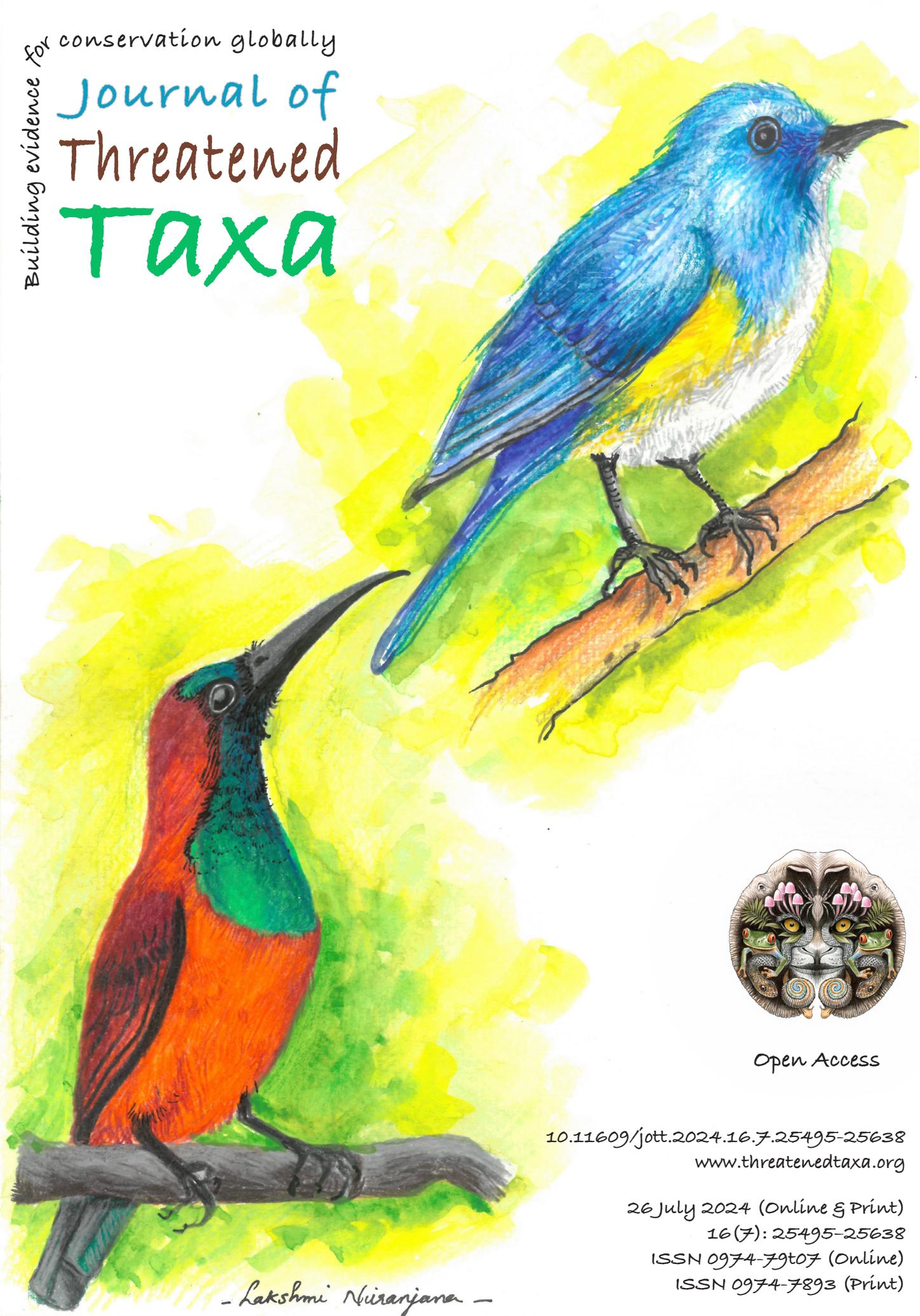


Building evidence for conservation globally

Journal of Threatened TAXA



Open Access

10.11609/jott.2024.16.7.25495-25638
www.threatenedtaxa.org

26 July 2024 (Online & Print)
16 (7): 25495-25638
ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

- Lakshmi Niranjana -



Publisher

Wildlife Information Liaison Development Societywww.wild.zooreach.org

Host

Zoo Outreach Organizationwww.zooreach.org43/2 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.orgEmail: 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**, Annasaheb 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. Hemanth 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: Mixed media illustration of a Blue bird and Sunbird. © Lakshmi Niranjan.



Incidence and risk factors associated with parasitic infections in captive wild mammals and birds in Indian zoos

Nikita Das¹ , P.D. Pawar² , P.P. Mhase³ , V.G. Nimbalkar⁴ , R.V. Jadhav⁵ , V.S. Dhaygude⁶ ,
Gavin Furtado⁷  & L.D. Singla⁸ 

¹⁻⁷ Department of Veterinary Parasitology, KNP College of Veterinary Science, Shirwal, Satara District, Maharashtra 412801, India.

⁸ Department of Veterinary Parasitology, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab 141004, India.

¹ dasnikita5@gmail.com, ² prashant_vet@yahoo.co.in (corresponding author), ³ prashantmhase@gmail.com,

⁴ vgnimbvet2002@yahoo.com, ⁵ rajivgandhizoo@puneoperation.org, ⁶ drvitthalp@gmail.com, ⁷ furtado.gavin2@gmail.com,

