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Hepatic and Rumenal Worms Infestations of Cattle in Vina Division (Adamawa – Cameroon)

Chahdini Gbambie Abass[1], Mamoudou Abdoulmoumini[2], Pagou Koumai Hervé[2], Abah Samuel[3], Woi Marie[2,3], and Mpoame Mbida[1]

[1]Reseach Unit of Biology and Applied Ecology, Department of Animal Biology, Faculty of Science, University of Dschang, PO Box 067 Dschang, Cameroon.

[2]Laboratory of Parasitology and Parasitic Pathology, IRAD of Wakwa, School of Science and Veterinary Medicine, University of Ngaoundere, PO Box 454 Ngaoundere, Cameroon.

[3]Medical Entomology and Veterinary Laboratory, Special Mission of tsetse fly Eradication, Regional Delegation of Livestock, fisheries and Animal industries, PO Box 263 Ngaoundere, Cameroon.

***Corresponding author**: CHAHDINI GBAMBIE Abass

Tel: (237) 699195762/ 677445323

E-mail : chahdinigbambieabass@yahoo.fr

Abstract— *The main objective of this work is to describe a preliminary epidemiological account of major hepatic and rumenal distome worms of cattle in Vina Division, Adamawa Region of Cameroon. A total of 1361 cattle dung specimens and 450 blood samples were collected between April 2018 and March 2019 in 06 subdivisions within Vina Division. The dung and blood samples were placed in a cooler. The cooler was immediately transported to the medical and veterinary laboratory of Special Mission of tsetse fly Eradication where samples were kept cold at +4°C for at most 48 hours. The qualitative method of concentration of worm eggs by simple sedimentation was performed.Blood parameters were measured using a haematology automated system. Of the 1361 cattle dung specimens examined, 424 presented distome eggs giving a prevalence of 31.15 %.These were Fasciola gigantica, Paramphistomum daubneyi and Dicrocoelium hopes eggs.All cattle age groups were infected by worms. In terms of prevalence, medium cattle were found to be the most infected. In lean cattle the parasitic loads of F. gigantic and D. hopes were high and then decreased as the health of the animals improved. All cattle breeds were infected by at least one of the worm species. Bokolo and Djafoun were most infected by F. gigantica, while Holstein and Aku were more influence by P. daubneyi. Goudali breed is the one that has undergone the least parasitic pressure. Male cattle were more infected than females, but females exhibited higher mean intensity of infestation. Older cattle were more susceptible to F. gigantic and D. hopes infection while Adults were more infected by P. daubneyi. Whatever the parasite considered, parasitic load progressively increased with the age of the cattle. The number of cattle infected by P. daubneyi and D. hopeswas greater in the rainy season unlike F. gigantic infection which was more recurrent in the dry season. Mbe locality had a high prevalence of F. gigantica and P. daubneyi. However, Ngaoundere 1, 2 and 3 presented the highest mean intensities for all worm species. Prevalence and mean intensities of cattle have been more important in extensive livestock status. All the worms were encountered all year round, except for November and December 2018 where D. hopes was absent. Polyparasitic cases were observed. Nevertheless, bispecifics associations were most frequent. Mean Corpuscular Volume, Platelet Concentrations, Mean Corpuscular Haemoglobin, Total Leucocytes Count and Granulocytes mean values were higher in cattle with significant parasitic loads while Total Erythrocyte Count and Packed Cell Volume were low. Today, it is well established that distomatoses represent one of the major parasitoses of cattle in Vina Division of Cameroon.*

Keywords— Fasciola gigantica; Paramphistomum daubneyi; Dicrocoelium hopes; Cattle; Epidemiological account; Vina Division; Cameroon.

