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Effects of Anthropogenic Activities on Chimpanzee Nest Location in the Tofala Hill Wildlife Sanctuary (THWS), South West Region, Cameroon

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Abstract— *Chimpanzee nest construction has been potentially influenced by altitude and human activities. This study entitle "effects of anthropogenic activities on chimpanzee nest location in the Tofala Hill Wildlife Sanctuary (THWS), South West Region, Cameroon," dated June 2017-March 2018 with the objectives to investigate the construction of arboreal (night nest) and ground (terrestrial or resting nest) nests among chimpanzee (Pan troglodytes ellioti) subpopulations in the THWS, and the effects of anthropogenic activities on chimpanzee nest location. A guided reconnaissance survey "recce" walks based on the line transect method was used to obtain information on the location, altitudinal distribution, height and age of chimpanzee nests in order to determine the encounter rates of chimpanzee nesting in the THWS. The different statistical tests were conducted using XLSTAT 2007. 8. 4 statistical software for data analysis. From the result, arboreal (night nest) nests accounted for 75.86% of total nest construction while ground (terrestrial or resting nest) nests accounted for 21.14%. Chimpanzee nested most at elevated heights (mean nesting height = 15.8m) and at high altitudes (800-1000m) with very low encounter rates of logging and agricultural activities (0.13 and 0.06 signs per km respectively). Nests were constructed amongst trees of the families; Fabaceae, Euphorbiaceae, Menispermaceae and Moraceae trees of girth 25.5 – 115cm. However, fruiting and flowering trees were most preferable. In the THWS, chimpanzees prefer to select their nesting sites mostly in the woodland and primary forests vegetation where human activities (agricultural and hunting activities) are low. Therefore, human predation appeared to be an important factor influencing chimpanzee nest location in the THWS.*

Keywords— Chimpanzee, Human-predation, Nest, Tofala Hill Wildlife Sanctuary.

I. INTRODUCTION

Nest building has been an important aspect in the behavioural ecology of great apes. Some years ago, some researchers suggested that, the knowledge and technological skills that chimpanzees possess about nest building may be a precursor to tool use which could be attributed to cognition and thinking (Yoshida, 2012). However, different species of great apes may build nests for different purposes. Chimpanzee were found to build nest purposely for sleeping as well as resting (resting nest). Therefore, nest structure varies depending on whether the nest is for night sleeping or day resting. Day nests are structurally simpler, less solid, and constructed in feeding trees at feeding height (Brownlow *et al*., 2001). The majority of these nests were simple day nests for napping, resting, eating and playing (Brownlow *et al*., 2001; McGrew, 2010). Chimpanzee nest construction has been potentially influenced by seasonality, altitude, nonhuman predation, temperature, day/night use, relation to old age/ injury, mate-guarding behaviour, availability of arboreal nesting opportunity, wind speeds, agricultural development and human hunting have all been considered (McGrew, 2010; Stewart, 2011; Koops *et al*., 2012a, 2012b) and vegetation types have been identified as key ecological factors determining ape distribution (Feilen and Marshall 2014). Habitats with a dense canopy are

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commonly selected by chimpanzees for nesting (Brownlow *et al*., 2001; Basabose and Yamagiwa, 2002; Sousa *et al*., 2011). Chimpanzees select nesting sites in relation to four main factors; anti-pathogen, anti-predation, increased thermoregulation and shelter, and increase confort ability and quality of sleep. For instance, the Kibale chimpanzees (Uganda) build nests at higher altitudes where the abundance and diversity of anopheline mosquitoes is lowest, rather than in sites where they feed, suggesting this behaviour may be related to the reduction of acquiring malaria infection (Krief *et al*., 2012).

