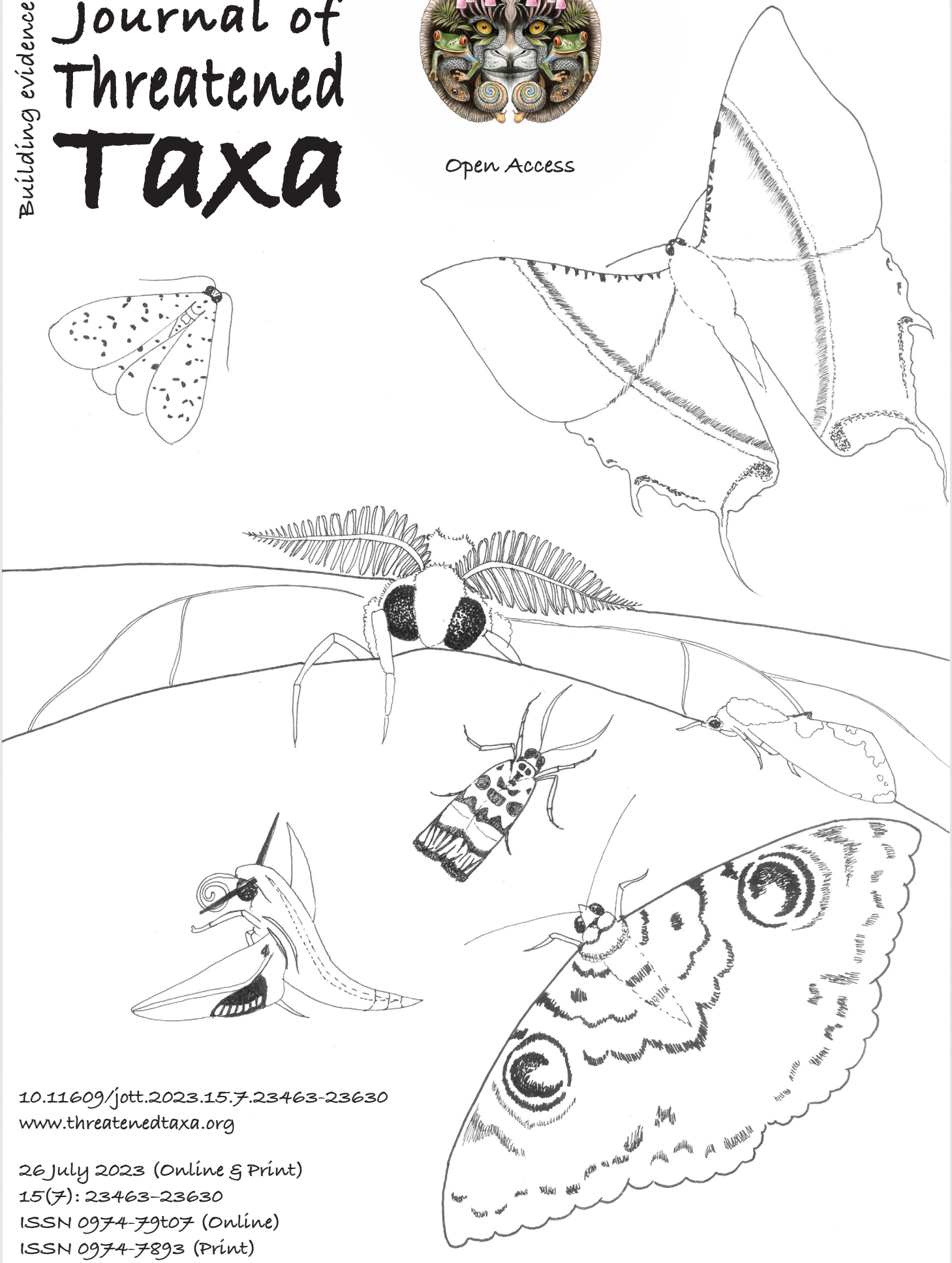
Building evidence for conservation globally

Journal of Threatened Taxa

Open Access



10.11609/jott.2023.15.7.23463-23630
www.threatenedtaxa.org

26 July 2023 (Online & Print)
15(7): 23463–23630
ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

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

43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Registered Office: 3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

For Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scope
For Article Submission Guidelines, visit https://threatenedtaxa.org/index.php/JoTT/about/submissions
For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/policies_various

continued on the back inside cover

Cover: Celebrating the unsung heroes—moths, our nocturnal pollinators. © Priyanka Iyer.

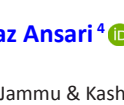
Journal of Threatened Taxa | www.threatenedtaxa.org | 26 July 2023 | 15(7): 23545–23556

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

https://doi.org/10.11609/jott.8203.15.7.23545-23556

#8203 | Received 21 November 2022 | Final received 13 June 2023 | Finally accepted 22 June 2023

OPEN ACCESS



COMMUNICATION

A preliminary assessment of Odonata (dragonflies & damselflies) across an elevation gradient – insights from Shiwaliks to Alpines, northwestern Himalaya, India

Neeraj Sharma [1], Dinesh Singh [2], Shakha Sharma [3] & Ajaz Ansari [4]

[1,2] Institute of Mountain Environment, University of Jammu, Bhaderwah Campus, Bhaderwah, UT of Jammu & Kashmir 182222, India.
[3] Government Gandhi Memorial Science College, Jammu, Jammu, UT of Jammu & Kashmir 180006, India.
[4] Department of Environmental Sciences, University of Jammu, Jammu, UT of Jammu & Kashmir 180006, India.
[1] nirazsharma@gmail.com, [2] itzmed12@gmail.com, [3] shakhasharma24@gmail.com (corresponding author), [4] ajazansari90@gmail.com

Abstract: Understanding the species distribution and richness along an environmental gradient helps identify hotspots and prioritize conservation efforts at landscape scale. This is more effective for the species that are indicators of environmental change, such as odonates. As the information about the distribution of this group of insects is scarce in Jammu & Kashmir, their documentation assumes a greater significance. Here, we present a checklist of odonate species from 23 sites across diverse landscapes in subtropical, temperate, and alpine ecosystems over an elevational gradient of 3,700 m in Jammu division. We recorded 63 species from 39 genera and 11 families, four Anisoptera and seven Zygoptera. The most represented families were Libellulidae (15 genera & 29 species) and Coenagrionidae (five genera & 10 species). The preliminary surveys resulted in addition of 24 new species to the Odanata fauna of Jammu & Kashmir, including three new to the northwestern Himalaya. The study underlines that even opportunistic records are useful in understanding the distribution range and delineating the potential habitats of odonates. The study calls for intensive odonate surveys to better understand their distribution and ecology in hitherto less explored region in the northwestern Himalaya.