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I. INTRODUCTION

Faced with a growing population explosion and urbanization, Cameroon, like other developing countries, suffers problems of malnutrition, food insufficiency and lack of protein of animal origin in particular (MINEPIA, 2015). Despite its potential, cattle production remains insufficient because of numerous constraints, including a breeding system that favours the installation of infectious and parasitic diseases (MINEPIA, 2014). This has a considerable economic impact particularly in cattle and sheep, and occasionally in humans (Aubry and Bernard, 2016). The parasites involved have a decisive influence on the health and productivity of animals (Boucheikhchoukh *et al*, 2012). Diseases caused by distomes (distomatoses) are usually characterized by poor animal body conditions, bloating, pronounced slimming, diarrhea, dehydration with depression of the eyeballs, liver lesions characterized by parenchymal hepatitis gradually cholangitis and cirrhosis (Assogba and Yao 2001, Loock 2003). The economic consequences of these conditions are prove when considering weight losses of milk as well as seizures of parasitized livers in the different slaughterhouses in areas of high endemicity (Assogba and Youssao, 2001). In Cameroon, these diseases are endemic in the Northern Regions (Adamawa, North and Far-North), which are the largest cattle-breeding areas (MINEPIA, 2015). These regions count for nearly 87% of Cameroon's cattle herd (Hamadou, 2001). In Vina Division, several cases of distomatoses were reported from Ngaoundere slaughterhouse (Abaliou 2014, Menya 2017). However, the current prevalence in the area is not known and in addition, the post mortem inspection in slaughterhouses used in previous studies gives only an approximate picture of these pathologies because of the diverse origins of the slaughtered cattle. The main objective of this study is to evaluate the prevalence and infection intensity of the main hepatic and rumenal distomes of cattle in Vina Division (Adamawa - Cameroon) with the aim of contributing to the development of effective strategies to fight against distomatoses in Cameroon.

II. MATERIALS AND METHODS

2.1 Study area

The present study was carried out in the Vina Division located in the Adamawa Region of Cameroon. Vina has a surface area of17196 km^2, eight Subdivisions and its Headquarters is Ngaoundere (Figure 1). Ngaoundere Town is located in the North of the Adamawa Region between Latitude 7 ° 19' North and Longitude 13 ° 35' East. The rainy and dry seasons are the two distinct seasons observed in the area. The dry season runs from November to May while the rainy season runs from May to November. The dry season is marked by a dry and warm wind coming from the North while during the rainy season, sometimes there are violent and continuous rains.

2.2. Collection and examination of samples

A total of 1361 cattle dung specimens were collected between April 2018 and March 2019 on 50 herds from 30 farms in 06 of the 08 Subdivisions in Vina Division. Farms were selected based on several factors including number of herds (at most 2), herd size (50 to 200), availability of shepherds, accessibility of the locality, presence or proximity of ponds or stagnant waters that may favour the development of mollusc intermediate hosts of distomes. At each farm, the sampled herd was randomly selected and at least 30% of each flock considered. The faeces and blood samples were taken respectively from rectum and jugular vein of animals and then labelled. Faeces were removed using gloves while anticoagulant (EDTA) tube, needle and needle holder were used to collect blood samples. Samples were placed in a cooler containing carboglacids and transported tothe Medical and Veterinary Entomology Laboratory of the Special Mission of tsetse fly Eradication (MSEG) for subsequent parasitological analysis. In the laboratory, the samples were kept cold at +4° C for a maximum of 48 hours before any analysis. The qualitative coprological analysis of concentration by simple sedimentation was performed for the detection of distome eggs (Hansen and Perry, 1994). Using an Olympus digital camera, all the eggs on each slide were filmed and identified based on Souslby (1982). Mc Master technique was used to determine faecal egg concentrations (EPG) (Chartier*et al*., 2000). The blood parameters taken included Packed Cell Volume (P.C.V), Mean Corpuscular Volume (M.C.V), Mean Corpuscular Haemoglobin (M.C.H), Total Erythrocyte Count (T.E.C),Total Leucocytes Count (T.L.C), granulocyte, lymphocyte and monocyte mean values as well as platelet concentration (P.C) evaluated using the MINDRAY BC-3000 PLUS haematology automated system.

2.3. Statistical analysis

Prevalence and mean intensity of infection were calculated according to the different intrinsic (breed, sex, age of animals) and extrinsic epidemiological parameters (season, breeding system, area of animal origin, month) (Bush *et al*., 1997). Collected data were stored in Microsoft Excel version 2010 software, and then imported into the SPSS software versions 19.0 for the different

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statistical analyses. Chi-square test (X^2) was used to compare prevalences and Kruskal-wallis test to compare mean intensities of infection measured in EPGs. Student test was used to compare the different haematological parameters of the samples of infected and uninfected animals. The significance level for all tests was set at 0.05.

