



Additions to the Odonata (Insecta) of Goa

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Author Contribution: PR Data collection, identification of specimen, photo-documentation and manuscript writing; MB Identification of specimen and editing of manuscript; OD Data collection, identification of specimen and photo-documentation.

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Abstract: The study reports the results from surveys for Odonates in the State of Goa over 19 months during 2007-2008. A total of 66 species of Odonates were documented with 34 new species records from the State. The present study has resulted in an increase of 47.30% in the number of species reported from Goa to 74 from the existing 39. Family Libellulidae dominated the odonate community with 32 species followed by Coenagrionidae with 14 species. *Orthetrum sabina* was the most abundant species while seven species were documented only once during the survey period. More survey effort are needed to completely document the odonate species diversity of the state.

Keywords: Anisoptera, Goa, new records, Zygoptera

INTRODUCTION

Goa lies between latitudes 14°53'-15°48'N & 73°45'-74°24'E, covering an area of 3,701km². Tucked between the Western Ghats and the Arabian Sea, it has a warm tropical climate with temperature ranging from 31°C to 21°C. Humidity throughout the year is high, the average being 86%. The southwest monsoons operate over the entire state registering an annual rainfall of around 300-400 cm.

The complete eastern stretch is under legal protection in the form of four wildlife sanctuaries and one national park. Serious taxonomic work to document the diversity of this small state though, has been found wanting. Sporadic efforts limited to certain taxa have been carried out by researchers and premier organizations like the Zoological Survey of India. Unfortunately, with the exception of Lepidoptera (Rhopalocera) and to some extent Odonata and Arachnida, other lesser known fauna have been neglected. For that matter, earlier studies on Odonata of the state were based on limited samples and does not cover the entire state and all seasons (Prasad 1995).

The Odonata diversity is well documented from the rest of the country after the pioneering work by Fraser (1936). The first peer reviewed work for the State of Goa was by Prasad (1995) wherein 22 species of Odonates were reported. The Fauna of Goa: State Fauna Series (2008) by Zoological Survey of India added another 17 species to the list by Prasad, thereby increasing the total species count to 39. In between these two reports Borkar et al. (2006) gave an account of Odonata in the campus of the Carmel College for Women in Salcette Taluka wherein 16 species not reported earlier were reported. This paper somehow did not figure in the compilation by the Zoological Survey of India, thereby ten species new to the state were not reported in the State Fauna Series, an anomaly that needs to be taken cognizance of for realistic assessment of status of odonate diversity.

A total of 499 species and subspecies of Odonata are known to occur in India (Prasad & Varshney 1995) out of which about 200 species are recorded from peninsular India, thereby highlighting the fact that the 39 species recorded for the state is an underestimate.

The present paper provides updated information on the diversity and

distribution of Odonata of Goa, based on extensive surveys from May 2007 to December 2008. The need to address gaps in information on Odonate diversity of Goa has been highlighted in the Goa State Biodiversity Strategy Action Plan (GSBSAP)

METHODS

Surveys were conducted throughout the state to cover varied habitats ranging from mountain streams, inland water bodies, paddy-field to marsh lands. The locations visited and the associated habitats are presented in Table 1. The survey locations are also marked on the state map

