

Building evidence for conservation globally

Journal of Threatened Taxa

10.11609/jott.2023.15.8.23631-23826

www.threatenedtaxa.org

26 August 2023 (Online & Print)

15(8): 23631-23826

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)



Open Access





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

EDITORS**Founder & Chief Editor****Dr. Sanjay Molur**Wildlife Information Liaison Development (WILD) Society & Zoo Outreach Organization (ZOO),
43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India**Deputy Chief Editor****Dr. Neelesh Dahanukar**

Noida, Uttar Pradesh, India

Managing Editor**Mr. B. Ravichandran**, WILD/ZOO, Coimbatore, Tamil Nadu 641006, India**Associate Editors****Dr. Mandar Paingankar**, Government Science College Gadchiroli, Maharashtra 442605, India**Dr. Ulrike Streicher**, Wildlife Veterinarian, Eugene, Oregon, USA**Ms. Priyanka Iyer**, ZOO/WILD, Coimbatore, Tamil Nadu 641006, India**Dr. B.A. Daniel**, ZOO/WILD, Coimbatore, Tamil Nadu 641006, India**Editorial Board****Dr. Russel Mittermeier**

Executive Vice Chair, Conservation International, Arlington, Virginia 22202, USA

Prof. Mewa Singh Ph.D., FASc, FNA, FNAsc, FNAPsy

Ramanna Fellow and Life-Long Distinguished Professor, Biopsychology Laboratory, and Institute of Excellence, University of Mysore, Mysuru, Karnataka 570006, India; Honorary Professor, Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore; and Adjunct Professor, National Institute of Advanced Studies, Bangalore

Stephen D. Nash

Scientific Illustrator, Conservation International, Dept. of Anatomical Sciences, Health Sciences Center, T-8, Room 045, Stony Brook University, Stony Brook, NY 11794-8081, USA

Dr. Fred Pluthero

Toronto, Canada

Dr. Priya Davidar

Sigur Nature Trust, Chadapatti, Mavinahalli PO, Nilgiris, Tamil Nadu 643223, India

Dr. Martin Fisher

Senior Associate Professor, Battcock Centre for Experimental Astrophysics, Cavendish Laboratory, JJ Thomson Avenue, Cambridge CB3 0HE, UK

Dr. John Fellowes

Honorary Assistant Professor, The Kadoorie Institute, 8/F, T.T. Tsui Building, The University of Hong Kong, Pokfulam Road, Hong Kong

Prof. Dr. Mirco Solé

Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, Vice-coordenador do Programa de Pós-Graduação em Zoologia, Rodovia Ilhéus/Itabuna, Km 16 (45662-000) Salobrinho, Ilhéus - Bahia - Brasil

Dr. Rajeev Raghavan

Professor of Taxonomy, Kerala University of Fisheries & Ocean Studies, Kochi, Kerala, India

English Editors**Mrs. Mira Bhojwani**, Pune, India**Dr. Fred Pluthero**, Toronto, Canada**Mr. P. Ilangovan**, Chennai, India**Ms. Sindhura Stothra Bhashyam**, Hyderabad, India**Web Development****Mrs. Latha G. Ravikumar**, ZOO/WILD, Coimbatore, India**Typesetting****Mrs. Radhika**, ZOO, Coimbatore, India**Mrs. Geetha**, ZOO, Coimbatore India**Fundraising/Communications****Mrs. Payal B. Molur**, Coimbatore, India**Subject Editors 2020–2022****Fungi****Dr. B. Shivaraju**, Bengaluru, Karnataka, India**Dr. R.K. Verma**, Tropical Forest Research Institute, Jabalpur, India**Dr. Vatsavaya S. Raju**, Kakatiya University, Warangal, Andhra Pradesh, India**Dr. M. Krishnappa**, Jnana Sahyadri, Kuvenpu University, Shimoga, Karnataka, India**Dr. K.R. Sridhar**, Mangalore University, Mangalagangotri, Mangalore, Karnataka, India**Dr. Gunjan Biswas**, Vidyasagar University, Midnapore, West Bengal, India**Dr. Kiran Ramchandra Ranadive**, Anna Sahab Magar Mahavidyalaya, Maharashtra, India**Plants****Dr. G.P. Sinha**, Botanical Survey of India, Allahabad, India**Dr. N.P. Balakrishnan**, Ret. Joint Director, BSI, Coimbatore, India**Dr. Shonil Bhagwat**, Open University and University of Oxford, UK**Prof. D.J. Bhat**, Retd. Professor, Goa University, Goa, India**Dr. Ferdinand Boero**, Università del Salento, Lecce, Italy**Dr. Dale R. Calder**, Royal Ontario Museum, Toronto, Ontario, Canada**Dr. Cleofas Cervancia**, Univ. of Philippines Los Baños College Laguna, Philippines**Dr. F.B. Vincent Florens**, University of Mauritius, Mauritius**Dr. Merlin Franco**, Curtin University, Malaysia**Dr. V. Irudayaraj**, St. Xavier's College, Palayamkottai, Tamil Nadu, India**Dr. B.S. Kholia**, Botanical Survey of India, Gangtok, Sikkim, India**Dr. Pankaj Kumar**, Department of Plant and Soil Science, Texas Tech University, Lubbock, Texas, USA**Dr. V. Sampath Kumar**, Botanical Survey of India, Howrah, West Bengal, India**Dr. A.J. Solomon Raju**, Andhra University, Visakhapatnam, India**Dr. Vijayasankar Raman**, University of Mississippi, USA**Dr. B. Ravi Prasad Rao**, Sri Krishnadevaraya University, Anantapur, India**Dr. K. Ravikumar**, FRLHT, Bengaluru, Karnataka, India**Dr. Aparna Watve**, Pune, Maharashtra, India**Dr. Qiang Liu**, Xishuangbanna Tropical Botanical Garden, Yunnan, China**Dr. Noor Azhar Mohamed Shazili**, Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia**Dr. M.K. Vasudeva Rao**, Shiv Ranjan Housing Society, Pune, Maharashtra, India**Prof. A.J. Solomon Raju**, Andhra University, Visakhapatnam, India**Dr. Mander Datar**, Agharkar Research Institute, Pune, Maharashtra, India**Dr. M.K. Janarthanam**, Goa University, Goa, India**Dr. K. Karthigeyan**, Botanical Survey of India, India**Dr. Errol Vela**, University of Montpellier, Montpellier, France**Dr. P. Lakshminarasiham**, Botanical Survey of India, Howrah, India**Dr. Larry R. Noblick**, Montgomery Botanical Center, Miami, USA**Dr. K. Haridasan**, Pallavur, Palakkad District, Kerala, India**Dr. Analinda Manila-Fajard**, University of the Philippines Los Baños, Laguna, Philippines**Dr. P.A. Siru**, Central University of Kerala, Kasaragod, Kerala, India**Dr. Afroz Alam**, Banasthali Vidyapith (accredited A grade by NAAC), Rajasthan, India**Dr. K.P. Rajesh**, Zamorin's Guruvayurappan College, GA College PO, Kozhikode, Kerala, India**Dr. David E. Boufford**, Harvard University Herbaria, Cambridge, MA 02138-2020, USA**Dr. Ritesh Kumar Choudhary**, Agharkar Research Institute, Pune, Maharashtra, India**Dr. A.G. Pandurangan**, Thiruvananthapuram, Kerala, India**Dr. Navendu Page**, Wildlife Institute of India, Chandrabani, Dehradun, Uttarakhand, India**Dr. Kannan C.S. Warrier**, Institute of Forest Genetics and Tree Breeding, Tamil Nadu, India**Invertebrates****Dr. R.K. Avasthi**, Rohtak University, Haryana, India**Dr. D.B. Bastawade**, Maharashtra, India**Dr. Partha Pratim Bhattacharjee**, Tripura University, Suryamaninagar, India**Dr. Kailash Chandra**, Zoological Survey of India, Jabalpur, Madhya Pradesh, India**Dr. Ansie Dippenaar-Schoeman**, University of Pretoria, Queenswood, South Africa**Dr. Rory Dow**, National Museum of natural History Naturalis, The Netherlands**Dr. Brian Fisher**, California Academy of Sciences, USA**Dr. Richard Gallon**, Ilandudno, North Wales, LL30 1UP**Dr. Hemant V. Ghate**, Modern College, Pune, India**Dr. M. Monwar Hossain**, Jahangirnagar University, Dhaka, BangladeshFor Focus, Scope, Aims, and Policies, visit https://threatenedtaxa.org/index.php/JoTT/aims_scopeFor 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: Coromandal Sacred Langur *Semnopithecus priam* - made with acrylic paint. © P. Kritika.



Seasonal variation and habitat role in distribution and activity patterns of Red-wattled Lapwing *Vanellus indicus* (Boddaert, 1783) (Aves: Charadriiformes: Charadriidae) in Udaipur, Rajasthan, India

Sahil Gupta¹  & Kanan Saxena² 

^{1,2} Department of Zoology, Govt. Meera Girls College, Mohanlal Sukhadia University, Udaipur, Rajasthan 313001, India.

¹sgsahil14@gmail.com, ²kananamitsaxena@gmail.com (corresponding author)

Abstract: Red-wattled Lapwings *Vanellus indicus* are resident waders in Asia. They usually inhabit areas close to water and are mainly insectivorous. Their principal habitats are grasslands, wetlands, arable lands, gardens and open forests. These highly active and vocal birds are known for their wide range of distraction displays. A field investigation of distribution across different seasons and diverse habitats in Udaipur, Rajasthan was conducted from 2019 to 2021. Populations of lapwings varied significantly among locations, with the largest documented at Fateh Sagar Lake and the lowest at Rang Sagar Lake. Both habitat types and seasons (summer, monsoon and winter) had significant effects on lapwing distribution. Wetlands were the most preferred habitat at ten major study locations, and the monsoon was found to be the most favored season. Bird activity patterns did not exhibit significant variation with seasons, with locomotion, vigilance, feeding and maintenance being the most performed activities.

Keywords: Behavioral activities, habitat preference, lapwings, seasonal effect, vigilance.

Abbreviations: MLSU—Mohanlal Sukhadia University | RCA—Rajasthan College of Agriculture

Editor: H. Byju, Coimbatore, Tamil Nadu, India.

