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## Communication

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# Encounter rates and group sizes of diurnal primate species of Mole National Park, Ghana

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**Abstract:** Primate species are not widely explored in Ghana's savannah ecosystems. We report data on encounter rates and group sizes of primates at the Mole National Park in Ghana. Forty transects, each of 5km length, were randomly laid in the park for the study. Four species of primates were visually recorded during field surveys: Olive Baboon *Papio anubis*, Patas Monkey *Erythrocebus patas*, Green Monkey *Chlorocebus sabaeus* and *Colobus vellerosus*. The status of *C. vellerosus* is Critically Endangered, the status of the other species is Least Concern according to the IUCN Red List. Encounter rates (groups/km) were 0.98, 0.65 and 0.45 for Olive Baboons, Patas Monkeys and Green Monkeys respectively. The mean group sizes were: Olive Baboon 10.8 (SE=1.1, range=1-38), Patas Monkey 12.2 (SE=3.3, range=1-35), and Green Monkey 10.0 (SE=1.9, range=1-25). Only one group of White-thighed Colobus with a group size of six was encountered. Encounter rates and group sizes of the same species varied in different parts of the park, and factors such as resource distribution and security against secret hunting may have influenced this variation. Authors recommend further studies to facilitate better understanding of these primates.

**Keywords:** Green Monkey Olive Baboon, Patas Monkey, resource distribution, savannah, White-thighed Colobus.

**Dagaare Abstract:** Ngmaane par3 nang bei a Ghana dagaw3 paalong zanoo ba maaleng kpare yaga. Te wulee a ngmaane ngabo ane alantaa a Mole National Park nang bei Ghana puo. Sobie lizaanaare ka te da ngmaa ngmaa bare kang zaa na mang ta m3l3 anuu ( 5km) w3l3 w3l3 ana bang de zani ne. Ngmaane par33 anaare la ka te da ny3 ne nimiri a muo puo zano nga puo: ngmaakpatere (Olive Baboon Papio aubis), ngmaazie (Patas Monkey Erythrocebus patas), ngmaaulmo (Green Monkey Chlorocebus saboeus) ane ngmaapulipilaa (Colobus vellerosus). A ngmaapulipilaa (Colobus vellerosus) par3 pogro la. Ky3 a ngmaane kyelee na eng da ba maaleng fer3 yaga aseng a tendaa dunizu kpaaroo IUCN Red list nang mane l3. A nyaabo nu3 da waa ngaa ane a taalangmo puo meng: 0.98, 0.65 ane 0.45 a ko ngmaakpate3 (Olive Baboon), ngmaapulipi3li (Patas Monkey) ane ngmaaulimo ( Green Monkey). A zaa ponsentaa ane a lantaa da la ngaa: ngmaakpatie da waa 10.8 (SE=1.1, ayi bonyeng te ta lizarenepie ne anii (range=1-38), ngmaapulipi3li meng da waa 12.2 (SE=3.3 ayi bonyeng te ta lizarenepie ne anuu ( range=1-35) k'a ngmaaulimu meng da waa 10.0 (SE=1.9 ayi bonyeng te ta lizare ne anuu (rang=1-25). Ky3 te da ny3 ngmaagbiepilaa (White-thighed Colobus) meng young k'a da lang taa ayobo (6). A ngmaane nyaabo ane a taa langmo da waa tietie a muo langbo3 min3 puo, bonso kaapag a zukaariba ba seng bong ana tou kaa zu ka nankpaanema ta ku'a, l3 laso aba yitaa nga. A gang segreb3 yeli ka ana viel3 la ka zaano kyaare ne a ngmaane la bang gaa nige a na veng la ka te bang a sie ti3g3.

