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## COMMUNICATION

### DRAGONFLIES AND DAMSELFLIES (INSECTA: ODONATA) OF THE KOLE WETLANDS, CENTRAL KERALA, INDIA

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## Dragonflies and damselflies (Insecta: Odonata) of the Kole Wetlands, central Kerala, India

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**Abstract:** A year-long study was conducted at the Kole Wetlands, a Ramsar site in central Kerala to document the diversity of dragonflies and damselflies and understand their seasonality. Checklist survey method was used to sample adult odonates in 30 randomly chosen locations. A total of 44 species (30 dragonflies and 14 damselflies) belonging to 33 genera and eight families were recorded in the study area. Species richness showed a peak in the post-monsoon season and a dip in the summer. The observations support the value of the Kole Wetlands in providing valuable resources for Odonata.

**Keywords:** Conservation, insect diversity, Ramsar site, seasonality, wetlands.

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**Competing interests:** The authors declare no competing interests.

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**Author contribution:** SKJ and SVG designed the study. AVC and SVG collected data from the field. AVC analysed the data. AVC, SKJ and SVG wrote the paper.

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## INTRODUCTION

Insect diversity is threatened worldwide because of habitat loss, pollution, biological factors including pathogens, introduced species, and climate change (Sánchez-Bayo & Wyckhuys 2019). Because insects constitute the world's most abundant and speciose animal group and provide critical services within ecosystems, such an event cannot be ignored and should prompt decisive action to avert a catastrophic collapse of nature's ecosystems (May 2010). The situation urgently demands carrying out insect diversity studies in tropical countries like India, from where such information is lacking (Poorani & Verghese 2015). The order Odonata, popularly known as dragonflies (suborder Anisoptera) and damselflies (suborder Zygoptera) are primarily associated with wetlands and surrounding landscapes. Their adults are terrestrial/aerial and larvae are aquatic. They have been suggested as barometers for environmental change due to their sensitivity to anthropogenic stressors (Hassall 2015) and variation in habitat quality (Clark & Samways 1996). Globally, 6,312 species of odonates are known (Schorr & Paulson 2020). In India, 497 species and 27 subspecies in 154 genera and 18 families are known (Joshi & Sawant 2020; Kalkman et al. 2020; Payra et al. 2020; Subramanian & Babu 2020); 175 species of odonates have been recorded from Kerala till date (Society for Odonate Studies 2020).

The wetlands in Kerala are subjected to acute pressure owing to rapid developmental activities and indiscriminate utilization of land and water. The major issues facing the wetlands of Kerala are pollution, eutrophication, encroachment, reclamation, mining, and biodiversity loss (Kokkal et al. 2008). The Kole Wetlands is a Ramsar site since 2002 (Islam & Rahmani 2008), an important bird area since 2004 (Islam & Rahmani 2004), and a high value biodiversity area since 2009 (MoEF 2009). The Kole wetlands are low-lying tracts located 0.5–1 m below the mean sea level. Wetland agriculture, mainly paddy cultivation is the most important activity undertaken in these wetlands. The name Kole in the regional language Malayalam indicates bumper yield or high returns under favourable conditions (Srinivasan 2012). Kole is a biodiversity-rich agro-ecosystem and the flora (Sujana & Sivaperuman 2008), avifauna (Nameer 2002), herpetofauna (Sreehari 2009), and butterflies (Sarath et al. 2017) of the area have been well documented. This is the first attempt to document the odonate diversity of the Kole Wetlands.

## METHODS

### Study area

The Kole wetlands are spread over Thrissur and Malappuram districts in Kerala, covering an area of 13,632ha. Extending from the northern bank of Chalakudy River in the south to the southern bank of Bharathapuzha River in the north, this area lies between 10.3333°–10.6666°N & 75.9666°–76.1833°E (Johnkutty & Venugopal 1993). A unique feature of the Kole lands is that they remain submerged under floodwater for about six months in a year during the southwest monsoon. The Kole wetlands are split into three regions by the rivers draining them – Ponnani Kole lies to the north of Kecherypuzha; Thrissur North Kole lies in between Kecherypuzha and Karuvannur rivers; and Thrissur South Kole lies to the south of Karuvannur River (Figure 1). Even though they are human-modified ecosystems, Kole wetlands offer a variety of microhabitats for odonates (Image 1).

