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Habitat preference and distribution of pangolin in Ala Forest Reserve and Onipanu Community Forest of Southwestern Nigeria

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Despite the ecological significance, social and economic values and the roles being played by pangolin, their ecological roles remain under-studied in context to Nigeria. There is dearth of information on the current status, distribution, habitat preferred by pangolin especially in the tropical rainforest ecoregion of Nigeria. Information on the overall habitat ecology, preference and the current distribution pattern of pangolin in the study areas were generated. Species name, height and diameter at breast height (DBH) of woody trees were recorded and Shannon-Wiener index of species diversity were used to evaluate diversity. Knowledgeable source, field guide books and indirect indices such as signs, footprints and decayed dead parts were employed. Hunters living in villages around the study sites were interviewed to facilitate opportunity to examine hunting practices, feeding and habits in areas where each species lived independently. Findings from this study reveal information on the presence of *Phataginus tetradactyla,* in the study ecosystem, habitat preference and the distribution pattern. The information provided will go a long way towards developing conservation strategies for pangolin in the study areas based on the available information on the ecological significance, social and economic values and the roles being played by this species of animal in context to Nigeria.

Key words: Conservation, ecological significance, feeding habitat, hunters, pangolin, tropical forest.

INTRODUCTION

Pangolins are the category of scaly anteaters mammals belonging to the order Pholidota, and eight pangolin species of which four are from Asia (*Manis javanica, Manis pentadactyla, Manis crassicaudata,* and *Manis culionensis*) and four from Africa (*Manis tricuspis, Manis tetradactyla, Manis gigantea,* and *Manis temminckii*) are recognised (Siew et al., 2016). Challender et al. (2014) earlier observed that historically, in Africa and Asia, pangolins have been exploited for food and medicinal purposes locally and this has resulted in an increasing threat to the animal. While Dipaola et al. (2020) stressed the use of sensory by the animal to detect and track prey with a conservation mindset.

Suwal (2011) reported on the wide distribution of

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pangolins in primary and secondary tropical forests, limestone forests, bamboo forests, grasslands and agricultural fields. Similarly, Maurice et al. (2019) observed that pangolins have a wide distribution, covering an array of natural and man-made habitats including tropical rain forests, subtropical thorn forests, deciduous forests, open scrublands, grasslands, cultivated lands and human settlements in Africa, unlike what was observed in India where the presence of pangolin in the pine-dominated forest was reported (Pabasara et al., 2015; Perera et al., 2017) in a comparative.

Intensive hunting to supply the illegal wildlife trade (Fa et al., 2002; Roberton et al., 2004), low reproductive output that has adversely affected the abundance of pangolin in the wild (Sterling et al., 2006), unregulated exploitation of pangolin due to the perceived preference for this animal (Soewu and Adekanola, 2011), and shifts in market trade from Southeast Asia to Africa (CIFOR, 2017) have been identified as some of the factors responsible for decreasing conservation status of pangolin. CIFOR (2017) stressed that the four species of pangolin that are of African origin are being traditionally hunted for food in the forests of the Congo Basin, where they are still found to be relatively abundant. The CIFOR, therefore, recommended that there is a need to curtail Chinese demands for pangolin in some notable African countries like Nigeria, Sierra Leone, Uganda, Zimbabwe and Zambia in the quest to achieve sustainable conservation of pangolin. International Union for Conservation of Nature (IUCN) through the Species Survival Commission (SSC) Pangolin Specialist Group (2016) and other notable authors (Waterman et al., 2014a; Challender et al., 2015) have raised concern on the increasing illegal international trade in pangolin based on seizure data and comparatively conservative extrapolation parameter since the year 2000.

In addition to the aforementioned factors that are responsible for the decline in pangolin, high demand as a result of medicinal values of some organs of pangolin in Africa to include the skin, heart, intestines and head used for treating asthma and cardiovascular and dermatological (Soewu and Sodeinde 2015), oil extracted from pangolin scales for treating bone and muscle disorders in some parts of India (Mohapatra et al., 2015) and Nepal, pangolin scales are also used by tribal ethnomedical practitioners in treating infertility in women (Katuwal et al., 2013; Mentor-Pop Report, 2017).

The unsustainable use is also rooted in the Africa belief ideology. For instance, a typical African especially in most rural, suburban and even urban areas considered all renewable natural resources, including terrestrial and aquatic as the gifts of nature whose utilization should not be regulated or should be under the most minimal control (Soewu, 2013a; Soewu and Sodeinde, 2015). A high level of unemployment and the attendant widespread of poverty in most African countries have been documented (Soewu, 2013b). Pangolin also played a significant ecological role which is of advantage to other animals in the same ecosystem. Pangolins excavate deep burrows for sleeping and nesting and the presence of remains of prey items and fecal matter are considered as important signs in distinguishing the species of pangolin (Irshad et al., 2015).

