



Indian Odonata: Diversity, Ecology, and Conservation Challenges

Ranjana Goswami, Divya Rawat and Chandra Singh Negi*

Ecology and Biodiversity Laboratory
Motiram Baburam Government Postgraduate College, Haldwani-263 139, India
*E-mail: csnsacred1@gmail.com

Abstract: Odonata is one of the most ancient groups of flying insects, with fossil records dating back to the Permian era (299-251 million years ago). Classified into three suborders based on morphology: the Anisozygoptera, Zygoptera, and Anisoptera, they are amphibious hemi-metabolic insects having the aquatic egg and larval stages, while the adults are terrestrial. Among the Anisozygoptera, *Epiophlebia laidlawi* Tillyard 1921, one of only four known species, is found in Darjeeling. This review summarizes literature of last 30 years and reveals: (i) the total diversity of species encountered remains very small- 508, considering country's large area as well as the multitude of habitat kinds; (ii) only 12 species of dragon flies and 14 species of damselflies find mention as rare, endangered, and threatened species (RET), while a very significant number (179) have been categorized as data deficient or not evaluated. The limited recorded diversity and conservation status of Indian odonates reflect a lack of comprehensive research, even in terms of basic inventorization. Most studies focus solely on species inventorization, overlooking ecological aspects. This paper highlights the urgent need for in-depth studies addressing habitat types and environmental changes. Addressing these gaps is crucial to safeguard these bioindicators and ensure the sustainability of freshwater ecosystems.

Keywords: Anisoptera, Anisozygoptera, Damselflies, Dragonflies, Odonata, Specialized species, Zygoptera

Nearly 1 million of the 1.9 million species documented globally are insects. Taxonomists estimate that the total number of species worldwide ranges between three million and hundred million. These diversity estimates, derived from taxonomic studies differ from those based on macro ecological patterns and biodiversity ratios (Masih and Pathak 2022). Among the insects that hover over forests, farms, meadows, ponds, and rivers most frequently are odonates, which include dragonflies and damselflies. Globally, 6,442 species of Odonata have been identified (Paulson et al., 2025), with 508 species reported from India, and 137 species from the State of Uttarakhand. The order Odonata is divided into three suborders based on morphology- Anisozygoptera, Zygoptera, and Anisoptera: Anisoptera (dragonflies), Anisozygoptera, and Zygoptera (damselflies), each comprising several superfamilies, families, genera, and species that reflect the rich taxonomic diversity of this insect group.

Globally, there are only four known species of Anisozygoptera- *Epiophlebia superstes* (Selys 1889), found exclusively in Japan; *E. laidlawi* Tillyard 1921 is restricted to the Himalayan region (Dawn 2021); while *E. sinensis* Li and Nel 2012 and *E. diana* Carle 2012 were both, reported recently from China (Blanke et al., 2013, Büsse and Ware 2022), respectively. Dragonflies and damselflies are easily distinguishable in their natural habitats (Masih and Pathak 2022). Dragonflies are generally more robust insects compared to damselflies, and while resting, dragonflies hold

their wings outstretched, whereas damselflies fold their wings along their bodies. Despite these morphological differences, both groups share similar overall life cycles, and more or less, similar habitat conditions (Masih and Pathak 2022). Within Anisoptera, the superfamily Aeshnoidea includes the family Aeshnidae, which consists of 13 genera and 52 species known for their large size and powerful flight. The superfamily Gomphoidea is represented by the family Gomphidae, with 31 genera and 89 species characterized by their clubbed tails. The Cordulegastroidea superfamily comprises two families: Chlorogomphidae and Cordulegasteridae, which together contain 6 genera and 17 species, typically inhabiting stream environments. The largest diversity within Anisoptera is found in the superfamily Libelluloidea, which includes families such as Libellulidae (43 genera, 97 species), Macromiidae (2 genera, 17 species), and Corduliidae (2 genera, 2 species), alongside 2 genera and 15 species of uncertain familial placement (incertae sedis) (Table 1). The family Libellulidae is particularly diverse and widespread, commonly encountered in a variety of freshwater habitats. The small suborder Anisozygoptera includes only one family, Epiophlebiidae, represented by a lone species- *Epiophlebia laidlawi* Tillyard 1921, reflecting its ancient and relict status (Table 1).

