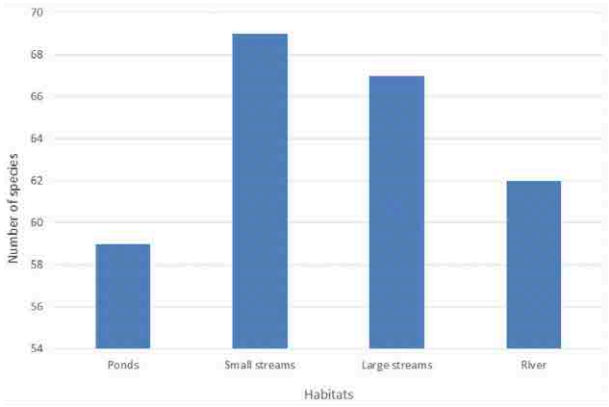

Figure 2. Odonate species richness in each habitat type of Aryanad Grama Panchayat.

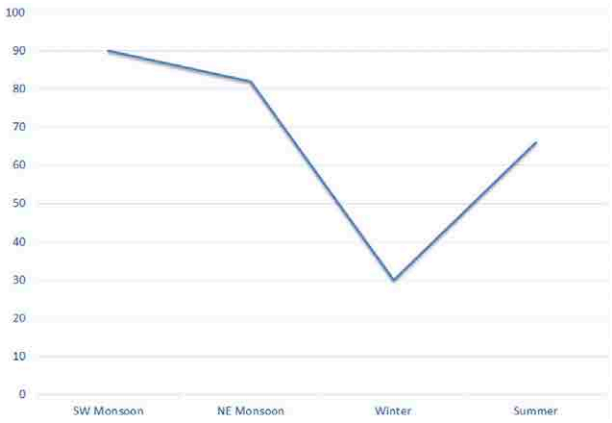

Figure 3. Odonate species richness in different seasons at Aryanad Grama Panchayat.

