

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

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

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.

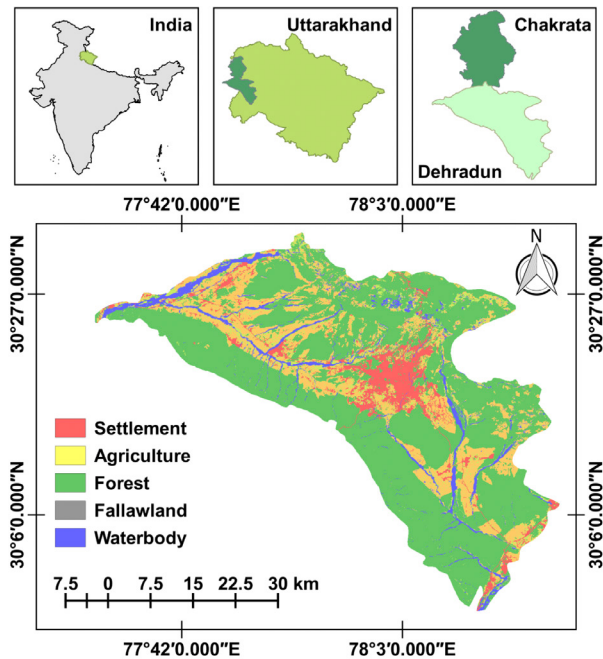


Figure 1. Location and major land-use types of Doon valley.

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 Platynemididae (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, *Burmogomphus sivalikensis* Laidlaw, 1922, and *Hylaeothemis gardeneri* Fraser, 1927 and two damselflies *Agriocnemis corbeti* Kumar & Prasad, 1978 and *Calicnemis 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

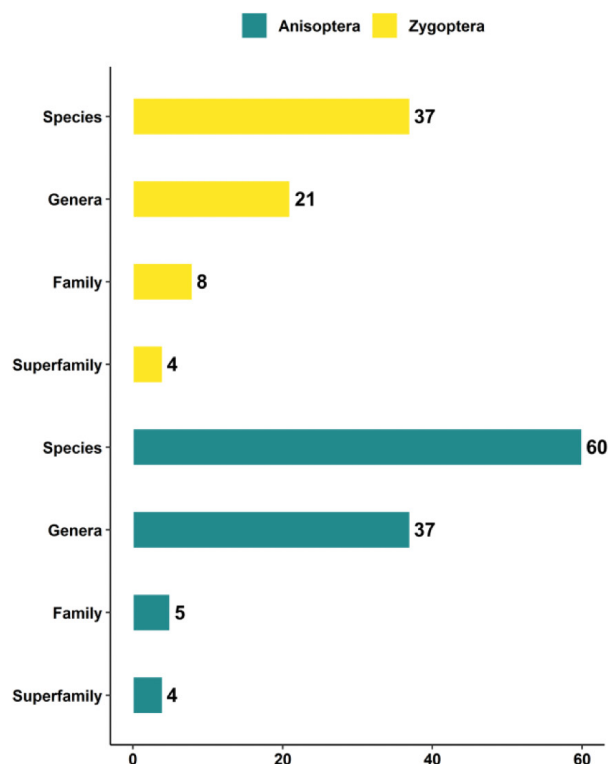


Figure 2. Taxa of Anisoptera and Zygoptera reported from Doon valley.