Keywords: Amphibiotic insects, Anisoptera, Greater Himalaya, mountains, Pir-Panjal, puddles, stream off shoots, summer ditches, Zygoptera

अमूर्त: पर्यावरण ढाल दे कन्नै-कन्नै प्रजातियें दे बंड ते समृद्धि गी समझने कन्नै हॉटस्पॉट दी पन्छान ते लैंडस्केप पैमाने पर संरक्षण दे प्रयासें गी प्राथमिकता देने च मदद मिलदी ऐ । एह् उनें प्रजातियें आस्तै मता असरदार ऐ जेह् ड़ियां पर्यावरण च बदलाव दे संकेतक न, जि'यां ओडोनेट । चूंकि जम्मू-कश्मीर च कीड़े-मकोड़े दे इस समूह दे बंड बारै जानकारी घट्ट ऐ, इस करी उंदे दस्तावेजें दा मता महत्व ऐ। इत्थें, अस उप-उष्णकटिबंधीय, समशीतोष्ण ते अल्पाइन पारिस्थितिकी प्रणाली च बक्ख-बक्ख परिदृश्यें च 23 थाह्रें थमां ओडोनाटा प्रजातियें दी जांच सूची पेश करदे आं। असें 39 जीनस ते 11 परिवारें थमां 63 प्रजातियां, चार एनिसोप्टेरन ते 7 ज़ाइगोप्टेरन दर्ज कीतियां ! सारें शा मते प्रतिनिधित्व आहले परिवार लिबेलुलिडी हे जिंदे च 15 जीनस ते 29 प्रजातियां ते कोएनग्रिओनिडी (5 जीनस ते 10 प्रजातियां) शामल हे ! सर्वेक्षणें दे नतीजे च जम्मू-कश्मीर दे ओडानाटा जीव-जंतुएं च 24 नमीं प्रजातियां बी शामल कीतियां गेइयां जिंदे च उत्तर-पश्चिमी हिमालय च त्रै नमीं प्रजातियां बी शामल न। अध्ययन इस गल्लै गी रेखांकित करदा ऐ जे अवसरवादी रिकार्ड बी वितरण सीमा गी समझने ते ओडोनेट दे संभावित आवासें गी रेखांकित करने च उपयोगी न। इस अध्ययन च उत्तर-पश्चिमी हिमालय च अजें तगर कम खोजे गेदे इलाके च उंदे बंड ते पारिस्थितिकी गी बेहतर तरीके कन्नै समझने लेई गहन ओडोनेट सर्वेक्षण दा आह्वान कीता गेआ ऐ।

Editor: Pankaj Koparde, MIT World Peace University, Pune, India.

Date of publication: 26 July 2023 (online & print)

Citation: Sharma, N., D. Singh, S. Sharma & A. Ansari (2023). A preliminary assessment of Odonata (dragonflies & damselflies) across an elevation gradient – insights from Shiwaliks to Alpines, northwestern Himalaya, India. *Journal of Threatened Taxa* 15(7): 23545–23556. https://doi.org/10.11609/jott.8203.15.7.23545-23556

Funding: The surveys were partly funded by Department of Wildlife Protection, Govt. of Jammu and Kashmir, and Ministry of Environment, Forest and Climate Change, Govt. of India.

Competing interests: The authors declare no competing interests.

Author details: Neeraj Sharma is an assistant professor in the faculty of life sciences at Institute of Mountain Environment, University of Jammu where he actively engages in research and scientific outreach on various aspects of mountain ecology and biodiversity involving mammals, birds, and insects. Dinesh Singh is a lecturer in the faculty of life sciences, Institute of Mountain Environment (IME), Bhaderwah Campus of University of Jammu. Aside from his interest in alpine vegetation and flora, he has contributed to the exploration of other animal groups in the region, including mammals, birds, odonata, and butterflies. Shakha Sharma is an assistant professor in the department of Zoology, Govt. Gandhi Memorial Sciences College, Jammu. Besides teaching, she has made significant contributions to the lepidopteran diversity of Jammu and Kashmir including several new distributional records and reports on range extension of butterflies in the region. Ajaz Ansari is a Ph.D scholar currently working on large carnivores in a high altitude protected area in Jammu and Kashmir. He has been instrumental in biodiversity assessment of protected area network in Jammu Shiwaliks and has developed expertise in data analysis and modelling.

Author contributions: NS, SS and DS conducted the field surveys and drafted the manuscript; NS and SS conceptualized, designed, and executed the surveys and wrote the manuscript; AA analysed the data, while SS communicated with the journal.

Acknowledgements: The authors would like to express their gratitude to Rector, Bhaderwah Campus, University of Jammu, for his administrative support during the surveys. Department of Wildlife Protection, Government of the UT of Jammu & Kashmir and Ministry of Environment, Forest and Climate Change, Govt. of India are thanked for partly funding the surveys. The authors gratefully appreciate the help rendered by Asha, Anil, Aasma and Vandana for assisting with field surveys and Muzaffar A Kichloo for the preparation of map.

INTRODUCTION

The Himalayan Odonata fauna comprises of 257 species in 112 genera and 18 families with 34 species endemic to the Himalayas (Subramaniam & Babu 2018). Though well-documented in the neighbouring states of Himachal Pradesh and Uttarakhand, the information on the distribution of Odonata in Jammu & Kashmir is scanty. The earlier accounts of Odonata from Jammu & Kashmir dates back to the records of Abott (Calvert 1899), Fraser (1933, 1934, 1936) followed by a few checklists (Singh & Baijal 1954; Asahina 1978; Kumar & Prasad 1981; Carfi et al. 1983; Kumar 1983; Lahiri & Das 1991; Dar et al. 2002; Mitra 2003). Recently, a few surveys have been conducted to describe the diversity and distribution of odonates of Jammu & Kashmir (Subramanian & Babu 2018; Sheikh et al. 2020; Riyaz & Sivasankaran 2021; Quereshi et al. 2022; Kumar et al. 2022). Singh (2022) described 65 species from Jammu & Kashmir based on available literature and the online curated website Odonata of India (https://www.indianodonata.org/) published until 2022.

Geographically, the union territory of Jammu & Kashmir comprises two regions, Jammu & Kashmir characterized by five distinct physiographic units. The Jammu region of Jammu & Kashmir offers a wide range of habitats from the alluvial plains of the Ravi and Chenab rivers in the south to the moderately elevated Shiwaliks, Pir-Panjal, and Greater Himalaya northwards, bordering Kashmir in the north and Ladakh in the north-east. Documenting odonate fauna from such regions becomes important as it helps fill the knowledge gap about distribution of species, which may have conservation implications. To gain a better understanding of the spatial distribution of odonates in the region, we conducted preliminary surveys in seasonal and perennial water bodies in parts of alluvial plains, sub-tropics, lesser, and the Greater Himalaya spanning a vast elevational gradient ranging from 260–3,960 m. The baseline information obtained on the abundance and distribution of 63 species of odonates for the region will be useful for monitoring the health of aquatic ecosystems on spatial and temporal scales.

METHODS

We sampled the adult dragonflies in 23 stations: eleven in the subtropics, nine in temperate, and three in alpine habitats in Rajouri, Jammu, Udhampur, Kathua,