The study was conducted from February 2019 to February 2020. Thirty sampling locations were chosen randomly intending maximum spatial coverage of the Kole wetlands. Nine sampling locations each were chosen in Ponnani Kole and Thrissur South Kole. The more extensive Thrissur North Kole was assigned 12 sampling locations. One sampling location in each of the three regions of the Kole wetlands was visited every month. The others were visited as frequently as possible (Table 1). The checklist survey method was adopted for the study (Royer et al. 1998). In every site, the observer searched all the available microhabitats for an hour and recorded the species encountered. All the field visits were made between 09.00h and 11.00h when the adult odonates were observed to be most active (A. Vivek Chandran pers. obs. 01.ii.2019). Individuals encountered were photographed and identified referring to taxonomic monographs (Fraser 1933, 1934, 1936) and field guides (Subramanian 2005, 2009; Kiran & Raju 2013). Species which could not be identified readily in the field were caught using a sweeping net, their detailed photographs taken and released back. Systematic arrangement and taxonomy followed in the checklist is after Subramanian et al. (2018). The odonate species were categorized into five relative frequency classes, based on the proportion of their occurrence per sampling visit (Adarsh et al. 2014). The categories include very common (80%–100%), common (60%–80%), occasional (40%–60%), rare (20%–40%), and very rare (<20%). The study period was divided into three seasons for data analysis—summer (February, March, April, & May), monsoon (June, July,

