

Impact of human activities on lizard species diversity in the department of Daloa (Central-western Côte d'Ivoire)

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Abstract

This study, conducted between April and June 2021 in eight (8) sampling transects in four secondary forests and four agricultural systems, highlighted the influence of human pressure on secondary forests and agricultural systems in the Department of Daloa on lizard diversity. Lizards were collected between 9:30 a.m. and 4:30 p.m. using a GPS, a hygrometer, a digital camera and a stick. Abiotic parameters (temperature, relative air humidity, canopy, ground litter cover, litter thickness, proportion of sunlight reaching the ground, tree density, and shrub density) were measured in situ at each sampling transect. The spatial variation in the measured abiotic parameters indicates that all these parameters varied significantly between the transects of conserved environments and agricultural systems. The inventory carried out identified 407 individuals of 10 species divided between 4 families and 5 genera. The Scincidae (4 species) and Geckonidae (3 species) families are the most diverse. Meanwhile, the Scincidae (225 individuals) and Agamidae (159 individuals) families are the most abundant. Species richness is higher in secondary forests (10 species) than in agricultural systems (6 species). *Agama africana*, *Agama agama*, *Hemidactylus angulatus*, *Hemidactylus muriceus*, *Mochlus fernandi* and *Trachylepis affinis* were found in both types of habitat. However, *Hemidactylus mabouia*, *Trachylepis quinquetaeniata*, *Trachylepis* sp. and *Varanus niloticus* were only observed in transects in conserved environments. The lizard community in conserved and anthropised environments in the Department of Daloa is less diverse and less stable and balanced. Furthermore, lizards are more diverse and less balanced in conserved environments.

Keywords: Diversity; Lizards; Secondary forest; Agricultural system; Human pressure; Department of Daloa.

1. Introduction

The rapid decline in biodiversity has become a proven phenomenon over the last decade, and one that is tending to accelerate [1]. The influence of environmental disturbances on biodiversity is now clearly recognised on a global scale [2]. Wetlands are veritable reservoirs of biodiversity that are threatened by climate change and the degradation and fragmentation of natural habitats due to human activities [3]. In order to assess the quality of habitats, ecosystems and the environment in general in a relevant way, it is essential to take an approach that considers different taxonomic

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groups with contrasting ecological needs [4]. Traditionally, emblematic species or species of hunting interest have been widely considered in the assessment and management of natural environments. However, other less emblematic groups such as lizards can provide additional information [5]. Lizards are excellent indicators of the ecological quality of environments and how they are managed at a local level [6]. They are particularly sensitive to management practices that affect the structure of their habitat and to climate change [7]. Furthermore, the lizards studied in this research are animals with low dispersal capabilities (rarely exceeding one kilometre) compared to other taxonomic groups, which also makes them highly sensitive to local disturbances. Indeed, following a disturbance to their habitat, it will be impossible for individuals to travel long distances to colonise new host environments [8]. Unfortunately, in Africa, there is a real lag in lizard monitoring methods. This leads to a critical lack of knowledge about the status of populations and their trends, which is essential for their conservation [9]. However, the information available on West African lizards remains fragmentary, as little work has been done in this area. In Côte d'Ivoire, the compilation of publications by [10] and [9] currently provides a list of 22 known lizard species. However, most of this research on lizards has been carried out in a few forest areas and savannah-forest transition zones in the country ([10] [9]). Thus, the overall objective of this study is to determine the influence of anthropogenic activities on the diversity of lizard species in the Daloa department. Specifically, the aim is (1) to characterise the abiotic environment of the ecosystems of the sampling transects selected in the secondary forests and agricultural systems of the Daloa department, (2) to study the composition and structure of lizard communities in conserved and anthropised environments in the Daloa Department, (3) and finally, to show the influence of the degree of human pressure on conserved and anthropised environments in the Daloa Department on the distribution of lizards.

2. Materials and Methods

2.1. Study environment

This study was conducted in the department of Daloa, located in the centre-west of Côte d'Ivoire, 141 km from Yamoussoukro and 383 km from Abidjan, between latitude 6°53 north and longitude 6°27 west [11]. It is bordered to the north by the department of Vavoua, to the south by the department of Issia, to the east by the department of Bouaflé and to the west by the department of Duékoué. To carry out this study, the criteria taken into account for the choice of transects were the four cardinal points of the department, accessibility, and preserved and anthropised environments (cocoa, coffee, cashew and rubber tree plantations, and maize, yam, cassava and rice fields). Applying these criteria resulted in the selection of eight sampling transects across all preserved and anthropised environments in the Daloa Department. These are four transects in preserved environments (T1, T3, T5 and T7) and four other transects in anthropised environments (T2, T4, T6 and T8) in the villages of Tapéguhé, Gonaté, Bribouo and Zakoua. Table 1 and Figure 1 present the overall characteristics of the sampling sites.

