Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2024; 12(3): 218-223

Received: 18-03-2024
Accepted: 20-04-2024

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Biolocalisation of ectoparasites on village hens (*Gallus gallus domesticus*) Linne 1758 in Ngaoundere town, Cameroon

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DOI: https://doi.org/10.22271/j.ento.2024.v12.i3c.9334

Abstract
Ectoparasites can affect animal health either by their direct pathogens role (nuisance, blood loss, serious skin damage and reduced productivity) or as pathogen vectors responsible of serious diseases. They are located in different parts of the head. The objective of this work was to determine the prevalence and the location of ectoparasites on village hens in the town of Ngaoundere in Cameroon during the period from June 2021 to February 2022. Thus a prospective study was conducted. The samples were collected on a monthly basis from the village hens; from 6 am to 8 am, in selected farms. Morphological discrimination and identification took place at the Veterinary and Medical Entomology Laboratory (MSEG) at Ngaoundere. As result, an overall prevalence of 70.08% was obtained and three species identified: *Echidnophaga gallinacean* Westwood, 1875; *Ceratophyllus gallinae* Shrank, 1803 and *Argas persicus* Oken; 1818. This prevalence varied seasonally with a significant preponderance in the rainy season (80.1%) compared to the dry season (55.1%) (p<0,001). Depending on the collection sites, high prevalence of *E. gallinacean* was observed on the farms of Manwi I, Hore-foret, Tchabbal and Darang Station (p<0,001). A total of 1357 ectoparasites were counted for a mean parasitic load per host of 7.93 ectoparasites. The eyelids were the most infested area with 48% followed by crest (20%) and the barbell (18%). These obtained values suggest a need to control ectoparasites of village chickens living in the town of Ngaoundere which are exposed to the risks of poly infestations in view of the diversity of ectoparasite circulating.

Keywords: Ectoparasites, *Gallus gallus domesticus*, Cameroon

Introduction
The increase in population is accompanied by a decrease in arable land and change in eating habits, which imposes a high demand for protein resources (Van Huis *et al.*, 2015) [1]. FAO indicates that global food production will need to increase by 70% to feed the world by 2050. Livestock farming is inevitably the most effective way to increase the production and consumption of animal proteins. In sub saharian Africa, traditional poultry farming plays a key role in the quest for self-sufficiency and sustainability of food security (Ayssiwede *et al.*, 2013) [2]. It contributes to meeting the domestic and economic needs of millions of small producers who are generally poor (Issa *et al.*, 2012) [3] in rural areas (Alders, 2005) [4]. In Cameroon, 85.9% of households are engaged in livestook farming with an estimated population of 20810500 (INS, 2019) [5]. Consumption of the poultry products (4.1 kg/capita/year) is well below the recommended standard (23 to 30 Kg/capita/year) is well below the recommended standard (23 to 30 Kg/capita/year). Among the causes of low poultry productivity is parasitism (Gragnon *et al.*, 2020, Bagari Iya *et al.*, 2021) [6, 7]. Indeed, the village chicken is affected by a wide range of parasites including ectoparasites (Amoussou, 2007; Brou *et al.*, 2018) [8, 9]. These external parasites, mainly included in the group of arthropods, can affect the health of animals either by their direct pathogenic role (nuisance, blood deprivation, skin lesions, decreased productivity) or by their role as vectors of pathogens responsible for serious diseases (Colebrook & Wall, 2004) [10]. In ectoparasitic insects, some are temporary parasites such as flies, mosquitoes, Simulias while others are permanent parasites such as most fleas notation *Echidnophaga gallinacean* Westwood, 1875.

It is a small and cosmopolitan burrowing chip. It is located in different parts of the head without feathers (Wall & Shearer, 2001) [11]. This siphonapter species is a formidable parasite of the chicken that reduces the growth and laying of eggs, leads to anemia and death in young. In addition, eye damage caused by scratching can lead to blindness (Wall & Shearer, 2001) [11]. To improve the yield of the local poultry herd, it is necessary to determine the distribution of ectoparasites (disease vectors or not) in different agro-ecological zones of the country, in order to develop a global control plan. Unfortunaly, no studies have been conducted to highlight the fauna of ectoparasites of local chickens in Cameroon. It is in this context that the present study is intended to contribute to the knowledge of arthropod fauna harmful to village chickens. Specifically, it was discussed to identify the prevalence and location of ectoparasites on poultry in the town of Ngaoundere.

