

Odonata diversity of mid-elevation catchments of the Bavali river from Coorg landscape of central Western Ghats, peninsular India

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ABSTRACT: The odonate diversity and distribution of the mid-elevation catchment area of Bavali River in the Coorg landscape of central Western Ghats is discussed. A total of 114 species of odonates including 32 Western Ghat endemic species were recorded from the study areas of Kanichar Gramapanchayath (KGP) which include 69 dragonflies (Anisoptera) and 45 damselflies (Zygoptera). Family Libellulidae dominated the odonate diversity with 39 species followed by Coenagrionidae (18 species) and Gomphidae (15 species). *Cyclogomphus flavoannulatus* Rangnekar *et al.*, 2019 reported in this study is the first report from Coorg landscape of central Western Ghats. The study area harbours 52.53 per cent of the Western Ghats (WG) and 60.64 per cent of the odonate diversity of Kerala. Additionally, it includes 36.78 per cent of WG and 42.67 per cent of endemic odonates of Kerala. About 28.07 per cent of the odonates recorded from the area are endemic to WG. Among the 114 species identified from the area, as per the IUCN Red List of Threatened species, there were 87 'least concern' species, 18 species were 'data deficient', four species belong to 'near threatened' category, three species belong to 'not assessed' category and two species belong to 'vulnerable' category. None of the species listed in the study area is protected under the Indian Wildlife (Protection) Amendment Act, 2022. This area lying outside any designated Protected Area harbours the largest number of odonate species in any region of Kerala known so far and shows high diversity and endemism comparable to that of other protected areas. © 2025 Association for Advancement of Entomology

KEY WORDS: Anisoptera, Zygoptera, Kerala, non-protected area, IUCN Red List, endemic

INTRODUCTION

Biodiversity conservation, in the last few decades, has focused on protecting different vulnerable hot spots but the protected areas (PAs) represent only a very small proportion of the ecosystem they intend

to protect and also majority of the research works are focused only on these PAs (Myers *et al.*, 2000; Oldekop *et al.*, 2016; Avigliano *et al.*, 2019). This strategy leaves the non-protected areas (NPAs) aside which are sometimes more likely to disappear (Western *et al.*, 2009; Avigliano *et al.*, 2019).

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Regarding taxa like Lepidoptera, fishes, birds and many other arthropods, strong reasons support that the study of biodiversity of NPAs is necessary and relevant (Avigliano *et al.*, 2019). Many species, even a considerable percentage of the population of threatened birds at the global scale, are found outside protected areas (Rodrigues *et al.*, 2004; Avigliano *et al.*, 2019).

Odonata in Kerala have been a well-studied group and has been continuing with discovery of many new species (Fraser 1933, 1934, 1936; Peters 1981; Rao and Lahiri 1982; Mathavan and Miller 1989; Radhakrishnan and Emiliyamma 2003; Emiliyamma 2005; Emiliyamma *et al.*, 2007; Emiliyamma 2014; Kiran and Raju 2013; Subramanian *et al.*, 2020; Emiliyamma *et al.*, 2020; Nair *et al.*, 2021; Nair *et al.*, 2022; Sadasivan *et al.*, 2022a; Sadasivan *et al.*, 2022b, Sadasivan *et al.*, 2022c, Vijayakumaran *et al.*, 2022, Payra *et al.*, 2023, Sadasivan *et al.*, 2023, Nair *et al.*, submitted to ENTOMON). As per recent studies, the odonate fauna of Kerala includes 189 species with 75 WG endemics (Nair *et al.*, submitted to ENTOMON). The Western Ghats which runs parallel to the west coast of India with nearly 1600km length, covers six states, Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu, and Kerala and is divided into three, the southern, central and northern segments. Section south of Palakkad gap till the spur hills in Kanyakumari is Southern WG, central part is from Palakkad gap to Amboli and northern part ranges in Maharashtra and Gujarat north of the Amboli Ghat (Sadasivan and Sengupta, 2024). The Coorg landscape extends from Northern border of Wayanad plateau to Nethravathi valley.

Bavali River is a major drainage of the western slopes of the Coorg landscape of Central Western Ghats. The river is nearly 84 km long, flows from Wayanad district to eastern hilly regions of Kannur district reaching Kottiyoor and passes through Kelakam, Kanichar and Pala, and then Aralam River joins it and finally near Iritty, Veni River also joins with Bavali which ends in the Valapattanam River finally draining into the Arabian Sea. Kanichar Gramapanchayath (KGP) is situated in the hilly regions of the western slopes of Western Ghats

and is on the eastern side of Kannur District between 11.54° N and 75.47° E with 51.96km² areas. The elevation of the region varies from 100–750 m ASL. This region is one of the main catchment areas of the Bavali River. The nearest PAs in the locality are Kottiyoor Reserve Forest (12 km away) and Aralam Wildlife Sanctuary (7km away). The odonate diversity and distribution of the mid-elevation catchment area of Bavali River in the Coorg landscape of central Western Ghats is discussed.