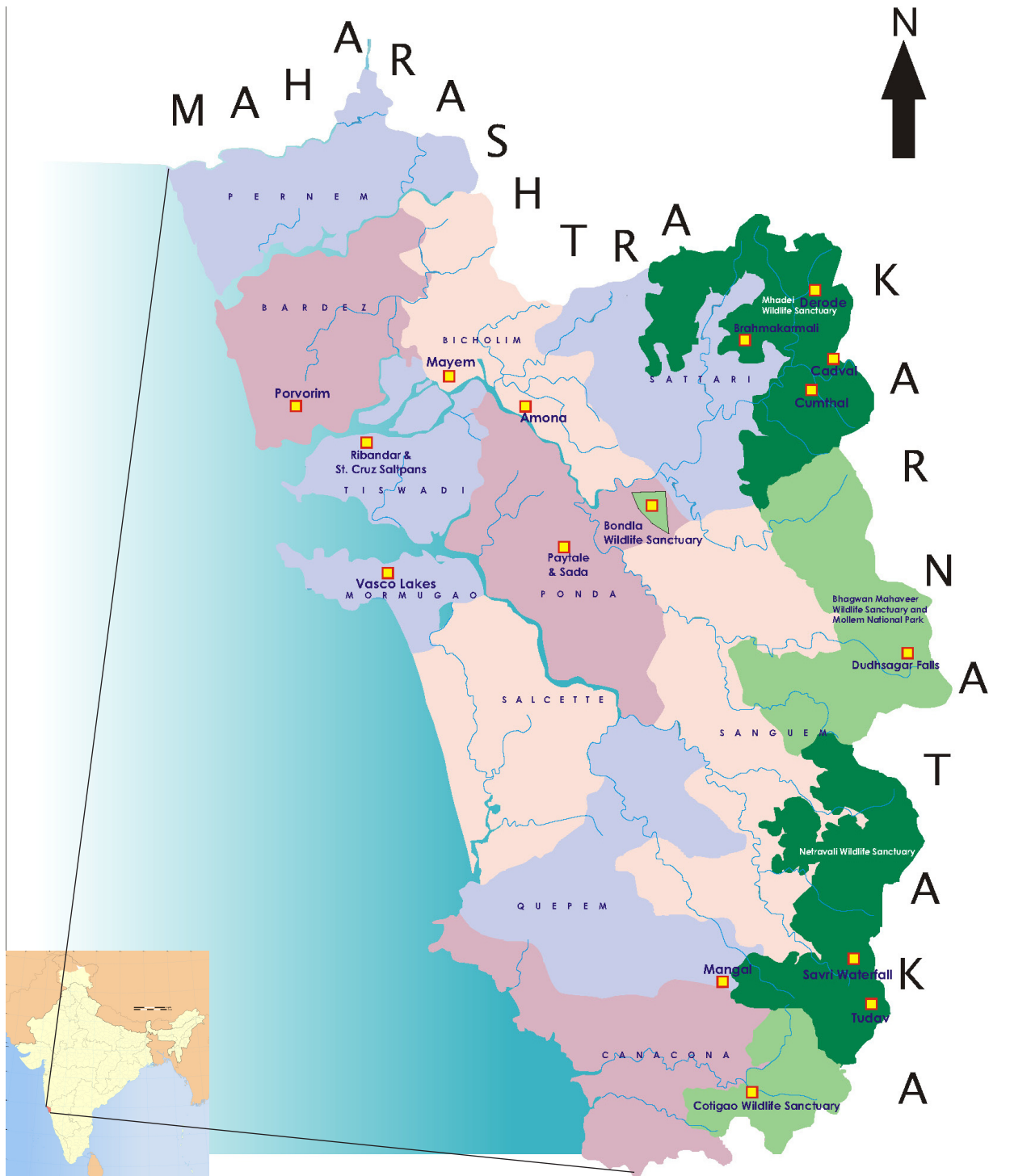


Image 1. The survey locations are marked on the state map

for easy reference (Image 1).

A total of 38 surveys were conducted in these locations to document the Odonata diversity. Observations were done over three seasons: Monsoons (June - September), Winter (October - January) and Summer (February - May) in the year 2007-08. Individual specimens were photo-documented from various angles and these images were cross-checked with identification manuals for identification. Collection and killing was avoided for species which could be visually identified. For difficult species, specimens were caught using sweep nets and collected in paper envelopes. The specimens were kept alive to let them excrete and clear their gut before being treated in acetone solution at the end of the day. Larger species were treated for 10-12 hours while smaller species, especially damselflies were treated for 7-8 hours before drying in the shade and then preserved in air-tight plastic envelopes properly labeled with the name of collector, date of collection, habitat and in few instances the latitude and longitude co-ordinates. The collected specimens were identified using standard field guides (Fraser 1933, 1934, 1936; Subramanian 2005). Systematic arrangement of the species follows Subramanian (2009).

Occurrence frequency was calculated by plotting the occurrence of individual species at the each sampling locations. A presence-absence matrix gave an indication of the most abundant species over the sampling locations and over varied habitats.

