Journal of Threatened Taxa

Building evidence for conservation globally

10.11609/jott.2021.13.14.20143-20310
www.threatenedtaxa.org

26 December 2021 (Online & Print)
Vol. 13 | No. 14 | Pages: 20143–20310

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

Open Access

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti,
Coimbatore, Tamil Nadu 641035, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

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continued on the back inside cover

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

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 December 2021 | 13(14): 20167–20173
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
https://doi.org/10.11609/jott.7518.13.14.20167-20173
#7518 | Received 12 June 2021 | Final received 04 October 2021 | Finally accepted 20 November 2021

OPEN ACCESS

COMMUNICATION

Checklist of Odonata (Insecta) of Doon Valley, Uttarakhand, India

Kritish De [1], Sarika Bhatt [2], Amar Paul Singh [3], Manisha Uniyal [4] & Virendra Prasad Uniyal [5]

[1] Department of Life Sciences, Sri Sathya Sai University for Human Excellence, Navanihal, Karnataka 585313, India.
[1,2,3,5] Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand 248001, India.
[2] Department of Zoology, Shri Guru Ram Rai University, Dehradun, Uttarakhand 248001, India.
[4] Department of Zoology, Dayanand Bijendra Swaroop PG College, Dehradun, Uttarakhand 248001, India.
[1] kritish.de@gmail.com (corresponding author), [2] amarpaulsingh4@gmail.com, [3] sarika.r.b04@gmail.com, [4] manishauniyal31@gmail.com, [5] uniyalvp@wii.gov.in

Abstract: In this communication, we have collated a checklist of 97 species of odonates from Doon valley, Uttarakhand by reviewing the literature. These species are distributed across 13 families, 58 genera, and eight superfamilies. Of these species, 60 were Anisoptera (dragonflies) and 37 were Zygoptera (damselflies). Three species of dragonflies and two damselflies are endemic to India. This checklist updates existing knowledge on insect diversity in the Doon valley and will aid conservation management of wetlands in the region.

Keywords: Anisoptera, conservation, damselfly, diversity, dragonfly, endemic species, Zygoptera.

Editor: K.A. Subramanian, Zoological Survey of India, Chennai, India.

Date of publication: 26 December 2021 (online & print)

Citation: De, K., S. Bhatt, A.P. Singh, M. Uniyal & V.P. Uniyal (2021). Checklist of Odonata (Insecta) of Doon Valley, Uttarakhand, India. *Journal of Threatened Taxa* 13(14): 20167–20173. https://doi.org/10.11609/jott.7518.13.14.20167-20173

Funding: This work was funded by National Mission on Himalayan Studies, Ministry of Environment, Forest and Climate Change, Government of India (Grant No.: NMHS/2017-18/MG42/26).

Competing interests: The authors declare no competing interests.

Author details: Kritish De is working as assistant professor at Sri Sathya Sai University for Human Excellence. Previously he worked as project fellow at Wildlife Institute of India. His research interests are biodiversity and ecology. Sarika Bhatt is a doctoral student at Shri Guru Ram Rai University. Her research interests are biodiversity and ecology of aquatic insects. Amar Paul Singh is presently working as a researcher at Wildlife Institute of India. His research interests include diversity, taxonomy, ecology and animal behaviour. Manisha Uniyal is working as assistant professor at Dayanand Brijendra Swaroop Postgraduate College. Her interests are biodiversity and ecology of aquatic ecosystem. Virendra Prasad Uniyal is working as Scientist – G at Wildlife Institute of India. His research interests are ecology and systematics of insects, bio-indicators, biodiversity surveys and ecological monitoring.

Author contributions: KD—conceptualization, formal analysis, writing original draft; SB—writing original draft; APS–writing original draft, MU—writing original draft, VPU—supervision, review, and editing the draft.

Acknowledgements: Authors express gratitude to the Director and Dean, Wildlife Institute of India, Dehradun for their support for the study. Authors are thankful to the National Mission on Himalayan Studies, Ministry of Environment, Forest and Climate Change, Government of India for sponsoring the work.