III. RESULTS

3.1. Parasites identified and animal health status

Out of the 1361 cattle dung samples examined, 424 were infected with more distome eggs giving a general prevalence of 31.15%. Three (3) species of distomes were identified. These include *Fasciola gigantica*, *Paramphistomum daubneyi* and *Dicrocoelium hopes* with the prevalences of 13.15%, 12.8% and 13.2% respectively. Mean faecal concentrations of *F. gigantica*, *P. daubneyi* and *D. hopes* were 191.94 ± 145.89; 173, 99 ± 119.90 and 132.40 ± 76.14 EPG (egg per gram of faeces) respectively.

The prevalence and mean intensities (expressed in EPG) according to body condition score (BCS) are shown on table I. In general, it appeared that, cattle of all age group were infected by worms. The medium cattle were most infected by all the worms compared to the other cattle groups. In lean cattle, mean intensities of *F. gigantica* and *D. hopes* were high and then decreased as the health of the animals improved. A significant difference was observed for *P. daubneyi* infections between thin and medium animals.

3.2. Influence of epidemiological factors

3.2.1. Cattle breed

At least one of the three distome species were identified in all cattle breeds (Table II). The higher prevalence for *F. gigantic* infection were observed in Bokolo (25.9%) and Djafoun (18.5%). Concerning *P. daubneyi*, it was Holstein (26.3%) and Aku (21.2%) who suffered the most. and lower in Simental (4.2%). In contrast, prevalence remained low among Simental (4.2%). As for *D. hopes*, the prevalence of Bokolo (22.2%) and Simental (20.8%) was highest. For mean intensities, both Djafoun and Aku were significantly ($P < 0.05$) more infected with *F. gigantica* and *D. hopes* compared to other breeds.

3.2.2. Cattle sex

Cattle of both sexes were simultaneously infected by worms encountered during this study (Table III).Male individuals had higher prevalence than females. With regards to mean intensities, the situation is not the same. Rather, the females suffered the most parasitic pressures.

3.2.3. Cattle age

Cattle of all age groups were affected (Table IV). However, older animals were more susceptible to *F. gigantica* and *D. hopes* infection compared to young and adults. For *P. daubneyi*, only adults had a high prevalence. Values of mean intensities showed that older cattle suffered more parasitic pressure than adults and young cattle. Whatever the parasite considered, the parasitic load progressively increased with the age of cattle.

3.2.4. Collection sites

Table V shows that, except for *D. Hopes* absent in the locality of Mbe, the presence of other parasites was noted in this locality and the other localities of Vina Division. However, Mbe locality had a high prevalence of *F. gigantica* and *P. daubneyi* infection compared to other localities. Mean infestation intensities showed no significant difference ($P > 0.05$) in infections with *F. gigantica* and *P. daubneyi* in the study area. However, it was in Ngaoundere 1, 2 and 3 respectively that parasitic loads were highest for all worms. *D. hopes* infection rates in Ngaoundere 1 locality were significantly higher compared to the other localities.

3.2.5. Breeding system

Cattle raised in both breeding systems were affected in this study (Table VI).Prevalence and parasitic load of cattle have been more important in extensive livestock status. No significant differences ($P > 0.05$) were observed between the two breeding systems in terms of mean infection intensities.

3.2.6. Monthly and seasonal variation of infestations

All the worms were encountered all year round, except for November and December 2018 where *D. hopes* was absent (Figure II). During this study, the higher prevalence in cattle was recorded in June 2018, September 2018 and February 2019 for *F. gigantic* infection while May, June and October 2018 were most favourable for *P. daubneyi* infection. Concerning *D. hopes*, it is during the months of July 2018 and March 2019 that the cattle were most affected by this hepatic worm.

Monthly change in mean infection intensities is shown in figure III. In general, the mean infection intensities were low. The greatest values recorded in cattle were during the month of May 2018 for all worms.

All the worms were encountered during the two seasons (Table VII). However, the number of infested

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cattle was greater in rainy season for *Paramphistomum daubneyi*and *Dicrocoelium hopes* infection. This situation was different in dry season during which cattle were affected by *Fasciola gigantica*.