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## INTRODUCTION

Population surveys are important for examining ecosystem functioning, forming the basis for management decisions and providing the means to evaluate the effectiveness of different conservation strategies (Nichols & Williams 2006; Stokes et al. 2010). The global biodiversity decline has not spared primates, and IUCN (2016) indicates primate population decline across large parts of their range. Threats to primate populations in their natural ranges are logging, mining, habitat destruction and hunting. The influx of people increases hunting pressure and causes further habitat loss (Masanja 2014). Primates have received conservation attention, and they are one of the few orders of mammals that have not lost a species or subspecies in the twentieth century (Mittermeier et al. 1997). But the danger of extinction can be particularly acute in the case of taxa that have received little attention and live in parts of the world that are not a major focus of biologists and conservationists (Oates et al. 2000). In Ghana and other countries of Upper Guinea and Dahomey gap, the need to obtain current information on species distribution, encounter rates and population dynamics is critical to the formulation of informed conservation and management plans. Conservation of primates in savannah ecosystems has been on ad-hoc basis without any empirical information on their population dynamics and ecology. Previous studies of the distribution, diversity and conservation of threatened species in Ghana have focused on forest ecosystems (Booth 1956; Asibey 1978; Abedi-Lartey & Amponsah 1999; Curtin 2002; Deschner & Kpelle 2003; Oates 2006; Wiafe 2013; 2016) with little attention given to primates in savannah ecosystems.

In 1958, Mole National Park was established enclosing some traditional hunting grounds and sacred sites. By 1964 all the inhabitants of five villages in the southern part of the Park were resettled elsewhere. Poor road access to and around the Park has limited the number of visitors (Mole Management Plan 2011), however, the main road leading to Mole National Park has recently been substantially improved (personal observation), and this has facilitated the influx of people to the area. This has also increased threats to primates that inhabit the park. For primate populations to be protected effectively, baseline information on encounter rates, distribution and group sizes are essential. Population monitoring enables direct measurement of the effect of local threats and assessment of the effectiveness of conservation measures. Surveying primate populations is also important for identifying priority areas for their protection, developing conservation management strategies, mitigating threats, and balancing economic and conservation priorities (Campbell et. al. 2016). It is against this background that the study of the composition, group sizes and encounter rates of primates at the Mole National Park was taken up. The objectives of the study were to: identify all diurnal primate species at the Park; estimate encounter rates of all identified primate species; and determine the sizes of primate groups encountered. The following were postulated to guide the study: (i) the encounter rates of all species were not the same in different parts of the Park, and (ii) group sizes of the same species found at different parts of the park were not the same.

### Theoretical framework

This study was based on the theory of 'Ideal Free Distribution' (Fretwell 1972) which explains the way in which animals distribute themselves among several resources. The theory states that the number of individual animals that will aggregate in various patches is proportional to the amount of resources available in each patch. This indicates that patches in the same landscape may have different levels of intrinsic resource values, yet the same principle of distribution can be applied but the number may differ. This means that populations of individuals of the same species will distribute themselves equally among patches with the same resource values. This study did not evaluate resource distribution, but the encounter rates, group sizes and their distribution pattern was attributed to the distribution of resources within the Park.

## METHODS

### Study area

Mole National Park is Ghana's largest protected area, covering about 4,577km². It is almost entirely located in the Northern Region and includes parts of West Gonja, Sawla–Tuna-Kalaba, Wa East and West Mamprusi districts. It lies between 9.183–0.166 $^{0}$N and 1.367–2.216 $^{0}$W (Figure 1). The main access to the Park is currently by road from Fulfulso junction through Damongo to Laribanga, or through Sawla and Larebanga to Mole National Park headquarters (Figure 2). The average annual rainfall is about 1100mm, decreasing to 1000mm in the north of the Park. More than 90% of the rain falls in the rainy season from April to October, with peaks in July and September. The dry season lasts from

