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Inventory of bat (*Scotophilus leucogaster,* Cretzschmar 1826) ectoparasites of savannah area in Burkina Faso

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Abstract

Scotophilus leucogaster (Cretzschmar 1826), is one of the most widespread insectivorous bats species in Burkina Faso. Despite its key role in the balance of the ecosystem, this species could be a host to a large number of ectoparasites, which can act as vectors for zoonotic agents. For this reason, we investigated on ectoparasites of *S. leucogaster* in savannah area of Burkina Faso. A total of 102 *S. leucogaster* were captured, using mists nets, in five different areas of Burkina Faso from August to November 2018. Ectoparasites were collected through hand picking and also by swabbing with cotton well soaked in 70% ethanol. The results revealed that 24.5% of the bats were infested with ectoparasites. Four (04) species of parasites were determined (tick: *Argas* sp, mites: *Cimex* sp, acarian: *Spinturnix* sp and *Macronyssus* sp), belonging to four (04) families and three (03) orders. The most abundant ectoparasites specie were *Argas* sp. The results also showed that adults males bats harbored high numbers of ectoparasites than female bats. Comparing the prevalence according to areas, we found that, the highest proportion of individuals infested was recorded at Bobo-Dioulasso. These results show that bats are hosts of several parasites and this parasitofauna could be responsible for public health problems.

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Introduction

Burkina Faso occupies a special place for wildlife conservation in West Africa (Kangoyé *et al.*, 2012). Currently in Burkina Faso, 44 species of insectivorous bats have been meet, and the most common of which is *Scotophilus leucogaster* (Cretzschmar 1826) (Kangoye *et al.*, 2015). *Scotophilus leucogaster* (Cretzschmar 1826) called white-bellied yellow Batin English is a species recorded in most of West African countries (IUCN,2017). Commonly encountered species, *S.leucogaster* is widespread and present in almost all vegetation zones except for the South-Sahelian zone (Kangoye *et al.*, 2015). There appear to be no major threats to this species as a whole (IUCN, 2017).

This species has been recorded from both dry and moist savanna habitats. Habitat models suggest it might be more widespread in southern Africa than currently recovered (Monadjem *et al.*, 2010). The diet of *S. leucogaster* comprised mainly Hemiptera and Coleoptera, with Hymenoptera, Homoptera, Orthoptera, Lepidoptera and Diptera thus playing a key role in the balance of the ecosystem (Barclay, 1985). Knowledge and protection of biodiversity are important for the environment.

Bats frequently fly to urban areas and settle in buildings (attics, cellars) and introduce pathogens (Naa, 2015). They are becoming increasingly important in the epidemiology of emerging diseases (Sara, 2002). Bats are hosts of a large number of ectoparasites (Klimpel and Mehlhorn, 2014), representing different groups of arthropods (Sampath, 2009). After the anopheles, ectoparasites of bats are among the vectors of most hemosporidia known, and may be the potential vectors of viruses and parasites (Sara, 2002). The ectoparasites of bats belong to five Orders: Siphonaptera (fleas), Diptera (flies), Hemiptera (true bugs), Dermaptera (earwigs), and Acari (ticks and mites).

Bats have frequent interactions with humans, serving as platforms for transmission of pathogens from bats to humans and other animals (Naa, 2015). *S. leucogaster* could be a potential reservoir for ectoparasites, creating public health problems especially in zoonotic diseases. Ther is very little information on ectoparasites of this species in Africa. Only Zumpt and Till (1954) found the presence of amite ectoparasite *Steatonyssus nyassae* on *S. leucogaster* in Sudan. However, there is a lack of information on ectoparasites of *S. leucogaster* in Burkina Faso. Our aim in this study was to investigate the existence of bat (*Scotophilus leucogaster*, Cretzschmar 1826) ectoparasites of savannah area in Burkina Faso.

Material and methods

Study sites

Burkina Faso is a landlocked country covering 274 200km². It occurs between 9°20'–15°3' N and, 2°20'E–5°3' W. Burkina Faso is characterized by a Sudano-Sahelien tropical climate with a dry season from October–November to April and a wet season from May to September–October, depending on climatic zones. Our study was carried out in Burkina Faso where we selected five (05) chief towns as study area: Ouagadougou, Bobo-Dioulasso, Koudougou, Banfora and Tenkodogo (Fig. 1).