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

Citation: Gupta, S. & K. Saxena (2023). Seasonal variation and habitat role in distribution and activity patterns of Red-wattled Lapwing *Vanellus indicus* (Boddaert, 1783) (Aves: Charadriiformes: Charadriidae) in Udaipur, Rajasthan, India. *Journal of Threatened Taxa* 15(8): 23729–23741. <https://doi.org/10.11609/jott.8075.15.8.23729-23741>

Copyright: © Gupta & Saxena 2023. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by providing adequate credit to the author(s) and the source of publication.

Funding: None.

Competing interests: The authors declare no competing interests.

Author details: SAHIL GUPTA is a research scholar at Department of Zoology, Mohanlal Sukhadia University, Udaipur, Rajasthan, India. His interests include ecological and ethological studies on birds. He has so far published five articles in reputed journals. KANAN SAXENA is professor and head at Department of Zoology, Government Meera Girls College, Udaipur, Rajasthan, India. She has several research papers to her credit and is recognized for her contribution in diverse fields such as ethology, entomology and toxicology. She has experience of 31 years in teaching & research.

Author contributions: SG carried out research work on Red-wattled lapwings under the supervision of Prof. Kanan Saxena. All the photographs and data were collected by him. He performed statistical analyses of data and wrote the manuscript. KS laid out the concept and framework of the research work. The interpretation of results was carried out by her. The manuscript was written under her guidance.

Acknowledgements: The authors are thankful to the authorities and staff of Government Meera Girls College and Mohanlal Sukhadia University for their constant support and timely help during each stage of this research work. We are highly grateful to our families for their continuous encouragement and motivation.



INTRODUCTION

Red-wattled Lapwings *Vanellus indicus* are resident waders that usually inhabit areas close to water. They are widely distributed throughout Asia, having been reported from India, Iran, Iraq, Kuwait, Oman, Syrian Arab Republic, Turkey, United Arab Emirates, Bangladesh, Bhutan, Cambodia, China, Indonesia, Israel, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, Singapore, Sri Lanka, Thailand, and Vietnam (Ali & Ripley 2001; Wiersma & Kirwan 2020; BirdLife International 2023). This species is found in lowlands up to 1,800 m in Sri Lanka, and to at least 2,300 m in the Himalaya. The principal habitats of lapwings are grasslands, wetlands, arable lands, gardens, and open forests (Wiersma & Kirwan 2019). The global population is estimated to be about 50,000 to 60,000 individuals (BirdLife International 2023). The IUCN Red List of Threatened Species classifies Red-wattled Lapwing as 'Least Concern', and it is listed under Schedule IV of the Indian Wildlife Protection Act, 1972.

The literature on the population structure and distribution of Red-wattled Lapwing is limited, and a proper assessment of populations is lacking, probably due to a perceived absence of immediate threats to the species. However, some reports do indicate threats to lapwing populations and habitats. Karakas (2016) recorded 20–30 breeding pairs in Turkey, and reported that the construction of dams posed a threat to the habitats of this species causing population decline and moderate range expansion in search of suitable habitats. Gupta & Kaushik (2011) highlighted habitat destruction and threats to lapwings in Kurukshetra, Haryana.

Red-wattled Lapwings are highly active and vocal birds that are known for their wide range of distraction displays (Kalsi & Khera 1987). These birds are mainly insectivorous but also are known to feed on food grains (Babi 1987), molluscs (Madhava & Botejue 2011) and fishes (Greeshma & Jayson 2019). Studies on the seasonal variations as well as variations in the daily activity patterns with breeding and non-breeding periods have not been reported earlier.

Udaipur city offers unique habitat diversity such as mountain ranges, elevated plateaus, green plains, forests, rivers, and wetlands which explains the choice of this city as the field for study. The presence of ample natural resources such as food and water make the city a perfect haven for bird species such as Red-wattled Lapwings. Thus, the study was conducted to provide baseline information regarding the distribution pattern, habitat preference, and activity patterns of Red-wattled

Lapwing at 10 major locations covering diverse habitats of Udaipur city.

MATERIALS AND METHODS

Study area

The field survey was carried out in different areas of Udaipur City (24.585° N and 73.712° E), southern Rajasthan, India between 01 September 2019 to 30 September 2021. The study was conducted during the three main seasons viz. summer (March to June), monsoon (July to September), and winter (October to February). Diverse habitats of Red-wattled Lapwings, such as wetlands, grasslands, open fields, river banks, islands, and gardens were selected for the assessment. The sampling sites were randomly chosen and their GPS (global positioning system) coordinates were determined using Garmin eTrex 20x (Appendix 1, Image 1a) for documenting the distribution pattern of Red-wattled Lapwings. The Red-wattled Lapwings were recorded in wetlands (Lake Fateh Sagar, Lake Pichola, Rang Sagar Lake, Goverdhan Sagar Lake, and Ayad River), crop-fields (farms near Fateh Sagar Lake, Ayad River, and agricultural lands in Rajasthan College of Agriculture (RCA) and Mohanlal Sukhadia University (MLSU) campuses), grasslands (inside MLSU, areas around Fateh Sagar Lake, Goverdhan Sagar Lake, Ayad River, and Sajjangarh Biological Park), urban parks (Sukhadia Memorial Park and Gulab Bagh), protected areas (Sajjangarh Biological Park and Gulab Bagh), institutional green spaces (MLSU and RCA campuses) and constructed buildings, roads, and footpaths (areas around Fateh Sagar Lake, Pichola Lake, Rang Sagar Lake, Goverdhan Sagar Lake, MLSU, and Ayad River) as shown in Image 1b.

Population monitoring

The population survey was carried out by adopting the point count method (Bibby et al. 2000). A total of 288 vantage points (maintained 200 m between two sites) spanning a total area of 37.5 km². We spent 5 min at each site and then started documentation of the lapwings without disturbing them. Birds were recorded using binoculars (Nikon Aculon A211 8 x 42) as well as auditory detections (using RecForge II app on a smartphone) within a range of 30 m at each site. Flying birds were not recorded. To analyze the correlation between the influence of season and habitat preference, the number of birds recorded during the first week of the month were selected for each season, viz.: January for

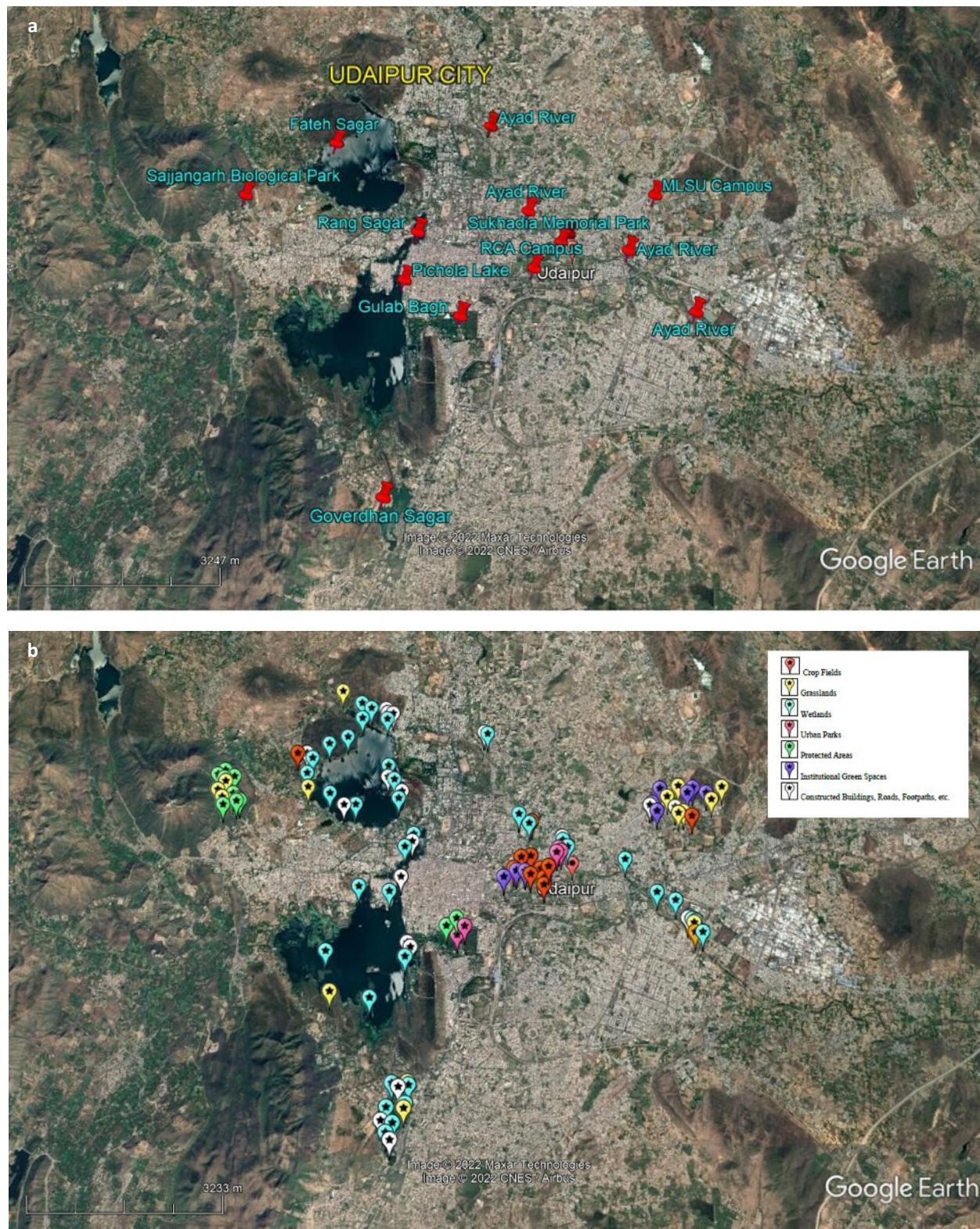


Image 1. a—Satellite map of selected sampling sites in Udaipur city for population survey of Red-wattled Lapwing | b—Satellite map showing diverse habitat areas of Red-wattled Lapwings at the study sites in Udaipur city.

winter, June for summer, and September for monsoon (Chaudhury & Koli 2018).

Activity pattern sampling

Focal sampling and scan sampling techniques (Altmann 1974) were employed to observe the activity patterns of lapwings daily between 0700–1000 h, 1200–1300 h, and 1600–1800 h during different seasons. About 6–8 pairs of birds were randomly selected from diverse habitats. The behaviour was recorded and observed using binoculars at a distance of 15 m to avoid disturbance. Each bird was observed at 5 min time intervals.