MATERIALS AND METHODS

The diversity and distribution of odonates were studied in the catchment areas of the Bavali River in Kanichar Gramapanchayath (KGP) of the Coorg landscape. The study was conducted at three stations in the low to mid-elevation range namely–Attamcherry Paddyfields (100m ASL), Poolakkutty (350m ASL), and Elapeedikka (750m ASL). Attamcherry is at the foothills of the Coorg-Kannur Hills of WG, 2 km away from Kanichar Town and is a long stretch of paddy fields with streams running through the borders. Poolakkutty 6km away from Kanichar town is a small town on the slopes of Periya Ghat, with numerous montane streams flowing down from the hills. Elapeedikka is a small hill station located in the mid-elevations about 6 km westwards from Kanichar town, bordering the Periya Ghats and Kottiyoor RF with numerous montane streams.

Field surveys were conducted at the above three sites, Attamcherry, Poolakkutty and Elapeedikka from 2020–2023. At least two visits of each of the stations were conducted every month during the Dry-Winter (Dec–Feb), Dry Summer (March–May), South- West Monsoon (June–August) and North-East monsoon (September–November) during morning hours (09.00am – 01.00pm) (IST: UTC +5.30). A modified line transect method was followed by walking for 1 hr in a transect through the periphery of waterbody and every 100m was divided into 10m distance of 10 numbers and adult odonates were thoroughly sampled (Cezario *et al.*, 2021; Kulkarni and Subramanian, 2013). Odonates were photographed, some were caught using insect

nets, identified and released and difficult-to-identify individuals were retained as voucher specimens in the TORG collection. Identification of species was done using field guides (Subramanian, 2009; Kiran and Raju, 2013; Fraser, 1933, 1934, 1936). Nomenclature and classification follow Kalkman *et al.* (2020) and Nair *et al.* (2021). The IUCN Red List of threatened species was referred from the IUCN site <http://www.iucnredlist.org> (IUCN, 2024).

Abbreviations used: PA—Protected Area, NPA—Non-protected Area, WG—Western Ghats, WLS—Wildlife Sanctuary, ASL—Above Sea Level, TORG—TNHS Odonata Research Group, IUCN—International Union for Conservation of Nature.

RESULTS AND DISCUSSION

A total of 114 species of odonates including 32 Western Ghat endemics were recorded from the study areas which includes 69 dragonflies (Anisoptera) and 45 damselflies (Zygoptera). Family Libellulidae dominated the diversity with 39 species followed by Coenagrionidae (18 species), and Gomphidae (15 species). The study area harbours 52.53 of WG and 60.64 per cent of the odonate diversity of Kerala. Additionally, it includes 32 endemics out of 87 (36.78 %) of WG and 32 out of 75 (42.67%) endemic odonates of Kerala. About 28.07 per cent (32 out of 114) of the odonates recorded from the area endemic to WG. Among the 114 species identified from the region, as per the IUCN Red List of Threatened species, there are 87 least concern species, 18 species were data deficient, four species belonged to near threatened category, three species belong to not assessed category, and two species belonged to vulnerable category. Among the three stations studied, the highest diversity was recorded from Attamcherry (99 species) with 24 WG endemics followed by Elapeedika (66 species) with 14 WG endemics and Poolakkutty (49 species) with 10 WG endemic species (Table 1).

Dragonflies Suborder: Anisoptera

A total of 69 dragonflies (Anisoptera) belonging to six families were found in the study areas. A

total of five species under two genera were found in the study areas under Aeshnidae. *Anax immaculifrons* (Rambur, 1842) and *Gynacantha dravida* Leiftnick, 1960 are present in all three locations where *G. millardi* Fraser, 1920 in two locations and *A. ephippiger* (Burmeister, 1839) at Attamcherry and *A. guttatus* (Burmeister, 1839) at Elapeedika only. Corduliidae was represented by a single member *Hemicordulia asiatica* (Selys, 1878) and was present only at low elevation, paddy fields of Attamcherry.