RESULTS AND DISCUSSIONS

In the field study spanning 20 months, 66 species of odonates belonging to 12 families were documented from Goa. The results are presented in Table 2. In Zygoptera, the family Coenagrionidae dominated the list with 14 species followed by Calopterygidae (3), Platystictidae (3), Platynemidae (2), Chlorocyphidae (2), Protoneuridae (1), Euphaeidae (2) and Lestidae (1) (Fig. 1). In Anisoptera, the family Libellulidae dominated the list with 32 species followed by Gomphidae (3), Aeshnidae (2) and Cordulidae (1) (Fig. 2). Of all the families, the maximum contribution to the species diversity was found in Libellulidae accounting to 47.76% followed by Coenagrionidae which contributed 20.89% of the total species. This is a general trend which can be attributed to the presence of habitat generalist species in the above families.

The most significant finding has been reports of 34 species and four families for the first time from the state of Goa. Three Species reported by Borkar et al (2006) but not reported by ZSI or documented during the present study have not been included since they were documented prior to the present investigation period and hence are beyond the scope of the present study, though it is felt that the findings have significant scientific value. The four new families viz., Platystictidae, Euphaeidae, Cordulidae, Aeshnidae include species which are mainly found in and around water bodies in areas with good forest cover. The absence of species representing these families in the previous studies suggests overlooking of such areas in the surveys, which is evident from the locations mentioned in the respective papers. The present study has resulted in

Table 1. Locality, associated habitats and number of surveys

	Locality name	District	Habitat	No. of species observed	Number of surveys
1.	Mangal	Quepem	Mountain village	05	01
2.	Savri Waterfall	Sanguem	Mountain stream	18	03
3.	Bhramkarmali	Sattari	Swamp forest	06	02
4.	Cumthal	Sattari	Forest stream	05	01
5.	Dudhsagar Falls	Sanguem	Mountain stream	13	03
6.	Vasco Lakes	Mormugao	Marsh Land	16	03
7.	Mayem	Bicholim	Village streams, paddy field	19	04
8.	Tudav	Sanguem	Mountain stream	07	01
9.	Cadval	Sattari	Forest stream	07	02
10.	Paytale Lake & Sada	Ponda	Forest lake & Lateritic plateau	23	04
11.	Cotigao	Canacona	Forest streams and river	15	02
12.	Porvorim	Bardez	Marsh Land	12	02
13.	Derode	Sattari	Forest stream	22	04
14.	Amona	Bicholim	Paddy fields & Marsh Land	07	01
15.	St. Cruz & Ribandar	Tiswadi	Marsh Land	10	01
16.	Bondla	Ponda	Forest stream	25	04

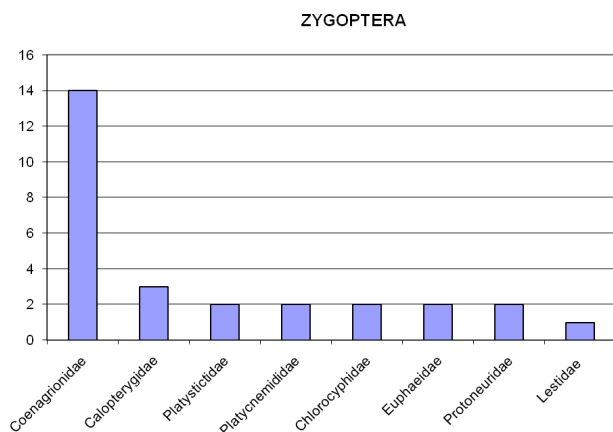


Figure 1. Family contribution under Sub-Order Zygoptera to odonate diversity of Goa

a staggering increase of 47.30% in the number of species reported from the Goa to 74 from the existing 39. The new records are marked with an asterisk in Table 2.

Orthetrum sabina was the most abundant species with an occurrence frequency of 81.25% followed by *Diplacodes trivialis* & *Pantala flavescens* (75%). *Orthetrum glaucum* was a close fourth with an occurrence frequency of 50%. These results indicate a fairly well distributed population of the above species in the entire state and also in varied habitats. Seven species viz., *Mortonagrion varalli*, *Agriocnemis splendidissima*, *Agriocnemis femina*, *Hylaeothemis indica*, *Idionyx saffronata*, *Neurothemis intermedia*, *Palpopleura sexmaculata* were documented only once during the survey period. The details are shown in Table 2.

