Cats, canines, and coexistence: dietary differentiation between the sympatric Snow Leopard and Grey Wolf in the western landscape of Nepal Himalaya

Anil Shrestha, Kanchan Thapa, Samundra Ambuhang Subba, Maheshwar Dhakal, Bishnu Prasad Devkota, Gokarna Jung Thapa, Sheren Shrestha, Sabita Malla & Kamal Thapa

26 May 2019 | Vol. 11 | No. 7 | Pages: 13815–13821
DOI: 10.11609/jott.4217.11.7.13815-13821
Cats, Canines, and Coexistence: Dietary Differentiation between the Sympatric Snow Leopard and Grey Wolf in the Western Landscape of Nepal Himalaya

Anil Shrestha, Kanchan Thapa, Samundra Ambuhang Subba, Maheshwar Dhakal, Bishnu Prasad Devkota, Gokarna Jung Thapa, Sheren Shrestha, Sabita Malla & Kamal Thapa

Abstract: Understanding the dietary habits of sympatric apex carnivores advances our knowledge of ecological processes and aids their conservation. We compared the diets of the sympatric Snow Leopard Panthera uncia and Grey Wolf Canis lupus using standard microscopic histological analyses of scats collected from the western complex of Nepal Himalaya. Our study revealed one of the highest recorded contributions of livestock to the diet of top predators (55% for Grey Wolf and 39% for Snow Leopard) and high dietary overlap (0.82) indicating potential exploitative or interference competition. Their diet composition, however, varied significantly based on their consumption of wild and domestic prey. Limitation in data precludes predicting direction and outcome of inter-specific interactions between these predators. Our findings suggest a high rate of negative interaction with humans in the region and plausibly retaliatory killings of these imperilled predators. To ensure the sustained survival of these two apex carnivores, conservation measures should enhance populations of their wild prey species while reducing livestock losses of the local community through preventive and mitigative interventions.

Keywords: Canis lupus, dietary pattern, dietary overlap, livestock, Naur, negative interaction, Panthera uncia, scat analysis, sympathy.

DOI: https://doi.org/10.11609/jott.4217.11.7.13815-13821

Editor: Jim Sanderson, Small Wild Cat Conservation Foundation, Corrales, USA. Date of publication: 26 May 2019 (online & print)

Manuscript details: #4217 | Received 23 April 2018 | Final received 30 April 2019 | Finally accepted 13 May 2019

Citation: Shrestha, A., K. Thapa, S.A. Subba, M. Dhakal, B.P. Devkota, G.J. Thapa, S. Shrestha, S. Malla & K. Thapa (2019). Cats, canines, and coexistence: dietary differentiation between the sympatric Snow Leopard and Grey Wolf in the western landscape of Nepal Himalaya. Journal of Threatened Taxa 11(7): 13815–13821. https://doi.org/10.11609/jott.4217.11.7.13815-13821

Copyright: © Shrestha et al. 2019. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by adequate credit to the author(s) and the source of publication.

Funding: WWF UK.

Competing interests: The authors declare no competing interests.

For Author details, Author contribution and Acknowledgements, see end of this article.
INTRODUCTION

Dietary habits of sympatric apex carnivores advance our understanding on ecological processes and regulation of the ecosystem functions, aiding their conservation (Macdonald 1983). In Nepal Himalaya, inter-specific interactions between apex predators have consequences for predator-prey relationships, habitat, and the entire ecosystem; this can also have a spillover effect on their relation to humans, through livestock depredation and retaliatory killing (Chetri et al. 2017). Information on dietary overlap and interactions of sympatric carnivores, however, is limited in these mountainous landscapes and nonexistent from the western complex of Nepal Himalaya.

With this background, we studied the dietary habits of the Snow Leopard *Panthera uncia* and Grey Wolf *Canis lupus* (hereafter referred to as ‘Wolf’) which live sympatriically in the western complex of Nepal Himalaya. Snow Leopards are twice the body size of Wolves (Jnawali et al. 2011) and are solitary hunters with a stalking ambush hunting behaviour (Jackson & Hunter 1996). In contrast, Wolves are coordinating cursorial pack-hunters (Viripaev & Vorobiev 1983).

