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Taxonomic Diversity and Structure of the Ophidian Population in Agroecosystems in the Department of Daloa (Central-western Côte d'Ivoire)

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Abstract: The ophidian fauna of the Daloa Department was studied to determine the composition and structure of the population. Sampling was carried out at five sites between July and December 2016. Three techniques were used: standardised transects, all-directional surveys and systematic excavations. The snake inventory revealed 26 species belonging to two infraorders, two superfamilies and seven families. The infraorders encountered were Caenopnhidia and Henopnhidia. The superfamilies observed were Colubroidea and Booidea. The families collected were as follows: Pythonidae, Atractaspidae, Colubridae, Lamprophiidae, Psammophiidae, Elapidae and Viperidae. Species richness showed notable spatial variability. It has undergone significant change over time. Some species are no longer observed (13 species), while others have been encountered for the first time (13 species). In addition, the structure of the population showed a predominance of accidental species (species that are passing through the environment) in the sites surveyed. The diversity of the population remains relatively low, while its degree of organisation is high. The Colubridae family is the most represented family.

1. Introduction

Biodiversity preservation now ranks among the major global challenges (UNEP, 1992). Faced with environmental damage observed worldwide, the signatories of the 1992 Rio conventions agreed to support any ecological and legal initiative promoting biodiversity conservation (Levêque *et al.,* 2001). This interest in biodiversity reflects a growing awareness of ecosystem degradation and the need for sustainable management (Solbrig, 1991). Consequently, safeguarding the environment in general, and natural resources and biodiversity in particular, has been elevated to the status of a fundamental priority for humanity. In Africa, to ensure biodiversity conservation, states have transformed certain tracts of forest and savannah into protected areas. In Côte d'Ivoire, this strategy has resulted in the establishment of several protected zones (Assemian, 2009). However, in the years following independence, the choice of agriculture-focused development led to a significant loss of flora and fauna. Among these species, reptiles are of particular importance due to their role in the functioning and balance of ecosystems (Meirte *et al.,* 2004; Elbahi *et al.,* 2023). According to Pough *et al.* (1998), agricultural areas offer reptiles a wide variety of habitats and facilitate interactions with humans. Thus, reptiles such as snakes benefit agriculture by feeding on numerous insects and vertebrates harmful to crops. On the other hand, snakes are also perceived as dangerous to humans because of their venom. Moreover, the species responsible for envenomation often go unidentified in the majority of cases (Chippaux *et al,* 2002; Farooq *et al,* 2021). The Daloa department in Côte d'Ivoire is recognised as an area with a strong agricultural focus. In this context, gaining a better understanding of snakes present in agricultural environments appears essential, given the importance of these areas for these animals. Furthermore, improved knowledge of the diversity and spatio-temporal distribution of snakes in this department would allow for more refined recommendations in the event of a bite (Talla, 2003). Such an in-depth study could contribute to the safety of agricultural workers, who share these environments with snakes. The only study devoted to snakes in the Daloa department dates back to 1963 and would benefit from being updated. This research focused on the inventory, systematics, biology and parasitology of the species (Doucet, 1963).

Taxonomic diversity is a measure of biodiversity that accounts for the number of species (species richness) and their relative abundances within a community. It is a fundamental indicator of biodiversity, often reflecting species richness, the variety of organism types, and their relationships, such as the number of species per genus or family (Dallahi *et al.,* 2016; Bozzuto, C., & Blanckenhorn, 2017; Supriatna, 2018; Arifi *et al.,* 2018; Gu *et al.,* 2025). A Scopus search indicates that more than 689,000 documents were published from 1992 to 2025, reflecting the broad importance of the country's concern. When "reptile" is added, 15,300 documents from 2000 to 2025. These findings prompt us to conduct a bibliometric analysis as an effective tool to provide more information on the evolution of the number of articles over time, as well as prolific authors and countries (Aria and Cuccurullo, 2017; Mouloudi *et al.,* 2023; Laita *et al*., 2024; Hammouti *et al.,* 2025; Merzouki *et al.,* 2025; Verma *et al.,* 2025).

The present study has the general objective of contributing to the improvement of knowledge concerning the ophidian herpetofauna of the Daloa department. More specifically, the aim is, on the one hand, to assess the taxonomic diversity of snakes in this area, and, on the other hand, to describe the spatio-temporal dynamics of this community.

2.Methodology

2.1. Sampling sites

This study was conducted in the department of Daloa, whose regional capital is the city of Daloa (Figure 1). This city is located in the Centre-West region of Côte d'Ivoire between latitudes 6° and 7° North and longitudes 6° and 7° West (Ligban *et al.,* 2009). It covers an area of 5,423 km² with an estimated population of 266,000 inhabitants according to (INS, 2012). The Department of Daloa is bordered to the north by the Departments of Vavoua and Zuénoula, to the south by those of Issia and Sinfra, to the west by the Departments of Bangolo and Duekoué, and to the east by that of Bouaflé. The sampling sites were chosen taking into account various types of habitats. These include agricultural systems and areas disturbed or undisturbed by human activities. Wetlands and natural and artificial shelters also influenced the choice of sites, in accordance with the methods of Heyer *et al.* (1994) and Rödel & Ernst (2004). A total of five sites were selected, two in urban areas and three in rural areas. In urban areas, these include the fallow land in the Tazibouo neighbourhood on the outskirts of Jean Lorougnon Guédé University and the low-lying rice-growing areas in the Abattoir neighbourhood. In rural areas, there are rice fields in the localities of Gadouan and Begafla and a cocoa plantation in Zaïbo (Table 1).

