

OPEN ACCESS



All articles published in the Journal of Threatened Taxa are registered under Creative Commons Attribution 4.0 International License unless otherwise mentioned. JoTT allows unrestricted use of articles in any medium, reproduction and distribution by providing adequate credit to the authors and the source of publication.



Journal of Threatened Taxa

The international journal of conservation and taxonomy

www.threatenedtaxa.org

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

COMMUNICATION

POPULATION STUDIES OF LOWE’S MONKEY (MAMMALIA: PRIMATES: CERCOPITHECIDAE: *CERCOPITHECUS LOWEI* THOMAS, 1923) IN KAKUM CONSERVATION AREA, GHANA

Edward D. Wiafe

26 February 2016 | Vol. 8 | No. 2 | Pp. 8434–8442
10.11609/jott.2193.8.2.8434-8442



For Focus, Scope, Aims, Policies and Guidelines visit http://threatenedtaxa.org/About_JoTT.asp
For Article Submission Guidelines visit http://threatenedtaxa.org/Submission_Guidelines.asp
For Policies against Scientific Misconduct visit http://threatenedtaxa.org/JoTT_Policy_against_Scientific_Misconduct.asp
For reprints contact <info@threatenedtaxa.org>

Partner



Publisher/Host





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

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 February 2016 | 8(2): 8434–8442

POPULATION STUDIES OF LOWE'S MONKEY (MAMMALIA: PRIMATES: CERCOPITHECIDAE: *CERCOPITHECUS LOWEI* THOMAS, 1923) IN KAKUM CONSERVATION AREA, GHANA

Edward D. Wiafe

OPEN ACCESS



Department of Environmental and Natural Resources, Presbyterian University College,
P.O. Box 393, Akropong-Akuapem, Ghana
edward.wiafe@presbyuniversity.edu.gh

Abstract: The status of Lowe's Monkey *Cercopithecus lowei* was assessed during a survey in Kakum Conservation Area, Ghana. Within the reserve logging and hunting was banned 20 years ago, and the forest underwent two decades of natural regeneration. The main objectives of the study were to evaluate the impact of conservation measures on the local population of Lowe's Monkey and assess its relationships with other primates and non-primate mammals. Data on population status were collected during line transect surveys. Comparing the present mean encounter rate of 1.03 (± 0.03) groups/km to that recorded in 1993 (0.31 \pm 0.16 groups/km) suggests an average population growth rate of 13.6% per annum. Conservation measures such as banning illegal logging and hunting have likely contributed to the population increase. Lowe's monkeys were often observed in close proximity to other primates (e.g., Black and White Colobus) and non-primate mammals (e.g., Maxwell's Duiker), but neither socio-positive nor antagonistic interactions were observed. Recommendations are made for further improvement and studies of the species elsewhere.

Keywords: Conservation measures, Lowe's Monkey, population density, rainforest protected area.

Akan Abstract: Saa adesua yi kenkanee nkwakuo a wote Kwae a ede Kakum Conservation Area a ewo Ghana, no dodow. Botae titiriw ne se wa peese wohwe se efiri se wogyae timba twa ne ahayo beye mfe aduonu (20) ni no, nkwakuo no dodow ako soro anaa aba fam. Afei, adesua no hwee nkitahodie a eda nkwakuo, nsoroboa foforo ne ntoteboa a ete kwae no mu. Enti wo twitwaa kwan totoo kwae no mu, na wofaa so kenkan nkwakuo no ena woyee adesua nkae no nso. Nhwewhe mu no daa adi se, afe 1993 mu no, na wo be tumi ahya kwakuo kuo 0.31(\pm 0.16) wa brofo-kwansin biako biara, nanso seisei nkwakuo no dodow ako soro akosi se brofo-kwansin biako biara wobetumi ahya nkwakuo kuo 1.03(\pm 0.03). ekyere se, afe biara nkwakuo no dodow ko soro beye 13.6%. Adesua no ko so kyeree se, nkwakuo no ne nsoroboa nkae bi te se efoc ne ntoteboa bi tese ctwe wahu won nyinaa bom wa faako; nanso woanhu anyonkofa anaa ctan biara wa saa mmoa yi mu. Yebetumi aka se, nkwakuo no dodow ako soro efise woagyae timba twa, ena woagyae ahayo nso. Adesua no aye nsusui a de ekan ko ne daakye adesua bba.

DOI: <http://dx.doi.org/10.11609/jott.2193.8.2.8434-8442>

Editor: Mewa Singh, University of Mysore, Mysuru, India.

Date of publication: 26 February 2016 (online & print)

Manuscript details: Ms # 2193 | Received 31 July 2015 | Final received 01 February 2016 | Finally accepted 07 February 2016

Citation: Wiafe, E.D. (2016). Population studies of Lowe's Monkey (Mammalia: Primates: Cercopithecidae: *Cercopithecus lowei* Thomas, 1923) in Kakum Conservation Area, Ghana. *Journal of Threatened Taxa* 8(2): 8434–8442; <http://dx.doi.org/10.11609/jott.2193.8.2.8434-8442>

Copyright: © Wiafe 2016. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use of this article in any medium, reproduction and distribution by providing adequate credit to the authors and the source of publication.

Funding: Idea Wild, Colorado, U.S.A.

Conflict of Interest: The author declares no competing interests.

Author Details: DR. EDWARD D. WIAFE is the Dean, Faculty of Development Studies, Presbyterian University, Ghana. He is a member of the IUCN/Species Specialist Group/ African Primates; International Primatological Society and Office holder in IUFRO. At the moment, he is currently working on human-wildlife conflict and food security.

Acknowledgements: The author is grateful to Idea Wild, Colorado (USA) for supplying equipment for the study. I also thank the Wildlife Division of the Forestry Commission for granting permission to conduct the studies in KCA and all the camp rangers for their assistance. I appreciate the encouragements from Prof. K.A. Monney, Dr. A.N. Allotey and all the anonymous reviewers for their guidance.



INTRODUCTION

Most studies on primates in Ghana have focused on diversity and distribution (Booth 1956; Asibey 1978; Abedi-Lartey & Amponsah 1999; Grubb 1998; Danquah et al. 2012) or on the conservation status of threatened species such as *Cercopithecus roloway* (e.g., Lindsay 1996; Curtin 2002; Oates 2006). Few studies have been conducted in Ghana on Lowe's Monkey *Cercopithecus lowei*. An account of its geographic distribution and locations of collected specimens is given by Lernould (1988) and Oates (1988, 2011) while Bourliere *et al.* (1970) and Galat & Galat-Luong (1985) described the general habitat, diet and behaviour of the taxon in Côte d'Ivoire.