We specifically investigated (a) the dietary pattern and relative importance of prey types for the sympatric Snow Leopard and Wolf, and (b) their dietary overlap in the western complex of Nepal Himalaya.

MATERIALS AND METHODS

Study area

Our study was carried out in the western landscape of Nepal Himalaya (83.281–28.493 in the east to 80.586–29.542 in the west) across the potential habitat of the Snow Leopard and the Wolf (Fig. 1). This covers an area of over 38,312km² with an altitude range of 3,000–5,500 m. Of the total study area, barren area (22%) is the most dominant land cover, followed by rugged and broken snow-capped mountains and glaciers (17%), alpine rolling grasslands (17%), and agriculture and settlement (12%) (ICIMOD 2010). The total potential habitat within the western landscape covers an area of 11,261km². The western landscape is one of three priority landscapes identified by The Global Snow Leopard and Ecosystem Protection Program (GLSLEP) (DNPWC 2017).

Wild prey species recorded in the study area included Bharal/ Blue Sheep/ Naur *Pseudois nayaur*, Himalayan Tahr *Hemitragus jemlahicus*, Kiang *Equus kiang*, Tibetan Argali *Ovis ammon*, Alpine Musk Deer *Moschus chrysogaster*, Tibetan Gazelle *Procapra picticaudata*, pika *Ochotona spp.*, marmot *Marmota spp.*, and Woolly Hare *Lepus oiostolus*.

With pastoralism as the main occupation of the local community, this region harbours a high density of livestock (73 head per km²), including domestic yak *Bos grunniens*, cow *Bos spp.* and hybrid, horse *Equus ferus caballus*, goat *Capra hircus*, sheep *Ovis aries*, and pig *Sus scrofa domesticus* (CBS 2011).

Scat survey

We systematically collected putative Snow Leopard and Wolf scat samples from each of the 56 grids measuring 16km² (4km x 4km; effective sample area ~896km²; Fig. 1) spread across 11,261km² following standard protocol (Thapa 2007) during the late spring season (April–May) in 2014. Within each grid, at least two transects (0.4–2.8 km) were laid 1.0–1.5 km apart (Jackson & Hunter 1996) and surveyed. Upon encounter of fresh scat samples, a few grams were collected and stored in 15ml tubes containing silica desiccant for micro-histological studies; the remaining scat was left in the field to avoid disturbing the regular movements and territorial marking of the predators (Lovari et al. 2009). All putative scat samples (n=265) were screened for species identification through molecular scatology (Kelly et al. 2012).

DNA extraction

DNA was extracted from scat samples using commercially available DNA stool kit (QIAGEN Inc.) following manufacturer instructions. We kept one negative control (water) in each batch of samples to monitor contamination during DNA extraction.

Species identification

All the samples were screened for PCR-based species identification using mitochondrial DNA (mtDNA) cytochrome-b segment Snow Leopard-specific primers (Janecka et al. 2008, 2011). All Snow Leopard-negative samples were further screened using D-Loop section of mtDNA (MIT forward/ reverse) with Wolf specific primers (Parra et al. 2008; Pilot et al. 2010). All PCR reactions for both Snow Leopard and Wolf were performed in duplicate for confirmation. Similar results in duplicate PCR runs were considered (Snow Leopard/Wolf) positive samples. Non-conformity and/or discrepancy in two PCR runs were verified with a third run for confirmation.

Diet analysis

Species-positive scat samples for Snow Leopard and...
Wolf were analyzed using a standard micro-histological study method (Oli et al. 1993; Devkota et al. 2013). Prey species were identified by comparing hair samples collected from these species-positive scat samples with reference to hair samples of all potential prey species (Oli et al. 1994; Wegge et al. 2012).

We calculated and compared relative frequencies of occurrence of each prey species:

\[
\frac{\text{No. of occurrences of each food item when present}}{\text{Total no. of occurrences of all food items}} \times 100
\]

(Lucherini & Crema 1995) for all mammalian prey items, which were identified to species level. To investigate the relative importance of prey type, we used \(\chi^2\) analysis to compare differences in frequencies of occurrence of prey items between the diet of the Snow Leopard and Wolf in terms of wild versus domestic prey (Azevedo et al. 2006).