Table 1. Characteristics of sampling sites

Sampling sites	Latitude (N)	Longitude (W)	Description
Tazibouo	6°54’30.38’’	6°26’18.98’’	A fallow field dominated by grasses, with a few trees and palm trees (Figure 1).
Abattoir	6°52’58.35’’	6°26’11.49’’	A rice field with young shoots and dominated by herbaceous plants. There are also a few trees and dwellings around this site (Figure 1).
Begafla	7°00’5.21’’	6°20’22.54’’	A rice field with a high presence of grassy formations. The rice field is bordered by a forest and crossed by a small stream (Figure 1).
Gadouan	6°47’7.88’’	6°23’18.91’’	A rice field with a few trees and palm trees. This rice field is bordered by a forest (Figure 1).
Zaïbo	6°36’5.00’’	8°55’53.00’’	A cocoa plantation with soil covered in litter composed of dead cocoa leaves (Figure 1).

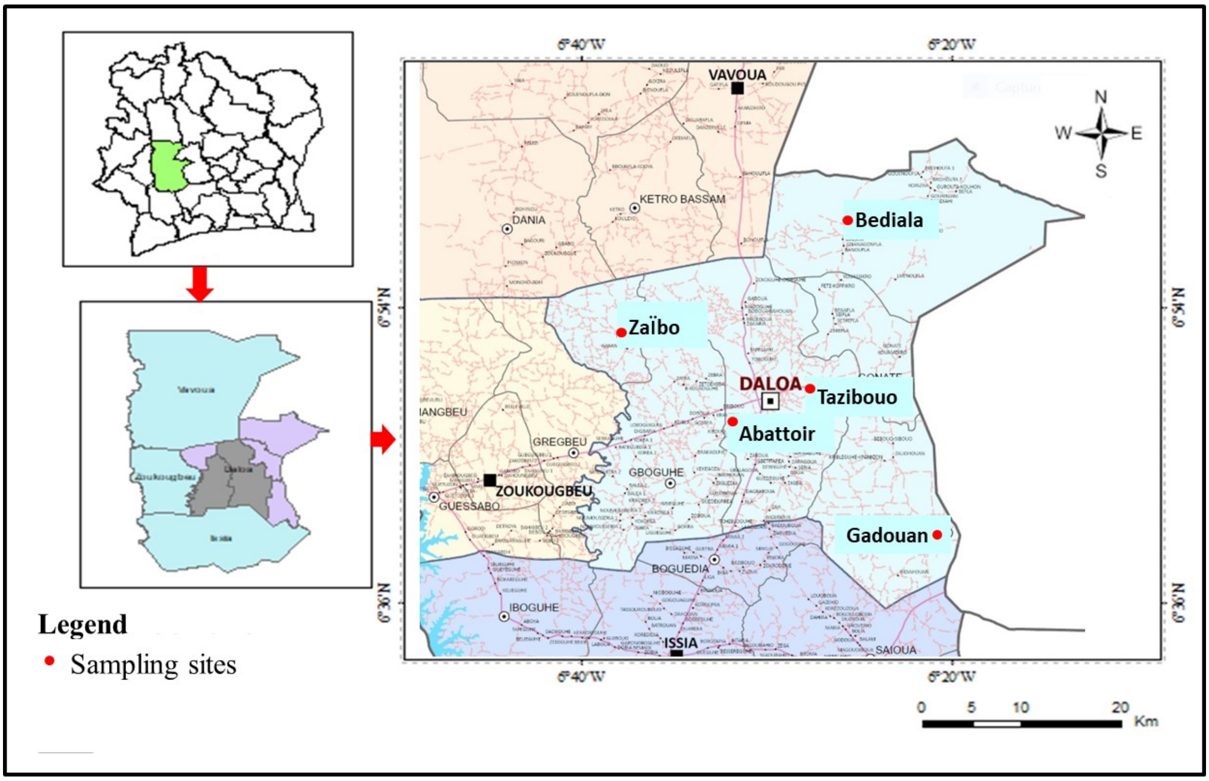

Figure 1. Presentation of the study area

2.2. Sampling

Snake sampling at the sites under consideration was carried out at the end of six campaigns between July and December 2016, covering the same study areas. Three complementary sampling techniques (Mebarki, 2012, Olivier & Maillet, 2013) were used. These were standardised transects, all-directional sampling and systematic searching of refuges. Standardised transects and systematic searches of refuges were used simultaneously on three transects 100 m long and 5 m wide (covering an area of 500 m2) during both the rainy and dry seasons. These transects were chosen within the area delimited for the all-directional survey and systematic search of refuge sites techniques. Every hour, we switched from one combination of methods to another. At each site studied, sampling was carried out between 8 a.m. and 6 p.m. by a team of two people. The three standardised transects defined at each study site are traversed successively for one hour by two collectors in order to inventory snake species (Mebarki, 2012). The all-directional survey is a technique that consists of opportunistic sampling (Heyer *et al*., 1994; Talla, 2003; Assémian, 2009) carried out by a team of two people over areas measuring 200 m long and 100 m wide. The prospectors spend an hour randomly covering several routes without any predefined paths to guide their trajectories. The systematic search of refuge sites consists of a team of two people regularly inspecting any place that could be a hunting, shelter or breeding site for snakes for one hour. This technique is particularly relevant for species that inhabit vegetation and specific microhabitats. These refuges include: decaying dead wood, under dry bark, litter, as well as the axils of sheathing leaves and the leaf axes of palm trees (Vonesh, 2001; Mebarki, 2012; Trape 2023).

2.3. Analysis of the population structure

2.3.1. Estimated species richness

To evaluate the effectiveness of the sampling techniques used, two non-parametric statistical methods for estimating species richness were employed using Estimate Software. Based on the assumption that the relative collection effort is the same in each area, the theoretical number of snake species was calculated using the Jack-knife-1 formula (Burnham and Overton, 1979; Heltshe and Forrester, 1983) and Chao-2 formula (Chao, 1987). These formulas are based on incidence (occurrence), i.e. the number of times a species is encountered in each sample (presence/absence) :

$$\mathbf{Sjack1 = Sobs + Qi\ (m-1)/m}$$

and Schao2 = Sobs+ Q 21/2Qi (Burnham and Overton, 1979; Heltshe and Forrester, 1983).