3.3. Types of parasitism

Table VIII shows in general that, of 424 infested cattle, 144 (33.96%) were parasitized by at least two worms while 280 (66.03%) were infected by a single species of distome. Bispecific associations *(Fasciola gigantica + Paramphistomum daubneyi*, Fasciola *gigantica + Dicrocoelium hopes* and *Paramphistomum daubneyi + Dicrocoelium hopes*) were frequently encountered. In the case of trispecific infestations (*F. gigantica + P. daubneyi + D. hopes*), only 18 cattle were simultaneously infested by these three parasites.

3.3.1. Influence of parasitic associations on the health status of cattle

Table IX shows that the prevalence of cattle infested with a single worm was higher regardless of the state of health of the animals. A significant difference ($P<0.05$) was observed between the infestations intensities of lean polyparasitic cattle and lean monoparasitc cattle.

3.3.2. Influence of cattle sex on parasitic associations

Table X shows that both types of parasitism have been observed in both male and female individuals. Females were significantly more infested than males either by a single parasite or by several.

3.4. Hematologic profile

Tables IX and X present, respectively, the haematological and leukocyte counts of cattle with high parasitic load and apparently healthy. Table IX shows that mean corpuscular volume, platelet concentration, mean corpuscular haemoglobin (M.C.H) were higher in infected animals, whereas total erythrocyte count and packed cell volume were lower. A significant difference ($P<0.05$) was observed between mean corpuscular volume, platelet concentration, total erythrocyte counts and packed cell volume of infested and uninfected cattle. Table X shows that the concentration of total leucocytes counts and granulocytes mean concentration were slightly higher in infected cattle while the mean concentration of lymphocytes and monocytes was lower.

IV. DISCUSSION

Coprological examinations made on the samples taken in the Vina Division revealed a diversity of parasite eggs in cattle. This confirms the hypothesis that tropical environment favours the development of all kinds of helminths (Chartier et Troncy, 2000a). The presence of *Fasciola gigantica*, *Paramphistomum daubneyi* and *Dicrocoelium hopes* in cattle had already been reported in Cameroon by Graber *et al*. (1966), Chollet *et al*. (2004) and Deya-yang (2014) respectively in the Far North Region (Maroua), North Region of Cameroon and Vina Division (Adamawa Region of Cameroon). This shows that, these worms are not foreign in the northern part of Cameroon (Sidibé, 2008). The presence of these three helminths has also been reported by several authors around the world. In Africa, several researchers have studied the subject, in fact, Assogba et Youssao (2001), Mashikhchuk *et al*. (2012) and Boucheikhchoukh *et al*. (2012 also reported the presence of these three worms respectively in Benin, in Algeria.

The prevalence observed (13.15%) for *F. gigantica* infestations in Vina Division is similar to that reported (13.12%) in Alibori in Benin by Assogba and Youssao (2001). It is close to that found by Ngwu*et al*. (2004) (10%) at the urban slaughterhouse in Nsukka, Nigeria. However, it is much higher than obtained in the Littoral (0.41%) and Borgou (0.66%) in Benin by Assogba and Youssao (2001) as well as that recorded by Achi *et al*. (2003) in northern and central Ivory Coast Regions (4.20%). Prevalence obtained (12.8%) for *P. daubneyi* infestations is much lower than that found by Assogba et Youssao (2001) in the Littoral (51, 83%) in Benin but is almost similar to the values obtained in the Borgou (10%) and Alibori (16, 02%). Loock (2003) found a prevalence of 29.34% in eastern France, which remains higher than the value obtained in the Vina Division. The same observation was made for *D. hopes*. The highest prevalence obtained by Assogba and Youssao (2001) was 58.25% in the Littoral (Benin). This is much higher than the prevalence (12.9%) obtained in Vina Division.

Several hypotheses may justify the low prevalence obtained in this study. On the one hand, pelvic faecal examinations have a low sensitivity (52%) in the diagnosis of hepatobiliary and ruminal distomatosis (Palmer, 2013). In addition, the detection of distome eggs by the sedimentation method is not precise enough, eggs being expelled with the faeces intermittently, depending on the rate of bile evacuation (Conceicao *et al.*, 2002). On the other hand, this may be due to the different climatic and ecological factors and the management or farming system in the different locality. Indeed, these different extrinsic factors act directly on the presence, survival and development of parasites in a given environment (Urguhart *et al.*, 1996, Menya, 2017).