All these aforementioned factors have resulted to the present rating of the conservation status of pangolin on IUCN Red Data Book despite the efforts IUCN has taken to address these ugly trends. This has led to the complete ban in the trade of pangolin as part of the efforts to revive the species that is at the brick of extinction (Soewu and Adekanola, 2011). Through the resolution reached at the meeting of members of IUCN in 1963, a treaty known as Convention on International Trade in Endangered Species of Wild Fauna and Flora was drafted and opened for signature in 1973 (Hutton and Dickinson, 2000). It is on this premise that IUCN developed a comprehensive inventory of the global conservation status of plant and animal species referred to as the Red List of Threatened Species using a set of quantitative criteria to evaluate the extinction risks of this biodiversity (Duarte et al., 2015). All African pangolins were previously regarded as near threatened on IUCN Red Data Book except *P. tetradactyla* and *S. temminckii* which were categorized as least concern (IUCN, 2010). All four African species are listed in Class B of the 1968 African Convention on Nature and Natural Resources (Soewu and Ayodele, 2009). African species Black-bellied Pangolin (*P. tetradactyla*), White-bellied Pangolin (*Phataginus tricuspis*), Gant Pangolin (*Smutsia gigantean*) and Temminck's Ground Pangolin (*S. temminckii*) are currently classified as vulnerable on the IUCN Red List of Threatened Species and in Class B of the 1986 African Convention on Nature and Natural Resources (Pietersen et al., 2014; Waterman et al., 2014a, b; IUCN, 2014). Due to rampant population decline, pangolin was listed as critically endangered as per International Union for Conservation of Nature (IUCN, 2014). Simultaneously, it was categorized in Appendix I (CITES) and IUCN (2016). Nigeria as one of the signatory parties to CITES has taken various initiatives at saving her biodiversity including pangolin through the promulgation of a decree and enacted of laws. For instance, three Western African species of pangolins are protected in Nigeria under Schedule 1 of Decree No. 11 (1985) of CITES.

The areas of study in this research fall within the rainforest fringe of South Western Nigeria and they are purposively selected as a result of increasing pressures on wildlife species from anthropogenic activities as reported in recent time in this particular ecological zone.

Emma-Okafor et al. (2010) reported that the destruction of natural habitats continues apace in Nigeria resulting in the depletion of the country's biodiversity. The authors noted that about 48 species of animals and 431 species

of plants are endangered, of which 16 species of mammals and 45 species of plant are categorized as rare, 30 species of animals and 20 species of plants are endemic.

The disappearance of species of animals like the forest elephant, chimpanzee, leopard, African Wild Dog, Nigeria-Cameroon Chimpanzee, and Nile Crocodile in the forest areas in South-Western Nigeria has led IUCN for placing these animals on the endangered list (IUCN Red List, 2019). Africa, a continent exceptionally rich in biodiversity, is rapidly urbanizing. Africa's urbanization is manifest in the growth of its megacities as well as that of its smaller towns and cities. The conservation planning and practice will increasingly need to account for direct and indirect impacts of the continent's urbanization. The South Western ecoregion is also one of the most densely populated areas in Africa, and already showed high levels of human activity before colonial times. There are indications that pangolins especially those that inhabit primary tropical forests are not being spared by these increasing human-induced pressures (Gomez et al., 2016). The authors reported that the recent spate of inter-continental pangolin trade originating from Nigeria has been a serious concern that requires close attention based on the possibility of the country having potential for trafficking. The author went further to affirm the record of seizures data of pangolin shipments originating in Nigeria between the years 2011 and 2015 and came out with the findings that nine seizures of pangolin were recorded with the majority of seizures occurring in 2015, with six incidents totalling no less than 5185 kg of scales. Soewu et al. (2012) affirmed that local trade in mammalian species including pangolin is a lucrative business in Southwest Nigeria. Unfortunately, there is a paucity of research carried out on international trade in pangolins especially in the tropical rainforest region of sub-Sahara Africa which has led to lack of published information in this regard.

Despite the ecological significance, social and economic values, increasing threats as a result of derivable benefits from pangolin there is a dearth of information on the current status, distribution, habitat preferred by pangolin especially in the tropical rainforest ecoregion of Nigeria. This has hampered conservation efforts towards the protection and monitoring of this species. Needless to say that, pangolins being the most traded species of the world in today's time, has attracted very little concern from the scientific community. There have been few scientific papers published on the habit and habitat of the pangolin and still, none have scientific evidence about the total number of the pangolin found in the world. International trade in pangolins is likely to be having a detrimental effect on population levels, although such pressure remains unquantified due to the paucity of research carried out on pangolins, and the lack of published information. Further investigation into the source, scale and extent of trade flows of African pangolins to Asia is desperately needed if we are to clamp down on this illicit trade, inform future policy decisions, and identify priority actions to aid in their conservation.

There is therefore a need to research the overall habitat ecology, preference and determine the current distribution pattern of pangolin in the study areas to generate updated and adequate information. Furthermore, given the threat to pangolin undermining its significance to the ecosystem and human wellbeing, there is a need to substantiate the claim with pragmatic data.

METHODOLOGY

Ondo state lies in latitude 7°15' North of the Equator and on longitude 5°15' East of the Greenwich meridian, which is within the rainforest and forest-mosaic zones of southwestern Nigeria and is bordered by Edo and Delta states to the east, Ogun and the Osun states to the west, and the Atlantic Ocean to the south (Figure 1). The state is made up of 18 Local Government Areas and had a population of 3,441,024 at the last (2006) census National Population Commission (NPC, 2006). The two selected areas of study are Ala Forest Reserve and Onipanu Community Forest, Odigbo Local Government Area, Ondo State.

Ala Forest Reserve

Ala Forest Reserve is located between longitude 5 East and latitude 70 north and falls within the high forest zone of Nigeria (Figure 2). It is located along Akure-Ondo and about 1 km away from the Cocoa Research Institute of Nigeria (CRIN) Owena substation. The reserve was gazetted as forest reserves by order number 2 of 9th January 1936 of the Western region of Nigeria. The Forest Reserve covers an area of 65.93 km^2 and is located within the old Akure Local Government bounded in the west and east by the Owena and Apomu rivers, respectively. Both the northern and southern boundaries are free areas as shown in Figure 2. The reserve lies within the Southwestern part of Nigeria populated by the Yoruba race most of whom are farmers (Pelemo et al., 2011).

Onipanu Community Forest, Odigbo Local Government Area, Ondo State

Ore with an area of 1,818 km^2 and a population of 230,351 (NPC, 2006) is the headquarters of Odigbo L.G.A. It lies between latitudes 06017'57′N and 06043'21′N and longitudes 04049'47"E and 05010'26"E of the equator. Although this area has a mixed population of diverse occupations, the people are largely farmers and hunters.