Table 1 Characteristics of sampling sites

Habitats	Ecosystems	Trans ects	Geographical location 29N UTM WGS-84		Altitud e (m)	Vegetati on cover	Habitat type	Sun exposu re	Degree of anthropisati on
			Longitude	Latitude					
Preserved	Secondary forests	T1	0780279	0770142	184	Woody	Dry	Low	Medium
		T3	0806897	0763484	193	Woody	Dry	Low	Medium
		T5	0775289	0760552	198	Woody	Dry	Low	Medium
		T7	0780763	0753046	187	Woody	Wet	Low	Low
Anthropis ed	Perennial crops	T2	0780665	0770385	196	Woody and herbaceo us	Dry	Medium	High
		T4	0753572	0713214	204	Woody and herbaceo us	Dry	Medium	High

		T6	0775660	0760380	233	Herbaceous	Dry	Medium	High
		T8	0781031	0752789	205	Herbaceous	Dry	Medium	High

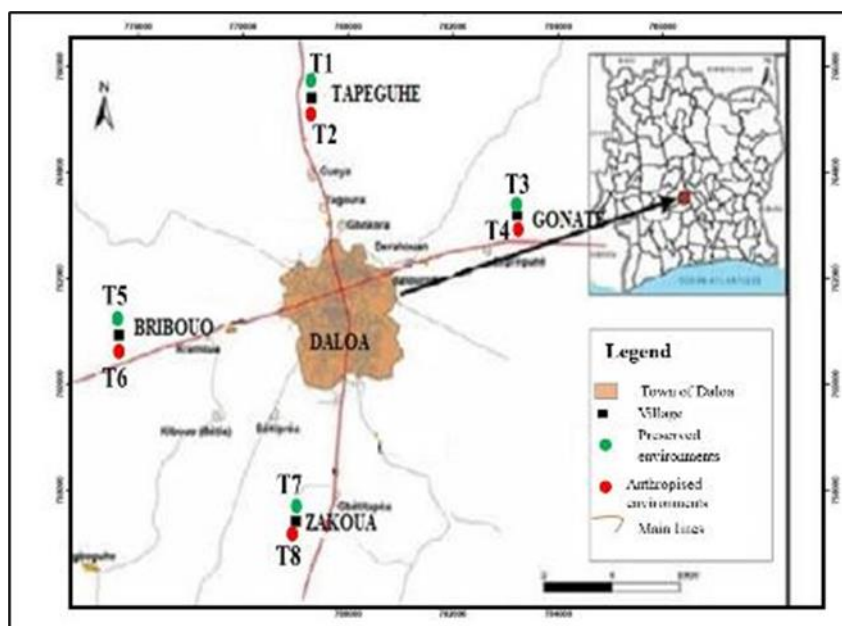


Figure 1 Presentation of the study area

2.2. Methods

2.2.1. Measurement of abiotic parameters in the study environments

This study, conducted in the department of Daloa, took place between April and June 2021 on a monthly basis. Physical data (air temperature and relative humidity) were recorded at the same time as biotic data. The physical parameters in each habitat and during each sampling campaign were measured in situ between 9:30 a.m. and 4:30 p.m., avoiding high winds [12]. Air temperature and relative humidity were measured at a fixed point located in the middle of each 25-metre sub-unit of the transect. To do this, the device was switched on and left in contact with the ambient air for thirty (30) seconds. The stabilised value of the desired parameter was then read on the display screen.

The measurement in centimetres of the thickness of plant litter consists of taking the average of a series of five (5) basic measurements using a tape measure deployed at each of the eight measurement sub-units per transect. The ground cover by litter, expressed as a percentage in each of the subunits, is estimated visually by the same observer, who stands with their back to the sun to avoid its glare [13]. The canopy estimate was obtained by vertically projecting the shadow cast by woody vegetation onto a circle with a diameter of two (2) metres in each of the transect subunits. The proportion of sunlight reaching the ground was obtained by vertically projecting the sunlight reaching the surface of each transect subunit [14]. In addition, the type of watercourse encountered was noted (permanent or temporary pools, rivers and streams, or absence) [13].

2.2.2. Sampling of Lizards

During this study, lizards were collected across all eight transects selected in the conserved and anthropised environments of the Department of Daloa using GPS by the same team of two (2) people. Surveys were conducted during the day, mainly in good weather (sunny, no strong winds or rain), which is favourable for ectothermic activity [15]. Sampling in each transect sub-unit consisted of walking slowly and quietly in sunny weather, stopping frequently. These stops allowed the team to discreetly observe individuals within the vegetation. The individuals were then photographed and identified. To this end, two complementary sampling methods were used on each transect: systematic search and observation ([16] [17]). The systematic search carried out on each of the eight sub-units of the transect, covering a

sampling area of 2,500 m² (25 m x 100 m), allows for the observation of more elusive lizards [18]. This technique involved lifting stones and dead wood and searching inside vegetation and under the bark of shrubs and trees [19]. The observation method (careful visual surveys) consists of detecting more sun-loving lizards by searching for them in all places likely to shelter them. This observation method made it possible to observe lizards in activity or at rest [20]. In situ, the pre-identification of lizard specimens requires approaching or capturing the fearful animal in order to note its distinctive morphological characteristics, then taking photographs and releasing it [21]. These photographs are necessary for subsequent identification in the laboratory [21]. Once in the laboratory, photographs of the various specimens are used to identify individuals down to the lowest possible taxonomic level. When dead individuals are collected, they are stored in labelled jars containing 70% ethyl alcohol, then identified to the lowest possible taxonomic level under a binocular magnifying glass at 40x magnification using appropriate reference works and guides, including that of [9]. Observation under a binocular microscope allows for better observation of external morphological characteristics such as: the scales of the cephalic plate (dorsal, ventral and profile) and the femoral pores located on the lateral sides of the feet [9].