In contrast, the suborder Zygoptera displays substantial diversity across multiple superfamilies. For instance, Lestoidea contains the families Lestidae and Synlestidae, with a combined 6 genera and 27 species (Table 1). The

Platystictoidea superfamily, represented by the family Platystictidae, includes 3 genera and 23 species mostly found in shaded, forested streams. The Calopterygoidea superfamily is home to several families, including Calopterygidae (6 genera, 9 species), Chlorocyphidae (8 genera, 22 species), Euphaeidae (5 genera, 20 species), and Philogangidae (2 genera, 2 species), all notable for their bright colors and iridescence (Table 1). Lastly, the superfamily Coenagrionoidea consists mainly of the families Coenagrionidae and Platycnemididae, which together account for 26 genera and 115 species, making them the most speciose among the damselflies (Table 1). Overall, this classification underscores the extensive taxonomic richness and ecological diversity of odonates, emphasizing their importance in freshwater ecosystems and their value as indicators of environmental health.

Due to their wide range of ecological roles and their ability to serve as bioindicators for assessing aquatic habitats, odonates are increasingly being utilized in both basic and applied research (Masih and Pathak 2022) as model organism for testing key hypotheses related to sexual selection, complex life cycles, the evolution of flight, and community ecology (Córdoba-Aguilar 2008); and being sensitive to environmental changes- both biotic as well as abiotic, they are invariably associated with the studies related

to conservation management, and assessment of aquatic environmental health (Córdoba-Aguilar 2008). Further, studies conducted on odonate spectrum extension analyses by latitude, have lately been suggested that odonates may provide valuable insights about climate change, or its effects vis-à-vis changes in population dynamics of odonates (Masih and Pathak 2022). Given their ecological importance, aesthetic value, and potential as environmental indicators, particularly as relates to understanding the relationship between Odonata diversity and the quality of their preferred habitats, odonates offer immense scope for advancing biodiversity research and conservation efforts. In this review, attempt is made to categorize Indian odonata in terms of their distribution across different states into generalized and specialized groups. Further, by consolidating existing records, this study seeks to provide a comprehensive understanding of the current status of odonata diversity in India, identify key research gaps, and propose strategies for their conservation and sustainable management amidst increasing anthropogenic and climatic pressures.

RESULTS AND DISCUSSION

Detailed literature review conducted for the last 35 years (1989 to 2025) brings out the following facts: Anisoptera (dragonflies) is distributed across 4 super families, 8 families,

Table 1. Distribution of the species across families and sub-orders

Suborders	Superfamily	Family	Genera	Species	
Anisoptera	Aeshnoidea	Aeshnidae	13	52	
	Gomphoidea	Gomphidae	31	89	
		Chlorogomphidae	03	08	
	Cordulegastroidea	Cordulegasteridae	03	09	
		Libelluloidea	Corduliidae	02	02
			Libellulidae	43	97
		Macromiidae	02	17	
	Genera incertae sedis	02	15		
Anisozygoptera	Epiophlebioidea	Epiophlebiidae	01	01	
Zygoptera	Lestoidea	Lestidae	05	21	
		Synlestidae	01	06	
	Platystictoidea	Platystictidae	03	23	
	Calopterygoidea	Calopterygidae	06	09	
		Chlorocyphidae	08	22	
		Euphaeidae	05	20	
		Philogangidae	02	02	
		Coenagrionoidea	Coenagrionidae	11	60
			Platycnemididae	15	55
		Total	156	508	

99 genera, and altogether 289 species, while Zygoptera is represented by 4 super families, 9 families, 56 genera, and 218 species. The rare order Anisozygoptera is represented by a monotypic species- *Epiophlebia laidlawi* Tillyard 1921 (Fig. 1). Out of the total 192 references consulted, as relates to distribution and habitats, 36 studies have been conducted on a landscape level, followed by water habitats (e.g., lakes, rivers, etc)- 29, those confined to the protected areas (PAs) constitute 27. Other studies are more or less, equitably conducted in other habitat types, such as forests (16), campus and educational institutes (14), agro-fields (11), and urban ecosystems (07).