Most primates live on trees and are said to be arboreal species, but even the more terrestrial species such as the chimpanzee choose to sleep at elevated heights on trees during the night. The most important theory behind nest building among chimpanzee is the avoidance of predators. It was reported by Anderson (2000) that, nesting at elevated heights on trees makes chimpanzees more inaccessible to potential predators and many primates sleep towards the terminal ends of branches as this could help them detect danger early and permit escape. Chimpanzees have also been found to construct ground nests irrespective of the predation risk. For instance, Hicks (2010) reported that occasional ground nests have been recorded at several study sites. Despite the fact that chimpanzee arboreal nests are found almost everywhere within chimpanzee range, little is known about the actual function of (tree) nest-building (Pruetz *et al*., 2008; Stewart, 2011; Stewart *et al*., 2007). Although several, nonmutually exclusive, hypotheses have been proposed to explain why chimpanzees build nests (McGrew, 2004). The hypothesis that has received most attention is the anti-predation function of arboreal nest building which states that arboreal sleeping was more secure than sleeping on the ground, as sleeping on the trees provides protection from large nocturnal predators (Anderson, 2000). Matsuzawa and Yamakoshi (1996) in the Ivory Coast and Guinea, noted that terrestrial chimpanzee nests were frequently found at high altitudes on steep mountainsides surrounded by small trees, bushes and grassland and hypothesized that terrestrial nests were preferred at high altitudes because of the higher wind speeds, which deterred chimpanzees from arboreal nesting. However, Koops *et al*. (2007) tested and refuted this hypothesis.

The Tofala Hill Wildlife Sanctuary within the Lebialem-Mone forest corridor is one of the most important biodiversity hotspots of global importance with high levels of species richness and endemism across the forest area (Nkemnyi *et al*., 2012). In our present study, we examined the impacts of human activities on chimpanzee nesting in the study area. We identified the various types of human activities; the number of arboreal and terrestrial nests were counted and recorded with respect to the type of human activities encountered at the point. We therefore tested the hypothesis that nest location varied in relation to the type and intensity of human activity.

II. MATERIALS AND METHODS

2.1. Location of the Tofala Hill Wildlife Sanctuary

The Tofala Hill Wildlife Sanctuary (THWS) formerly known as the Bechati-Fossimondi-Besali Forest (BFBF) is located between latitude 5° 37' to 5° 42' N and longitudes 9° 53' to 9° 58' E). The THWS in the Lebialem-Mone forest corridor within the Lebialem division in the Southwest region of Cameroon got its full protection on September 29, 2014. The forest is bordered by Banyang-mbo Wildlife Sanctuary (BMWS) to the southwest and has a surface area of about 100 km² of land. It lies 40 kilometers (25 miles) away from the nearest Cross River Gorilla locality in Mone River Forest Reserve in Cameroon. The forest is surrounded by many villages (Nkong, Bangang, Besali, Bechati, Agong, Folepi, Banti, Fonengeh, Bamumbu, Igumbo, Fossimondi, Fossimock'Mbi, Fonjumetaw, Fossongu and Njenawa) which collectively fall into two ethnic groups (Mundani and M'mock). The area is characterized by an undulated landscape from Bechati (200m) in the lower altitudes to Fossimondi (1800m) in the higher altitudes, with a chain of peaks notably the Tofala Hill (866m) (Fig. 1). It is also characterized by a Semi-evergreen tropical broadleaf forest which dominates the lower altitudes (International Tropical Timber Organization, 2006).