Sobs: total number of species observed in all samples; Qi: number of species recorded in i samples; m: total number of samples.

2.3.2. Occurrence of species

This method is used to determine the habitat preferences of a given species. It involves counting how many times species i appears in the samples (Dajoz, 2000). This number is expressed as a percentage of the total number of surveys and provides information on the species frequently encountered in a habitat. It is calculated as follows :

$$\mathbf{F = Fi / Ft \times 100}$$

Fi: number of surveys containing species i; Ft: total number of surveys conducted. Depending on the value of F, three groups of species are defined: constant species (F > 50%), accessory species (25% < F < 50%) and accidental species (F < 25%).

2.3.3. Shannon diversity index (H')

According to Dajoz (2000), this index measures the degree of organisation of the population. The Shannon and Weaver (1963) specific diversity index is used to highlight the overall diversity of the population. High values of the Shannon index correspond to a high diversity of the population studied. Its formula is as follows :

$$H' = - \Sigma \, qi \log2 \, qi.$$

It ranges from 0 to 5. H': diversity index expressed in bit units; Qi: relative frequency of species i in relation to individuals in the entire population; Log2: logarithm to the base 2. It is obtained using R software.

2.3.4. Equitability Index (E)

Pielou's (1969) regularity index, or evenness index, allows us to study the regularity of species distribution and compare the diversity of two populations with different species richness (Rs) (Barbault, 1992, Dajoz, 2000). The calculation of the specific diversity index must always be accompanied by that of equitability, as two populations with different physiognomies may have the same diversity. Equitability is obtained by relating the observed diversity to the maximum theoretical diversity of the population :

$$E = H' / \log2 \, (Rs)$$

H': Shannon diversity index; Log2(Rs): Hmax (diversity achieved when all species have the same abundance); Rs: specific richness.

Equitability varies from 0 to 1 and tends towards 0 when almost all individuals are concentrated in one species. It takes the value 1 when all species have the same abundance. Equity is an objective measure of the degree of diversity. According to Zabi (1993), it reflects the quality of a population's organisation. It is obtained using R software.

2.4. Assessment of similarity between the sites studied

The Sorensen similarity index (Qs) (Magurran, 1988) 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 :

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

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

2.5. Statistical processing of data

The assessment of estimated species richness and sampling technique efficiency was carried out using Estimate S software (version 6.0 b1). This was done in order to estimate the expected species richness in the environments studied.

3. Results and Discussion

3.1. Bibliometric analysis

Figure 2 shows the evolution of articles from 2000 to 2025, indicating a significant increase over time: 48 articles in 2000 to reach 1675 in 2025. The most areas studied are "Agricultural and Biological Sciences" [48.1%, 12164 articles] and "Environmental Science" [19.2%, 4856 articles], "Biochemistry, Genetics and Molecular Biology" [9.2%, 2340 articles], and other domains related to Medicine (**Figure 3**).