Materials and Methods

Study area

The work took place from June 2021 to February 2022 in the traditional farms of Hore-Foret, Manwi I, Manwi II, Darang, Mayo Daneyel and Tchabbal. These sites are near the town of Ngaoundere, the capital of the Department of Vina. The latter is between latitude 6°204 and 7°404 North and longitude 11° and 15° East (Mbahe, 1998) [12]. Its climate is of the transitional tropical type. The annual rainfall is about 1500 mm with a rainy season of 7 to 8 months (March to October; or even November) and a dry season of 4 or 5 months (late November to mid-March). The average temperature is 22 °C (Ndame, 2000) [13]. The hematophagous flea capture site (Figure 1) was selected based on herd size (at least 50 animals), accessibility, method of rearing absence of external deworming for at least three months and farmer consent.

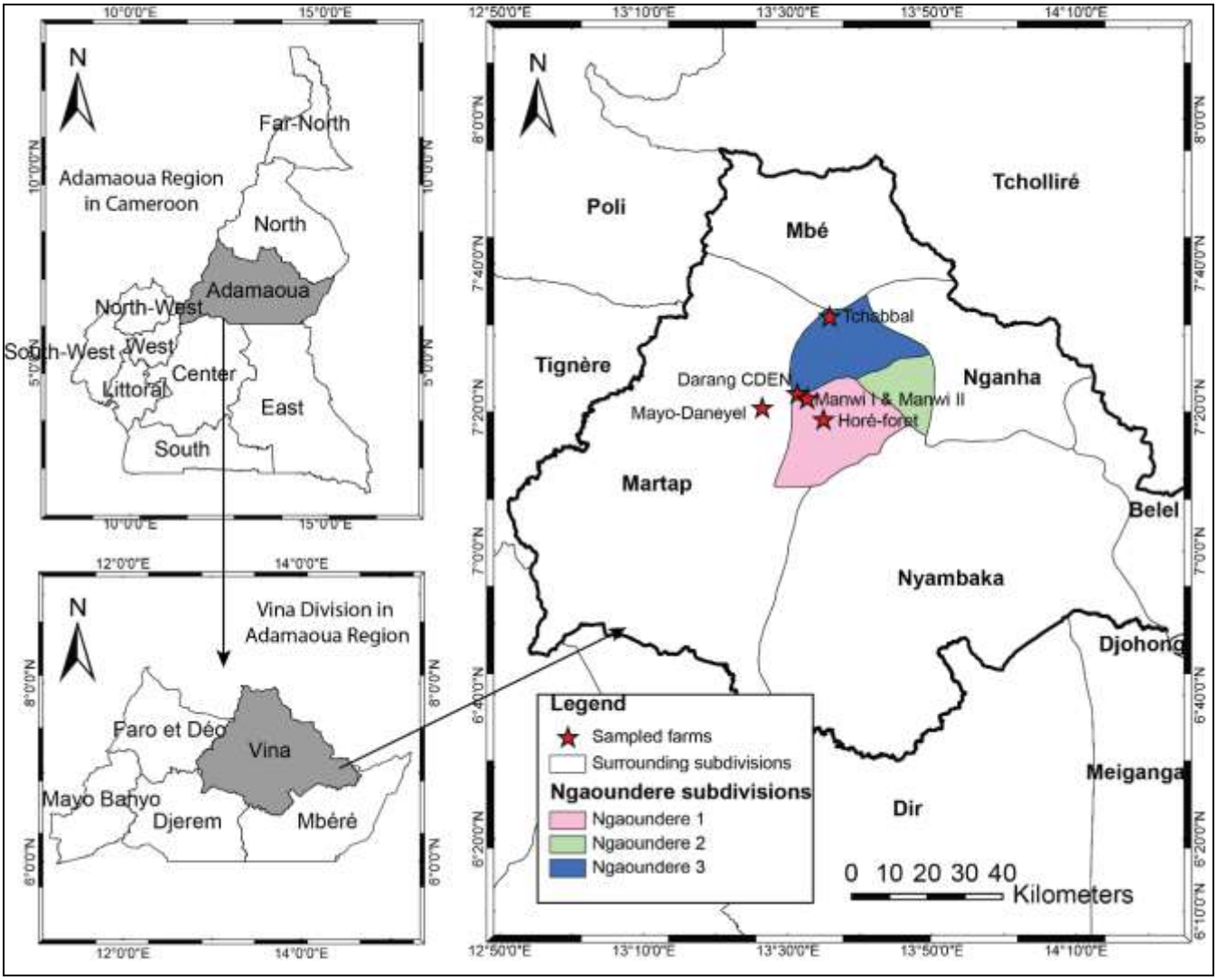


Fig 1: Location of the study area

Animal material

Study population

Hosts of parasitic arthropods were randomly selected and information on age, sex, species location of fleas and their numbers were recorded. Age was determined subjectively by the breeder's estimate. Animals under 22 weeks of age were considered young and those over 22 week of age were considered adult (Fraol *et al.*, 2014) [14].

Fleas collection, conservation and identification method

For the collection of arthropods, the village chickens were captured in the morning from 6 am to 8 am in their pens. Once these hens are caught, they were held and for 5 minutes the active search for ectoparasites took place. The head (barb, eyelids and crest) was examined first followed by the head and anal area. After sampling, these arthropods were stored in different bottles containing 70° alcohols. On these bottles, it was indicated the place collection and location of fleas on the

animal), the number of individuals, the sex and the age of the host (young and adults). The sampled hens were marked with the blue varnish on the left leg identification keys of Soulsby (1982) [15] and Mullen & Durden (2021) [16] made it possible to distinguish arthropod species from their morphological characteristics at the Laboratory of Medical and Veterinary Entomology of Ngaoundere.

Data analysis