Table 1 indicates that the maximum diversity was observed at Bondla (25 species) followed by Paytale (23) and Derode (22). This could also be attributed to the survey effort since at all these sites maximum surveys were conducted (4 times). Paytale and the surrounding areas in Ponda Taluka are of conservation importance since the site not only holds a good diversity of odonates but two of the seven species documented only once during the period were documented from this site.

It was also observed that the maximum diversity was found during the monsoon season wherein 46 species were documented followed by winter (43) and summer (29). This is in accordance with the life history of odonates and their dependence on water bodies. *Idionyx saffronata* and *Mortonagrion varalli* were recorded only in the monsoons, *Palpopleura sexmaculata* was recorded only in winter, while *Lathresticta asiatica* was recorded only in summer. The Kerala Dartlet *Agriocnemis cf. keralensis* hitherto known and reported only from Kerala where it was considered endemic, has been documented from the state, thereby indirectly suggesting its presence in the states of Karnataka and Tamil Nadu. This species was identified in consultation with David Raju, Naturalist, Taj & CC Africa.

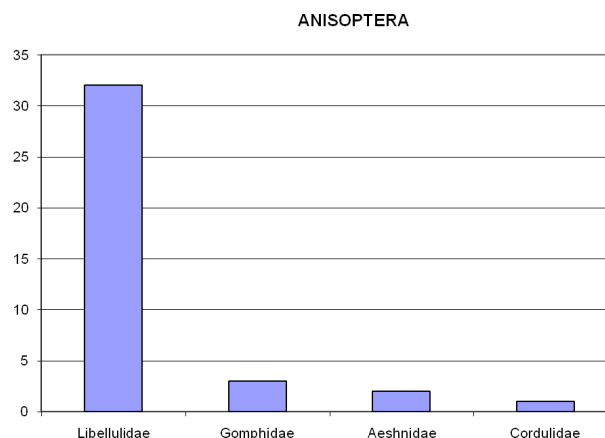


Figure 2. Family contribution under Sub-order Anisoptera to odonate diversity of Goa

Except *Aciagrion hisopa*, *Aciagrion pallidum*, *Agriocnemis lacteola*, *Enallagma parvum*, *Pseudagrion malabaricum*, *Ellatoneura tetrica* and *Lestes viridulus* listed by Kulkarni & Talmale (2008) from the Fauna of Goa, all other species were recorded in the present study.

Though the present study covers varied habitats in the state of Goa, the authors are conscious of the fact that more extensive surveys are needed along the water bodies throughout the state and especially in the network of protected areas to understand seasonality and flight periods. Biodiversity surveys still largely focus on larger animals, especially vertebrates and even the biodiversity hotspot status of the Western Ghats is based largely on data pertaining to vertebrates and flowering plants, as data on invertebrates is insufficient or non-existent (Meyers et al. 2000). The present work is expected to be the foundation on which academicians and researchers will undertake more systematic surveys and studies on habitat requirement of these "indicator" species.

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Table 2. Systematic list of Odonata from Goa with their occurrence matrix (May 2007 - November 2008)