Family Gomphidae was represented by 13 genera with 15 species. *Gomphidia kodaguensis* Fraser, 1923 and *Heliogomphus kalarensis* Fraser, 1934, WG endemics, were present in all three locations and are very common. *Heliogomphus promelas* (Selys, 1873) were comparatively not common but were found in lower and higher elevations only. *Burmagomphus chaukulensis* Joshi *et al.*, 2022, a recently discovered WG endemic gomphid, was very common in the area, at both low and high elevations (Attamcherry and Elapeedika). *Burmagomphus pyramidalis* Laidlaw, 1922 was very rare and found only once at low elevations (Attamcherry) during the study. A rare WG endemic, *Davidioides martini* Fraser, 1924 was recorded from low elevations. *Cyclogomphus flavoannulatus* Rangnekar *et al.*, 2019 has been recorded once from Attamcherry (wetland - paddy field), a rare record from North Kerala and an endemic from low elevations. It is the first record from the Coorg landscape. Previously it has been reported from Nilgiri-Silent Valley landscape, Lower Periyar, Cardamom Hills, Pandalam Hills and Agastyamalai landscapes (Nair *et al.*, 2021). *Ictinogomphus rapax* (Rambur, 1842) and *Paragomphus lineatus* (Selys, 1850) were common at low elevations. *Nychogomphus striatus* Fraser, 1924 was very rare and was found in low elevations. *Megalogomphus hannyngtoni* (Fraser, 1923) considered to be Near threatened as per IUCN Red List was found during South-West monsoon season at low elevations (Attamcherry). *Melligomphus acinaces* (Laidlaw, 1922), another WG endemic species, was common along mid and lower altitudes during monsoon seasons. *Macrogomphus wynaadicus* Fraser,

1924, *Merogomphus tamaracherriensis* Fraser, 1931 and *Microgomphus souteri* Fraser, 1924 were uncommon in low altitudes (Figs. 1 A, B,C, E,F, G).

Libellulidae was represented by 28 genera with 39 species. Interesting species under Libellulidae were *Epithemis mariae* (Laidlaw, 1915), a WG endemic (Fig. 1D), seen during monsoon and *Lyriothemis acigastra* (Selys, 1878). Macromiidae was represented by two genera (*Epophthalmia* and *Macromia*) with five species. *Macromia* includes *M. falcovcolorata* Fraser, 1922, common during monsoon at low elevations, *M. ida* Fraser, 1924, *M. indica* Fraser, 1924 and *M. irata* Fraser, 1924, not uncommon at low elevations during monsoon. Genera Insertae sedis is represented by two genera (*Idionyx* and *Macromidia*) with four species and all were present in low elevation. *Idionyx corona* Fraser, 1921, *I. travancorensis* Fraser, 1931 and *I. saffronata* Fraser, 1924 (Fig. 1H) were not uncommon during monsoon and the first two are new records from the Coorg landscape.

Damselflies suborder: Zygoptera

Calopterygidae is represented by two genera with four species. *Vestalis submontana* Fraser, 1934 is found only at Elapeedik (750m ASL). Family Chlorocyphidae is represented by *Heliocypha bisignata* (Hagen in Selys, 1853) and *Libellago indica* (Fraser, 1928) which were common in all the localities surveyed. Coenagrionidae is represented by six genera with 18 species. Among Coenagrionidae notable species were *Aciagrion approximans krishna* Fraser, 1921, a WG endemic, commonly found at midlands and high elevations. Also, WG endemics like *Ceriagrion chromothorax* Joshi and Sawant, 2019 (Fig. 2B) and *Pseudagrion indicum* Fraser, 1924 (Fig. 2D) were common at low elevations during monsoon. Family Euphaeidae includes *Dysphaea ethela* Fraser, 1924, *Euphaea dispar* (Rambur, 1842) and *E. fraseri* (Laidlaw, 1920) (Fig. 2A, E) where *E. dispar* is present only at high altitudes (Elapeedik, 750m ASL). *Euphaea dispar* and *E. fraseri* are endemic to WG. Lestidae is represented by *Lestes dorothea* Fraser, 1924, *L. elatus* Hagen in Selys, 1862, and *L. praemorsus* Hagen in Selys,

1862 where *L. dorothea* was present in all three locations. Platynemididae includes eight genera with 10 species and the narrowly distributed WG endemic, *Elatoneura souteri* (Fraser, 1924) (Fig. 2F) was found at Attamcherry paddy fields. *Melanoneura bilineata* Fraser, 1922 and *Phylloneura westermanni* (Hagen in Selys, 1860) are near threatened species as per the IUCN Red List and are WG endemic species, recorded from high altitude, Elapeedik.

Platystictidae is represented by two genera and five species and all of them are endemic to WG. *Indosticta* had one species *I. deccanensis* Laidlaw, 1915 (Fig. 2C) which was recorded from Poolakkutty and Elapeedik, thus distributed in midlands and higher elevations. Elapeedik is the type locality of the recently discovered *P. francyi* Sadasivan, Vibhu, Nair & Palot, 2022 (Fig. 2G). The commonest species of the family *P. graveyi* Laidlaw, 1915 was recorded from all three localities, while *P. mertonii* Fraser, 1924 (Fig. 2H) was commonly encountered in the monsoons from the high elevations. The distribution of *P. sanguinostigma* Fraser, 1922 was similar to that of *P. francyi* and is not uncommon in the monsoons.