We also calculated Pianka’s index to measure the dietary overlap between Snow Leopard and Wolf (Pianka & Pianka 1970):

\[
DO = \frac{\sum P_{ij}P_{ik}}{\sqrt{\sum P_{ij}^2 \sum P_{ik}^2}}
\]

where, DO is dietary overlap and \(P_{ij}\) and \(P_{ik}\) are the respective proportions of prey category \(i\) in the diet of the two predators ‘j’ and ‘k’. The value ranges from zero to one, indicating no dietary overlap (DO=0) to complete overlap (DO=1), respectively.
RESULTS

Diet composition of carnivores

Of the 265 putative scat samples collected and genetically screened, 35 (13%) belonged to Snow Leopards and 24 (9%) to Wolves; the rest (78%) belonged to other species. Five wild prey species—Bharal, hare, pika, marmot, and Musk Deer—were identified in both Snow Leopard and Wolf scat samples. Of the domestic prey species identified, Snow Leopard scat was found to have goat, sheep, domestic yak, cow, dog, and horse, while Wolf scat had five of these, excluding horse. Spatial distribution of genetically screened scat samples as Snow Leopard, Wolf, and negative is shown in Fig. 1.

Snow Leopard diet

The Snow Leopard diet was dominated by wild prey comprising about 61%, followed by domestic livestock making up for 39% of the total identified species (Fig. 2). Bharal was the most significant prey of Snow Leopard, contributing 29%, followed by goat (21%), hare (15%), pika (5%), domestic yak (5%), domestic cow (4%), and others (Fig. 3). About 54% of the confirmed Snow Leopard scats comprised a single prey species, followed by 32% with two species and 14% with three species.

Wolf diet

Domestic livestock contributed more than half (55%) of the Wolf’s diet while wild prey comprised only 45% (Fig. 2). Wolf diet was dominated by Bharal (28%), followed by domestic cow (15%), sheep (15%), goat (10%), dog (8%), domestic yak (8%), marmot (7%), and others (Fig. 3). About 46% of the confirmed Wolf scat comprised of a single prey species, followed by 29% comprising two species and 25% with three species.

Diet overlap between Snow Leopard and Wolf

High diet overlap (DO=0.82) was found between the sympatric Snow Leopard and Wolf. The diet composition (wild prey vs. domestic prey) of Snow Leopard and Wolf, however, varied significantly ($X^2=5.13$, d.f.=1, $P<0.023$).

DISCUSSION

This appears to be the first study on Snow Leopard (Image 1) and Grey Wolf (Image 2) dietary pattern in western Nepal Himalaya applying standard microhistological analysis of genetically confirmed scats. We compared our results specifically with similar studies that employed genetic screening to avoid biases (Weiskopf et al. 2016).

Our results showed that the diet of the Snow Leopard in the western landscape of Nepal Himalaya was dominated by wild herbivores (61%), with majority contributed by one principle prey species, i.e., Bharal, followed by livestock. This is consistent with the dietary...
pattern of the Snow Leopard in the central landscape of Nepal Himalaya (Wegge et al. 2012; Aryal et al. 2014). Similar trends were also recorded in other Snow Leopard range states, except that the principal prey species was not Bharal (Jumabay-Uulu et al. 2014; Weiskopf et al. 2016). The proportion of livestock (39%) and small mammals (30%) in Snow Leopard diet, however, was found to be higher in the present study as compared to other similar studies (Shehzad et al. 2012; Lovari et al. 2013; Aryal et al. 2014; Jumabay-Uulu et al. 2014; Weiskopf et al. 2016; Chetri et al. 2017).