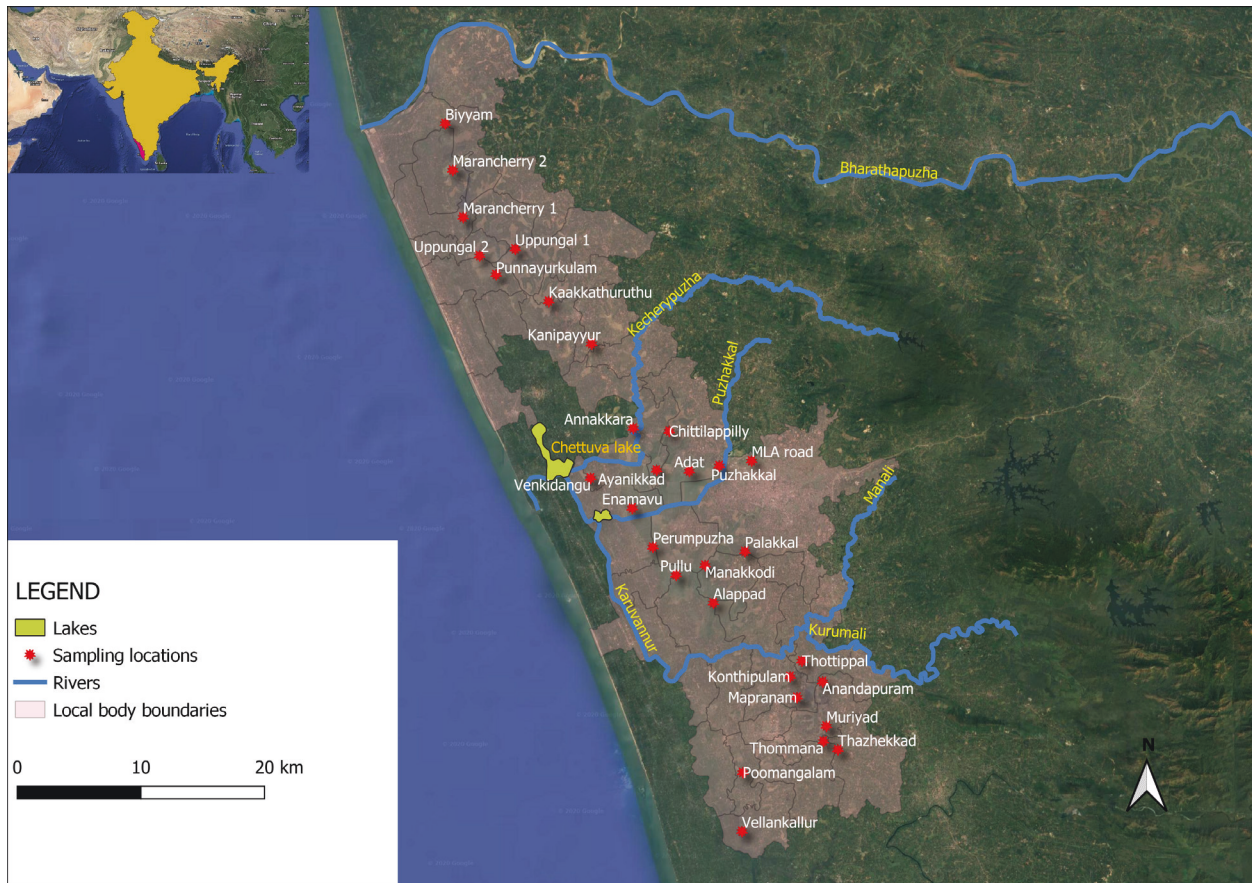


Figure 1. Study area: Kole wetlands, Kerala.

August, & September), and post-monsoon (October, November, December, & January).

## RESULTS AND DISCUSSION

A total of 44 species of Odonata—30 dragonflies and 14 damselflies, belonging to eight families—were recorded from the Kole wetlands in the study (Table 2). Families Libellulidae (25 species) and Coenagrionidae (11 species) dominated while families Macromiidae, Lestidae, Chlorocyphidae, and Platycnemididae had only single species representatives. The relative frequency categorization shows that 13 species were very common, six common, six occasional, one rare, and 18 very rare. Species richness was highest in the post-monsoon season and lowest in the summer season.

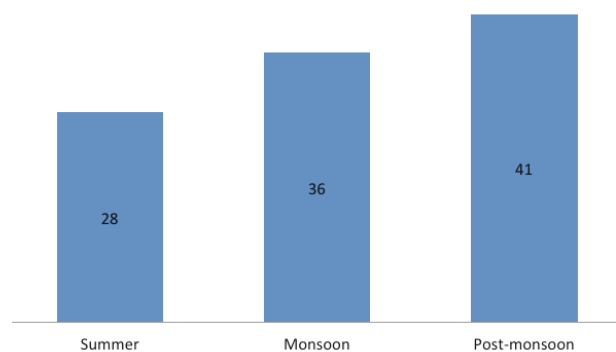
One-fourth (25.14%) of the total number of odonate species known to occur in Kerala were recorded from the Kole wetlands in the present study. A similar study in the temporary water bodies of Coimbatore recorded only 21 species (Arulprakash & Gunathilagaraj

2010), but 52 species were recorded from the Kerala Agricultural University (Adarsh et al. 2014). Even though it is subjected to large fluctuation in the water level, the Kole wetlands never dry up completely in any time of the year. Clearly, this is advantageous to the odonates and explains their greater diversity when compared to temporary water bodies. These wetlands, however, lack shaded habitats and hence supports less number of species than the more habitat diverse Kerala Agricultural University campus. The relatively lesser number of damselfly species recorded from the Kole wetlands could be due to the scarcity of shade. Shade and spread of aquatic vegetation favour damselflies more than dragonflies (Fraser 1933; Subramanian 2005). Even though the field visits were made during day time, crepuscular species like *T. tillarga* and *Z. petiolatum* could be recorded as they were seen perched on tall grasses or in shaded places. Some species were observed to be microhabitat-specific. This included *P. calamorum* (Image 1), which occurred only in ponds with hydrophytes (all eight encounters in the study) and *C. marginipes* which could be observed only in shaded