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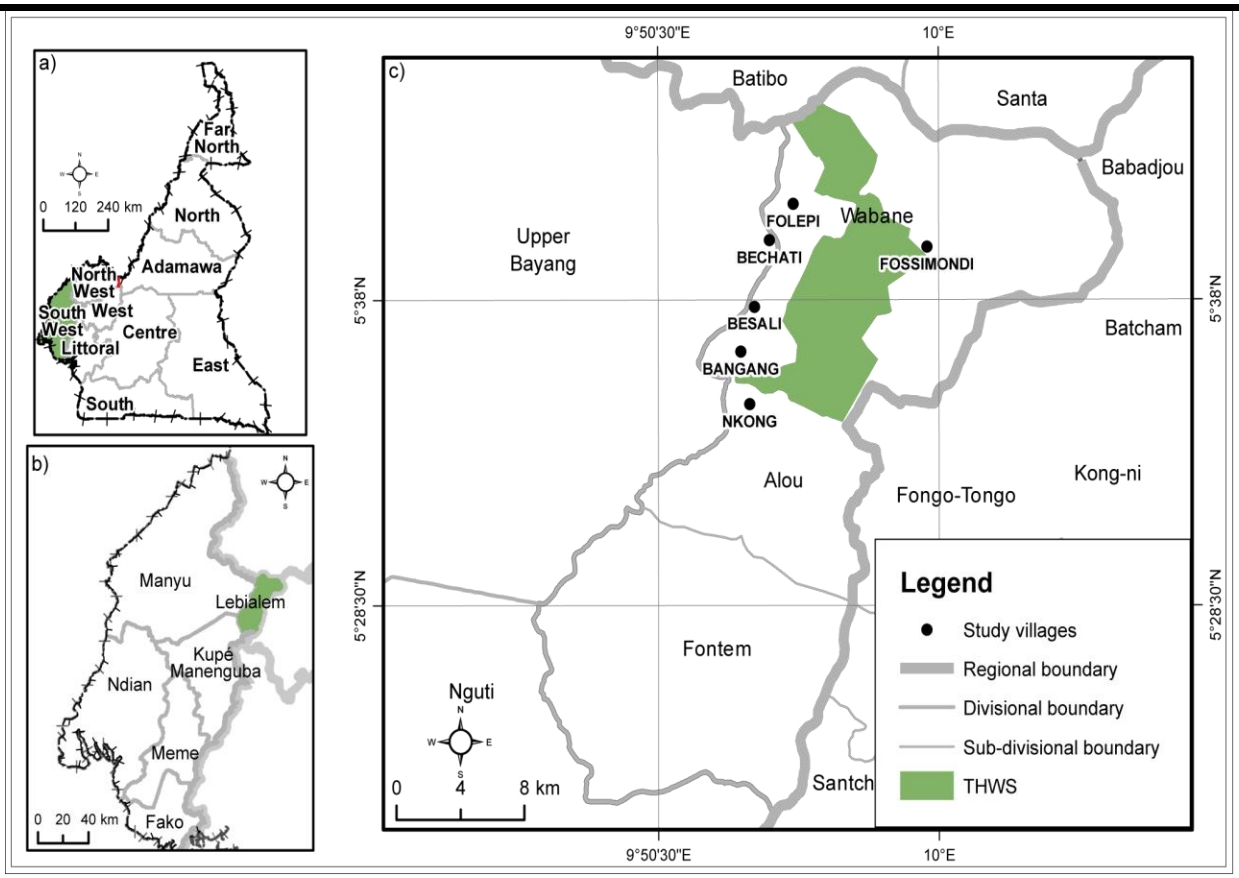

Fig.1: Location of Southwest Region, Lebialem Division, study villages and THWS area within Cameroon, (adapted from the administrative map of Cameroon, ERuDeF and ACF, 2011)