The activity patterns of selected birds were recorded for 480 hours during the entire study time. The following activity patterns of Red-wattled Lapwings were observed during the investigation: (i) locomotion, (ii) maintenance, (iii) feeding, (iv) vigilance, (v) vocalizations, (vi) displays, (vii) inactivity, (viii) social interaction, and (ix) miscellaneous activities. Since the birds were not tagged, there was a possibility of recording the activity of birds more than once. However, the probability of deviation in data due to the error gets reduced because the same bird was not recorded more than once during the time of scanning. To ensure that the same bird was not observed more than once during the scanning time, observations were made only of birds that were present throughout the observation time. The activity of a bird that flew away or towards the selected site

during a particular observation time was not recorded. Moreover, each bird was observed only for 5 min during every observation cycle and if birds are presumed to alter their activities with specific factors such as breeding or non-breeding seasons and time, then according to Maruyama et al. 2010, the spotting of same individual more than once doesn't imply strong pseudo-replication.

Statistical analyses

The statistical analyses were carried out using GraphPad Prism and Microsoft Excel software. Two-way analysis of variance (ANOVA) was used to test the significance of the population status of Red-wattled Lapwings in different months (Factor 1) at various sampling sites (Factor 2). Similarly, the numbers of lapwings in diverse habitats (Factor 1) during different seasons (Factor 2) were also tested using the two-way ANOVA method. Mann-Whitney U test and two-way ANOVA were used to study the activities of the birds across different months. A comparative analysis of activities between breeding and the non-breeding season was also performed by carrying out Mann-Whitney U test and multiple-t tests. Further, the activities at various periods during breeding and non-breeding season were also analyzed by two-way ANOVA. Data were computed at a probability level of 5% and were used as the minimal criteria of significance.

Table 1. Population status of *Vanellus indicus* during study periods 2019–2020 and 2020–2021 from all study sites of Udaipur City.

	Sites	2019–2020												2020–2021											
		Sep 19	Oct 19	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20	Jun 20	Jul 20	Aug 20	Mean ± SD	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Mar 21	Jun 21	Jul 21	Aug 21	Sep 21	Mean ± SD		
1.	Fateh Sagar	33	31	24	23	22	24	58	60	68	72	41.5 ± 20.45	43	31	28	29	32	52	66	74	68	56	61.7 ± 14.22		
2.	Rang Sagar	2	0	2	2	0	2	6	6	8	4	3.2 ± 2.70	3	1	0	2	2	4	4	8	6	4	3.6 ± 2.50		
3.	Pichola Lake	32	22	21	19	20	22	48	57	60	64	36.5 ± 18.62	30	22	21	23	23	36	48	50	54	39	37.9 ± 16.32		
4.	Ayad River	18	16	18	17	15	18	28	42	48	52	27.2 ± 14.53	22	19	18	18	17	24	32	48	46	24	26.8 ± 11.52		
5.	Goverdhan Sagar Lake	21	12	12	10	10	12	22	28	34	38	19.9 ± 10.44	14	8	8	7	8	12	18	26	31	16	15.4 ± 8.53		
6.	RCA Campus	10	10	12	12	10	11	30	27	32	28	18.2 ± 9.92	8	10	8	8	10	14	19	24	20	14	13.5 ± 5.76		
7.	MLSU Campus	21	24	22	20	22	20	47	43	48	56	32.3 ± 14.34	23	22	20	20	20	28	42	46	44	26	30.1 ± 11.28		
8.	Sajjangarh Park	15	16	16	14	14	16	39	52	58	46	28.6 ± 17.98	17	14	16	15	16	30	37	32	34	25	23.9 ± 9.10		
9.	Sukhadia Memorial Park	6	3	4	4	3	3	5	8	6	8	5 ± 1.94	2	0	1	0	2	4	6	4	6	5	3 ± 2.31		
10.	Gulab Bagh	14	10	8	9	8	8	12	22	26	28	14.5 ± 7.85	16	12	12	8	10	16	22	30	38	27	19.1 ± 9.85		

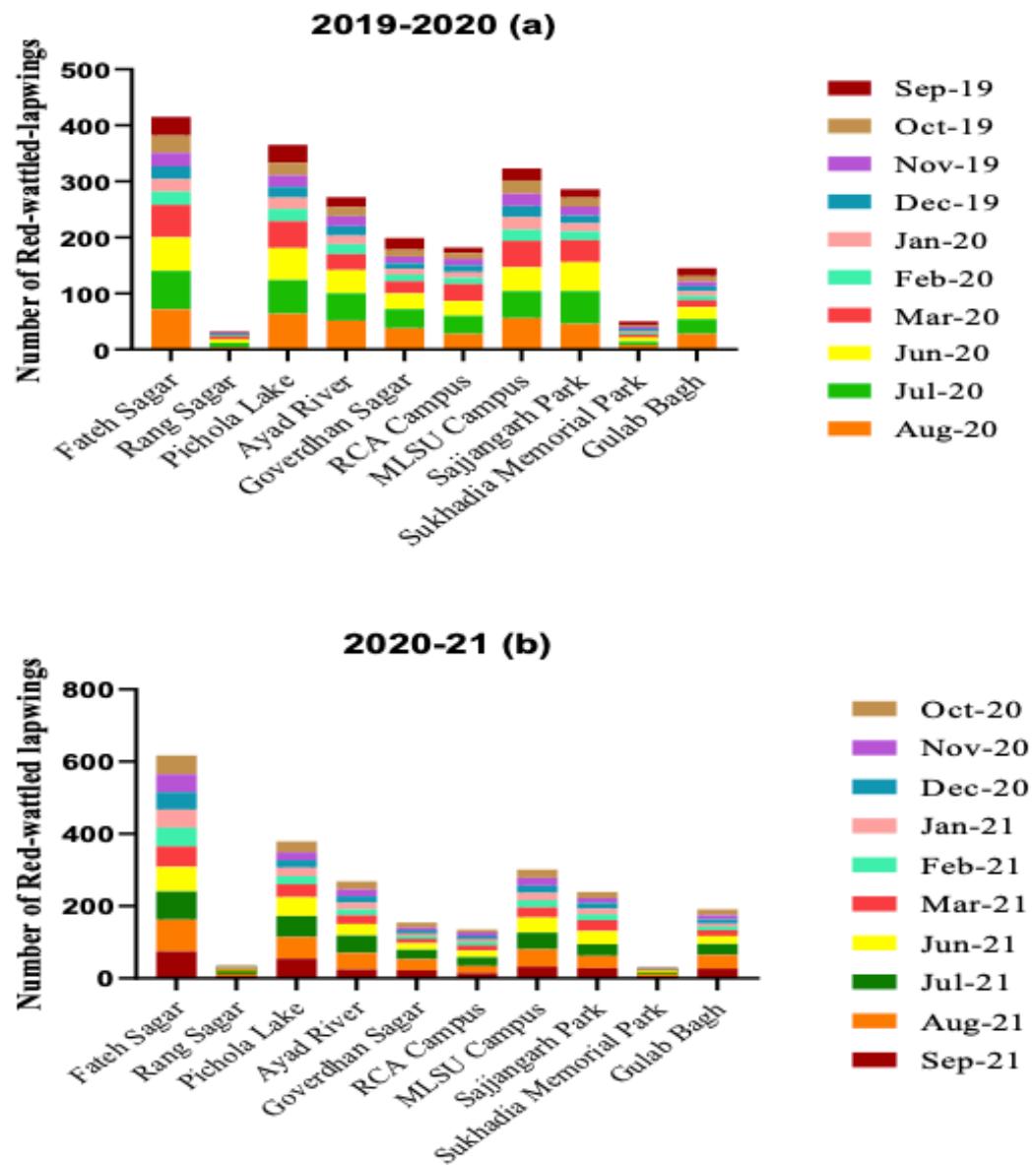


Figure 1. Population status of Red-wattled Lapwings at different locations of Udaipur City in various months during the study periods: a—2019–2020 | b—2020–2021.

RESULTS

During the current study, 2269 (Mean value = 226.9) Red-wattled Lapwings were observed in the period from September 2019 to August 2020, while 2350 (Mean value = 235) lapwings were recorded during the period between October 2020 and September 2021.

Maximum population of Red-wattled Lapwing was found at Lake Fateh Sagar (41.5 ± 20.45) and minimum at Rang Sagar Lake (3.2 ± 2.7) during the observation period from 2019 to 2020. The statistical analysis of data presented in Table 1 revealed that the variation of the population at diverse locations ($F = 32.37$; p

<0.0001 ; $df = 9$) was slightly more significant than that with different months ($F = 26.02$; $p < 0.0001$; $df = 8$). The highest population was recorded in August 2020 (39.60 ± 22.72) while the lowest was in January 2020 (12.4 ± 7.63) (Figure 1a).

During the study period from 2020 to 2021, the highest population occurred at Fateh Sagar (61.70 ± 14.22) while the lowest population was found at Sukhadia Memorial Park (3.00 ± 2.31) (Figure 1b). On performing ANOVA for Table 1, the result showed that the population varied highly significantly at various sites ($F = 105.30$; $p < 0.0001$; $df = 9$) compared to different months ($F = 26.71$; $p < 0.0001$; $df = 9$). The highest

population was observed in August 2021 (37.70 ± 24.91) while the least was in January 2021 (15.10 ± 14.45).

Combining the results of both years, the highest population was found at Lake Fateh Sagar (51.47 ± 14.28) and the lowest at Rang Sagar Lake (3.4 ± 0.28).

Further, the varied habitats and seasons on the population status of Red-wattled Lapwings were also analyzed (Figure 2). The Red-wattled Lapwings existed in diverse habitats (Image 2). It was found that the nature of the habitat produced a highly significant impact on the population ($F = 67.62$; $p < 0.0001$; $df = 6$). The highest population occurred in wetlands (50 ± 13.34) followed by crop fields (21.33 ± 9.85), protected areas encompassing scrub forests and shrubland (20 ± 7.82), grasslands (18.83 ± 9.35), institutional green spaces (18.33 ± 8.11), urban parks or gardens (15.83 ± 7.49) and constructed buildings, footpaths & roads (11.5 ± 3.39) (Table 2). Although the wetland was the most preferred habitat, the lowest numbers of lapwings were recorded at Rang Sagar Lake. This may be due to the indiscriminate dumping of garbage and sewage in the lake as well as excessive human disturbances near this wetland. Conversely, the presence of these birds near human habitation such as urban parks and constructed buildings indicates that these birds have adapted well to

the anthropogenic pressure.