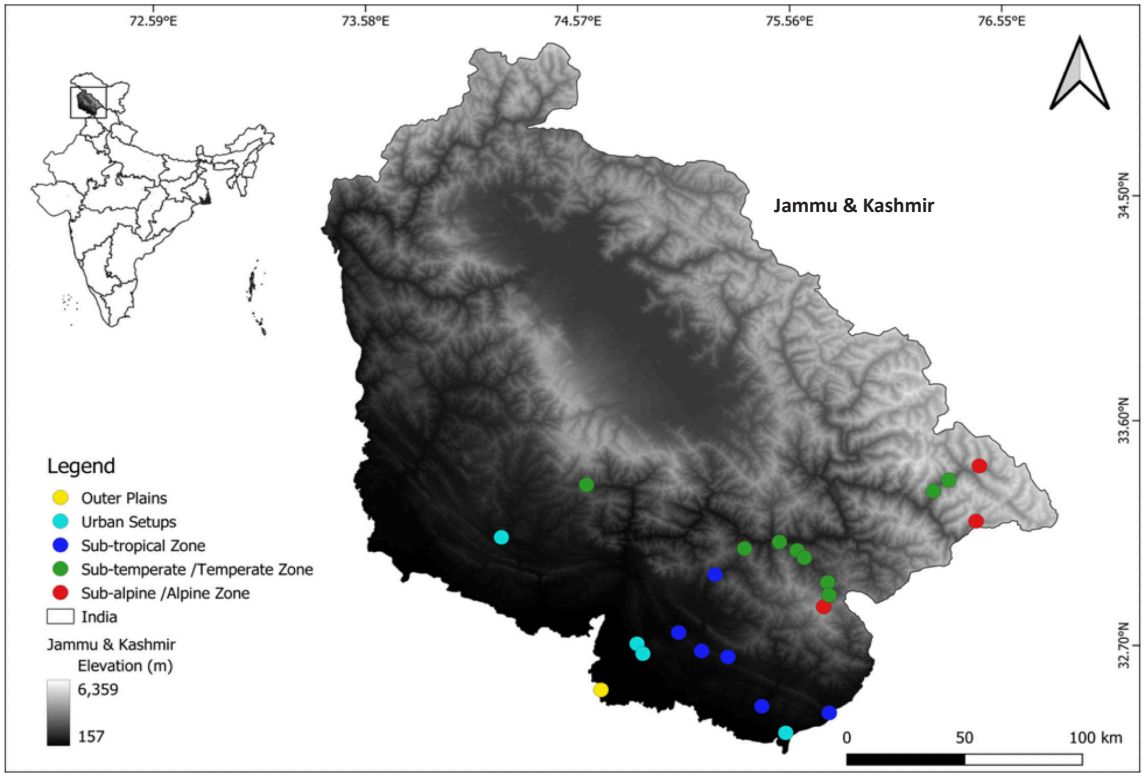


Figure 1. The sampling sites in three climatic zones (subtropical, subtemperate / temperate and alpine) in the study area. The outer plains and urban setups lie in the subtropical zone, a part of Jammu Shiwaliks.

Doda, and Kishtwar districts of Jammu division in the union territory of Jammu & Kashmir. The subtropical habitats included the alluvial plains and hills and ridges of Jammu Shiwaliks (250–1,150 m). Characterized by dry climate and soils with low water retention capacity, most of the sampled habitats included seasonal ponds, roadside ditches, and streams. The subtemperate and temperate ecosystems in the lesser Himalayas were scanned for forested perennial channels, rivulets, and streams in an elevation range of 1,150 to 3,000 m, while sub alpines and alpines included springs, minor streams, summer ditches, and swamps (3,200–4,200 m) in parts of the Greater Himalaya bordering the Zanskar region of Ladakh (Table 1, Image 1). During a two-year sampling period, we followed an opportunistic sampling strategy and visited all stations twice during summer to monsoon (end of May to mid-September) except for the alpines which were too far apart. The individuals were not

Table 1. Spatial attributes of sampling locations, including geomorphological features and the degree of disturbance.

Climate zones	Sampling sites / District	Geo co-ordinates *	Elevation (in m) *	Habitat description	Disturbance
Subtropical zone	1.Gharana and associated wetlands in agricultural landscape, Jammu	32.540°N, 74.690° E	260	A vast agriculture landscape comprised of a protected wetland, marshlands, ditches, channels, and paddy fields	High
	2.GGM Science College, Jammu	32.724° N, 74.851° E	302	Botanical Garden and college lawns	Moderate
	3. Kathua town, Kathua	32.367° N, 75.525° E	318	Urban drain dissecting the twon	High
	4.Trikutanagar, Jammu	32.685° N, 74.879° E	320	Urban storm water drain	High
	5. Nowshera, Rajouri	33.149° N, 74.234° E	543	Urban drain at the confluence with a perennial stream	High
	6. Jasrota WLS / Ujh Barrage, Kathua	32.474° N, 75.417° E	382	A lacustrine ecosystem surrounded with plantations, farmlands and habitations.	Low
	7. Thein Conservation Reserve, Kathua	32.446° N, 75.721° E	518	A terrestrial protected area bounded by a reservoir eastward.	Low
	8. Surinsar, Jammu	32.770° N, 75.041° E	605	Medium sized lake, seasonal ponds and channels	Moderate
	9. Battal, Udhampur	32.672° N, 75.264° E	630	Streams, roadside water channels and ditches	Low
	10. Mansar, Udhampur	32.696° N, 75.145° E	662	Large water body, ponds, and ditches	Moderate
	11. Samroli, Udhampur	33.002° N, 75.206° E	845	Seasonal and perennial streams, ditches, and roadside drains	Moderate
Subtemperate / Temperate zone	12. Pranoo, Doda	33.097° N, 75.580° E	1210	Neeru stream, main channel	Low
	13. Bhalla, Doda	33.068° N, 75.613° E	1270	Neeru stream and tributaries	Low
	14. Khellani, Doda	33.132° N, 75.500° E	1350	Streams, roadside water channels, and springs	Low
	15. Batote, Doda	33.106° N, 75.341° E	1430	Roadside springs, water channels and rivulets	Moderate
	16. Phalni, Rajouri	33.361°N, 74.621° E	1440	A fish farm housing Indian Major Carps adjacent to trout raceways of state fisheries department.	Low
	17. Bhaderwah, Doda	32.969° N, 75.718° E	1714	Springs, water channels and ditches in Bhaderwah Campus, seasonal channels	Low
	18. Kundail, Kishtwar	33.331° N, 76.204° E	2075	Bhot stream and springs	Low
	19. Thanthera, Doda	32.918° N, 75.723° E	2155	Basti stream and roadside springs	Low
	20. Chasoti, Kishtwar	33.374° N, 76.275° E	2356	A typical mountain village with terrace farmlands	Low
Subalpine / Alpine zone	21. Suncham, Kishtwar	32.429° N, 76.410° E	3260	Bhot stream, its tributary Hagshu, springs and channels.	Low
	22. Tun, Kishtwar	33.208° N, 76.396° E	3345	Sansari stream, seasonal ditches, and springs	Low
	23. Kailash Lake, Doda	32.871° N, 75.699° E	3960	Natural springs and rivulets	Low

* Geo co-ordinates and elevation taken as the centre point of each 1.5–2 km² grids sampled.

counted for abundance and density estimates, however, the frequency of sightings was taken into account for computing the relative frequency. The odonates were categorized as very common (sighted during 75–100 % of the sampling), common (sighted between 50–75 % times), occasional (observed between 25–50 %), and rare (sighted below 25% times) following Adarsh et al. (2014). All the field visits were conducted between 1000 h to 1200 h, when the adult odonates are most active. The individual odonates were photographed and identified to the species level referring to the field guides (Subramanian 2005, 2009; Kiran & Raju 2013; Singh 2022) and curated online platforms like Odonata of India website (https://www.indianodonata.org/). No specimens were, however, collected during the surveys. The species have been enlisted following the systematic arrangement and taxonomy of Subramanian et al. (2018) and Kalkman et al (2020).

RESULTS

A total of 63 odonates (40 dragonflies and 23 damselflies) were recorded from the study area. These belonged to 39 genera and 11 families, four anisopterans and seven zygopterans (Table 2, Figure 2, Images 1–63). In terms of habitat sharing, 50 species were exclusively found to be associated with one of the three ecosystems studied, indicating their limited geographical distribution. The sub-tropical ecosystems harboured high richness (SR = 46) accounting for 73% of the total, followed by temperate (SR = 28, 43%) and alpine (SR = 5, 8%). Fourteen species were found to be common across subtropical and temperate ecosystems, whereas temperate and alpine shared only two species, *Cordulegaster brevistigma* and *Orthetrum internum*. Families Calopterygidae, Chlorocyphidae, Chlorocyphidae, and Platycnemididae were confined to subtropical habitats, while Gomphidae, Libellulidae, Coenagrionidae, Euphaeidae, Lestidae, and Synlestidae exhibited affinities for both sub-tropical and temperate climate (Figure 3).