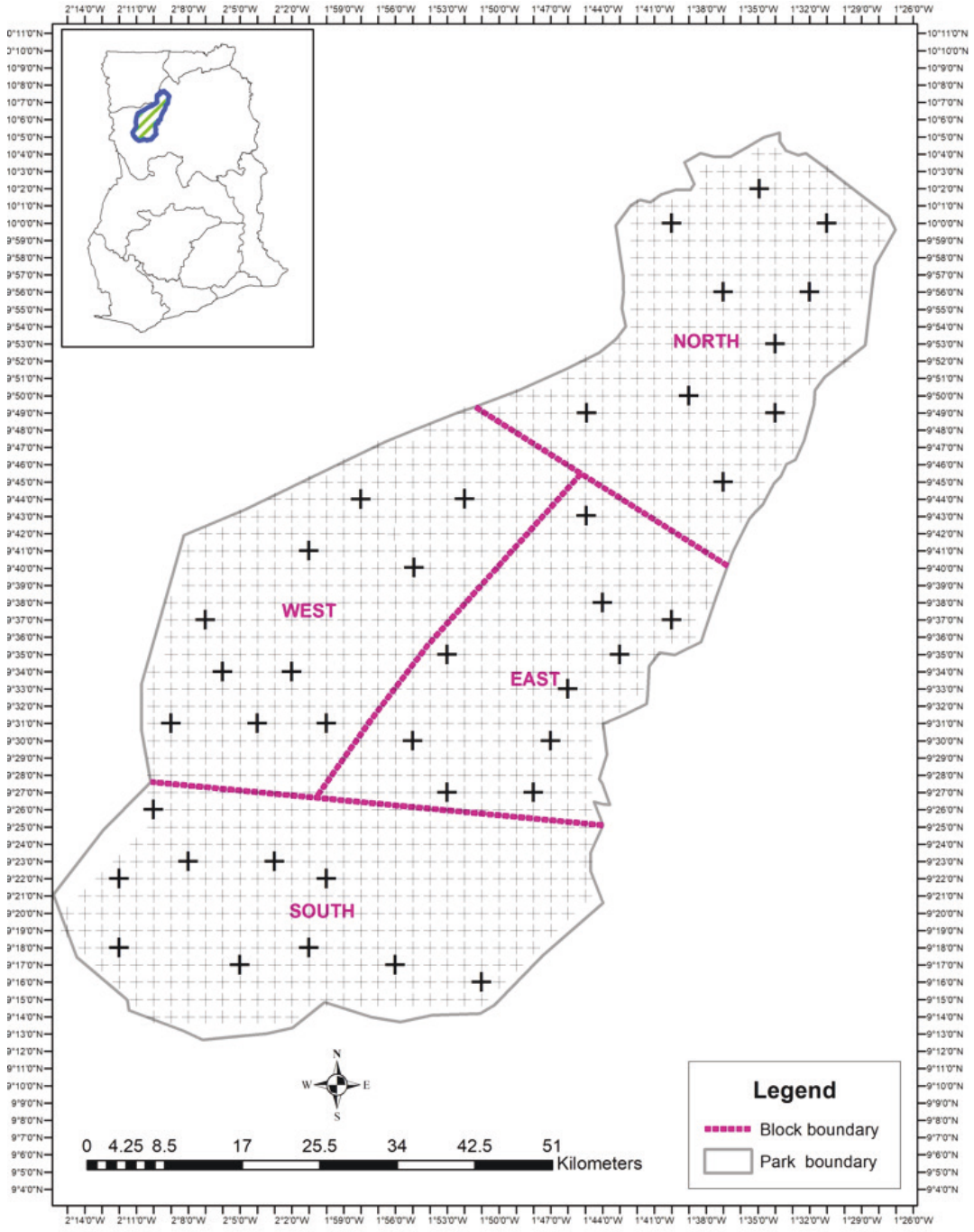


**Figure 1. Mole National Park showing the distribution of transects used for the primate's survey (Inset: Ghana map showing the location of Mole National Park).**

November to March. The mean annual temperature of 28°C varies from 26°C in December to 31°C in March. The average range from day to night is 13°C. It can be hot in March and April, with temperatures sometimes at 40°C (Mole Management Plan 2011). The Harmattan - the dry wind from the Sahara – may blow during December to February bringing dusty, hazy weather. The relative humidity reaches 90% at night in the rainy season and falls to about 70% in the afternoons. In the dry season the figures are 50% and 20% respectively (Mole Management Plan 2011; Wildlife Department, Ghana 1994). The topography is mostly flat, with the narrow Konkori Escarpment running north-south. The elevation ranges from 120—490 m. Most of the rivers are seasonal and drain into the White Volta (Mole Management Plan 2011).