Further, variation of the population across different habitats in diverse seasons also showed significance ($F = 33.92$; $p < 0.0001$; $df = 8$). The overall highest population of lapwings in various seasons was recorded in monsoon (33.14 ± 1.11) followed by summer (19.86 ± 1.21) and winter (14.57 ± 0.61) during the study periods (Table 2). On the contrary, the number of individuals was higher in the wetlands in the summer season.

The activity patterns of Red-wattled Lapwings studied during the periods 2019–2020 and 2020–2021 did not show any significant variation by performing Mann Whitney U-test ($U = 39$; $p = 0.9314$). A two-way ANOVA revealed that the percentage of each activity varied highly significantly across different months ($F = 218.4$; $p < 0.0001$; $df = 8$) but the percentage of all activities in a particular month did not vary considerably ($F = 0.0072$; $p > 0.9999$; $df = 8$) in 2019–2020 (Table 3). For the 2020–2021 study period, again the percentage of each activity varied significantly across different months ($F = 182.6$; $p < 0.0001$; $df = 8$) but the percentage of all activities in a particular month showed insignificant variation ($F = 0.0019$; $p > 0.9999$; $df = 8$) (Table 3).

The analysis of activity patterns during the breeding and non-breeding season showed that there were no

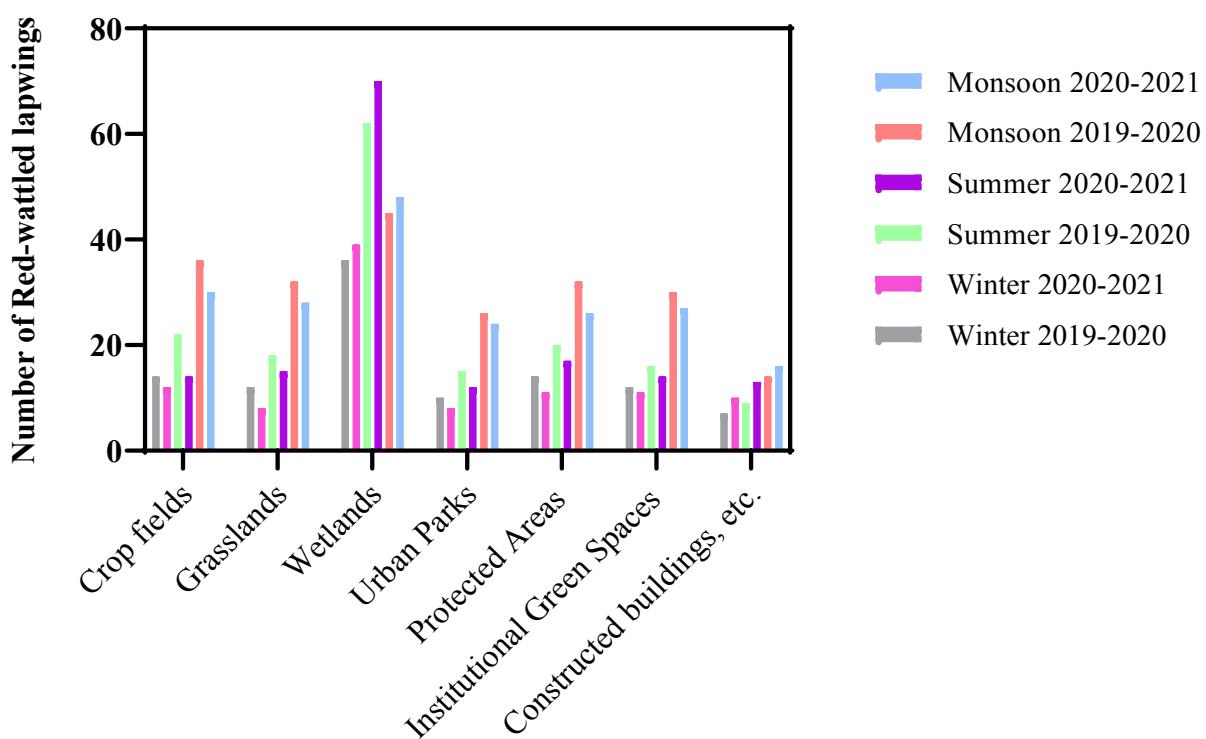


Figure 2. Population distribution of Red-wattled Lapwings across various habitats in Udaipur City during winter, summer, and monsoon seasons in 2019–2020 and 2020–2021.



Image 2. Red-wattled Lapwings thriving across different habitats in Udaipur City: a—Crop-field | b—Grassland | c—Wetland (Lake) | d—Wetland (River) | e—Protected area | f—Urban Park | g—Institutional green spaces | h—University Campus' fountain area | i—Embankment | j—Footpath | k—Building's rooftop | l—Vacant site | m—Roadside. © Sahil Gupta.

Table 2. Population distribution of *Vanellus indicus* across different habitats of Udaipur City in various seasons during 2019–2021.

	Habitats	Winter Season		Summer Season		Monsoon Season		Total	
		2019–2020	2020–2021	2019–2020	2020–2021	2019–2020	2020–2021	2019–2020	2020–2021
1.	Crop fields	14	12	22	14	36	30	72	56
2.	Grasslands	12	8	18	15	32	28	62	51
3.	Wetlands	36	39	62	70	45	48	143	157
4.	Urban Parks (Gardens)	10	8	15	12	26	24	51	44
5.	Protected Areas (Scrub Forests and shrubland)	14	11	20	17	32	26	66	54
6.	Institutional Green Spaces	12	11	16	14	30	27	58	52
7.	Constructed buildings, roads, footpaths, etc.	7	10	9	13	14	16	30	39
Total individuals in different seasons		105	99	162	155	215	199	482	453

Table 3. Activities of Red-wattled Lapwings during different months in the periods 2019–2020 and 2020–2021.

	Activity	Relative Percentage of Activities (2019–2020)									Relative Percentage of Activities (2020–2021)										
		Sep 19	Oct 19	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20	Apr 20	Aug 20	Mean ± SD	Oct 20	Nov 20	Dec 20	Jan 21	Feb 21	Jun 21	Jul 21	Aug 21	Sep 21	Mean ± SD
1	Locomotion	18.19	21.68	22.08	22.01	23.21	21.72	17.64	16.82	16.74	20.01 ± 2.59	21.13	22.78	22.11	23.27	21.12	15.01	16.54	16.65	16.98	19.51 ± 3.17
2	Foraging	12.86	15.12	15.19	15.08	15.23	15.7	10.93	12.97	12.82	13.99 ± 1.64	15.07	15.29	15.38	15.98	15.11	12.06	11.91	10.94	11.77	13.72 ± 1.98
3	Vigilance	32.28	31.03	30.45	30.23	29.08	30.8	40.87	41.05	40.24	34.00 ± 5.11	30.83	30.96	29.5	30.32	30.98	42.07	40.44	41.95	40.89	35.33 ± 5.74
4	Maintenance	15.84	15.28	15.81	15.88	16.32	15.43	13.24	12.06	12.12	14.66 ± 1.70	16.12	15.68	16.18	15.48	15.29	13.08	12.96	12.95	12.56	14.48 ± 1.54
5	Defense	1.17	1.19	1.08	1.26	0.98	1.14	1.98	2.04	1.27	1.34 ± 0.39	1.16	1.17	1.21	1.15	0.99	2.01	2.06	1.9	1.48	1.46 ± 0.42
6	Vocalization	2.38	1.95	2.05	1.99	1.66	1.72	2.6	2.66	2.42	2.16 ± 0.37	1.92	2.12	1.96	1.79	1.71	2.75	2.85	2.93	2.08	2.23 ± 0.48
7	Social interactions	0.73	0.63	0.67	0.68	0.7	0.82	0.72	0.66	0.74	0.70 ± 0.05	0.69	0.68	0.65	0.72	0.68	0.69	0.67	0.7	0.71	0.69 ± 0.02
8	Inactivity	11.67	9.68	10.02	9.78	10.06	10.72	8.88	8.62	10.33	9.97 ± 0.92	9.82	9.27	9.87	9.23	10.91	9.23	9.38	9.14	11.19	9.78 ± 0.77
9	Miscellaneous	4.88	3.44	2.65	3.17	2.76	3.67	3.14	3.12	3.32	3.35 ± 0.65	3.26	2.05	3.14	3.06	3.21	3.1	3.19	2.84	2.34	2.91 ± 0.43

significant differences in the behaviours during both seasons (Figure 3) (Mann Whitney $U = 40$; $p > 0.9999$). During the breeding season, vigilance (40.31%), locomotion (16.89%), maintenance (12.73%), and foraging (12.22%) were the main activities followed by inactivity (9.72%), miscellaneous activities (3.14%), vocalization (2.14%), defense (2.07%), and social interactions (0.78%) (Table 4). A two-way ANOVA at different periods of the day revealed that each activity varied significantly at different times during the breeding season ($F = 194.5$; $p < 0.0001$; $df = 8$) but there was no major difference in all activities performed in a particular period ($F = 2.29$; $p = 0.0712$; $df = 5$) (Table 4, Figure 4a).

The major activities of Red-wattled Lapwing during the non-breeding season were vigilance (30.66%)

followed by locomotion (21.21%), feeding (16.17%), maintenance (15.19%), and other activities such as inactivity (10.02%), miscellaneous (2.74%), defense (1.36%), vocalizations (1.94%), and social interactions (0.71%) (Table 4). Multiple t-tests for activities in breeding and non-breeding seasons revealed that significant differences exist in vigilance (t ratio = 5.571; $p = 0.000182$; $df = 10$; q -value = 0.000645) and defense (t ratio = 6.587; $p = 0.000062$; $df = 10$; q -value = 0.000437) (Table 4). In the non-breeding season, each activity at different periods of the day ($F = 230.6$; $p < 0.0001$; $df = 8$), as well as activities performed in a particular period ($F = 2.29$; $p = 0.0712$; $df = 5$), showed noteworthy variation, the former being far more significant than the latter (Table 4, Figure 4b).

