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Activity budget and distribution pattern modeling of red river hog [*Potamochoerus porcus* (Linnaeus 1758)] in the Gnanhouizounme community forest in South-Eastern Bénin

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Abstract

Known to have a great economic and ecological importance, the Red river hog is involved in several ecological processes and has also a good zootechnical potential. In Gnanhouizounme community forest, the activity budget of the Red river hog was established and its distribution was modelled. Hence, the photographic trapping method was used to collect its activities from March 2016 to September 2018. A generalized linear Poisson family model and correspondence analysis were used to determine the factors predicting abundance and the most activity during catching hours. A multinomial logistic model was used to assess the relationships between activities and seasons, undergrowth distribution structure, temperature, pressure and group composition. The species distribution was completely random in the forest, as well as to water points, 1 m and 40 m and aggregated when 40 m away from them. At the end of the large rainy season, the adult female vigilance increased than in large dry season where they carried out more of the digging the ground with its snout. Temperature, social behaviour, distance from the camera to the water and bare soils predicted their abundance. It is essential to put the other forest patches under integral protection, study its diet, control its migration corridors and develop a breeding program.

Key words: suids, pattern distribution, feeding, ethology, conservation

Budget d'activité et modélisation de la structure de la distribution du *Potamochoerus porcus* (Linnaeus 1758), dans la forêt communautaire de Gnanhouizounmè au sud-est du Bénin

Résumé

Connu pour avoir une grande importance économique, le potamochère roux est impliqué dans plusieurs processus écologiques et a également un bon potentiel zootechnique. Dans la forêt communautaire de Gnanhouizounmè, le budget d'activité du potamochère a été établi et sa structure de distribution a été modélisée. Ainsi, la méthode de piégeage photographique a été utilisée pour collecter ses activités de mars 2016 à septembre 2018. Un modèle linéaire généralisé de la famille de Poisson et une analyse des correspondances ont été utilisés pour déterminer les facteurs prédisant l'abondance et la plus grande activité pendant les heures de capture. Un modèle logistique multinomial a été utilisé pour évaluer les relations entre les activités et les saisons, la structure de distribution du sous-bois, la température, la pression et la composition des groupes. La distribution des espèces était complètement aléatoire dans la forêt, ainsi qu'aux points d'eau, à 1 m et 40 m et s'agrégeait en s'éloignant de 40 m. A la fin de la grande saison des pluies, les femelles adultes ont été beaucoup plus vigilantes que durant grande saison sèche où les potamochères roux creusaient et fouillaient le sol avec leurs museaux. La température, le comportement social, la distance entre la caméra et l'eau et les sols nus prédisaient leur abondance. Il est essentiel de mettre les autres fragments de forêt sous protection intégrale, d'étudier son régime alimentaire, de contrôler ses couloirs de migration et de développer un programme d'élevage autour du potamochère roux.

Mots clés : suidés, répartition des motifs, alimentation, éthologie, conservation.

Introduction

Habitat loss and overexploitation are known to be responsible for the great loss observed in biodiversity (Baldus, 2008). According to Cantú-Salazar and Gaston (2010), efforts to create protected areas appear to be a good alternative to better contain this lastingly biodiversity erosion. Unfortunately, these

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protected areas' management continues to suffer from numerous dysfunctions despite all the efforts made. From all the components of global biodiversity, Africa is the house of an impressive wealth of flora and fauna, ranging from individual species (elephant, rhinoceros, hippopotamus, giraffe and gorillas) to endemic habitats (hotspots) (Muzalami, 2007). Protected areas in Africa and Benin especially provide enough ecosystem services since their intrinsic values have been conserved according to basic sociocultural standards. For a long period, non-protected areas in Benin have not been taken into account (Amoussou *et al.,* 2006) in the implementation of sectoral management plans and annual work plans by the forest authorities. This situation makes them more vulnerable to threats, hence the creation of community areas. In the Bonou township located in south-Benin, the Gnanhouizounme community forest is an integral part of these reserves. Indeed, it is one of the few remaining dense forest ecosystems in the Dahomey-Gap southern Benin where the presence of endangered and endemic species is noted (ODDB, 2014).

The red river hog presence had been documented there (DGFRN, 2011; ODDB, 2017) but very few studies investigate their behavioural ecology and feeding ecology. The red river hog is besides one of the prolific wild pigs with several assets usable in the Benin game ranching programs (Codjia *et al.,* 2020). It is a vulnerable species of tropical and gallery forest but can also be found in other ecosystems such as dry forests, wooded savannahs and cultivated areas, closer to tropical rainforests (Leus and Vercammen, 2013). Today, there is a real need for information on the ethology, biology and conservation (Conway, 2013) of several animal species including the red river hog. Used in several other works in Africa, the photographic trapping method has been successfully used to study mammals (Nguelet *et al.*, 2016). This method, which makes use of new technologies, is seen as a good alternative, especially for species with nocturnal and discrete modes (Garteh, 2014 ; Ouattara *et al.*, 2019). It was used in this study which aims to model the pattern distribution and analyse the red river hog budget activity (*Potamochoerus porcus*) in the Gnanhouizounme community forest. Different factors predicting this species distribution were assessed. Red river hogs are only stochastically distributed in the Gnanhouizounme community forest. There is a large variation in the daily activities carried out by the red river hog depending on the day's period. There is no specific relationship between the alignment type, the environmental conditions, the size and composition of the groups when carrying out the main activities like feeding, travelling or resting. Apart from temperature, other meso variables contribute to the red river hog abundance determinism. We will try to answer these four hypotheses through this study results.