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Thin cattle were more infected than other cattle. A similar observation was also made by Habiba (2015). This observation may be explained by fact that cholangitis, fibrosis and biliary calcification follow the passage of immature worms into the parenchyma and the installation of adults in the bile ducts. In addition, adult worms secrete digestive enzymes that destroy hepatobiliary cells, hence prevent liver function. The prolonged loss of appetite is one of the consequences of these infestations which lead to weight loss of the infested animals (Kabore 2012, Menya 2017).

All cattle breeds carried the three worm species with prevalence and intensities of different infections depending on the parasite. However, some breeds seemed to be more resistant than others to some distomes. This is the case with the Gudali breed raised for several decades in the Adamawa Region, which was more adapted to the different environmental conditions that prevailed there and to certain human practices (Labonne *et al*., 2003). On the other hand, the other breeds predominantly introduced in the Region (Djafoun and Aku from the Far North and North, Holstein and Simental which are exotic breeds) are more susceptible to infections (Hamadou, 2017).

Infections of *F. gigantica* and *P. daubneyi* in male and female cattle were similar. Loock (2003) also showed that *P. daubneyi* infestations between males and females in the same age group were very similar. In the same vein, Bendiaf (2011) and Habiba (2015) indicated that in Algeria, the prevalence of animals with fascioliasis was not different in male and female cattle. In fact, cattle are transhumant independently of sex, for the search of pasture and drinking water at the edge of the lakes. On the other hand, some authors like Yildrim*et al*. (2007) suggest that females are the most exposed and most affected by the majority of pathologies because of reasons mainly physiological (pregnancy, lactation ...) they are preferred targets of parasitic and infectious diseases.

Old cattle were more infected than adults and young. Bendiaf (2011) also reported that older animals are more susceptible to fascioliasis than younger animals. Loock (2003) instead reported that adult cattle were more infected than young and old cattle by paramphistomatosis. Habiba (2015) indicated that young cattle are most exposed to fascioliasis. Old cattle had significantly higher infestation mean intensities of than juvenile with *P. daubneyi* and *D. hopes*. This may be due to the fact that ruminants often develop, with age, resistance to parasites. In the same vein, according to Zagare (1992) young animals do not make long trips in search of pasture contrary to adults who often travel long distances carrying with them thousands of parasitic germs.

The prevalence of *F. gigantica* and *P. daubneyi* was significantly higher in the Mbe Subdivision than in the others. *D. hopes* was absent there. The intensities of infection were significantly higher in Ngaoundéré 1 Subdivision. This may be due to the fact that Mbe Subdivision is located in a lowland area where lakes are found and stagnant water which form the main habitat of mollusc intermediate hosts of *F. gigantica* and *P. daubneyi*, whereas the molluscs intermediate hosts of *D. hopes* are rather terrestrial (Dreyfuss and Rondelaud, 2011). The prevalence of worms was not significantly influenced by livestock systems in the Vina Subdivisions where sampling was conducted. Mean intensities of infection were greater in extensive systems. This may be attributed to the fact that in the extensive breeding system, animals consume exclusively grass in untreated natural pastures, drink in contaminated water points and that their sanitary follow-up is not regular. In addition, animals migrate over large areas, exposing themselves to a high risk of infection by the different pathogens. According to Ravelomanantsoa (2016), the breeding system plays a very important role in the transmission of bovine distomes. In fact, he thinks that the practice of extensive livestock farming ensures the persistence of these diseases because the cattle are left to themselves in the wild and participate actively in the biological cycle of the parasite and dissemination of eggs.

The different distomes do not rage all year long. The same observation was made by Boucheikhchoukh *et al*. (2012) in the region of El Tarf in Algeria. Intensities of infection were low throughout the year but a significant peak was observed in May 2018. Prevalence of *P. daubneyi* and *D. hopes* was slightly higher in the rainy season, unlike those of *F. gigantica*, which was higher in the dry season. Intensities of infections were higher in the dry season compared to the rainy season, the difference between the two seasons being significant for *D. hopes* infections. This is due to a concentration of animals and close contact with lymnaea in the lowlands, which are the only grazing places of the dry season (Bendiaf, 2011).