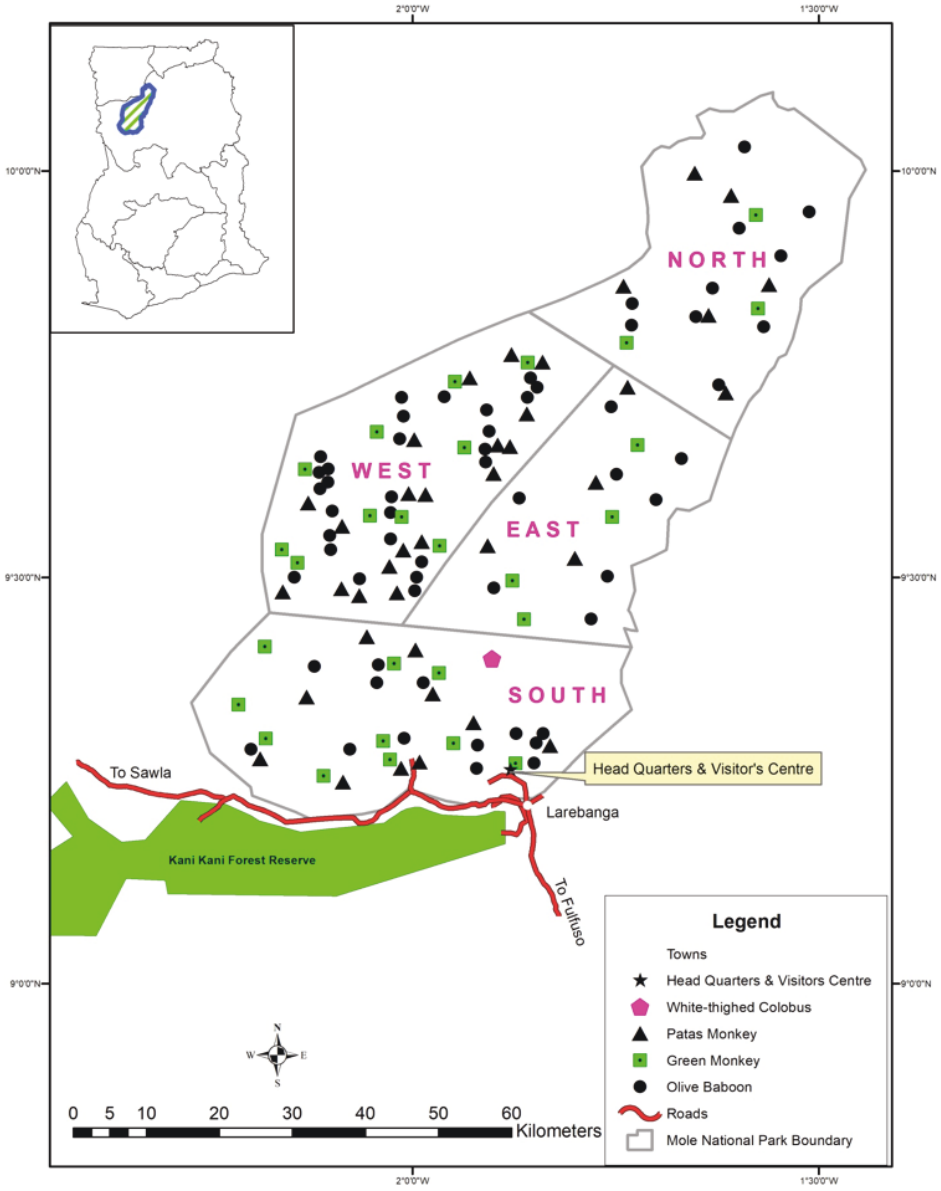


**Figure 2. Mole National Park showing distribution of diurnal primates.**

**Stratification of the study area and distribution of transects**

To equalize sampling effort, the entire park was divided into four blocks of approximately 1,140km² each based on the existing management systems used by the Park management. These were Northern sector (Ducie range), Western sector (Jang range), Southern sector (Headquarters range) and Eastern sector (Bawena range) (Figure 1). Latitudinal and longitudinal grids at one-minute intervals were placed over the map of the study site and the intersections of the lines formed the mid-point of each transect. In each block, 10 transects were laid at random with at least 2km apart as shown in Figure 1. Each transect was straight and ran for a length of 5km (Campbell et al. 2016). Transects were surveyed twice, therefore the total transect walk was 400km. Navigation was conducted using a compass and a Geographical Positioning System (GPS) gadget to reach the starting point of each transect. Transects which followed compass lines were measured with a GPS gadget, laid out with minimal cutting or disturbance (Peres 1999) and oriented northwards as a rule of the thumb (Campbell et al. 2016).

**Determination of group density, group size and distribution of primates**

A three-person survey team was maintained at every section or block throughout the survey to ensure

consistency in data collection procedures. During the census, the observers moved along a transect line and stopped at every 200m to listen and scan the surrounding area, at optimal walking-pace of about 1 km/h. At the beginning of each transect, the location, habitat type, date, weather, starting time and participating personnel were recorded as standard items. When a primate group was seen, 10 minutes was spent observing it, and the observer remained on the census route without following the animals away from the line. The information recorded followed the guidelines of National Research Council (1981) and Peres (1999) which included identification of species, number of individuals, the group size and other relevant information.