A significant number of studies could not be categorized, and thus have been relegated as 'Not specified' (52), i.e., constitutes just inventorisations of the species. Those, related to ecological analyses vis-à-vis habitat alteration/changes, or those incorporating the distribution or abundance of the odonates over a temporal or spatial scale, constitute just 38. In brief, current survey, only strengthens the views of Aghade et al. (2022) and (Masih and Pathak 2022) that studies on odonates lack both in expanse (i.e., lack of studies, that explores more habitats/sites), and on ecological aspects- i.e., studies, that explores the distribution and abundance of odonates across environmental gradient- habitats, temporal and spatial distribution, effect of changed climatic conditions, habitat alterations, and the like. Nonetheless, the wide-ranging habitats types reflect the ecological significance of odonates and the necessity of habitat-specific conservation efforts. Further, despite being one of the largest countries in the world, with wide range of habitats, not to speak of greater number of water bodies- types as well as numbers, research on odonates in India remains limited and geographically skewed. Studies are confined to only a few states, and within these states, research is often restricted to specific localities, rather than being comprehensive.

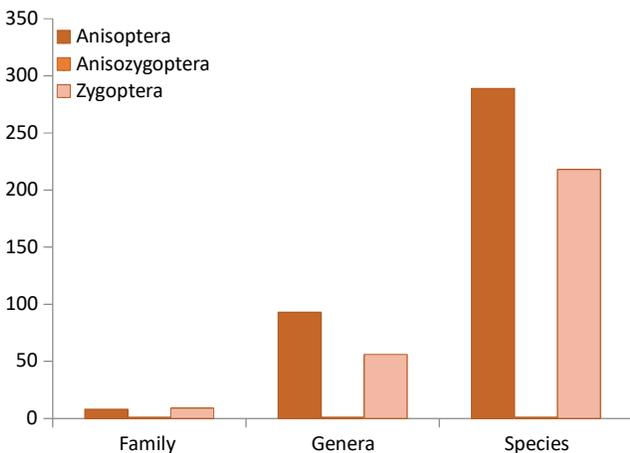


Fig. 1. Distribution of the odonates across the three sub-orders

In terms of studies conducted across the different states- most studies are reported from the state of Maharashtra (14), followed by, Kerala (12), Assam, Madhya Pradesh, West Bengal, and Odisha (10 each), Tamil Nadu and Rajasthan (9 each), Himachal Pradesh, Karnataka and Gujarat (7 each), followed by other states, where the number of studies numbers just a few (between 1-5). Table 2 reflects upon the Odonata diversity within each state. Overall, the total diversity exhibits an increase by 4 species, i.e., 508, instead of the earlier 504. The states which show an increase in Odonata diversity are the following- Andhra Pradesh (78 against 72), Chhattisgarh (88 against 87), Gujarat (74 against 63), Himachal Pradesh (136 against 122), Haryana (48 against 26), Jammu & Kashmir (94 against 67), Kerala (191 against 178), Maharashtra (143 against 139), Odisha (118 against 114), Punjab (70 against 41), Rajasthan (99 against 51), Sikkim (97 against 82), Uttar Pradesh (77 against 70), Uttarakhand (137 against 127), and West Bengal (241 against 240) (Table 2).