Cases of polyparasitism involving all worm species were observed. Indeed, Boucheikhchoukh *et al*. (2012) and Ravelomanantsoa (2016) also revealed cases of polyparasitism in cattle in the El Tarf Region of Algeria and in the Ambohimahasoa District of Madagascar, respectively. Cattle with high parasite loads (EPG $\geq$ 300) suffered normocytic and normochromic anaemia. Just as reported by Taimur *et al*. (1993), Egbu *et al*. (2013), El-Aziem (2017) and Menya (2017). The reduction in red blood cell and haematocrit concentration may be due to an acute loss of blood in the parenchyma and bile ducts (Donnadieu 2001, Lotfollahzadeh *et al*. 2008). Lofty *et al*. (2003) reported that chronic inflammations of the liver result in depression of erythrogenesis. In addition, Egbu *et al*. (2013) suggested that the severity of anaemia would depend on the number of worms present in the liver. The concentration of white blood cells and the amount of granulocytes increased in infected cattle; on the other hand, there has been a slight decrease in the amount of monocytes and lymphocytes. Taimur *et al*. (1993), Egbu *et al*. (2013), El-Aziem (2017) and Menya (2017) obtained similar results. Indeed, Penny *et al*. (1996) reported that toxins released, obstructive effects and inflammation caused by flukes induce an immune defence of the body, hence the changes observed in the leukocyte count. Granulocytes are involved in the control of parasitic diseases caused by metazoans (Ledieu, 2004). In addition, the interaction between immunoglobulins and eosinophils can lead to local accumulation of neutrophils and other leukocytes (Radostitis *et al*, 2006).

V. CONCLUSION

F. gigantica, *P. daubneyi* and*D. hopes* are the main distome worms encountered in Vina Division. These worms in breeding areas caused serious damage on animal health. In this study, epidemiological factors did not have a significant effect on worm infection. Nevertheless, slight differences were observed between the values obtained in the most cases. Haematological parameters were influenced by the statute of cattle. Indeed, haematological parameters of infected cattle show several changes compare to uninfected cattle. That is why, it is necessary to implement adequate control and fighting strategies against distome worms in breeding areas. It would also be important to undertake epidemiological investigations in different regions of the country to better understand the situation at the national level.