	Species Name	Mangal	Savri Waterfall	Brahmakarmali	Cumthal	Dudhsagar	Vasco	Mayem	Tudav	Cadval	Paytale & Sada	Cotigao	Porvorim	Derode	Amona	St. Cruz & Ribandar	Bondla
Order: Zygoptera																	
Family: Coenagrionidae																	
1	<i>Aciagrion occidentale</i> Laidlaw, 1919	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
2	<i>Agriocnemis</i> cf. <i>keralensis</i> Peters, 1981* (Image 2)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
3	<i>Agriocnemis pieris</i> Laidlaw, 1919	-	+	-	-	-	-	+	-	-	-	-	-	+	-	-	-
4	<i>Agriocnemis femina</i> Brauer, 1868* (Image 3)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
5	<i>Agriocnemis pygmea</i> Rambur, 1842	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-	+
6	<i>Agriocnemis splendidissima</i> Laidlaw, 1919* (Image 4)	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
7	<i>Ceriagrion cerinorubellum</i> Brauer, 1865	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-
8	<i>Ceriagrion coromandelianum</i> , Fabricius, 1798	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	+
9	<i>Ceriagrion olivaceum</i> Laidlaw, 1914* (Image 5)	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-
10	<i>Ischnura aurora</i> Brauer, 1865	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-
11	<i>Ischnura senegalensis</i> Rambur, 1842* (Image 6)	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	+
12	<i>Mortonagrion varralli</i> Fraser, 1920	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
13	<i>Pseudagrion indicum</i> Fraser, 1924	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
14	<i>Pseudagrion microcephalum</i> Rambur, 1842	-	-	-	-	-	-	+	-	-	+	+	-	-	-	-	+
Family: Platycnemididae																	
15	<i>Copera marginipes</i> Rambur, 1842	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-
16	<i>Copera vittata</i> Selys, 1863*	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	+
Family: Platystictidae																	
17	<i>Protosticta gravelyi</i> Laidlaw, 1915* (Image 7)	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
18	<i>Protosticta hearseyi</i> Fraser, 1922*	-	-	-	-	+	-	-	-	-	+	-	-	+	-	-	-
Family: Protoneuridae																	
19	<i>Prodasineura verticalis</i> Selys, 1860*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
20	<i>Disparoneura quadrimaculata</i> Rambur, 1842* (Image 8)	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-

	Species Name	Mangal	Savri Waterfall	Brahmakarmali	Cumthal	Dudhsagar	Vasco	Mayem	Tudav	Cadval	Paytale & Sada	Cotigao	Porvorim	Derode	Amona	St. Cruz & Ribandar	Bondla	
Family: Lestidae																		
21	<i>Lestes elatus</i> Hagen in Selys, 1862	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	
Family: Calopterygidae																		
22	<i>Neurobasis chinensis</i> Linnaeus, 1758	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	
23	<i>Vestalis apicalis</i> Selys, 1879	-	-	+	-	+	-	-	-	-	-	+	-	+	-	-	-	
24	<i>Vestalis gracilis</i> Rambur, 1942	-	+	-	-	+	-	-	-	-	+	+	-	+	-	-	+	
Family: Cholocyphidae																		
25	<i>Libellago lineata</i> Burmeister, 1839	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	
26	<i>Rhinocypha bisignata</i> Hagen in Selys, 1853	-	+	-	-	+	-	-	-	-	-	+	-	-	-	-	+	
Family: Euphaeidae																		
27	<i>Euphaea fraseri</i> Laidlaw, 1920* (Image 9)	-	+	-	-	+	-	-	-	-	+	+	-	+	-	-	-	
28	<i>Dysphaea ethela</i> Fraser, 1924*	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-	
Sub-Order: Anisoptera																		
Family: Gomphidae																		
29	<i>Heliogomphus promelas</i> Selys, 1873* (Image 10)	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-	-	
30	<i>Ictinogomphus rapax</i> Rambur, 1842*	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	+	
31	<i>Paragomphus lineatus</i> Selys, 1850	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	
Family: Aeshnidae																		
32	<i>Anax guttatus</i> Burmeister, 1839*	-	-	-	-	-	-	+	-	-	+	-	-	-	-	+	-	
33	<i>Gynacantha bayadera</i> Selys, 1891*	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	
Family: Corduliidae																		
34	<i>Idionyx saffronata</i> Fraser, 1924*	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	
Family: Libellulidae																		
35	<i>Acisoma panorpoides</i> Rambur, 1842* (Image 11)	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	
36	<i>Brachythemis contaminata</i> Fabricius, 1973	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	
37	<i>Bradinopyga geminata</i> Rambur, 1842*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+	