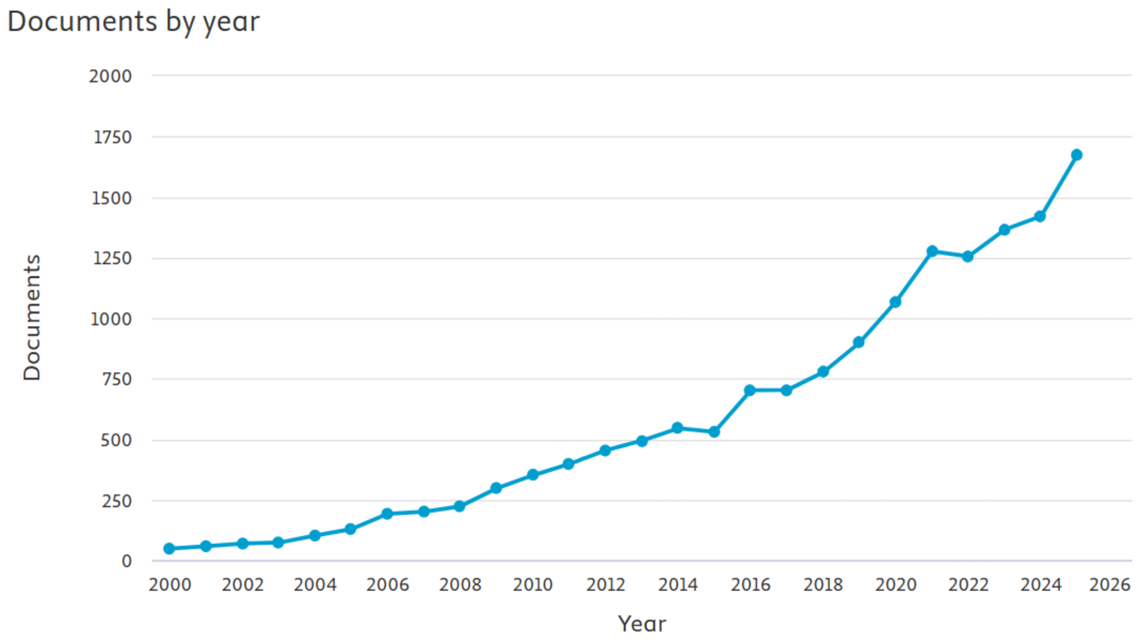

Figure 2. Increase in the scientific production from 2000 to 2025

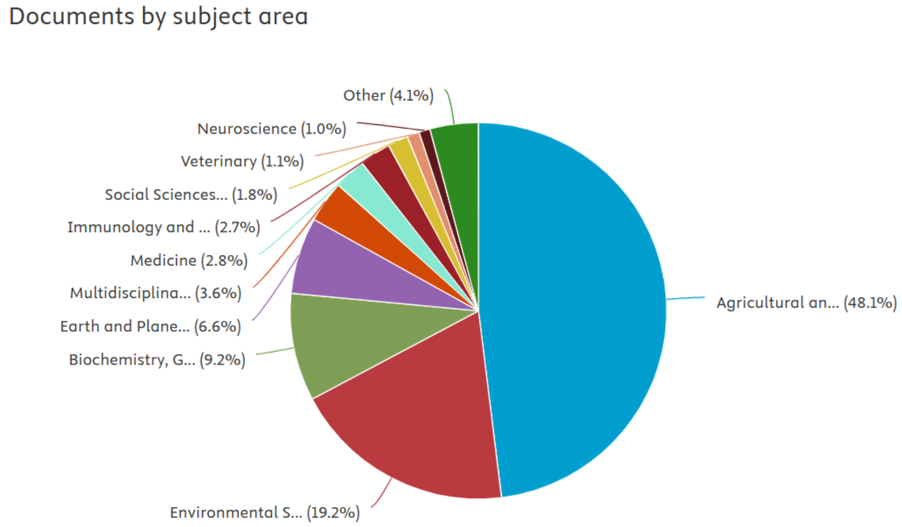

Figure 3. Presentation of the study area

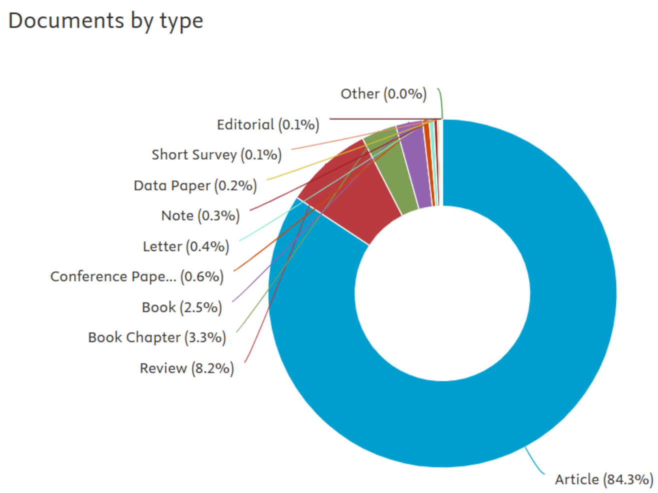

Figure 4. Presentation of the study area

Figure 4 indicates that more than 98% of the published documents are research articles, reviews, book chapters, and books. The US is the most concerned by this topic, publishing more than 5100 articles, followed by Germany (>2000 articles) and the UK (over 1900 articles) … as indicated in **Figure 5**. VOSviewer can provide more details on authors and countries, as well as potential cooperation among laboratories and institutions (Elmsellem *et al.,* 2023; Hammouti *et al.,* 2025b; Kachbou *et al.,* 2025; Taha *et al.,* 2026). **Figure 6** presents more than 100 countries with at least 5 articles via colored circles called nodes. The largest mustard node is attributed to the United States, that of Germany (green node) and orange one for UK, Brazil (light mustard) and Australia by light pink node but hidden under the US one.

