PLATINUM 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 allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

**Journal of Threatened Taxa**

Building evidence for conservation globally

www.threatenedtaxa.org

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


## Communication

# Insights into the diet and feeding behaviour of Red-capped Lark *Calandrella cinerea* (Aves: Passeriformes: Alaudidae)

Mary Mwangi, Nathan Gichuki, Robert Chira & Peter Njoroge

26 April 2019 | Vol. 11 | No. 6 | Pages: 13727–13733
DOI: 10.11609/jott.4564.11.6.13727-13733

Journal of Threatened Taxa

For Focus, Scope, Aims, Policies, and Guidelines visit https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-0
For Article Submission Guidelines, visit https://threatenedtaxa.org/index.php/JoTT/about/submissions#onlineSubmissions
For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-2
For reprints, contact <ravi@threatenedtaxa.org>

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.

Partner

صندوق محمد بن زايد للمحافظة على الكائنات الحية
The Mohamed bin Zayed SPECIES CONSERVATION FUND

Member

FJN

Publisher & Host

WILD ZOOREACH Threatened Taxa

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 April 2019 | 11(6): 13727–13733



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

PLATINUM
OPEN ACCESS

# Insights into the diet and feeding behaviour of Red-capped Lark *Calandrella cinerea* (Aves: Passeriformes: Alaudidae)

**Mary Mwangi [1], Nathan Gichuki [2], Robert Chira [3] & Peter Njoroge [4]**

[1] African Conservation Centre (ACC), P.O. Box 15289-00509, Nairobi, Kenya.
[2] School of Biological Sciences, University of Nairobi, P.O. Box 30197, GPO, Nairobi, Kenya.
[3] School of Biological Sciences, University of Nairobi, P.O. Box 30197, GPO, Nairobi, Kenya.
[4] Ornithology Section, Zoology Department, National Museums of Kenya, P.O.Box 40658-00100, Nairobi, Kenya.
[1] mwangimary15@gmail.com (corresponding author), [2] ngichuki@uonbi.ac.ke, [3] rchira@uonbi.ac.ke,
[4] pnjoroge@museums.or.ke

**Abstract:** Anthropogenic activities have continued to threaten critical habitats of many tropical birds. Few studies, however, have established the habitat requirements, diet and foraging strategies of the threatened species to guide conservation efforts. The Red-capped Lark *Calandrella cinerea*, which inhabits tropical grasslands in Africa is highly threatened by habitat loss and anthropogenic activities such as burning for pasture regeneration and overgrazing by livestock. Many aspects of the feeding behaviour of this threatened tropical lark are still unknown. We studied the diet and feeding behaviour of the adult Red-capped Lark in its open grassland habitat at Kedong, Naivasha, Kenya from 04 March 2016 to 12 August 2016. Findings revealed that birds predominantly consumed animal nutrients that included insect larvae/caterpillars, grasshoppers, moths/butterflies, ants, and beetles. This was supplemented with plant nutrients (grass seeds) from two grass species, *Eragrostis tenuifolia* and *Harpachne schimperi*. Picking and gulping were the most employed food capture and handling techniques respectively. In relation to foraging substrates, grass substrate was most selected for food capture as compared to large mammal dung and soil mounds. Given that tropical grasslands are becoming increasingly threatened biomes, the findings are critical in guiding the management of grassland habitats of birds to ensure their protection from negative impacts as well as deepen understanding on how they adapt to environmental changes.

**Keywords**: Africa, Anthropogenic activities, foraging strategies, habitat requirements, habitat loss, threatened birds open grassland habitat.

**DOI:** https://doi.org/10.11609/jott.4564.11.6.13727-13733

**Editor:** Reuven Yosef, Ben Gurion University of the Negev, Eilat, Israel. **Date of publication:** 26 April 2019 (online & print)

**Manuscript details:** #4564 | Received 11 September 2018 | Finally accepted 30 March 2019

**Citation:** Mwangi, M., N. Gichuki, R. Chira & P. Njoroge (2019). Insights into the diet and feeding behaviour of Red-capped Lark *Calandrella cinerea* (Aves: Passeriformes: Alaudidae). *Journal of Threatened Taxa* 11(6): 13727–13733. https://doi.org/10.11609/jott.4564.11.6.13727-13733

**Copyright:** © Mwangi 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:** Apart from self funding, the Larks Project (University of Groningen,Netherlands) provided field work support.