INTRODUCTION

Odonates are relatively well known because the adults are colourful, relatively large, and easily visible as they pursue insect prey in freshwater habitats ranging from permanent water bodies to pools and puddles (Thorp & Rogers 2011). They are excellent indicators for monitoring the health of freshwater ecosystems. The order Odonata is divided into three suborders, with 6,337 recorded species (Paulson et al. 2021), of which 493 (plus 27 subspecies) in 154 genera and 18 families are reported from India (Subramanian & Babu 2019). Of these, the Himalaya account for 257 species under 112 genera and 18 families (Subramanian & Babu 2018), and Indian endemics include 186 species (including subspecies) belonging to 69 genera, with 34 species being endemic to the Himalaya (Subramanian & Babu 2018).

The earliest accounts of odonates in the Doon valley were by Singh & Prasad (1976) and Prasad & Singh (1976), which documented the Anisoptera and Zygoptera, respectively. Subsequently, Kumar & Prasad (1981) published a list of western Himalayan odonates, which included odonates of Doon valley, and Hamalainen (1989) studied the odonate diversity of Dehradun valley. The diversity of odonates in Rajaji National Park was documented by Prasad & Singh (1995) and Kumar & Sharma (2003) documented the odonate fauna of Doon Valley's Asan Wetland. The diversity of odonates in Sahastradhara and other parts of Dehradun was documented by Husain (2018).

The Doon valley in the Indian state of Uttarakhand is a mountain valley bounded in the south-west by the Siwalik Range, in the north-east by the Mussoorie Range of the Lesser Himalaya, in the north-west by the Yamuna River, and in the south-east by the Ganga River. Habitats include hardwood deciduous forest, blossoming and fruiting trees, wetlands, Terai, and Bhabar ecosystems. There are several rivers: Song, Tons, Suswa, Jakhan, Rispana, and Asan, plus many lesser streams moving through Doon Valley, providing ideal wildlife habitats. Because there is no recent updated information on odonates of the Doon valley, the creation of a checklist with updates was deemed necessary for conservation management of the dragonflies and damselflies the valley.

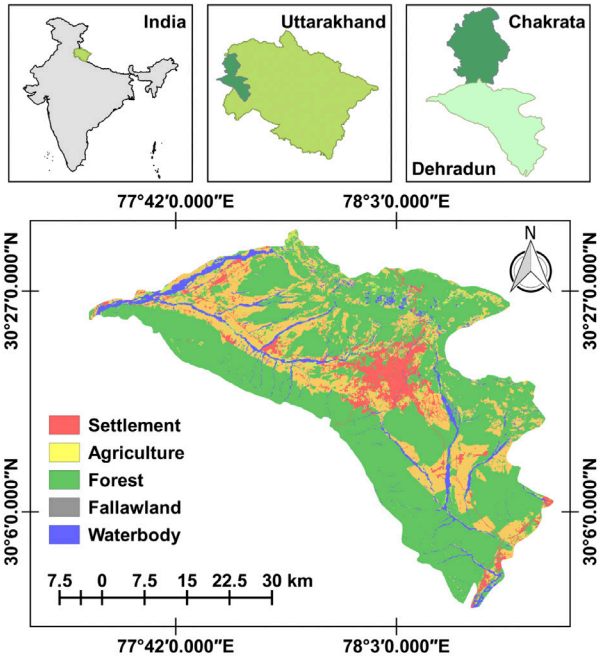

Figure 1. Location and major land-use types of Doon valley.

MATERIALS AND METHODS

The checklist provided in this communication is based on a review of existing literature (Sangal & Kumar 1970a,b; Singh & Prasad 1976; Prasad & Singh 1976, 1995; Kumar & Prasad 1978, 1981; Sangal & Tyagi 1985; Hamalainen 1989; Mitra, 1999, 2000a,b; Kumar & Sharma 2003; Husain 2018) on the odonate fauna of Doon valley (Figure 1). For the systematic position of the odonates, we followed Dijkstra et al. (2013). The nomenclature and endemic status of the species follow Kalkman et al. (2020).

RESULTS AND DISCUSSION

Currently, 97 species of odonates were reported from the Doon valley, Uttarakhand. This include 60 species, 37 genera, five families and four superfamilies of dragonflies (Anisoptera) (Table 1) and 37 species, 21 genera, eight families, and four superfamilies of damselflies (Zygoptera) (Table 2) (Figure 2).