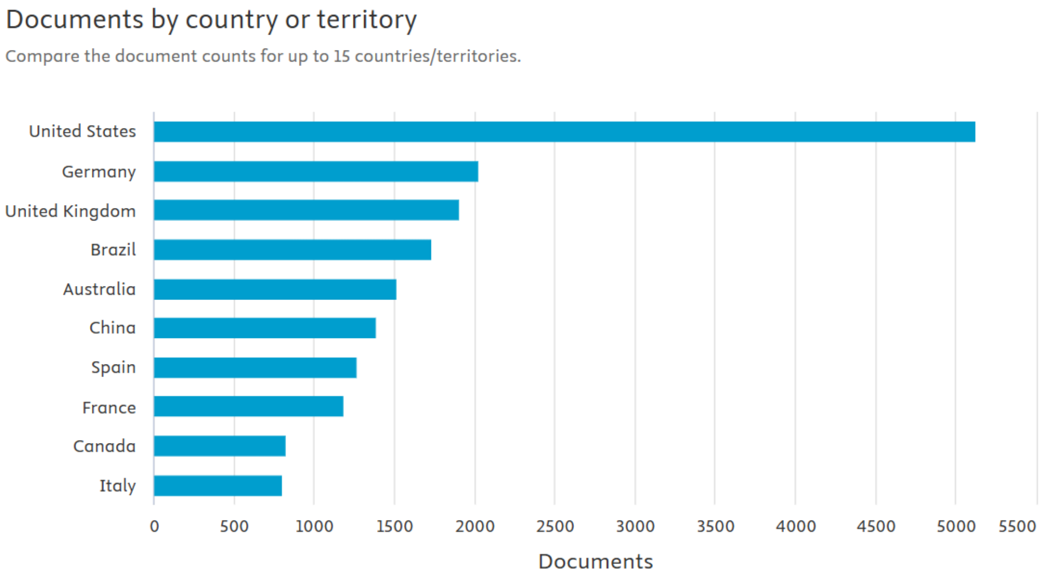

Figure 5. Top countries contributing from 2000 to 2025

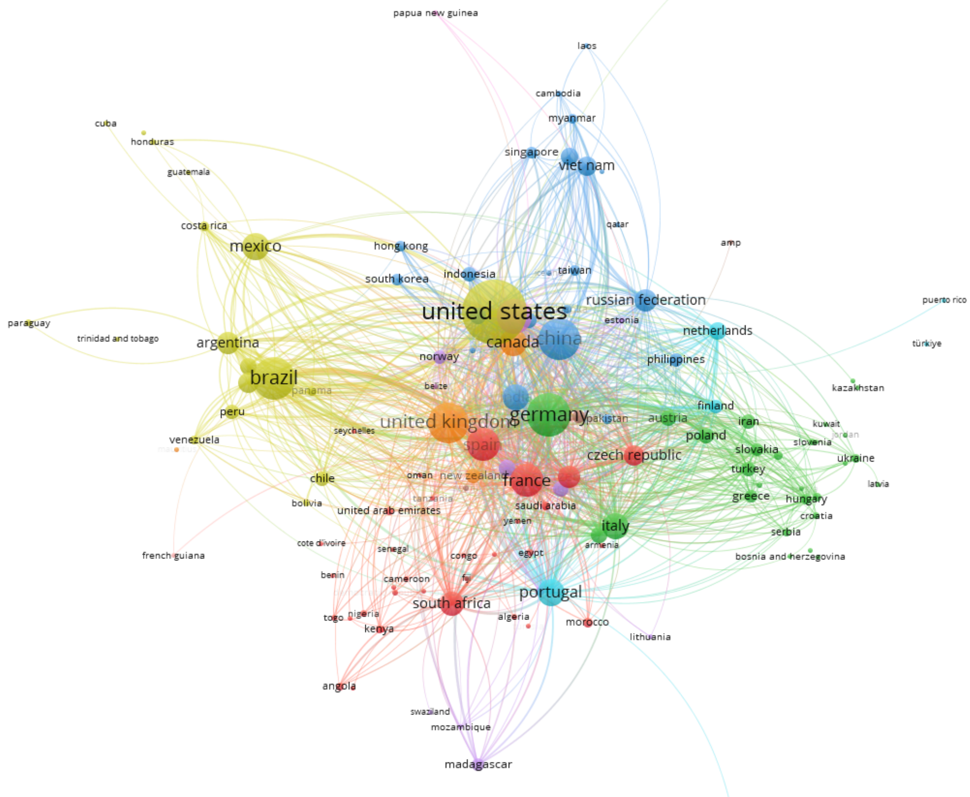

Figure 6. Network visualization of countries using VOSviewer

The analysis also shows the ranking of the top ten authors (**Figure 7**). The German Vences, Miguel Technische Universität Braunschweig, Braunschweig, published 180 articles on this field, and a total of 667 Scopus articles, an H-index of 73 and more than 25600 citations, followed by Bauer, Aaron Matthew Villanova University, Villanova, United States (152 articles) and Brown, Rafe M. University KS Natural History Museum, Lawrence, United States (144 articles).

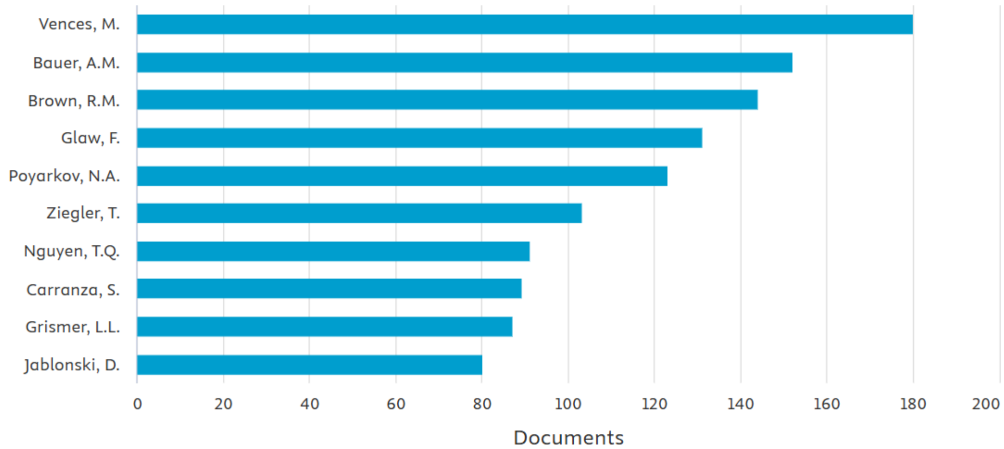

Figure 7. Top ten authors profiling from 2000 to 2025

3.2. Evaluation of sampling efficiency

Table 2 shows the sampling efficiency for each site. This ranges from 28.57% to 40 %. These extreme values were recorded at Zaïbo for the minimum and at Abattoir and Gadouan for the maximum. The assessment of the effectiveness of sampling carried out at the various sites studied revealed rates of less than 50 %. This relatively low effectiveness is thought to be linked to insufficient sampling effort. In fact, only daytime sampling was carried out. As a result, the possibility of encountering nocturnal species was very low and the species richness observed remained limited to diurnal taxa. In addition, many unidentified species observed were not taken into account.

Table 2. Observed and estimated specific abundance of snakes in each environment.

Study sites	Specific richness observed	Expected specific wealth	Sampling efficiency (%)
Tazibouo	10,00	32,93	30,37
Abattoir	4,00	10,00	40,00
Begafla	11,00	35,75	30,77
Gadouan	4,00	10,00	40,00
Zaïbo	6,00	21,00	28,57

3.3. Taxonomic composition and general characteristics of the stand

Sampling of the snake population at the five sites surveyed in the Department of Daloa identified a total of 26 species, divided into 2 infraorders, 2 superfamilies and 7 families (Table 3). The infraorders encountered are : Caenophidia and Henophidia. Caenophidia are grouped into a single superfamily (Colubroidea) and are the most diverse with 6 families. Henophidia are also represented by a single superfamily (Booidea) but comprise one family (Pythonidae). Thus, the Colubroidea superfamily is composed of Colubridae (13 species), Elapidae (4 species), Viperidae (3 species), Lamprophiidae (3 species), and Atractaspidae and Psammophiidae (1 species each). The Booidea superfamily is monospecific (Pythonidae) in the study area. A comparison of the species richness of the different study areas (Table 3) shows that the Begafla area has the greatest species richness (11 species). It is followed by the Tazibouo area (10 species) and Zaïbo (6 species). However, the Abattoir and Gadouan areas have the lowest diversity (4 species each). The snake species listed in this study belong to two suborders: Caenophidia and Henophidia. However, Doucet (1963) identified a third infraorder of snakes in the city of Daloa in addition to these two infraorders. This is Scolecophidia. This infraorder is described as comprising burrowing and very discreet snakes (Doucet, 1963). The absence of snakes belonging to this infraorder in our samples could be explained by the fact that the sampling techniques chosen (standardised transect, all-azimuth survey and systematic excavations) are not particularly suited to finding burrowing snakes. However, it should be noted that the species richness recorded across all sites surveyed in the Department of Daloa (RS = 26 species) is equal to that obtained by (Doucet, 1963). With regard to abundance, the high presence rate among Caenophidia could be explained by the fact that species from this infraorder are easier to observe. Indeed, Doucet (1963) showed that these species are more terrestrial and observable in herbaceous environments. Henophidia are also terrestrial but more observable in humid forest environments.

