**Original Research Article**

# Presence and abundance of chiropteran ectoparasites of Zoonotic importance in Abidjan district, Côte d'Ivoire

.


## ABSTRACT

**Aims:** The aim of this study is to produce information on the diversity and abundance of ectoparasites in bats in Côte d'Ivoire.

**Place and Duration of Study:**It was carried out from December 22, 2020, to January 28, 2021, in the Abidjan district, within the forest relics of the Abidjan National Zoo (ZNA) and the Adiopodoumé site of the Institut Pasteur de Côte d'Ivoire (IPCI)

**Methodology:**The first step was to capture the bats using mist nets and identify them with the help of research assistants. For each bat captured, ectoparasites were collected and identified using the Walker and Ramel keys

**Results:**In the course of this study, 89 bats were collected, most of them adult (91%) and female (50.6%). Most belonged to the genera *Micropteropus* (41.6%) and *Eidolon* (40.4%). Ectoparasites were collected at a rate of 20.22% (+/- 0.187), and identification revealed *Nycteribiabiarticulata* (69.7%) and *Ornithodoroserraticus* (30.3%), belonging to the Insecta and Arachnida classes respectively. A causal link was established in the univariate analysis (p<5%) between the presence of the parasite and the bat species collected.

**Conclusion:**These results provide non-exhaustive information on the diversity and abundance of bat ectoparasites in the Abidjan district belonging to the genera *Ornithodoros* and *Nicteribia*. These ectoparasites are vectors of zoonoses such as intermittent fever due to *Borellia* and vectors of animal diseases such as African swine fever. This research needs to be extended to the entire Côte d'Ivoire in order to identify ectoparasite vectors and gain a better understanding of local biodiversity and zoonotic risks (the transmission of diseases from animals to humans).



*Keywords:* Chiroptera - Ectoparasite - Zoonosis - Surveillance

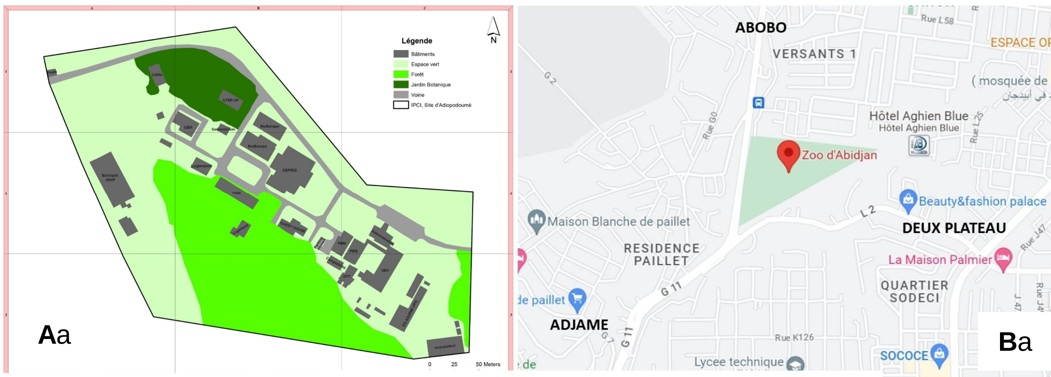

## 1. INTRODUCTION

In Côte d'Ivoire, studies on chiropterans have led to a better understanding of the diversity of this fauna. To date, there are 75 species belonging to 7(seven) different families, including the Pteroptidae (*Hypsignathusmonstrosus*, *Eidolon helvum*, *Micropteropussp*), Amballonarudae, Nicteridae, Rhinilophidae, Hipposideridae, Vespertilionidae (*Pipistrellus sp...*) and Molossidae (13; 14).Studies have also been conducted in Côte d'Ivoire on ectoparasites and the relationship between ticks and the diseases they can transmit to both animals and humans. These studies revealed 6 (six) species, all belonging to the Arachnida class (*Amblyommavariegatum, Rhipicepalusmicroplus, Rhipicephalussenegalensis, Hyalommatruncatum, Hyalommamarginatumrufipes and Hyalommaimpressum*).These studies have mainly focused on animals (ruminants, chicken, and swine) but very rarely on bats. The aim of our study is to produce information on the diversity and abundance of ectoparasites in batsand their related pathogens in the Abidjan district.