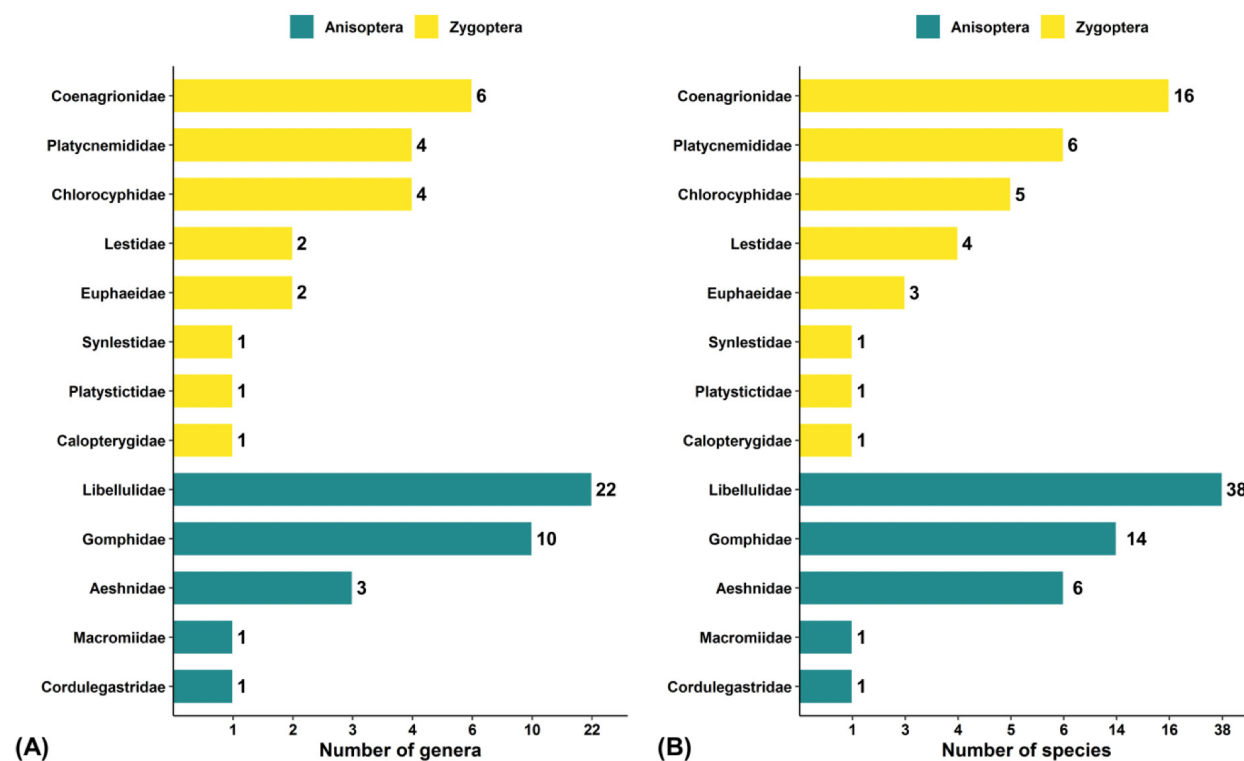


Figure 3. A—numbers of genera | B—species under different families of Anisoptera and Zygoptera.

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		
	<i>Anax guttatus</i> (Burmeister, 1839)	
	<i>Anax immaculifrons</i> Rambur, 1842	
	<i>Anax nigrofasciatus nigrolineatus</i> Fraser, 1935	
	<i>Anax parthenope</i> (Selys, 1839)	
Genus: Gynacantha Rambur, 1842		
	<i>Gynacantha bayadera</i> Selys, 1891	
Genus: Gynacanthaeschna Fraser, 1921		
	<i>Gynacanthaeschna sikkima</i> (Karsch, 1891)	
Superfamily: Gomphoidea Rambur, 1842		
Family: Gomphidae Rambur, 1842		
Genus: Anisogomphus Selys, 1858		
	<i>Anisogomphus occipitalis</i> (Selys, 1854)	
Genus: Anormogomphus Selys, 1854		
	<i>Anormogomphus heteropterus</i> Selys, 1854	Endemic to India
	<i>Anormogomphus kiritschenkoi</i> Bartenev, 1913	
Genus: Burmagomphus Williamson, 1907		
	<i>Burmogomphus hasimaricus</i> Fraser, 1926	
	<i>Burmogomphus sivalikensis</i> Laidlaw, 1922	Endemic to India
Genus: Ictinogomphus Cowley, 1934		
	<i>Ictinogomphus rapax</i> (Rambur, 1842)	
Genus: Lamelligomphus Fraser, 1922		
	<i>Lamelligomphus bitorceps</i> (Selys, 1878)	
	<i>Lamelligomphus risi</i> (Fraser, 1922)	
Genus: Nepogomphus Fraser, 1934		
	<i>Nepogomphus modestus</i> (Selys, 1878)	
Genus: Nychogomphus Carle, 1986		
	<i>Nychogomphus duaricus</i> (Fraser, 1924)	
Genus: Onychogomphus Selys, 1854		
	<i>Onychogomphus cerastis</i> (Selys, 1854)	
Genus: Paragomphus Cowley, 1934		
	<i>Paragomphus lineatus</i> (Selys, 1850)	
Genus: Scalmogomphus Chao, 1990		
	<i>Scalmogomphus bistrigatus</i> (Hagen in Selys, 1854)	
	<i>Scalmogomphus schmidtii</i> Fraser, 1937	
Superfamily: Libelluloidea Leach, 1815		
Family: Libellulidae Leach, 1815		
Genus: Acisoma Rambur, 1842		
	<i>Acisoma panorpoides</i> Rambur, 1842	
Genus: Brachydiplax Brauer, 1868		
	<i>Brachydiplax sobrina</i> (Rambur, 1842)	
Genus: Brachythemis Brauer, 1868		
	<i>Brachythemis contaminata</i> (Fabricius, 1793)	