**Table 1. Sampling locations in Kole wetlands, Kerala.**

Name of the site	Latitude	Longitude	Elevation (m)	Microhabitats	No. of visits made	Species richness
Puzhakkal	10.5415°N	76.1780°E	-1	B, E, F	12	19
Adat	10.5557° N	76.1477°E	-1	B, C, F	10	14
MLA road	10.5450°N	76.1963°E	1	C, D	10	11
Ayanikkad	10.5348°N	76.1277°E	0	A, C, D, F	11	18
Chittilappilly	10.5627°N	76.1358°E	-1	B, D, F	9	15
Annakkara	10.5623°N	76.1047°E	0	C, E, F	10	15
Enamavu	10.4724° N	76.1333°E	-2	B, C, F	9	13
Venkidangu	10.5270°N	76.1125°E	0	B, D, E, F	8	15
Perumpuzha	10.4821°N	76.1272°E	-1	B, C, D, F	9	19
Palakkal	10.4753°N	76.2022°E	-2	A, B, C, D, F	10	25
Manakkodi	10.4872°N	76.1733°E	-1	A, D, F	11	12
Pullu	10.4590°N	76.1455°E	-1	B, C, F	11	19
Alappad	10.4350°N	76.1702°E	-1	C, D, F	8	13
Thottipal	10.4033°N	76.2427°E	1	A, C, D, E	10	26
Konthipulam	10.3878°N	76.2366°E	0	A, F	12	22
Anandapuram	10.3806°N	76.2597°E	1	C, D	9	15
Mapranam	10.3634°N	76.2302°E	-1	B, C, D	11	19
Muriyad	10.3538°N	76.2591°E	0	A, B, C, D, F	10	23
Thommana	10.3397°N	76.2505°E	-1	A, C, F	9	28
Thazhekad	10.3306°N	76.2652°E	1	B, C, E, F	9	23
Poomangalam	10.3078°N	76.1861°E	0	B, C, E	8	16
Vellankallur	10.2951°N	76.2100°E	1	A, B, D, F	8	23
Kanipayyur	10.6565°N	76.0627°E	0	C, D, E	9	16
Kaakkathuruthu	10.6549°N	76.0475°E	-2	C, D, E	9	16
Punnayurkulam	10.6912°N	76.9986°E	-3	A, C, F	12	20
Uppungal 1	10.6942°N	76.0086°E	-3	A, B, C, F	10	22
Uppungal 2	10.6901°N	76.9977°E	-3	A, B, C, F	11	25
Marancherry 1	10.7380°N	75.9772°E	0	A, C, F	9	14
Marancherry 2	10.7395°N	75.9983°E	-3	A, C, E, F	8	20
Biyyam	10.7817°N	75.9727°E	0	A, E, F	8	16

areas of groves at the edge of Kole wetlands (all three encounters in the study). Species which showed such micro-habitat specificity were very rare. On the other hand, species such as *B. contaminata*, *R. variegata*, and *O. sabina* were seen in all microhabitats. They were the very common species. The number of migratory *P. flavescens* (Image 2) peaked in the months of October and November when hundreds could be seen foraging over the wetlands. The presence of species such as the endemic *A. keralensis* (Image 3) and the rare *Platylestes platystylus* (Image 4) (Emiliyamma et al. 2020) which was only recently recorded from peninsular India (Rison



**Figure 2. Species richness: number of odonate species recorded in each season.**



Image 1. Microhabitats of Kole wetlands: A—Vegetated pond | B—Canal | C—Paddyfield with herb growth | D—Tall grass beds | E—Groves at the edge | F—Flooded area. © A. Vivek Chandran.