While Lowe's Monkey has been classified as Least Concern by The IUCN Red List of Threatened Species as a subspecies of *C. campbelli* (Oates et al. 2008), its populations are nonetheless decreasing (Oates 1999; Deschner & Kpelle 2003; Gatti 2010). Lowe's Monkeys can now be found only in a few protected areas, such as Boabeng-Fiema Monkey Sanctuary, Ankasa, Bia and Kakum Conservation Areas (KCA) and other forest reserves in Ghana (Danquah et al. 2012).

Since an initial survey of KCA primates almost 20 years ago (Oates et al. 2000), there have not been further studies of the Lowe's Monkey population. This study was performed to determine encounter rates, troop/group sizes and distribution of Lowe's Monkeys in KCA and evaluate changes that have occurred since the ban on logging and hunting. It also examined population distribution patterns, the impact of seasonal fluctuations, community structure and interactions of Lowe's Monkeys with other mammals.

MATERIAL AND METHODS

Study site

Kakum Conservation Area is located between 1°30'–1°51'W & 5°20'–5°40'N and was originally made up of the 210km² Kakum National Park (KNP) and its twin 150km² Assin Attandanso Resource Reserve (AARR). It spans the Twifu Hemang Lower Denkyira, Assin and Abura-Asebu-Kwamangkesse districts of the Central Region of Ghana. The Kakum forest and Assin Attandanso forests were legally re-gazetted as a national park and resource reserve in 1991 under the wildlife reserves regulations (L.I 1525) under the administrative jurisdiction of the Wildlife Division of the Forestry Commission (Wildlife Department 1996). Under this law, no person is allowed

to hunt or destroy any living organism in the reserve.

The area was initially placed under timber production by the Forestry Department until 1989 when its management was transferred to the Wildlife Division because of change in management status. About 52 communities are scattered around the conservation area. Prior to the transfer of administration of the area from the Forestry Department to the Wildlife Department, the communities used to hunt and extract non-timber forest products from the area.

Timber exploitation started in the two reserves in 1936 with Mahogany *Khaya ivorensis* being the principal species logged. Other timber species were included for exploitation from the 1950s until 1989 when the two reserves were transferred from the Forestry Department to the Wildlife Department.

The Kakum and Assin Attandanso forests were demarcated between 1925 and 1926 and managed as forest reserves in 1931 and 1937, respectively, as a source of timber production and protection of the watersheds of the Kakum and other rivers which supply water to Cape Coast and its surrounding areas by the then Governing Council of the Gold Coast (now Ghana). The legal framework was supplied by Section 4(4) of the Colonial Forest Ordinance, Cap 63 and gazetted in the Gold Coast Gazette.

The conservation area has gone through a long period of disturbance as a result of commercial and subsistence hunting on the one hand and logging on the other. Prior to timber exploitation, the reserve was more or less a virgin forest since there was no evidence that farming might have taken place there for any considerable length of time (Paijmans & Jack 1960). It has, however, been alleged that the local people mined gold and clay several years before the area was reserved (Agyare 1995).

KCA forms part of the moist evergreen forest zone (Hall & Swaine 1981). The rainfall pattern is bimodal with a two peak rainy seasons separated by a short dry period in August. The major wet season is between April and July, peaking in June, and the minor wet season is between September and November, peaking in October. The wet season is followed by a long dry season from December to April during which most streams dry up and rivers break into pools. The mean annual rainfall is between 1500mm to 1750mm. The prevailing wind is southwesterly and is generally light. The average relative humidity is about 85% and the temperature fluctuates between 30°C and 35°C (Wildlife Department, Ghana 1996).

The Study Species

Lowe's Guenon or Monkey (*Cercopithecus lowei* Thomas, 1923) (Image 1) was considered a subspecies of Campbell's Monkey (*Cercopithecus campbelli* Waterhouse, 1838), from which two subspecies have initially been described and later separated as full species as *Cercopithecus campbelli* and *Cercopithecus lowei* (Grubb et al. 2003; Groves 2005).

Lowe's Monkey is found from River Sassandra (Côte d'Ivoire) to the River Volta (Ghana), in primary, secondary and gallery forests but is not common in marshy areas or mangroves (Bourliere et al. 1970). It is less exclusively arboreal than most of the allied species (Kingdon 1997) but stays close to cover and avoids exposure (Bourliere et al. 1970).

Data collection

Distribution of transects

To equalize sampling efforts the conservation area was divided into eight blocks (plots A-H) of approximately 45km² each (Danquah 2007; Wiafe et al. 2010) as shown in Fig. 1.

A grid with cells representing one minute of latitude or longitude was placed over the map of the study site. Intersections of latitude and longitude formed the mid-point of each transect, and two transects chosen at random at least 4km apart were laid in each block (Fig. 1). Transects were oriented northwards as a rule of thumb (Danquah 2007; Wiafe 2013).

Each transect was straight and ran for a length of 4km. Wooden beacons were placed at 100m intervals to indicate the distance covered during the census. Navigation was by compass and a geographical positioning system (GPS) to reach the starting point of each transect. Transects were measured with a GPS and laid out with minimal cutting and disturbance (Peres 1999).

Determination of encounter rates, group size and distribution of Lowe's monkeys

A 3-person survey team was formed, trained and maintained throughout the survey to ensure consistency in data collection procedures. Primates were counted using the line transect method (Buckland et al. 2001) in the dry season from November 2009 to January 2010 and in the wet season from May to July 2010, in order to evaluate speculated seasonal influences. During the census the observers moved along a transect line at optimal walking-pace of about 1km/h, and stopped every 50m to listen and scan the surrounding area. At the beginning of each transect the location, habitat type, date, weather (sunshine, cloudiness), starting time