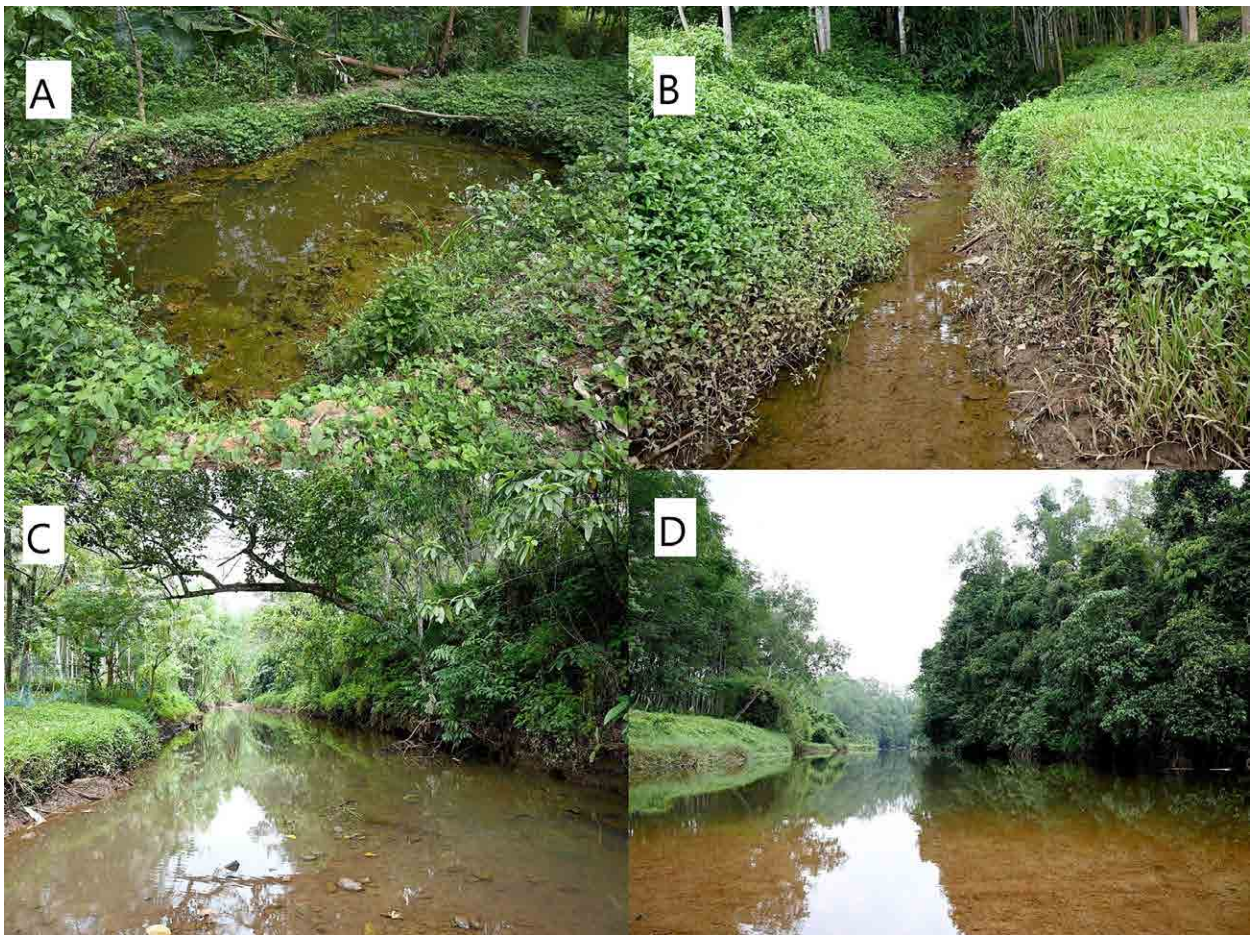

Image 1. The different habitat types sampled for odonates in Aryanad Grama Panchayat: A—Pond | B—Small stream | C—Large stream | D—Karamana River. © Reji Chandran.

Epophthalmia species, particularly *E. frontalis* and *E. vittata*.

Another large Macromiid with its superior and inferior anal appendages of almost the same length was identified as *E. vittata*. Its last segments including the anal appendages were reddish brown with restricted yellow markings (Image 9).