As a whole, more than half of the Wolf’s diet (55%) was dominated by domestic livestock, but the single-most frequently encountered species was wild prey—Bharal (28%). Our findings confirm the preference of large prey by pack-living Wolves (Chetri et al. 2017) but differ in the proportion contributed to their diet by the cliff-dwelling primary prey, Bharal. Further detailed studies are needed to understand the underlying reason for this observation. As compared to other studies, the contributions of livestock to Wolf diet recorded here were among the highest (Jumabay-Uulu et al. 2014; Wang et al. 2014; Chetri et al. 2017). Interestingly, the contribution of wild prey and small mammals to Wolf diet was less in our study as compared to other studies (Jumabay-Uulu et al. 2014; Chetri et al. 2017). These findings may be an outcome of local circumstances; further research will be needed to verify the causes and effects of these findings.

Our study revealed a very high dietary overlap (0.82) between these sympatric predators. This differs significantly from a recent study carried out in the central landscape of Nepal Himalaya wherein a dietary overlap of 0.44 was recorded (Chetri et al. 2017).

High dietary overlap along with their dependence on one primary wild prey species, Bharal (contributing one-third of their diet), may warrant higher potential exploitative or interference competition between Snow Leopards and Wolves in the western landscape.

Interestingly, the finer scale dietary pattern showed a higher contribution of wild prey to the diet of Snow Leopard as compared to that of the Wolf; domestic livestock was dominant in the diet of the latter. The direction and outcome of the interaction between these two predators, however, are difficult to predict from our current study due to our limited sample size, restricted collection season (limited to spring), and lack of information on the population density of the prey species.

Nevertheless, in our study area, the relative contribution of livestock to the diet of both top predators (55% for Wolves and 39% for Snow Leopards) was higher as compared to other studies (Chetri et al. 2017). Further exploration would be necessary to establish if seasonality and local herding practices had a role in bringing this about.

Additionally, prime habitats of these species in the study area see very high anthropogenic activity in the form of Caterpillar Fungus *Ophiocordyceps* spp. (‘yarsagumba’) collection during the latter part of the scat collection season (April–May). This may also have had direct or indirect impacts on wild and domestic prey availability or accessibility, leading to greater livestock in the predator diet.

Increased dependence of both apex carnivores on livestock may lead to further escalation of human-
carnivore negative interactions in the long run. This may trigger retaliatory killings of Snow Leopard and Wolf, as was reported from the region, thereby affecting the abundance of these predators in the region. Conservation measures focuses on preventive and mitigative measures that aid in securing people's livelihoods can potentially reduce retaliation against the predators. We recommend further detailed research on population trends of both predators and their principal prey species in the region to determine the degree of their interaction and ramifications on livestock predation in the area.

REFERENCES

Aryal, A., D. Brunton, W. Ji, D. Karmacharya, T. McCarthy, R. Bencini & D. Raubenheimer (2014). Multipronged strategy including genetic analysis for assessing conservation options for the Snow Leopard in the central Himalaya. Journal of Mammalogy 95(4): 871–881. https://doi.org/10.1644/13-MAMM-A-243

Azevedo, F., V. Lester, W. Gorsuch, S. Lariviére, A. Wirsing & D. Murray (2006). Dietary breadth and overlap among five sympatric prairie carnivores. Journal of Zoology 269: 127–135. https://doi.org/10.1111/j.1469-7998.2006.00075.x

CBS (2011). Statistical Year Book of Nepal. Central Bureau of Statistics. Government of Nepal, National Planning Commission Secretariat, Kathmandu, Nepal, 278pp.

Chetri, M., M. Odden & P. Wegge (2017). Snow Leopard and Himalayan Wolf: food habits and prey selection in the central Himalayas, Nepal. PLoS ONE 12(2): e0170549. https://doi.org/10.1371/journal.pone.0170549

DNPWC (2017). Snow Leopard Conservation Action Plan (2017–2021). Department of National Parks and Wildlife Conservation, Kathmandu, Nepal, 38pp.

Devkota, B.P., T. Siwal & J. Kolejka (2013). Prey density and diet of Snow Leopard (Uncia uncia) in Shy Phokusundo National Park, Nepal. Applied Ecology and Environmental Sciences 14(1): 55–60. https://doi.org/10.12691/aees-1-4-4

ICIMOD (2010). The Landcover of Nepal. Regional Database System. International Center for Integrated Mountain Development, Kathmandu, Nepal. Retrieved from http://rs.iicimod.org/Home/DataDetail?metadataid=9224. Downloaded on 04 April 2019.