The occurrence data (relative frequency) during the study period shows that 48 species (76%) belonged to occasional and rare (n = 24, each) category. Eleven species were found common and four very common. *Orthetrum pruinosum*, *O. triangulare*, and *Sympetrum commixtum* among the Anisoptera and *Amphiallagma parvum* among the Zygoptera were the most commonly encountered species during the current sampling. In all, 60 species are classified as 'Least Concern' by the IUCN, while three species have not yet been evaluated for their threat status (Table 2). Families Aeshnidae and Libellulidae are found in all three climatic zones, occupying a greater elevational range than other Anisoptera families (Figure 3). Family Cordulegastridae comprising a solitary taxon *Cordulegaster brevistigma* was restricted to temperate and alpine zones, whilst members of the family Gomphidae were restricted to subtropical and temperate regions. Most of

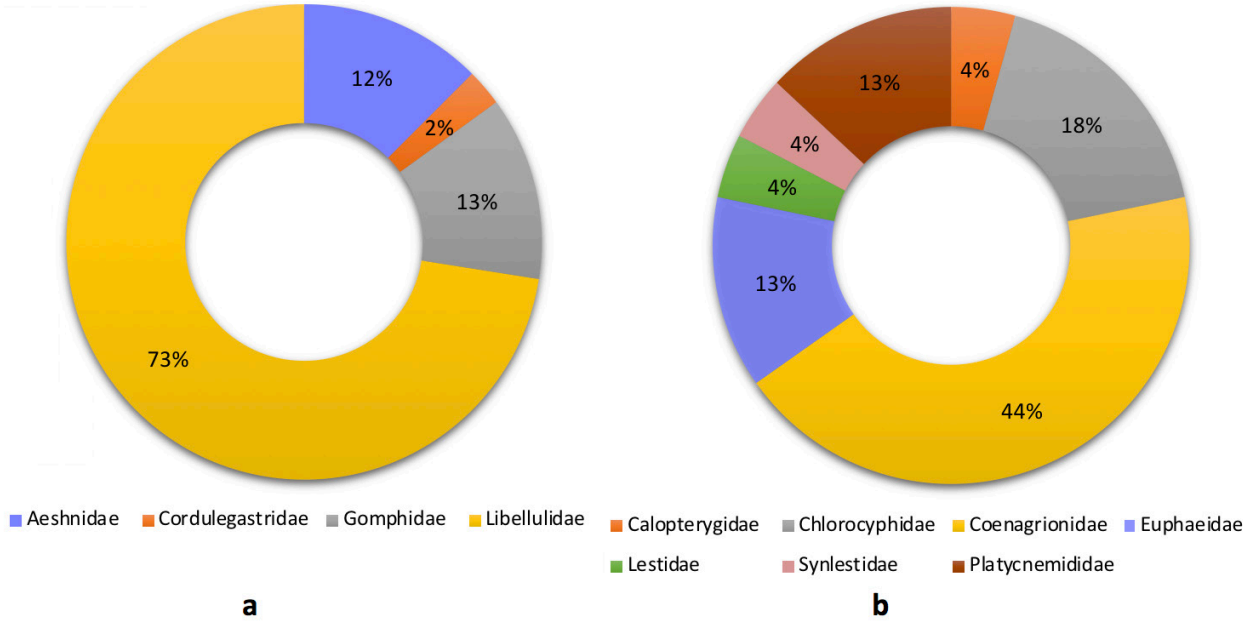


Figure 2. The species observed in different families: a—Anisoptera | b—Zygoptera.

Table 2. Checklist of odonates in the three distinct ecosystems in Jammu division of Jammu & Kashmir depicting distribution, relative frequency and threat status.

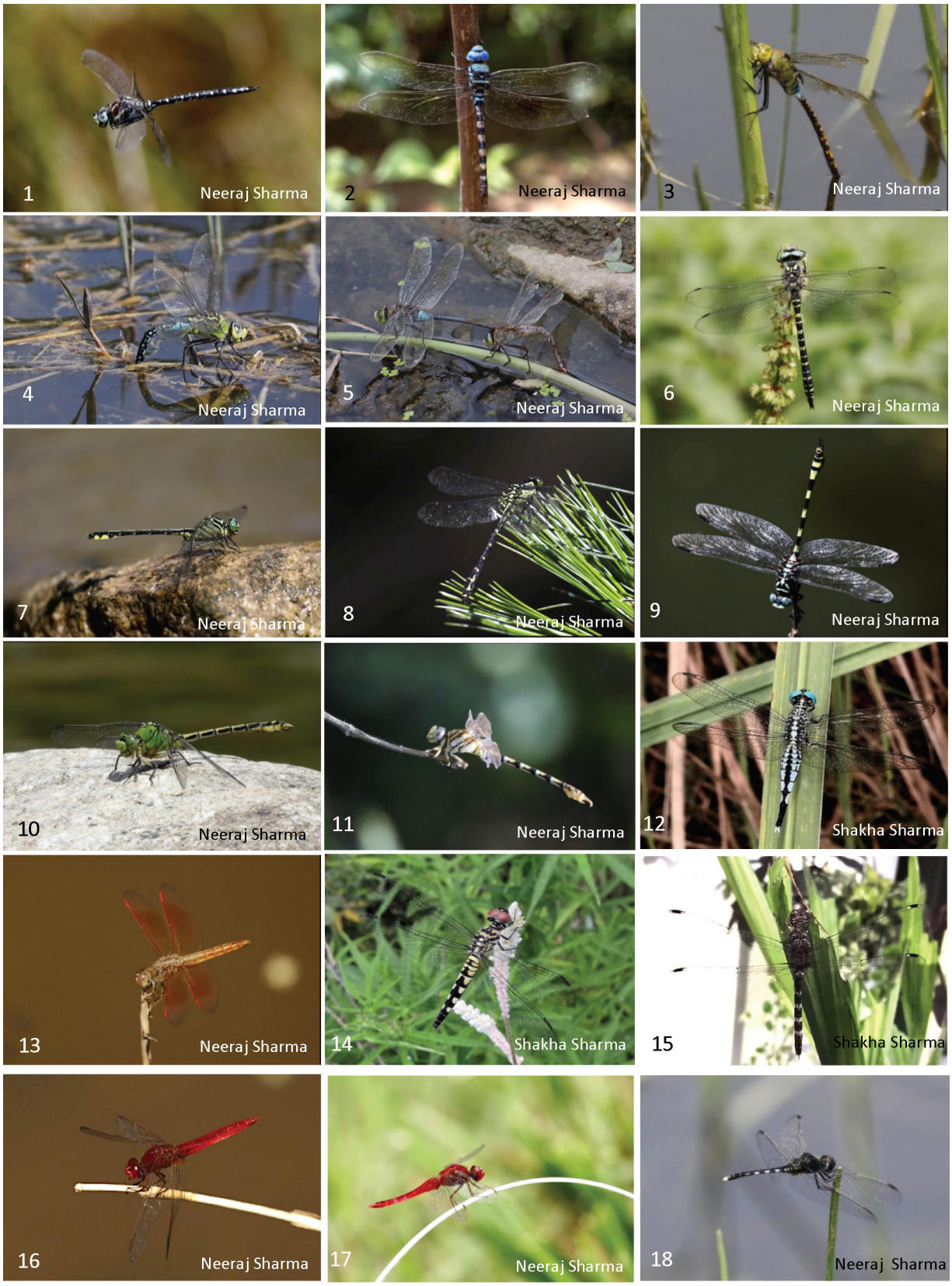
	Suborder / Family / Species	Distribution			Relative frequency	IUCN Red List status	Image number
		ST	TM	AL			
Suborder : Anisoptera (Dragonflies)							
Family : Aeshnidae							
1.	*Aeshna juncea* (Bartenef, 1929)	-	-	+	RA	LC	1
2.	*Anax immaculifrons* (Rambur, 1842)	+	-	-	OC	LC	2
3.	*Anax indicus* (Lieftinck, 1942)*	+	-	-	RA	LC	3
4.	*Anax nigrolineatus* (Fraser, 1935)*	-	+	-	OC	LC	4
5.	*Anax parthenope* (Selys, 1839)	-	+	-	RA	LC	5
Family : Cordulegastridae							
6.	*Cordulegaster brevistigma* (Selys, 1854)	-	+	+	OC	LC	6
Family : Gomphidae							
7.	*Anisogomphus bivittatus* (Selys, 1854)*	-	+	-	OC	LC	7
8.	*Davidius davidii* (Selys, 1878)**	-	+	-	RA	LC	8
9.	*Ictinogomphus rapax* (Rambur, 1842)*	+	-	-	OC	LC	9
10.	*Ophiogomphus reductus* (Calvert, 1898)	-	+	-	OC	LC	10
11.	*Paragomphus lineatus* (Selys, 1850)	+	+	-	OC	LC	11
Family : Libellulidae							
12	*Acisoma panorpoides* (Rambur, 1842)	+	-	-	RA	LC	12
13	*Brachythemis contaminata* (Fabricius, 1793)	+	-	-	OC	LC	13
14	*Brachydiplax sobrina* (Rambur, 1842)*	+	-	-	RA	LC	14
15	*Bradinopyga geminata* (Rambur, 1842)	+	-	-	OC	LC	15
16	*Crocothemis erythraea* (Brullé, 1832)	+	-	-	OC	LC	16
17	*Crocothemis servilia* (Drury, 1770)	+	+	-	CO	LC	17
18	*Diplacodes lefebvrii* (Rambur, 1842)	+	-	-	OC	LC	18
19	*Diplacodes nebulosa* (Fabricius, 1793)*	+	-	-	RA	LC	19
20	*Libellula quadrimaculata* (Linnaeus, 1758)	-	+	-	RA	LC	20
21	*Neurothemis tullia* (Drury, 1773)	+	-	-	RA	LC	21
22	*Orthetrum cancellatum* (Linnaeus, 1758)	-	+	-	RA	LC	22
23	*Orthetrum glaucum* (Brauer, 1865)	-	+	-	OC	LC	23
24	*Orthetrum internum* (McLachlan, 1894)	-	+	+	CO	NE	24
25	*Orthetrum luzonicum* (Brauer, 1868)	-	+	-	CO	LC	25
26	*Orthetrum pruinosum* (Burmeister, 1839)	+	+	-	VC	LC	26
27	*Orthetrum sabina* (Drury, 1770)	+	-	-	CO	LC	27
28	*Orthetrum taeniolatum* (Schneider, 1845)*	+	-	-	RA	LC	28
29	*Orthetrum triangulare* (Selys, 1878)	+	+	-	VC	LC	29
30	*Palpopleura sexmaculata* (Fabricius, 1787)	+	+	-	CO	LC	30
31	*Pantala flavescens* (Fabricius, 1798)	+	-	-	OC	LC	31
32	*Rhyothemis triangularis* (Kirby, 1889)	+	-	-	RA	LC	32
33	*Rhyothemis variegata* (Linnaeus, 1763)	+	-	-	OC	LC	33
34	*Sympetrum commixtum* (Selys, 1884)	-	-	+	VC	LC	34
35	*Sympetrum fonscolombii* (Selys, 1840)	-	+	-	RA	LC	35
36	*Sympetrum speciosum* (Oguma, 1915)*	-	-	+	CO	NE	36
37	*Tramea transmarina* (Selys, 1878)**	-	+	-	OC	LC	37