Table 3. List of snakes collected in different environments.

SUBORDER/SUPERFAMILY/FAMILY/SPECIES	**French names**	**Ta**	**Ab**	**Be**	**Ga**	**Za**	**HP**	**DG**	**SC**
HENOPHIDIA									
BOOIDEA									
Pythonidae (1)									
Python sebae (Gmelin,1788)	Python de Séba					x	F,S	AO,AC	NT
CAENOPHIDIA									
COLUBROIDEA									
Atractaspidae (1)									
Aparallactus modestus (Günther, 1859)	Aparallacte modeste	xx					F	AO,AC	LC
Colubridae (13)									
Afronatrix anoscopus (Copé,1861)	Couleuvre des ruisseaux	x				x	F,S	AO	LC
Crotaphopeltis hotamboeia (Laurenti,1768)	Hétérure commune			x			F,S	AO,AC	LC
Dasypeltis fasciata Smith, 1849	Mangeur d'œufs forestier			xx	x		F	AO,AC	LC
Dipsadoboa unicolor Günther, 1858	Dipsadoboa unicolore			xx			F	AO,AC	LC
Grayia smithii (Leach, 1818)	Couleuvre des rivières de Smith			x			F,S	AO,AC	LC
Hapsidophrys lineatus Fischer, 1856	Couleuvre émeraude lignée			x		x	F	AO,AC	LC
Hapsidophrys smaragdinus (Schlegel, 1837)	Couleuvre émeraude	x					F,S	AO,AC	LC
Mehelya poensis (Smith, 1847)	Serpent-lime de forêt	xx					F,S	AO,AC	LC

Natriciteres variegata (Peters, 1861)	Couleuvre des marais variable	x					F,S	AO,AC	LC
Philothamnus heterodermus (Hallowell, 1857)	Philothamne hétéroderme			x			F,S	AO,AC	LC
Philothamnus irregularis (Leach, 1819)	Philothamne irregulier			x			F,S	AO	LC
Telescopus variegatus (Reinhardt, 1843)	Telescope variable	x	x	x			F,S	AO,AC	LC
Thrasops occidentalis Parker, 1940	Thrasops occidental			x			F	AO	LC
Lamprophiidae (3)									
Boaedon lineatus (Duméril, Bibron et Duméril, 1854)	Boedon ligne	x					F,S	AO	LC
Boaedon virgatus (Hallowell,1856)	Boedon raye	x	x x			x	F,S	AO,AC	LC
Hormonotus modestus (Duméril, Bibron et Duméril, 1854)	Couleuvre modeste				x		F,S	AO,AC	LC
Psammophiidae (1)									
Psammophis phillipsi (Hallowell,1844)	Psammophis de Phillips					x	F	AO	LC
Elapidae (4)									
Dendroaspis viridis (Hallowell, 1844)	Mamba vert		x				F	AO	LC
Naja guineensis Broadley,Trape, Chirio, Ineich et Wüster, 2018	Cobra de forêt de Guinée	x			x		F	HG	LC
Naja nigricollis Reinhardt,1843	Cobra cracheur à cou noir	x		x			F,S	AO,AC	LC
Pseudohaje nigra Günther, 1858	Pseudo-cobra noir					x	F,S	AO	LC
Viperidae (3)									
Bitis rhinoceros (Schelgel, 1855)	Vipère rhinoceros				x		F	HG	LC
Causus lichtensteini (Jan, 1859)	Causus de Lichtenstein		x				F	AO,AC	LC
Causus maculatus (Hallowell, 1842)	Causus maculé			x			F,S	AO,AC	LC
Total 2/2/5/26		10	4	11	4	6			

empty : species not observed; **x** : accidental species; **xx** : incidental species; **xxx** : constant species; **HP**: Preferred habitat; **GD** : Geographical distribution; **CS** : Conservation status; **Ta** : Tazibouo; **Ab** : Abattoir; **Be** : Begafla; **Ga** : Gadouan; **Za**: Zaïbo; **WA**: West Africa; **CA**: Central Africa; **HG**: Upper Guinea Forest Block; **NT**: Near Threatened; **LC**: Least Concern ; **S** : Savannah ; **F** : Forest.

The structure of the snake population studied shows that the Colubridae family is the most represented of the families observed. Our results corroborate those of Kouadio *et al.* (2022), which indicate that the Colubridae family is one of the most represented snake families in Taï National Park and in the park's peripheral agrosystems. The dynamics of the taxonomic composition of the snake population in the Department of Daloa indicate the absence of 13 species, compared to Doucet's inventory (1963), which have been replaced by 13 other species. The species reported by Doucet (1963) and not observed in the present study are: *Typhlops punctatus punctatus, Eryx muelleri muelleri, Natrix anoscopus,* *Bothrophthalmus lineatus, Grayia smithi, Dasypeltis fasciata, Telescopus variegatus, Dromophis praeornatus praeornatus, Miodon acanthias, Aparallactus modestus modestus, Causus rhombeatus, Echis carinatus and Atractaspis aterrima*.