**Table 2. Checklist of Odonata recorded from Kole wetlands, central Kerala, India.**

	Name of the species	Common English name	Relative frequency in Kole wetlands	Endemicity	IUCN Red List status
	<b>Class: Insecta</b>				
	<b>Order: Odonata</b>				
	<b>Suborder: Anisoptera</b>				
	<b>Family: Aeshnidae</b>				
1	<i>Anax guttatus</i> (Burmeister, 1839)	Pale-spotted Emperor	VR	-	LC
2	<i>Anax indicus</i> Lieftinck, 1942	Lesser Green Emperor	VR	-	LC
	<b>Family: Gomphidae</b>				
3	<i>Ictinogomphus rapax</i> (Rambur, 1842)	Indian Common Clubtail	C	-	LC
4	<i>Paragomphus lineatus</i> Selys, 1850	Common Hooktail	VR	-	LC
	<b>Family: Macromiidae</b>				
5	<i>Epophthalmia vittata</i> Burmeister, 1839	Common Torrent Hawk	VR	-	LC
	<b>Family: Libellulidae</b>				
6	<i>Acisoma panorpoides</i> Rambur, 1842	Trumpet Tail	VC	-	LC
7	<i>Aethriamanta brevipennis</i> (Rambur, 1842)	Scarlet Marsh Hawk	O	-	LC
8	<i>Brachydiplax chalybea</i> Brauer, 1868	Rufous-backed Marsh Hawk	VC	-	LC
9	<i>Brachydiplax sobrina</i> (Rambur, 1842)	Little Blue Marsh Hawk	O	-	LC
10	<i>Brachythemis contaminata</i> (Fabricius, 1793)	Ditch Jewel	VC	-	LC
11	<i>Bradinopyga geminata</i> (Rambur, 1842)	Granite Ghost	VR	-	LC
12	<i>Crocothemis servilia</i> (Drury, 1770)	Ruddy Marsh Skimmer	VC	-	LC
13	<i>Diplacodes nebulosa</i> (Fabricius, 1793)	Black-tipped Ground Skimmer	VR	-	LC
14	<i>Diplacodes trivialis</i> (Rambur, 1842)	Ground Skimmer	VC	-	LC
15	<i>Hydrobasileus croceus</i> (Brauer, 1867)	Amber-winged Marsh Glider	C	-	LC
16	<i>Lathrecista asiatica</i> (Fabricius, 1798)	Asiatic Bloodtail	VR	-	LC
17	<i>Neurothemis tullia</i> (Drury, 1773)	Pied Paddy Skimmer	VC	-	LC
18	<i>Orthetrum chrysis</i> (Selys, 1891)	Brown-backed Red Marsh Hawk	VR	-	LC
19	<i>Orthetrum pruinosum</i> (Burmeister, 1839)	Crimson-tailed Marsh Hawk	VR	-	LC
20	<i>Orthetrum Sabina</i> (Drury, 1770)	Green Marsh Hawk	VC	-	LC
21	<i>Pantala flavescens</i> (Fabricius, 1798)	Wandering Glider	VC	-	LC
22	<i>Potamarcha congener</i> (Rambur, 1842)	Yellow-tailed Ashy Skimmer	VR	-	LC
23	<i>Rhodothemis rufa</i> (Rambur, 1842)	Rufous Marsh Glider	VC	-	LC
24	<i>Rhyothemis variegata</i> (Linnaeus, 1763)	Common Picturewing	VC	-	LC
25	<i>Tholymis tillarga</i> (Fabricius, 1798)	Coral-tailed Cloudwing	O	-	LC
26	<i>Tramea limbata</i> (Desjardins, 1832)	Black Marsh Trotter	O	-	LC
27	<i>Trithemis aurora</i> (Burmeister, 1839)	Crimson Marsh Glider	VR	-	LC
28	<i>Trithemis pallidinervis</i> (Kirby, 1889)	Long-legged Marsh Glider	C	-	LC
29	<i>Urothemis signata</i> (Rambur, 1842)	Greater Crimson Glider	VC	-	LC
30	<i>Zyxomma petiolatum</i> Rambur, 1842	Brown Dusk Hawk	VR	-	LC