⁸ ldsingla@gmail.com

Abstract: Present study was conducted to record the seasonal incidence and worm burden (eggs per gram of faeces) of helminthic infections and to evaluate the efficacy of deworming protocols followed for control of parasitic infections in captive animals (including birds) at the zoo. Freshly voided faecal samples were collected during winter, monsoon and summer from 150 captive animals including wild mammals (n = 95) and birds (n = 55) between 1–15 years of age kept at Rajiv Gandhi Zoo and Wildlife Research Centre Karaj, Pune (Zoo-I) and Nisargakavi Bahinabai Chaudhary Zoo, Pimpri Chinwad (Zoo-II) in Maharashtra, India. Samples were processed and examined by standard sedimentation and floatation methods to assess the prevalence of helminth infections. Faecal samples of positive animals were collected pre and post-treatment, and the efficacy of the drugs used was evaluated based on faecal egg count reduction test (FECRT). The overall seasonal prevalence of gastro-intestinal parasitic infection in mammals varied among seasons with the highest prevalence (29.50 %) in monsoon followed by winter (26.30 %) and lowest in summer (8.40 %), while the same was found non-significant in birds. Of 19 bird species screened, 25 % of peafowl were positive for *Ascaridia* spp., 25 % of crested eagles for *Capillaria* spp., and 50% of brown fish owls for *Strongyloides* spp. Among mammals, 75 % of Black Buck, 50 % of Leopards and 25 % of Giant Malabar Squirrels were positive for *Strongyloides* spp., while all four Bonnet Macaques were positive for *Balantidium coli*. The range of eggs per gram (EPG) of faeces recorded was 50–300 in mammals and 100–350 in birds. At Zoo I (Rajiv Gandhi Zoo and Wildlife Research Centre Karaj, Pune), there was 85.89 and 77.36 per cent reduction in egg counts after treatment with fenbendazole @5 mg/kg in herbivores and birds, respectively. While in carnivores the reduction was 69.93 % after treatment with a drug combination @10 mg/kg (Praziquantel 50 mg + Pyrantel 144 mg + fenbantel 150 mg). In Zoo II (Nisargakavi Bahinabai Chaudhary Zoo, Pimpri Chinwad) the reduction in EPG was 72.35 % in carnivores with drug combination @10 mg/kg (Praziquantel 50mg + pyrantel 144 mg + fenbantel 150 mg) and 68.98% in birds with albendazole @10 mg/kg.

Keywords: FECRT, helminthic infections, prevalence, preventive management, worm.

Editor: Alok Kumar Dixit, College of Veterinary Science & A.H., Rewa, India.

Date of publication: 26 July 2024 (online & print)

Citation: Das, N., P.D. Pawar, P.P. Mhase, V.G. Nimbalkar, R.V. Jadhav, V.S. Dhaygude, G. Furtado & L.D. Singla (2024). Incidence and risk factors associated with parasitic infections in captive wild mammals and birds in Indian zoos. *Journal of Threatened Taxa* 16(7): 25590–25597. <https://doi.org/10.11609/jott.8134.16.7.25590-25597>

Copyright: © Das et al. 2024. 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: Self-funded.

Competing interests: The authors declare no competing interests.

Author details: Nikita Das (M.V.Sc scholar), P.D. Pawar (sectional head Department of Veterinary Parasitology), P.P. Mhase (assistant professor Department of Veterinary Microbiology), V.G. Nimbalkar (farm manager Livestock farm complex), R.V. Jadhav (director Katraj Zoological Park, Pune), V.S. Dhaygude (sectional head Department of Veterinary Pathology), Gavin Furtado (veterinary officer) & L.D. Singla (director and professor, Human Resource, GADVASU, Ludhiana).

Author contributions: Nikita Das (collection processing of samples along with history), P.D. Pawar (planning and execution of research plan as per objective), P.P. Mhase (compilation of all data), V.G. Nimbalkar (statistical analysis of data), R.V. Jadhav (permission and support during collection of samples), V.S. Dhaygude (writing of manuscript), Gavin Furtado (help in collection of history and schedule deworming plan) & L.D. Singla (help in analysis of results and corrections in the manuscript).

Acknowledgements: Authors sincerely acknowledge the support provided by the Rajiv Gandhi Zoo and Wild life Research Centre Karaj, Pune and Nisargakavi Bahinabai Chaudhary Zoo, Pimpri Chinwad, and Department of Veterinary Pathology, KNP College of Veterinary Science, Shirwal, Maharashtra.

INTRODUCTION

India is the World's 8th most bio-diverse region with a 0.46 BioD score on the diversity index, including 1,02,718 species of fauna (ZSI 2021). The nation is unique in having immense natural beauty, rich, and diverse wildlife comprising mixed species of different types of animals. Many countries including India in different parts of the world have adopted the strategy to protect wild animals via the use of parks and the construction of zoological gardens (Parasani et al. 2001). The zoological gardens display wild animals for aesthetic, recreational, educational, and conservation purposes (Varadharajan & Pythal 1999). Wild mammals and birds act as reservoirs and amplifiers of emerging human and domestic livestock pathogens (including parasites) of public health significance which has gained considerable attention in recent years (Moudgil et al. 2015).

The mortality in animals in captivity has been reported to be at a higher rate due to a variety of factors, including various bacterial, viral, fungal, and parasitic infections (Rao & Acharjyo 1984). Knowledge on parasitic diseases of wildlife is still in infancy in India, and data is on the baseline to understand the epidemiology of parasitic diseases in wild fauna kept in Indian zoos (Singh et al. 2009). Only a few researchers have carried out basic work on the prevalence of parasites in captive wild animals in India (Singh et al. 2006; Gupta et al. 2011; Jaiswal et al. 2014; Mir et al. 2016) except for recent comprehensive studies on animals (Moudgil et al. 2020a,b) from Punjab state.

The parasitic control and prevention programs for wildlifemainly depend on different factors like financial resources, public health structures, reduction of parasitic load, action on the animal reservoirs & vectors, improved diagnostic tools, environmental & ecological changes, human behaviours, education of the people that are involved in the wildlife, and domestic animal chain (Chomel 2008).

Though we can achieve better animal health in zoological gardens by quarantining newly inducted animals, improving hygiene practices and enforcing policy for not allowing visitors to feed animals (Singh et al. 2006), however, the most important part is the implementation of strategic prevention and control programs for prevalent parasitic species in wild animals based on parasitological analysis. The present study was planned to record the seasonal incidence of helminthic infections, assess the worm burden based on estimation of the eggs per gram (EPG) of faeces, and evaluate the efficacy of regular scheduled anthelmintic treatment

administered in zoo mammals and birds.