### Data Analysis

Kilometric Indices of Abundance (KIA), which is the ratio of the number of animals encountered to the distance covered, was used to present the frequency of group encounters (Groupe 1991; Gatti 2010).

## RESULTS

### Species composition

We confirmed the presence of four diurnal primate species in the Mole National Park. Apart from the White-thighed Colobus that has been classified as Critically Endangered, Olive Baboon, Green Monkey and Patas Monkey have been classified as Least Concern (IUCN 2016).

Olive Baboons *Papio anubis* were the most widespread diurnal primates encountered at the Mole National Park. They were found in all parts of the park with majority (27) groups encountered at the western part; 13 groups at the southern part; 10 and eight groups encountered at the northern part and eastern parts respectively (Table 1) as shown in Figure 2.

The number of groups of Patas Monkeys *Erythrocebus patas* found in the western part of the Park was 19; 10 groups were at the southern, four at the eastern and six at the northern part of the Park (Table 1) (Figure 2).

The Green monkeys *Chlorocebus sabaeus* encountered were 10 groups at the western and southern parts each, while the eastern and northern parts encountered four and three groups respectively (Table 1) shown in Figure 2.

The White-thighed Colobus *Colobus vellerosus* group was encountered only once at the southern part of the Park (Table 1). The group was made up of six individuals along a riverine forest (Figure 2).

### Encounter rates of primates identified in Mole National Park

The most encountered primate in the park was the Olive Baboon with a mean encounter rate of 0.98/km (SE=0.29, Min. = 0.5, Max. = 1.8). This was followed by the Patas Monkey with a mean encounter rate of 0.68/km (SE = 0.13, Min. = 0.2, Max. =0.3) and the Green Monkey with a mean encounter rate of 0.48/km (SE =0.23, Min. =0.3, Max. =1.3). The White-thighed Colobus was encountered only once with six individuals. At the eastern part of the park, the KIA of the Olive Baboon was 1.8, Green Monkey was 0.7 and Patas Monkey was 1.3. At the southern part, the KIA of Olive Baboon was 0.9, Green Monkey was 0.7, Patas Monkey was 0.7 and White-thighed Colobus was 0.07. At the western part, the KIA for Olive Baboon was 0.5, and Green Monkey and Patas Monkey was 0.3 respectively; while KIA of 0.7, 0.2 and 0.4 were for Olive Baboon, Green Monkey and Patas Monkey respectively for northern part (Table 2). However, no significant difference was found in the KIA of all species encountered (ANOVA: F=1.21, df =5.39, p=0.37).

### Group size of primates encountered

Members of each group of primates were encountered as follows:

(i) Relatively higher mean group sizes of *P. anubis*

**Table 1. Number of groups of primates observed in each range.**

| Common name | Scientific name | Number of groups | | | | Mean | *SE |
|---|---|---|---|---|---|---|---|
| | | western | southern | eastern | northern | | |
| Olive Baboon | *Papio anubis* | 27 | 13 | 8 | 10 | 14.5 | 4.3 |
| Patas Monkey | *Erythrocebus patas* | 19 | 10 | 4 | 6 | 9.8 | 3.3 |
| Green Monkey | *Chlorocebus sabaeus* | 10 | 10 | 4 | 3 | 6.8 | 1.9 |
| White-thighed Colobus | *Colobus vellerosus* | - | 1 | - | - | | |

*SE represents standard error

**Table 2. Kilometric Indices of Abundance (KIA) of primates encountered at Mole National Park.**

| Common name | Scientific name | KIA | | | | Mean | SE |
|---|---|---|---|---|---|---|---|
| | | Eastern | Southern | Western | Northern | | |
| Olive Baboon | *Papio anubis* | 1.8 | 0.9 | 0.5 | 0.7 | 0.98 | 0.29 |
| Patas Monkey | *Erythrocebus patas* | 1.3 | 0.7 | 0.3 | 0.4 | 0.68 | 0.13 |
| Green Monkey | *Chlorocebus sabaeus* | 0.7 | 0.7 | 0.3 | 0.2 | 0.48 | 0.23 |
| White-thighed Colobus | *Colobus vellerosus* | - | 0.07 | - | - | - | - |