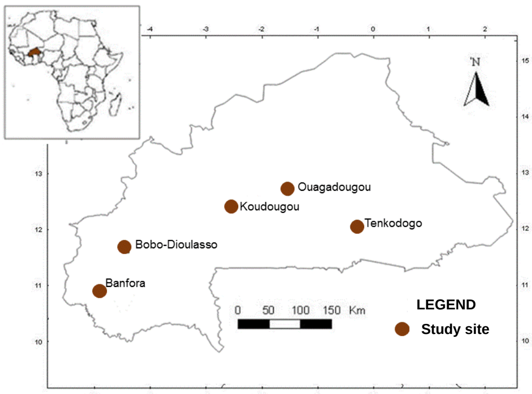

Fig. 1. Map showing the study sites .

Trapping of bats

Samples were collected within the epizootic virus project of (LNR-FHV)/ Muraz center. Bat samples were collected from August to November 2018. Bats were captured in 12m by 6m mist nets with four or five shelves as part of an ongoing study of bat ecology. The nets were set from up 6 pm to 5 am and inspected every 30minutes to ensure that bats captured did not stay too long in the net struggling.

Bats hunt at night for food and therefore it was necessary to work on them quickly and release them to go and feed. Captured bats, were removed and placed in aerated bags and brought to the laboratory for the research of parasites. Thick garden gloves were used while removing the bats from the nets to prevent scratches and bites. The weight, forearm lengths, sex of bats and reproductive status were recorded. Bats were identified with the help of a field guide 'Bats of West Africa' by Rosevear (1965), Hayman and Hill (1971); and of Bergmans (2002).

Ectoparasites collection

Individual bats were carefully handled and examined for ectoparasites. The fur, wing membranes and ears of each bat were carefully searched with a light-emitting diode (LED) lamp. Visible ectoparasites were carefully picked up with the fine forceps and fixed in plastic eppendorf tubes (70% ethanol) to ensure that the specimens were not dehydrated and that the important features remained intact. Each sample was then labelled with a unique number and locality. This information as well as other data including the species of bat were recorded on a data sheet for future reference.

Apart from the visible ectoparasites that were picked, bats are known also to harbor ectoparasites that are so small not visible to the neck eye. Such parasites were collected by cleaning the whole body surface of the bat with cotton wool soaked in ethanol (70%). This will immobilize and pick up any microscopic parasites on the surface of the bats. The used cotton was then placed in a Ziploc bag, sealed and labelled. Bat parasites transported to Laboratory and collected ectoparasites were identified using manuals and keys (Kolenati, 1856; Dodds, 2008; Delfinado and Baker, 1963).

Data analysis

Statistical analysis of the data was carried out, with the aid of the R. 3.3.3 statistical software. A Shapiro-Wilk test was used to check for normality of the data which proved the data not to be normally distributed therefore non-parametric tests were used in the analysis of data. Pearson's Chi-squared test was used to test for significance in parasitic load among the age categories, the sexe and reproductive status of bats. A Kruskal-Wallis H test was used to test for significance in ectoparasite infection in bats. The prevalence, mean intensity and mean abundance were calculated according to the definitions of Bush *et al.* (1997). The prevalence is the percentage of bats infested.

The mean intensity estimates the population size of a parasites species on the host. The mean abundance estimates the mean number of parasites per host individual across the entire sampled host population.

Results

Parasites recovered from bats

Of the 120 bats collected, 25 were infested with at least one parasite. A total of 68 ectoparasites divided into four major families (Argasidae, Cimicidae, Spinturnicidae, and Macronyssidae) were recorded. The Argasidae family represented by *Argas* sp constituted the most abundant with 73.53% of all ectoparasites encountered, following by Spinturnicidae 16.17% represented by *Spinturnix* sp. The family of Cimicidae (*Cimex* sp 7.35%) and Macronyssidae (*Macronyssus* sp, 2.95%) were less represented (Fig. 2).