MATERIALS AND METHODS

Area of the study

The study was conducted in two zoos located at Pune, Maharashtra, India (18.5204 °N & 73.8567 °E), the first zoo (Zoo I) was Rajiv Gandhi Zoological Park and Wildlife Research Center (RGZP) and the second zoo (Zoo II), Nisargakavi Bahinabai Chaudhary Zoo, Pimpri Chinchwad. Freshly voided faecal samples of 150 wild animals including Indian Peafowl (6), Pariah Kite (6), Brown Fish Owl (1), Shikra (2), Flying Fox (1), Eagle Owl (1), Brown Owl (1), Long-billed Vulture (2), Black Kite (2), Ring-neck Dove (1), Great Horn Owl (1), Painted Stork (1), Crested Eagle (2), Laggar Falcon (2), Amazon Parrot (4), African Grey Parrot (4), Plum-headed Parakeet (1), Spot-billed Duck (4), Rose Ring Parakeet (1), Budgerigar (2), Cockatiel (2), Tiger (7), Leopard (6), Jungle Cat (16), Indian Wolf (1), Lion (2), Hyena (2), Jackal (5), Sloth Bear (2), Black Buck (4), Chinkara (2), Four-horned Antelope (5), Gaur (4), Indian Elephant (2), Barking Deer (2), Sambar (3), Spotted Deer (5), Blue Bull (4), Malabar Giant Squirrel (4), Bonnet Macaque (4), Rhesus Macaque (4), Trinket Snake (2), Bamboo Pit Viper (5), Reticulated Python (1), King Cobra (3), Common Krait (1), Banded Racer (1), Earth Boa (4), Indian Rat Snake (1), and Star Tortoise (1) were collected and examined.

A total of 450 faecal samples were collected during three different seasons, 150 each time (110 samples from Zoo I and 40 samples from Zoo II) throughout 2021. Along with the faecal sample, individual data regarding age, sex, and captivity were recorded separately. The data regarding the drug used for deworming, dose and period of deworming was also noted separately. Fresh faecal samples were collected randomly and pooled together from enclosures premises.

Coprological evaluations

The faecal samples were subjected to detailed parasitological analysis to confirm parasitic eggs /oocysts by direct smear examination. These samples were also subjected to standard sedimentation and floatation techniques (Soulsby 1982). Positive samples were further analysed quantitatively to indirectly calculate the parasitic load by eggs per gram of faeces (Gupta & Singla 2012).

Treatment given

The treatment at Zoo I was carried with fenbendazole

for herbivores @5 mg/kg body weight (BW) for two days (Table 7). The carnivores and reptiles were treated with a combination of praziquantel 50 mg, pyrantel-embonate 144 mg and fenbantel 150 mg @10 mg/kg BW for three days. Whereas, for the birds fenbendazole was given orally @5 mg/kg body weight (with restricted feed) once and repeated after 14 days during the study period.

The deworming zoo II in birds was carried out with albendazole@ 10 mg/kg as a single dose orally. The carnivores were treated with a combination of praziquantel 50 mg, pyrantel-embonate 144 mg and febantel 150 mg) @ 10 mg/kg BW for three days (Table 8).

The faecal samples of positive animals were collected before treatment and 14th day post-treatment. The efficacies of the above drugs were assessed based on the faecal egg count reduction test (FECRT).

$$\text{Percent efficacy (FECRT)} = \frac{(\text{Pre-treatment mean EPG} - \text{Post-treatment mean EPG})}{\text{Pre-treatment mean EPG}} \times 100$$

Statistical analysis

The data was processed in Microsoft Excel, and descriptive analysis was done using SPSS statistic software for Windows, Version 20 developed by IBM Company, USA. Parametric and non-parametric statistical tests including the Chi-square test, student t-test and faecal egg count reduction test was used to interpret the final results.

RESULTS AND DISCUSSION

Overall seasonal prevalence

The seasonal prevalence of gastro-intestinal parasitic infection in mammals varied significantly ($P<0.01$) with a higher prevalence (29.50%) in monsoon followed by winter (26.30%) and summer (8.40%). At the same time, the same was found non-significant in birds

with a prevalence rate of 21.80, 20.00, and 18.80% in monsoon, winter, and summer, respectively (Table 1). During monsoon season, high humidity and suitable environmental temperatures can prolong the survival of infective parasitic stages (Singh et al. 2009) resulting in higher prevalence rate. Mammals had a higher overall prevalence (21.50%, CI: 16.8–26.6) than birds (18.80%, CI: 13.10–25.60). The findings are similar to Moudgil et al. (2020a), who reported a 25.5% prevalence of gastrointestinal parasitism in zoo animals. In contrast, Muraleedharan et al. (1990) and Singh et al. (2006) recorded a higher prevalence of gastrointestinal parasites. Similarly, in other previous studies, higher prevalence had been recorded from different states of India, i.e., Bihar (51.90%; Modi et al. 1997a), Andhra Pradesh (46.59%; Kumar & Rao 2003), and Punjab (32.98%; Moudgil et al. 2020b). Comparatively lower prevalence in the present study could be associated with the adoption of better management practices including balanced feeding, regular deworming, regular screening and treatment of positive animals and daily cage and premises cleaning.

Prevalence based on sex and location

Sex and location (Table 2) based variation in prevalence rate was found non-significant during all three seasons. However, Kumar & Rao (2003) found a higher prevalence of parasitic infection in males than females kept in the different zoological gardens of Andhra Pradesh (India) and Nekede Owerri (Southeast Nigeria).

Species based seasonal prevalence

All the omnivores were positive for gastrointestinal parasites during the winter (Table 3) followed by 28.60 % prevalence in herbivores, 16.70 % in reptiles, and 5.04 % (2/37) in carnivores. The observations are similar to Thawait et al. (2014). The prevalence was significantly higher ($p<0.01$) in omnivores during the winter and monsoon season. The prevalence during summer

Table 1. Overall seasonal prevalence of gastrointestinal parasitic infections in mammals and birds.