2.2.3. Data analysis method

Specific richness

Specific richness (Sr) corresponds to the total number of lizard species collected in a transect. This index is used to determine the total number of different taxonomic categories to which the organisms collected in a sampling environment belong [22].

Frequency of occurrence

The frequency of occurrence 'F' of species is the ratio, expressed as a percentage, between the number of surveys "Fi" in which species i appears and the total number of samples 'Ft' from the biocenotic unit in question [23]. It is used to determine the consistency of a species in a given environment. The frequency of occurrence 'F' is calculated using the following formula :

$$F = \frac{F_i \times 100}{F_t}$$

Where Fi = number of surveys containing species i; Ft = total number of samples taken.

For Dajoz (2000), the frequency value will be used to determine three (3) categories of species: F > 50%: constant species; 25% ≤ F ≤ 50%: accessory species; F < 25%: accidental species.

Shannon diversity index

The Shannon diversity index, [24] H' is based on the number of species and the regularity of their frequency distribution.

$$H' = - \sum p_i \log_2 p_i$$

Where: N = sum of species numbers; ni = population size of species i.

H' fluctuates between 0 and log S. A high Shannon index corresponds to favourable environmental conditions allowing many species to establish themselves. Generally, the value of H' ranges between 0.5 (very low diversity) and 4.5 or 5 (most diverse communities).

Equitability of Pielou

Pielou's J index of evenness, which corresponds to the ratio of diversity H' to the maximum diversity that can be obtained with the same number of taxa

$$J = \frac{H'}{\log_2 S}$$

The evenness index J varies between 0 and 1 (when it is close to 0, it means that one species dominates the community; when it is equal to 1, all species have the same abundance).

Assessment of similarity between the sites studied

The Jaccard similarity index (Q_s) [25] was used to calculate the number of similar species between the different sites studied. It was calculated based on the presence or absence of each species in each environment. It is expressed by the following formula

$$Q_s = 2c/(a + b)$$

a: number of species mentioned in environment 1; b: number of species described in environment 2; c: number of species common to both environments.

2.2.4. Statistical processing

Kohonen self-organising maps (SOM)

In order to organise the habitats studied according to environmental variables and species assemblages, we used Kohonen's Self Organising Maps (SOM) algorithm [26]. This non-linear classification method has already proven its effectiveness in ecological analysis [27]. The advantage of this method is that it visually represents simplified profiles from complex databases by identifying similar groups [28]. However, unlike traditional methods, SOM easily handles extreme data (e.g. rare species), which is often found in ecological databases ([29] [30]). SOM consists of two layers of neurons. The input layer, consisting of the data matrix, is connected to the two-dimensional output layer called the Kohonen map. The latter is composed of artificial output neurons or nodes. The number of nodes is chosen following a calculation of the topographic error, which is an indicator of how well the map is preserved [26].

This topographical error must be less than 1 [28]. SOM estimates the connection intensities (weights) between the input and output layers using a competitive unsupervised process described by [26]. This feature is linked to the fact that no indication of the resulting classes that may be obtained is provided to the system. This process iteratively searches for similarities between the observed data and represents them in the output map while preserving neighbourhoods. At the end of the learning process (data mixing process), a map is obtained and each hexagon contains a virtual object for which the descriptor values have been calculated. These virtual objects represent the distribution of real objects. Finally, the SOM produces an output matrix with the final weight values, where the output neurons are in rows and the species are in columns. The SOM Toolbox (version 6.1) interface for Matlab used in this study was developed by the Helsinki University of Technology and is available at: <http://www.cis.hut.fi/projects/somtoolbox>. The choice of map size is a determining factor in detecting the best possible deviation between data points. For example, if the map is too large, i.e. if the number of units on the map is significantly greater than the number of samples, the data will be too scattered by the model. The optimal map size is chosen by minimising quantisation and topography errors [26]. Once the Kohonen map was obtained, a hierarchical classification analysis algorithm based on the Ward method and Euclidean distance was then used to highlight clusters of real objects on the map [28]. These groupings were made on the basis of affinities in terms of lizard populations in the samples projected onto the output layer cells. Kohonen's self-organising maps were created using the SOM Toolbox software (version 6.1) for Matlab.