**Competing interests:** The authors declare no competing interests.

**Author Details:** Mary Mwangi has a BSc (wildlife management) from Moi University and an MSc (biology of conservation) from the University of Nairobi, both in Kenya. She has published two journal articles on ecology of the Red-capped Lark. Prof. Nathan Gichuki has extensive knowledge of tropical biodiversity research, especially ornithology and has published more than 50 journal articles in internationally recognized and peer reviewed journals. Dr. Robert Chira is a senior research scientist and lecturer at the School of Biological Sciences, University of Nairobi. He has over 30 years' experience in conservation related research and is an author to over 15 peer reviewed journal articles. Dr. Peter Njoroge has been actively engaged in biodiversity research for the last 24 years especially research on avian species. He has published over 50 journal articles on conservation, avian ecology and environment-related issues.

**Author Contribution:** MM conducted the fieldwork under the instructions and supervision of RC, NG and PN. RC, NG and PN guided MM in data exploration, analysis and drafting of this manuscript. All the authors reviewed the final manuscript and approved its submission.

**Acknowledgements:** The Lark's Project (coordinated by Prof. Irene Tieleman of University of Groningen, Netherlands) was very supportive during fieldwork conducted to collect data. Joseph Mwangi, Naomi Muraya, Ken Wanjohi, Peter Kinyajui and Paul Kimani offered great fieldwork assistance. Thanks to the management of the Kedong ranch (Naivasha, Kenya) for granting free access to the study area. Finally, we appreciate Dr. Victor Mose, Eric Ochwangi and Caroline Mburu (Amboseli Conservation Program, African Conservation Centre) for their assistance in statistical analysis.




## INTRODUCTION

Loss of habitat has become one of the greatest threats to the survival of many bird species all over the world (Thivyanathan 2016). As negative impacts of anthropogenic activities continue to intensify in and around tropical grasslands, bird species that depend on such habitats face serious threats of local extinction. There is, therefore, a need to understand how birds adapt to their habitats as well as inter-specific interactions that they have with other conspecific species (Davis 1977; Benton et al. 2002; Clancy 2011). This knowledge is essential for effective species protection and habitat management (Mansor & MohdSah 2012). In Kenya, the Red-capped Lark (Image 1) inhabits dry/warm tropical and wet/cool montane grasslands (Ndithia et al. 2017). Despite the increasing threat to its grassland habitats, few studies have been conducted on its food resource in relation to diet and feeding behaviour. This study therefore assessed the feeding behaviour of the Red-capped Lark in Kedong Valley, an extensive tropical grassland area in Naivasha, Kenya. The objectives of the study were to determine the dietary composition and feeding behaviour of the resident population of Red-capped Lark. We hypothesized that diet and feeding behaviour would not be influenced by seasonality and insect prey availability.


Image 1. Red-capped Lark *Calandrella cinerea.*

## MATERIALS AND METHODS

This study was undertaken at Kedong ranch (0.893$^0$S & 36.398$^0$E, 2,077m) in Naivasha, located in Kenya's Central Rift Valley (Fig. 1). It lies between two conservation areas (Hell's Gate and Longonot national parks) hence, it is of high conservation priority (Bennun & Njoroge 2001). The study area supports a wide range of wildlife species, including a resident population of Red-capped Lark. It is exposed to intensive grazing by livestock and wildlife. The tropical climate of the area is characterized by a bimodal rainfall pattern with annual average rainfall of 600–1100 mm and an annual average temperature of 25.0$^0$C. The natural vegetation is dominated by tall perennial grasses, particularly *Pennisetum mezianum*, *Themeda triandra*, *Eragrostis tenuifolia, Chloris virgata, Cynodon nlemfuensis (var.nlemfuensis)*, and *Harpachne schimperi*. The most common forbs growing amongst the grasses are *Felicia muricata* and *Indigofera bogdanii* while common tree species include *Acacia xanthopholea*, *Acocanthera schimperi* and *Euphorbia candelabrum*. Fieldwork was conducted from 04 March to 12 August 2016, with breeding period between (March and May) and (June and July) while non-breeding between June and August. Data on feeding behaviour were obtained through focal animal sampling (Martin & Bateson 1988; Nhlane 1992; Akinpelu & Oyedipe 2004). Focal individuals were selected randomly and observations on feeding made from a distance of about 50m using a telescope (Akinpelu & Oyedipe 2004). The observations were conducted in the morning (0700—1100 hr) and late in the afternoon (1600—1800 hr) when birds were most actively feeding (Felicity et al. 2014). Each focal individual was observed for 15 minutes and if stopped foraging or went out of view, another adult bird was selected to complete the observation period (De Melo & Guiherme 2016). Timed data on feeding was recorded (Block 1991) including food items consumed by birds, food capture technique, food handling technique and foraging substrate selected for food capture. A total of 136 hours of observation on non-consecutive days were completed on 176 birds (82 birds during breeding and 94 birds during non-breeding periods). In order to control variability of measurements, data collected were tested for normality using the R-QQ plot for normality and, where appropriate, Shapiro-Wilk Test. Statistical tests were performed using R-program version 3.2.1 and PAST software. To establish the relationship between food availability and utilization by the Red-capped Larks, mean weekly consumption rates were correlated with mean weekly captures of various types of insect prey. Differences in food capture and handling techniques were evaluated using two-sample t-test. The mean values of test variables were reported as mean ± SE. In all the statistical tests conducted, significance of the test was checked at $\alpha < 0.05$.