	Season	Examined (mammals + birds)	Positive mammals	Prevalence (%)	Positive birds	Prevalence (%)
1	Winter	150 (95+55)	25	26.30 (CI 17.8–26.30)	11	20.00 (CI 10.40–33.0)
2	Summer	150 (95+55)	8	8.40 (CI 3.70–15.90)	8	14.50 (CI 6.50–26.70)
3	Monsoon	150 (95+55)	28	29.50 (CI 20.60–39.90)	12	21.80 (CI 11.80–35.00)
	Overall	450 (285+165)	61	21.50 (CI 16.80–26.60)	31	18.80 (CI 13.10–25.60)
	χ^2		20.86**			1.033 ^{NS}

CI—95% Confidence Interval | *—significant at $P<0.05$ | **—significant at $P<0.01$ | NS—non-significance.

among different species was found lower than the other seasons, contrary to the studies from southeastern Nigeria that reported higher infections in the summer season in wild cats (Okoye et al. 2014). The hot and dry climate in the study region and clean surroundings on the premises might have attributed to the low parasitic infections during the summer season.

In the monsoon season, 10.80% of carnivores were found positive for gastrointestinal parasites. *Balantidium coli*cysts were most commonly found in lions (Image 5) and strongyle eggs and *Strongyloides* larvae in Hyena (Image 6). Among herbivorous animals, gaurs and blackbucks (Image 3 & 4) were found positive for *Strongyloides* species, whereas chinkara and nilgai were positive for *Trichuris* eggs (Image 1) and *B. coli* (Image 2), respectively. Similar findings were previously recorded by Cook et al. (1979). Among omnivores, *B. coli* cysts were seen in Bonnet macaque (Image 8) and *Strongyloides* species larvae in Malabar Giant Squirrel (Image 7). Prevalence was found higher in monkeys as they were kept in cages, which could have led to excessive stress, further leading to a 100% infection rate of gastrointestinal parasites. Thawait et al. (2014) also recorded a similar observation where the prevalence of different gastrointestinal parasites was found higher in monkeys (60%), followed by herbivores (45.6%) and carnivores (45.2%). In python, *Strongyloides* species eggs (Image 13) were abundant, whereas *B. coli* cysts were seen in Star back

Table 2. Seasonal prevalence of gastrointestinal parasites based on sex and location in different animals.

Variables	Sex		Location	
	Female	Male	Zoo I	Zoo II
Winter	8/29 (27.00)	4/25 (16.00)	24/85(28.20)	1/10(10.00)
χ^2	8.38 ^{NS}		3.74 ^{NS}	
Summer	0/29(0)	4/25(16.0)	7/85(8.20)	1/10(10.00)
χ^2	4.62 ^{NS}		0.48 ^{NS}	
Monsoon	9/29(31.00)	9/25(36.00)	26/85(30.60)	2/10(20.00)
χ^2 value	1.05 ^{NS}		0.48 ^{NS}	

^{NS}—non-significance | Figures in parentheses indicate percentages | Zoo I—Rajiv Gandhi Zoological Park and Wildlife Research Center | Zoo II—NisargakaviBahinabaiChaudhary Zoo.

tortoise (Image 14). Similar observations were reported in Kerala by Akhila et al. (2018), i.e., overall *Strongyloides* species larvae were most prominently found accounting for 25.7% of all infections, followed by *Capillaria* species (22.8%) and strongyles (20.00%) in captive snakes.

Seasonal prevalence in birds

In the monsoon season, adult birds showed a significant higher prevalence of gastrointestinal parasites compared to young birds. (Table 4). Similarly, a highly significant difference was observed in males during the monsoon season. The presence of *Ascaridia galli* was

Table 3. Seasonal prevalence of gastrointestinal parasites found in different species of animals.

Variables	Carnivores	Herbivores	Omnivores	Reptiles	χ^2 Value
Winter	2/37(5.40)	8/28(28.60)	12/12(100)	3/18(16.70)	25.232**
Summer	2/37(5.40)	2/28(7.10)	2/12(16.70)	2/18(11.20)	1.72 ^{NS}
Monsoon	4/37(10.80)	8/28(28.60)	12/12(100)	4/18(22.20)	35.380**

*—Significant at $P<0.05$ | **—significant at $P < 0.01$ | ns—non-significance. Figures in parenthesis indicates percentages

Table 4. Age, sex, location wise seasonal prevalence of gastrointestinal parasites in birds.

Variables /season	Age		Sex		Location	
	Adult	Young	Female	Male	Zoo I	Zoo II
Winter	11/40 (27.50)	1/15 (6.70)	4/18 (22.20)	2/14 (14.30)	8/25 (32.0)	4/30 (13.0)
χ^2 value	2.77 ^{NS}		0.71 ^{NS}		2.78 ^{NS}	
Summer	9/40 (22.50)	2/15 (13.30)	2/18 (11.10)	4/14 (26.60)	7/25 (28)	4/30 (13.0)
χ^2 value	0.57 ^{NS}		1.57 ^{NS}		1.83 ^{NS}	
Monsoon	6/40 (15.00)	2/15 (13.30)	3/18 (16.70)	3/14 (21.40)	3/25 (12.0)	5/30 (16.70)
χ^2 value	17.39**		46.54**		47.43**	

*—significant at $P<0.05$ | **—significant at $P < 0.01$ | ns—non-significance. Figures in parenthesis indicates percentages.

commonly observed in peafowl (Image 9) and African Grey Parrots (Image 11), followed by *Capillaria* in Long-billed Vultures (Image 10) and Great Horn Owls (Image 12). Such observation is more or less similar to the findings of Parsani et al. (2007) in birds in Ahmedabad. Sahoo et al. (2010) reported a prevalence of 29.5% from Orissa at Nandankanan Zoo in wild birds. The birds in the zoo are often subjected to the stress of caged captivity, overcrowding and environmental conditions favorable for the development of parasites. As a result, the birds in captivity generally harbor more parasitic infections than their freely living counterparts.