3. Résultat

3.1. Specific composition of lizards in Daloa ecosystems

The specific composition of lizards in the preserved and anthropised environments of the Department of Daloa is presented in Table 2. Across all the transects visited, 10 species divided into 4 families and 5 genera were observed. The most diverse families are Scincidae (six species), followed by Gekkonidae and Agamidae with two species each, while the least diverse are Varanidae with one species (Table 2). The distribution of species according to the environments surveyed (Table 2) shows that the highest species richness (10 species) is found in conserved environments, while the lowest (6 species) is observed in anthropised environments. In addition, species such as *Agama africana*, *Agama agama*, *Hemidactylus angulatus*, *Hemidactylus muriceus*, *Mochlus fernandi* and *Trachylepis affinis* were observed in both types of habitat (conserved and anthropised). Furthermore, *Hemidactylus mabouia*, *Trachylepis quinquetaeniata*, *Trachylepis* sp. and *Varanus niloticus* were only recorded in the transects of conserved environments. On the other hand, no species was observed solely in anthropised environments. However, *Trachylepis affinis* is the only species present in all study transects.

3.2. Occurrence of different species of lizards

The distribution of species according to their occurrence (Table 2) indicates only constant and accidental species. Thus, six constant species (*Agama africana*, *Agama agama*, *Hemidactylus muriceus*, *Trachylepis affinis*, *Trachylepis* sp. and *Varanus niloticus*) are noted in preserved environments and three constant species (*Agama agama*, *Mochlus fernandi* and *Trachylepis affinis*) are recorded in anthropised environments. In addition, *Trachylepis affinis* (Scincidae) was recorded as a constant species in all study transects. Furthermore, *Agama agama* (Agamidae) was recorded as a constant species in all transects in anthropised environments.

Table 2 Values (%) of the Jaccard similarity index relating to pairwise comparisons of sites hosting lizard populations in the Department of Daloa.

			Transects of preserved environments				Transects of anthropised environments			
			T1	T3	T5	T7	T2	T4	T6	T8
Suborders	Familie s	Species								
Saurians	Agamid ae	<i>Agama africana</i>	-	*	-	***	-	*	-	-
		<i>Agama agama</i>	***	*	*	-	***	***	***	***
	Geckoni dae	<i>Hemidactylus angulatus</i>	-	-	*	-	-	-	*	*
		<i>Hemidactylus mabouia</i>	-	-	-	*	-	-	-	-
		<i>Hemidactylus muriceus</i>	***	-	*	*	-	-	*	-
	Scincida e	<i>Mochlus fernandi</i>	*	*	-	-	***	-	-	***
		<i>Trachylepis affinis</i>	***	***	***	***	***	***	***	***
		<i>Trachylepis quinquetaeniata</i>	-	*	-	-	-	-	-	-
		<i>Trachylepis</i> sp.	***	*	-	-	-	-	-	-
	Varanid ae	<i>Varanus niloticus</i>	-	*	-	***	-	-	-	-
Taxons	4	10	5	7	4	5	3	3	4	4
Nombre d'espèces		10	10				6			

*= accidental species, **= accessory species, ***= constant species, - = absent species

3.3. Similarity between transects

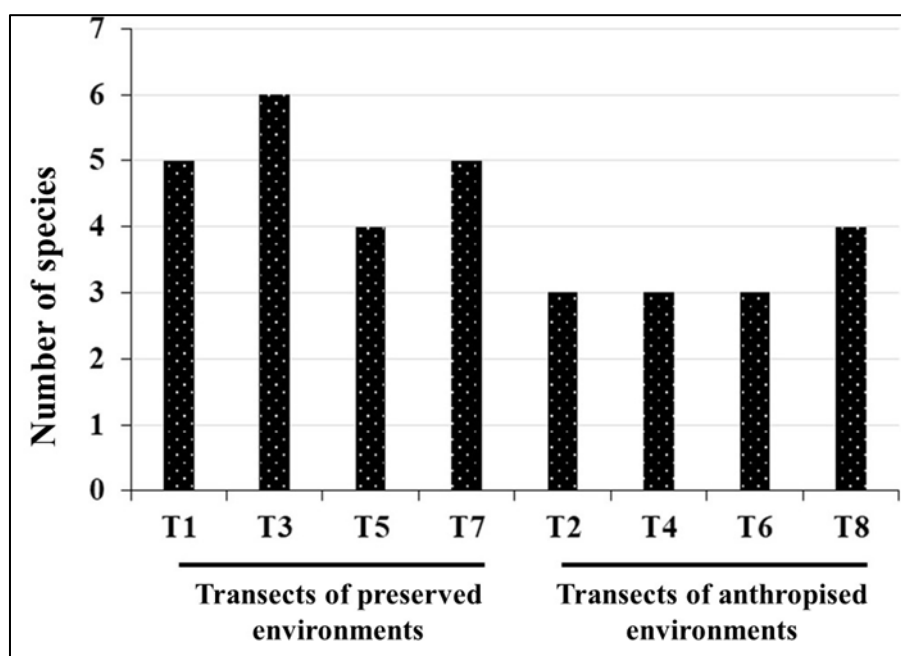
The degree of similarity between transects based on their specific composition is shown in Table 3. Similarity percentages range from 12.5 to 75.0 %. The highest rate was observed between transects T5 and T6 (75.0 %), followed by T2 and T8. The lowest rate was recorded between T7 and T8 (12.5 %). The list of species common to the study sites taken in pairs is illustrated in Table 3.