From Kerala State, many studies are available on odonate diversity from Protected Areas. From Silent Valley and New Amarambalam Reserve, Rao and Lahiri (1982) recorded 23 species; Emiliyamma and Radhakrishnan (2000, 2014) reported 39 species from Parambikulam; Mathavan and Miller (1989) reported 36 species from Periyar Tiger Reserve; Gnanakumar *et al.* (2012) reported 55 species from Chimmomy WLS; Adarsh *et al.* (2015) recorded 48 species from Chinnar; Varghese *et al.* (2014) reported 82 species from Thattekkad Bird sanctuary; Palot and Kiran (2016) listed 93 species from Aralam WLS, and Muneer *et al.* (2023) reported 85 species from Wayanad WLS. Sadasivan *et al.* (2022a) reported 116 species including 33 WG endemics from Shendurney WLS. Sadasivan *et al.* (2024) recently reported 111 species from Silent Valley National Park and its environs.

Regarding Non-protected areas in Kerala, certain

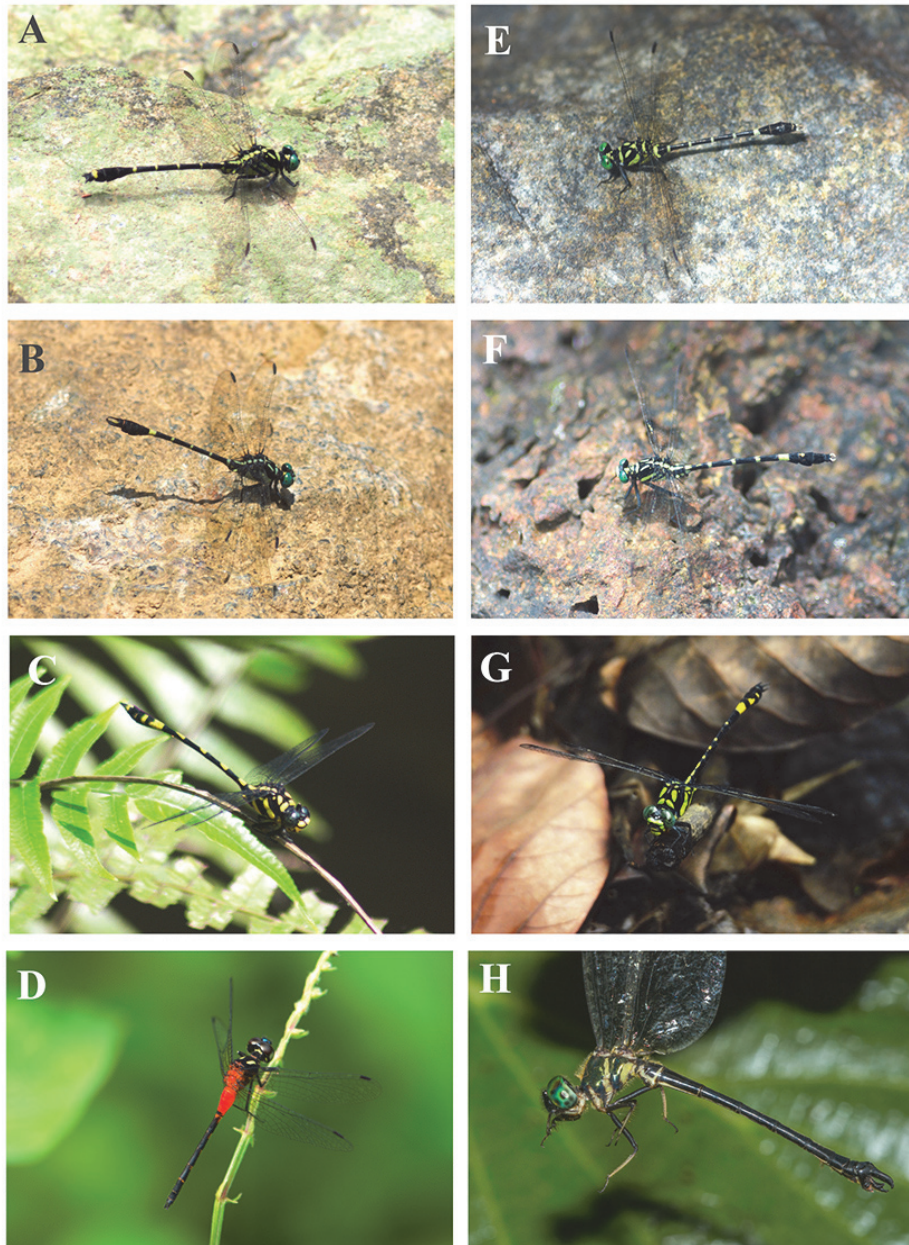


Fig. 1 A. *Burmagomphus chaukulensis* Joshi et al., 2022© Vibhu V; B. *Melligomphus acinaces* (Laidlaw, 1922) © Vinayan P Nair; C. *Gomphidia kodaguensis* Fraser, 1923© Vinayan P Nair; D. *Epithemis mariae* (Laidlaw, 1915) © Vinayan P Nair; E. *Microgomphus souteri* Fraser, 1924 © Vinayan P Nair; F. *Merogomphus tamaracherriensis* Fraser, 1931© Vinayan P Nair; G. *Megalogomphus hanningtoni* (Fraser, 1923) © Vibhu V; H. *Idionyx saffronata* Fraser, 1924 © Kalesh Sadasivan