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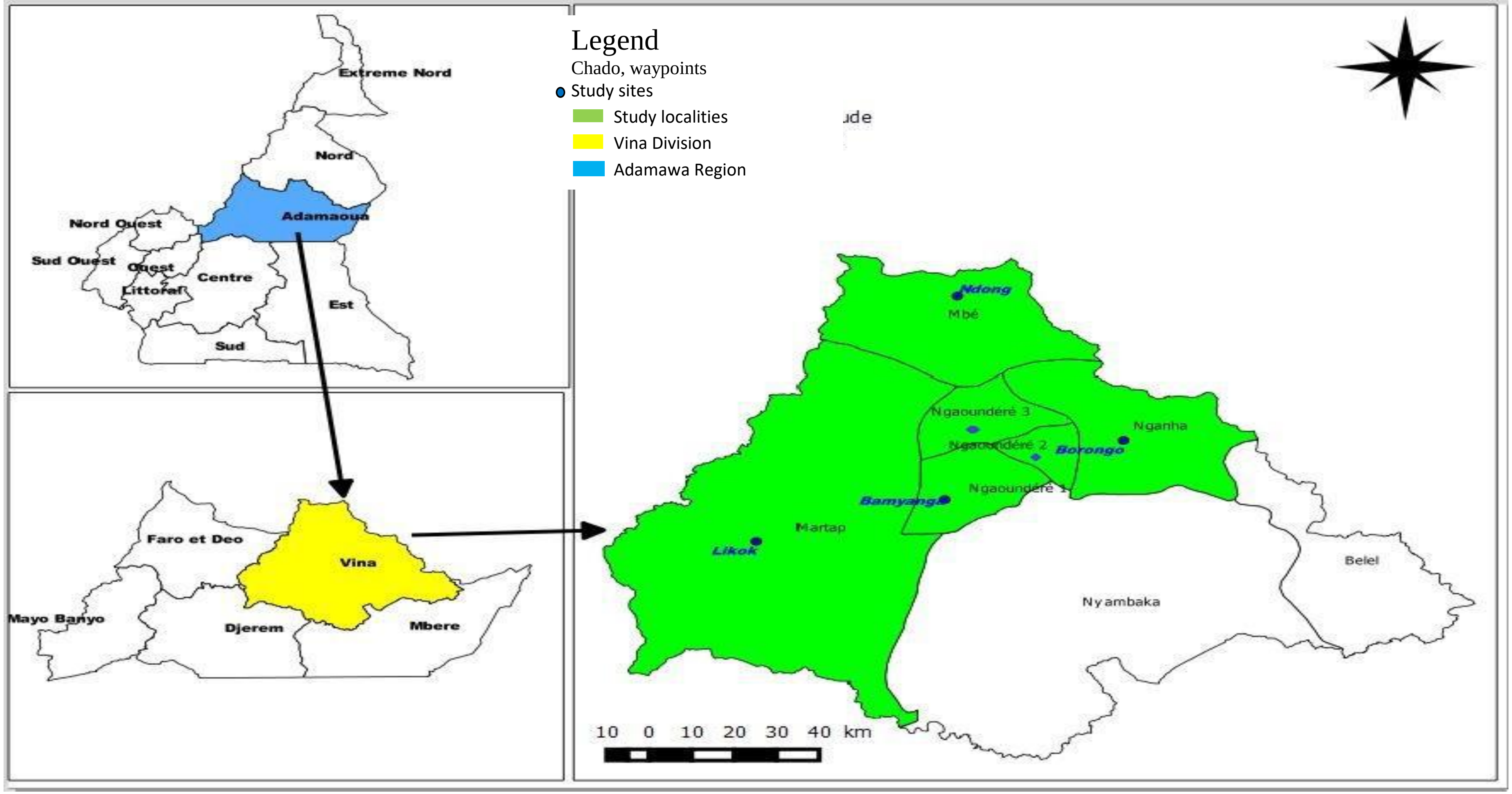

Fig.1: Map of the Vina Division

Source: National Institute of Mapping modified by Alain Wandji, (2019)

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Table I: EPG (means± SD) and prevalence (%) of main hepatic and rumen worms harvested according to the BCS range

Worms	BCS range			Total
	[1-2[	[2-3]	[4-5]	
Fasciola gigantica	(198.18±181.03[a]) 12.4	(195.54±131.78[a]) 14.5	(152.6±107.33[a]) 12.6	(191.94±145.8) 13.6
Paramphistomum daubneyi	(174.47±111.2[a]) 10.6	(180±125.47[a]) 14.5	(131.25±101.44[b]) 10.6	(173.99±119.9) 12.8
Dicrocoelium hopes	(146.67±79.11[a]) 13.8	(126.85±76.86[a]) 14.1	(109.09±30.15[a]) 7.3	(132.4±5.69) 13.2

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

Legend:[1-2[= Thin;[2;3] =Medium;[4-5] = greasy

Table II: EPG (means± SD) and prevalence (%) of main hepatic and rumen worms harvested according to breed

Worms	Breed							Total
	Aku	Bokolo	Djafoun	Gudali	Holstein	Methis	Simental	
Fasciola gigantica	(277.78±226.3[a]) 17.3	(157.14±113.3[b]) 25.9	(330±262.6[a]) 18.5	(174.2±115.4[b]) 13	(216.67±132.9[ab]) 15.8	(137.5±106.6[b]) 10.5	(200±0[ab]) 4.2	(191.94±145.89) 13.6
Paramphistomum daubneyi	(150±80.17[a]) 21.2	(160±89.44[a]) 18.5	(211.11±116.6[ab]) 16.7	(179.6±131.7[a]) 11.3	(155.56±101.37[a]) 26.3	(133.3±50[a]) 11.8	(300±0[b]) 4.2	(173.9±119.9) 12.8
Dicrocoeliumhopes	(183.33±126.7[a]) 11.5	(150±54.77[ab]) 22.2	(163.64±92.44[a]) 20.4	(128±73.61[b]) 12.1	(100±0[b]) 18.4	(123.08±43.8[b]) 17.1	(100±0[b]) 20.8	(179±76.14) 13.2