Among the dragonflies, maximum number of species and genus were reported from Libellulidae (38 species, 22 genera), followed by Gomphidae (14 species, 10 genera), Aeshnidae (six species, three genera), Cordulegastridae (one genus, one species), and Macromiidae (one genus, one species) (Figure 3A).

Among the damselflies, maximum number of species

and genus were reported from the Coenagrionidae (16 species, six genera), followed by the Platycnemididae (six species, four genera), Chlorocyphidae (five species, four genera), Lestidae (four species, two genera), Euphaeidae (three species, two genera); Calopterygidae, Platystictidae, and Synlestidae were represented with one genus and one species, each (Figure 3B). Percentage of genera and species of five families of Anisoptera and eight families of Zygoptera are given in Figure 4.

Among the odonates reported from the Doon valley, three dragonflies namely *Anormogomphus heteropterus* Selys, 1854, *Burmagomphus sivalikensis* Laidlaw, 1922, and *Hylaeothemis gardeneri* Fraser, 1927 and two damselflies *Agriocnemis corbeti* Kumar & Prasad, 1978 and *Calicnemia doonensis doonensi* Sangal & Tyagi, 1984 are endemic to India.

Insect populations are supposedly encountering broad decays; however, we, for the most part, have inadequate information on their abundance (Bried et al. 2020). There is a scarcity of knowledge on environmental variables and Odonata diversity in the Doon valley. Aquatic ecosystems are typically spatially and temporally constrained, and are often found in largely rural landscapes, making them vulnerable to farmland water management activities, which can put additional

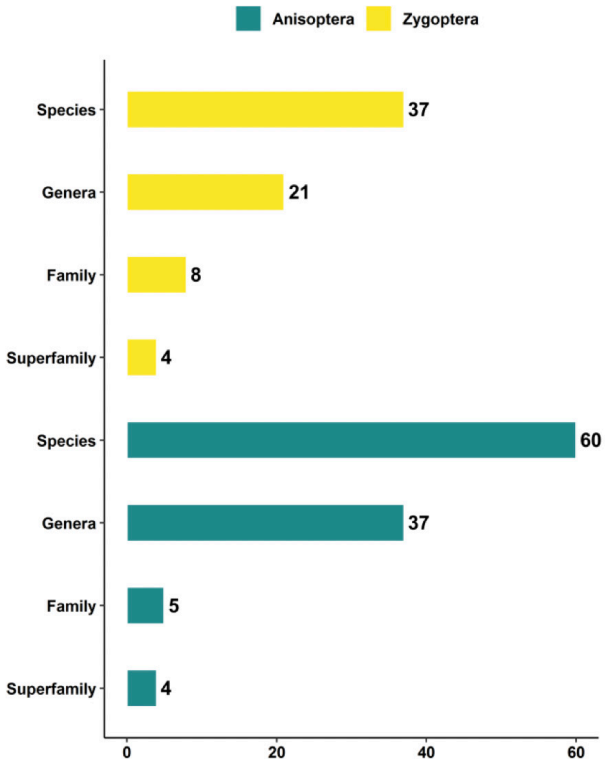

Figure 2. Taxa of Anisoptera and Zygoptera reported from Doon valley.