Jackson, R.M. & D.O. Hunter (1996). Snow Leopard Survey and Conservation Handbook. International Snow Leopard Trust and US Geological Survey, Fort Collins, 154pp+appendices.

Janecka, J.E., R. Jackson, Z. Yuquang, L. Diqiang, B. Munkhtsog, V. Buckley-Beason & W.J. Murphy (2008). Population monitoring of Snow Leopards using noninvasive collection of scat samples: a pilot study. Animal Conservation 11(5): 401–411. https://doi.org/10.1111/j.1469-1795.2008.00195.x

Janecka, J.E., B. Munkhtsog, R.M. Jackson, G. Naranaaatar, D.P. Mallon & W.J. Murphy (2011). Comparison of noninvasive genetic and camera-trapping techniques for surveying Snow Leopards. Journal of Mammalogy 92(4): 771–783. https://doi.org/10.1644/10-MAMM-A-036.1

Jnawali, S., H.S. Baral, S. Lee, K.P. Acharya, G.P. Upadhyay, M. Pandey, R. Shrestha, D. Joshi, B. Laminchhane & J. Griffiths (compilers) (2011). The Status of Nepal Mammals: The National Red List Series. Department of National Parks and Wildlife Conservation Kathmandu, Nepal, viii+266pp.

Jumabay-Uulu, K., P. Wegge, C. Mishra & K. Sharma (2014). Large carnivores and low diversity of optimal prey: a comparison of the diets of Snow Leopards Panthera uncia and wolves Canis lupus in Sarychat-Ertash Reserve in Kyrgyzstan. Orxv 48(4): 529–535. https://doi.org/10.1017/S0003065313000308

Kelly, M.J., J. Betsch, C. Wultsch, M. Mesa & L.S. Mills (2012). Noninvasive sampling for carnivores, pp47–69. In: Boitani, L. & R.A. Powell (eds.). Carnivore Ecology and Conservation: A Handbook of Techniques. Oxford University Press, New York, 506pp.

Lovari, S., R. Boesi, I. Minder, N. Mucci, E. Randi & A. Dematteis & S. Ale (2009). Restoring a keystone predator may endanger a prey species in a human-altered ecosystem: the return of the snow leopard to Sagarmatha National Park. Animal Conservation 12: 559–570. https://doi.org/10.1111/j.1469-1795.2009.00285.x

Lovari, S., I. Minder, F. Ferretti, N. Mucci, E. Randi & B. Pellizzi (2013). Common and Snow Leopards share prey, but not habitats: competition avoidance by large predators? Journal of Zoology 291: 127–135. https://doi.org/10.1111/jzo.12053

Lucherini, M. & G. Crema (1995). Seasonal variation in the food habits of badgers in an alpine valley. Hystric: The Italian Journal of Mammalogy 7: 165–172.

Macdonald, D.W. (1983). The ecology of carnivore social behaviour. Nature 301(5899): 379–384.

Oli, M., I. Taylor & D.M. Rogers (1993). Diet of the Snow Leopard (Panthera uncia) in the Annapurna Conservation Area, Nepal. Journal of Zoology 231: 365–370. https://doi.org/10.1111/j.1469-7998.1993.tb01924.x

Oli, M.K., I.R. Taylor & M.E. Rogers (1994). Snow Leopard Panthera uncia predation of livestock: an assessment of local perceptions in the Annapurna Conservation Area, Nepal. Biological Conservation 68: 63–68. https://doi.org/10.1016/0006-3207(94)90547-9

Parra, D., S. Méndez, J. Canon & S. Dunner (2008). Genetic differentiation in pointing dog breeds inferred from microsatellites and mitochondrial DNA sequence. Animal Genetics 39: 1–7. https://doi.org/10.1111/j.1365-2052.2007.01658.x

Planka, E.R. & H.D. Planka (1970). The ecology of Moloch horridus (Lacertilia: Agamidae) in Western Australia. Copeia 1970(1): 90–103. https://doi.org/10.1093/cce/1970-1-90

Piatt, M., W. Branicki, W. Jędrezejewski, J. Gospczyński, B. Jędrezejewska, I. Dykyy, M. Shkvrya & E. Tsingarska (2010). Phylogeographic history of grey wolves in Europe. BMC Evolutionary Biology 10: 104.