Genus: Bradinopyga Kirby, 1893		
	<i>Bradinopyga geminata</i> (Rambur, 1842)	
Genus: Cratilla Kirby, 1900		
	<i>Cratilla lineata calverti</i> Förster, 1903	
Genus: Crocothemis Brauer, 1868		
	<i>Crocothemis erythraea</i> (Brullé, 1832)	
	<i>Crocothemis servilia</i> (Drury, 1773)	
Genus: Diplacodes Kirby, 1889		
	<i>Diplacodes lefebvrei</i> (Rambur, 1842)	
	<i>Diplacodes nebulosa</i> (Fabricius, 1793)	
	<i>Diplacodes trivialis</i> Rambur, 1842	
Genus: Hylaeothemis Ris, 1909		
	<i>Hylaeothemis gardeneri</i> Fraser, 1927	Endemic to India
Genus: Neurothemis Brauer, 1867		
	<i>Neurothemis fulvia</i> (Drury, 1773)	
	<i>Neurothemis intermedia intermedia</i> (Rambur, 1842)	
	<i>Neurothemis tullia</i> (Drury, 1773)	
Genus: Orthetrum Newman, 1833		
	<i>Orthetrum brunneum</i> (Fonscolombe, 1837)	
	<i>Orthetrum glaucum</i> Brauer, 1865	
	<i>Orthetrum internum</i> McLachlan, 1894	
	<i>Orthetrum luzonicum</i> (Brauer, 1868)	
	<i>Orthetrum pruinosum neglectum</i> (Burmeister, 1839)	
	<i>Orthetrum sabina sabina</i> (Drury, 1770)	
	<i>Orthetrum taeniolatum</i> (Schneider, 1845)	
	<i>Orthetrum triangulare triangulare</i> (Selys, 1878)	
Genus: Palpopleura Rambur, 1842		
	<i>Palpopleura sexmaculata</i> (Fabricius, 1787)	
Genus: Pantala Hagen, 1861		
	<i>Pantala flavescens</i> (Fabricius, 1798)	
Genus: Potamarcha Karsch, 1890		
	<i>Potamarcha congener</i> (Rambur, 1842)	
Genus: Rhyothemis Hagen, 1867		
	<i>Rhyothemis variegata variegata</i> (Linnaeus, 1763)	
Genus: Sympetrum Newman, 1833		
	<i>Sympetrum striolatum commixtum</i> (Selys, 1884)	
Genus: Tetrathemis Brauer, 1868		
	<i>Tetrathemis platyptera</i> Selys, 1878	
Genus: Tholymis Hagen, 1867		
	<i>Tholymis tillarga</i> (Fabricius, 1798)	
Genus: Tramea Hagen, 1861		
	<i>Tramea basilaris</i> (Palisot de Beauvois, 1817)	
	<i>Tramea virginia</i> (Rambur, 1842)	
Genus: Trithemis Brauer, 1868		
	<i>Trithemis aurora</i> (Burmeister, 1839)	