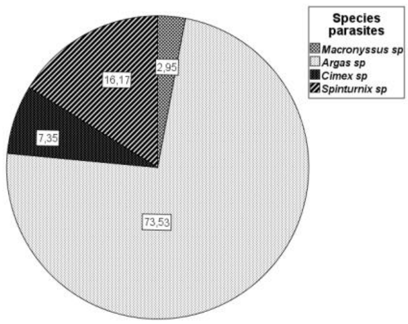

Fig. 2. Pie chart percentages of frequency of ectoparasites occurrence.

Argas sp

Argas sp is a soft tick associated with bats and their habitats (cracks and crevices in walls, caves and buildings infested with bats). This species was the most encountered in our study with 50 parasites. *Argas* sp was found in Bobo-Dioulasso, Banfora and Tenkodogo.

We found only the larvae of *Argas* sp. They have three pairs of legs. These larvae are characterized by a body with a circular outline (Fig. 3). The legs come from the anterior half of the body and are shorter than the body.

The coxa are contiguous and the tarsi are tapered and lack dorsal bumps. The integument is smooth and marked by a fine network of small irregular cells among which radiate regular and sub-parallel rows of larger disks. The species has been found on almost all the different parts of the body of its hosts except at the level of the anus and the eyes. The proportion of the species is 73.53% on all ectoparasites collected.

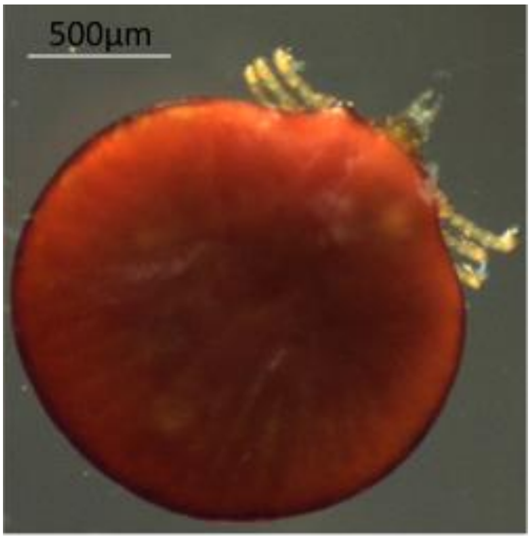

Fig. 3. *Argas* sp larva.

Spinturnix sp

Spinturnix sp is an exclusive ectoparasite mite of bats that is part of the Spinturnicidae family. It was found only on the wing membranes of bats to the detriment of other parts of the body. This genus is characterized by the presence of hidden stigmas (4 pairs) at the base of coxa P1, P2, P3, P4. This ectoparasite species has dorsal shields with sclerotine, and 2 or 3 ventral shields: sternal, genital-ventral and anal that are important for gender identification (Fig. 4).

During our study, the species was found in Bobo-Dioulasso, Banfora and Tenkodogo. The proportion of the species is 16.17% on all ectoparasites collected.

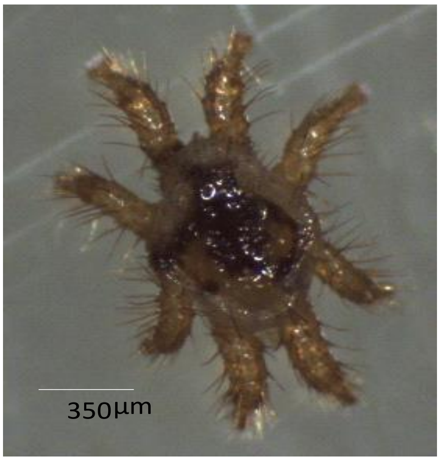

Fig. 4. *Spinturnix* sp.

Cimex sp

Cimex sp is a small wingless hematophagous insect, reddish brown in color (light yellow in immatures) and 7 mm long in adulthood. It is characterized by a rounded and flattened shape (Fig. 5). The head of the adult in these species is absolutely similar to that of the nymph, with the exception of the complete fusion of the ecdysial lines and the sclerotization of the ventral side. The head is pyramid-shaped, the eyes are clearly visible, the antennae are thin and the mouthparts are folded under the head and thorax. It was found in Bobo-Dioulasso with a proportion of 7.35% of all ectoparasites collected.