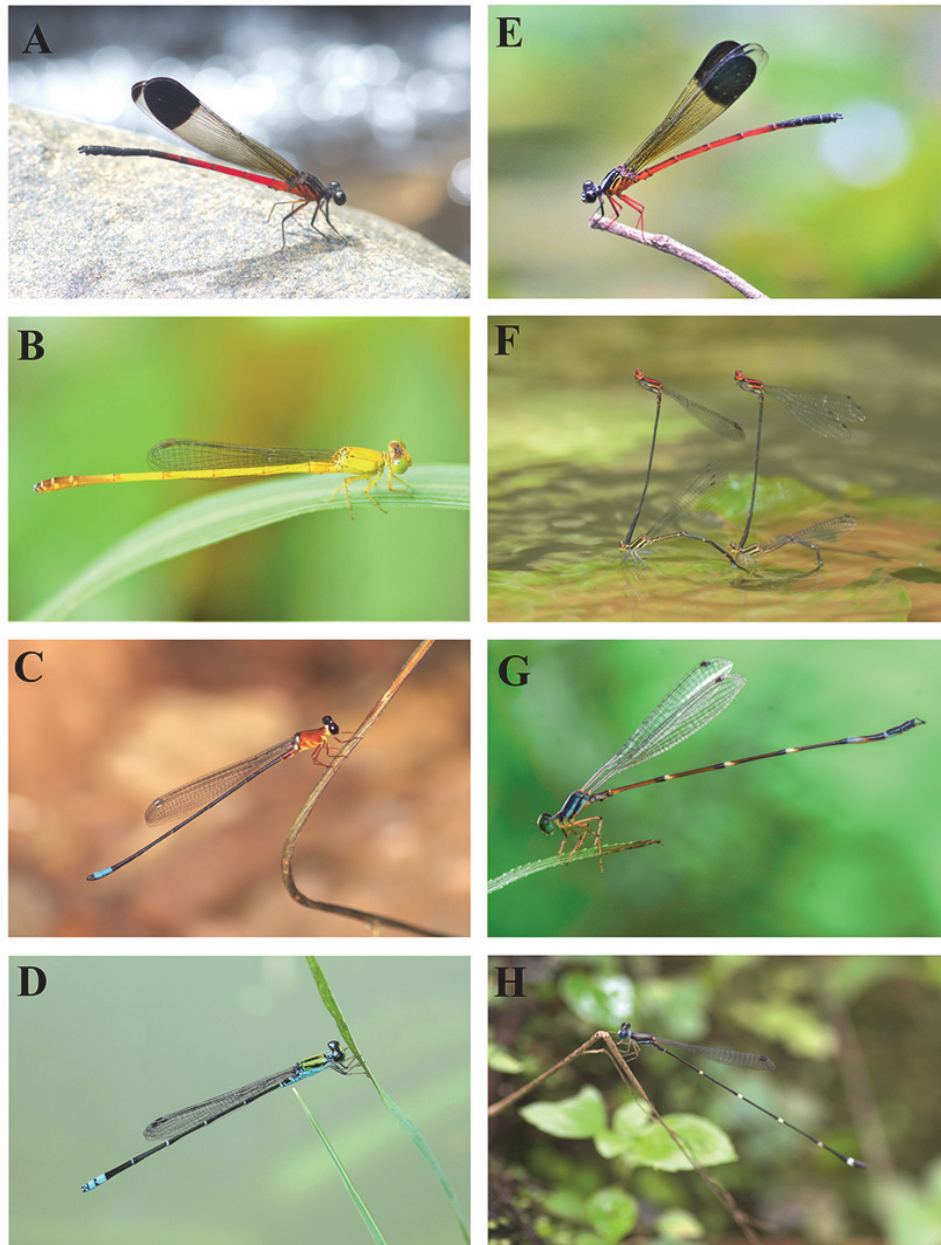


Fig. 2. A. *Euphaea dispar* (Rambur, 1842) © Vinayan P Nair; B. *Ceriagrion chromothorax* Joshi & Sawant, 2019 © Vinayan P Nair; C. *Indosticta deccanensis* Laidlaw, 1915 © Vinayan P Nair; D. *Pseudagrion indicum* Fraser, 1924 © Vinayan P Nair; E. *Euphaea fraseri* (Laidlaw, 1920) © Vinayan P Nair; F. *Elattoneura souteri* (Fraser, 1924) © Vibhu V; G. *Protosticta francyi* Sadasivan et al., 2022 © Vibhu; H. *Prorosticta mertonii* Fraser, 1924 © Vinayan P Nair

Table 1. Checklist of Odonates in locations of Kanichar grama panchayath

No.	Scientific name	IUCN	A [#]	B [#]	C [#]
Dragonflies suborder: Anisoptera					
Family: Aeshnidae					
1.	<i>Anax ephippiger</i> (Burmeister, 1839)	LC	√		
2.	<i>A. guttatus</i> (Burmeister, 1839)	LC			√
3.	<i>A. immaculifrons</i> (Rambur, 1842)	LC	√	√	√
4.	<i>Gynacantha dravida</i> Lieftinck, 1960	DD	√	√	√
5.	<i>G. millardi</i> Fraser, 1920	LC	√		√
Family: Corduliidae					
6.	<i>Hemicordulia asiatica</i> (Selys, 1878)	LC	√		
Family: Gomphidae					