Reconnaissance survey

The reconnaissance survey was carried out before the commencement of the study at Ala Forest Reserve and Onipanu Community Forest, to get acquainted with the terrain of the Reserve and to seek the consent of the local community before the commencement of the study. Also, information on the various species of pangolin found at the Forest Reserve and Onipaanu Community Forest was gotten during the survey. This is considered an upward review of an earlier study undertaken Phenotypic

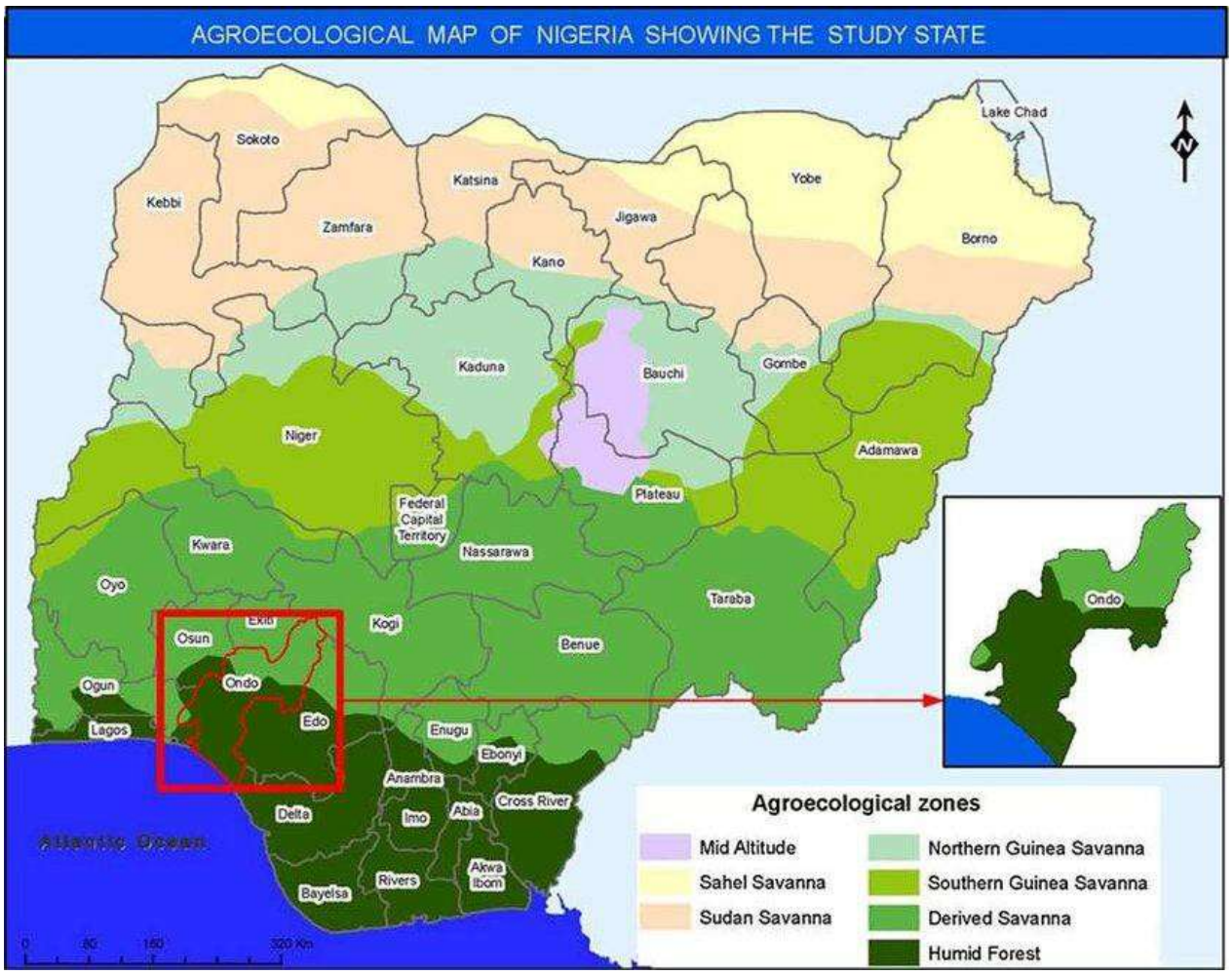

Figure 1. Map of Nigeria showing Ondo State.
Source: Authors

characterization and occurrence of pangolin species in the bushmeat market at Emure-Ile, Ondo State, Nigeria (Oguntuase and Oni, 2018). These authors established the presence of two distinct species of pangolins (*P. tricuspis* and *P. tetradactyla*) in Emure-Ile, Ondo State, Nigeria which is a few kilometers away from Ala-Forest Reserve, Ondo State. Collected information during the reconnaissance survey served as bedrock towards the success of the project. The questionnaires used for the study were also pretested to determine their validity before the commencement of the administration.

Assessment of vegetation structure and other characteristic features of pangolin habitat

The assessment of vegetation structure and other characteristic features of pangolin habitat were carried out where pangolins or other activities were sighted and indices of pangolins were established using plot sampling technique (Ogunjemite et al., 2005; Newton et al., 2007). A line transect was constructed at each study area and the characteristic features such as termite hill, hollow tree, deadwood and distance to water source were recorded. Within each of the transects, a total enumeration of the woody trees found around the pangolin activity areas was carried out. The species name, height and diameter at breast height (DBH) of woody trees were recorded. Shannon-Wiener (Magurran, 1988) index of species diversity was used to evaluate diversity. Shannon's Evenness (E) was calculated from the ratio of observed diversity to maximum Shannon-Wiener diversity. Mathematically, Shannon-Wiener Index is represented as:

$$\text{(i) } H = \sum \frac{ni}{n} \ln \frac{ni}{no}$$

where H= value of SW Diversity index and n = total number ith species.