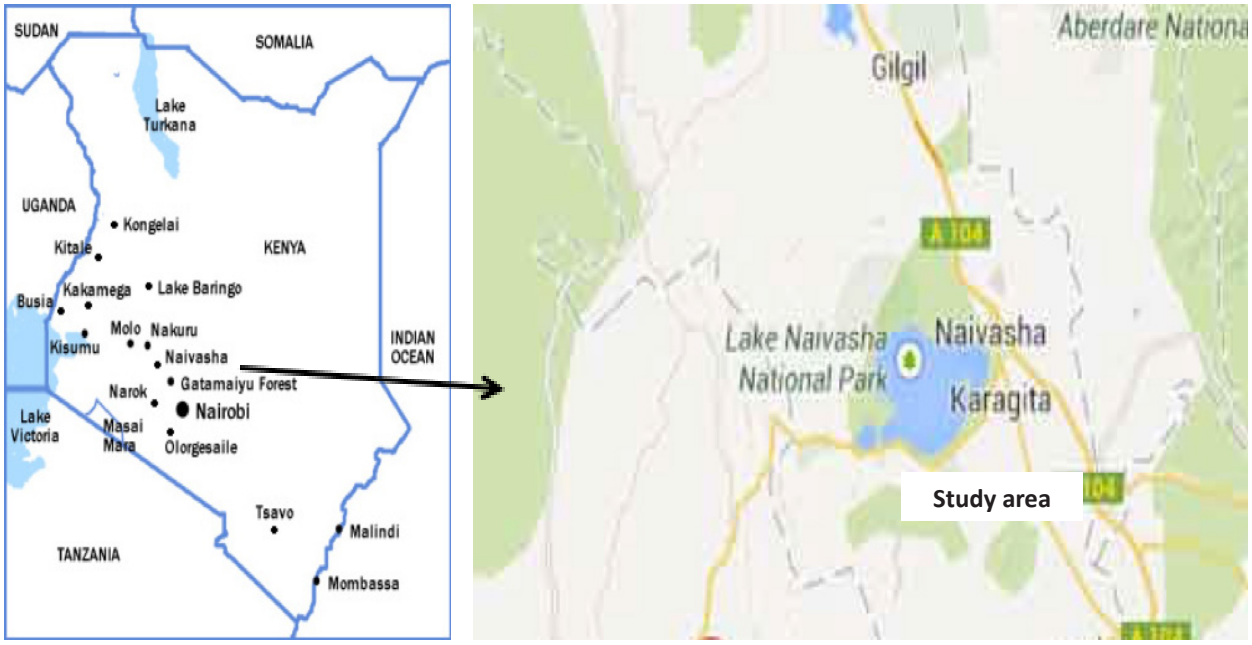


Figure 1. A composite map showing location of the study area in Kenya. (Source: Google Maps)