7.	<i>Burmagomphus chaukulensis</i> Joshi, Ogale & Sawant, 2022*	NA	√		√
8.	<i>Burmagomphus pyramidalis</i> Laidlaw, 1922	LC	√		
9.	<i>Cyclogomphus flavoannulatus</i> Rangnekar <i>et al.</i> 2019*	DD	√		
10.	<i>Davidioides martini</i> Fraser, 1924*	DD	√		
11.	<i>Gomphidia kodaguensis</i> Fraser, 1923*	DD	√	√	√
12.	<i>Heliogomphus kalarensis</i> Fraser, 1934*	DD	√	√	√
13.	<i>H. promelas</i> (Selys, 1873)	NT	√		√
14.	<i>Ictinogomphus rapax</i> (Rambur, 1842)	LC	√		
15.	<i>Macrogomphus wynaadicus</i> Fraser, 1924*	DD	√		
16.	<i>Megalogomphus hanningtoni</i> (Fraser, 1923)	NT	√		
17.	<i>Merogomphus tamaracherriensis</i> Fraser, 1931*	NA	√		
18.	<i>Melligomphus acinaces</i> (Laidlaw, 1922)*	DD	√	√	
19.	<i>Microgomphus souteri</i> Fraser, 1924*	LC	√		
20.	<i>Nychogomphus striatus</i> Fraser, 1924	DD	√		
21.	<i>Paragomphus lineatus</i> (Selys, 1850)	LC	√		
Family: Libellulidae					
22.	<i>Acisoma panorpoides</i> Rambur, 1842	LC	√		√
23.	<i>Aethriamanta brevipennis</i> (Rambur, 1842)	LC		√	
24.	<i>Brachydiplax chalybea</i> Brauer, 1868	LC	√		