Assessment of habitat use of pangolin

A modified method of the survey by Mahmood et al. (2013) was employed to survey the potential habitats of pangolins through field observation and traversing the line transect for their indices and signs. The researchers were accompanied by experienced local hunters that possessed in-depth indigenous knowledge on hunting,

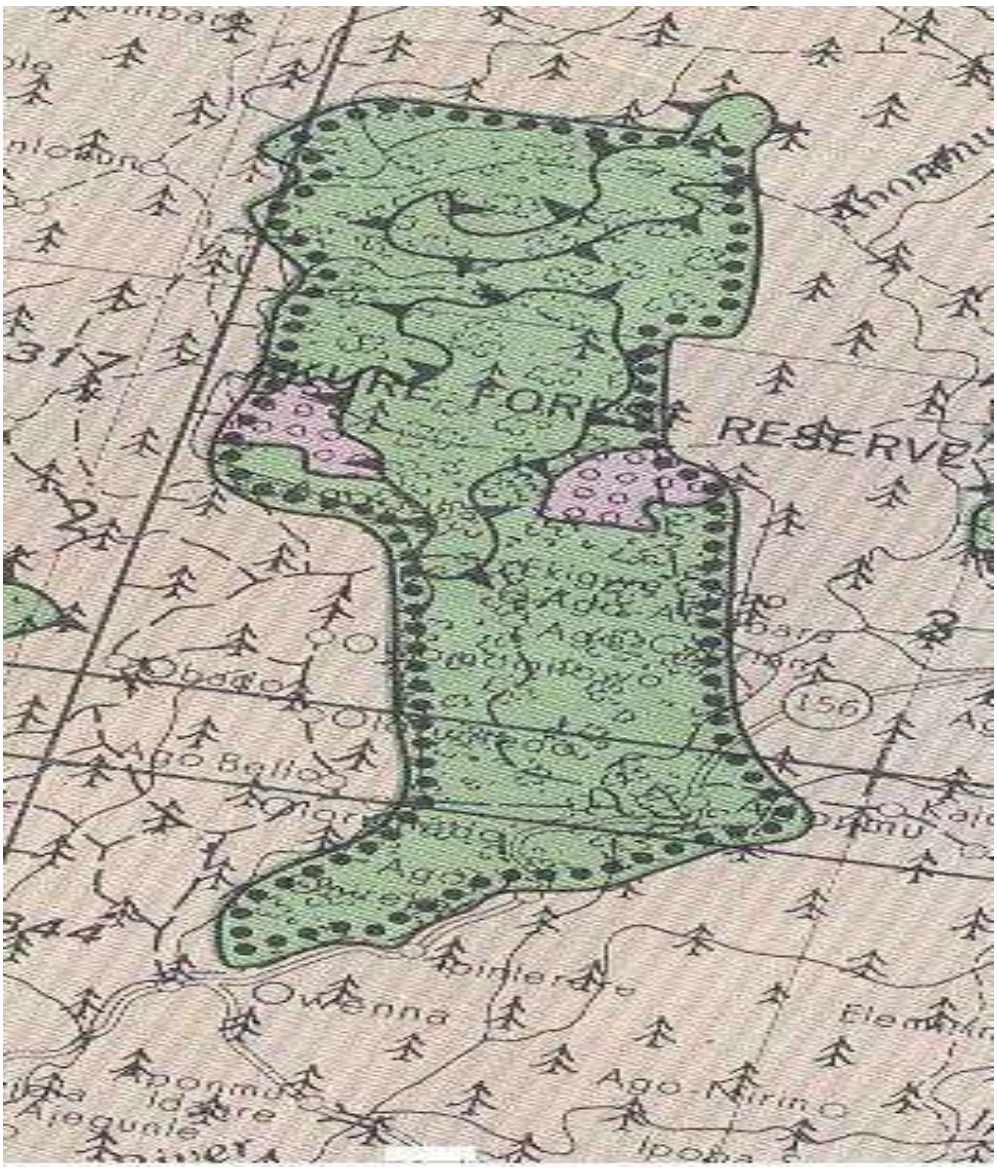

Figure 2. Map of Akure Forest Reserve, Ondo State.
Source**:** Authors

habitat structure and distribution pattern of pangolin in the study areas. The knowledgeable source coupled with the experience of the researchers acquired from a past similar study (Oguntuase and Oni, 2018) was complemented with the consultation of relevant literature and field guide book on African mammals (Kingdon, 2004). The tracks and signs observed indicated the presence of both species of pangolin is more prevalent in the rainy season, the period when pangolins are more active. The field signs most commonly reported (Allen, 1938) as being used to indicate pangolin activity including diggings made by both species when searching for food were employed in this study. Pangolin burrows were distinct from those of other species, as having a uniquely round entrance. Rodents' holes are significantly smaller, and although porcupines also live in burrows, they use natural holes and rock crevices rather than excavate their own.

The random search was also carried out for the field observation in a bid to collect necessary information on the burrows (old, new); scats, footprints and traces of tail of pangolins in the study areas. All these were noted and recorded in the field notebook. The GPS reading was taken in the place where burrows and other related matters of pangolins were found. The burrows were selected by the judgmental method and then the physical properties of the burrow such as colour, length, breadth, location, aspect, inclination, soil type were studied. Burrows were taken as the most prominent indirect signs and were searched on the other side of the transect. Burrows were classified as Fresh burrows (recently very active), new (no active this year) and old burrows (more than one-year-old). Only fresh burrows were used for the density calculation. The dominance of vegetation in each transect was calculated using a modified method of vegetation analysis (Zobel et al., 1987) while frequency, relative frequency, density, relative density, dominance and relative dominance were calculated to get important value

Table 1. Woody Plants Diversity in Pangolin Habitat of Ala Forest Reserve and Onipaanu community forest.