In addition, 13 species observed are reported for the first time in the Department of Daloa : *Python sebae, Afronatrix anoscopus, Dipsadoboa unicolor, Hapsidophrys smaragdinus, Natriciteres variegata, Philothamnus heterodermus, Philothamnus irregularis, Boaedon lineatus, Hormonotus modestus, Naja guineensis, Pseudohaje nigra, Causus lichtensteini* and *Causus maculatus*. This is probably due to the introduction of new snake species into the Daloa Department. Only 13 snake species identified in 1963 are still found in the current population. These are : *Aparallactus modestus, Crotaphopeltis hotamboeia, Dasypeltis fasciata, Grayia smithii, Hapsidophrys lineatus, Mehelya poensis, Telescopus variegatus, Thrasops occidentalis, Boaedon virgatus, Psammophis phillipsi, Dendroaspis viridis, Naja nigricollis* and *Bitis rhinoceros.* This change in the composition of the snake population could be explained by a change in habitats (Auclerc, 2012).

3.4. Occurrence of taxa at the surveyed sites

Based on their frequency of occurrence, the species collected across the five study areas are grouped into two categories: incidental species and accidental species. Table 4 shows the percentages of species categories defined according to occurrences observed at the study sites. For the five (5) sites surveyed, accidental species are in the majority, with proportions ranging from 75% (Abattoir) to 100.00% (Zaïbo and Gadouan). This category is followed by accessory species, with percentages ranging from 0.00% (Zaïbo and Gadouan) to 25% (Abattoir). At the Tazibouo site, the accessory category is represented by the species Aparallactus modestus and Mehelya poensis. At the Abattoir site, the accessory category is represented by the species Boaedon virgatus. At Gadouan, Dasypeltis fasciata and Dipsadoboa unicolor are the accessory species. No accessory species were recorded at the Begafla and Zaïbo sites.

The majority of species observed at the five study sites fall into the category of so-called accidental species, with an occurrence ranging from 75 to 100%. This observation could be explained by the fact that the various species inventoried are in transit in search of prey, hunting sites and sunlight. Indeed, Talla (2003) explains that snakes can sometimes leave their usual habitat to spread out into another area that generally serves as a hunting, breeding, sunbathing and refuge site. Our results are similar to those of Rafael de Fraga *et al.* (2014) in that they also recorded a large number of species classified as accidental in the south-western Amazon rainforest over a two-year period with a team of fourteen people.

Table 4. Proportions (%) of snake species categories based on occurrence at sites surveyed in the Department of Daloa.

Study sites	Constant (%)	Accessories (%)	Accidental (%)
Tazibouo	00,00	20,00	80,00
Abattoir	0,00	25,00	75,00
Begafla	0,00	18,18	81,82
Gadouan	0,00	00,00	100,00
Zaïbo	0,00	00,00	100,00

3.5. Spatial distribution of abundances

The spatial distribution of snake families in the Daloa Department indicates that Zaïbo (5 families) has the highest number of families. It is followed by Gadouan, Abattoir and Tazibouo, each with four families (Figure 8). The lowest number of families was observed in Begafla (3 families). Across all five study areas, the Colubridae family is numerically the most abundant in Begafla (14 individuals), Tazibouo (6 individuals) and Gadouan (2 individuals). Next, the Atractaspidae were abundant in Tazibouo (5 individuals). In contrast, the Pythonidae family was abundant in Zaïbo (4 individuals). The remaining families had the lowest proportions (ranging from 0 to 2 individuals). The spatial distribution of species richness indicates notable differences between study sites. This spatial disparity could be explained by the type of habitat, which determines prey availability and the level of human pressure (Graitson, 2017).

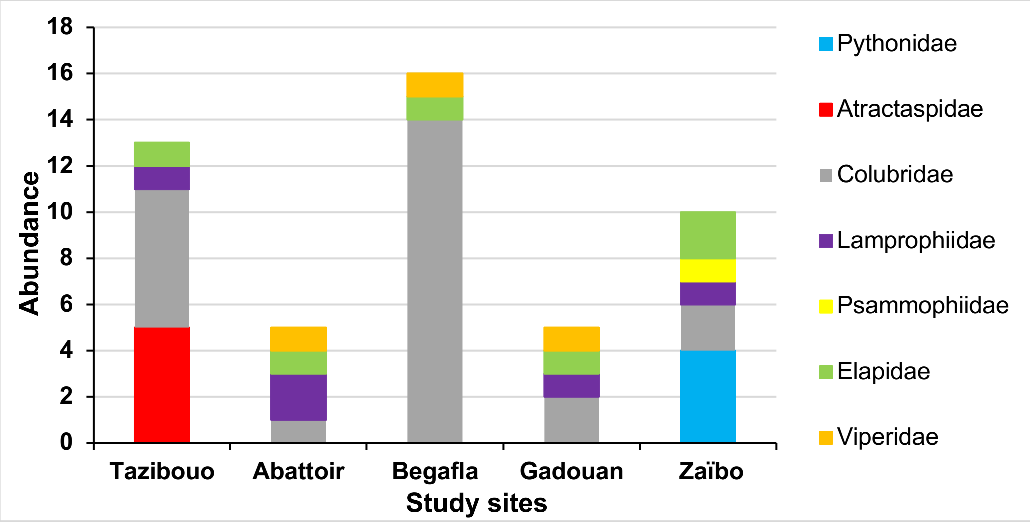

Figure 8. Spatial distribution of family abundances according to study area

3.6. Seasonal variations

Across all five study areas, the highest abundances were recorded during the dry season (Figure 9). During the dry season, snakes were most abundant in Begafla (13 individuals), Tazibouo (12 individuals) and Zaïbo (7 individuals). In contrast, during the rainy season, snakes in the study area are very scarce, ranging from 2 (Gadouan) to 5 individuals (Tazibouo). In terms of abundance, the highest abundances are noted during the dry season at each of the five study sites.