The data were collected in the Excel version 2016 spread sheet and transferred to the statistical software R [17] (R Core Team, 2023) according to 03 axes: the calculation of the prevalence of infestation by the chip as well as the average infestation loads, looking for risk factors for ectoparasitic infestation and determining preferred anatomical sites on their hosts. The risk factors selected for analysis were sex, host species, farm, season, age and locations. The Wilcoxon test was used for variable with two categories and the Kruscal-Wallis for variables with more than two categories. The design of the descriptive tables was based on the calculation of average loads, standard deviations, minimum and maximum loads. Similarly, descriptive graph was produced using functions of the ggstatsplot package (Patil, 2021) [18].

Results

Prevalence of ectoprasites

At Ngaoundéré III three species were identified on 244 hens with an overall prevalence of 70.08%. The species were identified were *Echdnophaga gallinaceae* Westwood, 1875, *Ceratophyllus gallinae* Shrank, 1803 and *Argas persicus* Oken, 1818. This prevalence varied seasonnally with a significant preponderance in the rainy season (59.9%) compared to the dry season (40.1%) (p<0.001) (Table 1). With the exception of *A. persicus*, ectoparasitic species were significantly more infesting during the rainy season (p<0.001) (Table 2).

Table 1: Prevalence and average loads of fleas for dry and rainy seasons

Season	N	Number of ectoparasites	Mean load	Prevalence
Dry season	98	300	3.06	40.1
Rainy season	146	1057	7.24	59.9

Table 2: Variation in rates of infested animals and average flea loads by season

Flea species	Dry season, N=98	Rainy season, N=146	P-Values
E. gallinaceae	53 (54.08%)	116 (79.45%)	<0.001
C. gallinae	28 (28.57%)	77 (52.74%)	<0.001
A. persicus	2 (2.04%)	2 (137%)	1.000

P-values, Obtained from the independence test $\chi 2$

Depending on the collection sites, high prevalence of *E gallinaceae* was observed at Manwi I, Hore foret, Tchabbal and Darang station farms. In the Manwi I farm, the hens were (76.3%) very infested with *C. gallinae. The species A. persicus* showed relatively low infestations (5.26%) in the single point of Hore Foret (Table 3).