Captivity based prevalence

Captivity based prevalence found significantly higher in herds (groups), i.e., 33.30% (95% CI = 25.60–41.80), followed by birds 18.80% (95% CI = 13.10–25.60) and individually enclosed animals 9.72% (95% CI = 5.40–15.80) (Table 5). At the beginning of the study, the birds showed the highest prevalence in monsoon, i.e., 32% (95% CI = 14.90–53.50), followed by winter with 28% (95% CI = 12.10–49.40) and summer with 12% (95% CI = 2.50–31.20) at Zoo I. The parasitic gastrointestinal infections in the mammals kept in herds (groups) were highest (45.70%) in the monsoons (95% CI = 30.90–61.00) followed by winter (45.60%) (95% CI = 30.90–61.00) and summer (8.7%) (95% CI = 2.40–61). Initially, in Zoo II, the captivity-based prevalence in birds and herds during the season of monsoon was 13.3% (95% CI = 3.80–30.70) and 100% (95% CI = 2.5–100), respectively. That could be because of overcrowding and competition for food and water, causing stress and lowered immunity, making them more vulnerable to parasitic illnesses (Dhoot et al. 2002; Singh et al. 2009). The individual enclosed animals had a significantly lower prevalence than herd animals and birds, as they might get special care, management and appropriate anthelmintic treatment throughout the year (Table 5). Similar observations have been reported by Moudgil et al. (2020a) from Punjab from different zoos.

Seasonal EPG recorded in both mammals and birds

The mean EPG of mammals of both zoos during the pre-monsoon season was the highest (183.9 ± 16.00). The EPG recorded in the positive herbivores was moderate (50–100) while it was more in carnivores (100–300). The mean EPG observed in the pre-winter and pre-summer seasons was (156 ± 13) and post-winter and post-summer was (20 ± 6.40) (Table 6). Similar results were shown by Modi et al. (1997b) from Bihar; Kumar & Rao (2003) from Andhra Pradesh and Moudgil et al. (2014) from Punjab, where the monsoon season has the highest prevalence,

Table 5. Prevalence of gastrointestinal parasites based on captivity.

Overall/ Captivity	Frequency of positive samples	Prevalence (%)	χ^2
Birds	31/165	18.80 (CI 13.10–25.60)	24.858**
Individual enclosed	14/144	9.70 (CI 5.40–15.80)	
Groups (herds)	47/141	33.30 (CI 25.60–41.80)	

CI—95% Confidence Interval | *—significant at $P < 0.05$ | **—significant at $P < 0.01$ | ns—non-significance.

followed by winter while the summers had the lowest prevalence. During the study period, the intensity of parasitic infection was also recorded in captive birds at both zoos. The mean EPG recorded in birds was highest in the winter season (265 ± 18.30), followed by monsoon (200 ± 26.10) and summer (181.2 ± 32.60).

Drug-wise efficacy study

The treatment was carried out for positive animals and birds in the present investigation as per Table 7 and 8. The faecal samples were collected two times (pre and post treatment) for the study from different animals and birds. At Zoo I (Rajiv Gandhi Zoo and Wildlife Research Centre Karaj, Pune), there was 85.89% and 77.36% reduction in eggs counts after treatment with fenbendazole @5mg/kg in herbivores and birds, respectively. In carnivores, the reduction was 69.93% after treatment with drug combination @10 mg/kg (Praziquantel 50mg + Pyrantel 144mg + fenbantel 150 mg) (Table 7). In Zoo II (Nisargakavi Bahinabai Chaudhary Zoo, Pimpri Chinwad) the reduction in EPG was 72.35% in carnivores with drug combination @10mg/kg (Praziquantel 50mg + pyrantel 144mg + fenbantel 150mg) and 68.98% in birds with albendazole @10mg/kg.

The drugs used were able to eliminate the development stages of the parasites in herbivores, carnivores as well as birds. Cent-percent efficacy was observed against *Trichuris* species and strongyle parasites for herbivores and carnivores, as eggs of these two species of parasites were not detected in the faeces post-treatment. Similarly, in birds, both albendazole and fenbendazole were able to eliminate *Ascaridia* sp., parasites, as no eggs of *Ascaridia* species were seen in the faeces post-treatment.

In the Nisargakavi Bahinabai Chaudhary Zoo, the faecal egg count reduction in mammals was 66.60–100 %. The average reduction in carnivores was 72.35%. The fecal egg count reduction in EPG birds was 76.20–56.30 % with an average of 68.98%. A highly significant reduction in the faecal egg count when compared to pre and post-

Table 6. Seasonal EPG recorded in both mammals and birds.

EPG	Mammals (Range)	Mean ± SE	Birds(Range)	Mean± SE
Pre-winter	50–300	156 ±13.00	150–350	265±18.30
Post-winter	0–100	20 ± 6.40	0–150	60±16.30
Pre-summer	50–300	156±13.00	100–300	181.2±32.60
Post-summer	0–100	20±6.40	0–150	56.2±17.50
Pre-monsoon	50–300	183.9±16.00	100–300	200±26.10
Post-monsoon	0–150	55.30±11.30	0–150	83.3±16.60

Table 7. Species-wise drug and dosing used for deworming at Zoo I.

	Species	drug used (contents)	Dosing	Pre- treatment EPG	Post-treatment EPG	Percentage reduction in EPG
1	Herbivores	5% suspension containing fenbendazole	@ 5mg/kg body weight once a day for 2 days.	156 ±13.00	20 ± 6.40	85.89%
2	Carnivores	Praziquantel 50mg + Pyrantel 144mg +fenbantel 150 mg	@10mg/kg body weight for 3 days.	183.9±16.00	55.30±11.30	69.93%
3	Birds	5% suspension containing fenbendazole	@5mg/kg body weight for 1 day	265±18.30	60±16.30	77.36%

Table 8. Species-wise drug and dosing used for deworming at Zoo II.