Geographical Location

The Gnanhouizoun community forest is located in the village Gnanhouizounmè in the district of Dame-Wogon in Bonou Township. Kassiagbonou forest patch is located in the Oueme Department between 6°54' 62" and 6°54' 37" North latitude and between 2°24' 17" and 2°23' 57" East longitude (Figure 1). It is bounded to the north by the Ouinhi Township, to the south by Adjohoun, to the east by the Sakete and Adja-Ouere township and to the west by those of Ze and Zogbodomey. It has an area of 250 km² and a population of 44,349 inhabitants spread over five districts and twenty-eight villages (INSAE, 2015).

The Gnanhouizoun community forest is consisted of 2 forest patches (Mairie de Bonou, 2019): Zindji (6 ha 24 a 26 ca) and Kassiagbonou (20 ha 46 a 32 ca). One hundred ha additional land were obtained in 2020 for the extension of the community protected areas (Houngbedji Mariano Gboja, personal communication). Our study focuses on Kassiagbonou forest patch (Figure 1). The climate of the study area is sub-equatorial with two rainy seasons, April-July (large) and October-November (ASECNA, 2016). The dry season extends from August-September (small) and December-March (large) with an annual rainfall average included between 900 and 1,500 mm. The annual average temperature is between 25 and 30 °C. It is a relic of dense humid semi-deciduous forest on vertisol where countless animals and plant species can be found (DGFRN, 2011). The two forest patches are under a community-led biodiversity conservation program since 2009 and conservation actions are still ongoing (Houngbedji Mariano Gboja, personal communication).

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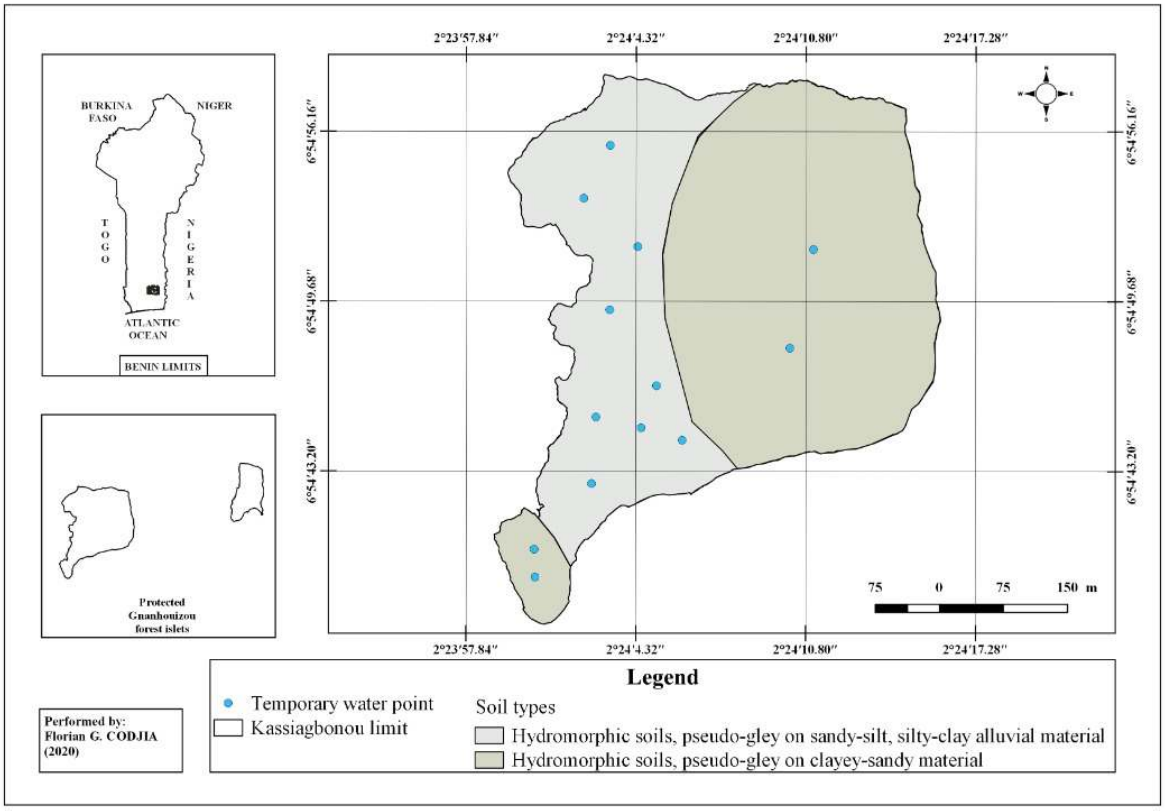

Figure 1. Study area

Materials and Methods

The biological material on which this study will focus was the red river hogs (*Potamochoerus porcus* (Linnaeus 1758)) found in the Gnanhouizounme community forest, southern Benin.

Data collection

The ''*Organisation pour le Développement Durable et la Biodiversité* (ODDB)'' 2016-2018 camera trap database was used based on a data-operating agreement. A total of twelve Bushnell (8 megapixel), Maginon and Medion (12 megapixel each) digital infrared cameras were used on thirty-seven stations in this study. These devices incorporate motion sensor or infrared detectors were remotely activated when an animal passed in front of their sensors (Lima, 2018). The different cameras were installed randomly during seven missions with local guides over the extent of the Gnanhouizoun community protected area (Figure 2). The camera installation periods were March to May for 2016, February to December for 2017, and February to September for 2018. The cameras were set approximately 30-45 cm from the ground at the trees base (Amin *et al.*, 2017) and pointed towards a target areas 4-8 m forward (perpendicular to the circuit). They were set up to operate 24 hours a day to capture animal photos and videos as well as to record any other environmental variables (temperature, pressure, etc.) following any movement. The cameras coordinates were recorded using the GPS (Global Positioning System) with an accuracy of ±5 m. As one species was targeted in this study, only data related to the red river hog were extracted from the database. For each useful photo, the activity carried out, type of formation, dispersal pattern in the undergrowth, dates with seasons (Pyšková *et al.,* 2018), size and composition of the red river hog group were recorded. Vegetation overlay, habitat type, soil type, all considered here as covariates were measured in order to establish possible relationships between the habitats used and human actions. Also, the distances from the camera to the agglomeration, fields, water point, bare soil and swamp were measured. For these measured distances, the coordinates of the cameras trap were used. These different points were integrated into the Qgis 2.18.9 software and the *nnjoin* extension using the Euclidean distance method resulted in the smallest distance (Codjia, 2018).