Table 3 Values (%) of the Jaccard similarity index relating to pairwise comparisons of sites hosting lizard populations in the Department of Daloa

Environm ents	Secondary forest (Transects of preserved environments)				Agricultural system (Transects of anthropised environments)			
	T1	T3	T5	T7	T2	T4	T6	T8
Transects	T1	T3	T5	T7	T2	T4	T6	T8
T1		37.5	50.0	25.0	60.0	33.3	60.0	50.0
T3			25.0	37.5	28.6	50.0	28.6	25.0
T5				28.6	40.0	40.0	75.0	60.0
T7					14.3	33.3	33.3	12.5
T2						50.0	50.0	75.0
T4							50.0	40.0
T6								40.0
T8								

3.4. Spatial distribution of species richness

Figure 2 illustrates the variations in species richness in the transects of conserved and anthropised environments in the Department of Daloa. Across all the transects surveyed, the number of species varies between 3 and 6 species in anthropised environments (T2, T4, T6) and transects T3 in conserved environments. In the transects of preserved habitats, transect T3 recorded the highest number of species (six species) and the lowest (four species) was observed in T5. However, in the transects of anthropised environments, the highest species richness (four species) is noted in transect T8 and the lowest (three species) in transects T2, T4 and T6.



T1, T3, T5 and T7 : Transects of preserved environments ; T2, T4, T6 and T8 : Transects of anthropised environments.

Figure 2 Variations in species richness on transects in conserved and anthropised environments in the Department of Daloa between April and June 2021

3.5. Spatial distribution of the Shannon diversity index and evenness

The spatial variations in the Shannon diversity index and evenness in the conserved and anthropised environments of the Daloa Department are illustrated in Figure 3. On the study transects, transect T5, located in conserved environments, recorded the lowest values for the Shannon index and evenness, at 0.40 and 0.30 respectively. The highest values for these indices, at 1.22 and 0.87 respectively, were recorded in conserved environments on transect T7. In anthropised environments, transect T8 recorded the highest values for the Shannon index (1.19) and evenness (0.86) and the lowest values for the Shannon index (0.70) and evenness (0.50) recorded in T6.

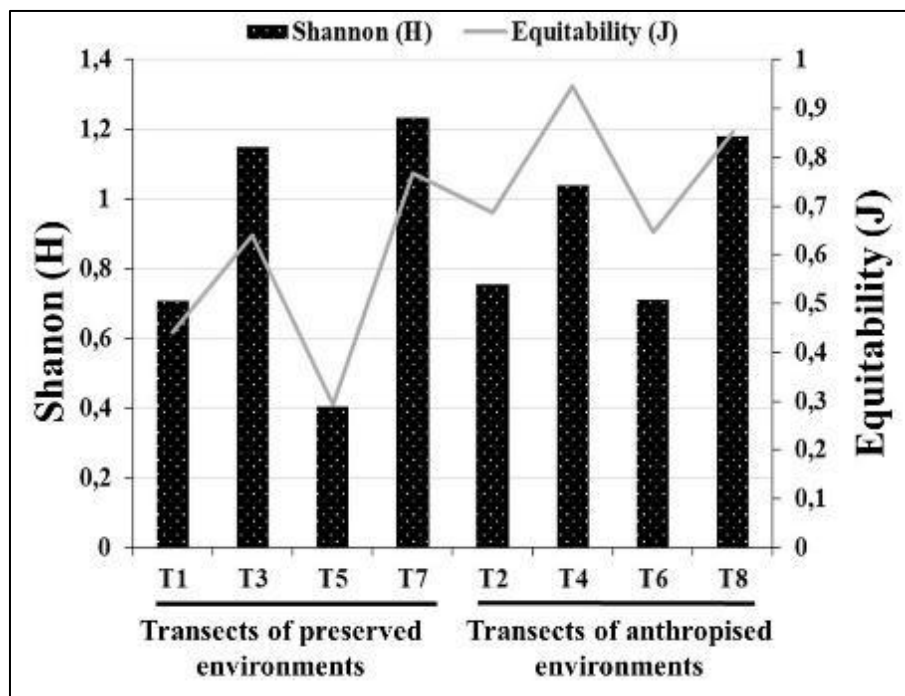


Figure 3 Spatial variations in the Shannon diversity index and evenness in conserved and anthropised environments in the Department of Daloa between April and June 2021.

3.6. Distribution profile of lizards in the ecosystems of the Department of Daloa

The distribution of amphibian populations in the study area was analysed using SOM (Self Organising Maps) designed from the presence/absence matrix of lizard species. This made it possible to classify the 24 samples (8 transects x 3 campaigns). Kohonen's self-organising map (or SOM) made it possible to classify the 10 lizard species according to their monthly and spatial occurrence probabilities. The size of the map used is 25 cells (5 rows x 5 columns). It minimises both quantification errors (0.631) and topography errors (0.000) (Table 4).

Table 4 Different Kohonen map sizes and corresponding quantisation and topography errors

Map size	Quantification error	Topographical error
5*4(20)	0.690	0.000
7*3(21)	0.657	0.000
6*4(24)	0.634	0.000
5*5(25)	0.631	0.000

The selected size is in bold.