Species	Common name	Families	Ala forest reserve	Onipaanu Forest
Eleais guineensis	Oil palm tree	Arecaceae		+
Tectona grandis	Teak tree	Lamiaceae	+	
Cola nitida	Kola nut tree	Sterculiaceae		+
Cordia alliodora	Laurel (Omo tree)	Boraginaceae		+

Source: Author

index (IVI), that is: IVI= relative frequency+ relative density+ relative dominance.

Hunter interviews

Hunters living in villages around the study sites were interviewed orally. This interview facilitated the opportunity to examine hunting practices in areas where each species lived independently, the feeding habits in the area where they were believed to co-exist. Hunters living in the proximity of the two sites were interviewed and data were collected based on their knowledge of pangolin ecology, historic or traditional and contemporary pangolin hunting practices, and the dynamics of the trade-in pangolins. Potential interviewees were identified based on their reputation as hunters knowledgeable about pangolins and their years of experience in hunting. The Snowball sampling method was used in identifying the hunters. Adopted respondent-driven sampling method Salganik and Heckathorn (2004), a snowball sampling method was used in identifying the hunters, since the researchers were inferred by previous interviewees or named experienced pangolin hunters in neighbouring villages or communities. Interviewees were selected according to their availability and willingness to participate in an informal interview.

Data analysis

Data collected were pooled together and analysed using SPSS package 25 and descriptive statistics, percentages and were presented in chart and tables. The physiological composition of woody species was analysed using the Shanon Wiener Index (SWI) and represented in table showing the species name, local name, and number of species found at the study areas.

Mathematically, Shannon-Wiener Index is represented as:

$$H = \sum \frac{ni}{n} \ln \frac{ni}{no}$$

where H= value of Shannon Wiener Diversity index and n = total number ith species.

The Importance Value Index (IVI), for tree species in potential sites of Conservation Priority (CP) was calculated by using formulae (Cottom and Cartis, 1956):

Relative density = number of quarter with species (k) / 4 times number of sample points × 100

Relative dominance = Total basal area of species (*k*) along the transect / Total basal area of all the species along transect × 100

Relative frequency = number of samples point along transect with species (k) / Total numbers of sample points on transect × 100

Important value index (IVI) = Relative density + Relative dominance + Relative frequency

The burrow density of the CP was calculated for each zone:

Burrow Density (D) = Number of active burrows / Area sampled 100 × 100

RESULTS

Habitat preference of pangolin

Woody trees species richness and family diversity

A total of twenty-five (25) individual tree species belonging to four (4) families (Arecaceae, Lamiaceae, Lamiaceae and Boraginaceae) were recorded in the two (2) study areas. This is made up of twenty (20) individual tree species belonging to one (1) family (Lamiaceae) recorded at Ala Forest Reserve, Akure and three (3) individual tree species belonging to three (3) families (Arecaceae, Lamiaceae and Boraginaceae) were recorded at Onipanu community forest, Ore (Table 1). The teak tree (*Tectona grandis*) was the most prevalent tree species in the Ala Forest Reserve. The Onipaanu community forest had undergone major land-use changes over the years as most of its natural forest had been converted for agricultural use (oil palm plantain and kola nut plantation).

Diameter at breast height (DBH) classes distribution of woody trees in pangolin habitat in the study areas

The total frequency distribution of woody trees in the two study areas (Table 2) revealed that DBH class 41 to 60 cm had the highest frequency of 7 (35%). In Ala Forest Reserve DBH class 4160 cm had the highest frequency of 7 (35%) while the lowest frequency of 1 (5%) was recorded in the DBH classes 1-20 cm. The DBH classes 60-80 cm had the highest frequency of 2 (40%) while DBH classes 21-40, 41-60 and 81-100 cm recorded the lowest number of occurrences 1 (20%) in the Onipaanu

Table 2. Percentage Distribution of the DBH of Woody Tree species in Pangolin Habitat in the Study Areas.

DBH classes (cm)	Ala forest reserve		Onipaanu community forest	
	No of trees	Mean ± SD	No of trees	Mean ± SD
1-20	1	15.45±0.5	0	-
21-40	2	20.50±0.02	1	23.40±1.54
41-60	7	45.62±2.10	1	41.45±0.03
60-80	3	53.80±1.03	2	60.84±0.12
81-100	3	74.50±1.50	1	70.11±3.12
101-120	2	110.21±0.5	0	-
>120	2	135.82±1.25	0	-
Total	20	65.13±2.50	5	48.95±1.50

Source: Authors.

Table 3. Percentage distribution of the height of woody tree species in pangolin habitat in study areas.

Height (m)	Ala forest reserve		Onipaanu community forest	
	No. of trees	Mean ± SD	No. of trees	Mean ± SD
≤5	1	3.68±0.11	0	-
6-10	3	7.45±0.04	1	6.65±0.28
11-15	5	13.56±0.43	2	10.34±1.29
16-20	7	18.60±1.16	1	16.53±1.12
>20	4	23.50±0.17	1	20.47±0.59
Total	20	13.36±1.52	5	13.50±1.03

Source: Authors.

community forest (Table 2).

Height distribution of woody trees in pangolin habitat in the study areas

Table 3 shows the height distribution of woody tree species in the study areas. Height class 1115 m had the highest frequency of 7 (35%). In Ala Forest Reserve, height class 11-15 m had the highest frequency 7 (35%), while height class ≤5 m had the least frequency of 1 (5%). In Onipaanu community forest, height class 11-15 m had the highest frequency 2 (40%), while height classes 6-10, 16-20 and >20 m had the least frequency 1 (20%).