	Suborder / Family / Species	Distribution			Relative frequency	IUCN Red List status	Image number
		ST	TM	AL			
38	*Tramea virginia* (Rambur, 1842)	+	+	-	OC	LC	38
39	*Trithemis aurora* (Burmeister, 1839)	+	-	-	OC	LC	39
40	*Trithemis festiva* (Rambur, 1842)	+	+	-	CO	LC	40
Suborder : Zygoptera (Damselflies)							
Family : Calopterygidae							
41	*Neurobasis chinensis* (Linnaeus, 1758)	+	-	-	RA	LC	41
Family : Chlorocyphidae							
42	*Aristocypha trifasciata* (Selys, 1853)*	+	-	-	OC	LC	42
43	*Aristocypha quadrimaculata* (Selys, 1853)	+	-	-	CO	LC	43
44	*Paracypha unimaculata* (Selys, 1853)	+	-	-	RA	LC	44
45	*Libellago lineata* (Burmeister, 1839)	+	-	-	OC	LC	45
Family : Coenagrionidae							
46	*Amphiallagma parvum* (Selys, 1876)*	+	+	-	VC	LC	46
47	*Agriocnemis pygmaea* (Rambur, 1842)*	+	-	-	RA	LC	47
48	*Ceriagrion coromandelianum* (Fabricius, 1798)	+	-	-	CO	LC	48
49	*Ischnura forcipata* (Morton, 1907)	+	+	-	CO	LC	49
50	*Ischnura rubilio* (Selys, 1876)	+	+	-	OC	NE	50
51	*Pseudagrion decorum* (Rambur, 1842)*	+	-	-	RA	LC	51
52	*Pseudagrion hypermelas* (Selys, 1876)*	+	-	-	RA	LC	52
53	*Pseudagrion microcephalum* (Rambur, 1842)*	+	-	-	RA	LC	53
54	*Pseudagrion rubriceps* (Selys, 1876)	+	+	-	OC	LC	54
55	*Pseudagrion spencei* (Fraser, 1922)*	+	-	-	OC	LC	55
Family : Euphaeidae							
56	*Anisopleura comes* (Hagen,1880)*	+	+	-	RA	LC	56
57	*Anisopleura lestoides* (Selys,1853)*	-	+	-	OC	LC	57
58	*Bayadera indica* (Selys, 1853)*	+	-	-	RA	LC	58
Family : Lestidae							
59	*Lestes dorothea* (Fraser, 1924)*	+	+	-	OC	LC	59
Family : Synlestidae							
60	*Megalestes major* (Selys, 1862)*	+	+	-	CO	LC	60
Family : Platycnemididae							
61	*Calicnemia imitans* (Lieftinck, 1948)**	+	-	-	RA	LC	61
62	*Copera marginipes* (Rambur, 1842)	+	-	-	RA	LC	62
63	*Drepanosticta carmichaeli* (Laidlaw, 1915)*	+	-	-	RA	LC	63

+—presence | -—absence | ST—Sub-tropical | TM—Subtemperate / Temperate zone | AL—Alpine zone | OC—Occasional | CO—Common | VC—Very Common | RA—Rare | LC—Least Concern | NE—Not Evaluated | *—Addition to the Odonata fauna of Jammu & Kashmir | **—Addition to the Odonata fauna of northwestern Himalaya, India.