Overall, the results show that amongst all the

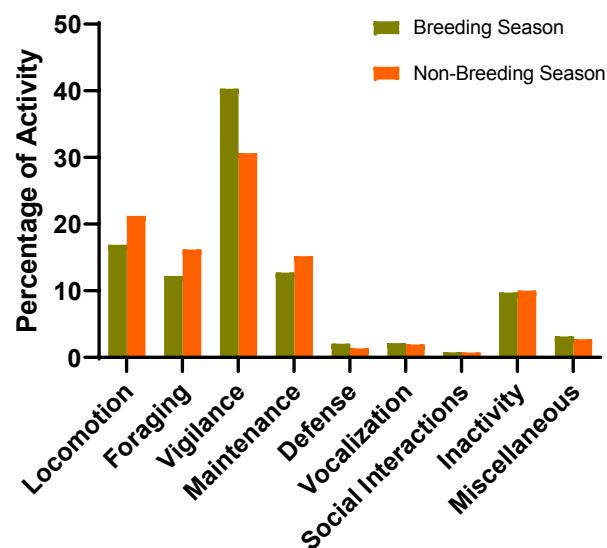


Figure 3. Percentage of activities of Red-wattled Lapwings across breeding and non-breeding seasons.

activities displayed during the study period, the Red-wattled Lapwing showed the highest level of vigilance activity (alert posture/crouched in alert, neck usually extended forward with upright posture and horizontal bill) throughout the months of breeding as well as non-breeding seasons. Locomotion (walking, running, and flying) was the second most performed activity. Feeding (foraging- foraging-stop-run-peck, foot stirring as well as prey handling) and maintenance (preening, bathing, scratching, stretching, grooming legs with bill, and shaking the plumage) were the next most important activities. It was found that during the non-breeding season, the birds were less vigilant and spent more time feeding, especially during morning and late afternoon.

Red-wattled Lapwings were often observed standing still or resting during the study schedule. It was more prominent during the evening hour (1700–1800 h). Miscellaneous activities such as disheveling of feathers, tail shaking, stomping the ground, head lowering, spreading wings, and defecating were also demonstrated by Red-wattled Lapwing during the investigation.

The defense strategies adopted by Red-wattled Lapwing included distraction displays like injury feigning, crouched run, false brooding, false feeding, aggression and mobbing, escape behaviour, and swooping. The lapwings showed defense behaviour and uttered loud alarm calls more during the breeding season (March to September) to protect their nests and young ones from predators.

Red wattled-Lapwings were also spotted interacting among themselves as well as found in association with

birds like Cattle Egret *Bubulcus ibis*, Little Cormorant *Microcarbo niger*, Red-naped Ibis *Pseudibis papillosa*, Painted Stork *Mycteria leucocephala*, Asian Openbill Stork *Anastomus oscitans*, Little Grebe *Tachybaptus ruficollis*, and mammals like cattle. The lapwings were frequently seen roosting with birds like cormorants and alerting other bird species by making alarm calls. Two intra- and one inter-specific conflicts were observed. The intra-specific conflicts were for territory and mate while the interspecific fight with Cattle Egret *Bubulcus ibis* was for food. We observed that when predators like crows or dogs were sighted, lapwings showed active defense behaviour, especially during the breeding season. We also documented that during the non-breeding season, a foraging lapwing was not found to be scared in the presence of a dog who was at less than 1 m. Our observations revealed that when humans were at 5 m or less, the Red-wattled Lapwings were often observed uttering loud calls, running, and on approaching closer, the birds often flew away. Thus, a diverse range of behaviour of Red-wattled Lapwings was observed during our study.

DISCUSSIONS

Population Studies on Red-wattled Lapwings

The overall highest population was found at Fateh Sagar Lake while the lowest was recorded at Rang Sagar Lake, which could probably be ascribed to several factors such as high level of human disturbance, indiscriminate dumping of garbage and poor sewage management of Rang Sagar Lake (Pillai 2000) rendering it one of the most polluted lakes of Udaipur city and unsuitable habitat for lapwings. The breeding season of Red-wattled Lapwing extends from March to August (Kumar et al. 2005). The occurrence of the highest number of Red-wattled Lapwings in August and the lowest number of lapwings in January is probably because August and January coincide with the breeding and non-breeding seasons of these birds, respectively.

Red-wattled Lapwings usually prefer open areas near water resources (Wiersma & Kirwan 2019). In our surveys the birds were found over a wide range of open habitats such as croplands, grasslands, wetlands, protected areas, institutional green spaces, constructed buildings, roads, footpaths, etc. which corroborate with earlier observations (Ali 1996; del Hoyo et al. 1996; Ali & Ripley 2001; Narwade et al. 2010; Sethi et al. 2011; Muralidhar & Barve 2013). The habitat preference of lapwings reveals that the proximity of water and food

Table 4. Percentage of activities of Red-wattled Lapwings at a different period of the day during the breeding and non-breeding seasons.

	Activity	Period of day (hours) during Breeding Season						Total Percentage	Period of day (hours) during Non-Breeding Season						Total Percentage
		0701–0800	0801–0900	0901–1000	1201–1300	1601–1700	1701–1800		0701–0800	0801–0900	0901–1000	1201–1300	1601–1700	1701–1800	
1	Locomotion	3.52	3.69	3.21	2.04	2.23	2.2	16.89	3.56	3.8	3.95	3.12	3.74	3.04	21.21
2	Foraging	2.06	2.62	2.29	1.46	2.16	1.63	12.22	2.16	3.24	3.47	2.1	2.98	2.12	16.17
3	Vigilance	6.72	7.14	7.03	6.38	6.93	6.11	40.31	4.93	5.52	5.68	4.44	5.57	4.52	30.66
4	Maintenance	1.37	2.64	2.66	2.76	1.78	1.52	12.73	2.38	2.68	2.78	2.42	2.56	2.37	15.19
5	Defense	0.37	0.39	0.36	0.32	0.35	0.28	2.07	0.2	0.22	0.25	0.24	0.21	0.24	1.36
6	Vocalization	0.38	0.37	0.35	0.29	0.36	0.39	2.14	0.33	0.35	0.34	0.31	0.32	0.29	1.94
7	Social interactions	0.09	0.11	0.23	0.17	0.1	0.08	0.78	0.08	0.14	0.17	0.15	0.11	0.06	0.71
8	Inactivity	1.62	1.42	1.39	1.73	1.67	1.89	9.72	1.69	1.49	1.45	1.72	1.64	2.03	10.02
9	Miscellaneous	0.5	0.57	0.59	0.48	0.56	0.46	3.14	0.46	0.48	0.49	0.44	0.45	0.42	2.74

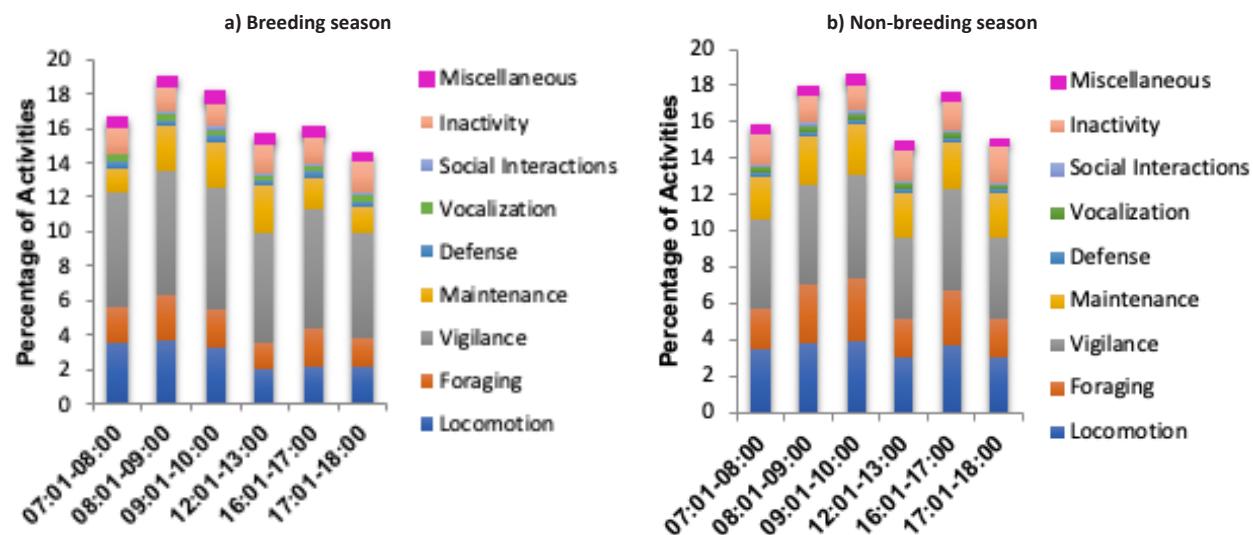


Figure 4. Percentage of activities of Red-wattled Lapwings at different hours of the day during: a—breeding season | b—non-breeding season.

resources, as well as the level of disturbance, play key factors in deciding the dwelling sites of these birds. This correlates with previous studies on shorebirds, waders, and other terrestrial birds (Smith et al. 2007; Verma & Murmu 2015). Further, the presence of these birds near human habitations such as urban parks and construction sites confirms that these birds have adapted very well to anthropogenic pressures.

The effect of seasonal variation on the distribution of Red-wattled Lapwings across different habitats of Udaipur City reveals that the monsoon season is the most favorable season for these birds followed by summer and winter. The highest population of birds during monsoon could be attributed to the abundance of food (in the form of insects) and water (Delgado & Moreira 2010; Franca et al. 2020). Red-wattled Lapwings

are also known to feed on food grains (Babi 1987). Therefore, the high population of Red-wattled Lapwings in croplands during the monsoon could be attributed to the presence of harvest of maize and sorghum (Jat et al. 2004; Lin 2005). Also, during monsoon, growth of wild grass and vegetation increases across different habitats like protected areas, grasslands, institutional green spaces, urban parks or gardens, along roads, and empty plots, thus providing shelter along with insects as food to lapwings.

The wetlands were the most preferred sites during all seasons. However, unlike other habitats where the lapwings' population was higher during monsoon, at wetlands the trend was reversed, the population was lesser than that in summer. This is because during monsoon due to rain, the water level increases

thereby flooding the islands of wetlands (Kushlan 1981; Chaudhury & Koli 2018). So, during monsoon, the Red-wattled Lapwings were mainly encountered on the embankment of the wetlands and not on the islands. The highest population of lapwings was recorded at the wetlands during summer (breeding season) because the shallow wetlands serve as breeding as well as feeding grounds for these birds. The most preferred site of lapwings during winter was also shallow wetlands, this is perhaps due to decreased water level, the wetland serves as feeding as well as social interactions grounds for the birds (Chaudhury & Koli 2018).