**Table 3. Mean group sizes of primate species identified in Mole National Park.**

| Name of species | Eastern | | | Southern | | | Western | | | Northern | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | SE | Range | mean | SE | Range | mean | SE | Range | Mean | SE | Range |
| Olive Baboon | 16.8 | 2.3 | 7–30 | 17.1 | 3.4 | 4–38 | 7.8 | 1.1 | 1–19 | 6.8 | 1.1 | 3–15 |
| Patas Monkey | 26.7 | 4.6 | 14–35 | 13.1 | 3.2 | 3–34 | 9.5 | 1.4 | 1–19 | 2.7 | 0.6 | 1–5 |
| Green Monkey | 14.5 | 4.7 | 3–25 | 12.9 | 2.3 | 6–25 | 9.5 | 1.4 | 3–18 | 1.7 | 0.3 | 1–2 |
| White-thighed Colobus | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

were recorded at the southern part 17.1 (SE=3.4), than the eastern, 16.8 (SE=2.3); western, 7.8 (SE=1.1) and northern, 6.8 (SE=1.1) (Kruskal-Wallis: H=15.07, p=0.0017) parts (Table 3).

(ii) The mean group size of *E. patas,* at the southern part was 13.1 (SE=3.2); western part, 9.5 (SE=1.4); eastern part, 26.7 (SE=4.6); and northern part, 2.7 (SE=0.6) (Table 3). The group sizes of patas monkey in the eastern part was found to be higher than all other parts, followed by the southern, western and northern parts (H=19.43, p=0.0002).

(iii) The mean group size of *C. sabaeus* at the southern part was 12.9 (SE=2.3); eastern part, 14.5 (SE=4.7); western part, 9.5 (SE=1.4) and northern part, 1.7 (SE=0.3) (Table 3). The average group size of Green Monkey in the eastern part was significantly higher than all other parts, followed by the southern and the western parts. The least group size was encountered at the northern part of the Park. (H=9.09, p=0.03)

*(iv) C. vellerosus* recorded only six individuals during the survey.

## DISCUSSION

The population ecology and behaviour of savannah non-human primates have been extensively studied in east and southern Africa (e.g., Struhsaker 1967; Henzi & Lucas 1980; Isbell et al. 1991; Barrett et al. 2006). There is, however, a paucity of information on savannah primates in Ghana. This is probably because almost all the species occurring in this area are classified as Least Concern by IUCN, and also are not endemic in the sub-region. Much attention has therefore been paid to those species facing extinction spasm and in critical condition. Species of primates living in Ghana's premier national park have enjoyed the peace of being situated in a low human populated area, and the main road to the place was in deplorable condition until recently when it was improved and brought in large influx of people. The presence of White-thighed Colobus *Colobus vellerosus* in the Park is quite strange, as it does not typically occur in Guinea savannah area. There could equally be similar forest related species in the savannah park that an organized thorough survey could encounter.

Olive baboons were common, and the most conspicuous primate species in the Park. Early primate studies reported a total of 34 groups through aerial survey in the Mole National Park (Wilson 1993). The mean of the groups of Olive Baboons was 14.5 (SE=4.3) and encounter rate of 0.98 group/km in Mole National Park is high when compared to Gashaka Gumti National Park (Nigeria) of 0.17 groups /km (Isabell et al. 2002); 0.2-1.4 groups/km$^2$ (Dunn 1993). The mean group size of the Olive Baboon was 10.8 (SE=1.1, range=1-38), but there was variations in group sizes at different parts of the Park (Table 3). It was observed that the mean group size was higher in the southern part than all other areas with the least group size found in the northern part (Table 3). This is probably because of variations

in resources distribution and the security situation at a particular locality in the Park. The Olive Baboon groups were found to be very conspicuous at every part of the Park and sometimes two or more troops of Olive Baboons group around the visitors centre to forage most of the time. They used to search for feed everywhere, even in the refuse containers, and also posed for cameras when they came closer to tourists. In a zoological study in Mole National Park, Wilson (1993) observed that Olive Baboons were easily seen from helicopter, but was afraid that the population could become a nuisance that require culling or translocation.