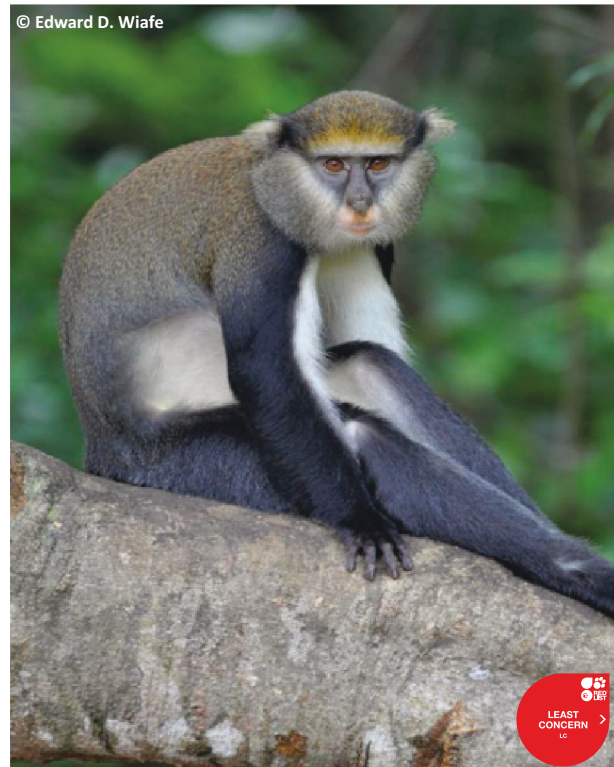


Image 1. An adult male Lowe's Monkey *Cercopithecus lowei*.

and names of participating personnel were recorded as standard items. When a primate group was seen, 10 minutes were spent observing it and the observers remained on the transect line without following the animals. The following data were recorded (National Research Council 1981; Peres 1999; Davies 2002):

- Identification of species and number of individuals. The group size was estimated when conditions prevented counting.
- Mode of detection (sight, vocalization, or sound produced by animals moving through the vegetation).
- Time of sighting
- Observer distance and location along transect (GPS)
- Animal-observer distance: distance from observer's position to the group when was first detected (sighting distance) measured with linear tape (after the monkeys left)
- Shortest transect-animal distance: (perpendicular distance from the transect line to the group)
- Activity of animals at first detection (for each group)
- Age class and sex of individuals in each group

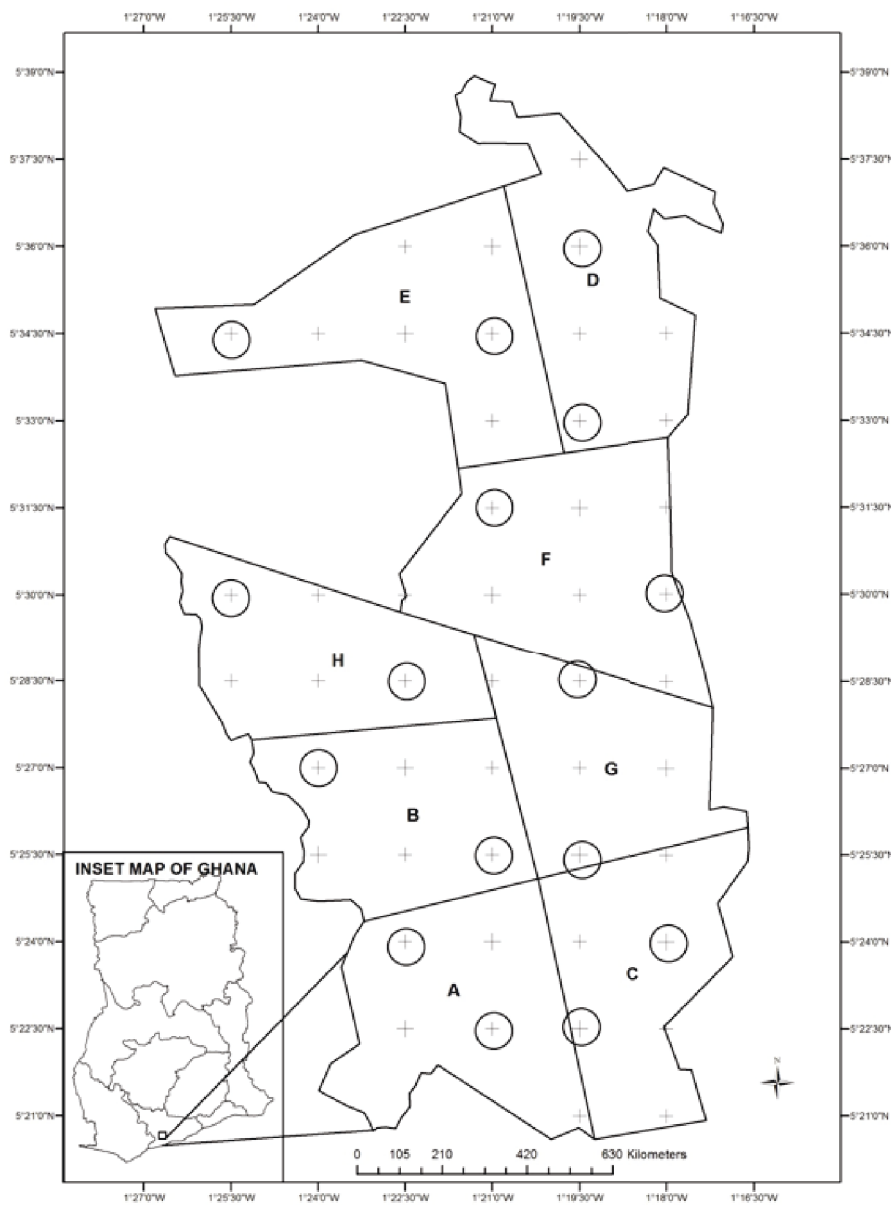


Figure 1. Map of Kakum Conservation Area showing the divisions into forest blocks (A–H) and the distribution of transects (circled). Inset: map of Ghana locating the position of the study site.

Determination of relationships between Lowe’s monkey and other mammals

In each block, one group of monkeys was selected and followed for 10 days to observe and describe interactions (e.g., animals found on the same tree, foraging, communicating, attack or other observation) with other mammals. Each observation day started at approximately 05:00hr and ended at 19:00hr. Inclusion of “dark” hours provided opportunities to record relationships of some nocturnal species. The observer depended mostly on binoculars and the distances between the observer and the animals varied between 20m and as close as 3m depending on visibility. The nomenclature of mammals followed Kingdon (1997).

Data Analysis

The Kilometric Indices of Abundance (KIA), which is the ratio of the number of groups encountered to the distance covered, was applied (Groupe 1991; Gatti 2010).