## RESULTS

### Diet and utilization of food resource

The study revealed that diet of the Red-capped Lark comprised both insect food and plant diet (grass seeds), with insect diet being predominant. During breeding period, 63.2% (n = 221 observations) of diet was insect food and 36.8% (n = 131) plant food (grass seeds). Furthermore, during the non-breeding period, 81.5% (n = 421) of diet was insect food and 18.5% (n = 95) grass seeds. Insect diet comprised of insects in the orders Coleoptera, Orthoptera, Lepidoptera, and Hymenoptera. Out of six grass species identified in the open grassland habitat area of the Red-capped Lark (*Eragrostis tenuifolia, Chloris virgata, Cynodon nlemfuensis* (*var. nlemfuensis*), *Themeda triandra, Harpachne schimperi* and *Pennisetum mezianum*) the larks predominantly consumed seeds from only two grass species; *Eragrostis tenuifolia* and *Harpachne schimperi.* There was, however, a clear seasonal pattern with birds consuming more grass seeds (36.8% of diet) during the breeding period than during non-breeding period (18.5% of diet). The prey preferences by birds were calculated by converting observations of positively identified items into the proportion of total feeding observations made. During the breeding period, 221 feeding observations involving consumption of insect prey were completed. Insects in the order Orthoptera (21.9% of diet; n = 78), Lepidoptera (20% of diet; n = 45) and Coleoptera (12% of diet; n = 27) comprised the largest proportion of the insect diet. Insects in the order Hymenoptera (7% of diet; n=16) accounted for the lowest proportion (Fig. 2). During non-breeding period, 421 observations on consumed insect food items were completed. The most frequently consumed insects were those in the orders Orthoptera (28.4% of diet; n = 119) Lepidoptera (18.02%; n = 76) Hymenoptera (17.6%; n = 74) and Coleoptera (17.4%; n = 73) (Fig. 2).

The availability and abundance of different food items influenced consumption rate and mode of food sourcing. When availability of insect prey items in the grassland was correlated with mean weekly consumption rates of prey items by the sampled adult birds, Pearson's correlation coefficients for individual insect groups showed positive relationships between availability and utilization of insect prey items. There was a significant

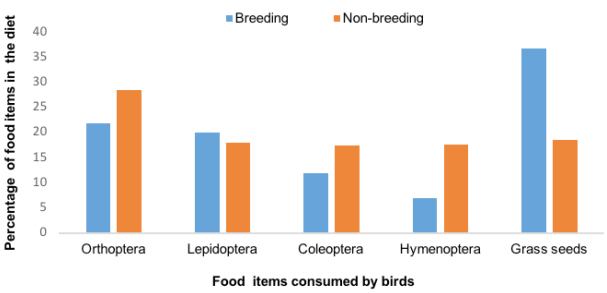


Figure 2. Dietary preferences of Red-capped Lark during breeding and non-breeding periods.

Table 1. The Red-capped Larks selection of foraging substrates (grass, dung and soil mounds) for food capture.

| Breeding period | | | Non-breeding period | | |
|---|---|---|---|---|---|
| **Type of substrate** | **n** | **% in frequency** | **Type of substrate** | **n** | **% in frequency** |
| Grass | 337 | 94.6% | Grass | 420 | 81.3% |
| Dung | 12 | 3.3% | Dung | 56 | 10.8% |
| Soil mounds | 7 | 1.9% | Soil mounds | 40 | 7.7% |
| **Total** | **356** | **100%** | | **516** | **100%** |

positive correlation between insect prey availability and mean consumption rate for insects in the order Lepidoptera ($r^2$ = 0.57, p<0.05). There was, however, non-significant positive correlation for Coleoptera ($r^2$ = 0.19, p<0.05), Orthoptera ($r^2$ = 0.01, p<0.05) and Hymenoptera ($r^2$ = 0.09, p<0.05).

**Food capture and handling techniques**

The Red-capped Lark employed active foraging while searching for food on the ground. The two food capture techniques employed by birds were picking (birds picking prey while walking) and run-picking (picking of food that was preceded by a short sprint). Picking was the most common food capture technique during both breeding and non-breeding periods. During the breeding period, there was significant difference in mean rates that birds employed picking (5.5±0.3) as compared to run-picking (0.02 ±0.02) (paired t-test; $t_{0.05, 2, 82}$ = 20.94, p<0.05). During the non-breeding period, there was significant difference in rates of picking prey items (5.3±0.2) as compared to the run-picking (0.1 ± 0.02) ($t_{0.05, 2, 94}$ = 23.35, p<0.05). The directly picked food items included grass seeds, butterflies/moths, insect larvae and grasshoppers. The prey items picked on the run included grasshoppers and butterfly/moths. Tearing & gulping and gulping were the two food handling techniques used by birds. While gulping entailed capturing and swallowing food items directly without manipulation other than being held briefly using the bill, tearing & gulping entailed capturing, and cutting of food into smaller pieces followed by swallowing. Gulping was observed to be the most frequent food handling technique employed. During the breeding season, there was significant difference in the mean rates where birds employed gulping (4.71±0.27) as compared to tearing & gulping (0.92±0.14 times) ($t_{0.05, 2, 82}$ = 11.95, p<0.05). Gulping was used to handle food for 88.2% of feeding bouts observed while tearing & gulping accounted for 11.8% of the bouts. For the non-breeding season, there was significant difference in mean rates that birds employed gulping (4.03±0.24) as compared to tearing & gulping (1.58±0.15) ($t_{0.05, 2, 94}$ = 8.31, p<0.05). Gulping was employed for 69.6% of feeding bouts compared to tearing & gulping which accounted for 30.4% of the bouts. The food items consumed by gulping were often grass seeds, insect larvae, grasshoppers and butterflies/moths while those by tearing & gulping were mostly grasshoppers, beetles, butterflies/moths and insect larvae.