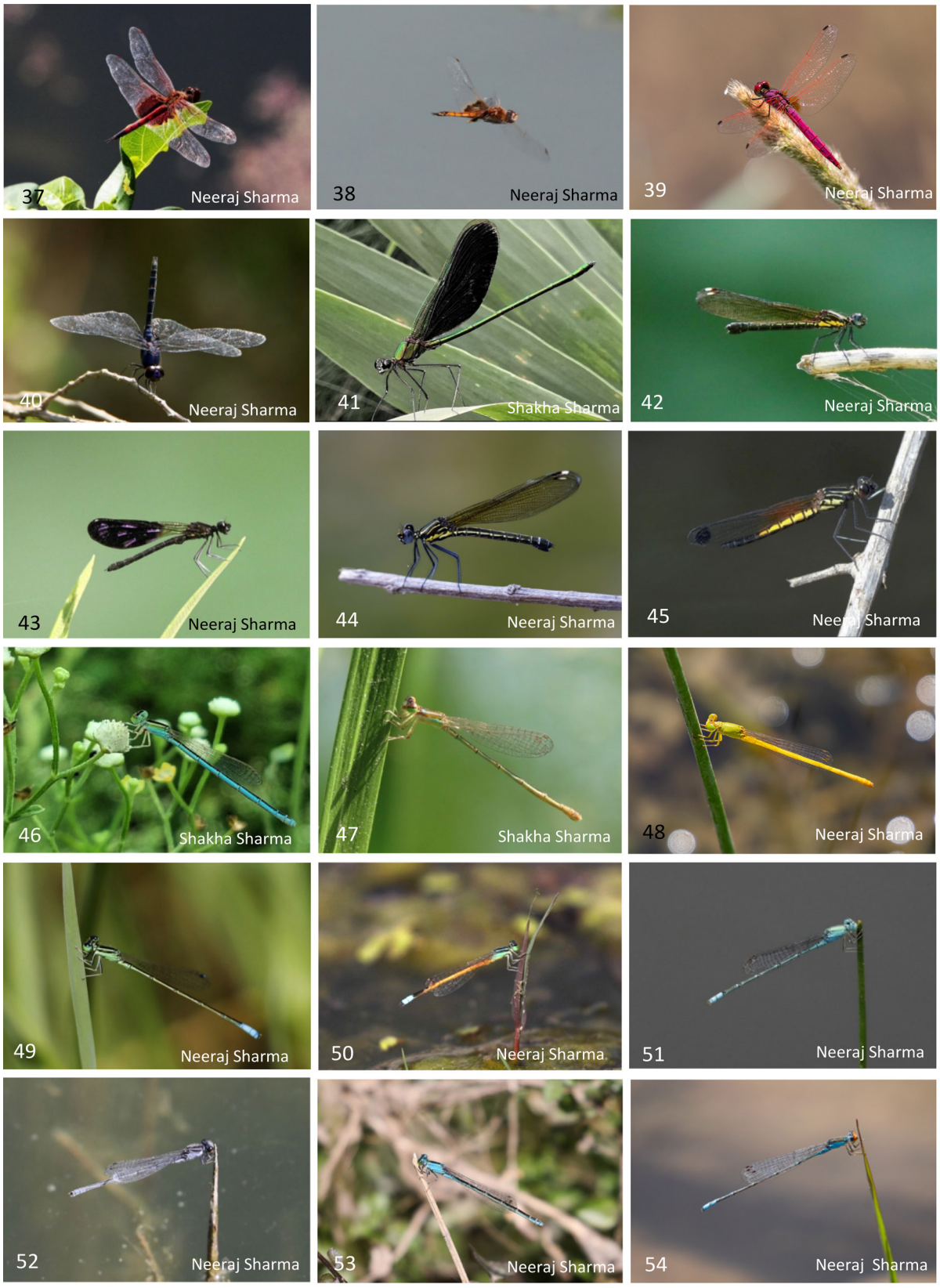
the Zygoptera families occupied subtropical regions, although a few extended their range into sub-temperate and temperate zones (Figure 3).

Twenty-four (10 Anisoptera and 14 Zygoptera) among the 63 species encountered during the surveys are reported for the first time in Jammu & Kashmir, including three new to the northwestern Himalaya. These include *Anax indicus*, *A. nigrolineatus*, *Anisogomphus bivittatus*, *Ictinogomphus rapax*, *Brachydiplax sobrina*, *Diplacodes nebulosa*, *Orthetrum taeniolatum*, *Sympetrum speciosum*, *Aristocypha trifasciata*, *Amphiallagma parvum*, *Agriocnemis pygmaea*, *Pseudagrion decorum*, *P. hypermelas*, *P. microcephalum*, *P. spencei*, *Anisopleura comes*, *A. lestoides*, *Bayadera indica*,



Images 1–18. 1—*Aeshna juncea* | 2—*Anax immaculifrons* | 3—*Anax indicus* | 4—*Anax nigrolineatus* | 5—*Anax parthenope* | 6—*Cordulegaster brevistigma* | 7—*Anisogomphus bivittatus* | 8—*Davidius davidii* | 9—*Ictinogomphus rapax* | 10—*Ophiogomphus reductus* | 11—*Paragomphus lineatus* | 12—*Acisoma panorpoides* | 13—*Brachythemis contaminata* | 14—*Brachydiplax sobrina* | 15—*Bradinopyga geminata* | 16—*Crocothemis erythraea* | 17—*Crocothemis servilia* | 18—*Diplacodes lefebvrii*.

Images 19–36. 19—*Diplacodes nebulosa* | 20—*Libellula quadrimaculata* | 21—*Neurothemis tullia* | 22—*Orthetrum cancellatum* | 23—*Orthetrum glaucum* | 24—*Orthetrum internum* | 25—*Orthetrum luzonicum* | 26—*Orthetrum pruinosum* | 27—*Orthetrum sabina* | 28—*Orthetrum taeniolatum* | 29—*Orthetrum triangulare* | 30—*Palpopleura sexmaculata* | 31—*Pantala flavescens* | 32—*Rhyothemis triangularis* | 33—*Rhyothemis variegata* | 34—*Sympetrum commixtum* | 35—*Sympetrum fonscolombii* | 36—*Sympetrum speciosum.*



Images 37—54. 37—*Tramea transmarina* | 38—*Tramea virginia* | 39—*Trithemis aurora* | 40—*Trithemis festiva* | 41—*Neurobasis chinensis* | 42—*Aristocypha trifasciata* | 43—*Aristocypha quadrimaculata* | 44—*Paracypha unimaculata* | 45—*Libellago lineata* | 46—*Amphiallagma parvum* | 47—*Agriocnemis pygmaea* | 48—*Ceriagrion coromandelianum* | 49—*Ischnura forcipata* | 50—*Ischnura rubilio* | 51—*Pseudagrion decorum* | 52—*Pseudagrion hypermelas* | 53—*Pseudagrion microcephalum* | 54—*Pseudagrion rubriceps*.

Images 55–63. 55—*Pseudagrion spencei* | 56—*Anisopleura comes* | 57—*Anisopleura lestoides* | 58—*Bayadera indica* | 59—*Lestes dorothea* | 60—*Megalestes major* | 61—*Calicnemia imitans* | 62—*Copera marginipes* | 63—*Drepanosticta carmichaeli.*