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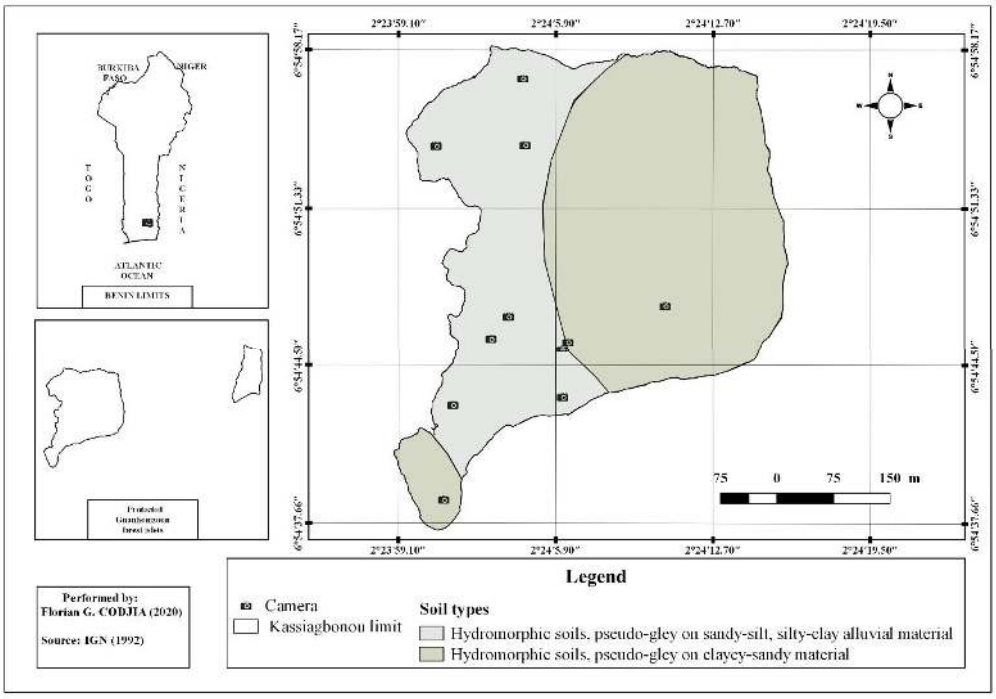

Figure 2. Camera trap locations in Kassiagbonou patch of Gnanhouizounme community forest

Data analysis

To study the pattern distribution, the geographical coordinates of species occurrence based on the camera traps detection were used. To see if this distribution was correlated with water points, an analysis of the red river hogs distribution in relation to water points with their corresponding geographical position was carried out. These data were analysed using the empirical K function (Venables and Ripley, 2002) of *spatstat* package (Baddeley *et al.,* 2020). About activity budget, the individuals' number observed during each hour for 24 hours was exploited and analysed using the clock.plot function. In addition, a correspondence analysis allowed us to see at the red river hog capture hours, the activities most performed using the CA function of the *FactoMineR* package. To see the ecological (social behaviour, seasons, habitats, undergrowth distribution structure, temperature, herd composition, activities) and anthropo-environmental factors (distance from the camera to agglomeration, camera to water, camera to bare soil, camera to field, camera to swamps and soil type) likely to influence the species abundance, a generalized Poisson family linear model was done. This analysis had already been carried out separately as we were faced with two categories of data from different sources (collected from camera data and the other by cartographic estimation methods) and not having the same repetition modalities. The stepAIC function of the *MASS* package allowed to make the variable selection. The links between activities and seasons, undergrowth distribution structure, temperature and herd composition were studied using a multinomial logistic model with the *net stargazer* package. Another generalized Poisson family linear model was done on the environmental factors and the step AIC function allowed to make the variable selection

Results

Red river hogs' distribution pattern

The red river hogs distribution analysis indicated that the estimated empirical K function (shown as a solid black line) was below of the confidence interval upper limit as shown in Figure 3b. Thus, the red river hogs distribution was completely random in the Gnanhouizounme community forest (Figure 3a). The same applied in relation to the temporary water points at 1 m and 40 m (Figure 3d) and aggregated when 40 m away from them (Figure 3d).