2.2. Description of the study site

Two seasons (rainy and dry seasons) are commonly observed in the study area. The rainy season last from mid-march to the end of October with August being the wettest month while the dry season begins from early November and ends in mid-march with February being the driest. The area has a humid tropical climate with a mono-modal rainfall pattern. Annual rainfall ranges from 3438 to 5429mm with a mean of 4526mm (Nchenji, 2005). The climate is characterized at high altitudes by low temperatures, low rainfalls, high relative humidity and mountains often covered in clouds and at low altitudes by moderate temperatures, low rainfalls, low relative humidity and mountains relatively clear. Daily temperatures vary between 20°C and 35°C, and an annual temperature range of between 21°C and 26°C with the peak in March. The topography is undulating and characterized by elevated, prominent mountainous terrain, with altitude ranging from lowland Bechati, Besali, (200m) and 72m (Nkong) through 1470m (Alongkong) to about 2000m at Fossimondi. The area is an important watershed with many fast flowing forest streams that jointly form the Manyu River. Also, it is a major watershed that supplies Mezam in the North West, Mifi, Mbamedjin dam and Mbouda in the West and Fontem, Tinto and Mamfe in the Southwest. Humid volcanic soils with average fertility are found in the higher altitudes around Fossimondi and sandy-loam to reddish alluvial soils with the lowest fertility around Bechati, in the lower altitudes. There is tropical forest vegetation in the lower parts from the villages of Nkong, Bangang through Besali to Bechati, woodland in the middle part around the villages Talung, Alongkong, Nchingang and Banteng and the tropical savannah vegetation at the higher attitudes of M'mouck Leteh to Magha. However, its altitudinal range of 130m to 2500 m gives rise to two broad vegetation types; the lowland forest and the sub-montane forest (Oates *et al*., 2007). The area is a biodiversity hotspot harbouring over 400 plant species, 42 of which are threatened and two great apes with one critically endangered, Cross River gorilla (*Gorilla gorilla delhi*) and the most endangered subspecies of the African chimpanzees (*Pan Troglodytes ellioti*), several species of monkeys, 8 globally threatened bird species and 03 endemic species of amphibians (Ekinde and Khumbah, 2006; Nkembi *et al*., 2006; IUCN, 2009).

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The human population of the sanctuary area is estimated to be 7,000 inhabitants (Nkembi *et al*., 2006). Agricultural activity is the primary activity practised in the area though people are also involved in other minor activities for livelihood.

2.3. Data Collection and Analysis

Data on chimpanzee nesting was collected in 16 weeks (10 weeks of June, July, August, September and October 2017, and 6 weeks of January, February and March 2018). A guided reconnaissance survey "recce" walk was used to determine the encounter rates of chimpanzee nesting in the study area (White and Edward, 2000). This was based on the line transect survey method which is considered more informative than the travel "recce" which is a random walk that allows deviation of any degree (Kühl *et al*., 2008). During the survey, deviations from predetermined directions were kept to a minimum except when terrain or vegetation made it impossible to continue in a straight line. A total distance of 47km was covered while following chimpanzee tracks and collecting data on nest number, nest height, nest age, nest location and signs of human activities. Team members could differentiate chimpanzee nests from those of gorilla using the stepwise variable selection method employed by Sanz *et al*. (2007) to distinguish between chimpanzee and gorilla nests at Bechati. The Marked Nest Count (MNC) method was used to estimate nest encounter rates since nest decay rate was lacking (Devos *et al*., 2008). In order to estimate the age of the nests, we followed the classification system used by Tutin *et al*. (1983). Nests are categorized as fresh, recent, or old. Fresh nests had green, unwilled leaves, urine and faeces present. Recent nests contained wilted green leaves. Old nests had brown leaves or leaves that were turning brown. Nonetheless, fresh nests were normally considered to be less than 2 days old, recent nests more than 3 days old but less than 1 week old and old nests to be in between 1 week and 1 month old (Koops *et al*., 2012a). Furthermore, identified nests were classified as either arboreal (tree or night nests) or ground (terrestrial or resting nest) nests since Brownlow *et al*. (2001) demonstrated that ground or day nests are commonly used as rest stops between feeding episodes while arboreal or night nests are more complex in order to provide adequate support throughout the night. Too close nests (50 meters) from the recorded point were considered as nests created by the same ape species and of the same nest site (Morgan and Sanz, 2007).

The Encounter rate (ER) or Index of Kilometric Abundance (IKA) was obtained by dividing the total number of nests observed by the length (L) of recce walk (in kilometer).