Characteristic features and frequency of occurrence in pangolin habitats in the study areas

The result of other features found in the habitat of pangolin revealed that Ala Forest Reserve had a higher number of deadwood (n=9) compared to the eight (8) dead woods found in the Onipaanu community forest. Ala Forest Reserve had a higher number of termite hill occurrences in the sample area (n=5) compared to that of Onipaanu Forest Reserve (n=4). The majority of the locations are closer to the water source (10 m) except for location 1 and location 3 in Ala Forest Reserve that was farther with distances of 20 and 15 m, respectively to the water source. Also, location 3 and location 2 in Onipaanu Forest Reserve were farther with distances 30 and 15 m, respectively (Table 4).

Distribution of pangolin in the study areas (Burrow Count)

The vegetation cover of the pangolin habitat varied between the study areas. The long-tailed pangolin was more common in the study areas. The indirect indices used in determining the presence of pangolin in the study areas included the burrow count and the presence of scales. As presented in Table 4, Onipaanu Community Forest recorded a higher number of burrows found in trees (n=8), compared to (n=3) burrows found in Ala Forest Reserve. Also, near most of these burrows were the scales of these pangolin species found. These scales belonged to the long-tailed pangolin; this suggests they may be relatively abundant in the area.

Table 4. Frequency of occurrence of indices of pangolin sighted in plot sampled in pangolin habitats in the study areas.

Ala forest reserve	Location 1	Location 2	Location 3	Location 4	Total
No of Dead wood around	3	0	1	3	7
No of Termite hill found	3	1	1	0	5
Distance to water source	20m	10m	15m	10m	55m
No of burrows found in trees	1	1	0	0	2
Onipaanu community forest	**Location 1**	**Location 2**	**Location 3**	**Location 4**	**Total**
No of Dead wood around	2	2	4	0	8
No of Termite hill found	0	1	1	2	4
Distance to water source	10m	15m	30m	10m	65m
No of burrows found in trees	2	0	1	1	4

Source: Authors.

T**able 5.** Food the animals feeds on-feeding preference.

No	Food
1	Termites from the Termite Hill
2	Ant and other insects

Source: Authors.

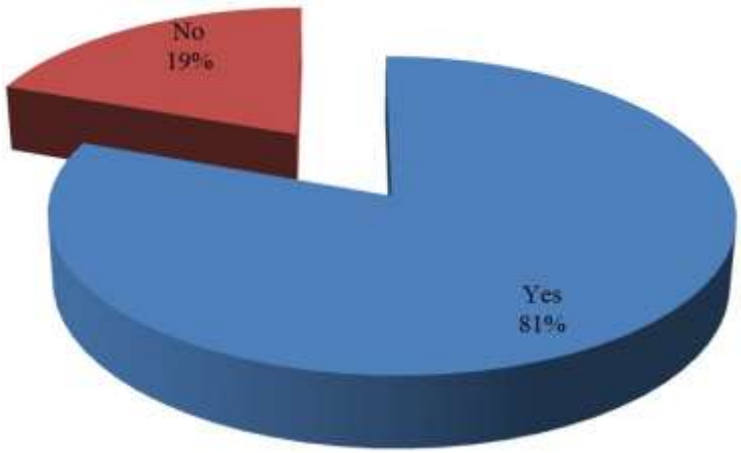

Figure 3. If ever killed Pangolin.
Source: Authors.

Mode of feeding of pangolin in the study areas

Some of the animals feed on termites and ants since termite hills were found in different locations across the study areas. All the hunters that were interacted with explained that the animal feed on insects on palm trees and other woody tree species. The animals are often said to be abundant mostly during the rainy season, maybe due to sufficient food and proximity to the water source. The presence of termite mounds and anthills within the preferred habitat of pangolins in the Ala Forest Reserve and Onipaanu Community Forest is due to their feeding preferences (Table 5).

Hunting practise and traditional significance of pangolin

The study shows that 81% of the respondents have killed pangolin before (Figure 3), while 82% of the respondents

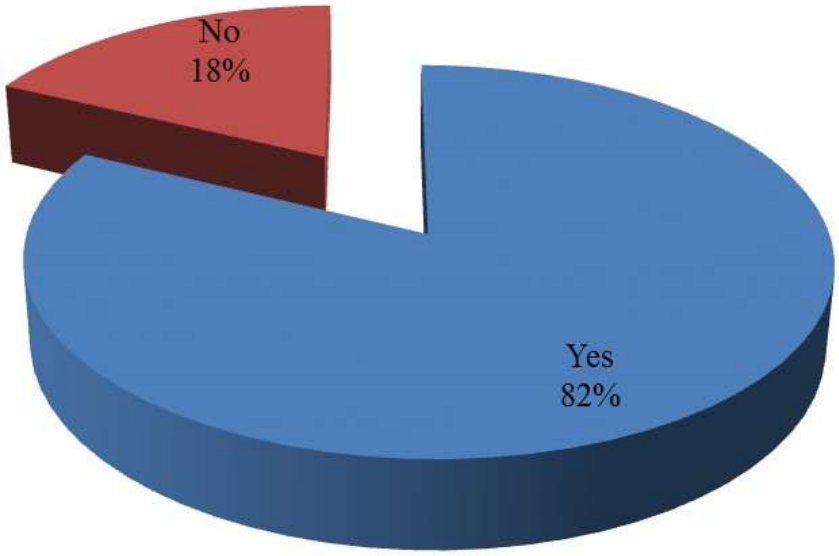

Figure 4. If ever eaten pangolin meat.
Source: Authors.