Shehzad, W., T.M. McCarthy, F. Pompanov, L. Purevjav, E. Coissac, T. Riaz & P. Taberlet (2012). Prey preference of Snow Leopard (Panthera uncia) in South Gobi, Mongolia. PLoS ONE 7(2): e32104. https://doi.org/10.1371/journal.pone.0032104

Thapa, K. (2007). Snow Leopard Monitoring Guideline for Nepal Himalaya. WWF Nepal, 60pp.

Viripaev, V. & G. Vorobiev (1983). The Wolf in Kirghizia. Frunze: Science, 95pp.

Wang, J., A. Lagueudic, P.J. Damerell, P. Riordan & K. Shi (2014). Dietary overlap of Snow Leopard and other carnivores in the Pamirs of northwestern China. Chinese Science Bulletin 59(25): 3162–3168. https://doi.org/10.1007/s11434-014-0370-y

Wegge, P., R. Shrestha & Ø. Flagstad (2012). Snow Leopard Panthera uncia predation on livestock and wild prey in a mountain valley in northern Nepal: implications for conservation management. Wildlife Biology 18(2): 131–141. https://doi.org/10.2981/11-049

Weiskopf, S.R., S.M. Kachel & K.P. McCarthy (2016). What are Snow Leopards really eating? Identifying bias in food-habit studies. Wildlife Society Bulletin 40(2): 233–240. https://doi.org/10.1002/ wsb.640

13820
Journal of Threatened Taxa | www.threatenedtaxa.org | 26 May 2019 | 11(7): 13815–13821

Shrestha et al.
Author details: Anil Shrestha is a lecturer and research coordinator at Faculty of Forestry, University of British Columbia, Canada. His research focuses on threatened species and ecosystem by applying an interdisciplinary approach. He contributed on this project as WWF’s senior research officer. Kanchan Thapa is a conservation biologist at WWF Nepal with an interest in carnivore ecology and population dynamics. Samundra Ambu Hang Subba is a research officer at WWF Nepal. His research focuses on terrestrial carnivores in Nepal. Maheshwar Dhakal is a joint secretary at Ministry of Forest and Environment. His research focus on biodiversity conservation and climate change. Bishnu Prasad Devkota is a Lecturer at Tribhuvan University, Institute of Forestry, Pokhara. His research focus on snow leopard ecology in the high mountains of Nepal. Gokarna Jung Thapa is a geographical information systems specialist whose research is focused on geospatial modelling. Sheren Shrestha is a senior research officer at WWF Nepal. His work focuses on mountain biodiversity and communication science. Sabita Malla is a wildlife biologist at WWF Nepal. Her research focuses on landscape level approach conservation and keen interest in human wildlife conflict management in Nepal. Kamal Thapa is a freelance researcher and his research focuses on mountain carnivores. He contributed on this project as WWF’s senior research officer.

Author contribution: KaT (Kamal Thapa), MD and GJT designed the study. KaT, AS and BPD contributed to the sample collection. BPD analyzed the hair samples. AS and KT analyzed the data and discussed the results. AS and KT wrote manuscript. SAS, MD, BPD, GJT, SS, SM and KaT participated in the manuscript editing.

Acknowledgements: We thank the Department of National Parks and Wildlife Conservation for granting permission to conduct this work, and protected area authorities, community institutions and local people for facilitating the research. We are thankful to Friends of Nature & Green Governance Nepal for conducting fecal surveys. We thank Centre of Molecular Dynamics Nepal for carrying out genetic laboratory work in Nepal. Our sincere thanks to WWF UK for funding the project. We would like to thank Shannon Barber Meyer and Rishi Kumar Sharma for reviewing the earlier version. We appreciate help received from Santosh Pudasaini for translating abstract in Nepali.
**Articles**