The 25 cells of the self-organising map are divided into two groups (GI and GII) based on a hierarchical classification analysis (Figure 4A). The groups are illustrated by different patterns on the Kohonen map (Figure 4B). Each group on the SOM map contains samples with similar specific compositions. Group I (white polygon) includes lizard samples mainly from transects (T2, T4, T6 and T8) in preserved environments (100 %) and transects (T1) in preserved

environments (25 %). Group II (brown polygon) includes samples mainly from transects (T3, T5 and T7) in preserved environments (75%) (Figure 5).

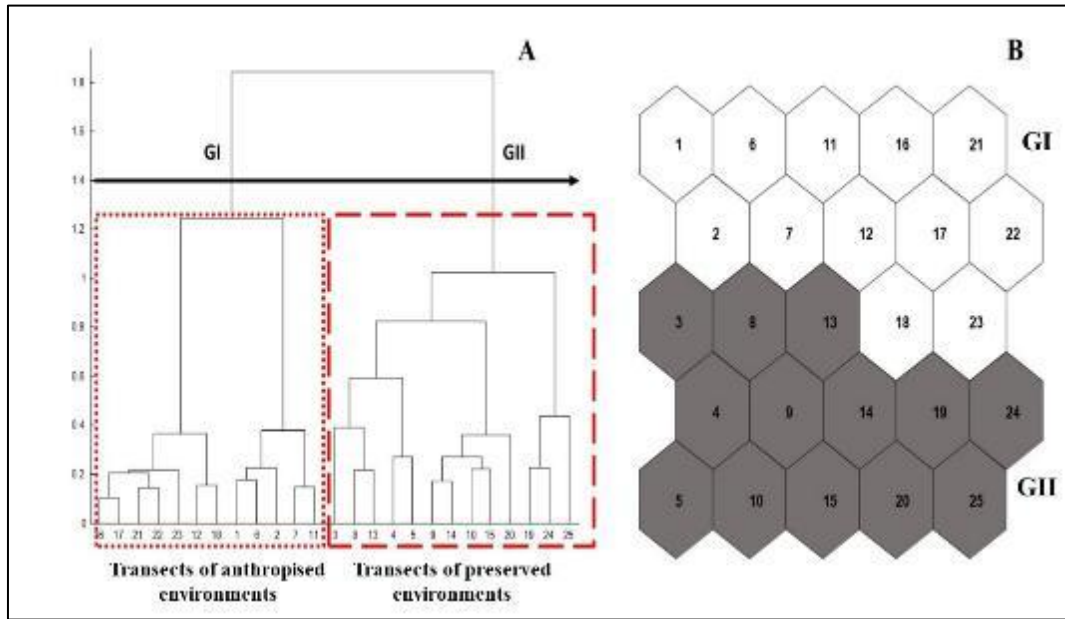
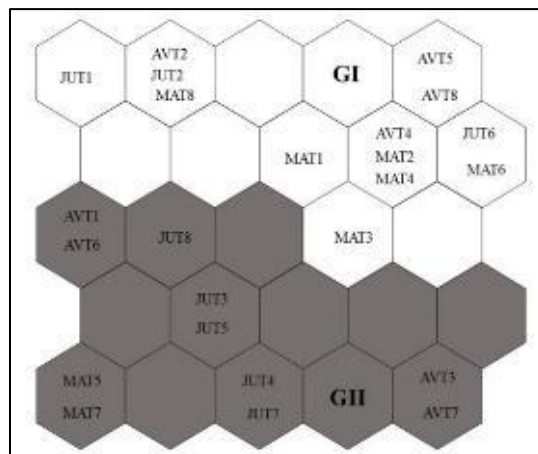


Figure 4 Ascending hierarchical classification of SOM cells based on lizard species in conserved and anthropised environments in the Department of Daloa between April and June 2021.

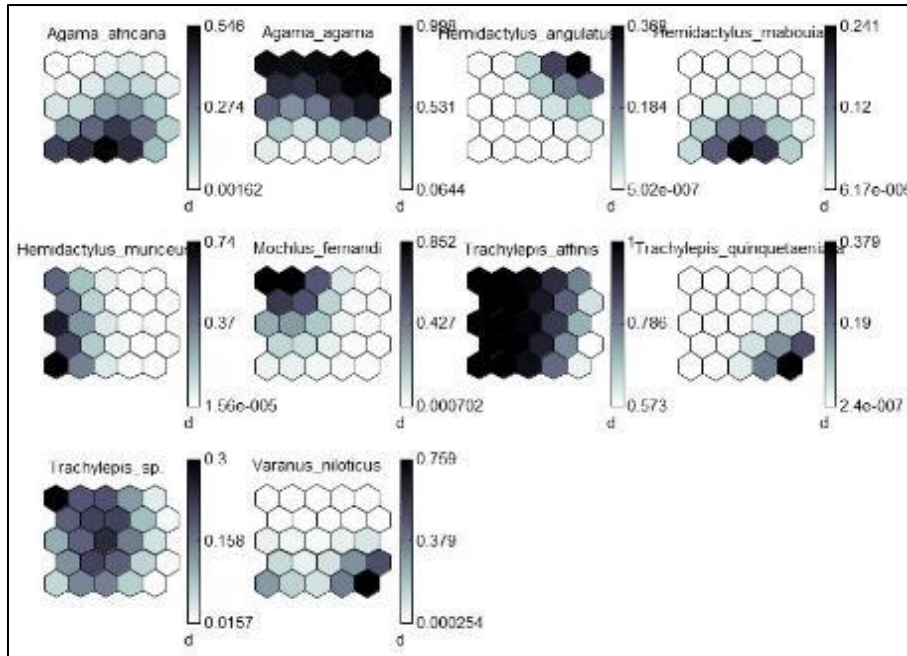
A = Ascending hierarchical classification of Kohonen map cells using the Ward method and Euclidean distance as the assembly distance (numbers [1 to 25] correspond to Kohonen map cell numbers; Roman numerals [I to II] represent the selected groups). B = Kohonen map with cells numbered from 1 to 25.