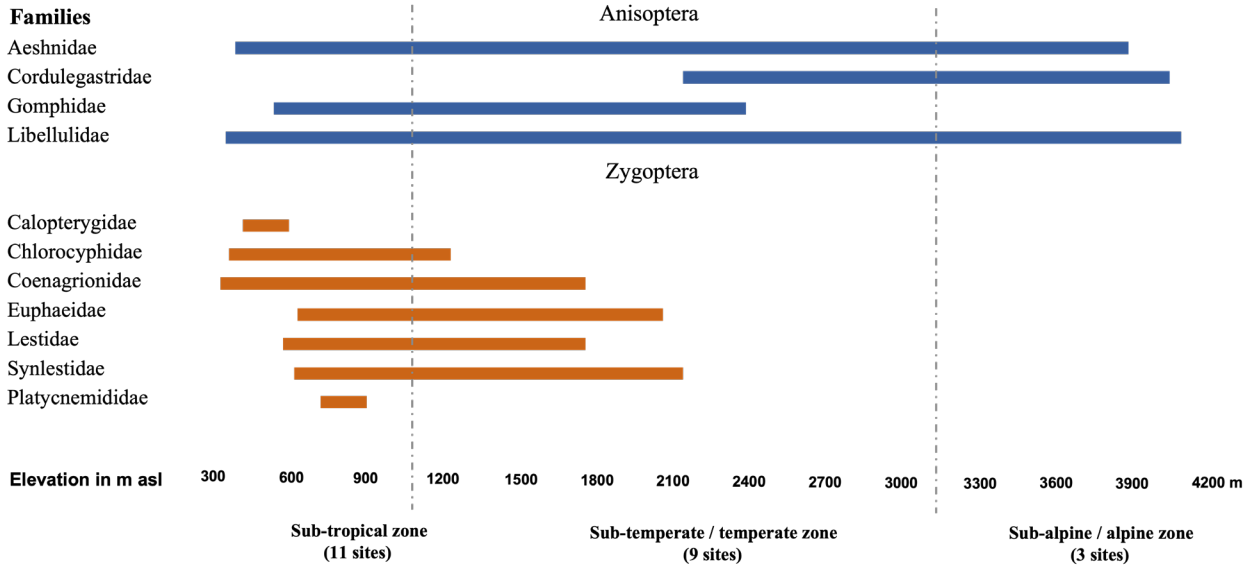


Figure 3. The elevational distribution of odonatan families in the study area. The blue bars represent Anisoptera, while the red bars represent Zygoptera. The dashed lines separate the three climatic zones, the subtropical (11 sites), subtemperate / temperate (9 sites) and alpine (3 sites).

Lestes dorothea, *Megalestes major*, and *Drepanosticta carmichaeli*. Among these *Sympetrum speciosum* and *Aristocypha trifasciata* reported by Singh (2022) are based on the media records of the first author already published in Odonata of India website (https://www.indianodonata.org/). The newly added Odonata fauna to the northwestern Himalaya include *Davidius davidii*, *Tramea transmarina*, and *Calicnemia imitans* (Table 2).

DISCUSSION

The Anisoptera families Libellulidae (29 species) and Aeshnidae & Gomphidae (5 species, each) accounted for nearly 62% of all species observed during the current sampling. Four families (Cordulegastridae, Calopterygidae, Lestidae, and Synlestidae) and 24 genera were monotypic indicating their restricted distribution in the region. Libellulidae and Gomphidae are well-distributed (Subramanian 2005) Anisoptera across the Indian subcontinent. The widespread dispersal and distribution may be attributed to the larger body size of species in these families (Dalzochio et al. 2011). The habitat heterogeneity and varying microclimatic regime sustain a high species richness and diversity (Cramer & Willig 2005; Storch et al. 2023) among different groups of animals. High species richness has been recorded from the small water bodies like rivulets, and streams as they create conducive microhabitats suitable for their survival as observed by Arunima & Nameer (2021), Chandran & Chandran (2021) Chandran et al. (2021), and Thakuria & Kalita (2021) as well. Key conditions for many species include shading around water bodies, specific vegetation structure for breeding and oviposition or nymphal microhabitat availability (Rantala et al. 2004; Cheri & Finn 2023). Subtropical ecosystems supported more odonates than temperate and alpine habitats, indicating a declining trend in species richness with increasing elevation as reported in other insect groups (Vetaas et al. 2019, Fontana et al. 2020; Dewan et al. 2022). No damselfly was found above 2,200 m in the current sampling effort (Figure 3). This does not, however, elude their presence in sub-alpine and alpine climate zones, as these landscapes were not visited as frequently as subtropical and temperate ones were.

Singh (2022) described 184 odonate species from north-western region of India, including 65 from the Union Territory of Jammu & Kashmir. During their explorations in selected localities of the Jammu division, Kumar et al. (2022) observed 32 odonate species, 25 of which are new to Jammu & Kashmir. This communication adds 24 more species to odonate fauna of Jammu & Kashmir, including three new to the northwestern Himalaya. This trend may be explained by the fact that the area has been less explored for Odonata. Recent studies conducted in the Himalaya reveals that Odonata fauna of the region is threatened due to habitat destruction, agricultural expansion, pesticides, tourism, urban and industrial pollution (Subramanian & Babu 2018; De et al. 2021) and this holds true for the study area. Aquatic ecosystems are spatially and temporally constrained (De et al. 2021), and the sites of current explorations are found in close proximity to human settlements, roads and highways making them vulnerable to management activities that threaten the existence of aquatic biodiversity including odonates. Most roadside ditches are being destroyed by road expansions, ponds are being encroached upon for land reclamation, and rivers and streams are being exposed to sand extraction and increased pollutant loads.

In terms of the occurrence data, 48 species belonged to occasional and rare categories. Arunima & Nameer (2021) in their observations recorded a moderately high number of occasional and rare species. Interestingly, all taxa found during the sampling figure in the least concern category of conservation (IUCN 2023) indicating a stable worldwide population. The study though preliminary with limited area coverage and ecological scope has unveiled vital information regarding the distribution of the observed odonate species in the heterogenous landscapes of northwestern Himalaya. Though the current observations on the Odonata do not necessarily provide a complete checklist for the region, they do add to the knowledge of the insect fauna of the Union Territory of Jammu & Kashmir. More systematic research on odonate assemblages and seasonality is needed to describe the ecology and biomonitoring of their habitats in the region as macroinvertebrates are standard bioindicators of freshwater ecosystems (Barbour et al. 1999).

REFERENCES

Adarsh, C.K., K.S. Aneesh & P.O. Nameer (2014). A preliminary checklist of odonates in Kerala Agricultural University (KAU) campus, Thrissur District, Kerala, southern India. *Journal of Threatened Taxa* 6(8): 6127–6137. https://doi.org/10.11609/JoTT.o3491.6127-37

Arunima, J. & P.O. Nameer (2021). A preliminary checklist of dragonflies and damselflies (Insecta: Odonata) of Vakkom Grama Panchayath, Thiruvanthapuram District, Kerala, India. *Journal of Threatened Taxa* 13(8): 19125–19136. https://doi.org/10.11609/jott.7311.13.8.19125-19136

Asahina, S. (1978). A new and some known species of odonata from Kashmir (Insecta), *Senckenbergian Biology* 59 : 115–120.

Barbour, M.T., J. Gerritsen, B.D. Snyder & J.B. Stribling (1999). Rapid

bioassessment protocols for use in streams and wadeable Rivers: Periphyton, benthic macroinvertebrates, and fish, 2nd ed.; U.S. Environmental Protection Agency, Office of Water: Washington, DC,USA.

Cramer, M.J. & M.R. Willig (2005). Habitat heterogeneity, species diversity and null models. *Oikos* 108(2): 209–218. https://doi.org/10.1111/j.0030-1299.2005.12944.x

Calvert, P.P. (1899). Odonata (dragonflies) from the Indian Ocean, and from Kashmir, collected by Dr. W.L. Abott, pp. 141–154. In: Proceedings of the Academy of Natural Sciences of Philadephia.

Carfi, S., C.P. Del & F. Terzani (1983). Odonata captured in Jammu and Kashmir Himachal Pradesh and Uttar Pradesh India, *Giornale Italiano di Entomologia* 1(5): 261–264.