Comparison of encounter rate

The Lowe’s Monkey encounter rate change was calculated as:

$$\text{Growth rate} = \frac{(N_t - N_0)}{N_0} \times 100$$

Where N_t = Encounter rate at time t (2009–2010)
 N_0 = Encounter rate at the beginning of the period of interest (1993)

Since the time lag between the first and second survey was 17 years, an annual population growth rate was calculated by dividing growth rate by 17.

Statistical analysis involved the use of Paleontological Statistics Software Package for Education and Data Analysis, PAST (Hammer et al. 2001). The Wilcoxon pairwise-test was used to test the differences in KIA of species between two samples of repeated measures.

RESULTS AND DISCUSSIONS

Lowe's Monkey encounter rates in KCA

The mean KIA in the wet season and the dry season did not differ (wet season: 0.99 ± 0.70 groups; dry season: 1.07 ± 0.66 groups; $W = 23$, $N = 16$, $p = 0.55$) (Fig. 2). Therefore, the combined average KIA was 1.03 groups/km (SD = 0.03).

The average group size encountered in the wet season was 10.2 (SD = 5.2, $N = 16$, range = 1–23) and in the dry season the average was 11.8 (SD = 4.9, $N = 16$, range = 4–26). Similarly, there was no significant difference between the two seasons for group size ($W = 15$, $p = 0.09$).

Compared to the findings of Oates (2006) and previous surveys (Struhsaker 1993; Struhsaker & Oates 1995; Whitesides & Oates 1995; Abedi-Lartey 1999; Oates et al. 2000; Magnuson 2003), Lowe's Monkey KIAs in the KCA were found to be relatively high (from an average of 0.31 ± 0.16 groups/km calculated in previous studies to 1.03 ± 0.03 groups/km in the current study), suggesting that the average population growth rate was 13.6% per annum, which would be quite encouraging. The population of Lowe's Monkeys in the KCA could probably be higher than the densities reported from census of other protected forest areas conducted during the same period in Ghana (Gatti 2010). In KCA, KIAs were similar in all areas of the reserve, which contrasts with Ankasa Resource Reserve where primate signs were concentrated around the core of the conservation area where the Nkwanta camp is situated. The KIA was the highest in a band going from this camp to the Ankasa Gate Camp. This is likely due to the regular patrol activity of the Wildlife Division staff and visitors in that area. However, in Kakum and Bia Conservation Areas primates are found randomly scattered over the whole conservation area.

The average group size of 11.8 individuals in both the wet and the dry seasons could be considered to be quite low compared to other primate species surveyed in other areas, such as the Red Colobus *Procolobus tephrosceles*

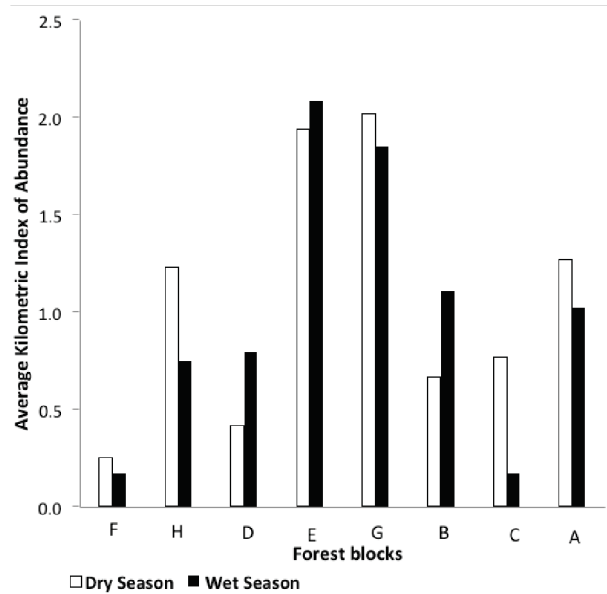


Figure 2. Seasonal Encounter rates (KIA) of Lowe's Monkeys in the various forest blocks.

in Kibale National Park (Uganda), which was recorded in groups ranging from 8–80 individuals (Struhsaker 1997). Nevertheless, Struhsaker (1997) emphasizes that an important source of sample variance in estimating group densities potentially arises from the problem of group spread and temporary fragmentation. Moreover, intra-specific group size and social system can vary between forests of different management histories. Sometimes primate species in logged forests live in fission-fusion groups and differences in foraging party size may also be recorded whilst hunting by people may also reduce group size as in Bia Conservation Area, Ghana (Martin & Asibey 1979; Struhsaker 1997).

Effect of ban on logging and hunting on Lowe's Monkey in KCA

In 1993, Conservation International funded a 32-day survey in KCA, Bia Conservation Area and Nini-Suhien National Park in the months of March, April, August, and November (Oates et al. 2000). Though the main focus of the 1993 survey was on Miss Waldron's Red Colobus *Procolobus waldroni*, Roloway Monkey *Cercopithecus roloway*, and White-naped Mangabey *Cercocebus lunulatus*, which they could not find in KCA, they reported data on other primates species including Lowe's Monkey. Detailed group encounter rates of several anthropoid species recorded in the current survey (Table 1) was compared with encounter rates of similar species recorded in the Conservation International survey in 1993 (Table 2). The average encounter rates of Lowe's

Table 1. Encounter rates per km (KIA) of anthropoid primates in Kakum Conservation Area during the dry and the wet seasons of 2009–2010

Forest block	Lowe's Monkey		Lesser Spot-Nosed Monkey		Geoffroy's Black-and-white Colobus		Olive Colobus	
	wet	dry	wet	dry	wet	dry	wet	dry
A	0.75	1.23	0.15	0.21	0.40	0.10	0.04	0.08
B	0.17	0.25	0.15	0.13	0.00	0.00	0.00	0.04
C	2.08	1.94	0.33	0.33	0.85	0.44	0.00	0.00
D	1.02	1.27	0.00	0.21	0.00	0.00	0.00	0.00
E	1.10	0.67	0.00	0.29	0.13	0.00	0.00	0.00
F	0.17	0.77	1.13	0.29	0.00	0.00	0.00	0.00
G	1.85	2.02	0.35	0.27	0.77	1.15	0.06	0.10
H	0.79	0.42	0.00	0.27	0.13	0.00	0.04	0.00
total	7.93	8.57	2.11	2.00	2.28	1.69	0.14	0.22
mean	0.99	1.07	0.26	0.25	0.29	0.21	0.02	0.03