GI and GII represent the defined groups. The Arabic numerals (1 to 8) designate the sampling transects ; AV = April ; JU = June ; MA = May.

Figure 5 Distribution of samples in the SOM based on data on the presence/absence of lizards collected in conserved and anthropised environments in the Department of Daloa between April and June 2021

The distribution of each species of lizard in each group defined by the SOM is shown in Figure 6. The distribution is based on an analysis of the contribution of each of the 10 species of lizard in each group. Group 1 (GI) comprises five species : *Agama agama*, *Hemidactylus angulatus*, *Mochlus fernandi*, *Trachylepis affinis* and *Trachylepis* sp. Group 2 (GII) comprises six species : *Agama africana*, *Hemidactylus mabouia*, *Hemidactylus muriceus*; *Varanus niloticus*; *Trachylepis quinquetaeniata* and *Trachylepis affinis*. The number of species recorded between the different groups does not differ significantly (Kruskal-Wallis test, $P > 0.05$) (Table 5).



Dark colour = high probability of presence; light colour = low probability of presence; d = scale. (Dark colour = high frequency; light colour = low frequency (see absence))

Figure 6 Distribution profile of lizard species on the Kohonen map based on data on the presence/absence of lizards collected in conserved and anthropised environments in the department of Daloa between April and June 2021

Table 5 Distribution of lizard species collected in conserved and anthropised environments in the Daloa department between April and June 2021 in each group defined by SOM.



Groups	Lizard species
Group I 	<i>Agama agama</i> ; <i>Hemidactylus angulatus</i> ; <i>Mochlus fernandi</i> ; <i>Trachylepis affinis</i> and <i>Trachylepis Sp.</i>
Group II 	<i>Agama africana</i> ; <i>Hemidactylus mabouia</i> ; <i>Hemidactylus muriceus</i> ; <i>Trachylepis quinquetaeniata</i> and <i>Varanus niloticus</i> .

Figure 7 below illustrates the influence of abiotic parameters on groups I and II defined by Kohonen's self-organising map (SOM). Temperature, proportion of sunlight reaching the ground, and relative humidity influence the distribution of species in group I. Species in group II are influenced by canopy cover, tree density, shrub density, ground litter cover, and litter thickness.

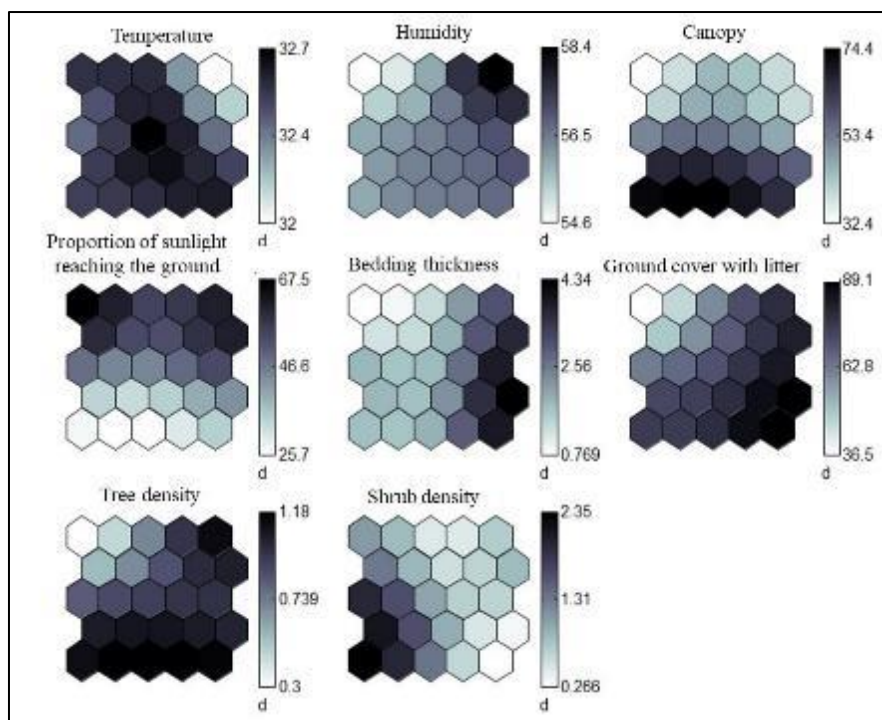


Figure 7 Influence of abiotic parameters on groups I and II defined by Kohonen's self-organising map (SOM)

3.7. Influence of the degree of anthropisation of environments on the distribution of lizards

Table 6 shows the distribution of species richness and abundance of lizards according to the degree of anthropisation of environments at the sampling transects selected in the conserved and anthropised environments of the Department of Daloa. The highest species richness (4 to 6 species) was observed in environments with moderate human pressure. These are transects T1, T3, T5 and T7. However, the highest abundance (88 to 82 individuals) was noted in environments with high human pressure (T2, T4, T6 and T8).