Chandran, R. & A.V. Chandran (2021). Dragonflies and damselflies (Insecta: Odonata) of Aryanad Grama Panchayat, Kerala, India. *Journal of Threatened Taxa* 13(14): 20153–20166. https://doi.org/10.11609/jott.7342.13.14.20153-20166

Chandran, A.V., S.K. Jose & S.V. Gopalan (2021). Dragonflies and damselflies (Insecta: Odonata) of the Kole Wetlands, Central Kerala, India. *Journal of Threatened Taxa* 13(3): 17963–17971. https://doi.org/10.11609/jott.5885.13.3.17963-17971

Cheri, C.R. & D.S. Finn (2023). Odonata as Indicators? Dragonflies and Damselflies Respond to Riparian Conditions along Ozark Spring Streams. *Hydrobiology* 2: 260–276. https://doi.org/10.3390/hydrobiology2010017

Dar, G.A., R.C. Bhagat & M.A. Khan (2002). *Biodiversity of the Kashmir Himalaya*. Valley Book House, Srinagar, India, 399 pp.

Dalzochio, M.S., J.M. Costa & M.A. Uchôa (2011). Diversity of Odonata (Insecta) in lotic systems from Serra da Bodoquena, Mato Grosso do Sul State, Brazil. *Revista Brasileira de Entomologia* 55(1): 88–94.

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

Dewan, S., J.N. Sanders & B.K. Acharya (2022). Turnover in butterfly communities and traits along an elevational gradient in the Eastern Himalaya, India. *Ecosphere* 13(3): e3984. https:// doi.org/10.1002/ecs2.3984

Fontana, V., E. Guariento, A. Hilpold, G. Niedrist, M. Steinwandter, D. Spitale, J. Nascimbene, U. Tappeiner & J. Seeber (2020). Species richness and beta diversity patterns of multiple taxa along an elevational gradient in pastured grasslands in the European Alps. *Scientific Reports* 10: 1–11.

Fraser, F. (1933). The Fauna of British India, Including Ceylon and Burma, Odonata Volume-I. Taylor and Francis Ltd., London.

Fraser, F. (1934). The Fauna of British India, Including Ceylon and Burma, Odonata Volume-II. Taylor and Francis Ltd., London.

Fraser, F. (1936). The Fauna of British India, Including Ceylon and Burma, Odonata Volume-III. Taylor and Francis Ltd., London.

IUCN (2023). International Union for Conservation of Nature. https://www.iucnredlist.org. Assessed on 12 January 2023.

Kalkman, V.J., R. Babu, M. Bedjanič, K. Conniff, T. Gyeltshen, M.K. Khan, K.A. Subramanian, A. Zia & A.G. Orr (2020). Checklist of the dragonflies and damselflies (Insecta: Odonata) of Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. *Zootaxa* 4849(1): 001–084. https://doi.org/10.11646/zootaxa.4849.1.1

Kiran, C.G. & D.V. Raju (2013). *Dragonflies and Damselflies of Kerala (Keralathile Thumbikal)*. Tropical Institute of Ecological Sciences, 156 pp.

Kumar, A. (1983). An annotated list of odonatan from the Jammu region (Western Himalaya, Jammu & Kashmir), India. *Fraseria* 4: 15–16.

Kumar, A.M. & M. Prasad (1981). Field ecology, zoogeography and taxonomy of the Odonata of western Himalaya, India, Records of the Zoological Survey of India, Occasional Paper No. 20: 1–118.

Kumar, K., A.P. Singh & R. Singh (2022). The Diversity of Odonata (Insecta) in Selected Localities of Jammu and Kashmir. *Indian Forester* 148(5): 547–551. https://doi.org/10.36808/if/2022/v148i5/156920

Lahiri, A.R. & S. Das (1991). Observation on the epicranio-orbital complex of some Indian Aeshninae (Odonata: Aeshnidae). *Records of the Zoological Survey of India* 89(1–4): 155–166.

Mitra, T.R. (2003). Ecology and biogeography of Odonata with special reference to Indian Fauna, Records of the Zoological Survey of India, Occasional Paper No. 202. 41 pp.

Qureshi, A.A., N.A. Paray, R.M. Khandi, S. Syeed & R.A. Ganai (2022). Diversity of Odonata of District Pulwama of Kashmir. *Indian Journal of Entomology* e21116. https://doi.org/10.55446/IJE.2021.131.

Rantala, M.J., J. Ilmonen, J. Koskimäki, J. Suhonen & K. Tynkkynen (2004). The macrophyte, Stratiotes aloides, protects larvae of dragonfly *Aeshna viridis* against fish predation. *Aquatic Ecol*ogy 38: 77–82.

Riyaz, M. & K. Sivasankaran (2021). A Preliminary survey of Dragonflies and Damselflies (Insecta: Odonata) in and around Hirpora Wildlife Sanctuary Shopian, Kashmir. *Egyptian Academic Journal of Biological Sciences* 14(1): 133–139. https://doi.org/10.21608/EAJBSA.2021.157352

Sheikh, A.H., M.A. Lone & M.A. Wani (2020). New distributional records of dragonflies (Libellulidae: Anisoptera: Odonata) from Rajouri district of Jammu and Kashmir. *Journal of the Entomological Research Society* 44(1): 121–124.

Singh, S. & H.N. Bajjal (1954). Entomological Survey of the Himalayas II- on a collection of Odonata. *Agra University Journal of Research (Science)* 3: 385–400.

Singh, D. (2022). *Field Guide to the Dragonflies and Damselflies of North west India*. Bishen Singh Mahendra Pal Singh, Dehradun, 518 pp.

Storch, F., S. Boch, M.M. Gossner, H. Feldhaar, C. Ammer, P. Schall, A. Polle, F. Kroiher, J. Müller & J. Bauhus (2023). Linking structure and species richness to support forest biodiversity monitoring at large scales. *Annals of Forest Science* 80: 3. https://doi.org/10.1186/s13595-022-01169-1

Subramanian, K.A. (2005). *Dragonflies and Damselflies of Peninsular India - A Field Guide*. Gadgil, M. (ed.). The Project Lifescape Series. Indian Academy of Sciences, Bangalore, India, 118 pp.

Subramaniam, K.A. (2009). *Dragonflies of India: A Field Guide*. Vigyan Prasar, Noida, 168 pp.

Subramanian, K.A. & R. Babu (2018). Insecta: Odonata, pp. 227–240. In: Chandra, K., D. Gupta, K.C. Gopi, B. Tripathy & V. Kumar (eds.). *Faunal Diversity of Indian Himalaya*. Zoological Survey of India, Kolkata, 872 pp.

Subramanian, K.A., K.G. Emiliyamma, R. Babu, C. Radhakrishnan & S.S. Talmale (2018). *Atlas of Odonata (Insecta) of the Western Ghats, India*. Zoological Survey of India, Kolkata, 417 pp.

Thakuria, D. & J. Kalita (2021). Diversity and distribution of odonates in Rani Reserve Forest, Assam, India. *Journal of Threatened Taxa* 13(1): 17487–17503. https://doi.org/10.11609/jott.5964.13.1.17487-17503

Vetaas, O.R., K.P. Paudel & M.Christensen (2019). Principal factors controlling biodiversity along an elevation gradient: water, energy and their interaction. *Journal of Biogeography* 46: 1652–1663.

Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

Print copies of the Journal are available at cost. Write to:
The Managing Editor, JoTT,
c/o Wildlife Information Liaison Development Society,
43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore,
Tamil Nadu 641006, India
ravi@threatenedtaxa.org

Journal of Threatened Taxa

www.threatenedtaxa.org

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

July 2023 | Vol. 15 | No. 7 | Pages: 23463–23630
Date of Publication: 26 July 2023 (Online & Print)
DOI: 10.11609/jott.2023.15.7.23463-23630

Publisher & Host

WILD ZOOREACH
Threatened Taxa