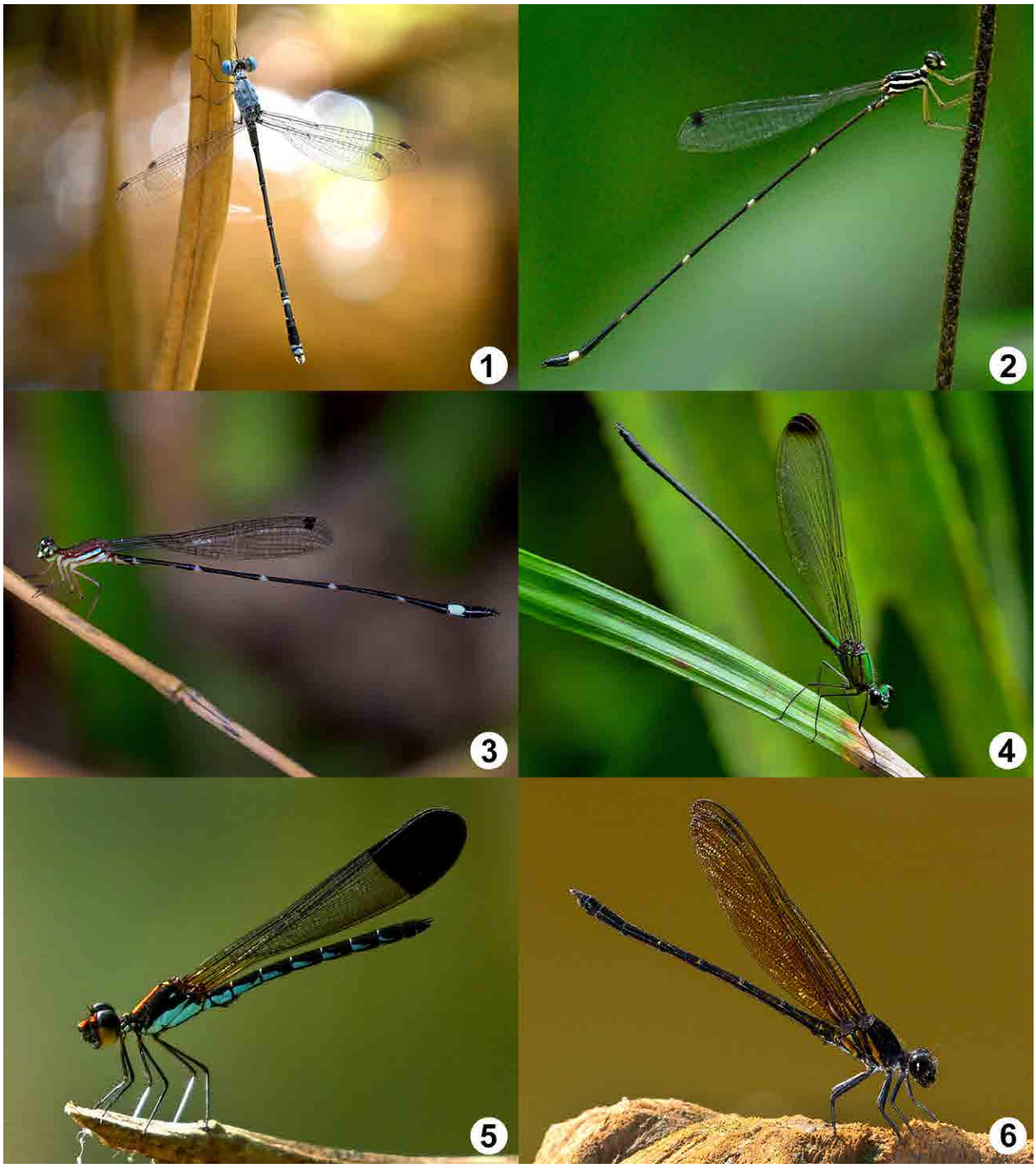

Image 2. 1—*Lestes praemorsus* | 2—*Protosticta gravelyi* | 3—*Protosticta sanguinostigma* | 4—*Vestalis submontana* | 5—*Calocypha laidlawi* | 6—*Dysphaea ethela*. © Reji Chandran.

***Macromia ida* Fraser, 1924**

It is a rare species recorded only from a few locations in Kerala, Karnataka and Tamil Nadu. A single female of this species was sighted near the Karamana River in the southwest monsoon season. It was identified referring to its facial markings and paired dorsal spots on its second abdominal segment.

***Idionyx gomantakensis* Subramanian, Rangnekar & Naik, 2013**

This species was described based on specimens collected from Goa and it remains 'Not Evaluated' in the IUCN Red List. Only very few records of this species are available, all of them from Goa and Kerala. It was