Patas Monkeys, with an average group of 9.8 (SE=3.3) and an encounter rate of 0.68 group/km were also relatively common. The 1993 aerial survey could not give accurate groups of monkey in Mole because the species would 'freeze' or take cover as soon as they heard the noise of the helicopter; therefore, the number of groups was under-estimated to be 15 (Wilson 1993). In Comoé National Park in Côte d'Ivoire, Fisher et al. (2000) observed groups of between 3-17; W national park, 3-38 groups by Poche' (1976) and 16-45 groups at Kalamaloue' National Park in Cameroon (Nakagawa et al. 2003). The mean group size of the Patas Monkey was 12.2 (SE=1.5, range= 4 – 19).

Green Monkeys were also found in all parts of the Park with mean group size of 10 (SE=1.2, range=1-25) and encounter rate of 0.48 group/km as compared to 18 groups in 1993 (Wilson 1993). In Mali, Green Monkeys were found to be 1.2 groups/km$^2$ in Bafing Faunal Reserve (Pavy 1993).

The hypotheses that the encounter rates of all species were not the same in different parts of the Park was rejected. This indicates that there was not much variation in the encounter rates of the species which may imply that the factors controlling encounter rates of the species might be the same for all primate taxa. However, the hypothesis that the group sizes of the same species found at different parts of the park were not the same was supported by the study. Variations in group sizes were found to occur in the same species at different localities in the same park, and this could be attributed to unstudied differences in the habitat (Kruger et al. 1998); security situation at the locality against poaching (Wiafe 2016) or other unknown factors. Mole National Park might be heterogeneous in terms of habitat (resources) richness, distribution and pressure from other users. It is worth noting that the three primates encountered in the northern part recorded smaller numbers in the group sizes than all other parts. This might be attributed to the narrowness of that part of the park or probably its proximity to the regional capital city (Wa); with the assumption that human presence and pressure is higher in that area than in all other areas. It has been suggested that the size of many animals are the result of the local ecology interacting with the species' adaptation (Dunbar 1988). It could then be inferred that the variations in the group sizes observed in Mole National Park are a consequence of cost and benefits of some particular local environmental factors and inequality of resource distribution.

This study confirmed the presence of four diurnal monkey species in the savannah protected area of Ghana. Among these monkeys, one is classified as Critically Endangered by IUCN (*Colobus vellerosus*) and three others as Least Concern (*Papio anubis*, *Chlorocebus sabaeus* and *Erythrocebus patas*). With the exception of *Colobus vellerosus*, these monkeys were encountered everywhere in the national park and were abundant.

Mole National Park could be considered a high conservation area and the park can be regarded as a natural laboratory for research and conservation of biodiversity. Studies of inter-specific and intra-specific relationships are required to strengthen understanding of these primates in the park. Promotion of primate-focused eco-tourism is suggested to boost the socio-economic lives of the humans living in the fringe communities of the park, and promote conservation of the primates.

## REFERENCES

**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.

**Asibey, E.O.A. (1978).** Primate conservation in Ghana, pp55–74. In: Chivers, D.J. & W. Lane-Petter (eds.). *Recent Advances in Primatology - 2*. Academic Press, New York.

**Barrett, A.S., L.R. Brown, L. Barrett & S.P. Henzi (2006).** Phytosociology and plant community utilization by vervet monkeys of the Blydeberg Conservancy, Limpopo Province. *Koedo* 49: 49-68.

**Booth, A.H. (1956).** The distribution of primates in the Gold Coast. *Journal of West African Science Association* 2: 122–133.

**Campbell, G., J. Head, J. Junker & K.A.I. Nekaris (2016).** Primate abundance and distribution: background concepts and methods, pp79–110. In: Wich, S.A. & A.J. Marshall (eds.). *An Introduction to Primate Conservation*. Oxford University Press.

**Curtin, S. (2002).** The diet of the Roloway monkey (*Cercopithecus diana roloway*), in Bia National Park, Ghana, pp351–373. In: Glenn, M.E. & M. Cords (eds.). *The Guenons: Diversity and Adaptations in African Monkeys*. New York: Kluwer Academic press.

**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. Washington, Conservation International.

**Dunbar, R.I.M. (1988).** *Primate Social Systems*. Cornel University Press,

Ithaca, NY, 373pp.

**Dunn, A. (1993).** The Large Mammals of Gashaka Gumti National Park, Nigeria: Line transects surveys from Forest and Savannah. Nigerian Federal Ministry of Agriculture, Water Resources and Rural Development, Nigerian Conservation Foundation, and World Wide Fund for Nature, UK.

**Fisher, F., M. Gross & B. Kunz (2000).** Primates of the Comoé National Park, Ivory Coast. *African Primates* 41: 10–15.