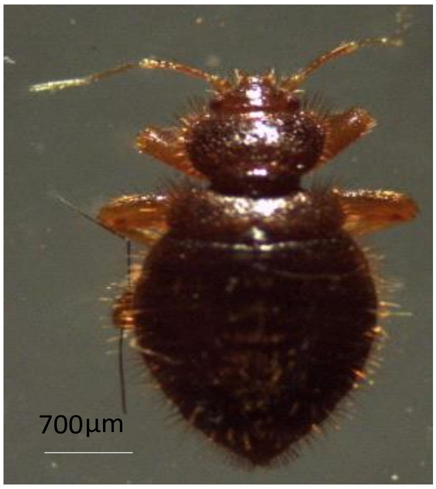

Fig. 5. *Cimex* sp.

Macronyssus sp

Macronyssus sp is a small ectoparasite mite exclusive to bats. The size of *Macronyssus* sp is less than 0.5mm. The legs are relatively long.

We found it only in Banfora with a proportion of 2.95% on all ectoparasites. It has only been found on the females of our host (*S. leucogaster*). *Macronyssus* sp is characterized by a very large idisoma and weakly sclerified with an ovoid shape in the prosome portion (Fig. 6). The opisthosoma is well developed.

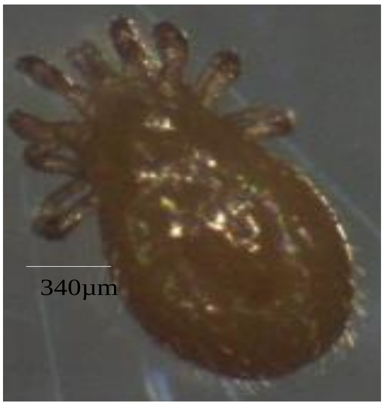

Fig. 6. *Macronyssus* sp.

Ectoparasites prevalences, mean abundance and mean intensity

The overall prevalence was 24.5% for all captured bats. Table 1 shows that the prevalence of *Argas* sp was the highest (18.62%).

The same prevalence (1.96%) was observed in *Macronyssus* sp and *Cimex* sp. There was no significant difference between the average intensity of ectoparasites collected according to the species (Kruskal-Wallis, HW = 3, ddl = 3, p-value = 0.39). The average abundance of *Argas* sp was high (0.49) compared to others species (*Spinturnix* sp (0.10), *Cimex* sp (0.049) and *Macronyssus* sp (0.029)).

Table 1. Prevalence, mean intensity and meanabondance of parasite of *Scotophilus leucogaster*.

Parasites species	Prevalence	Mean abundance	Mean intensity
Argas sp	18,62	0,49	2,63
Spinturnix sp	6,86	0,10	1,57
Cimex sp	1,96	0,049	2,5
Macronyssus sp	1,96	0,0196	1

Influence of sex on bats ectoparasites distribution

From all bats collected, we found that 22.22% females and 27.08% males were infested. Thus, we find a significant difference in the prevalence of infestation at the sex level (x^2 = 30.07, df = 2, p-value<0.05). Species richness and mean intensity were higher in males than in females (Table 2).

Table 2. Prevalence (%), mean intensity and mean abundance in to relation hot sex.

Parasite species	Prevalence			Mean intensity		Mean abundance	
	Male	Female	χ^2	Male	Female	Male	Female
Argas sp	18,75	22 ,22	0,58	2,66	2,16	0,5	0,48
Spinturnix sp	4,16	5,55	0,65	3,5	1,33	0.14	0,074
Cimex sp	8,33	1,85	0.04	1	1	0,08	0,018
Macronyssus sp	4,16	0	0.04	1	0	0,04	0

Distribution of ectoparasites according to the status and age class of bats based on reproductive status

We observed that 52% of breeders were infested, following by nulliparas (44%) and post-lactating (4%). However, we did not find any suckling, pregnant or non-breeding bats affected. We found a significant difference in the reproductive status of parasitized bats (p-value <0.05). The distribution of ectoparasites by age class revealed that 56% of adult and 44% of sub-adult were infested. There was no significant difference between the age classes of parasitized bats (X^2 = 0.36 df = 1, p-value = 0.54).