25.	<i>B. sobrina</i> (Rambur, 1842)	LC	√		
26.	<i>B. contaminata</i> (Fabricius, 1793)	LC	√		
27.	<i>Bradinopyga geminata</i> (Rambur, 1842)	LC	√		√
28.	<i>Cratilla lineata calverti</i> (Forster, 1903)	LC	√		√
29.	<i>Crocothemis servilia</i> (Drury, 1770)	LC	√		√
30.	<i>Diplacodes trivialis</i> (Rambur, 1842)	LC	√	√	√
31.	<i>Epithemis mariae</i> (Laidlaw, 1915)*	LC	√		
32.	<i>Hydrobasileus croceus</i> (Brauer, 1867)	LC	√		
33.	<i>Hylaeothemis apicalis</i> Fraser, 1924	DD	√	√	√
34.	<i>Lathrecista asiatica</i> (Fabricius, 1798)	LC	√	√	√
35.	<i>Lyriothemis acigastra</i> (Selys, 1878)	DD	√		
36.	<i>Neurothemis fulvia</i> (Drury, 1773)	LC	√	√	√
37.	<i>N. intermedia intermedia</i> (Rambur, 1842)	LC	√	√	√
38.	<i>N. tullia</i> (Drury, 1773)	LC	√	√	√
39.	<i>Onychothemis testacea ceylanica</i> Ris, 1912	LC	√	√	√
40.	<i>Orthetrum chrysis</i> (Selys, 1891)	LC	√	√	√
41.	<i>O. glaucum</i> (Brauer, 1865)	LC		√	√
42.	<i>O. luzonicum</i> (Brauer, 1868)	LC	√	√	√
43.	<i>O. pruinosum neglectum</i> (Rambur, 1842)	LC	√	√	√
44.	<i>O. sabina sabina</i> (Drury, 1770)	LC	√	√	√
45.	<i>Paplopleura sexmaculata</i> (Fabricius, 1787)	LC		√	√
46.	<i>Pantala flavescens</i> (Fabricius, 1798)	LC	√	√	√
47.	<i>Potamarcha congener</i> (Rambur, 1842)	LC	√		
48.	<i>Rhodothemis rufa</i> (Rambur, 1842)	LC	√		√
49.	<i>Rhyothemis triangularis</i> Kirby, 1889	LC	√	√	√
50.	<i>R. variegata variegata</i> (Linnaeus, 1763)	LC	√	√	√
51.	<i>Tetrathemis platyptera</i> Selys, 1878	LC	√	√	√
52.	<i>Tholymis tillarga</i> (Fabricius, 1798)	LC	√	√	√
53.	<i>Tramea basilaris</i> (Palisot de Beauvois, 1805)	LC	√		
54.	<i>T. limbata</i> (Desjardins, 1832)	LC	√	√	√
55.	<i>Trithemis aurora</i> (Burmeister, 1839)	LC	√	√	√

56.	<i>T. festiva</i> (Rambur, 1842)	LC	√	√	√
57.	<i>Trithemis pallidinervis</i> (Kirby, 1889)	LC	√		
58.	<i>Urothemis signata</i> (Rambur, 1842)	LC	√		
59.	<i>Zygonyx iris malabarica</i> Fraser, 1926	LC	√	√	√
60.	<i>Zyxomma petiolatum</i> Rambur, 1842	LC	√		
Family: Macromiidae					
61.	<i>Epophthalmia vittata vittata</i> Burmeister, 1839	LC	√		
62.	<i>Macromia flavocolorata</i> Fraser, 1922	LC	√		
63.	<i>M. ida</i> Fraser, 1924*	LC	√		
64.	<i>M. indica</i> Fraser, 1924*	DD	√		
65.	<i>M. irata</i> Fraser, 1924*	LC	√		
Genera insertae sedis					
66.	<i>Idionyx corona</i> Fraser, 1921*	DD	√		
67.	<i>I. saffronata</i> Fraser, 1924*	DD	√		
68.	<i>I. travancorensis</i> Fraser, 1931*	DD	√		
69.	<i>Macromidia donaldi donaldi</i> (Fraser, 1924)*	LC	√		
Damselflies Suborder: Zygoptera					
Family: Calopterygidae					
70.	<i>Neurobasis chinensis</i> (Linnaeus, 1758)	LC	√	√	√
71.	<i>Vestalis apicalis</i> Selys, 1873	LC	√	√	√
72.	<i>V. gracilis</i> (Rambur, 1842)	LC	√	√	√
73.	<i>V. submontana</i> Fraser, 1934	LC			√
Family: Chlorocyphidae					
74.	<i>Helioocypha bisignata</i> (Hagen in Selys, 1853)	LC	√	√	√
75.	<i>Libellago indica</i> (Fraser, 1928)	LC	√	√	√
Family: Coenagrionidae					
76.	<i>Aciaagrion approximans krishna</i> Fraser, 1921*	LC		√	√
77.	<i>Ac. occidentale</i> Laidlaw, 1919	LC	√		
78.	<i>Agriocnemis pieris</i> Laidlaw, 1919	LC	√	√	√
79.	<i>Ag. pygmaea</i> (Rambur, 1842)	LC	√	√	√
80.	<i>Ag. splendidissima</i> Laidlaw, 1919	LC		√	