	Species Name	Mangal	Savri Waterfall	Brahmakarmali	Cumthal	Dudhsagar	Vasco	Mayem	Tudav	Cadval	Paytale & Sada	Cotigao	Porvorim	Derode	Amona	St. Cruz & Ribandar	Bondla
38	<i>Cratilla lineata</i> Foerster, 1903* (Image 12)	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-
39	<i>Crocothemis servilia</i> Druru, 1770	-	-	-	+	-	+	-	-	-	+	+	-	-	+	+	+
40	<i>Diplacodes trivialis</i> Rambur, 1842	+	+	-	-	+	+	+	-	+	-	+	+	+	+	+	+
41	<i>Hydrobasileus croceus</i> Brauer, 1867*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
42	<i>Hylaeothemis indica</i> Fraser, 1946*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
43	<i>Indothemis carnatica</i> Fabricius, 1798* (Image 13)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
44	<i>Lathrecista asiatica</i> Fabricius, 1798*	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-
45	<i>Neurothemis fulvia</i> Druru, 1773	-	+	-	-	+	-	-	-	-	+	-	-	+	+	-	-
46	<i>Neurothemis intermedia</i> Rambur, 1842	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
47	<i>Neurothemis tullia</i> Drury, 1773	-	-	+	-	-	+	+	-	-	+	-	+	-	-	+	+
48	<i>Orthetrum chrysis</i> Selys, 1891* (Image 14)	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	+
49	<i>Orthetrum glaucum</i> Brauer, 1865	-	+	-	+	-	+	+	+	+	-	-	-	+	+	-	-
50	<i>Orthetrum pruinatum</i> Rambur, 1842	+	+	-	+	-	+	-	+	-	-	-	-	+	-	-	+
51	<i>Orthetrum luzonicum</i> Brauer, 1868*	-	-	+	-	-	-	+	-	-	+	-	-	-	-	-	-
52	<i>Orthetrum taeniolatum</i> Schneider, 1845	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
53	<i>Orthetrum sabina</i> Drury, 1770	+	+	+	-	-	+	+	+	+	+	+	+	-	+	+	+
54	<i>Potamarcha congener</i> Rambur, 1842	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+
55	<i>Palpopleura sexmaculata</i> Fabricius, 1787* (Image 15)	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
56	<i>Pantala flavescens</i> Fabricius, 1798	+	-	-	+	+	+	-	-	+	+	+	+	+	+	+	+
57	<i>Rhodothemis rufa</i> Rambur, 1842*	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-
58	<i>Rhyothemis variegata</i> Linnaeus, 1763* (Image 16)	-	-	-	-	-	+	+	-	-	-	-	-	-	-	+	-
59	<i>Tetrathemis platyptera</i> Selys, 1878* (Image 17)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
60	<i>Tholymis tillarga</i> Fabricius, 1798	-	+	-	-	-	-	+	-	-	-	-	-	+	-	+	-
61	<i>Tramea basilaris</i> Palisot de Beauvois, 1805*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+
62	<i>Tramea limbata</i> * Desjardins, 1832	-	-	-	-	-	+	-	-	-	+	-	-	-	-	+	+
63	<i>Trithemis aurora</i> Burmeister, 1839	-	+	-	+	+	-	+	+	-	-	-	-	+	-	-	-

	Species Name	Mangal	Savri Waterfall	Brahmakarmali	Cumthal	Dudhsagar	Vasco	Mayem	Tudav	Cadval	Paytale & Sada	Cotigao	Porvorim	Derode	Amona	St. Cruz & Ribandar	Bondla
64	<i>Trithemis festiva</i> Rambur, 1842	-	-	-	-	-	-	+	+	-	+	+	-	+	-	-	-
65	<i>Trithemis pallidinervis</i> Kirby, 1889*	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-
66	<i>Zyxomma petiolatum</i> Rambur, 1842*	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	+

* New records for the State of Goa



Image 2. *Agriocnemis keralensis*



Image 3. *Agriocnemis femina*



Image 4. *Agriocnemis splendissima*



Image 5. *Ceragrion olivaceum*



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Image 6. *Ischnura senegalensis*



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Image 7. *Protosticta graveleyi*



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Image 8. *Disparoneura quadrimaculata*



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Image 9. *Euphea fraseri*



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Image 10. *Heliogomphus promelas*



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Image 11. *Acisoma panorpoides*



Image 12. *Cratilla lineata*



Image 13. *Indothemis carnatica*



Image 14. *Orthetrum chrysis*



Image 15. *Palpopleura sexmaculata*



Image 16. *Rhythemis varieagata*



Image 17. *Trithemis pallidinervis*

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