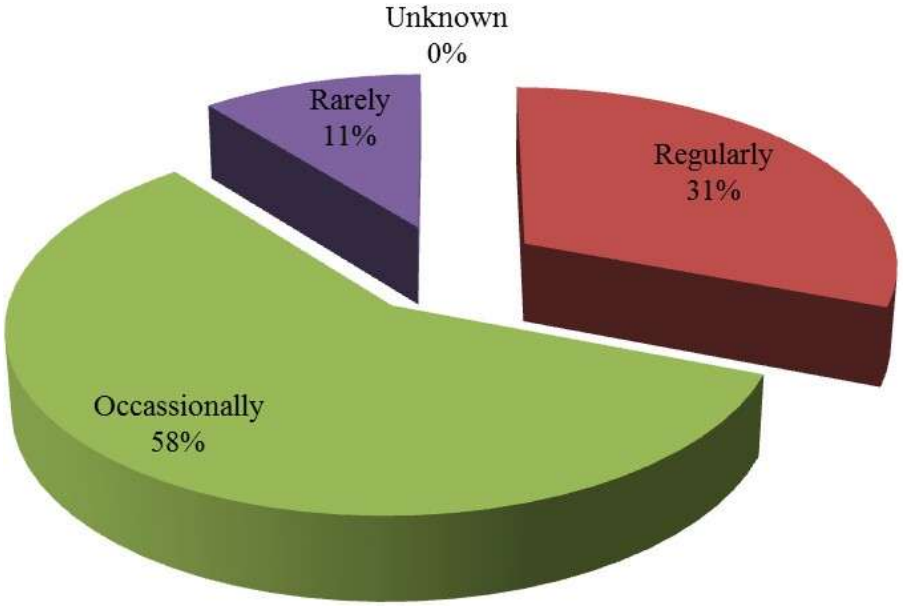

Figure 5. Frequency of hunting pangolin.
Source: Authors.

have eaten pangolin meat before (Figure 4). Furthermore, 58% of the respondents occasionally hunt for pangolin in the study areas, while 31 and 11% of the respondents regularly and rarely hunt for pangolin, respectively (Figure 5). The main reason for hunting for pangolin is for meat (74%), while 22% hunt for pangolin for trade purposes (Figure 6). The study shows that 60.5% of the respondents set traps to catch the animal, while 18.5% hunt for pangolin by finding their burrows, 11.3% make use of hunting dogs to hunt for pangolin (Figure 7).

DISCUSSION

Findings from this study reveal that *P. tetradactyla* also

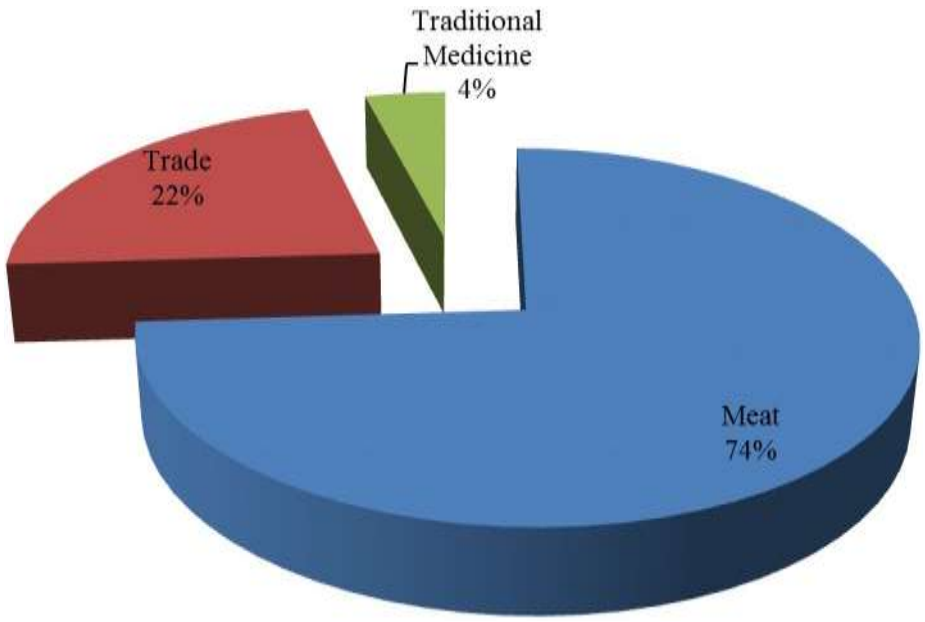

Figure 6. Reasons for hunting pangolin.
Source: Authors.