**Foraging substrates and their selection for food capture**

Although Red-capped Larks predominantly foraged in open grass substrate, other foraging substrates included piles of mammal dung and fresh soil mounds. In the grassland habitat of the Red-capped Lark, fresh soil mounds were often small piles of fresh soil around holes dug overnight by mammals from where birds obtained ants and termites. These microhabitats were ephemeral and were critical as foraging substrates. The foraging substrate most preferred by birds during breeding (94.6% of feeding observations) and non-breeding (81.3% of observations) periods was grass substrate followed by the dung substrate (3.3% of observations during breeding and 10.8% of observations during non-breeding), and soil mounds (1.9% of observations during breeding and 7.7% of observations during non-breeding (Table 1).

## DISCUSSION

The study confirmed that the Red-capped Lark is omnivorous and relies on animal food (insect prey) and plant diet (grass seeds). Similar to findings of previous studies on diet of the Red-capped Lark (Winterbottom & Wilson 1959; Borrett & Wilson 1971; Hockey et al. 2005; Mwangi et al. 2018), the study confirmed that its animal diet consists of ants (Hymenoptera), Lepidotera (moths, butterflies and their larvae), Coleoptera (beetles) and Orthoptera (grasshoppers). Although birds feed primarily on insects in orders Orthoptera, Coleoptera, Hymenoptera (Okolie et al. 2015; Mwansat & Tushak

2011), they may prefer insect prey belonging to some orders and not others. A study on insect diet of some afro-tropical insectivorous passerines at the Jos wildlife park in Nigeria also revealed that insects in the family Formicidae (order Hymenoptera) were key insect food source for birds (Mwansat & Tushak 2011). Majority of birds rely on insect diet whose nutritional value is considered adequate due to its rich and easily digestible fat and protein (Okolie et al. 2015). In addition, insect food promotes faster growth in birds by providing them with essential elements of growth such as phosphorous, protein, non-chitin carbohydrates, lipids, vitamins and minerals (Klasing 2000). For Red-capped Larks, feeding is a critical activity for its survival hence these factors are likely to play a role in preference of insect diet in larger proportion than the plant diet.

The Red-capped lark complemented insect diet with grass seeds from two grass species; *Eragrostis tenuifolia* and *Harpachne schimperi*. These results are consistent with findings of another study of stomach contents of Red-capped Larks which confirmed presence of grass seeds of *Brachiaria* and *Setaria* spp. in the diet (Borrett & Wilson 1971). Such seeds are often abundant in the herb layer and dry grass on the ground (Nkwabi et al. 2010). Garnett & Crowley (1999) found seeds of annual grasses such as *Schizachyrium* spp. to be a key food source for tropical grassland birds in Australia. The importance of grass seeds as food for grassland birds has also been revealed in the West African Thrush *Turdus pelios* (Akinpelu & Oyedipe 2004). Grass seeds have high-energy content (Ndithia & Perrin 2006), hence grass substrate acts not only as a habitat for insect prey of Red-capped Larks but also as a source of plant diet. Furthermore, the grassland habitat provides the Red-capped Lark with leaves, fiber and grass needed for nest-construction during the breeding period.

The results of this study revealed that compared to plant diet, the largest proportion of the Red-capped Lark's diet comprised of insect diet with the most abundant insects being the most consumed. This has also been reported in diets of other passerine tropical birds such as the Fork-tailed Drongo *Dicrurus adsimilis* in southwestern Nigeria where its diet comprised of 86% insect prey and 14% plant food (Okosodo et al. 2016). In central Brazil, the diet of the White-naped Jay *Cyanocorax cyanopogon* consisted of 59% insect prey, 28% vegetable food and 13% human food waste (Barros et al. 2014). In the same tropical grasslands of central Brazil, the diet of Curl-crested Jays *Cyanocorax cristatellu* was found to comprise 48% insect diet, 40% plant diet, and 12% flower nectar (Amaral & Macedo 2003). The diet of the Plush-crested Jays *Cyanocorax chrysops* which inhabit glades and edges of the Brazilian Atlantic forests was dominated by insect prey (88.9%) with wild plant foods constituting 3.7% while indeterminate material, such as human food waste comprised 7.4% of the bird's diet (Uejima et al. 2012). Given that utilization of insects by birds is probably a reflection of insect abundance (Mwansat & Tushak 2011), this was also likely to have been the case for the Red-capped Lark where the most abundant insect prey was the most consumed.