The present review improves upon the last data carried out by Subramanian and Babu 2024, regarding the distribution of odonates across the States. The total diversity of odonates within the country has improved by 4 species- (i) *Melanoneura agasthyamalaica* sp. nov, (ii) *Phylloneura rupestris* (Chandran, Chandran and Jose 2024), (iii) *Protosticta sexcolorata* sp. nov, and (iv) *Euphaea wayanadensis* Anooj, Susanth and Sadasivan 2025. Similarly, for the State of Uttarakhand, the total number of odonates have improved from 127 to 137, including 3



Fig. 2. Three new records being reported for the first time from the State of Uttarakhand. (1) *Ophiogomphus reductus* Calvert 1898 (2) *Calicnemia nipalica* Kimmins 1958 and (3) *Ceriagrion olivaceum* (Laidlaw 1914)

species- (i) *Ophiogomphus reductus* Calvert 1898, (ii) *Calicnemia nipalica* Kimmins 1958 and (iii) *Ceriagrion olivaceum* (Laidlaw 1914), which are being reported for the first time (Fig. 2).

Altogether, 508 species are reported from the country (Table 1), out of which 12 species from Anisoptera, and 15 species from Zygoptera, and the lone species from Anisozygoptera, are included in the IUCN Red Data list

(IUCN 2024, Table 3). The Rare, Endangered, and Threatened (RET) species (28) could further be categorized, in terms of the status, as the following- Critically endangered (01), endangered (03), vulnerable species (11), and the near threatened (13) (Table 3). These classifications emphasize the urgency of conservation efforts to protect these species and their habitats from ongoing threats such as habitat destruction, pollution, and climate change.

Table 2. Distribution of Odonata diversity across India

States	Species diversity		Reference
	Subramanian and Babu (2024)	Current study	
Andhra Pradesh	72	78	Prasad 2007, Amaravathi et al., 2018
Arunachal Pradesh	110	95	Ram and Prasad 1999, Payra et al., 2017,
Assam	173	117	Baruah and Saikai 2015, Choudhury et al., 2020, Thakuria and Kalita 2021, Das et al., 2022, Chetia and Das, 2022
Chhattisgarh	87	88	Dawn and Chandra 2014, Sahu and Rai 2019
Gujarat	63	74	Rohmare et al., 2016, Mokaria and Jethva 2019, Sharma and Kumar 2020, Rathod et al., 2021
Goa	87	79	Rangnekar et al., 2010, Rangnekar and Naik 2014, D'Souza and Pal 2019
Himachal Pradesh	122	136	Sharma 2019, Singh et al., 2021, Raj et al., 2024
Haryana	26	48	Sharma and Joshi 2007
Jammu and Kashmir	67	94	Paray and Mir 2023, Hussain et al., 2024
Jharkhand	72	57	Saha and Hembrom 2020, Devidas et al., 2023
Karnataka	141	101	Kumar and Shetty 2019, Thampuran et al., 2021, Rani et al., 2023
Kerala	178	191	Nair et al., 2021, Chandran et al., 2021, 2023, 2024, Bhatia and Kumari 2024, Davisian et al., 2024
Madhya Pradesh	88	84	Mishra et al., 2019, Chourasia et al., 2020, Dubey et al., 2021, Tiple et al., 2022
Maharashtra	139	143	Koparde et al., 2014, Tiple and Koparde 2015, Gajbe 2020, Supanekar et al., 2021, Bharthi and Koparde 2022, Sawant et al., 2022, 2023
Manipur	92	56	Takhelmayum and Gupta 2014, Singh et al., 2016
Meghalaya	160	72	Bora 2019, Bora et al., 2020
Mizoram	65	28	Laltanpuli et al., 2013
Nagaland	107	90	Joshi and Kunte 2014
Odisha	114	118	Pandey and Mohapatra 2017, Debata et al., 2017, Payra et al., 2019, 2020
Punjab	41	70	Singh 2022
Rajasthan	51	99	Singh et al., 2017, Singh and Hermans 2019, Bishnoi and Dang 2019, Johari and Jain 2021
Sikkim	82	97	Mitra 2004, Payra and Bhutia 2017
Tamil Nadu	147	113	Veeramani et al., 2018, Pavithran et al., 2020, Manikandan et al., 2021, Manikandan et al., 2023
Telangana	57	35	Rehman et al., 2015
Tripura	76	75	Majumder et al., 2014, Datta et al., 2023
Uttar Pradesh	70	77	Kanaujia et al., 2015, Dubey and Dubey 2019
Uttarakhand	127	137	Dayakrishna and Arya 2015, Uniyal et al., 2019, De et al., 2021
West Bengal	240	241	Goswami et al., 2018, Payra and Tiple 2019, Ghosh 2023, Samanta et al., 2023