Activity Patterns

The investigation of the activity pattern of Red-wattled Lapwings in the present study revealed that a major part of their routine includes vigilance, locomotion, feeding and maintenance. Similar prominence of the above-mentioned activities has also been noted in other species of lapwings such as the Southern Lapwing *Vanellus chilensis* (Maruyama et al. 2010) and River Lapwing *Vanellus duvaucelii* (Mishra et al. 2018). This confirms the active and vigilant nature of lapwings. During the study, it was observed that lapwings were vigilant during both breeding and non-breeding seasons and different periods from morning to evening. The percentage of vigilance was higher in the breeding season than in the non-breeding season. This could be due to the ground/shallow feeding as well as ground-nesting nature of the bird, which requires constant vigil against any predator or other risk factors for their enhanced survival (Lendrem 1986; Walters 1990).

Locomotion was the second most recorded activity. Locomotion is an important activity of birds that helps them to move from one place to another in search of food, water, shelter, nesting sites, and even as defense (escape) to move away from potential threats.

Feeding and maintenance were the next most visible activities of Red-wattled Lapwings. Maintenance is an imperative activity that contributes to the fitness of birds and keeps away parasites (Bush & Clayton 2018). This is perhaps because as reported in certain birds, ritualized preening has become part of courtship displays performed during breeding (Howe 1975) while in some birds, the preening oil is used to attract mates (Johansson & Jones 2007; Hirao et al. 2009).

The other behaviours displayed by Red-wattled Lapwings included defense, vocalization, social interactions, inactivity, and miscellaneous activities. Inactivity (sleeping, standing, or resting) provides them rest and helps in conserving energy (Maruyama et al.

2010).

The birds of the Charadriidae family including Red-wattled Lapwings are known for their characteristic defense strategies and vocalizations (Kalsi & Khera 1987; Walters 1990; Mishra & Kumar 2022). Vocalizations are an important part and parcel of their day-to-day activities. Though calls are less prominent than vigilance, feeding, locomotion, and maintenance activities these are quite an important mode of communication in lapwings.

CONCLUSION

The study suggests that Red-wattled Lapwings thrive across different habitats in Udaipur city throughout all seasons, with monsoon being the most favoured season. The primary habitats of these birds were found to be wetlands due to the presence of ample food and water resources. However, the lowest occurrence of lapwings in Rang Sagar Lake indicates that high level of disturbance and water pollution are anthropogenically induced threats to these birds. The study also revealed that breeding and non-breeding seasons did not produce a significant impact on the activity patterns of lapwings. Moreover, these birds are highly vigilant and vocal and display a broad range of activity patterns including feeding, locomotion, maintenance, defense, social interactions, resting, and other miscellaneous activities which supports their survival.

Overall, it can be ascertained from the present study that the availability of wide-ranging habitats, abundant supply of food and water, and highly active defense techniques of Red-wattled Lapwings have helped these birds to adapt to the growing anthropogenic pressure and there is no immediate threat to the population of Red-wattled Lapwings in Udaipur city. However, habitat destruction through pollution and ever-increasing human activities can cause a decline in their population in the future. The following measures may be helpful to conserve habitats of Red-wattled Lapwing:

1. Carrying out extensive population surveys of Red-wattled Lapwings.
2. Satellite monitoring of birds' habitats to keep track of factors that may be a threat to their survival.
3. A strict ban should be imposed on the discharge of untreated industrial effluents, sewage, microplastics, medical waste, and garbage in wetlands.
4. The use of motor boats that cause oil spillage must be prohibited.
5. Restricting vehicles and night tourism around

lakes and protected areas.

REFERENCES

Ali, S. (1996). *The Book of Indian Birds*. 12th Ed. Bombay Natural History Society, Mumbai, 354 pp.

Ali, S. & S.D. Ripley (2001). *Handbook of the Birds of India and Pakistan*. Oxford University Press, Mumbai, 342 pp.

Altmann, J. (1974). The observational study of behaviour: sampling methods. *Behavior* 49: 227–266.

Babi, A.Z. (1987). Feeding behaviour of Red-wattled Lapwing. *Newsletter for Birdwatchers* 27(1–2): 15.

Bibby, C.J., N.D. Burgess, D.A. Hill & S.H. Mustoe (2000). *Bird Census Techniques*. Academic Press, London, 302 pp.

BirdLife International (2023). Species factsheet: *Vanellus indicus*. Downloaded from <http://datazone.birdlife.org/species/factsheet/red-wattled-lapwing-vanellus-indicus> on 02/04/2023.

Madhava, W. & S. Botejue (2011). An observation of *Vanellus indicus* Boddaert, 1783 (Aves: Charadriidae) feed on an exotic *Laevicaulis alte* Ferussac 1821 (Gastropoda: Veronicellidae) at a human habitation in Sri Lanka. *Taprobanica* 1(1): 36–38. <https://doi.org/10.4038/tapro.v1i1.2776>

Bush, S.E. & D.H. Clayton (2018). Anti-parasite behaviour of birds. *Philosophical transactions of the Royal Society B: Biological sciences* 373(1751): 20170196. <https://doi.org/10.1098/rstb.2017.0196>

Chaudhury, S. & V.K. Koli (2018). Population status, habitat preference, and nesting characteristics of Black-headed Ibis *Threskiornis melanocephalus* Latham, 1790 in southern Rajasthan, India. *Journal of Asia-Pacific Biodiversity* 11(2): 223–228. <https://doi.org/10.1016/j.japb.2018.01.013>

Delgado, A. & F. Moreira (2010). Between-year variations in Little Bustard *Tetrax tetrax* population densities are influenced by agricultural intensification and rainfall. *Ibis* 152(3): 633–642. <https://doi.org/10.1111/j.1474-919X.2010.01026.x>

del Hoyo, J., A. Elliott & J. Sargatal (1996). *Handbook of the Birds of the World* Vol. 3. Hoatzin to Auks. Lynx Edicions, Barcelona, 821 pp.

Franca, L.F., V.H. Figueiredo-Paixão, T.A. Duarte-Silva & K.B. dos Santos (2020). The effects of rainfall and arthropod abundance on breeding season of insectivorous birds, in a semi-arid neotropical environment. *Zoologia* 37: 1–7. <https://doi.org/10.3897/zootaxa.37.e37716>

Greeshma, P. & E.A. Jayson (2019). Is Red-wattled Lapwing *Vanellus indicus* a Piscivore? *Journal of the Bombay Natural History Society* 116: 39–40. <https://doi.org/10.17087/jbnhs/2019/v116/122813>

Gupta, R.C. & T.K. Kaushik (2011). On the fundamentals of natural history and present threats to Red-wattled Lapwing in Kurukshetra environs. *Journal of Applied and Natural Science* 3(1): 62–67. <https://doi.org/10.31018/jans.v3i1.155>

Hirao, A., M. Aoyama & S. Sugita (2009). The role of uropygial gland on sexual behavior in domestic chicken *Gallus gallus domesticus*. *Behavioural Processes* 80(2): 115–120. <https://doi.org/10.1016/j.beproc.2008.10.006>

Howe, M.A. (1975). Behavioral aspects of the pair bond in Wilson's Phalarope. *The Wilson Bulletin* 87(2): 248–270.

Jat, M.L., R.V. Singh, J.K. Balyan & B.S. Kumpawat (2004). Water balance studies for agricultural planning in Udaipur region. *Journal of Agrometeorology* 6(2): 280–283. <https://doi.org/10.54386/jam.v6i2.802>

Johansson, B.G. & T.M. Jones (2007). The role of chemical communication in mate choice. *Biological reviews of the Cambridge Philosophical Society* 82(2): 265–289. <https://doi.org/10.1111/j.1469-185X.2007.00009.x>

Kalsi, R.S. & S. Khera (1987). Agonistic and distraction behaviour of the Red-wattled Lapwing *Vanellus indicus indicus*. *Pavo* 25(1–2): 43–56.

Karakas, R. (2016). Status and distribution of Red-wattled Lapwing *Vanellus indicus* (Boddaert, 1783) (Charadriiformes: Charadriidae) in Turkey. *Acta Zoologica Bulgarica* 68(1): 71–76.

Kumar, A., J.P. Sati, P.C. Tak & J.R.B. Alfred (2005). *Handbook on Indian Wetland Birds and their Conservation*. Zoological Survey of India, Kolkata, 480 pp.

Kushlan, J.A. (1981). Resource use strategies of wading birds. *Wilson Bulletin* 93(2): 145–163. <https://www.jstor.org/stable/4161456>

Lendrem, D. (1986). Temporal patterns: vigilance in birds, pp. 83–102. In: *Modelling in Behavioural Ecology: Studies in Behavioural Adaptation*. Springer, Dordrecht, 214 pp. https://doi.org/10.1007/978-94-011-6568-6_5

Lin, E. (2005). Production and processing of small seeds for birds. Food and Agriculture Organization of the United Nations, Rome, 56 pp. <https://www.fao.org/3/y5831e/y5831e00.htm>

Maruyama, P.K., A.F. Cunha, E. Tizo-Pedroso & K. Del-Claro (2010). Relation of group size and daily activity patterns to Southern Lapwing (*Vanellus chilensis*) behaviour. *Journal of Ethology* 28: 339–344. <https://doi.org/10.1007/s10164-009-0193-5>

Mishra, H., V. Kumar & A. Kumar (2018). Population structure, behavior, and distribution pattern of the River Lapwing *Vanellus duvaucelii* (Lesson, 1826). *Journal of Asia-Pacific Biodiversity* 11(3): 422–430. <https://doi.org/10.1016/j.japb.2018.06.001>

Mishra, H. & A. Kumar (2022). Diagnosing nest predators and anti-predator response of Red-wattled Lapwing, *Vanellus indicus* (Boddaert, 1783). *Acta Ecologica Sinica* 42(1): 6–10. <https://doi.org/10.1016/j.chnaes.2020.11.004>

Muralidhar, A. & S. Barve (2013). Peculiar choice of nesting of Red-wattled Lapwing *Vanellus indicus* in an urban area in Mumbai, Maharashtra. *Indian BIRDS* 8(1): 6–9.

Narwade, S., M. Fartade & K. Fartade (2010). Effect of agricultural activities on breeding success of Red-wattled Lapwing *Vanellus indicus*. *National Journal of Life Sciences* 7(1): 31–34.

Narwade, S., M. Fartade & K. Fartade (2011). Nesting ecology of Red-wattled Lapwing in agricultural landscape. *Life Science Bulletin* 8(1): 97–100.