Birds provide very critical ecosystem services, with one of the most important service being pest reduction (Barros et al. 2014). The findings of this study suggested that the Red-capped Lark provides this ecosystem service given that it feeds on insect pests such as the Black Maize Beetle *Heteronychus arator*, one of the most important coleopteran pests that feeds on cultivated crops. By feeding on harmful insects, the Red-capped Lark likely plays the role of keeping in check harmful insects that reduce productivity of agricultural crops and quality of stored grains. Such services offered by birds have also been confirmed for tropical birds such as the Common Bulbul *Pycnonotus babatus* population in Nigeria and 11 sympatric bird species in Macadamia Orchards in Australia (Crisol-Martinez et al. 2016).

An important factor that most likely influenced preference of the grassland habitat by the Red-capped Lark was availability of grass seeds and insect food. Preference for grassland over other vegetation types has previously been reported for the Red-capped Lark population inhabiting the grasslands of Serengeti in Tanzania (Nkwabi et al. 2010). Apart from open grasslands, the Red-capped Larks have been observed to prefer heavily grazed pastures (Borrett & Wilson 1971). For avian species, habitats vary in relation to availability of food resource hence the link between insect prey availability and feeding behaviour can be attributed to vegetation type in the habitat. As a result, this makes prey availability (Thivyanathan 2016) and prey visibility (Gokula & Vijayan 2007; Asokan & Ali 2010) to influence successful feeding and define the quality of habitats for birds. The foraging behaviour of birds is influenced by the structure of its habitat given that prey visibility defines quality of a habitat for birds (Gokula & Vijayan 2007; Asokan & Ali 2010). The suitability of a habitat for birds, therefore, is defined by key factors of availability, abundance and distribution of food resource. The vegetation type/cover in a given area influences insect abundance and diversity (Wardle & Barker 1997). In addition, the type of food substrate where birds obtain food from influences food intake rate, type of feeding

method and ability to increase vigilance to probably reduce predation risk. In birds, prey availability is a key factor that influences successful foraging (Thivyanathan 2016), and suitability of a habitat for birds is, hence, influenced by the key factors of availability, abundance and distribution of food resource. Habitats vary in the relative availability of food resource for avian species making the relationship between insect prey availability and feeding behaviour to be influenced by the vegetation type in the habitat. Since the Red-capped Lark only inhabits the open grassland in the study area and not adjacent woodlands, positive correlation between insect prey types that were available and utilized is likely to have been due to abundance of the prey in the grassland habitat. Food availability (grass seeds and insect food) due to vegetation structure of the open grassland most likely influenced preference of the habitat by the Red-capped Lark (Robinson & Holmes 1984).

## Conclusions and Recommendations

The study of the Red-capped Lark provides valuable insights on the diet and feeding behavior of tropical grassland birds. Changes in the composition of the diet seems to be directly influenced by availability and abundance in the foraging environment and by the physiological requirements of the body. The findings bring out the need for long-term studies on feeding behavior of the Red-capped Lark to shed light on how diet changes in quality with season and how it influences reproductive success. For instance, it would be useful to quantitatively determine the relationship between the size and number of insect prey items consumed by parental and non-parental birds. Quantitative evidence pertaining to these questions would help ecologists to develop predictive models concerning adaptations of tropical grasslands birds to dynamics of the habitat. Furthermore, this information would provide a better understanding of ecology of grassland passerine birds hence guide development of effective conservation strategies. With habitats of many avian species especially in the tropics increasingly becoming fragmented and degraded at a rapid rate, findings of such studies would provide a good framework for co-existence between grassland birds, livestock and people in the wildlife-rich eastern African rangelands.