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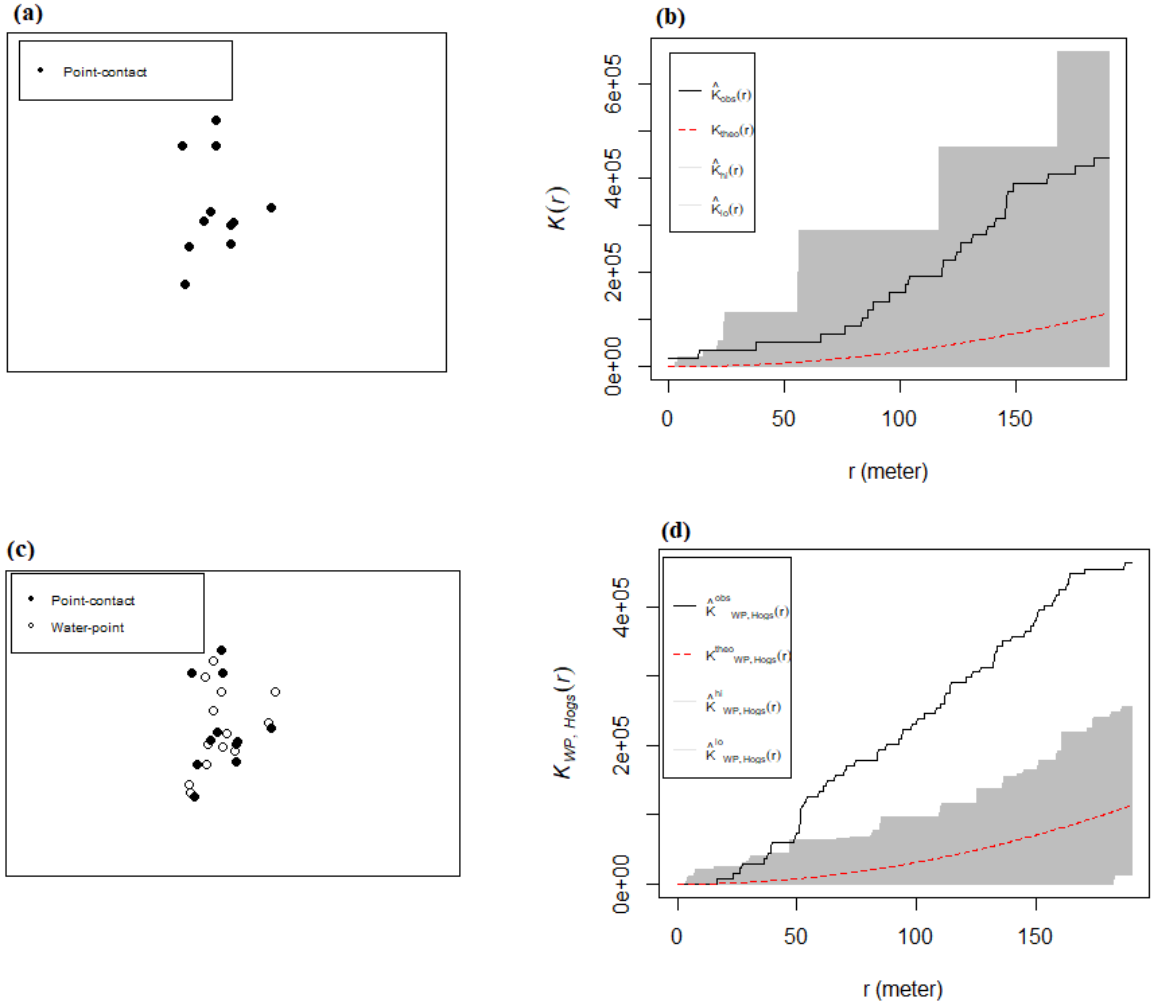

Figure 3. **Red river hogs distribution in the Gnanhouizounme Forest (a); Red river hogs distribution pattern in the Gnanhouizounme Forest (b); Distribution in relation to water points in the Gnanhouizounme Forest (c) and Red river hogs distribution pattern in relation to water points in the rainy season in the Gnanhouizounme Forest (d).**

Red river hogs activity budget

The data had shown that the red river hog was a nocturnal species (Figure 4). They were active between 6 p.m. and 6 a.m. (Figure 5) and the peak of their activities was between 7 p.m. and 8 p.m. and between 5 a.m. and 6 a.m. (Figure 4).

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Figure 4. **Red river hogs activity budget in the Gnanhouizounme community forest**

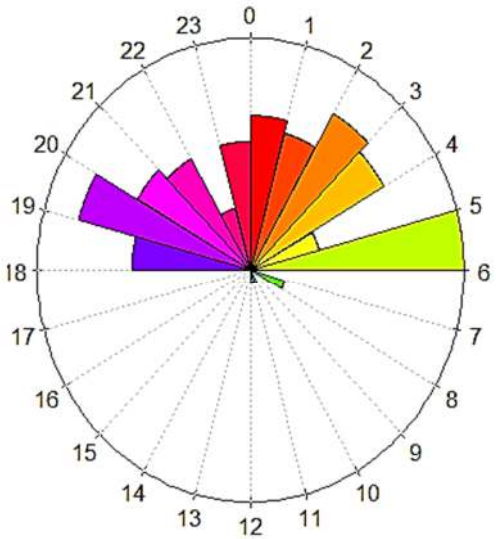

Figure 5. **Kassiagbonou patch in Gnanhouizounme Forest, (a): cracking pods and/or nuts with a juvenile individual; (b; c): females and offspring crossing temporary water pool during the large rainy season; (d): digging the ground with its snout**

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Activities and work hours

Correspondence analysis showed that 51.88% of the factors variability was summarized on the two main axes (Table 1). The projection of the variables modalities was respectively presented in Figure 6. From midnight to 3 a.m., 4 to 6 a.m., 7 to 8 a.m., 10 a.m. to midday and 9 p.m. to midnight, the most common activities were respectively digging the ground with its snout, chewing elements from the soil excavation, female vigilance adult, socialization and fighting over food, cracking pods and/or nuts. Between 7 and 8 p.m., it was the departure for the pasture and the sniff out odours with care. From 6 to 7 p.m., 8 to 9 p.m. and 3 to 4 a.m., they searched the water surface by crossing it.