**Fretwell, S.D. (1972).** *Populations in a Seasonal Environment*. Princeton, NJ: Princeton University Press.

**Gatti, S. (2010).** Status of primate populations in protected Areas targeted by the community forest Biodiversity project. WAPCA and WD/FC, Accra.

**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

**Henzi, S.P. & J.W. Lucas (1980).** Observations of inter troop movement of adult Vervet Monkeys (*Cercopithecus aethiops*). *Folia Primatologia* 33: 220–235.

**Isbell, L.A., D.L. Cheney & R.M. Seyfarth (1991).** Group fusions and minimum group size in Vervet Monkeys (*Cercopithecus aethiops*). *American Journal of Primatology* 25: 57–65.

**Isabell, L.A., D.L. Cheney & R.M. Seyfarth (2002).** Why vervet monkeys (*Cercopithecus aethiops*) live in multi-male groups. In: Glenn, M.E. & M. Cords (eds.). *The Guenons: Diversity and adaptation in African monkeys*. Kluwer Academic/ Plenum, New York.

**International Union Conservation of Nature (IUCN) (2016).** The IUCN Red List of Threatened Species 2016. IUCN, Basel, Switzerland.

**Kruger, O., E. Affeldt, M. Brackmann & K. Milhahn (1998).** Group size and composition of *Colobus guereza* in Kyambura Gorge, Southwest Uganda, in relation to Chimpanzee activity. *International Journal of Primatology* 19(2): 287–297.

**Mittermeier, R.A., A.B. Rylands, A.E. Eudey, Rodriguez-Dina & T. Butynski (1997).** Specialist group reports: Primate Specialist Group. *Species* 28: 56–57.

**Masanja, G.F. (2014).** Human population growth and wildlife extinction in Ugalla ecosystem, western Tanzania. *Journal of Sustainable Development Studies* 5(2): 192–217.

**Mole Management Plan (2011).** Mole National Park Management Plan. Wildlife Division (Forestry Commission), Ghana.

**National Research Council (NRC) (1981).** *Techniques for the Study of Primate Population Ecology*. National Academy Press, Washington D.C.

**Nakagawa, N., H. Ohsawa & Y. Muroyama (2003).** Life-history parameters of a wild group of West African Patas Monkeys (*Erythrocebus patas patas*). *Primates* 44: 281–290.

**Nichols, D.J. & K.B. Williams (2006).** Monitoring for conservation. *Trends in Ecology and Evolution* 21(12): 668-673

**Oates, J.F. (2006).** Primate Conservation in the Forest of Western Ghana: Field Survey results, 2005–2006. A report to the Wildlife Division. Accra, Forestry Commission.

**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.

**Pavy, J.M. (1993).** Mali. Bafing Faunal Reserve. Biodiversity and Human Resource: Survey and Recommendations. Report. Cleverly, MD.

**Peres, C.A. (1999).** General guidelines for standardizing line-transect surveys of tropical forest primates. *Neotropical Primates* 7(1): 11–16.

**Poche', R.M. (1976).** Notes on Primates in Parc National du W du Niger, West Africa. *Mammalia* 40: 187–198.

**Stokes, E.J., S. Strindberg, P.C. Bakabana, P.W. Elkan & F.C. Iyengue (2010).** Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. *PLoS One* 5: e310294.

**Struhsaker, T.T. (1967).** Ecology of vervet monkeys in Masai-Amboseli Game Reserve, Kenya. *Ecology* 48: 891-904.

**Wiafe, E.D. (2013).** Status of the Critically Endangered Roloway Monkey (*Cercopithecus diana roloway*) in Dadieso Forest Reserve, Ghana. *African Primates* 8: 9–16.

**Wiafe, E.D. (2016).** Population studies of Lowe's monkey (*Cercopithecus lowei* Thomas, 1923) in Kakum Conservation Area, Ghana. *Journal of Threatened Taxa* 8(2): 8434–8442. https://doi.org/10.11609/jott.2193.8.2.8434-8442

**Wildlife Department, Ghana, (1994).** Forest Resource Management Project, GWD/IUCN: Mole National Park. The Management Plan, 198pp.

**Wilson, V.J. (1993).** A zoological survey of Mole National Park, North-Western Ghana, part 1-Large mammals. Forest Resource Management Programme. Wildlife Department/ IUCN project, Accra-Ghana, 89pp.

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