Table 2. Group encounter rates per km (KIA) of anthropoid primates in Kakum Conservation Area, Bia Conservation Area and Nini-Suhien National Park in 1993 in Ghana (Oates et al. 2000)

Site name	Lowe's monkey	Lesser Spot-nosed monkey	<i>Cercopithecus</i> sp.	Geoffroy's Black-and-white Colobus	Olive colobus
Kakum (Antwikwaa) ¹	0.50	0.42	0.17	0.00	0.17
Kakum (Obuo) ²	0.25	0.31	0.25	0.00	0.19
Kakum (Obuo) ³	0.19	0.50	0.00	0.00	0.06
Bia C. A.	0.07	0.14	0.05	0.00	0.00
Nini-Suhien NP	0.00	0.00	0.00	0.00	0.00
mean	0.20	0.27	0.09	0.00	0.08

¹ Struhsaker and Oates; ² Oates; ³ Struhsaker

Monkeys in KCA was then 0.31 (SD=0.16) groups per km (Oates et al. 2000) representing the population at early days of wildlife conservation in KCA, after several years of logging and intensive hunting activity. Comparative analysis indicated that the population growth is over 200% spread over 17 years at an average rate of about 13.6% per annum. This comparison must be viewed with caution, since the distribution of transects, methods of data analysis and even the focal species used in both survey periods were different. The seasons of both survey periods were also different.

Moreover, a similar primate population study conducted in two wildlife reserves and two forest reserves indicated the following KIAs: Ankasa (0.0427), Bia (0.0092), Cape Three Points Forest Reserve (0.0598) and Krokosua Hills forest reserve (0.0290) (Gatti 2010).

Relationship between Lowe's Monkeys and other mammals of Kakum Conservation Area

Some observations were made on interactions between Lowe's Monkeys and other mammals. Lowe's Monkeys occupy one or more niches and belong to guilds

that can be defined by various combinations of habits or behaviors, such as: (i) arboreal against terrestrial, (ii) nocturnal against diurnal, and (iii) diet frugivore against folivore against insectivore (Bourliere, 1985).

In all, 19 species were encountered in the conservation area, with distributions varying among forest blocks as shown in Table 3. Monkeys predominated, with 11 species belonging to the Cercopithecidae, while 18% of other mammals were Bovidae. Table 3 shows the details of the mammalian diversity indices at the various blocks of the conservation area in the dry and wet seasons. These mammals were normally found in close proximity to Lowe's monkeys, indicating mutual tolerance. Only one carnivore, *Civettictis civetta*, was encountered in relatively low numbers 0.01/km in both dry and wet seasons.

In all, four diurnal and two nocturnal primate species were encountered and confirmed to be currently present. Arranging them into eco-taxonomic categories, the KCA's primates were arranged into four structures (Chapman et al. 1999) as follows:

- (i) Pottos: *Perodicticus potto*;

Table 3. KIAs of mammalian species encountered on transects in KCA during dry and wet seasons

Common name	Scientific name	KIA (dry)	KIA (wet)
Demidoff's Galago	<i>Galagoides demidoff</i>	0.15	0.04
Potto	<i>Perodictus potto</i>	0.09	0.03
Lowe's Monkey	<i>Cercopithecus lowei</i>	1.49	1.28
Lesser Spot-Nosed Monkey	<i>Cercopithecus petaurista</i>	0.25	0.26
Geoffroy's Black-and-white Colobus	<i>Colobus vellerosus</i>	0.21	0.28
Olive Colobus	<i>Procolobus verus</i>	0.03	0.02
African Civet	<i>Civettictis civetta</i>	0.01	0.01
African Brush-tailed Porcupine	<i>Atherurus africanus</i>	0.02	0.01
Common Slender Mongoose	<i>Herpestes sanguinea</i>	0.32	0.37
Tree Hyrax	<i>Dendrohyrax dorsalis</i>	0.08	0.05
African Elephant	<i>Loxodonta cyclotis</i>	0.10	0.17
Red River Hog	<i>Potamochoerus porcus</i>	0.17	0.12
Bay Duiker	<i>Cephalophus dorsalis</i>	0.11	0.13
Black Duiker	<i>Cephalophus niger</i>	0.05	0.10
Yellow-backed Duiker	<i>Cephalophus silvicultor</i>	0.01	0.03
Maxwell's Duiker	<i>Philantomba maxwellii</i>	0.29	0.29
Royal Antelope	<i>Neotragus pygmaeus</i>	0.03	0.02
Bongo	<i>Tragelaphus euryceros</i>	0.01	0.01
Bushbuck	<i>Tragelaphus scriptus</i>	0.09	0.03

(ii) Galago: *Galagoides demidoff*;

(iii) Arboreal cercopithecines: *Cercopithecus lowei* and *Cercopithecus petaurista*;

(iv) Colobines: *Procolobus verus* and *Colobus vellerosus*.

The Lowe's Monkeys were observed to be associated with other mammals in most of the forest blocks. In blocks A and G, they were observed to be associated (foraging on the same trees or found in close range) with Black-and-white Colobus Monkeys *Colobus vellerosus* at one location. Of the average of seven observations recorded, neither affiliative nor antagonistic interactions were observed between the two species. The Black-and-white Colobus Monkeys were observed in the emergent layer while the Lowe's Monkeys were observed in the middle to lower canopy layer.

In all blocks, 80% of observations recorded associations (foraging and moving together) between Lowe's Monkeys and Spot-nosed Monkeys *Cercopithecus petaurista* during the afternoon. These species were observed to move together and feed from the same food source. The Lowe's Monkeys were normally found at lower layers than the Spot-nosed Monkeys.

Table 4. Number of species in selected African primates communities sites after Chapman et al. (1999)

Site	Country	Number of Species
Tai National Park	Cote d'Ivoire	11
Tiwai Island Sanctuary	Sierra Leone	11
Douala Edéa Wildlife Reserve	Cameroon	13–14
Salonga National Park	D.R. Congo	8–9
Makokou	Gabon	17
Ituri Forest	D.R. Congo	17
Lopé National Park	Gabon	15
Kibale National Park	Uganda	11–13
Budongo Forest Reserve	Uganda	8

In block A, Olive Colobus, Spot-nosed Monkey and Lowe's Monkeys usually came together from mid-morning (around 10.00 hours GMT) and foraged along the Cape Coast-Twifo Praso main road. This observation was also made in block G near the satellite camp. This observation could be influenced by proximity to safe human establishments.