Table 1. Eigenvalues, variability percent, cumulative variability percent explained by the factor axes

Axes	Eigenvalue	Percentage of variance	Cumulative percentage of variance
dim 1	0.53579423	31.236711	31.23671
dim 2	0.35408745	20.643237	51.87995
dim 3	0.23739648	13.840174	65.72012
dim 4	0.21618693	12.603661	78.32378
dim 5	0.17433124	10.163481	88.48726
dim 6	0.09671498	5.638467	94.12573
dim 7	0.07262755	4.234173	98.35990
dim 8	0.02813207	1.640095	100.00000

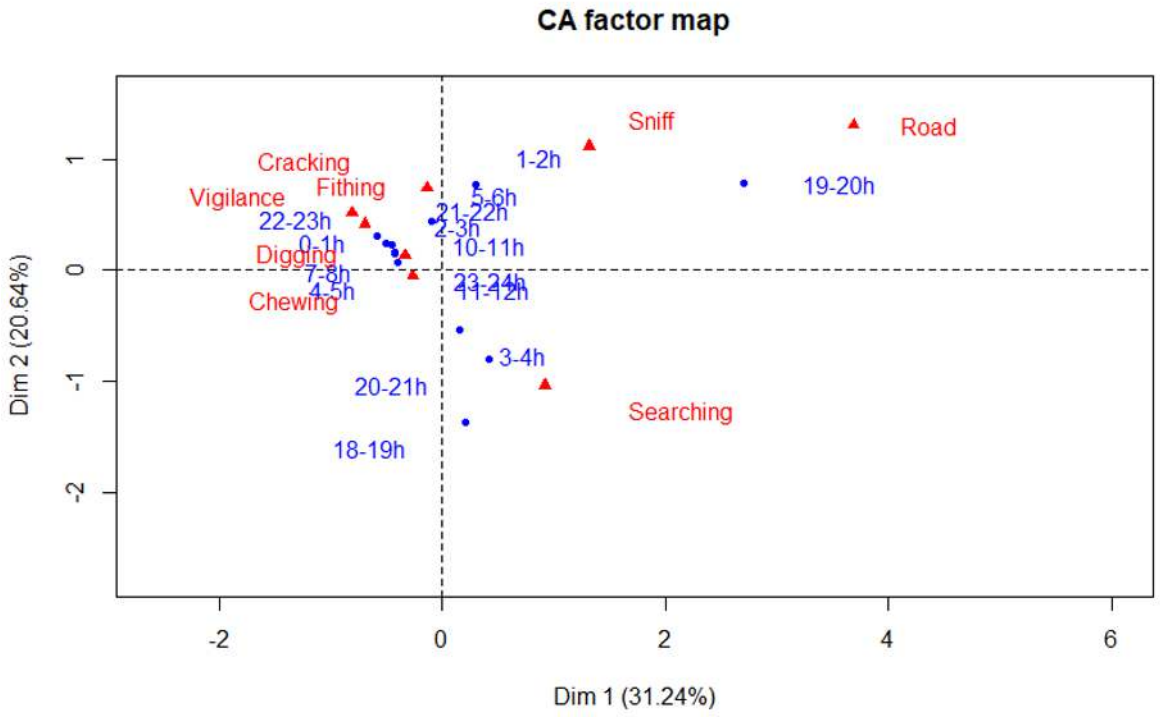

Figure 6. Projection of quantitative variables

Link between activity and saisons, undergrowth distribution structure, temperature, pressure and group composition

When the temperature increased by one unit, the red river hogs performed more adult female vigilance, socialization and fighting over food, searching the surface of the water by crossing it than chewing elements from the soil excavation (Table 2). When the red river hogs' herd was made up of adult and juvenile, they performed more searching the surface of the water by crossing it than when they were just adults. But when the herd was made up of adults and subadult, they did more adult female vigilance

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than when they were just adults. When the red river hogs having fun and fighting over food than chewing elements from the soil excavation, they followed each other one by one. Red river hogs achieved more adult female vigilance when they followed each other in line with the sub-adult individuals in the centre. Also when they were dispersed in the custody of an adult individual, they did much more search the water surface by crossing it. At the end of the large dry season, the animals did much more digging the ground with their snout than chewing elements from the soil excavation. Also at the end of the large rainy season the animals did much more adult female vigilance when the large rainy season had begun.

Table 2. Result of logistic multinomial model

Variables	Digging	Fighting	Searching	Vigilance
SaisonsEnd_LDS	-149.124***	108.145***	305.256	136.046***
SaisonsEnd_LRS	-1361.276***	2185.019***	-1458.922***	5926.805***
SaisonsEnd_SDS	5610.029***	-1690.082***	1854.985***	-2063.709***
SaisonsLDS	-3323.647***	-1347.913***	-1448.845***	-5035.552***
SaisonsLRS	0.000	0.000	0.000	0.000
SaisonsSRS	0.000	0.000	0.000	0.000
UndergrowthDisp_CV_Adlt	-3462.513***	6961.836***	140.118***	-1161.515***
UndergrowthFwd_Juv_AP	-7682.840***	-2670.746***	743.066***	-2219.471***
UndergrowthFwd_Line	-520.917***	179.182***	285.957***	189.447***
UndergrowthFwd_Sub_Ctr	203.941***	145.297***	606.057***	226.903***
C	-3141.421***	1123.890***	194.268	3546.357***
Fa	1177.808***	-405.277***	-112.484**	-1218.539***
BunchAJ	-8008.941***	-998.303***	4130.319***	-1740.255***
BunchAS	-9356.135***	2517.970***	-1943.229***	2793.857***

*** : p<0.1; ** : p<0.05; *** : p<0.01**

Description: End_LDS = End Large Dry Season; End_LRS = End Large Rainy Season; End_SDS = End Small Dry Season; LDS = Large Dry Season; LRS = Large Rainy Season; SRS= Small Rainy Season; Disp_CV_Adlt = Disperse under the care and vigilance of the adult individual; Fwd_Juv_AP = Followed one after the other in line with the juveniles attached to a close adult or progenitor; Fwd_Line = Followed one after the other in line; Fwd_Sub_Ctr = Followed one after the other in line with the sub-adults in the centre; AJ = Adult-Juvenile; AS = Adult-Sub adult.