## REFERENCES

**Akinpelu, A. & O. Oyedipe (2004).** A twelve-month field study of the West African Thrush *Turduspelios* (Passeriformes: *Muscicapidae*) Part 1: Food and feeding ecology. *International Journal of Tropical Biology* 52(4): 1001–1007. https://doi.org/10.15517/rbt.v53i1-2.14512

**Amaral, M. & R. Macedo (2003).** Breeding patterns and habitat use in the endemic Curl-crested Jay *Cyanocorax cristatellu* of central Brazil. *Journal of Field Ornithology* 74(4): 331–340. https://doi.org/10.1648/0273-8570-74.4.331

**Asokan, S. & A. Ali (2010).** Foraging behavior of selected insectivorous birds in Cauvery Delta region of Nagapattinam District, Tamil Nadu, India. *Journal of Threatened Taxa* 2(2): 690–694. https://doi.org/10.11609/JoTT.o2201.690-4

**Barros, R., C. Costa & M. Pascotto (2014).** Diet and feeding behaviour of the White-naped Jay, *Cyanocorax cyanopogon* (Wied, 1821) (Aves, Passeriformes, Corvidae) in a disturbed environment in central Brazil. *Brazilian Journal of Biology* 74 (4): 899–905. https://doi.org/10.1590/1519-6984.09313

**Bennun, L. & P. Njoroge (2001).** Important Bird Areas in Africa and associated Islands: Priority sites for conservation. Newbury and Cambridge, UK: Pisces Publications and Birdlife International (BirdLife Conservation Series No. 11).

**Benton, G.T., D.M. Bryant, L. Cole & H.Q. Crick (2002).** Linking agricultural practice to insect and bird populations: a historical study over three decades. *Journal of Applied Ecology* 39: 673–687. https://doi.org/10.1046/j.1365-2664.2002.00745.x

**Block, W.M. (1991)**. Foraging ecology of Nuttall's Woodpecker. *The Auk* 108: 303–317.

**Borrett, R.P. & K.J. Wilson (1971)**. Notes on the food of the Red-capped lark. *Journal of African Ornithology* 42(1): 37–40. https://doi.org/10.1080/00306525.1971.9634390

**Clancy, G.P. (2011).** The feeding behaviour and diet of the Black-necked Stork *Ephippiorhynchus asiaticus australis* in northern New South Wales. *Corella* 36(1): 17–23.

**Crisol-Martínez, E., L. Moreno-Moyano, K. Wormington, P. Brown & D. Stanley (2016).** Using Next-Generation Sequencing to Contrast the Diet and Explore Pest-Reduction Services of Sympatric Bird Species in Macadamia Orchards in Australia. *PLoS ONE* 11(3): e0150159. https://doi.org/10.1371/journal.pone.0150159

**Davis, N.B. (1977).** Prey selection and social behaviour in wag-tails (Aves: Motacillidae. *Journal of Animal Ecology* 46: 37–57. https://doi.org/10.2307/3945

**De melo, T.N. & E. Guilherme (2016).** The foraging behavior of the Large-headed Flatbill,*Ramphotrigon megacephalum* and the Dusky-tailed Flatbill, *Ramphotrigon fuscicauda*(Aves: Tyrannidae). *Zoologia* 33(6): e20160104. http://doi.org/10.1590/s1984-4689zool-20160104

**Felicity, N.L., B. Tiffany-ahien, R.D. Amanda, G.R. Carlos & J.A. Ian (2014).** Foraging behaviour of Cerulean Warblers *Setophaga cerulean* during the breeding and Non- breeding seasons; evidence for the breeding currency hypothesis. *Journal of Field Ornithology* 85(3): 310–320. https://doi.org/10.1111/jofo.12070

**Crowley, G. & S. Garnett (1999).** Seeds of the annual grasses *Schizachyrium spp*. as a food resource for tropical granivorous birds. *Austral Ecology* 24(3): 208–220. https://doi.org/10.1046/j.1442-9993.1999.00964.x

**Gokula, V. & L. Vijayan (2000).** Foraging pattern of birds during the breeding season in thorn forest of Mudumalai wildlife sanctuary, Tamil Nadu, South India. *Tropical Ecology* 41: 195–208.

**Hockey, P., W. Dean & P. Ryan (2005).** Birds of Southern Africa, VIIthed. The Trustees of the John Voelcker Bird Book Fund, Cape Town.