In all the forest blocks, between 70–100 % of the observations recorded the presence of Duikers [Maxwell's Duiker *Philantomba maxwellii*, Black Duiker *Cephalophus niger*, Bay Duiker *Cephalophus dorsalis* or Yellow-backed Duiker *Cephalophus silvicultor*] foraging below the fruit trees where the Lowe's Monkeys were found foraging. These antelopes appear to take advantage of the opportunity of the monkeys dropping fruits from the canopy, which would not have been possible to reach for these species.

Comparison of Primate Community Structure in KCA to other African Forest Areas

Primate community structure in KCA has been consistent since the early 1990s, when the management of the park was converted from timber production to wildlife conservation. Comparing the number of primate species recorded at KCA (6 species) to other primate ranges in Africa (Table 4), it could be deduced that the number of primate species encountered at KCA was too small as compared to the 11 primate species recorded in neighboring Tai National Park in Côte d'Ivoire and Tiwai Island Sanctuary in Sierra Leone respectively (Chapman et al. 1999). Though Douala-Edea forest (Cameroon) and Salonga forest (Democratic Republic of Congo) lack a terrestrial cercopithecine (i.e., species that spends more time on the forest floor than in the tree tops) similar to KCA, the number of species were 14 and 9 (Chapman et al. 1999) respectively. These were both higher than the

six found in KCA. However, many primate communities show considerable variations in their number of species. For example, 17 species were found in Makokou forest (Gabon) and Ituri forest (Democratic Republic of Congo), 15 at Lope forest in Gabon, 11–13 and eight at Kibale and Budongo forests respectively in Uganda.

The numbers in these communities were distributed across the various eco-taxonomic categories. For example communities in western-central Africa (Cameroon and Gabon) are relatively richer in nocturnal prosimians (pottos and galagos) than other areas. Communities in central Africa (Cameroon to the Democratic Republic of Congo) are relatively rich in arboreal cercopithecines, whilst West Africa (Sierra Leone and Côte d'Ivoire) was found to be richer in colobines (Chapman et al. 1999). Similarly, KCA recorded two prosimians, two arboreal cercopithecines and two colobines, which were neither terrestrial cercopithecines nor apes. The reasons for the production of these patterns of variation in forest primate community structure could be the ecological variations occurring at different areas. Vegetation structure may play a significant role in producing the high species-richness at Ituri and Makokou (Gabon) (Oates et al. 1990). Oates et al. (1990) further argue that habitat heterogeneity tends to increase both the species richness and biomass of primate communities.

The moist and wet forests of tropical Africa have been greatly affected by climatic vicissitudes of the last few million years. Such a pattern of environmental change might have led to a variety of evolutionary forces operating on primates living in African forests. Such historical events and adaptive features of these kinds would have played major roles in producing the patterns of variation seen in present day primate communities (Chapman et al. 1999). The effect of historical events on the primate community in KCA could be attributed to its past management history. As logging was in progress, hunting was also in progress and unrestricted because the latter was used as incentives for tree spotters (Mensah-Ntiamoah 1989).

CONCLUSIONS AND RECOMMENDATIONS

The encounter rates of Lowe's Monkeys in the various forest blocks did not differ significantly in dry and wet seasons, indicating that seasonality has little or no effect on population density. The major effect of seasonality could be due to vegetation, but Lowe's Monkey has the ability to switch easily from one food to another. Therefore the observed seasonality may not have

deleterious effects on individual members of a group since the seasonal impact is not so harsh. However, the densities of Lowe's monkeys differed from one forest block to another, which suggests that there were some variations in local conditions at various blocks, probably as a result of different officers conducting the protection operations or the differences in habitat quality or other ecological factors. Lowe's Monkeys were most of the time found in close proximity with other primates like black and white colobus and non-primate mammals such as Maxwell's Duiker. The primates forage together sometimes, and some non-primates take advantage of feed leftover dropped from the top of the trees. However, neither positive nor negative interactions were established between Lowe's Monkeys and other monkeys or non-primate mammals.

Based on these conclusions, it is recommended that the home ranges of Lowe's Monkey populations in the KCA be mapped and delineated on the ground. This is necessary for the regular monitoring of the groups, particularly group size and behavior. Special effort should also be made to protect all primate populations in KCA.

The population of Lowe's Monkeys seems to have increased from 1993, when the conservation area was formally gazetted, to 2010 at an average annual rate of 13.6%. This can be most likely attributed to the consistency of the protection measures operating at the conservation area. Moreover, since past logging activities were selective, there was likely little impact on the food trees of a forest generalist like Lowe's monkey. The perception of the inhabitants of the fringe communities around the KCA on Lowe's Monkey conservation is not documented, and research in this field is also recommended.

The primate community structure observed in KCA differs from those that were found in other African rainforests, such as the nearby Tai National Park in Côte d'Ivoire. The number of species in the community was also lower than all the other documented communities in Africa. This might be attributed to the vegetation homogeneity that occurs in KCA as opposed to other areas like Tai National Park, where the area is large and different kinds of vegetation can be found.

Populations of Lowe's Monkey and other primates in forest reserves sharing common boundaries with the KCA (such as Pra-Suhien, Bimpong and Adjousu Forest Reserves to the west, north and east respectively of KCA) should be studied. These reserves are still experiencing logging operations, and it will be worthwhile to compare data from these areas to that obtained for the KCA.