Factors predicting the red river hogs abundance

The variable selection made by the backward method showed that only the variable temperature, social behaviour among ecological factors, the distance from the camera to the water and the distance from the camera to the bare soil from anthropo-environmental factors explain the red river hog abundance (Table 3 and Table 4). When the temperature increased by one unit, the average number of red river hogs increased by 0.24 (=exp(0.08914)). When red river hogs were not close to the herd or to a lesser extent lone, the smaller individual there was in the herds not far from them. When the distance from the water to the camera increased by one unit, the average red river hogs number decreased by 1.30 10^{-4}.

Table 3. Results of the generalized Poisson linear model on ecological factors influencing species abundance

Parameters	Estimate	Std.Error	Zvalue	Pr(>|z|)
(Intercept)	-0.63715	1.23019	-0.518	0.604512
Social_BehaviorNt_Clse_Hrd	-1.58183	0.45772	-3.456	0.000549
Temperature	0.08914	0.05024	1.774	0.076005

Description: Nt_Clse_Hrd = Not close to the herd and/or solitary.

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Table 4. Results of the generalized Poisson linear model on anthropo-environmental factors influencing species abundance

Parameters	Estimate	Std.Error	Zvalue	Pr(>|z|)
(Intercept)	2.263e+00	2.189e-01	10.339	< 0.0001
Dist_Wt	-1.340e-04	3.898e-05	-3.439	0.000585
Dist_SN	-1.811e-05	9.026e-06	-2.006	0.044832

Description: Dist_Wt = Distance from the camera to the water ; Dist_SN = Distance from the camera to the bare soil.

Discussion

Distribution pattern and factors influencing the red river hogs' abundance

The results of this study show that the red river hogs' distribution in Gnanhouizounme community forest is random and then aggregates beyond 40 m from the temporary water points left after the rainy season. This situation can be intrinsically tied to the wide species trophic spectrum range. Codjia *et al.* (2021) showed that in addition to cultivated plant species (*Manihot esculenta*, *Elaeis guineensis* Jacq., *Zea mays* L., *Dioscorea praehensilis* and *Dioscorea sagittifolia* Pax), red river hog eats some animal species (*Archachatina spp*, earthworms, *Cardiosoma spp*, carcasses of *Tragelaphus spekii*, raptors). Twelve percent of fruit species are involved in the red river hog diet in southern Benin. It is therefore clear that this species has an omnivorous diet as translated in the work of Cerling and Viehl (2004); Clauss *et al.* (2008a); Clauss *et al.* (2008b). The non-uniformity in distribution can also be explained with the red river hog distribution that is not only function of abiotic factors (climatic, edaphic), but can also refer to anthropogenic factors, predation, mutualism, cooperation (Winterbach *et al.,* 2013), intra-group competition (de Oliveira and Pereira, 2013). It is why this study results show that out of the 15 ecological, anthropo-environmental parameters considered, only temperature, social behaviour, distance from the camera to water and distance from the camera to bare soil influenced the red river hogs abundance. The work of Rich *et al.* (2017) showed that just like spatial occupation, the prey availability and food species are determining factors in our tropical forest habitats.

In fact, most wild ungulates are more likely to congregate in places where they are in good condition to ensure their daily food supply, their own survival and thus live far from any quietness that can threaten their existence in the population. We know in Kassiagbonou, there is not any permanent water point. Some are created during the rainy season as parts of the forest is temporarily inundated. This forest red river hogs have a random distribution in relation to the temporary water points in 1 m and 40 m and aggregated when 40 m away from them. This again explains why the red river hog is an omnivorous guild mammal (Klop and Van-Goethem, 2008) and at the same time are quite dependent on water from which it likes wetlands helping it to better dig the ground, wallow in mud (Houehounha, 2011) to ensure thermoregulation (Kimmel, 1998), take refuge in resting and breeding lodges. It will be good to think about the creation of some artificial ponds in this forest. The work of Morgan (2007) has shown that when habitat conditions are suitable, the red river hogs are used to aggregate in large herds demonstrating in our case that quite good conditions are offered to them beyond 40 m from these temporary water points. The basic and feeding ecology (Codjia *et al.,* 2020) are therefore quite essential in explaining the temporal and spatial distribution bringing more elements to have a higher red river hogs detection probability. From all above, red river hogs are not only stochastically distributed in the Gnanhouizounme community forest. Nowadays, the distribution analysis requires the consideration of certain factors (Codjia, 2018) playing an essential role in the species' population survival. In this context, Rabeil (2003); Biffi *et al.* (2016) think that it is essential to highlight the environmental distribution factors specific to each species, to relate these factors to the species' behaviour and anthropogenic (Michez, 2005). In this study, the distance from the camera to water, camera to bare soil, temperature and social behaviour influence the red river hogs abundance in the Gnanhouizounme community forest. Red river hogs, unlike common warthogs, cannot live several days without water consumption (Le-Glaunec, 2006). It thus occupies different biotopes and its habitat remains conditioned by water presence (Vercammen *et al.,* 1993) and it is therefore not surprising that swampy areas and riverbanks remain its favourite habitat (Houehounha, 2011). This leads the red river hog to stay in these forest habitats that are close to water at every season. This can also contribute to the nature of the different life forms involved in the diet of this species and highlights several hypotheses. Already that Geophytes were one of the most involved life forms in the red river hog feeding in southern Benin (Codjia *et al.*, 2021), there can be a close relationship between the distribution of these consumed life forms and the red river hog.