## 2. MATERIAL AND METHODS

2.1 Study area and period

This work was conducted in Côte d'Ivoire by setting up net traps at two sites, namely the wooded perimeter around the Institut Pasteur de Côte d'Ivoire (Adiopodoumé site) WGS84 (Latitude: 5° 19' 7.49" N; Longitude: -4° 8' 7.43" W) and the Abidjan National Zoo WGS84 (Latitude: 5° 22' 51.58" N; Longitude: 4° 0' 16.72" W) from December 22, 2020, to January 28, 2021. Located in Adiopodoumé, the 17-hectare Adiopodoume site is made up of a degraded secondary forest that was used to build the institute's infrastructure facilities. The Abidjan National Zoo, currently estimated at around 18 hectares, is located in the commune of Cocody, precisely at the intersection of the roads linking the communes of Abobo and Adjamé to the Plateau-Dokui and Deux Plateau districts. It is made up of secondary forest that is in a very advanced state of degradation. It is home to many free-living animals (bats and some birds) and animals in captivity (17).




**A) Institut Pasteur of Côte d'Ivoire, Adiopodoumé site** **B) Abidjan National Zoo, limits and situation**

Figure 1: Administrative map of study area

2.2. Capturing and identifying bats

At the Institut Pasteur and Zoo National d'Abidjan, trapping carried out continuously throughout the study. Three mist nets at 4 levels and of different sizes (12, 9 and 6 meters), each 3 meters high and 12 meters long, were set up in the undergrowth of each site using bamboo fixed in the ground and ropes to hold them in place. Set up from 6.30 in the evening and taken down before 6.30 in the morning, the traps visited every 30 minutes to remove the bats so that they do not injure themselves by becoming entangled in the mesh of the nets. They are placed in individual cotton bags and hung from a branch or rope provided for this purpose (Fig. 1). The animals were then taken to the Animal Resource Management Unit (UGRA) of the Institut Pasteur de Côte d'Ivoire (IPCI) at the Adiopodoumé site for identification of the bat species and ectoparasites. To identify the bats, information such as weight, sex, age, physiological state and, using a ruler, the various measurements (forearms, fingers, head, body and tail) of each bat were determined according to a determination key described by Webalaand al. (16).


Fig 1. Capture and identification of bats **(Mist nets break; B. Capture of Bats; C and D. Identification of bats)**

2.3. Collecting ectoparasites

After each capture, the bats were taken back to the Animal Resource Management Unit (UGRA) of the Institut Pasteur de Côte d'Ivoire (IPCI) at the Adiopodoumé site. Once at the Unit, some of the animals underwent flash anesthesia with Isoflurane, while others were directly inspected in their entirety. Animal inspection and ectoparasite collection were carried out under SHPII in the UGRA laboratory, in compliance with biosafety measures. Ectoparasites were collected using blunt-tipped forceps, sometimes aided by a binocular magnifying glass. The parasites collected were then immersed in jars containing 70° alcohol (11). Each jar was then identified with the animal's ID number and stored at room temperature pending identification of the parasites collected. For each bat sampled, the examiner recorded the number of parasites collected. Once the ectoparasiteshad been collected, the bats were each placed in transport bags containing fruit and then transported to their capture areas to be released.

2.4 Identification of ectoparasites

The ectoparasiteswere then identified in the laboratory of the Institut Pasteur's Entomology and Herpetology Unit (UEH) (Fig 2). They were identified using an binocular magnifier (OPTIKA)and dichotomous identification keys. The identification key of Walker et al.(18) was used for tick identification and that of Ramelfor insect identification(19The specimens were sorted according to their class, then identified by genus and species.

Fig 2. Parasiteidentification

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2.5. Data analysis

After data management of the database using MS Excel. The actual analysis was carried out using R software version 4.2.1 (MacOS) on the Rstudio 2022.07.1 editor. It consisted firstly of a univariate analysis known as the descriptive method for calculating means, standard deviations and confidence intervals, and secondly of a multivariate analysis for calculating the p-value and the Chi2 test.

## 3. RESULTS AND DISCUSSION

**3.1.**Results

3.1.1. Identification of bats

Eighty-nine bats were collected at the two sites, i.e. the wooded area around the InstitutPasteur site at Adiopodoumé and the forest at Zoo National Abidjan.

3.1.1.1. Distribution of bats according to species

Among the 89 observations, the majority were species belonging to the genus *Micropteropussp*with 37 individuals, i.e. 41.6%, followed by the species *Eidolon helvum* with 36 individuals, i.e. 40.4%.