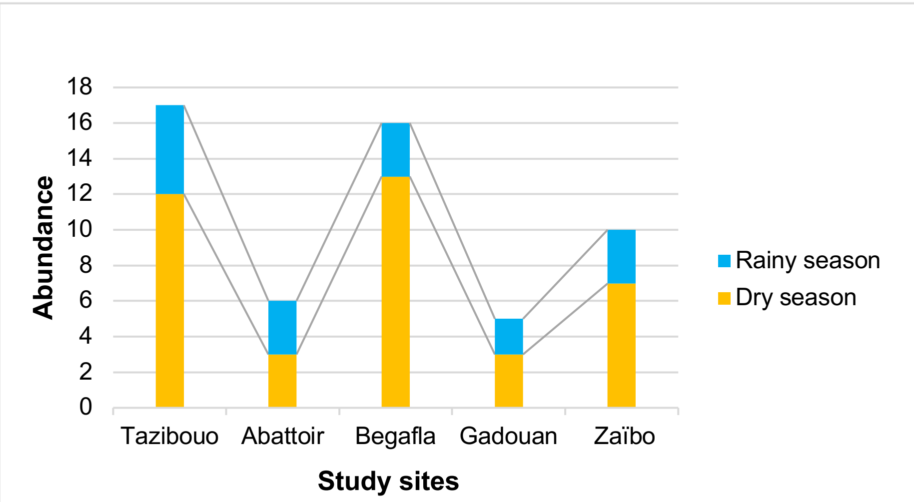

Figure 9. Seasonal variations in the abundance of the ophidian population in the study area

This observation could be related to the metabolism and lifestyle of snakes. As snakes are ectothermic animals, they must reach a specific body temperature in order to be able to move, search for food and choose their habitat (Graitson, 2017). The strong solar radiation during the dry season is likely to provide this body heat, resulting in relatively high abundance.

3.7. Analysis of population diversity

3.7.1. Spatial variations in Shannon and evenness indices

Figure 10 shows the spatial variability of the Shannon (H') and evenness (E) indices for the ophidian population in the Department of Daloa. With regard to H', relatively high variability is observed between the sites studied. The highest value (H' = 2.60) is obtained at Begafla, while the lowest (H' = 1.61) is recorded at Gadouan. As for the E index, it varies little from one site to another. The values range from 0.96 (Tazibouo) to 1.00 (Abattoir and Gadouan). Analysis of the snake population also revealed that the Shannon diversity index is relatively low at all sites surveyed. This low diversity may be related to insufficient sampling effort. On the other hand, the evenness index indicates a fairly high degree of organisation of the population at all the sites studied (Barbault, 1981). Indeed, the results obtained indicate that the evenness index tends towards 1. It takes the value 1 when all species have the same abundance (Zabi, 1993).

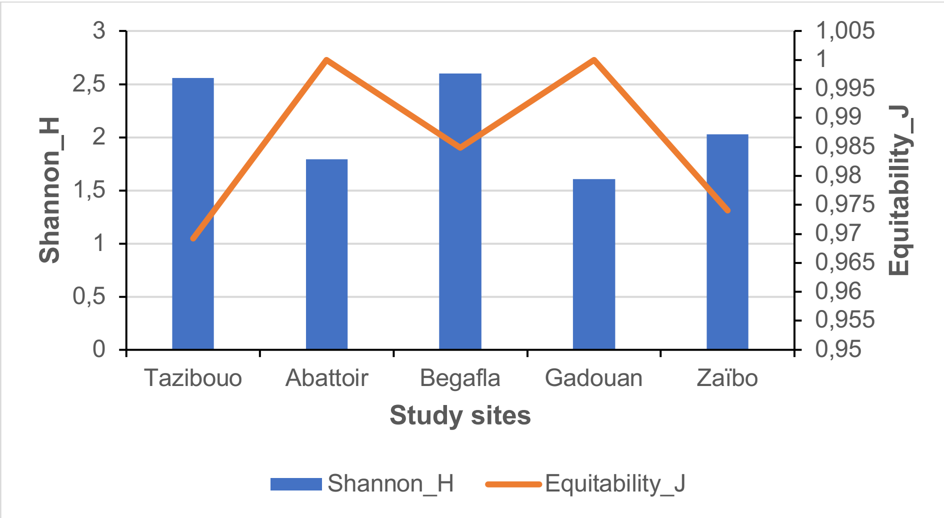

Figure 10. Spatial variations in Shannon indices and evenness indices for the ophidian population in the Department of Daloa.

3.8. Similarities between the sites studied

The degree of similarity between sites based on their specific composition is shown in Table 5. The similarity percentages range from 0 to 16.67%. The highest rate was observed between the Tazibouo and Abattoir sites (16.67%). Zero rates were recorded between Gadouan and Abattoir, and between Gadouan and Zaïbo.

Table 5. Values (%) of the Sorensen similarity index relating to pairwise comparisons of sites hosting snake populations in the Department of Daloa.

Study sites	Tazibouo	Abattoir	Begafla	Gadouan	Zaïbo
Tazibouo	1	16,67	10,53	7,14	14,29
Abattoir		1	7,14	0	11,11
Begafla			1	7,14	6,25
Gadouan				1	0
Zaïbo					1

Conclusion

This study assessed the taxonomic diversity and population structure of snakes in the Department of Daloa.The snake fauna inventory revealed 26 species. These taxa are divided into two infraorders: Caenopnhidia and Henopnhidia, two superfamilies: Booidea and Colubroidea, and seven families. The families encountered are: Pythonidae, Atractaspidae, Colubridae, Lamprophiidae, Psammophiidae, Elapidae, and Viperidae. The ophidian fauna shows a change in its taxonomic composition over time. Thirteen species previously observed are no longer present, while 13 other species have been encountered for the first time in the Department of Daloa. Furthermore, species richness varies considerably from one area to another. The Shannon diversity index is relatively low, while the degree of population organisation remains high. The structure of the population indicates a predominance of accidental species in the sites surveyed. The Colubridae family is the most represented family with 25 individuals spread across thirteen (13) species. For a more in-depth understanding of the snake fauna of the Daloa Department, it would be desirable to increase sampling efforts and the number of study sites, taking into account all types of habitats existing in the Department of Daloa, especially undertaking night surveys and conducting a study on species observed for the first time in the Department with a view to establishing an identification key.

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