Cats, canines, and coexistence: dietary differentiation between the sympatric Snow Leopard and Grey Wolf in the western landscape of Nepal Himalaya
– Anil Shrestha, Kanchan Thapa, Samundra Ambuhang Subba, Maheshwar Dhakal, Bishnu Prasad Devkota, Gokarna Jung Thapa, Sheren Shrestha, Sabita Malla & Kamal Thapa, Pp. 13815–13821

Genetic diversity among the endemic barb *Barbodes tumba* (Teleostei: Cyprinidae) populations from Mindanao, Philippines
– Onaya P. Abdulmalik-Labe & Jonas P. Quilang, Pp. 13822–13832

The importance of conserving fragmented forest patches with high diversity of flowering plants in the northern Western Ghats: an example from Maharashtra, India
– Amol Kishor Kasodekar, Amol Dilip Jadhav, Rani Babanrao Bhagat, Rakesh Mahadev Pawar, Vidya Shrikant Gupta & Narendra Yeshwant Kadoo, Pp. 13833–13849

**Communications**

First assessment of bird diversity in the UNESCO Sheka Forest Biosphere Reserve, southwestern Ethiopia: species richness, distribution and potential for avian conservation
– Matthias Van Opstal, Bernard Oosterlynck, Million Belay, Jesse Erens & Matthias De Beenhouwer, Pp. 13850–13867

Roadkill of animals on the road passing from Kalaburagi to Chincholi, Karnataka, India
– Shankerappa Shantveerappa Hatti & Heena Mubeen, Pp. 13868–13874

*Ceriagrion chromothorax* sp. nov. (Odonata: Zygoptera: Coenagrionidae) from Sindhudurg, Maharashtra, India
– Shantanu Joshi & Dattaprasad Sawant, Pp. 13875–13885

The diversity and distribution of polypores (Basidiomycota: Aphyllorhales) in wet evergreen and shola forests of Silent Valley National Park, southern Western Ghats, India, with three new records
– C.K. Adarsh, K. Vidyasagar & P.N. Ganesh, Pp. 13886–13909

**Short Communications**

Recent photographic records of Fishing Cat *Prionailurus viverrinus* (Bennett, 1833) (Carnivora: Felidae) in the Ayeyarwady Delta of Myanmar
– Naing Lin & Steven G. Platt, Pp. 13910–13914

Rediscovery of Van Hasselt’s Mouse-eared Bat *Myotis hasseltii* (Temminck, 1840) and its first genetic data from Hanoi, northern Vietnam
– Vuong Tan Tuan, Satoru Arai, Fuka Kikuchi, Chu Thi Hang, Tran Anh Tuan, Gábor Csorba & Tamás Görföl, Pp. 13915–13919

Notes on the diet of adult Yellow Catfish *Aspistor luniscutis* (Pisces: Siluriformes) in northern Rio de Janeiro State, southeastern Brazil
– Ana Paula Madeira Di Beneditto & Maria Thereza Manhães Tavares, Pp. 13920–13924

Waterbirds from the mudflats of Thane Creek, Mumbai, Maharashtra, India: a review of distribution records from India
– Omkar Dilip Adhikari, Pp. 13925–13930

Moths of the superfamily Tineoidea (Insecta: Lepidoptera) from the Western Ghats, India
– Amit Katewa & Prakash Chand Pathania, Pp. 13931–13936

Winter season bloomer Hairy Bergenia *Bergenia ciliata* (Haw.) Sternb. (Saxifragales: Saxifragaceae), an important winter forage for diverse insect groups
– Aseesh Pandey, Ravindra K. Joshi & Bhawana Kapkoti Negi, Pp. 13937–13940

**Notes**

Kerala state bird checklist: additions during 2015 – May 2019
– Abhinand Chandran & J. Praveen, Pp. 13941–13946

What is in a name? The birthright of *Oxyopes nilgiricus* Sherriffs, 1955 (Araneae: Oxyopidae)
– John T.D. Caleb, P. 13947

**Book Review**

Study on biological and ecological characteristics of mudskippers
– Ali Reza Radkhah & Soheil Eagderi, Pp. 13948–13950

**Partner**

**Member**

Publisher & Host