**TABLE 1: DISTRIBUTION OF COLLECTIONS ACCORDING TO SPECIES (N=89)**

| Species | absoluteFrequencies (n) | relative Frequencies (%) |
|---|---|---|
| *Eidolonhelvum* | 36 | 40,4 |
| *Hypsignathusmonstrosus* | 12 | 13,5 |
| *Micropteropus*sp. | 37 | 41,6 |
| *Pipistrellus*sp. | 4 | 4,5 |

3.1.1.2. Distribution of bats according to sex and age

Of the 89 bats collected, 45 (50.6%) were females and adults represented the majority with 81 observations (91%) (Table 2).

**TABLE 2: breakdown of observations by sex (n=89)**

| Sex | absolute Frequencies (n) | relative Frequencies (%) |
|---|---|---|
| Female | 45 | 50,6 |
| Male | 44 | 49,4 |

3.1.2. Diversity and abundance of ectoparasites in relation to collection areas and bat species.

3.1.2.1. Prevalence of ectoparasites as a function of bat capture areas

Among the 89 bats, 20.22% [20.13-20.30] carried ectoparasites for the entire study. No ectoparasiteswere found on the bats captured at the Adiopodoumé site.Two ectoparasites were identified, namely insects of the species *Nycteribiabiarticulata* (Hermann, 1804) (n=39), i.e. 69.7%, and ticks of the species *Ornithodoroserraticus* (n=17), representing 30.3% of ectoparasites (Table3).

TABLE 3: Diversity and abundance of ectoparasites according to the areas where bat species were captured.

| **Group** | **Family** | **Genus** | **Taxons** | **Study area** | | | |
|---|---|---|---|---|---|---|---|
| | | | | **IPCIforest** | **Zoo National** | **Cumulative number** | **relative Frequencie** |
| | *Nycteribiidae* | *Nycteribia* | *N. biarticulata* | 0 | 39 | 39 | 69,7 |
| **Insect Mite** | *Argasidae* | *Ornithodoros* | *O. erraticus* | 0 | 17 | 17 | 30,3 |
| **Total** | | | **2** | **0** | **56** | **56** | **100** |

Bivariate analysischi-square, showed that there was no statistically significant link (p= 0.074) between the presence of ectoparasite species and the collection site (Table 4).

Table 4: Distribution of ectoparasites according to collection area (N=89)

| | | PRESENCE OF ECTOPARASITES | | |
|---|---|---|---|---|
| | | YES N (%) | NO N (%) | TOTAL |
| SITE | IPCI FOREST | 0 (0,0) | 15 (21,1) | 15 |
| | ZNA | 18 (100,0) | 56 (78,9) | 74 |
| TOTAL | | 18 (100,0) | 71 (100,0) | 89 |

3.1.2.2. Prevalence of ectoparasites according to bat species

However, there was a statistically significant link (P< 0.001) between the presence of parasites and the bat species collected (Table 5).

Table 5. Distribution of ectoparasites by species (N=89)

| | | PRESENCE OF ECTOPARASITES | | |
|---|---|---|---|---|
| | | YES N (%) | NO N (%) | TOTAL |
| GENUS AND SPECIES | *Eidolonhelvum* | 17 (94,4) | 19 (26,8) | 36 |
| | *Hypsignathusmonstrosus* | 0 (0,0) | 12 (16,9) | 12 |
| | *Micropteropus*sp | 1 (5,6) | 36 (50,7) | 37 |
| | *Pipistrellus*sp | 0 (0,0) | 4 (5,6) | 4 |
| TOTAL | | 18 (100,0) | 71 (100,0) | 89 |

3.1.2.3. Ectoparasite species present on bat species

Both types of ectoparasite (Arachnida and Insecta) were collected on the bat species *Eidolon helvum*, but only one insect was collected on the bat of the genus *Micropteropus* (Table 6).