REFERENCES

- Abedi-Lartey, M. (1999).** Survey of endangered endemic primates in Western Ghana. Report to the Wildlife Conservation Society, New York, and the Ghana Game and Wildlife Department, Accra.
- Abedi-Lartey, M., & J. Amponsah (1999).** Preliminary survey of anthropoid primates in Krokosua Hills Forest Reserve. Unpublished Report to the Protected Areas Development Program and Wildlife Division of the Forestry Commission, Accra, Ghana.
- Agyare, A.K. (1995).** Socio-economic perspectives of Kakum National Park and Assin Attandanso Resource Reserve. Unpublished Report, Wildlife Department, Accra, Ghana.
- Asibey, E.O.A. (1978).** Primate conservation in Ghana, pp. 5574. In: Chivers, D.J. & W. Lane-Petter (eds.). *Recent Advances in Primatology - Vol. 2*. Academic Press, New York.
- Booth, A.H. (1956).** The distribution of primates in the Gold Coast. *Journal of West African Science Association* 2: 122–133.
- Bourliere, F., C. Hunkeler & M. Bertrand (1970).** Ecology and Behaviour of Lowe's Guenon (*Cercopithecus loweri*) in Ivory Coast, pp. 297–350. In: Napier, J.R. & P.H. Napier (eds.). *Old World Monkeys: Evolution, Systematics and Behaviour*. Academic Press, London.
- Bourliere, F. (1985).** Primate communities: their structure and role in tropical ecosystems. *International Journal of Primatology* 6 (1): 1–26.
- Buckland, S.T., D.R. Anderson, K.P. Burnham, J.L. Laake, D.L. Borchers & L. Thomas (2001).** *Introduction to Distance Sampling: Estimating Abundance of Biological Populations*. Oxford University Press, Oxford.
- Chapman, C.A., A. Gautier-Hion, J.F. Oates & D.A. Onderdonk (1999).** African primate communities: determinants of structure and threats to survival, pp. 1–37. In: Fleagle, J.G., C.H. Janson & K.E. Reed (eds.). *Primate Communities*. Cambridge University Press, Cambridge.
- Curtin, S. (2002).** The diet of the Roloway Monkey (*Cercopithecus diana roloway*), in Bia National Park, Ghana, pp. 351–373. In: Glenn, M.E. & M. Cords (eds.). *The Guenons: Diversity and Adaptations in African Monkeys*. Kluwer Academic Press, New York.
- Danquah, E. (2007).** A survey of large mammals of Ankasa and Bia Conservation Areas. Protected Area Development Programme Phase 2 Report, Accra.
- Danquah, E., S.K. Oppong, E. Akom, & M. Sam (2012).** Preliminary survey of chimpanzees and threatened monkeys in the Bia-Goaso Forest Block in southwestern Ghana. *African Primates* 7(2): 163–174.
- Davies, G. (2002).** Primates, pp. 99–120. In: Davies, G. (ed.). *African Forest Biodiversity: A Field Survey Manual for Vertebrates*. Earthwatch, U.K.
- Deschner, T. & D. Kpelle (2003).** A Rapid Survey of Primates in Southwestern Ghana. Preliminary Report. Southwestern Ghana R.A.P 2003. Draw River, Boi-Tano, Tano Nimiri, and Krokosua Hills forest reserves, Ghana, West Africa. Conservation International, Washington, D.C.
- Galat, G. & A. Galat-Luong (1985).** La communauté de Primates diurnes de la forêt de Tai, Côte d'Ivoire. *Revue de Ecologie (La Terre et la Vie)*: 40: 7–32.
- Gatti, S. (2010).** Community Forest Biodiversity Project: Status of Primate Populations in Protected Areas Targeted under Community Forest Biodiversity Project. Accra, West Africa Primate Conservation Action (WAPCA) and Wildlife Division of Forestry Commission.
- Groupe, C. (1991).** Méthodes de suivi des populations de chevreuils en forêt de plaine: Exemple: L'indice kilométrique (I.K.). *Bulletin Mensuel ONC*, Supplément 157, Fiche N 70. Paris, Office National de la Chasse.
- Groves, C.P. (2005).** Order Primates, pp. 111–184. In: Wilson, D.E. & D.M. Reeder (eds.). *Mammal Species of the World*. The Johns Hopkins University Press, Baltimore.
- Grubb, P. (1998).** Ghana, pp. 1–26. In: Grubb, P., T.S. Jones, A.G. Davies, E. Edberg, E.D. Starin & J.E. Hills (eds.). *Mammals of Ghana, Sierra Leone and the Gambia*. The Trendline Press, St Ives, UK.
- Grubb, P., T.M. Butynski, J.F. Oates, S.K. Bearder, T.R. Disotell, C.P. Groves & T.T. Struhsaker (2003).** Assessment of the Diversity of African Primates. *International Journal of Primatology* 24(6): 1301–1357.
- Hall, J.B. & M.D. Swaine (1981).** *Distribution and Ecology of Vascular Plants in Tropical Rain Forest*. W. Junk Publishers, Den Haag.
- Hammer, Ø., D.A.T. Harper & P.D. Ryan (2001).** PAST: Paleontological Statistics Software Package for Education and Data Analysis (Version 2.13) *Palaeontologia Electronica* 4(1): 1–9.
- Kingdon, J. (1997).** *The Kingdon Field Guide to African Mammals*. Academic Press, London.
- Lernould, J. (1988).** Classification and geographical distribution of guenons: a review, pp. 54–78. In: Gautier-Hion, A., F. Bourlière, J. Gautier & J. Kingdon (eds.). *A Primate Radiation: Evolutionary Biology of the African Guenons*. Cambridge University Press, Cambridge.
- Lindsay, M. (1996).** Roloway monkey project, Ghana. *International Zoo News* 43: 300–301.
- Martin, C. & E.O.A. Asibey (1979).** Effects of Timber Exploitation on Primate Population Distribution in the Bia Rain Forest Area of Ghana. Paper delivered at the 7th Congress of the International Primatological Society. Bangalore, India.
- Magnuson, L. (2003).** Distribution and abundance of the Roloway Monkey (*Cercopithecus diana roloway*) and other primate species in Ghana. *African Primates* 6(1&2): 19–25.
- Mensah-Ntiemoah, A.Y. (1989).** Pre-feasibility Studies on Wildlife Potentials in the Kakum and Assin Attandanso Forest Reserves. Accra, Department of Game and Wildlife.
- National Research Council (NRC) (1981).** *Techniques for the Study of Primate Population Ecology*. National Academy Press, Washington D.C.
- Oates, J.F. (1988).** The distribution of *Cercopithecus* monkeys in West African forests, pp. 79–103. In: Gautier-Hion, A., F. Bourlière, J. Gautier & J. Kingdon (eds.). *A Primate Radiation: Evolutionary Biology of the African Guenons*. Cambridge University Press, Cambridge.
- Oates, J.F. (1999).** *Myth and Reality in the Rainforest: How Conservation Strategies are Failing in West Africa*. University of California Press, Berkeley.
- Oates, J.F. (2006).** Primate conservation in the forest of Western Ghana: field survey results, 2005–2006. Report to the Wildlife Division, Forestry Commission, Accra.
- Oates J.F. (2011).** Primates of West Africa. In: Mittermeier, R.A. & A.B. Rylands (eds.). *A Field Guide and Natural History*. Conservation International, Arlington, VA, 555pp.
- Oates, J.F., M. Abedi-Lartey, M. McGraw, T.T. Struhsaker & G.H. Whitesides (2000).** Extinction of a West African Red Colobus. *Conservation Biology* 14 (5): 1526–1532.
- Oates, J.F., S. Gippoliti & C.P. Groves (2008).** *Cercopithecus campbelli* ssp. *lowei*. The IUCN Red List of Threatened Species 2008: e.T136931A4350879. Downloaded on 12 February 2016; <http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T136931A4350879.en>
- Pajmians, K. & W.H. Jack (1960).** Greater Kakum Forest Reserves. Working Plan presented to the Forestry Department, Ghana. Accra, Forestry Department.
- Peres, C.A. (1999).** General guidelines for standardizing line-transect surveys of tropical forest primates. *Neotropical Primates* 7: 11–16.
- Struhsaker, T.T. (1993).** Ghana's Forests and Primates. Report of a Field Trip to Bia and Kakum National Parks and Boabeng-Fiema Monkey Sanctuary in November, 1993. Ghana Game and Wildlife Department, Accra; USAID, Accra; and Conservation International, Washington, DC.
- Struhsaker, T.T. (1997).** *Ecology of an African Rain Forest: Logging in Kibale and the Conflict between Conservation and Exploitation*. University Press of Florida, Gainesville.
- Struhsaker, T.T. & J.F. Oates (1995).** The biodiversity crisis in southwestern Ghana. *African Primates* 1(1): 5–6.
- Whitesides, G.H. & J.F. Oates (1995).** Wildlife Surveys in the Rainforest Zone of Ghana. Accra, Ghana Game and Wildlife Department and the World Bank.
- Wiafe, E.D., K.B. Dakwa & S. Yeboah (2010).** Assemblages of avian communities in Forest Elephant (*Loxodonta cyclotis*) range in Ghana. *Pachyderm* 48: 41–47.
- Wiafe, E.D. (2013).** Status of the Critically Endangered roloway monkey (*Cercopithecus diana roloway*) in Dadieso Forest Reserve, Ghana. *African Primates* 8: 9–16.
- Wildlife Department, Ghana (1996).** Management Plan for Kakum National Park and Assin Attandanso Resource Reserve, Ghana. Unpublished report. Accra, Wildlife Department.