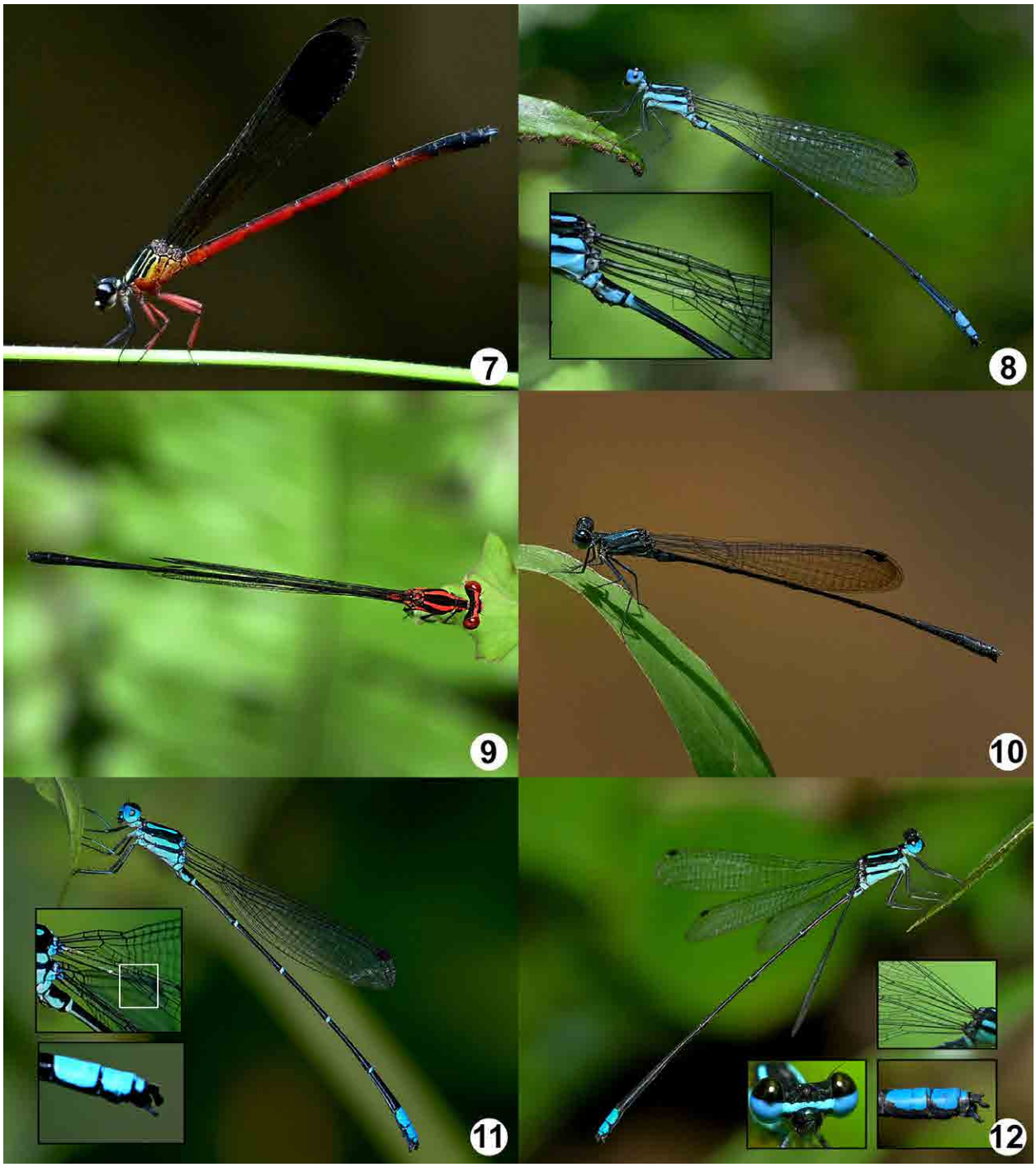

Image 3. 7—*Euphaea fraseri* | 8—*Caconeura risi* | 9—*Elattoneura souteri* | 10—*Elattoneura tetrica* | 11—*Esme longistyla* | 12—*Melanoneura bilineata*. © Reji Chandran.

recorded only from the small streams of Aryanad in summer and southwest monsoon seasons.

Our study has unveiled crucial information regarding the distribution, habitat preference and seasonality of a large number of odonate species in the Western Ghats landscape. While the five *Orthetrum* species were recorded from all the sampled habitats and in all four seasons, many of the endemic species showed high habitat specificity and definite seasonality. The former can be called eurytopic or generalist species and the latter are stenotopic or specialist species. The peak in

Image 4. 13—*Pseudagrion indicum* | 14—*Gomphidia kodaguensis* | 15—*Burmagomphus laidlawi* | 16—*Heliogomphus promelas* | 17—*Macrogomphus wynaadicus* | 18—*Melligomphus acinaces*. © Reji Chandran.

species richness during the southwest monsoon season was expected because most odonate species in India are known to emerge and breed during the monsoon (Subramanian 2005). Odonate diversity dips in winter coinciding with a fall in water level in their habitats and picks up in summer with the pre-monsoon showers. The small streams support the highest number of species probably because they have different microhabitats in the form of pools, marshes and slow flowing stretches. Aryanad village, with its plantations, home gardens and forests at the fringes probably functions as an ecotone, hosting rich biodiversity. Ecotones are ecological