	<i>Trithemis festiva</i> (Rambur, 1842)	
	<i>Trithemis kirbyi</i> Selys, 1891	
	<i>Trithemis pallidinervis</i> (Kirby, 1889)	
Genus: Urothemis Brauer, 1868		
	<i>Urothemis signata</i> (Rambur, 1842)	
Genus: Zygonyx Selys in Hagen, 1867		
	<i>Zygonyx torridus isis</i> Fraser, 1924	
Genus: Zyxomma Rambur, 1842		
	<i>Zyxomma petiolatum</i> Rambur, 1842	
Family: Macromiidae Needham, 1903		
Genus: Macromia Rambur, 1842		
	<i>Macromia moorei</i> Selys, 1874	
Superfamily: Cordulegastroidea Hagen, 1875		
Family: Cordulegastridae Hagen, 1875		
Genus: Cordulegaster Leach in Brewster, 1815		
	<i>Cordulegaster brevistigma</i> (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		
	<i>Neurobasis chinensis</i> (Linnaeus, 1758)	
Family: Chlorocyphidae Cowley, 1937		
Genus: Aristocypha Laidlaw, 1950		
	<i>Aristocypha quadrimaculata</i> (Selys, 1853)	
	<i>Aristocypha trifasciata</i> (Selys, 1853)	
Genus: Libellago Selys, 1840		
	<i>Libellago lineata</i> (Burmeister, 1839)	
Genus: Heliocypha Fraser, 1949		
	<i>Heliocypha biforata</i> (Selys, 1859)	
Genus: Paracypha Fraser, 1949		
	<i>Paracypha unimaculata</i> Selys, 1853	
Family: Euphaeidae Yakobson & Bianchi, 1905		
Genus: Anisopleura Selys, 1853		
	<i>Anisopleura comes</i> Hagen, 1880	
	<i>Anisopleura lestoides</i> Selys, 1853	
Genus: Bayadera Selys, 1853		
	<i>Bayadera indica</i> (Selys, 1853)	
Superfamily: Coenagrionoidea Kirby, 1890		
Family: Coenagrionidae Kirby, 1890		
Genus: Agriocnemis Selys, 1877		
	<i>Agriocnemis clauseni</i> Fraser, 1922	
	<i>Agriocnemis corbeti</i> Kumar & Prasad, 1978	Endemic to India
	<i>Agriocnemis pygmaea</i> (Rambur, 1842)	

Genus: Amphiallagma Kennedy, 1920		
	<i>Amphiallagma parvum</i> (Selys, 1876)	
Genus: Ceriagrion Selys, 1876		
	<i>Ceriagrion cerinorubellum</i> (Brauer, 1865)	
	<i>Ceriagrion coromandelianum</i> (Fabricius, 1798)	
	<i>Ceriagrion fallax</i> Ris, 1914	
Genus: Ischnura Charpentier, 1840		
	<i>Ischnura rubilio</i> Selys, 1876	
	<i>Ischnura forcipata</i> Morton, 1908	
	<i>Ischnura nursei</i> Morton, 1907	
	<i>Ischnura senegalensis</i> Rambur, 1842	
Genus: Paracercion Weekers & Dumont, 2004		
	<i>Paracercion calamorum</i> (Ris, 1916)	
Genus: Pseudagrion Selys, 1876		
	<i>Pseudagrion rubriceps rubriceps</i> Selys, 1876	
	<i>Pseudagrion decorum</i> (Rambur, 1842)	
	<i>Pseudagrion laidlawi</i> Fraser, 1922	
	<i>Pseudagrion spencei</i> Fraser, 1922	
Family: Platynemididae Yakobson & Bianchi, 1905		
Genus: Calicnemis Strand, 1928		
	<i>Calicnemis doonensis doonensis</i> Sangal & Tyagi, 1984	Endemic to India
	<i>Calicnemis eximia</i> Selys, 1863	
	<i>Calicnemis miles</i> (Laidlaw, 1917)	
Genus: Copera Kirby, 1890		
	<i>Copera marginipes</i> (Rambur, 1842)	
Genus: Elatoneura Cowley, 1935		
	<i>Elatoneura campioni campioni</i> (Fraser, 1922)	
Genus: Prodasineura Cowley, 1934		
	<i>Prodasineura autumnalis</i> (Fraser, 1922)	
Superfamily: Lestoidea Calvert, 1901		
Family: Lestidae Calvert, 1901		
Genus: Indolestes Fraser, 1922		
	<i>Indolestes cyaneus</i> (Selys, 1862)	
Genus: Lestes Leach in Brewster, 1815		
	<i>Lestes concinnus</i> Hagen in Selys, 1862	
	<i>Lestes praemorsus decipiens</i> Kirby, 1893	
	<i>Lestes viridulus</i> Rambur, 1842	
Family: Synlestidae Tillyard, 1917		
Genus: Megalestes Selys, 1862		
	<i>Megalestes major</i> Selys, 1862	
Superfamily: Platystictoidea Kennedy, 1920		
Family: Platystictidae Kennedy, 1920		
Genus: Drepanosticta Laidlaw, 1917		
	<i>Drepanosticta carmichaeli</i> (Laidlaw, 1915)	