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Bare soil, referring to the exposed soil without plants or building coverage on the Earth's surface (Li et al., 2017, Rasul et al., 2018). Since red river hogs are known to wallow in mud to protect themselves from high temperatures, parasites and insects (Houehounha, 2011), these bare soils are therefore of high importance for the red river hogs, especially during the early wet and dry seasons but also during the large rainy season. Hence the bare soil's proximity is favourable to red river hogs even if the high percentage of this land cover class in the ecosystems is not desirable enough because it highlights habitat fragmentation. Like bushpigs, *Potamochoerus larvatus* (Jori and Bastos, 2009), *Potamochoerus porcus* has a large tolerance for cold temperatures as a result, it can be observed at high elevation (Kingdon, 1997; Meijaard *et al.*, 2011) or medium. That's why the results of this study show that red river hogs carry out their activities from 6:00 p.m. to 6:00 a.m. It is therefore logic when the temperature rises by one unit and the average number of red river hogs increases by 0.24. As in the common warthog, intraspecific competition can occur when solitary individuals find themselves in the same areas wanting to use the same food and water resources (Le-Glaunec, 2006).

The separation of an individual from the parent population is not often favourable because it becomes more vulnerable to threats and provides enough effort (surveillance, vigilance, defence, etc.) on its own. In our situation the single red river hog individual captured by the cameras might not necessarily mean that it is lonely and that the rest of the group is far away, but if this is verified, this individual reduces to itself its survival probability. It will therefore not be able to perform all intrinsic activities and functions but will no longer be able to cope with threats from its immediate environment. Indeed, the capture rate associated with these alleged lonely individuals was very low, reducing abundance when social behaviour increased by one unit. This situation means that the capture probability of this lonely individual during similar and short periods of time in the Gnanhouizounme community forest will quite be low, as was the case. Apart from temperature, other meso variables contribute then to the red river hog abundance determinism.

Activity budget, link between activity and seasons, undergrowth distribution structure, temperature, pressure and bunch composition

Our results show that the red river hogs are primarily nocturnal within the Gnanhouizounme community forest. They are active from 6 p.m. to 6 a.m. and the observation peak frequency is between 7 and 8 p.m. and between 5 to 6 a.m. This nocturnal behaviour is characteristic of habitats where hunting pressure is high. Also the area where hunting is absent or highly controlled, red river hogs are very active during the day, so this is most likely the normal behaviour. Our results further show the implication of temperature in the red river hog's activities patterns. For instance, they appreciate the less hot periods of time hence having a large tolerance for cold temperatures (Meijaard *et al.,* 2011). That is why the red river hogs are captured in the Gnanhouizounme community forest during a period when the temperature is between 22 and 29°C. These red river hogs can adapt in other areas to exceed this optimum in situations of strong environment anthropisation. Since hunting in this forest is prohibited, there are no hunting activities in Kassigbonou. Hunting still occurs in non-protected forest patches in Gnanhouizounme but not in Zindji and Kassiagbonou. Indeed, Gnanhouizounme community forests is made up of 15 patch's forests of size varying between 1 and 40 ha among them Zindji and Kassiagbonou are the two protected forests. So, the animals move among protected and non-protected forest patches.

For sustainable conservation of the red river hog within Gnanhouizounme landscape, it's urgent to extend the protection to the remaining forest patches which are part of its home range. Kassiagbonou patches of forest must be a portion of the habitat used by the red river hog as their home range varies between 4 and 10 km^2 (Meijaard *et al.*, 2011). This is also the case of Houegoudo forest fragments in Ze Township (Atlantic Department of Benin) where red river hog hunting predominates (Codjia, *et al.,* in press) and according to the riparian people some species of individuals migrate to the Gnanhouizounme patch of forest during periods of high flooding. This migration is normal, as highlighted in the work of Leus and Vercammen (2013), it allows them, through variations in density to explore other habitats often in fruits searching. The peak frequency observed from 7 to 8 p.m. and 5 to 6 a.m. respectively are due to the red river hogs taking off to carry out daily activities and returning early before daybreak while chewing elements from the soil excavation. Thus, the main activities carried out in a 24-hour period are digging the ground with its snout, female vigilance adult, having fun and fighting over food, cracking pods and/or nuts, drinking and searching the water surface by crossing it, chewing elements from the soil excavation. From all above, there is a large variation in the daily activities carried out by the red river hog depending on the day's period. The hog's ability to participate in structuring (Beaune *et al.,* 2012) and dynamics of tropical forests (Stoner *et al.*, 2007) through seed dispersal (Seufert *et al.*, 2010) is still being verified in this study. The red river hog herd composition within this forest is shown in Figure 7.