Table 3. RET species as per IUCN 2024

Sub-order	Species	Status
Zygoptera (01)	<i>Protosticta myristicaensis</i> Joshi and Kunte 2020	CR
Anisoptera (02)	<i>Idionyx galeata</i> Fraser 1924, <i>Orthetrum andamanicum</i> Bedjanič, Kalkman and Subramanian 2020	EN
Zygoptera (01)	<i>Libellago balus</i> Hämäläinen 2002	
Anisoptera (03)	<i>Chlorogomphus xanthoptera</i> Fraser 1919, <i>Cyclogomphus ypsilon</i> Selys 1854, and <i>Chloropetalia selysi</i> Fraser 1929	VU
Zygoptera (08)	<i>Disparoneura apicalis</i> Fraser 1924, <i>Calicnemia nipalica</i> Kimmins 1958, <i>Coeliccia fraseri</i> Laidlaw 1932, <i>Anisopleura vallei</i> St. Quentin 1937, <i>Libellago blanda</i> Hagen in Selys 1853, <i>Libellago andamanensis</i> Fraser 1924, <i>Protosticta sanguinostigma</i> Fraser 1922, <i>Indosticta deccanensis</i> Laidlaw 1915	
Anisoptera (07)	<i>Planaeschna intersedans</i> Martin 1909, <i>Anormogomphus kiritschenkoi</i> Bartenev 1913, <i>Asiagomphus personatus</i> Selys 1873, <i>Heliogomphus promelas</i> Selys 1873, <i>Neallogaster ornata</i> Asahina 1982, <i>Idionyx optata</i> Selys 1878, and <i>Megalogomphus hannyingtoni</i> Fraser 1923	NT
Anisozygoptera (01)	<i>Epiophlebia laidlawi</i> Tillyard 1921	
Zygoptera (05)	<i>Indolestes indicus</i> Fraser 1922, <i>Indocypha vittata</i> Selys 1891, <i>Elatoneura atkinsonii</i> Selys 1886, <i>Melanoneura bilineata</i> Fraser 1922, and <i>Phylloneura westermanni</i> Selys 1860	

CR- Critically Endangered, EN- Endangered, V- Vulnerable, NT- Near threatened

Table 4. List of highly specialized species restricted to just a few sites/ or reported from 1-2 states only