OPEN ACCESS



All articles published in the Journal of Threatened Taxa are registered under Creative Commons Attribution 4.0 International License unless otherwise mentioned. JoTT allows unrestricted use of articles in any medium, reproduction and distribution by providing adequate credit to the authors and the source of publication.

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

February 2016 | Vol. 8 | No. 2 | Pages: 8421–8540

Date of Publication: 26 February 2016 (Online & Print)

DOI: 10.11609/jott.2016.8.2.8421–8540

www.threatenedtaxa.org

Article

Rediscovery, systematics and proposed Red List status of *Ledebouria junnarensis* S.S. Rahangdale and S.R. Rahangdale nom. nov. (Asparagaceae) - an endemic species from the Western Ghats, Maharashtra, India

-- Savita Sanjaykumar Rahangdale & Sanjaykumar Ramlal Rahangdale, Pp. 8421–8433

Communications

Population studies of Lowe's Monkey (Mammalia: Primates: Cercopithecidae: *Cercopithecus lowei* Thomas, 1923) in Kakum Conservation Area, Ghana

-- Edward D. Wiawe, Pp. 8434–8442

Numerical taxonomy of *Berlinia* species (Caesalpinioideae: Leguminosae) and their distribution in Nigeria

-- Emmanuel C. Chukwuma, Abiodun E. Ayodele, Michael O. Soladoye & Deborah M. Chukwuma, Pp. 8443–8451

Data Paper

Flora of Fergusson College campus, Pune, India: monitoring changes over half a century

-- Ashish N. Nerlekar, Sairandhri A. Lapalikar, Akshay A. Onkar, S.L. Laware & M.C. Mahajan, Pp. 8452–8487

Short Communications

Tangled skeins: a first report of non-captive mating behavior in the Southeast Asian Paradise Flying Snake (Reptilia: Squamata: Colubridae: *Chrysopelea paradisi*)

-- Hinrich Kaiser, Johnny Lim, Heike Worth & Mark O'Shea, Pp. 8488–8494

Estimating the density of Red Junglefowl *Gallus gallus* (Galliformes: Phasianidae) in the tropical forest of Similipal Tiger Reserve, eastern India

-- Himanshu S. Palei, Hemanta K. Sahu & Anup K. Nayak, Pp. 8495–8498

The effect of daytime rain on the Indian Flying Fox (Mammalia: Chiroptera: Pteropodidae *Pteropus giganteus*)

-- S. Baskaran, A. Rathinakumar, J. Maruthupandian, P. Kaliraj & G. Marimuthu, Pp. 8499–8502

An observation on the Odonata fauna of the Asansol-Durgapur Industrial Area, Burdwan, West Bengal, India

-- Amar Kumar Nayak & Utpal Singha Roy, Pp. 8503–8517

Three interesting wood rotting macro-fungi from Jharkhand, India

-- Manoj Emanuel Hembrom, Arvind Parihar & Kanad Das, Pp. 8518–8525

Notes

Description of a new species of *Oligosita* Walker (Hymenoptera: Trichogrammatidae) from Punjab, India

-- Mohsin Ikram & Mohd. Yousuf, Pp. 8526–8527

Range extension of *Lestes nodalis* Selys, 1891 (Odonata: Zygoptera: Lestidae) in southern India

-- K.G. Emiliyamma & Muhamed Jafer Palot, Pp. 8528–8530

Report on the genus *Herdonia* Walker (Lepidoptera: Thyrididae) in Karnataka Western Ghats, India

-- P.R. Shashank, Pp. 8531–8532

Long-horned grasshoppers (Orthoptera: Tettigoniidae) in Radhanagari Wildlife Sanctuary, Maharashtra, India

-- Sunil M. Gaikwad, Yogesh J. Koli, Gopal. A. Raut, Sadashiv H. Waghmare & Ganesh P. Bhawane, 5pp Pp. 8533–8537

Intrusion of devil weed *Chromolaena odorata*, an exotic invasive, into Kinnerasani and Eturnagaram wildlife sanctuaries, Telangana, India

-- Sateesh Suthari, Ramesh Kandagatla, Sarede Geetha, Ajmeera Ragan & Vatsavaya S. Raju, Pp. 8538–8540