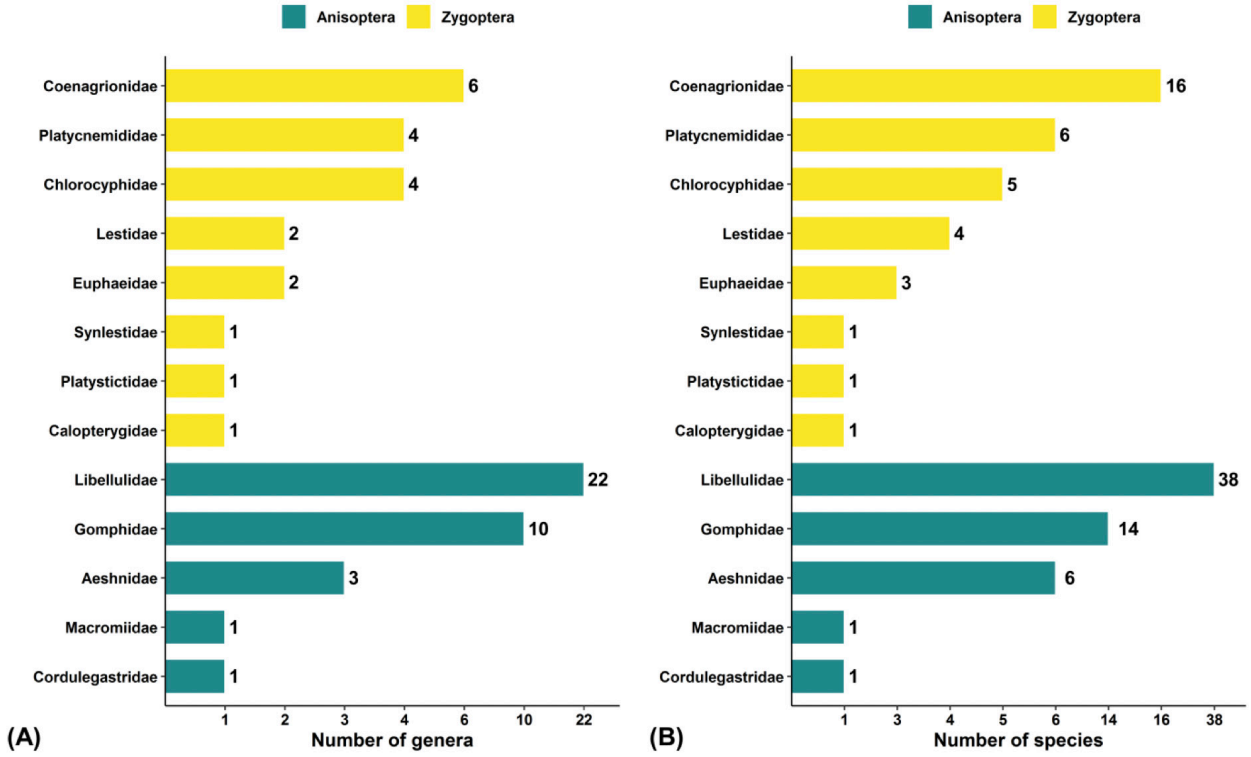

Figure 3. A—numbers of genera | B—species under different families of Anisoptera and Zygoptera.

Table 1. List of dragonflies reported from the Doon valley.