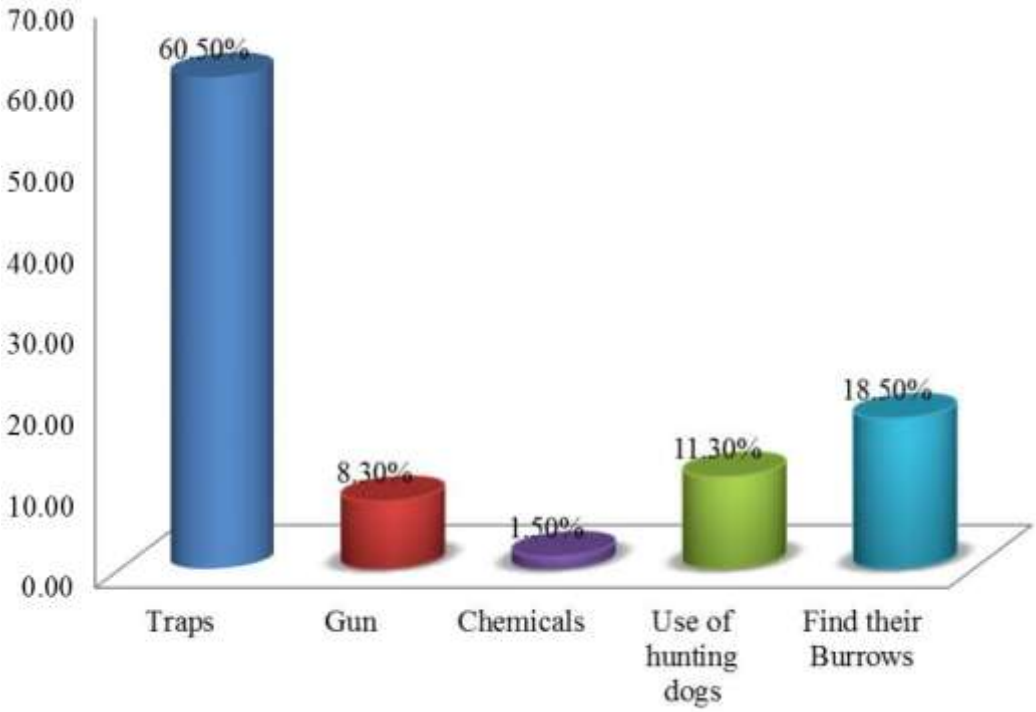

Figure 7. Techniques for hunting pangolin.
Source: Authors.

known as long-tailed was the most common pangolin species in the study areas. This supports the findings of Oguntuase and Oni (2018) who reported that *P. tetradactyla* is one of the two (2) pangolin species found

in Ondo State. This further supports the previous distribution of pangolin species in Africa with the total exclusion of giant pangolin and Temminck's pangolin from Nigeria, and the forest habitat preference of the *Phataginus* species. Findings from this study show that there were various woody tree species found in the study areas. The arrangement of vegetation influences the distribution of fauna species. The woody plants recorded in the pangolin habitat were supported by the findings of Odewumi and Ogunsina (2018) and were also among the important woody species recorded by Ogunjemite et al. (2012) in Old Oyo National Park. The habitat characteristics of the study areas are in tandem with the description of Maurice et al. (2019) that pangolin was present in various woodland and forest habitat types. Palm trees and some woody species were important to the distribution and presence of pangolin in the study areas because ants and termites are always found on the tree which provides food for the pangolin. The results of the study, therefore, supported the view of Odewumi and Ogunsina (2018) and Peteirson et al. (2014) that vegetation structure and plant diversity strongly influenced the distribution of pangolins in their habitats.

Deadwood was more common than termite hills in areas where pangolin activities (feeding) were sighted. This is because ants and insect larvae are more commonly found in dead woods. This is in accordance with the statement by Mahmood et al. (2013) and Peiterson et al. (2014) that pangolins are terrestrial animals that lived inside woody plant holes, piles of plant debris, earthen burrows, and caves so their distributions are bound to be influenced by plant species that formed their primary habitat. Also, it was observed that a higher percentage of pangolins signs were sighted not far from the water source (River). This agrees with Odewumi and Ogunsina (2018) and Challender et al. (2015) that *M. tetradactyla* were never far from permanent water and water courses as they were also known to inhabit older or abandoned tree plantations. Species richness of termites was significantly higher in a natural forest than in the oil palm plantations (Attingnon et al., 2005).

The use of trap as a traditional method of hunting by a majority of the hunters is a serious concern since it makes it very difficult to control the rate of harvesting or killing this animal in the wild. The uncontrolled use of traditional means of hunting in Africa makes the rate of harvest of wildlife resources surpass production (Fa et al., 2006). This is similar to the observation reported by Mohapatra et al. (2015) on the reasons for the use of pangolin body parts in India. The period and time of hunting this animal also vary depending on the occasion demand for instance during a festive period or regularly. The main reason for hunting the animal is for meat to meet the protein intake of the people. Lee et al. (2020) reported that rural people rely heavily on wild meat as a source of income and food and these had led to widespread unsustainable exploitation, harvesting and consumption of wildlife-based resources. In Nigeria, it is an important source of protein, widely consumed in both rural and urban areas (Soewu and Ayodele, 2009). Other reasons include hunting for subsistence (Soewu et al., 2012) and medicinal purposes (Soewu and Adekanola, 2011). In addition to all these, Oni et al. (2020) opined that conservation of pangolin could enhance ecosystem balance, promote tourism and sustainability. There are indications that the presence of *P. tetradactyla* also known as long-tailed has been established as the most common pangolin species in the study areas. This species of pangolin preferred forest habitat with characteristic features as observed in this study collaborated with findings from the literature. The diversity of woody tree species, vegetation structure and arrangement largely influence the distribution pattern of pangolin. The feeding pattern of pangolin also influences their distribution this explains the reason why this species of animal is commonly found on dead woods where ants and insect larvae are in abundance. Availability of water is also a very important factor to be considered in habitat type. The traditional method of hunting, hunting for bushmeat, source of income, medicinal purposes and other forms of traditional use are serious threats to the conservation of pangolin in the study area.

Conclusion

The presence of *P. tetradactyla* also known as long-tailed in the study area has been established as the most common pangolin species. This is largely due to the availability of diverse species of woody plants that provided suitable habitat for this species of animal and survival of ants and termites that serve as food for the pangolin. Deadwood plant holes, earthen burrow and caves as observed during the study equally formed primary habitat for the pangolin. Availability of water body is a very important features that influence the distribution of pangolin across the study area since the animal was sighted not far from the water source. Although the Percentage presence of the animal was established in abandoned oil plantation; however, species richness of termites was significantly higher in a natural forest. The uncontrolled method of hunting through the use of trap as observed in the study area is considered to be unsustainable and a serious threat to the population of the pangolin in the area of study. Various reasons were adjudged for the increasing hunting for the animal including source of food, meat or protein substitute, source of income, medicine while conservation for posterity, ecotourism is preferable. In-depth understanding based on the information provided on the ecology, traditional uses, subsistence and market values of pangolin as presented in this study is considered very important towards achieving sustainable conservation of this species of animal in the

sub-tropical rain forest belt of Africa.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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