Table 3: Variation in rates of infested animals and average flea loads by locality

Flea species	Manwi I, N=38	Horé-Forêt, N=38	Tchabbal, N=26	Darang station, N=30	Darang CDEN, N=36	Mayo-Daniel, N=39	Manwi II, N=37	P-Values
E. gallinae	34 (89.47%)	35 (92.1%)	23 (88.46%)	28 (93.33%)	27 (75.00%)	1 (2.56%)	21 (56.76%)	< 0.001
C. gallinae	29 (76.32%)	16 (42.11%)	15 (57.69%)	14 (46.67%)	17 (47.22%)	0 (0.00%)	14 (37.84%)	< 0.001
A. persicus	0 (0.00%)	2 (5.26%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (5.41%)	0.155

Depending on the age of the hosts, adults and young animals were prone to ectoparsitic infestations (Table 4). Depending on the species, infestations ranged from 1.08% in *A. persicus* to 74.19% in *E. gallinaceae*. There were no significant differences in prevalence between youth and adults.

Table 4: Variation in rates of infested animals and average flea loads by host age

Species	Adult, N=151	Young, N=93	P-Value
E. gallinacea	100 (66.23%)	69 (74.19%)	0.190
C. gallinae	61 (40.40%)	44 (47.31%)	0.289
A. persicus	3 (1.99%)	1 (1.08%)	1.000

P-values, Obtained from the independence test $\chi 2$

Depending on the sex of the hosts, both males and females were infested with ectoparasites during the study. Infestations ranged from 1.31% in *A persicus* to 70.3% in *E gallinacea*. There were no significant differences in prevalence between males and females (Table 5).

Table 5: Variation in rates of infested animals and average flea loads by sex

Fleas species	Male, N=91	Female, N=153	Total	p-value
E. gallinacea	64 (70.33%)	105 (68.63%)	169 (69.26%)	0.780
C. gallinae	42 (46.15%)	63 (41.18%)	105 (43.03%)	0.448
A. persicus	2 (2.20%)	2 (1.31%)	4 (1.63%)	0.630

Parasitic loads of ectoparasites

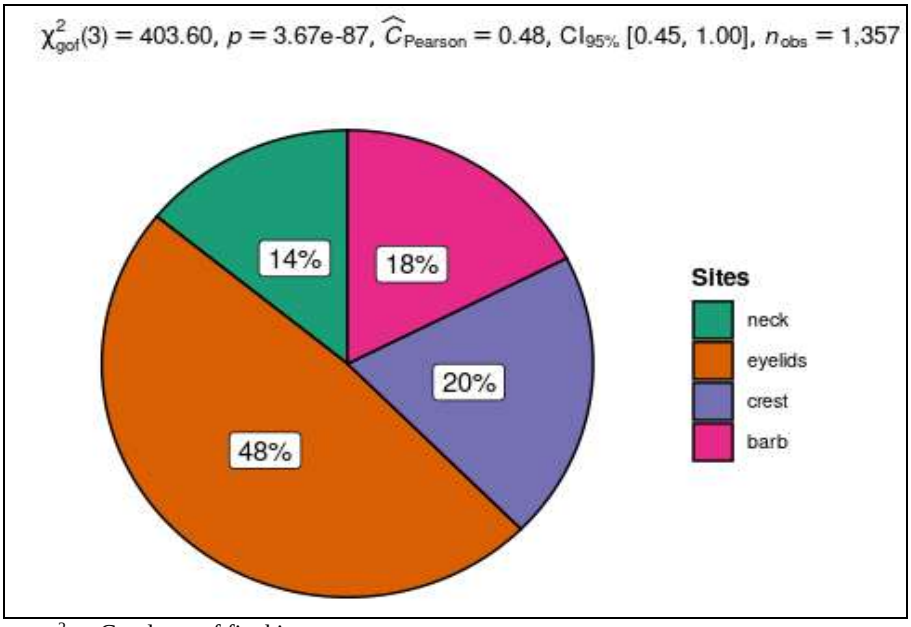
A total of 1357 ectoparasites were counted on 244 host during the study. The mean parasite load per host was 5.56 ectoparasites. Pestload was influenced by seasonality (Table 1). During the rainy season, hosts were significantly more parsitized (7.24 fleas / host) compare to dry season (3.06 fleas/ host), (p<0.001).