	Species	Content of the drug used for deworming	Dosing	Pre- treatment EPG	Post-treatment EPG	percentage reduction in EPG
2	Carnivores	Praziquantel 50mg + pyrantel 144mg + fenbantel 150 mg	@10mg/kg body weight for 3 days.	200±26.10	55.30±11.30	72.35%
3	Birds	Albendazole	@ 10mg/kg. body weight for 1 day	181.2±32.60	56.2±17.50	68.98%

treatment egg counts in both zoos may be due to proper dosing of drugs in animals according to body weight, good hygienic management practices, and individual care of wild animals and birds. It has been observed that confinement of wild animals in the zoo makes them prone to different parasitic infections despite providing adequate attention to feed, water, and maintenance of hygiene in captivity (Barmon et al. 2014). Despite regular deworming practices, the prevalence of parasitic infections varying from 25–95 % has been reported in zoo birds at various locations in India (Parasani et al. 2007). Besides proper dosing with specific and recommended drugs, in animals according to their body weight, good hygienic management practices and individual care of wild animals and birds in captivity is required for the management of these infections.

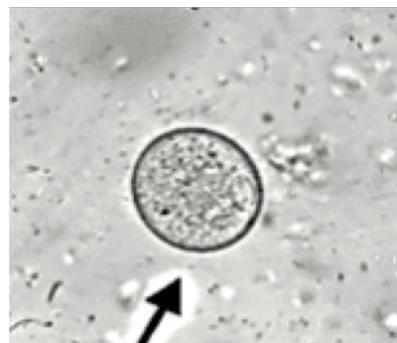
SUMMARY AND CONCLUSION

Climatic conditions during different seasons and captivity play a major role in the prevalence of parasitic infections in zoo animals. Captivity enhances the repeated exposure of the animals to the environment contaminated by the infective stages of the parasites. Furthermore, such environmental conditions can be favourable to the parasites' developmental stages being propagated as a result and the enclosure being contaminated. It is possible to infer from the study's findings that appropriate control methods, such as periodical examination, following the collection of faecal samples, and successful treatment is administered with anthelmintic. It may be suggested that cleaning the premises and proper disposal of excreta and refusals may minimize/avoid the associated losses.

Eggs of parasites observed in herbivores:

Image 1. *Trichuris* sp. (40X) in Chinkara.Image 2. *Balantidium coli* (40X) in Nilgai.Image 3. *Strongyloides* (40X) in Gaur.Image 4. *Strongyloides* (40X) in Black Buck.

Eggs of parasites observed in carnivores:

Image 5. *Balantidium coli* (40X) in African Lion.Image 6. *Strongyloides* (40X) in Spotted Hyena.

Eggs of parasites observed in omnivores:

Image 7. *Strongyloides* (40X) in Giant Malabar Squirrel.Image 8. *Balantidium coli* (40X) Bonnet Macaque.

REFERENCES

Akhila, S., V.S. Sukanya, A. Anto & S. Karunakaran (2018). Prevalence of endoparasites in captive snakes of Kerala, India. *Annals of Parasitology* 64(2): 129–135. <https://doi.org/10.17420/ap6402.144>

Barmon, B.C., N. Begum, S.S. Labony, U.K. Kundu, A.R. Dey & T.R. Dev (2014). Study of gastrointestinal parasites of deer at Char Kukri Mukri in Bhola district. *Bangladesh Journal of Veterinary Medicine* 12(1): 27–33.

Chomel, B.B. (2008). Control and prevention of emerging parasitic zoonoses. *International Journal for Parasitology* 38(11): 1211–1217. <https://doi.org/10.1016/j.ijpara.2008.05.001>

Cook, T.W., B.T. Ridgeway, R. Androeid & J. Hodge (1979). Gastrointestinal helminths in White-tailed Deer of Illinois. *Journal of Wild Diseases* 15(3): 405–407.

Dhoot, V.M., S.V. Upadhye & S.W. Kolte (2002). Prevalence of parasitism in wild animals and birds of Mahrajbag Zoo, Nagpur. *Indian Veterinary Journal* 79(3): 225–227.

Gupta, A., A.K. Dixit, P. Dixit, C. Mahajan & A.B. Srivastava (2011). Incidence of gastro-intestinal parasites in wild ruminants around Jabalpur, India. *Journal of Threatened Taxa* 3(11): 2226–2228. <https://doi.org/10.11609/JoTT.o2431.2226-8>.

Gupta, S.K. & L.D. Singla (2012). Diagnostic trends in parasitic diseases of animals, pp. 81–112. In: Gupta, R.P., S.R. Garg, V. Nehra & D. Lather (eds.). *Veterinary Diagnostics: Current Trends*. Satish Serial Publishing House, Delhi.

Jaiswal, S., P. Fontanillas, J. Flannick, A. Manning, P.V. Grauman, B.G. Mar & B.L. Ebert (2014). Age-related clonal hematopoiesis associated with adverse outcomes. *New England Journal of Medicine* 371(26): 2488–2498. <https://doi.org/10.1056/NEJMoa1408617>

Kumar, B.V. & A.N. Rao (2003). Influence of age on the prevalence of parasitic infections among the felids in Animal Reserve Centre at Vizag Zoo, Vishakhapatnam, Andhra Pradesh. *Zoo's Print* 18(10): 11.

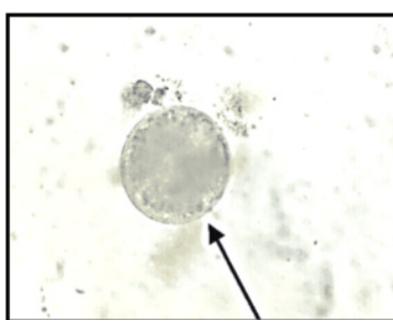
Mir, A.Q., K. Dua, L.D. Singla, S. Sharma & M.P. Singh (2016). Prevalence of parasitic infection in captive wild animals in BirMotiBagh mini zoo (Deer Park), Patiala, Punjab. *VeterinaryWorld* 9(6): 540–543. <https://doi.org/10.14202/vetworld.2016.540-543>

Modi, G.S., B.N. Prasad & B.K. Sinha (1997a). Seasonal effect on the prevalence of parasitic zoonotic diseases among zoo

Eggs of parasites observed in birds:

Image 9. *Ascaridiagalli* (40X) in Indian Peafowl.