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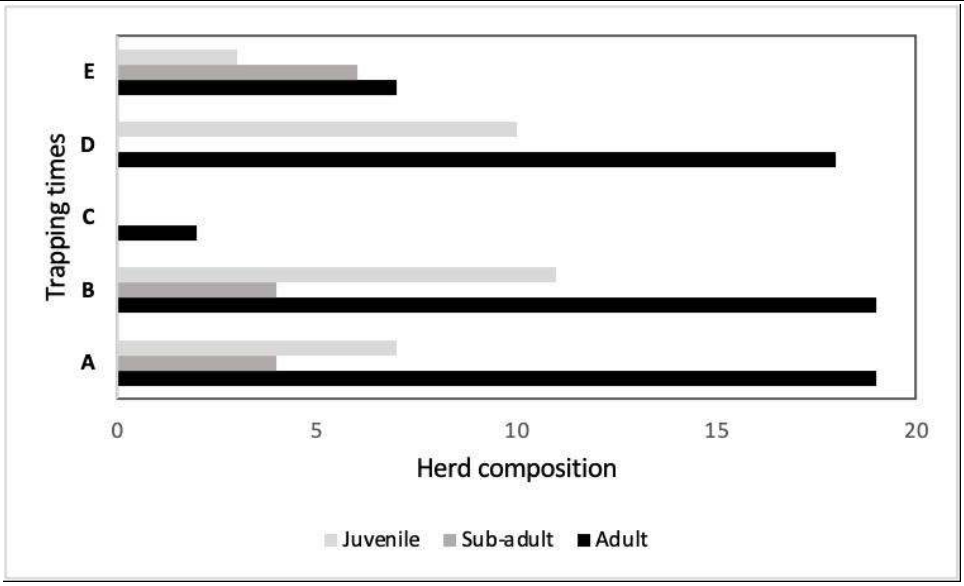

Caption: A = Midnight to (6 to 3 a.m.); B = 3 a.m. to (8 to 6 a.m.); C = 7a.m. to (19 to midday); D = 6 p.m. to (half past 8 p.m.); E = 9 p.m. to (24 four to midnight).

Figure 7. The herd composition of red river hog

A good recruitment level of new individuals and even recent offspring exist within their population. The near-total absence of subadults, juvenile individuals from 7 a.m. to (nineteen to midday) and then subadult from 6p.m. to (half past 8 p.m.) is nothing else due to the separation of some individuals from the herd faced with sudden noise, danger or other factors that make them temporarily lone. Furthermore, the typical herd composition observed in the work of Malbrant and Maclatchy (1949) and Leslie and Huffman (2015) are adult males, adult females, immature individuals of both sexes or recent offspring. However, as was the case in this study, lonely individuals can be observed and more rarely (Abernethy and White, 1999). We must have liked to go as far as the group's size to assess their densities according to the activities carried out in this forest compared to others in Africa, but the sampling method will be reviewed for this purpose in our future studies.

Only subadult individuals having fun and fighting over food under adults' supervision that are not necessarily their parents. When the red river hog group is made up of adults and juveniles, they perform more searching the surface of the water by crossing it than when they are just adults. But when they are made up of adults and subadult, they do more female adult vigilance than when they are just adults. This aspect therefore extends to the sub-adult individuals and not only to the group juveniles as translated in the work of White and Cameron (2009) remain in the adult females custody that are not their mothers but perform surveillance or guarding functions. That is why, with regard to their distribution in the undergrowth, when they are dispersed in the adult individual custody, they do much more search the water surface by crossing it but when they follow one another in line with the sub-adult individuals in the centre, the adult female vigilance.

The red river hog individuals' distribution in the undergrowth during the activities is also functioning of the spatial spread of the food resources eaten both on the ground and on the water surface. From this study, it was noted that at the end of the dry season the animal digging the ground with its snout is much more important than chewing elements from the soil excavation. In fact, during the dry season, some life forms of the plant species most consumed by the red river hog go through a bad period and therefore are forced to dig into the ground, this is the case of the geophytes. In this context, the red river hogs will make more effort to feed but also the soil will be hard for them to dig up earthworms. They will thus have to dig deeper to look for snails, crustaceans, rapacious, animals killed by bush fires and will consume surface products (fruits, etc.). Hunters know that the red river hogs abundance is high at the beginning and end of the rainy season, which means that these species will be more vigilant and will strengthen the surveillance level, as the results of this study have shown. There is then a specific relationship between the alignment type, the environmental conditions, the size and composition group when carrying out the main activities.

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Conclusion

The study can provide a broad overview of the red river hog's activity budget components while attempting to model its pattern distribution according to the water points presence. It appears that the red river hogs distribution in the Kassiagbonou fragment within the Gnanhouizounme community forest does not depend only on edaphic factors. Indeed, several other anthropic factors and those related to ecology but also to the seasonal food resources availability are explanatory of the spatial and temporal red river hog distribution. This means that it presents a random distribution in relation to the water points in 1 m and 40 m and an aggregated distribution when 40 m away from the water points. Despite the population growth effects and climate disturbances, the red river hog remains a nocturnal and discreet species because its activities budget is from 8 p.m. to 6 a.m. A few rare individuals are known to get away from the group or to be solitary reducing their survival chances. The season, the ambient temperature and the group composition most often influence the nature of the activities carried out and their alignment in the Kassiagbonou island undergrowth. Depending on the resources variation, these species often go beyond this island core limits and go to other unprotected areas of this forest to feed and benefit from another microclimate, which reduces their protection level from the various threats.

Since wildlife species seem to fluctuate their genes and in case of threats/resource variations migrate to the closest islands, in light of this study results, we suggest -i- to carry out a phyto-ecological characterization of the red river hog habitats, -ii- to study the red river hog diet through the barcoding or isotope approaches, -iii- to control red river hogs migration corridors, -iv- to set up a game ranching program around this species in the Gnanhouizounme community forest, -v- to organize an integral enumeration activity of this forest animal and floristic biodiversity with a particular emphasis on the red river hogs and -vi- to proceed with other islands integral protection (out of Kassiagbonou and Zindji), where there are also enough red river hog occurrence signs in order to increase their conservation chances.

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