ER= N /L _____ Equation 1.

Where: N = Number of nests observed, L = Length of recce (Km). Encounter rates were considered high if ≥ 0.5 and low if < 0.5 for both signs of Chimpanzee and human activity. Statistical tests were conducted using XLSTAT 2007. 8. 4 statistic software with level of significance set at 5%. Mann-Whitney tests, Kruskal-Wallis tests and t-test were used to compare encounter rates between nest type, vegetation type and altitudes.

III. RESULTS AND DISCUSSION

A total of 16 chimpanzee nest sites (11 sites of arboreal nest and 5 sites of ground nest) were observed in the study area. We recorded 66 arboreal nests and 21 ground nests in the sampled area. Arboreal nest (night nest) accounted for 75.86% of total nest observed while ground nest (resting nest) accounted for 21.14%. However, 100% of night nest were arboreal since no ground night nest was recorded. This result strongly confirm those of Cardell and Bernice (2013) in the lebialem landscape where 100% of night nest sites observed (n = 20) in Bechati were arboreal. Fresh nests of both arboreal and ground nest had encounter rates greater than recent and old nest (Table 1). However, the encounter rates of estimated ages of arboreal and ground nest did not differ significantly (Mann-Whitney: U = 8, P = 0.20). No recent ground nest was observed in all ground nesting sites.

Table.1: Encounter rates of estimated ages of arboreal and ground nest in the study area.

Type of nest	Estimated age of signs	Number encountered	Total distant covered /km	Encounter rate
Arboreal nest	Fresh	35	47	0.74
	Recent	5	47	0.11
	Old	26	47	0.55
Ground nest (resting nest)	Fresh	20	47	0.43
	Recent	0	47	0
	Old	1	47	0.02

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3.1. Nest Site Selectivity

Chimpanzee nests were not evenly located in all nest sites due to human presence, preferred nesting trees, predation risk and food scarcity. Chimpanzee nested mostly in the woodland vegetation and primary forest and less in the old secondary forest and agricultural land use (Table 2). Chimpanzee nesting and signs of human activities in the different vegetation types showed no significant difference (Kruskal-Wallis = 7.815: DF = 3, P = 0.572). The high frequency of chimpanzee nest in the woodland and primary forest could be attributed to low human presence while low nest frequency in the old secondary forest and agricultural land use could be due to high human presence. Chimpanzees therefore select sites of very low human activity for nesting. In conformity with the present study, Pruetz *et al*. (2002) reported that in Senegal, human presence in the area may have influenced the nesting behaviour in the chimpanzees as they are at risk of predators. Also, other studies have found nest distribution across habitat types to differ from chance and most nests (79%) were in primary forest (koops *et al*., 2012a). As an adaptation when dealing with declines of their preferred habitat, chimpanzees evidently nest in savannah-woodlands (Marchesi *et al*., 1995).

Table.2: Number of nest and human signs in the different vegetation types of the study area

Vegetation types	Description	Nest		Human sign
		AN	GN	
Primary forest (PF)	Large trees and open undergrowth.	10	8	7
Old secondary forest (OSF) vegetation,	Large trees with little undergrowth, dense vegetation dominated by lianas.	2	3	39
Woodland (WL)	Forest dominated by trees, canopy covers more than 25% of ground surface	53	10	21
Agricultural land use (AL)	Land with very minor limitations to agricultural use, wide range of agricultural crops grown,	1	0	37

Where: AN=Arboreal Nest; GN=Ground Nest

3.2. Nesting Heights

In the study area, 57.58% of arboreal nests were above 20m high and the total mean nest height at all nesting sites was 15.8m (Table 3). Very few nests (n = 13) had mean nest height less than 10m (Table 3) and nests were constructed amongst trees of the families Fabaceae, Euphorbiaceae, Menispermaceae and Moraceae trees of girth 25.5 – 115cm. However, fruiting and flowering trees were most preferable. Chimpanzees prefer constructing their arboreal nests high up above 10m (Fig. 2a). The mean number of nests per nesting site was 6 nests. Other studies have found selectivity in nest height in chimpanzee. For instance, in Kahuzi-Biega, DRC, mean nest height was 10m (Basabose and Yamagiwa, 2002) and 13.6m in Assirik, Senegal (Pruetz *et al*., 2008).