81.	<i>Archibasis oscillans</i> (Selys, 1877)	LC	√		
82.	<i>Ceriagrion olivaceum aurantiacum</i> Fraser 1924	LC	√		
83.	<i>C. cerinorubellum</i> (Brauer, 1865)	LC	√		
84.	<i>C. chromothorax</i> Joshi & Sawant, 2019*	DD	√		
85.	<i>C. coromandelianum</i> (Fabricius, 1798)	LC	√	√	√
86.	<i>C. rubiae</i> Laidlaw, 1916	LC	√	√	√
87.	<i>Ischnura rubilio</i> Selys, 1876	LC	√		
88.	<i>Pseudagrion australasiae</i> Selys, 1876	LC	√		
89.	<i>P. decorum</i> (Rambur, 1842)	LC	√		
90.	<i>P. indicum</i> Fraser, 1924*	LC	√		
91.	<i>P. malabaricum</i> Fraser, 1924	LC	√		√
92.	<i>P. microcephalum</i> (Rambur, 1872)	LC	√		√
93.	<i>P. rubriceps</i> (Selys, 1876)	LC	√	√	√
Family: Euphaeidae					
94.	<i>Dysphaea ethela</i> Fraser, 1924	DD	√		
95.	<i>Euphaea dispar</i> (Rambur, 1842)*	LC			√
96.	<i>E. fraseri</i> (Laidlaw, 1920)*	LC	√	√	
Family: Lestidae					
97.	<i>Lestes dorothea</i> Fraser, 1924	LC	√	√	√
98.	<i>L. elatus</i> Hagen in Selys, 1862	LC	√		√
99.	<i>L. praemorsus decipiens</i> Kirby, 1893	LC	√		√
Family: Platycnemididae					
100.	<i>Caconeura ramburi</i> (Fraser, 1922)	DD			√
101.	<i>Ca. risi</i> (Fraser, 1931)*	DD	√	√	√
102.	<i>Copera marginipes</i> (Rambur, 1842)	LC	√	√	√
103.	<i>Co. vittata deccanensis</i> Laidlaw, 1917	LC	√	√	√
104.	<i>Elatoneura souteri</i> (Fraser, 1924)*	DD	√		
105.	<i>Esme longistyla</i> Fraser, 1931*	LC			√
106.	<i>Melanoneura bilineata</i> Fraser, 1922*	NT			√
107.	<i>Onychargia atrocyana</i> (Selys, 1865)	LC	√		√
108.	<i>Phylloneura westermanni</i> (Hagen in Selys, 1860)*	NT			√

109.	<i>Prodasineura verticalis annandalei</i> (Fraser, 1921)	LC	√		
Family: Platystictidae					
110.	<i>Indosticta deccanensis</i> Laidlaw, 1915*	VL		√	√
111.	<i>Protosticta francyi</i> Sadasivan, Vibhu, Nair & Palot, 2022*	NA		√	√
112.	<i>P. gravelyi</i> Laidlaw, 1915*	LC	√	√	√
113.	<i>P. mertonii</i> Fraser, 1924*	LC			√
114.	<i>P. sanguinostigma</i> Fraser, 1922*	VL		√	√
Total 114 species			99	49	66

Note: *—Endemic to Western Ghats, IUCN—Red List status, LC—Least Concern, NA—Not Assessed, DD—Data Deficient, VL—Vulnerable, NT—Near Threatened;

#Locations: A- Attamcherry (100m ASL), B- Poolakkutty (350m ASL) and C. Elapeedika (750m ASL)

studies are available. Raju (2007) reported 45 species from Kuttanad Wetlands. Adarsh *et al.* (2014) reported 52 species from Kerala Agricultural University Campus, Thrissur, while Nair (2014, 2017, per. rec.) reported 85 species from Varadoor, Kannur, South India. Further Rodrigues *et al.* (2022) reported 66 species from Kattampally wetland, Kannur. Later Chandran and Chandran (2021) reported 93 species from Aryanad Gramapanchayath with 24 WG endemics.

Considering the high rate of deforestation and the relatively low sampling effort, the NPAs could disappear before being studied, losing potential scientific, environmental and cultural richness. Due to their relatively small area and proximity to human settlements, the NPAs are also prone to be affected by several threats. Anthropogenic environmental pollution proves to be one of the most concerning human effects on the quality of the environment and biodiversity conservation (Avigliano *et al.*, 2009). As per Gray *et al.* (2006) rarefaction-based richness and endemism often do not differ significantly among unprotected and protected areas. The NPAs harbour a good number of species which are ecologically generalist and possess a good amount of ecological plasticity (Büchli and Vuilleumier, 2014; Gaynor *et al.*, 2018). The report of 114 species with 32 Western Ghat endemics from this study forms the highest Odonata diversity reported so far from any non-protected area in

Kerala. The high degree of endemism and presence of rare and narrow endemic species like *Davidioides martini* Fraser, 1924, *Elatoneura souteri* (Fraser, 1924), *Melanoneura bilineata* Fraser, 1922 etc., increase the ecological importance of the area. Moreover, the area is the type locality of *Protosticta francyi* Sadasivan, Vibhu, Nair & Palot, 2022, a recently described endemic damselfly.

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