Species	State	Reference
Anisoptera		
<i>Gynacantha pallampurica</i> (Lahiri, Sandhu and Walia 2007)	Himachal Pradesh	Lahiri et al., 2007, Kalkman et al., 2020
<i>Gynacantha andamae</i> (Yeh and Veenakumari 2000)	Andaman	Yeh and Veenakumari, 2000, Kalkman et al., 2020
<i>Gynacantha odoneli</i> (Fraser 1922)	West Bengal	Kalkman et al., 2020, Dawn 2021
<i>Gomphidia williamsoni</i> (Fraser 1923)	West Bengal	Kalkman et al., 2020, Dawn 2021
<i>Orthetrum andamanicum</i> Bedjanič, (Kalkman and Subramanian 2020)	Andaman	Bedjanic et al., 2020, Kalkman et al., 2020
<i>Orthetrum erythronigrum</i> (Subramanian, Babu and Kalkman 2020)	Andaman	Subramanian et al., 2020
<i>Orthetrum martensi</i> (Asahina 1978)	Andaman	Kalkman et al., 2020
<i>Rhyothemis phyllis</i> (Sulzer 1776)	Andaman	Raja et al., 2000, Kalkman et al., 2020
<i>Idionyx stevensi</i> (Fraser 1924)	West Bengal	Dawn 2021
<i>Idionyx gomantakensis</i> (Subramanian, Rangnaker and Nayak 2013)	Kerala	Nair et al., 2022
<i>Idionyx intricata</i> (Fraser 1926)	Kolkata	Kalkman et al., 2020
Zygoptera		
<i>Lestes barbarus</i> (Fabricius 1798)	West Bengal	Subramanian and Babu 2017, Dawn 2021
<i>L. garoensis</i> (Lahiri 1987)	West Bengal	Subramanian and Babu 2017, Dawn 2021, Samanta et al., 2023
<i>Ceriagrion pratermissum</i> (Lieftinck 1929)	West Bengal	Subramanian and Babu 2017, Kalkman et al., 2020, Dawn 2021
<i>C. olivaceum</i> (Laidlaw 1914)	West Bengal, Rajasthan, Uttarakhand.	Dawn 2021, Singh 2022, own record (unpublished, Figure 2)
<i>Coenagrion exclamationis</i> (Fraser 1919)	West Bengal	Subramanian and Babu 2017, Kalkman et al., 2020, Dawn 2021
<i>Calicnemia nipalica</i> (Kimmins 1958)	West Bengal, Uttarakhand, Sikkim	Subramanian and Babu 2017, Kalkman et al., 2020, Dawn 2021, own record (unpublished, Figure 2)
<i>Coeliccia svihleri</i> (Asahina 1970)	Kolkata	Subramanian and Babu 2017, Kalkman et al., 2020, Dawn 2021
<i>C. prakritiae</i> (Lahiri 1985)	Kolkata	Subramanian and Babu 2017, Kalkman et al., 2020, Dawn 2021
<i>Melanoneura agasthyamalaica</i> sp. nov	Kerala	Chandran et al., 2024
<i>Phylloneura rupestris</i> (Chandran, Chandran and Jose 2024)	Thiruvananthapuram	Chandran et al., 2024
<i>Protosticta sexcolorata</i> sp. nov	Wayanad	Chandran et al., 2023
<i>Euphaea wayanadensis</i> Anooj, Susanth and Sadasivan 2025	Wayanad	Anooj et al., 2025

More significantly, 179 species- 113 and 66 species from Anisoptera and Zygoptera, respectively, are categorized as 'Data deficient' or 'Not evaluated'. Further, two species- *Nihonogomphus pulcherrimus* (Fraser 1927) from the family Gomphidae and *Lyriothemis flava* (Oguma 1915), from the family Libellulidae, remain unaccounted for; since they are just mentioned in the check list by (Subramanian and Babu 2024), however, find no mention, elsewhere. Among Anisoptera, around 11 species, distributed across 8 Genera are highly specialized, while in Zygoptera, 12 species across 9 genera are highly specialized, i.e., are reported from a few sites, only (Table 4). These species would require more intensive studies to ascertain their precise status in the wild, so that conservation efforts could be undertaken.

CONCLUSION

The number of Odonata species reported across the states of India is relatively low, considering the country's vast area, multitude of water bodies and diversity of habitat types, climate regimes, diversity of vegetation profiles, etc. Most of the extensive studies are again, confined to few states, such as Assam, Himachal Pradesh, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, and West Bengal; and even within these states, studies are mostly confined to the 'inventorization' of odonates, rather than those addressing the ecological aspects of its distribution, both on spatial and temporal scales, as well as effects on its abundance (primarily) vis-à-vis changes in habitat conditions, and like. The lack of studies is reflected in relatively meagre number of species designated as RET species (28), while those designated as 'Data deficient' and 'Not evaluated', number a huge 179. Further, an additional 23 species have been reported from a few sites, or 1-2 states only. Even though, over the years, 40 new species of odonates, totalling 508, have been reported from the country, which do reflect upon the resurgence in research on odonates, there is a need for more intensive and extensive study of odonates that incorporates the vulnerability aspects, and not just confined to the habitat studies alone. This is more so, since odonates remain an excellent bioindicators, reflecting upon the health of the ecosystems. Any decline in their abundance, reflects upon the deterioration of their habitats. In other words, preserving their habitats is essential to maintain stable populations and diversity of these insects.

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