	Name of the species	Common English name	Relative frequency in Kole wetlands	Endemicity	IUCN Red List status
	<b>Suborder: Zygoptera</b>				
	<b>Family: Lestidae</b>				
31	<i>Platylestes platystylus</i> (Rambur, 1842)	Green-eyed Spreadwing	VR	-	LC
	<b>Family: Coenagrionidae</b>				
32	<i>Aciagrion occidentale</i> Laidlaw, 1919	Green-striped Slender Dartlet	VR	-	LC
33	<i>Agriocnemis keralensis</i> Peters, 1981	Kerala Dartlet	C	EN WG	LC
34	<i>Agriocnemis pygmaea</i> (Rambur, 1842)	Pygmy Dartlet	VC	-	LC
35	<i>Ceriagrion cerinorubellum</i> (Brauer, 1865)	Orange-tailed Marsh Dart	C	-	LC
36	<i>Ceriagrion coromandelianum</i> (Fabricius, 1798)	Coromandel Marsh Dart	C	-	LC
37	<i>Ischnura rubilio</i> Selys, 1876	Western Golden Dartlet	O	-	NE
38	<i>Ischnura senegalensis</i> (Rambur, 1842)	Senegal Golden Dartlet	O	-	LC
39	<i>Paracercion calamorum</i> (Ris, 1916)	Dusky Lilly-squatter	VR	-	LC
40	<i>Pseudagrion australisae</i> Selys, 1876	Look-alike Sprite	R	-	LC
41	<i>Pseudagrion decorum</i> (Rambur, 1842)	Three-lined Dart	VR	-	LC
42	<i>Pseudagrion microcephalum</i> (Rambur, 1842)	Blue Grass Dart	VC	-	LC
	<b>Family: Chlorocyphidae</b>				
43	<i>Libellago indica</i> (Fraser, 1928)	Southern Heliodor	VR	EN P	NE
	<b>Family: Platycnemididae</b>				
44	<i>Copera marginipes</i> (Rambur, 1842)	Yellow Bush Dart	VR	-	LC

Relative frequency classes: VC—Very Common | C—Common | O—Occasional | R—Rare | VR—Very rare. IUCN status: LC—Least Concern | NE—Not Evaluated. Endemicity: EN WG—Endemic to the Western Ghats | EN P—Endemic to peninsular India.



Image 2. *Paracercion calamorum*.



Image 3. *Pantala flavescens*.

& Chandran 2020) proclaim the importance of these wetlands as odonate habitats. The maximum number of species detected in the study (18) belonged to the very rare relative frequency class. This is suggestive of the utility of the survey method to detect species occurring in low abundances. It has to be noted that none of the odonate species recorded in the study is protected under the Wildlife Protection Act of 1972 (MoEF 2019)

and all except two are listed as Least Concern species by the International Union for the Conservation of Nature and Natural Resources (IUCN 2020). The conservation of their wetland habitats is the only way to conserve these species. Our study presents the Odonata list of these wetlands for the first time and adds to the knowledge of insect fauna of India. The Kole wetlands provide



Image 4. *Agriocnemis keralensis*.



Image 5. *Platylestes platystylus*.



Image 6. *Pseudagrion australasiae* (dorsal and left lateral views of anal appendages in inset).

immense opportunities for ecological and behavioural studies of Odonata as many of the common species are present in large numbers and can be easily observed. The Kole wetlands are plagued by the problem of pollution due to the inflow of untreated sewage and indiscriminate use of pesticides in agriculture (Sujana & Sivaperuman 2008; Jayson 2018). These wetlands provide an ideal opportunity to study the response of odonates to varying degrees of pollution.

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