Suborder: Anisoptera Selys, 1854		
Superfamily: Aeshnoidea Leach, 1815		
Family: Aeshnidae Leach, 1815		
Genus: *Anax* Leach in Brewster, 1815		
	Anax guttatus (Burmeister, 1839)	
	Anax immaculifrons Rambur, 1842	
	Anax nigrofasciatus nigrolineatus Fraser, 1935	
	Anax parthenope (Selys, 1839)	
Genus: *Gynacantha* Rambur, 1842		
	Gynacantha bayadera Selys, 1891	
Genus: *Gynacanthaeschna* Fraser, 1921		
	Gynacanthaeschna sikkima (Karsch, 1891)	
Superfamily: Gomphoidea Rambur, 1842		
Family: Gomphidae Rambur, 1842		
Genus: *Anisogomphus* Selys, 1858		
	Anisogomphus occipitalis (Selys, 1854)	
Genus: *Anormogomphus* Selys, 1854		
	Anormogomphus heteropterus Selys, 1854	Endemic to India
	Anormogomphus kiritschenkoi Bartenef, 1913	
Genus: *Burmagomphus* Williamson, 1907		
	Burmagomphus hasimaricus Fraser, 1926	
	Burmagomphus sivalikensis Laidlaw, 1922	Endemic to India
Genus: *Ictinogomphus* Cowley, 1934		
	Ictinogomphus rapax (Rambur, 1842)	
Genus: *Lamelligomphus* Fraser, 1922		
	Lamelligomphus biforceps (Selys, 1878)	
	Lamelligomphus risi (Fraser, 1922)	
Genus: *Nepogomphus* Fraser, 1934		
	Nepogomphus modestus (Selys, 1878)	
Genus: *Nychogomphus* Carle, 1986		
	Nychogomphus duaricus (Fraser, 1924)	
Genus: *Onychogomphus* Selys, 1854		
	Onychogomphus cerastis (Selys, 1854)	
Genus: *Paragomphus* Cowley, 1934		
	Paragomphus lineatus (Selys, 1850)	
Genus: *Scalmogomphus* Chao, 1990		
	Scalmogomphus bistrigatus (Hagen in Selys, 1854)	
	Scalmogomphus schmidti Fraser, 1937	
Superfamily: Libelluloidea Leach, 1815		
Family: Libellulidae Leach, 1815		
Genus: *Acisoma* Rambur, 1842		
	Acisoma panorpoides Rambur, 1842	
Genus: *Brachydiplax* Brauer, 1868		
	Brachydiplax sobrina (Rambur, 1842)	
Genus: *Brachythemis* Brauer, 1868		
	Brachythemis contaminata (Fabricius, 1793)	
Genus: *Bradinopyga* Kirby, 1893		
	Bradinopyga geminata (Rambur, 1842)	
Genus: *Cratilla* Kirby, 1900		
	Cratilla lineata calverti Förster, 1903	
Genus: *Crocothemis* Brauer, 1868		
	Crocothemis erythraea (Brullé, 1832)	
	Crocothemis servilia (Drury, 1773)	
Genus: *Diplacodes* Kirby, 1889		
	Diplacodes lefebvrii (Rambur, 1842)	
	Diplacodes nebulosa (Fabricius, 1793)	
	Diplacodes trivialis Rambur, 1842	
Genus: *Hylaeothemis* Ris, 1909		
	Hylaeothemis gardeneri Fraser, 1927	Endemic to India
Genus: *Neurothemis* Brauer, 1867		
	Neurothemis fulvia (Drury, 1773)	
	Neurothemis intermedia intermedia (Rambur, 1842)	
	Neurothemis tullia (Drury, 1773)	
Genus: *Orthetrum* Newman, 1833		
	Orthetrum brunneum (Fonscolombe, 1837)	
	Orthetrum glaucum Brauer, 1865	
	Orthetrum internum McLachlan, 1894	
	Orthetrum luzonicum (Brauer, 1868)	
	Orthetrum pruinosum neglectum (Burmeister, 1839)	
	Orthetrum sabina sabina (Drury, 1770)	
	Orthetrum taeniolatum (Schneider, 1845)	
	Orthetrum triangulare triangulare (Selys, 1878)	
Genus: *Palpopleura* Rambur, 1842		
	Palpopleura sexmaculata (Fabricius, 1787)	
Genus: *Pantala* Hagen, 1861		
	Pantala flavescens (Fabricius, 1798)	
Genus: *Potamarcha* Karsch, 1890		
	Potamarcha congener (Rambur, 1842)	
Genus: *Rhyothemis* Hagen, 1867		
	Rhyothemis variegate variegata (Linnaeus, 1763)	
Genus: *Sympetrum* Newman, 1833		
	Sympetrum striolatum commixtum (Selys, 1884)	
Genus: *Tetrathemis* Brauer, 1868		
	Tetrathemis platyptera Selys, 1878	
Genus: *Tholymis* Hagen, 1867		
	Tholymis tillarga (Fabricius, 1798)	
Genus: *Tramea* Hagen, 1861		
	Tramea basilaris (Palisot de Beauvois, 1817)	
	Tramea virginia (Rambur, 1842)	
Genus: *Trithemis* Brauer, 1868		
	Trithemis aurora (Burmeister, 1839)	

	Trithemis festiva (Rambur, 1842)	
	Trithemis kirbyi Selys, 1891	
	Trithemis pallidinervis (Kirby, 1889)	
Genus: *Urothemis* Brauer, 1868		
	Urothemis signata (Rambur, 1842)	
Genus: *Zygonyx* Selys in Hagen, 1867		
	Zygonyx torridus isis Fraser, 1924	
Genus: *Zyxomma* Rambur, 1842		
	Zyxomma petiolatum Rambur, 1842	
Family: Macromiidae Needham, 1903		
Genus: *Macromia* Rambur, 1842		
	Macromia moorei Selys, 1874	
Superfamily: Cordulegastroidea Hagen, 1875		
Family: Cordulegastridae Hagen, 1875		
Genus: *Cordulegaster* Leach in Brewster, 1815		
	Cordulegaster brevistigma (Selys, 1854)	

Table 2. List of damselflies reported from the Doon valley.