Relationship between ectoparasites

The analyzes showed significant preferential association trends between some ectoparasite species. Thus two cases of mixed infestations were reported *Argas* sp and *Spinturnix* sp and co-infestation with *Argas* sp with *Cimex* sp. No co-infestation between *Macronyssus* sp and *Argas* sp, *Cimex* sp and *Spinturnix* sp was observed. Indeed, there was a negative correlation between *Macronyssus* sp and *Argas* sp (r = - 0.5) as well as *Macronyssus* sp and *Cimex* sp (r = - 0.5).

Discussion

The diversity of ectoparasites found in this study could be due to the structure of the habitat populated by *S. leucogaster*. According to ACR (African Chiroptera Report) (2016) *S. leucogaster* coexists with men in caves, rocks and abandoned houses. This distribution and its diet make the species a potential host for parasites. We isolated the *Cimex* sp (Cimicidae) on two bats. It is a stink bug very close to bats and can infest the man. The genus *Cimex* is well known for the consequences caused by their bites. Its bite could cause an allergic reaction (caused by saliva), psychological effects andiron deficiency anemia (Zorrilla-Vaca *et al.*, 2014).

As for the acariens, we found three species, the *Argas* sp tick and mites *Spinturnix* sp and *Macronyssus* sp. Several studies confirm their presence in bats such as those of Mariama *et al.* (2013) in Malaysia. Indeed, the genre *Macronyssus* has the most common ectoparasites of bats, order *Mesostigmata*. This genus was found in South Africa with a wide distribution in the bat species *Miniopterus natalensis* (Simon, 2012).

The isolated *Argas* sp tick has a wide distribution in the world. It has been found in several insectivores like the genera *Scotophilus* or the genera *Pipistrellus* (Kolonin, 2007, Orlova, 2013, Hornok *et al.*, 2014, Leulmi *et al.*, 2016). Several pathogens have been detected in these species. In 1966, *Coxiella burnetii*, the Q fever agent, was detected in *Argas vespertilionis* ticks collected in southern Kazakhstan. *Argas* sp was represented only by larvae on bats. This could be explained by the fact that *Argas* feed on their hosts from the time they have a few days to 2 weeks (Nozais *et al.*, 1996). Nymphs and adults gorge in less than an hour; thus, the probability of finding ticks at these stages of growth in bats is low. It is also known for its ability to bite humans (Socolovschi *et al.*, 2012). Other studies have reported the infestation of this tick by bacteria of the genus *Borrelia* (Orlova, 2013).

We found a significant difference in the reproductive status of parasitized bats (p-value <0.05). In fact, depending on the reproductive status, the nulliparas were less infested than breeders. This could be explained by the fact that non-breeding females generally sleep individually or in small groups away from maternity colonies (Hamilton and Barclay, 1994) and can thus avoid ectoparasites or reduce infestation by frequently changing breeding sites per day. We found that adult bats are more parasitized than sub-adults (p-value <0.05).

There are many mechanisms that can cause differences in age-infestation levels without being related to the effects of parasites such as differential exposure to parasites or changes in sexual maturation (Wilson *et al.*, 2002).

The distribution of ectoparasites according to the sex of the bats gave us a significant difference, the males are more parasitized than the females (p-value <0.05). Also, species richness and mean intensity were higher in males than females. These results are similar to those found by Christe *et al.* (2003) and Lucan *et al.* (2006) and could be attributed to ecological factors (behavioral difference) or physiological factors.

Males may be more susceptible to infection than females; not only because the highest androgen levels could reduce their immunocompetence, but also because sex steroid hormones affect disease resistance genes and the behaviors that make them more vulnerable to infestation (Christe *et al.*, 2003).

We observed a correlation between ectoparasites species, which could lead us to take into account the different factors of variability between species. Indeed, according to Sol *et al.* (2003), many factors of interspecies heterogeneity can influence the host-parasite relationship.

Conclusion

This study shows that 24.5% of bats are parasitized. Of the 68 ectoparasites encountered, 73.52% were *Argas* sp, 7.35% *Cimex* sp, 16.17% *Spinturnix* sp and 2.94% *Macronyssus* sp. The most abundant parasite is *Argas* sp. Infestation rates were higher in males than in females. There is a difference in infestation with regard to the reproductive status of bats. Thus, the results of this study show that *S. leucogaster* is infested by ectoparasites and could be vector of several zoonotic pathologies.

Abbreviations

LNR-FHV: Laboratoire National de Références des Fièvres Hémorragiques Virales.

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