Eggs of parasites observed in reptiles:

Image 13. *Strongyloides* (40X) in Reticulated Python.Image 10. *Capillaria* spp. (40X) in Long-billed Indian Vulture.Image 14. *Balantidium coli* (40X) in Star Back Tortoise.Image 11. *Ascaridiagalli* (40X) in African Grey Parrot.Image 12. *Capillaria* spp. (40X) in Great Horn Owl.

animals in Bihar. *Zoo's Print* 12: 8–11.

Modi, G.S., B.N. Prasad & P.K. Sinha (1997b). Effect of age on the prevalence of intestinal parasitism among zoo animals in Bihar. *Indian Veterinary Journal* 74: 351–353.

Moudgil, A.D., L.D. Singla & M.P. Singh (2014). First report on molecular identification and fenbendazole resistance against *Baylisascaris transfuga* infection in *Melursus ursinus* (Sloth Bear). *Helminthologia* 51(4): 262–268. <https://doi.org/10.2478/s11687-014-0239-2>

Moudgil, A.D., L.D. Singla & Pallavi (2015). Parasitosis in wild felids of India: an overview. *Journal of Threatened Taxa* 7(10): 7641–7648. <https://doi.org/10.11609/JOTT.o4236.7641-8>

Moudgil, A.D., L.D. Singla & M.P. Singh (2020a). Seasonal coprological survey for assessment of risk factors associated with gastrointestinal parasitism in zoo-housed animals of Punjab, India. *Biological Rhythm Research* 51(8): 1273–1287. <https://doi.org/10.1080/09291016.2019.1571706>

Moudgil, A.D., L.D. Singla & M.P. Singh (2020b). Seasonal variation in gastrointestinal parasitism of zoo-housed birds of Punjab, India. *Biological Rhythm Research* 51(8): 1075–1086. <https://doi.org/10.1080/09291016.2019.1576284>

Muraleedharan, K., V. Iswariah, K.S.

Ziauddin & K. Srinivasan (1990). A survey of gastro-intestinal parasites of animals of zoological gardens at Mysore. *Mysore Journal of Agricultural Science* 24(2): 250–256.

Okoye, I.C., N.R. Obieze, F.N. Okoh & E.C. Amadi (2014). Descriptive epidemiology and seasonality of intestinal parasites of cats in Southeast Nigeria. *Comparative Clinical Pathology* 23(4): 999–1005. <https://doi.org/10.1007/s00580-013-1734-4>

Parsani, H.R., R.R. Momin, M.G. Maradia & V. Singh (2001). A survey of gastrointestinal parasites of captive animals at Rajkot municipal corporation zoo, Rajkot, Gujarat. *Zoos' Print Journal* 16(10): 604–606. <https://doi.org/10.11609/JOTT.ZPJ.16.10.604-6>

Parsani, H.R. Momin & V. Singh (2007). Prevalence of parasitic infections in captive zoo birds in Gujarat. *Journal of Veterinary Parasitology* 21(2): 129–131.

Rao, A.T. & L.N. Acharjyo (1984). Diagnosis and classification of common hooved wild life in North America. *Mid-American Agriculture Research in Veron* 53: 593–594.

Sahoo, N., M. Dehuri, K.M.N. Bharti, P.K. Roy, A. Das & R.K. Samantaray (2010). Prevalence of endoparasitic infection in birds of Nandankanan Zoo. *Journal of Veterinary Parasitology* 24(1): 95–96.

Singh, P., M.P. Gupta, L.D. Singla, N. Singh & D.R. Sharma (2006). Prevalence and chemotherapy of gastrointestinal helminthic infections in wild carnivores in Mahendra Choudhury Zoological Park, Punjab. *Journal of Veterinary Parasitology* 20(1): 17–23.

Singh, P., L.D. Singla, M.P. Gupta, S. Sharma & D.R. Sharma (2009). Epidemiology and chemotherapy of parasitic infections in wild omnivores in the Mahendra Choudhury Zoological Park, Chhat Bir, Punjab. *Journal of Threatened Taxa* 1(1): 62–64. <https://doi.org/10.11609/JOTT.o1767a.62-4>

Soulsby, E.J.L. (1982). *Helminths, Arthropods and Protozoa of Domesticated Animals*, 7th Edition, ELBS, Bailliere Tindall, London, 809 pp.

Thawait, V.K., S.K. Maiti & A.A. Dixit (2014). Prevalence of gastro-intestinal parasites in captive wild animals of Nandan Van Zoo, Raipur, Chhattisgarh. *Veterinary World* 7(7): 448–451. <https://doi.org/10.14202/vetworld.2014.448-451>

Varadharajan, A. & C. Pythal (1999). Incidence of gastro intestinal parasitism in free living Feral Bonnet Macaque (*Macacaradiata* L). *Zoo's Print Journal* 14(6): 41–42. <https://doi.org/10.11609/JOTT.ZPJ.14.6.41-2>

ZSI (2021). India adds 557 new species to its fauna: Zoological Survey of India. Archived 13 September 2021 at the Wayback Machine, *The Hindu*, 27 Aug 2021.

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 Sondhi, 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, Zoological Records.