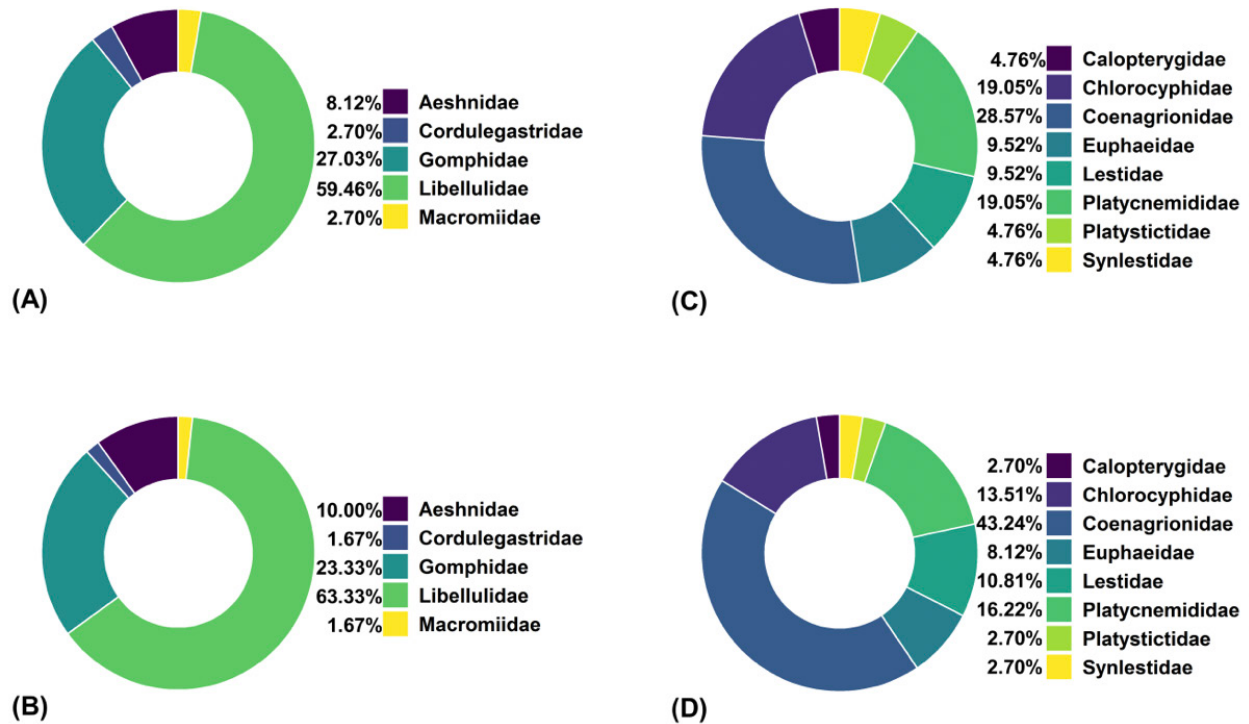


Figure 4. A—Percentage of genera | B—Percentage of species of five families of Anisoptera | C—Percentage of genera | D—Percentage of species of eight families of Zygoptera.

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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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

www.threatenedtaxa.org

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