Table.3: Arboreal nesting in the Tofala Hill Wildlife Sanctuary

Nest site	Nest number (n)	Mean nest height (m)
1	11	22.5
2	5	10
3	4	25
4	10	20
5	11	21
6	2	15.5
7	6	8
8	8	12
9	3	9
10	4	5
11	2	26
Mean ±SD	6 ±3.162	6 ±3.303	15.818 ±7.072

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Examples of high arboreal nests and low arboreal nests are shown in figure 2a and figure 2b below.

Fig.2a: High arboreal nest (photograph by Akongte)

Fig.2b: Low arboreal nest

3.3. Impact of human activities on chimpanzee arboreal nesting in the THWS

a) Effects of Hunting and Logging on Arboreal Nesting in the THWS

The encounter rates (ER) of arboreal nesting, hunting signs and logging activities were recorded at different altitudes (Fig. 3). Altitudes were classified as low (200-599m), mid (600-799m) and high (800-1100m).

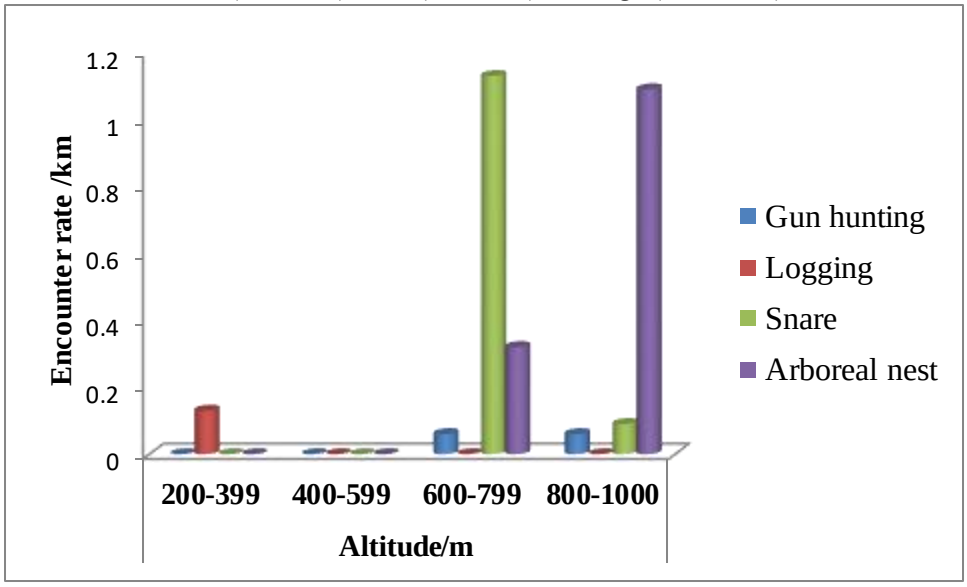

Fig.3: Effect of hunting and logging on arboreal nesting in the THWS

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Arboreal nests were encountered only at mid (ER = 0.32 signs/km) and high (ER = 1.09 signs/km) altitudes with very low encounter rate of hunting signs (ER = 0.06 signs/km) (Fig. 3). No arboreal nest was encountered at low altitudes with encounter rate of 0.13 for logging activity. Snare traps were highly encountered at mid altitude (ER = 1.13 signs/km) than at high altitude (ER = 0.09 signs/km). Chimpanzees preferred high altitudes for their arboreal nest construction due to low encounter of logging and snare traps. It is anticipated that zero hunting signs encountered at low altitudes could be attributed to low encounters of preferred animals by hunters for bush meat.