Table 6 Distribution of specific richness and abundance of lizards according to the degree of anthropisation of conserved and anthropised environments in the Department of Daloa between April and June 2021

Degree of human pressure	Average				High			
Environments	Preserved environments				Anthropised environments			
Transects	T1	T3	T5	T7	T2	T4	T6	T8
Specific resources	5	6	4	5	3	3	3	4
Abundance	80	32	43	28	82	48	38	56
Representative common species	<i>Trachylepis affinis</i>				<i>Agama agama</i> and <i>Trachylepis affinis</i>			

4. Discussion

The physical characterisation of habitats in the forest ecosystems and agricultural systems of the Daloa Department has enabled them to be classified as preserved environments (habitats with low and medium anthropogenic pressure) and anthropised environments (highly degraded habitats). In preserved environments, transects T1, T3, T5 and T7 contain a high density of trees and shrubs. They therefore appear to be better preserved than the others and are representative of secondary forests ([31] [32]). Analysis of the lizard population in preserved and anthropised environments in the Department of Daloa identified 407 individuals of 10 species belonging to 4 families and 5 genera. The distribution of species according to habitat shows that species richness in preserved environments (10 species) is higher than in anthropised environments (6 species). This situation is thought to be due to the type of habitat explored. Indeed, our study was conducted in secondary forests undergoing regeneration and in agricultural systems. Our results corroborate those of [33], who assert that reptile species richness is linked to the type of habitat surveyed. The distribution of species

by family indicates that Agamidae and Geckonidae, with 2 and 3 species respectively, are present in both types of habitat (secondary forest and agricultural system). The presence of Agamidae and Geckonidae in the conserved and anthropised environments of the Department of Daloa can be explained by the fact that these families of lizards inhabit a wide variety of habitats and are adapted to degraded environments [9]. The distribution of species by family also indicates that Scincidae and Geckonidae, with 4 and 3 species respectively, are the most diverse. The diversity of Scincidae and Geckonidae, as well as the presence of Varanidae in the conserved areas of the Department of Daloa, can be explained by the fact that these families of lizards colonise and prefer habitats with low human pressure ([33] [9]). The results relating to spatial variations in the Shannon diversity index and evenness show that transect T7, located in conserved environments, has the highest Shannon index values (1.22 bits) and low evenness values (0.10). This can be explained by the fact that this transect is located in a secondary rainforest with low anthropogenic pressure. According to [23], high Shannon diversity index values reflect diverse lizard communities with a poor level of organisation. The results relating to spatial variations in the Shannon diversity index and evenness also show that transect T4, located in anthropised environments, has the lowest Shannon index values (1.09 bits) and the highest evenness values (1.30). This could be explained by the fact that this transect is located in an old cocoa plantation subject to high anthropogenic pressure. According to [23], low Shannon diversity index values reflect poorly diversified lizard communities with a good level of organisation. Thus, habitat stability and biotic interactions could be important factors in the structure of animal communities. The influence of the degree of anthropisation of ecosystems in conserved and anthropised environments in the Department of Daloa on the distribution of lizards indicates that saurians are diverse and not very abundant in environments with less anthropic pressure. This high taxonomic richness of lizard populations recorded in less anthropised environments is thought to be related to the favourable ecological conditions offered by this habitat and to their habits ([34] [35]). Indeed, the transects of secondary forests are located in a sparse, warm, humid, dry habitat with little sunlight and shade, offering numerous prey and refuges. Lizards use this habitat to warm themselves, feed and protect themselves from predators [36].

5. Conclusion

Analysis of the lizard population in conserved and anthropised environments in the Department of Daloa identified 407 individuals of 10 species belonging to 4 families and 5 genera. Analysis of lizard species diversity according to the habitats surveyed revealed a high diversity in less anthropised environments (conserved environments) compared to more anthropised environments (agricultural systems). The influence of the degree of human pressure on secondary forests and agricultural systems in the Daloa Department on the distribution of lizards shows that lizards (*Agama agama* and *Trachylepis affinis*), which are indicator species of degraded environments, are more abundant in more anthropised environments (agricultural systems). Analysis of the diversity of lizard communities indicates that the lizard population is more diverse in conserved environments in transect T7 and more balanced in anthropised environments in transect T4. In order to better control the impacts of anthropogenic activities on ecosystems in conserved and anthropised environments in the Department of Daloa, biomonitoring of these systems is necessary.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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