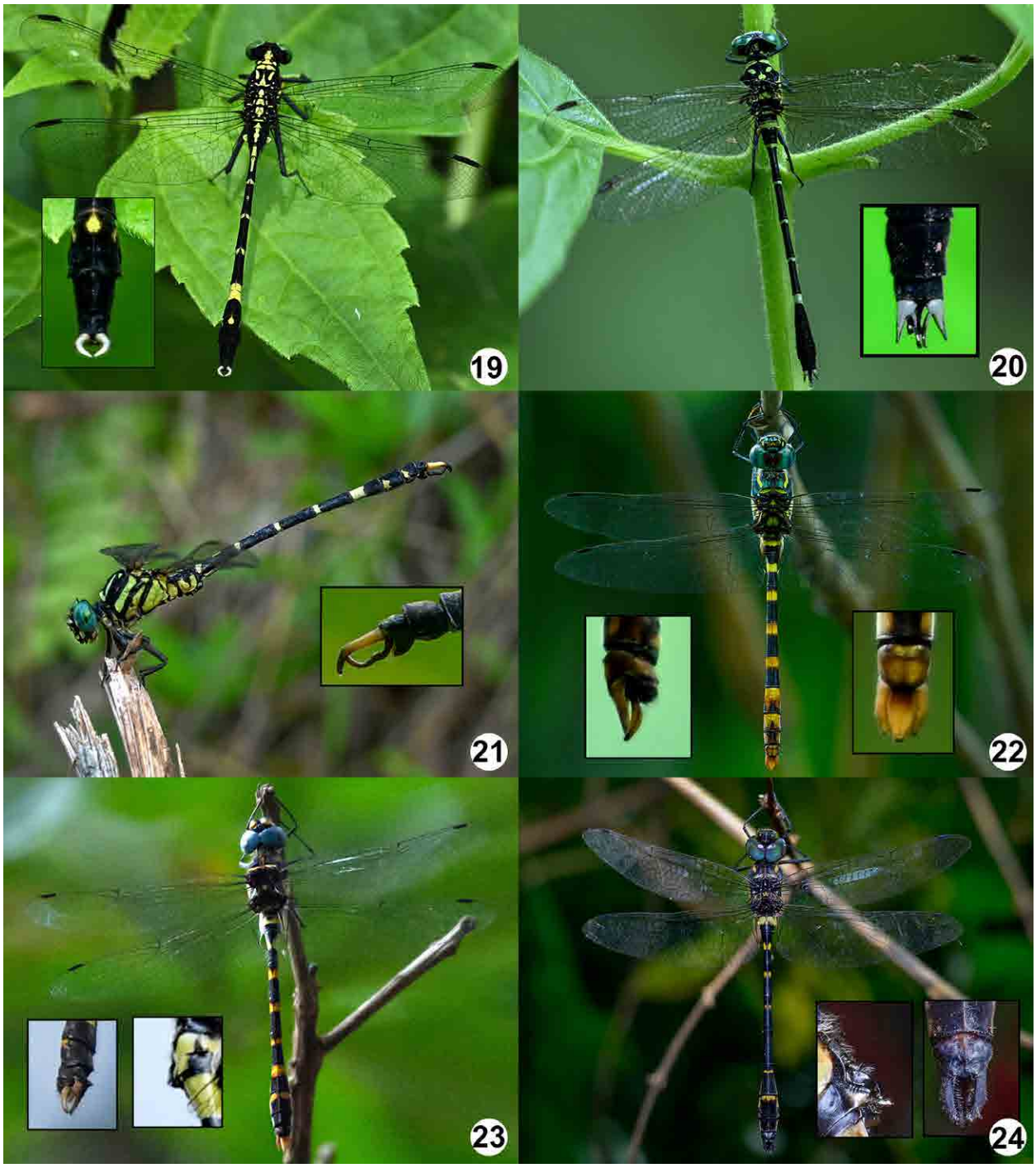

Image 5. 19—*Merogomphus tamaracherriensis* | 20—*Microgomphus souteri* | 21—*Nychogomphus striatus* | 22—*Epophthalmia frontalis* | 23—*Macromia bellicosa* | 24—*Macromia cingulata*. © Reji Chandran.

transition zones characterised by high species turnover rates and local biodiversity peaks (Risser 1995; Odum & Barrett 2005). This calls for effective conservation measures to protect the microhabitats of odonates by the local administration of Aryanad.