Suborder: Zygoptera Selys, 1854		
Superfamily: Calopterygoidea Selys, 1850		
Family: Calopterygidae Selys, 1850		
Genus: *Neurobasis* Selys, 1853		
	Neurobasis chinensis (Linnaeus, 1758)	
	Family: Chlorocyphidae Cowley, 1937	
Genus: *Aristocypha* Laidlaw, 1950		
	Aristocypha quadrimaculata (Selys, 1853)	
	Aristocypha trifasciata (Selys, 1853)	
Genus: *Libellago* Selys, 1840		
	Libellago lineata (Burmeister, 1839)	
Genus: *Heliocypha* Fraser, 1949		
	Heliocypha biforata (Selys, 1859)	
Genus: *Paracypha* Fraser, 1949		
	Paracypha unimaculata Selys, 1853	
Family: Euphaeidae Yakobson & Bianchi, 1905		
Genus: *Anisopleura* Selys, 1853		
	Anisopleura comes Hagen, 1880	
	Anisopleura lestoides Selys, 1853	
Genus: *Bayadera* Selys, 1853		
	Bayadera indica (Selys, 1853)	
Superfamily: Coenagrionoidea Kirby, 1890		
Family: Coenagrionidae Kirby, 1890		
Genus: *Agriocnemis* Selys, 1877		
	Agriocnemis clauseni Fraser, 1922	
	Agriocnemis corbeti Kumar & Prasad, 1978	Endemic to India
	Agriocnemis pygmaea (Rambur, 1842)	
Genus: *Amphiallagma* Kennedy, 1920		
	Amphiallagma parvum (Selys, 1876)	
Genus: *Ceriagrion* Selys, 1876		
	Ceriagrion cerinorubellum (Brauer, 1865)	
	Ceriagrion coromandelianum (Fabricius, 1798)	
	Ceriagrion fallax Ris, 1914	
Genus: *Ischnura* Charpentier, 1840		
	Ischnura rubilio Selys, 1876	
	Ischnura forcipata Morton, 1908	
	Ischnura nursei Morton, 1907	
	Ischnura senegalensis Rambur, 1842	
Genus: *Paracercion* Weekers & Dumont, 2004		
	Paracercion calamorum (Ris, 1916)	
Genus: *Pseudagrion* Selys, 1876		
	Pseudagrion rubriceps rubriceps Selys, 1876	
	Pseudagrion decorum (Rambur, 1842)	
	Pseudagrion laidlawi Fraser, 1922	
	Pseudagrion spencei Fraser, 1922	
Family: Platycnemididae Yakobson & Bianchi, 1905		
Genus: *Calicnemia* Strand, 1928		
	Calicnemia doonensis doonensi Sangal & Tyagi, 1984	Endemic to India
	Calicnemia eximia Selys, 1863	
	Calicnemia miles (Laidlaw, 1917)	
Genus: *Copera* Kirby, 1890		
	Copera marginipes (Rambur, 1842)	
Genus: *Elattoneura* Cowley, 1935		
	Elattoneura campioni campioni (Fraser, 1922)	
Genus: *Prodasineura* Cowley, 1934		
	Prodasineura autumnalis (Fraser, 1922)	
Superfamily: Lestoidea Calvert, 1901		
Family: Lestidae Calvert, 1901		
Genus: *Indolestes* Fraser, 1922		
	Indolestes cyaneus (Selys, 1862)	
Genus: *Lestes* Leach in Brewster, 1815		
	Lestes concinnus Hagen in Selys, 1862	
	Lestes praemorsus decipiens Kirby, 1893	
	Lestes viridulus Rambur, 1842	
Family: Synlestidae Tillyard, 1917		
Genus: *Megalestes* Selys, 1862		
	Megalestes major Selys, 1862	
Superfamily: Platystictoidea Kennedy, 1920		
Family: Platystictidae Kennedy, 1920		
Genus: *Drepanosticta* Laidlaw, 1917		
	Drepanosticta carmichaeli (Laidlaw, 1915)	