b) Effects of Agricultural Activities on Arboreal Nesting in the THWS

A majority of farm lands (66.22%) were encountered at low altitudes while 25.67% was encountered at mid altitude and 8.11% at high altitude (Fig. 4)

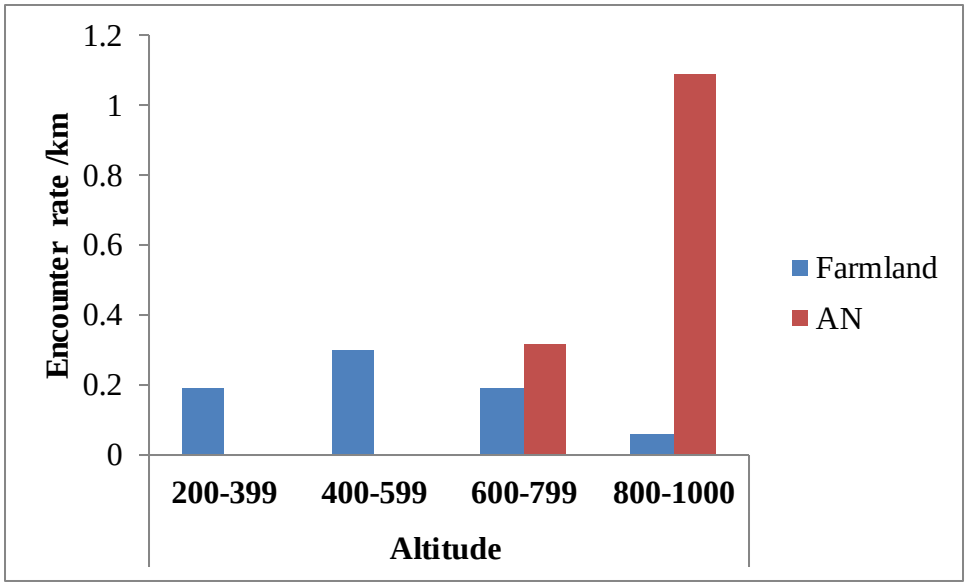

Fig.4: Effect of agricultural activities on arboreal nesting in the THWS

The highest encounter rate of arboreal nesting of 1.09 signs per km was recorded at high altitude where encounter rates of agricultural activities (farmland) was very low (0.06 signs per km). The encounter rates of arboreal nesting and farm land in the different altitudes did not differ significantly ($t = 2.146$, $P = 0.069$). By implication, increase agricultural activities decrease the chances of arboreal nest construction while decrease in the number of farmlands increases the chances of arboreal nest construction. In the study area, human predation (hunting and agricultural activities) has a great impact on chimpanzee arboreal nest location. In this light, Mittermeier *et al.* (2009) demonstrated that encroachment into traditional chimpanzee territory creates a dangerous social dynamic between farmers and nonhuman primates. Many studies have also reported that agricultural development and human hunting have all been considered as factors influencing chimpanzee distribution in an area (McGrew, 2010; Stewart, 2011). Also, according to Cadell and Bernice (2013) in the Lebialem-Mone Forest Landscape (LMFL), human-predation and agricultural development appear to have a substantial impact on the location (terrestrial vs. arboreal) of chimpanzee night nests (sleeping platforms).

IV. CONCLUSION

Our findings strongly support the presence of both arboreal nest (night nest) and ground nest (terrestrial nest) in the THWS. Chimpanzees have the ability of constructing more arboreal nests than ground nest especially in woodlands and primary forests where human activities occurred at very low encounter rate. This could be attributed to avoidance of human predation since chimpanzees preferred arboreal nest construction at high altitudes where hunting, logging and agricultural activities appeared at low frequencies. Nonhuman predation pressure may influence nest site selection but our results clearly highlight the importance of human predation pressure in arboreal nest construction.

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