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Image 6. 25—*Macromia flavocolorata* | 26—*Macromia ida* (female) | 27—*Macromia irata* | 28—*Idionyx gomantakensis* | 29—*Idionyx saffronata* | 30—*Macromidia donaldi*. © Reji Chandran.

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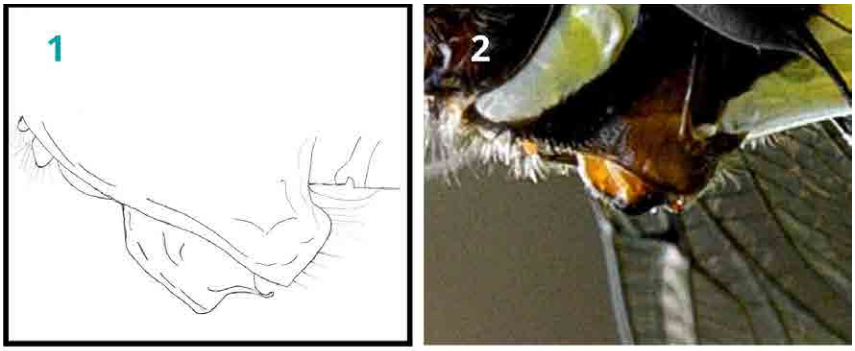
Image 7. *Calocypha laidlawi* female (left) and mating pair (right). © Reji Chandran.



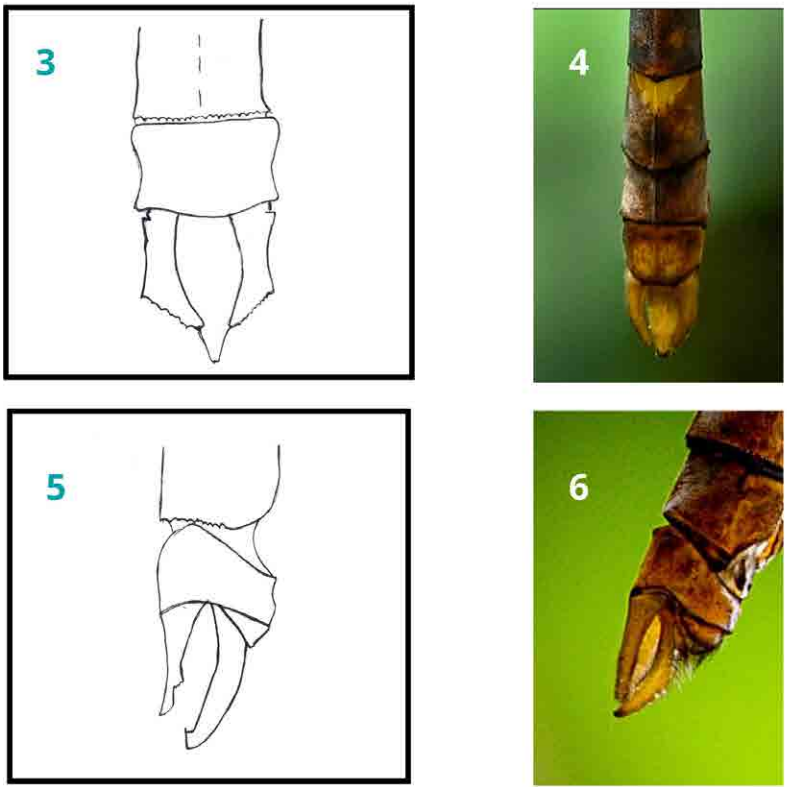


Image 8. *Epophthalmia frontalis*: 1—Accessory genitalia of *E. frontalis frontalis* redrawn from Asahina (1987) | 2—Accessory genitalia of *E.frontalis* photographed from Aryanad | 3 & 5—dorsal & right lateral views of anal appendages of *E. frontalis binocellata* redrawn from Fraser (1936) | 4 & 6—dorsal & right lateral views of *E. frontalis* photographed from Aryanad.
© Images—Reji Chandran; Drawings—A. Vivek Chandran.

Image 9. *Epophthalmia vittata* in flight; inset—right lateral view of anal appendages of *Epophthalmia vittata vittata* redrawn from Fraser (1936). © Image—Reji Chandran; Drawing—A. Vivek Chandran.

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