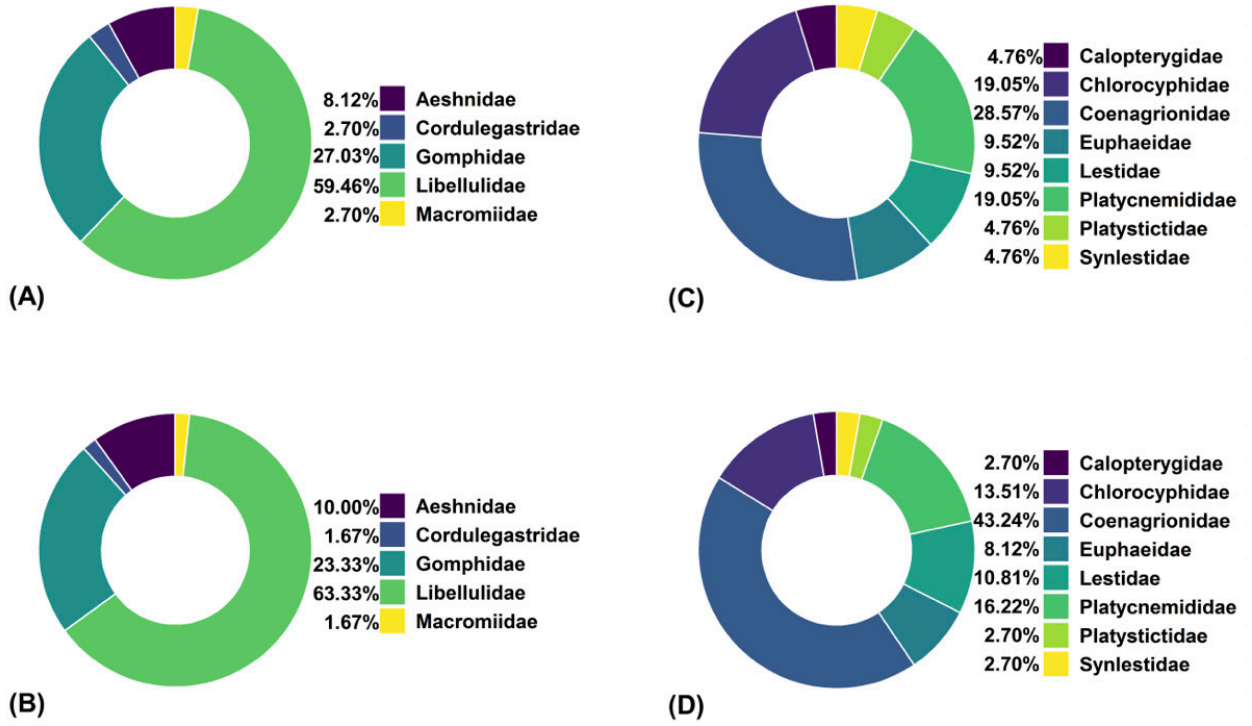

Figure 4. A—Percentage of genera | B—Percentage of species of five families of Anisoptera | C—Percentage of genera | D—Percentage of species of eight families of Zygoptera.

strain on water supplies (Balzan 2012). Since water and habitat management projects are the two most significant trend drivers, conservation research should pay more attention to understanding their function and mechanisms in driving Odonata trend changes (Tang & Visconti 2020). For appropriate biodiversity conservation and management practises, future research should focus on how odonate assemblage structure and diversity are correlated with different habitat variables in Doon valley.

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NAAS rating (India) 5.64

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Journal of Threatened Taxa

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

December 2021 | Vol. 13 | No. 14 | Pages: 20143–20310
Date of Publication: 26 December 2021 (Online & Print)
DOI: 10.11609/jott.2021.13.14.20143-20310

Publisher & Host

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Threatened Taxa