**Klasing, K. (2000).** *Comparative Avian Nutrition*. CABI Publishing, 352pp.

**Mansor, M.S. & S.A. MohdSah (2012).** Foraging Patterns Reveal Niche Separation in Tropical Insectivorous Birds. *Acta Ornithologica* 47(1): 27-36. https://doi.org/10.3161/000164512X653890

**Martin, P. & P. Bateson (1988).** *Measuring Behaviour*. Cambridge University Press, UK, 188pp.

**Mwangi, M., P. Njoroge, R. Chira & N. Gichuki (2018).** Nest food provisioning in the Red- capped Lark *Calandrella cinerea* does not vary with parental sex differences and time of day. *Scopus* 38(2): 7–15

**Mwansat, G.S. & L.G. Turshak (2011).** Insect Diet of Some Afrotropical Insectivorous passerines at the Jos Wildlife Park, Nigeria. *Science World Journal* 6(4): 1–4.

**Ndithia, K.H. & M.R. Perrin (2006).** The spatial ecology of the Rosy-faced Lovebird *Agapornis roseicollis* in Namibia. *Ostrich* 77(1&2)**:** 52–57. https://doi.org/10.2989/00306520609485508

**Ndithia, H.K., S.N. Bakari, K.D. Matson, M. Muchai & I. Tieleman (2017)**. Geographical and temporal variation in environmental conditions affects nestling growth but not immune function in a year-round breeding equatorial lark. *Frontiers in Zoology* 14: 28. https://doi.org/10.1186/s12983-017-0213-1

**Nhlane, M.E. (1992).** The feeding behaviour of the African pied Wagtail *Motacilla aguimp* on a sewage farm in Blantyre City. *Proceedings of the VII Ornithological Congress* 397–402. https://doi.org/10.1080/00306525.1990.9633929

**Nkwabi, A.K., A.R. Sinclair, K.L. Metzger & S.A. Mduma (2010).** Disturbance, species loss and compensation: Wildfire and grazing effects on avian community and its food supply in the Serengeti Ecosystem, Tanzania. *Austral Ecology* 36(4): 403–412. https://doi.org/10.1111/j.1442-9993.2010.02167.x

**Okolie, M.O, L.G. Turshak & G.S. Mwansat (2015).** Insects as important delicacy for birds: expanding our knowledge of insect food ecology of birds in the tropics. *Ecology & Safety* 9: 434–441. https://hdl.handle.net/123456789/1352

**Okosodo, E., J. Orimaye & F. Obasogie (2016).** Food and Feeding Ecology of Common Bulbul (Pycnonotus barbatus) in Leventis Foundation Agricultural School Ilesa South Western Nigeria. *Greener Journal of Agricultural Sciences* 6(1): 010–016. https://doi.org/10.15580/GJAS.2016.1.121615169

**Schulze, M.D., J.L. Cordova, N.E. Seavy & D.F. Whitacre (2000).** Behaviour, diet, and breeding biology of Double toothed Kites *Harpagus bidentatus* at a Guatemalan low land site. *The Condor* 102: 113–126. https://doi.org/10.2307/1370412

**Thivyanathan, N. (2016).** Foraging Patterns of Birds in Resource Partitioning in Tropical Mixed Dry Deciduous Forest, India. *Journal of Energy and Natural Resources* 5(2): 16–29. https://doi.org/10.11648/j.jenr.20160502.11

**Uejima, A.M., A.L. Boesing & L.D. Anjos (2012).** Breeding and foraging variation of the Plush- crested Jay (*Cyanocorax chrysops*) in the Brazilian Atlantic Forest. *The Wilson Journal of Ornithology* 124(1): 87–95. https://doi.org/10.1676/11-027.1

**Wardle, D.A. & G.M. Barker (1997).** Competition and herbivory in establishing grassland communities: Implications for plant biomass, species diversity and soil microbial activity. *Oikos* 80: 470–480. https://doi.org/10.2307/3546620

**Winterbottom, J.M. & A.H. Wilson (1959)**. Notes on the breeding of the Red-capped Lark *Calandrella cinerea* (Gmel.) at Cape Town. *Ostrich* 30 (Suppl.1): 289–299. https://doi.org/10.1080/00306525.1959.9633336

Journal of Threatened Taxa

www.threatenedtaxa.org

PLATINUM 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 allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

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

**April 2019 | Vol. 11 | No. 6 | Pages: 13631–13814**
**Date of Publication: 26 April 2019 (Online & Print)**
**DOI: 10.11609/jott.2019.11.6.13631-13814**



Partner

صندوق محمد بن زايد للمحافظة على الكائنات الحية
The Mohamed bin Zayed Species Conservation Fund

Member

FJN

Publisher & Host

WILD ZOOREACH
Threatened Taxa