Analysis of preferential anatomical sites of fleas

The loads of ectoparasites were analysed according to the anatomical sites from which they were taken in Table 6. It appears that the ectoparasites species are preferentially located at the level of the barbell, ridge, eyelids and neck. The species *E. gallinacea* and *C. gallinaea* were abundant in the eyelids. Ticks *A persicus* was collected only at the crest. The eyelids were the most infected area with 48% followed by the crest (20%) and the barbell (18%) (Figure 2).

Table 6*:* Average counts of flea according to anatomical sites

Flea species	Barb	Crest	Eyelids	Neck
A. persicus	0	6	0	0
C. gallinae	23	71	171	40
E. gallinacea	215	194	485	152



- x^2_{gof}: Goodness of fit chi-square.
- p: p-value.
- $\hat{C}_{person}$: Coefficient correlation Pearson.
- $CI^{95\%}$: 95% confidence interval.
- n_{obs}: Number of observation.

Fig 2: Relative proportion of flea counts collected by host anatomical area

The effect of potential factors for variation of flea loadings by anatomical region was explored (Table 7). It appears that locality, season and sex significantly influenced the mean loads of ectoparasites on anatomical sites.

Table 7: Mean loads of ectoparasites according to anatomical sites

Factors	Categories	Barb	Crest	Eyelids	Neck
Locality	Manwi I, N=38	1.74±1.70 (0.00, 6.00)	1.45±1.81 (0.00, 7.00)	4.03±2.26 (0.00, 9.00)	1.45±1.66 (0.00, 5.00)
	Horé-Forêt, N=38	0.76±1.08 (0.00, 3.00)	0.84±1.48 (0.00, 5.00)	3.08±2.36 (0.00, 9.00)	1.03±1.24 (0.00, 5.00)
	Tchabbal, N=26	1.00±1.33 (0.00, 5.00)	1.50±2.04 (0.00, 7.00)	3.35±2.38 (0.00, 8.00)	1.27±1.48 (0.00, 5.00)
	Darang station, N=30	1.07±1.20 (0.00, 3.00)	1.20±1.79 (0.00, 7.00)	3.53±2.37 (0.00, 8.00)	0.83±0.95 (0.00, 3.00)
	Darang CDEN, N=36	0.86±1.15 (0.00, 3.00)	1.50±2.42 (0.00, 7.00)	2.97±2.46 (0.00, 9.00)	1.03±1.23 (0.00, 4.00)
	Mayo-Daniel, N=39	0.05±0.32 (0.00, 2.00)	0.00±0.00 (0.00, 0.00)	0.00±0.00 (0.00, 0.00)	0.00±0.00 (0.00, 0.00)
	Manwi II, N=37	1.41±2.18 (0.00, 6.00)	1.49±2.46 (0.00, 8.00)	2.32±2.78 (0.00, 11.00)	0.08±0.36 (0.00, 2.00)
	p-value	<0.001	<0.001	<0.001	<0.001
Age	Adult, N=151	0.88±1.40 (0.00, 6.00)	1.03±1.86 (0.00, 8.00)	2.58±2.57 (0.00, 11.00)	0.70±1.15 (0.00, 5.00)
	Young, N=93	1.13±1.56 (0.00, 6.00)	1.25±2.00 (0.00, 8.00)	2.86±2.54 (0.00, 8.00)	0.94±1.34 (0.00, 5.00)
	p-value	0.211	0.260	0.321	0.148
Season	Dry season, N=98	0.60±1.12 (0.00, 6.00)	0.58±1.07 (0.00, 6.00)	1.36±1.84 (0.00, 9.00)	0.52±0.92 (0.00, 4.00)
	Rainy season, N=146	1.23±1.61 (0.00, 6.00)	1.47±2.25 (0.00, 8.00)	3.58±2.58 (0.00, 11.00)	0.97±1.37 (0.00, 5.00)
	p-value	0.002	0.021	0.000	0.019
Sex of host	Male, N=91	0.57±1.11 (0.00, 6.00)	2.22±2.48 (0.00, 8.00)	2.47±2.35 (0.00, 9.00)	0.62±1.08 (0.00, 5.00)
	Female, N=153	1.22±1.60 (0.00, 6.00)	0.45±1.02 (0.00, 6.00)	2.82±2.67 (0.00, 11.00)	0.89±1.30 (0.00, 5.00)
	P-Value	0.001	<0.001	0.384	0.108