Pillai, G.S. (2000). Udaipur lakes a victim of poor sewage management. The Times of India. <https://timesofindia.indiatimes.com/city/udaipur/udaipur-lakes-a-victim-of-poor-sewage-management/articleshowprint/77939263.cms>. Accessed on 10 October 2022.

Sethi, V.K., D. Bhatt, A. Kumar & A.B. Naithani (2011). The hatching success of ground- and roof-nesting Red-wattled Lapwing *Vanellus indicus* in Haridwar, India. *Forktail* 27: 7–10.

Smith, P.A., H.G. Gilchrist & J.N.M. Smith (2007). Effects of nest habitat, food, and parental behavior on shorebird nest success. *Condor* 109(1): 15–31. <https://doi.org/10.1093/condor/109.1.15>

Verma, S.K. & T.D. Murmu (2015). Impact of environmental and disturbance variables on avian community structure along a gradient of urbanization in Jamshedpur, India. *PLoS ONE* 10(7): e0133383. <https://doi.org/10.1371/journal.pone.0133383>

Walters, J.R. (1990). Anti-Predatory behavior of lapwings: field evidence of discriminative abilities. *Wilson Bulletin* 102(1): 49–70. <https://doi.org/10.2307/4162824>

Wiersma, P. & G.M. Kirwan (2019). Red-wattled Lapwing (*Vanellus indicus*). In: del Hoyo, J., A. Elliott, J. Sargatal, D.A. Christie & E. de Juana (eds.). *Handbook of the Birds of the World Alive*. Barcelona: Lynx Editions. Retrieved from <https://www.hbw.com/node/53807> on 10th January 2022.

Wiersma, P. & G.M. Kirwan (2020). Red-wattled Lapwing (*Vanellus indicus*), version 1.0. In: J. del Hoyo, A. Elliott, J. Sargatal, D.A. Christie & E. de Juana (Eds.). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bow.rewlap1.01>

Appendix I. GPS coordinates of major study sites.

	Main Sites/Locations	Habitats	GPS Coordinates
1.	Fateh Sagar	Wetland, crop-fields, grasslands and constructed buildings, roads and footpaths	24.601°N, 73.674°E
2.	Rang Sagar	Wetland and constructed buildings, roads and footpaths	24.584°N, 73.679°E
3.	Pichola Lake	Wetland and constructed buildings, roads and footpaths	24.572°N, 73.678°E
4.	Ayad River	Wetland, crop-fields, grasslands and constructed buildings, roads and footpaths	24.606°N, 73.696°E
5.	Goverdhan Sagar	Wetland, grasslands and constructed buildings, roads and footpaths	24.543°N, 73.683°E
6.	RCA Campus	Crop-fields and institutional green spaces	24.580°N, 73.702°E
7.	MLSU Campus	Institutional green spaces, crop-fields, grasslands and constructed buildings, roads and footpaths	24.594°N, 73.731°E
8.	Sajjangarh Biological Park	Protected areas and grasslands	24.591°N, 73.652°E
9.	Sukhadia Memorial Park	Urban Park	24.585°N, 73.709°E
10.	Gulab Bagh	Protected areas and urban park	24.572°N, 73.692°E



Mr. Jatishwor Singh Irungbam, Biology Centre CAS, Branišovská, Czech Republic.

Dr. Ian J. Kitching, Natural History Museum, Cromwell Road, UK

Dr. George Mathew, Kerala Forest Research Institute, Peechi, India

Dr. John Noyes, Natural History Museum, London, UK

Dr. Albert G. Orr, Griffith University, Nathan, Australia

Dr. Sameer Padhye, Katholieke Universiteit Leuven, Belgium

Dr. Nancy van der Poorten, Toronto, Canada

Dr. Karen Schnabel, NIWA, Wellington, New Zealand

Dr. R.M. Sharma, (Retd.) Scientist, Zoological Survey of India, Pune, India

Dr. Manju Siliwal, WILD, Coimbatore, Tamil Nadu, India

Dr. G.P. Sinha, Botanical Survey of India, Allahabad, India

Dr. K.A. Subramanian, Zoological Survey of India, New Alipore, Kolkata, India

Dr. P.M. Sureshan, Zoological Survey of India, Kozhikode, Kerala, India

Dr. R. Varatharajan, Manipur University, Imphal, Manipur, India

Dr. Eduard Vives, Museu de Ciències Naturals de Barcelona, Terrassa, Spain

Dr. James Young, Hong Kong Lepidopterists' Society, Hong Kong

Dr. R. Sundararaj, Institute of Wood Science & Technology, Bengaluru, India

Dr. M. Nithyanandan, Environmental Department, La Al Kuwait Real Estate. Co. K.S.C., Kuwait

Dr. Himender Bharti, Punjabi University, Punjab, India

Mr. Purnendu Roy, London, UK

Dr. Saito Motoki, The Butterfly Society of Japan, Tokyo, Japan

Dr. Sanjay Sondi, TITLI TRUST, Kalpavriksh, Dehradun, India

Dr. Nguyen Thi Phuong Lien, Vietnam Academy of Science and Technology, Hanoi, Vietnam

Dr. Nitin Kulkarni, Tropical Research Institute, Jabalpur, India

Dr. Robin Wen Jiang Ngiam, National Parks Board, Singapore

Dr. Lional Monod, Natural History Museum of Geneva, Genève, Switzerland.

Dr. Asheesh Shivam, Nehru Gram Bharti University, Allahabad, India

Dr. Rosana Moreira da Rocha, Universidade Federal do Paraná, Curitiba, Brasil

Dr. Kurt R. Arnold, North Dakota State University, Saxony, Germany

Dr. James M. Carpenter, American Museum of Natural History, New York, USA

Dr. David M. Claborn, Missouri State University, Springfield, USA

Dr. Karen Schnabel, Marine Biologist, Wellington, New Zealand

Dr. Amazonas Chagas Júnior, Universidade Federal de Mato Grosso, Cuiabá, Brasil

Mr. Monsoon Jyoti Gogoi, Assam University, Silchar, Assam, India

Dr. Heo Chong Chin, Universiti Teknologi MARA (UiTM), Selangor, Malaysia

Dr. R.J. Shiel, University of Adelaide, SA 5005, Australia

Dr. Siddharth Kulkarni, The George Washington University, Washington, USA

Dr. Priyadarshan Dharma Rajan, ATREE, Bengaluru, India

Dr. Phil Alderslade, CSIRO Marine And Atmospheric Research, Hobart, Australia

Dr. John E.N. Veron, Coral Reef Research, Townsville, Australia

Dr. Daniel Whitmore, State Museum of Natural History Stuttgart, Rosenstein, Germany.

Dr. Yu-Feng Hsu, National Taiwan Normal University, Taipei City, Taiwan

Dr. Keith V. Wolfe, Antioch, California, USA

Dr. Siddharth Kulkarni, The Hormiga Lab, The George Washington University, Washington, D.C., USA

Dr. Tomas Ditrich, Faculty of Education, University of South Bohemia in Ceske Budejovice, Czech Republic

Dr. Mihaly Foldvari, Natural History Museum, University of Oslo, Norway

Dr. V.P. Uniyal, Wildlife Institute of India, Dehradun, Uttarakhand 248001, India

Dr. John T.D. Caleb, Zoological Survey of India, Kolkata, West Bengal, India

Dr. Priyadarshan Dharma Rajan, Ashoka Trust for Research in Ecology and the Environment (ATREE), Royal Enclave, Bangalore, Karnataka, India

Fishes

Dr. Neelesh Dahanukar, IISER, Pune, Maharashtra, India

Dr. Topiltzin Contreras MacBeath, Universidad Autónoma del estado de Morelos, México

Dr. Heok Hee Ng, National University of Singapore, Science Drive, Singapore

Dr. Rajeev Raghavan, St. Albert's College, Kochi, Kerala, India

Dr. Robert D. Sluka, Chiltern Gateway Project, A Rocha UK, Southall, Middlesex, UK

Dr. E. Vivekanandan, Central Marine Fisheries Research Institute, Chennai, India

Dr. Davor Zanella, University of Zagreb, Zagreb, Croatia

Dr. A. Biju Kumar, University of Kerala, Thiruvananthapuram, Kerala, India

Dr. Akhilesh K.V., ICAR-Central Marine Fisheries Research Institute, Mumbai Research

Centre, Mumbai, Maharashtra, India

Dr. J.A. Johnson, Wildlife Institute of India, Dehradun, Uttarakhand, India

Dr. R. Ravinesh, Gujarat Institute of Desert Ecology, Gujarat, India

Amphibians

Dr. Sushil K. Dutta, Indian Institute of Science, Bengaluru, Karnataka, India

Dr. Annemarie Ohler, Muséum national d'Histoire naturelle, Paris, France

Reptiles

Dr. Gernot Vogel, Heidelberg, Germany

Dr. Raju Vyas, Vadodara, Gujarat, India

Dr. Pritpal S. Soorae, Environment Agency, Abu Dhabi, UAE.

Prof. Dr. Wayne J. Fuller, Near East University, Mersin, Turkey

Prof. Chandrashekher U. Rironker, Goa University, Taleigao Plateau, Goa, India

Dr. S.R. Ganesh, Chennai Snake Park, Chennai, Tamil Nadu, India

Dr. Himansu Sekhar Das, Terrestrial & Marine Biodiversity, Abu Dhabi, UAE

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, Zootaxa, and Biological Records.