NAAS rating (India) 5.64

Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia
Mr. H. Biju, 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 Jayopal, 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 Mundkur, 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. Kumara, 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, Budhanilkantha Municipality, Kathmandu, Nepal
Dr. Susan Cheyne, Borneo Nature Foundation International, Palangkaraya, Indonesia
Dr. Hemanta Kafley, Wildlife Sciences, Tarleton State University, Texas, USA

Other Disciplines

Dr. Aniruddha Belsare, Columbia MO 65203, USA (Veterinary)
Dr. Mandar 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 Helleni 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. Bharat Baviskar, Wild-CER, Nagpur, Maharashtra 440013, India

Reviewers 2021–2023

Due to paucity of space, the list of reviewers for 2021–2023 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

Articles

Spatial assemblage of shorebirds (Aves: Charadriiformes) in an altered wetland of the southern coast of Sri Lanka

– V.N. Mendis, E.J.A.P. Buddhi Priyankara, E.G.D.P. Jayasekara & W.A.D. Mahaulpatha, Pp. 25495–25506

Current conservation status of Bengal Florican *Houbaropsis bengalensis* in Manas National Park, Assam, India

– Miranda Thakur, Jonmani Kalita, Namita Brahma, Koushik Rajbongshi, Kangkanjyoti Bhattacharyya, Amal Chandra Sarmah, Alolika Sinha, Deba Kumar Dutta, Dhritiman Das & Bibhuti Prasad Lahkar, Pp. 25507–25515

Assemblages of frugivorous butterflies in two urban parks in Quezon City, Philippines

– Michael Gabriel A. Itliong, Nikki Heherson A. Dagamac & Jade Aster T. Badon, Pp. 25516–25527

Assessment of the status of *Spodoptera* species (Lepidoptera: Noctuidae: Armyworm) in India through DNA barcoding technique

– Dinesh Nalage, P.S. Kudnar, Tejswini Sontakke, Ishwar Chittapure, Yashdeep Gowda, Shantanu Kharbal & Yashashri Alamwar, Pp. 25528–25535

Taxonomy and distribution of some orthopteran species (Orthoptera: Gryllidae, Trigonidiidae, Acrididae) from northwestern Morocco

– Hanae El Harche, Samiha Kaioua & Dalale Mansouri, Pp. 25536–25544

Impact of root harvest on *Decalepis hamiltonii* Wight & Arn. population across habitats in Savandurga Reserve Forest, Karnataka, India

– M. Sathy Sangeetha, Kaliamoorthy Ravikumar & H.C. Chetan, Pp. 25545–25570

Communications

Rare encounters: Jungle Cat *Felis chaus* Schreber, 1777 (Mammalia: Carnivora: Felidae) in the lower reaches of the Jordan River, Jordan

– Ehab Eid & Mohammad Farid Alayyan, Pp. 25571–25576

Diversity of bird species in Ebpanan Marsh, Maguindanao del Norte, Bangsamoro Autonomous Region in Muslim Mindanao (BARMM), Philippines

– Gindol Rey A. Limbaro, Benito Anthony A. Pingoy & Peter Jan D. de Vera, Pp. 25577–25583

Heleocoris stephanus (Heteroptera: Naucoridae: Laccocorinae), a new species of creeping water bug from Kallada River, Kerala, India

– Dani Benchamin, R. Sreejai & M.S. Arya, Pp. 25584–25589

Incidence and risk factors associated with parasitic infections in captive wild mammals and birds in Indian zoos

– Nikita Das, P.D. Pawar, P.P. Mhase, V.G. Nimbalkar, R.V. Jadhav, V.S. Dhaygude, Gavin Furtado & L.D. Singla, Pp. 25590–25597

Bryophyte diversity of Berinag (Pithoragarh District) in Kumaun Himalaya, Uttarakhand, India

– D. Dhami & P. Chaturvedi, Pp. 25598–25603

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

July 2024 | Vol. 16 | No. 7 | Pages: 25495–25638

Date of Publication: 26 July 2024 (Online & Print)

DOI: 10.11609/jott.2024.16.7.25495-25638

Short Communications

The opportunistic feeding behaviour of *Schistura notostigma* (Teleostei: Nemacheilidae) in tropical mountain streams in Sri Lanka

– J. Bandara, M.P. Gunawardena & R.T.P Jayasuriya, Pp. 25604–25608

First record of *Pieris napi* L. (Lepidoptera: Pieridae) from Kashmir Valley, India

– Firdousa Rasool & Altaf Hussain Mir, Pp. 25609–25612

Reassessment of *Strobilanthes recurva* (Acanthaceae), an endangered plant from Manipur, India

– Rajkumari Jashmi Devi & Biseshwori Thongam, Pp. 25613–25616

New distribution record of Slender Wild Basil *Clinopodium gracile* (Benth.) Kuntze (Lamiaceae: Nepetoideae: Mentheae) for the flora of Himachal Pradesh, India

– Rimjhim Chandra & Mamita Kalita, Pp. 25617–25622

Notes

Rusty-spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) (Mammalia: Carnivora: Felidae) in the semi-natural subterranean habitat in Karnataka, India

– Shirish Manchi, Goldin Quadros, Dipika Bajpai, Shomita Mukherjee, Suma Haleholi, Mahesh Marennavar, Sangmesh Neeralagi, Prakash Ganiger, Suresh Lamani & Nikhil Kulkarni, Pp. 25623–25626

First record of Scaly-breasted Munia *Lonchura punctulata* (Linnaeus, 1758) (Aves: Passeriformes: Estrildidae) from Kashmir, India

– Shazia Shafayat, Fayaz Ahmad Ahanger, Tariq Ahmad, Bilal A. Bhat & Zakir Hussain Najar, Pp. 25627–25629

First record of *Prosyznskia diatreta* (Simon, 1902) (Araneae: Salticidae) from Gujarat, India

– Manisha P. Patel & Dhruv A. Prajapati, Pp. 25630–25631

Medicago monantha (Fabaceae) and *Euphorbia jodhpurensis* (Euphorbiaceae) as new additions to the flora of Maharashtra State, India

– Praveen V. Kale & Rajendra D. Shinde, Pp. 25632–25636

Book Review

All eyes on the island: A book review of The Great Nicobar Betrayal

– Lakshmi Ravinder Nair, Pp. 25637–25638

Publisher & Host



Threatened Taxa