Table 6. Matrix of bat species and their parasites

| SPECES OF BATS | NUMBER | FREQUENCY (%) | PARASITES |
|---|---|---|---|
| ***EIDOLONHELVUM*** | **55** | **98,21** | ***Nycteribiabiarticulata***<br><br>***Ornithodoroserraticus*** |
| ***MICROPTEROPUSSP*** | **1** | **1,79** | ***Nycteribiabiarticulata*** |

3.2. **DISCUSSION**

In this study, four genera of Chiropterawere identified. These are the genera *Eidolon, Hypsignathus, Micropteropus* and *Pipistrellus*. Studies carried out in several regions of Côte d'Ivoire have identified species belonging to these genera and several other Chiroptera genera (14; 20). The genera *Micropteropus*(n=37) and *Eidolon*(n=36) were the majority of bats found. The two species identified in this study, *Eidolon helvum* and *Hypsignathusmonstrosus*, are megachiropters. A study carried out by Niamienet al.(21)on the population of hammerhead bats, *Hypsignathusmonstrosus* in the plateau commune of Abidjan showed that this species has a marked preference for *Terminalia catappa* l. (Combretaceae) breeding sites and that numbers varied according to tree species and season.

*Eidolon helvum* was the majority species, yet this species has conservation status, as it is classified as vulnerable in certain regions.And according to Rickettset al. (22), among mammals, chiropterans constitute a group of threatened species, some of which have seen their numbers decline at a particularly alarming rate

Several studies have shown that bats are infected by a wide variety of endoparasites and ectoparasites. Several studies have shown that bats are infected by a wide variety of endoparasites and ectoparasites, and to date many groups of ectoparasites, such as bat flies (Diptera), bugs (Hemiptera), fleas (siphonoptera) and several arachnids such as fleas (Mesostigmata) and ticks including *Ornithodoros spp*.(24, 25,26). In this study, two species of ectoparasites were identified, namely insecta of the species *Nycteribiabiarticulata*(Speiser 1900)and ticks of the species *Ornithodoroserraticus*(Lucas 1849). The data collected demonstrate the presence of ectoparasites in the district's bats, and analysis of the data shows that the diversity and abundance of ectoparasitesare influenced by bat species p< 0, 001.

According to Parola and Raoult(27), ticks of the genus *Ornithodoros*are known to be vectors of relapsing fever, which is an infection caused by certain species of *Borrelia* in humans. AndTicks of the genus *Ornithodoros* are known to be reservoirs of medically important pathogenic bacteria found throughout the world in birds, as well as the African swine fever virus.(28; 29). In Algeria, the species *Ornithodoroserraticus*has been found in rodent burrows in the east of the country (30).

In Côte d'Ivoire, knowledge of soft ticks is incomplete and less extensive than that of hard ticks (Ixodidae), given their veterinary and public health importance (31;32).Further studies are needed to determine the specific composition of Argasidae and the diseases they could transmit. Precise knowledge of the distribution of these ticks and their monitoring are vital for defining areas at risk of tick-borne diseases and for establishing appropriate tick control and prevention measures. Against this backdrop, ongoing tick monitoring is an ongoing need in our regions.The insect species *Nycteribiabiarticulata* identified in this study was also collected from a bat species in Latvia different from the one discovered in this study (33). This could be explained by the fact that this ectoparasite species has a host diversity. Several species of *Nycteribia* in the Nycteribiidae family have been identified in bats in several studies (34; 35; 36).

These diseases are unique in that the diversity and complexity of the epidemiological cycles of the pathogens responsible complicate their study and monitoring. Côte d'Ivoire therefore has a strong interest in stepping up its research into the diversity of ectoparasites on wildlife in order to understand their diversity, but also to step up surveillance of the diseases that these ectoparasites could transmit.

## 4. CONCLUSION

In Côte d'Ivoire, studies have identified numerous bat species in different biotopes.. However, none of these studies had focused on bat ectoparasites. This study, which is one of the first of its kind, highlights the presence of insecta and arachnidarespectivly*Nycteribiabiarticulata* and *Ornithodoroserraticus* on bats at two sites: the wooded area around the Institut Pasteur site at Adiopodoumé and the forest at Zoo National Abidjan. The vast majority of these ectoparasiteswere identified on the *Eidolon helvum*, a species classified as vulnerable in other countries, which nests in the business center of Côte d'Ivoire's economic capital. Many studies have shown the role of these two types of ectoparasite (Insecta and Arachnida) in the transmission of both human and animal pathogens such as *Bartonella*, *Borellia* and African swine fever virus.

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**DEFINITIONS, ACRONYMS, ABBREVIATIONS**

IPCI: Institut Pasteur of Côte d'Ivoire
ZNA: Zoo National of Abidjan
UGRA: Unit of Animal Ressources Management
UEH: Unit of Enthomology and Herpetology