NAAS rating (India) 5.64

Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia

Mr. H. Byju, Coimbatore, Tamil Nadu, India

Dr. Chris Bowden, Royal Society for the Protection of Birds, Sandy, UK

Dr. Priya Davidar, Pondicherry University, Kalapet, Puducherry, India

Dr. J.W. Duckworth, IUCN SSC, Bath, UK

Dr. Rajah Jayapal, SACON, Coimbatore, Tamil Nadu, India

Dr. Rajiv S. Kalsi, M.L.N. College, Yamuna Nagar, Haryana, India

Dr. V. Santharam, Rishi Valley Education Centre, Chittoor Dt., Andhra Pradesh, India

Dr. S. Balachandran, Bombay Natural History Society, Mumbai, India

Mr. J. Praveen, Bengaluru, India

Dr. C. Srinivasulu, Osmania University, Hyderabad, India

Dr. K.S. Gopi Sundar, International Crane Foundation, Baraboo, USA

Dr. Gombobaatar Sundev, Professor of Ornithology, Ulaanbaatar, Mongolia

Prof. Reuven Yosef, International Birding & Research Centre, Eilat, Israel

Dr. Taej Munduk, Wetlands International, Wageningen, The Netherlands

Dr. Carol Inskip, Bishop Auckland Co., Durham, UK

Dr. Tim Inskip, Bishop Auckland Co., Durham, UK

Dr. V. Gokula, National College, Tiruchirappalli, Tamil Nadu, India

Dr. Arkady Lelej, Russian Academy of Sciences, Vladivostok, Russia

Dr. Simon Dowell, Science Director, Chester Zoo, UK

Dr. Mário Gabriel Santiago dos Santos, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, Vila Real, Portugal

Dr. Grant Connette, Smithsonian Institution, Royal, VA, USA

Dr. P.A. Azeez, Coimbatore, Tamil Nadu, India

Mammals

Dr. Giovanni Amori, CNR - Institute of Ecosystem Studies, Rome, Italy

Dr. Anwaruddin Chowdhury, Guwahati, India

Dr. David Mallon, Zoological Society of London, UK

Dr. Shomita Mukherjee, SACON, Coimbatore, Tamil Nadu, India

Dr. Angie Appel, Wild Cat Network, Germany

Dr. P.O. Nameer, Kerala Agricultural University, Thrissur, Kerala, India

Dr. Ian Redmond, UNEP Convention on Migratory Species, Lansdown, UK

Dr. Heidi S. Riddle, Riddle's Elephant and Wildlife Sanctuary, Arkansas, USA

Dr. Karin Schwartz, George Mason University, Fairfax, Virginia.

Dr. Lala A.K. Singh, Bhubaneswar, Orissa, India

Dr. Mewa Singh, Mysore University, Mysore, India

Dr. Paul Racey, University of Exeter, Devon, UK

Dr. Honnavalli N. Kumar, SACON, Anaikatty P.O., Coimbatore, Tamil Nadu, India

Dr. Nishith Dharaiya, HNG University, Patan, Gujarat, India

Dr. Spartaco Gippoliti, Socio Onorario Società Italiana per la Storia della Fauna "Giuseppe Altobello", Rome, Italy

Dr. Justus Joshua, Green Future Foundation, Tiruchirappalli, Tamil Nadu, India

Dr. H. Raghuram, The American College, Madurai, Tamil Nadu, India

Dr. Paul Bates, Harison Institute, Kent, UK

Dr. Jim Sanderson, Small Wild Cat Conservation Foundation, Hartford, USA

Dr. Dan Challender, University of Kent, Canterbury, UK

Dr. David Mallon, Manchester Metropolitan University, Derbyshire, UK

Dr. Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA

Dr. S.S. Talmale, Zoological Survey of India, Pune, Maharashtra, India

Prof. Karan Bahadur Shah, Budhanilakantha Municipality, Kathmandu, Nepal

Dr. Susan Cheyne, Borneo Nature Foundation International, Palangkaraja, Indonesia

Dr. Hemanta Kafley, Wildlife Sciences, Tarleton State University, Texas, USA

Other Disciplines

Dr. Aniruddha Belsare, Columbia MO 65203, USA (Veterinary)

Dr. Manda S. Paingankar, University of Pune, Pune, Maharashtra, India (Molecular)

Dr. Jack Tordoff, Critical Ecosystem Partnership Fund, Arlington, USA (Communities)

Dr. Ulrike Streicher, University of Oregon, Eugene, USA (Veterinary)

Dr. Hari Balasubramanian, EcoAdvisors, Nova Scotia, Canada (Communities)

Dr. Rayanna Hellenn Santos Bezerra, Universidade Federal de Sergipe, São Cristóvão, Brazil

Dr. Jamie R. Wood, Landcare Research, Canterbury, New Zealand

Dr. Wendy Collinson-Jonker, Endangered Wildlife Trust, Gauteng, South Africa

Dr. Rajeshkumar G. Jani, Anand Agricultural University, Anand, Gujarat, India

Dr. O.N. Tiwari, Senior Scientist, ICAR-Indian Agricultural Research Institute (IARI), New Delhi, India

Dr. L.D. Singla, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India

Dr. Rupika S. Rajakaruna, University of Peradeniya, Peradeniya, Sri Lanka

Dr. Bahar Baviskar, Wild-CER, Nagpur, Maharashtra 440013, India

Reviewers 2020–2022

Due to paucity of space, the list of reviewers for 2018–2020 is available online.

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

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



OPEN ACCESS



The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under [Creative Commons Attribution 4.0 International License](#) unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

www.threatenedtaxa.org

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

August 2023 | Vol. 15 | No. 8 | Pages: 23631–23826

Date of Publication: 26 August 2023 (Online & Print)

DOI: 10.11609/jott.2023.15.8.23631-23836

Articles

Group densities of endangered small apes (Hylobatidae) in two adjacent forest reserves in Merapoh, Pahang, Malaysia

– Adilah Suhailin Kamaruzaman, Nurul Iza Adriana Mohd Rameli, Susan Lappan, Thad Quincy Bartlett, Nik Rosely Nik Fadzly, Mohd Sah Shahru Anuar & Nadine Ruppert, Pp. 23631–23640

Population demography of the Blackbuck *Antilope cervicapra* (Cetartiodactyla: Bovidae) at Point Calimere Wildlife Sanctuary, India

– Subhasish Arandhara, Selvaraj Sathishkumar, Sourav Gupta & Nagarajan Baskaran, Pp. 23641–23652

Communications

Camera trap surveys reveal a wildlife haven: mammal communities in a tropical forest adjacent to a coal mining landscape in India

– Nimaan Charan Palei, Bhakta Padarbinda Rath, Himanshu Shekhar Palei & Arun Kumar Mishra, Pp. 23653–23661

Observations of Gray Fox *Urocyon cinereoargenteus* (Schreber, 1775) (Mammalia: Carnivora: Canidae) denning behavior in New Hampshire, USA

– Maximilian L. Allen & Jacob P. Kritzer, Pp. 23662–23668

Historical and contemporary perpetuation of assumed occurrence reports of two species of bats in Rajasthan, India

– Dharmendra Khandal, Ishan Dhar & Shyamkant S. Talmale, Pp. 23669–23674

Preference of *Helopsaltes pleskei* (Taczanowski, 1890) (Aves: Passeriformes: Locustellidae) on uninhabited islets (Chengdo, Jikgudo, and Heukgeomdo) in South Korea as breeding sites

– Young-Hun Jeong, Sung-Hwan Choi, Seon-Mi Park, Jun-Won Lee & Hong-Shik Oh, Pp. 23675–23680

Avifaunal diversity of Tsirang District with a new country record for Bhutan

– Gyeltshen, Sangay Chhophel, Karma Wangda, Kinley, Tshering Penjor & Karma Dorji, Pp. 23681–23695

Importance of conserving a critical wintering ground for shorebirds in the Valinokkam Lagoon—a first study of the avifaunal distribution of the southeastern coast of India

– H. Byju, N. Raveendran, S. Ravichandran & R. Kishore, Pp. 23696–23709

Diversity and conservation status of avifauna in the Surguja region, Chhattisgarh, India

– A.M.K. Bharos, Anurag Vishwakarma, Akhilesh Bharos & Ravi Naidu, Pp. 23710–23728

Seasonal variation and habitat role in distribution and activity patterns of Red-wattled Lapwing *Vanellus indicus* (Boddaert, 1783) (Aves: Charadriiformes: Charadriidae) in Udaipur, Rajasthan, India

– Sahil Gupta & Kanan Saxena, Pp. 23729–23741

Notes on nesting behavior of Yellow-footed Green Pigeon *Treron phoenicopterus* (Latham, 1790) in Aligarh Muslim University campus and its surroundings, Uttar Pradesh, India

– Ayesha Mohammad Maslehuddin & Satish Kumar, Pp. 23742–23749

Observations on cooperative fishing, use of bait for hunting, propensity for marigold flowers and sentient behaviour in Mugger Crocodiles *Crocodylus palustris* (Lesson, 1831) of river Savitri at Mahad, Maharashtra, India
– Utkarsha M. Chavan & Manoj R. Borkar, Pp. 23750–23762

Communal egg-laying by the Frontier Bow-fingered Gecko *Altiphylax stoliczkai* (Steindachner, 1867) in Ladakh, India
– Dimpi A. Patel, Chinnasamy Ramesh, Sunetro Ghosal & Pankaj Raina, Pp. 23763–23770

Description of a new species of the genus *Anthaxia* (Haplanthaxia Reitter, 1911) from India with molecular barcoding and phylogenetic analysis
– S. Seena, P.P. Anand & Y. Shibu Vardhanan, Pp. 23771–23777

Odonata diversity in the Egra and its adjoining blocks of Purba Medinipur District, West Bengal, India
– Tarak Samanta, Asim Giri, Lina Chatterjee & Arjan Basu Roy, Pp. 23778–23785

Morpho-anatomy and habitat characteristics of *Xanthostemon verdugonianus* Náves ex Fern.-Vill. (Myrtaceae), a threatened and endemic species in the Philippines
– Jess H. Jumawan, Arlyn Jane M. Sinogbuhan, Angie A. Abucayon & Princess Ansie T. Taperla, Pp. 23786–23798

The epiphytic pteridophyte flora of Cooch Behar District of West Bengal, India, and its ethnomedicinal value
– Aninda Mandal, Pp. 23799–23804

Seed germination and storage conditions of *Ilex embeloides* Hook.f. (Magnoliopsida: Aquifoliaceae), a threatened northeastern Indian species
– Leoris Malngiang, Krishna Upadhyaya & Hiranjit Choudhury, Pp. 23805–23811

Short Communications

Mantispa indica Westwood, 1852 (Neuroptera: Mantispidae), a rare species with some morphological notes from Assam, India
– Kushal Choudhury, Pp. 23812–23816

Notes

Auto-fellatio behaviour observed in the Indian Palm Squirrel *Funambulus palmarum* (Linnaeus, 1766)
– Anbazhagan Abinesh, C.S. Vishnu & Chinnasamy Ramesh, Pp. 23817–23818

A novel anti-predatory mechanism in *Indrella ampulla* (Gastropoda: Ariophantidae)
– Karunakar Majhi, Maitreya Sil & Aniruddha Datta-Roy, Pp. 23819–23821

Hedychium coccineum Buch.-Ham. ex Sm. (Zingiberaceae): an addition to the flora of Andhra Pradesh, India
– P. Janaki Rao, J. Prakasa Rao & S.B. Padal, Pp. 23822–23826

Publisher & Host