Discussion

Parasites (internal and external) are very frequently found in village poultry. This was observed in this study on ectoparasites (70.08%), as in those carried out in other regions like Ethiopia (59.4%: Walkite *et al.*, 2021) [19], Nigeria (69.7%: (Oche *et al.* 2016) [20], Benin (79.8%: Salifou *et al.*, 2008) [21] and Niger (100%: Tager-Kagan, 1992) [22]. The lack of technical and health monitoring of these farms is undoubtedly one of the main causes of these observations (Bagari Iya *et al.*, 2021) [7]. Also, a high density would promote the maintenance and abundance of ectoparasites between congeners. Seasonal differences were noted for flea species (p<0.001) showing that the rainy season is ideal to flea development. This high rate of infestation during the rainy season can be explained by the combination of favourable conditions (temperature and humidity) for the development of parasites during rainy period (Bonfoh *et al.*, 2000) [23]. Two species of parasitic fleas (*Echidnophaga gallinacea* and *Ceratophyllus gallinae*) and one species of tick (*Argas persicus*) were found at the study sites. The most abundant was *A. gallinacea* (69.26%) followed by *C. gallinae* (43.03%). This high abundance of *E. gallinacea* already been reported by authors in Ethiopia (Hiluf *et al.*, 2018) [24], Kenya (Mungabe *et al.*, 2008) [25], South Africa (Moyo *et al.*, 2015) [26], and Zimbabwe [27, 28] (Permin *et al.*, 2002, Mukaratirwa & Hove, 2009). This species, on the other hand was rarely

found (20.6%) in Ethiopia (Hiluf *et al.*, 2018) [24]. The strong presence of this species is linked to the favorable conditions finds in the Adamawa Region (Beaucoumu & Colyn, 1998) [29] and the lack of control measures for these parasites (Mugabe *et al.*, 2008) [25]. The infestation rate of the parasitic tick was lower than that of 6.2% obtained in Nigeria (Lawal *et al.*, 2021) [30]. This species of ectoparasites appreciates farms where there are several domestic animals. It can transmit bacteria, viruses and parasites to village chickens (Haider shah *et al.*, 2004) [31].

Ectoparasite infestation rates have also varied depending on several factors. Those which significantly had an impact on the prevalence were the season and geographic location of farm. Average charges varied depending on gender.

Fleas cause dermatitis and skin ulcers and carry certain desease-causing agents such as *Rickettsia felis* (Loftis *et al.*, 2006) [32]. Such infections can lead to reduced egg production, feed efficiency and weight (Arends, 2003) [33]. In young birds, large numbers of embedded fleas can cause anemia, exsanguination and death, thereby leading to economic losses for farmers (Agboola *et al.*, 2007) [34].

Conclusion

The results obtained during this study made it possible to establish the prevalence of 70.08% in the study area. Two species of flea *Echindnophaga gallinaceae* and *Ceratophyllus gallinacea* as well as a species of tick *Agars persicus* were found. The species *E. gallinacea* and *C. gallinacea* were abundant in the eyelids. The *A. persicus* tick was only collected at the crest. The locality, season and sex significantly influenced the average loads of ectoparasite species at anatomical sites. Does this external parasitism, as well as blood parasitism, which needs to be identified, have a significant impact on the productivity of village hens in Cameroon? This question needs to be answered in order to determine whether or not it is necessary for farmers to spend money to combat it.

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