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

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Table III: EPG (means± SD) and prevalence (%) of main hepatic and rumen worms harvested according to the host sex

Worms	Host Sex		Total
	M	**F**	
Fasciola gigantica	(192.98±163.51[a]) 13.9	(191.47±138.08[a]) 12.9	(191.94±145.89) 13.6
Paramphistomum daubneyi	(151.85±88.46[a]) 12.9	(183.03±130.82[a]) 12.5	(173.99±119.9) 12.8
Dicrocoelium hopes	(122.22±67.04[a]) 14.7	(135.82±78.90[a]) 11.2	(132.4±76.14) 13.2

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

Legend: M = male; F = female

Table IV: EPG (means± SD) and prevalence (%) of main hepatic and rumen worms harvested depending on the ages groups

Worms	Ages groups			Total
	[0;4[	**[4 ; 8[**	**[8 ; 12[**	
Fasciola gigantica	(164.44±93.31[a]) 12.8	(186.81±146.97[a]) 12.8	(226±175.9[a]) 16.4	(191.94±145.89) 13.6
Paramphistomum daubneyi	(157.14±85.94[a]) 11.9	(171.28±135.69[a]) 13.4	(200±108.01[b]) 12.4	(173.99±119.90) 12.8
Dicrocoelium hopes	(113.04±34.05[a]) 13.1	(126.44±61.87[a]) 12.4	(163.04±114.2[b]) 15.4	(132.4±76.14) 13.2

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

Legend: [0;4[= juveniles;[4; 8[= Adults; [8; 12]= Old

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Table V: EPG (means± SD) and prevalence (%) of main hepatic and rumen worms harvested according to the season

Worms	Season		Total
	R	D	
Fasciolagigantica	(157.73±80.15[a]) 13.3	(229.21±187.20[a]) 13.9	(191.94±145.89) 13.6
Paramphistomum daubneyi	(153.85±79.95[a]) 14.4	(204.35±158.51[a]) 11	(173.99±119.90) 12.8
Dicrocoelium hopes	(116.19±37.01[a]) 14.5	(155.41±106.16[b]) 11.7	(132.4±76.14) 13.2

*Numbers followed by the same letter on rows do not vary significantly to P=0.05

Legend: R = Rainy; D = Dry

Table II: EPG (means± SD) and prevalence (%) of main hepatic and rumen worms harvested according on the localities

Worms	Localities						Total
	Ndéré 1	Ndéré 2	Ndéré 3	Mbé	Martap	Nganha	
Fasciola gigantica	(228.57±203.6[a]) 18.2	(175.76±86.7[a]) 22.4	(156.36±78.7[a]) 8.2	(220±109.5[a]) 41.7	(130±67.49[a]) 14.3	(223.08±123.5[a]) 15.5	(191.94±145.89) 13.6
Paramphistomum daubneyi	(212.07±167.6[a]) 15.1	(167.86±81.9[a]) 9.3	(159.68±87.7[a]) 19.6	(150±75.59[a]) 66.7	(128.57±48.8[a]) 11.4	(110±31.62[a]) 11.9	(173.99±119.9) 12.8
Dicrocoelium hopes	(163.64±116.32[a]) 11.7	(100±0[b]) 13.3	(127.78±59.33[b]) 16.2	(0) 0.0	(100±0[b]) 4.3	(100±0[b]) 6	(132.4±76.14) 13.2

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

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Table VII: EPG (means± SD) and prevalence (%) of main hepatic and rumen worms harvested according to the breeding system

Worms	Breeding systems		Total
	I	E	
Fasciola gigantica	(186.36±121.21[a]) 13.7	(193.66±153.08[a]) 13.6	(191.94±145.89) 13.6
Paramphistomum daubneyi	(145.95±76.72[a]) 11.5	(181.62±128.35[a]) 13.2	(173.99±119.90) 12.8
Dicrocoelium hopes	(118.6±39.37[a]) 13.4	(136.76±84.15[a]) 13.2	(132.4±76.14) 13.2

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

Legend: I = Intensive; E = Extensive

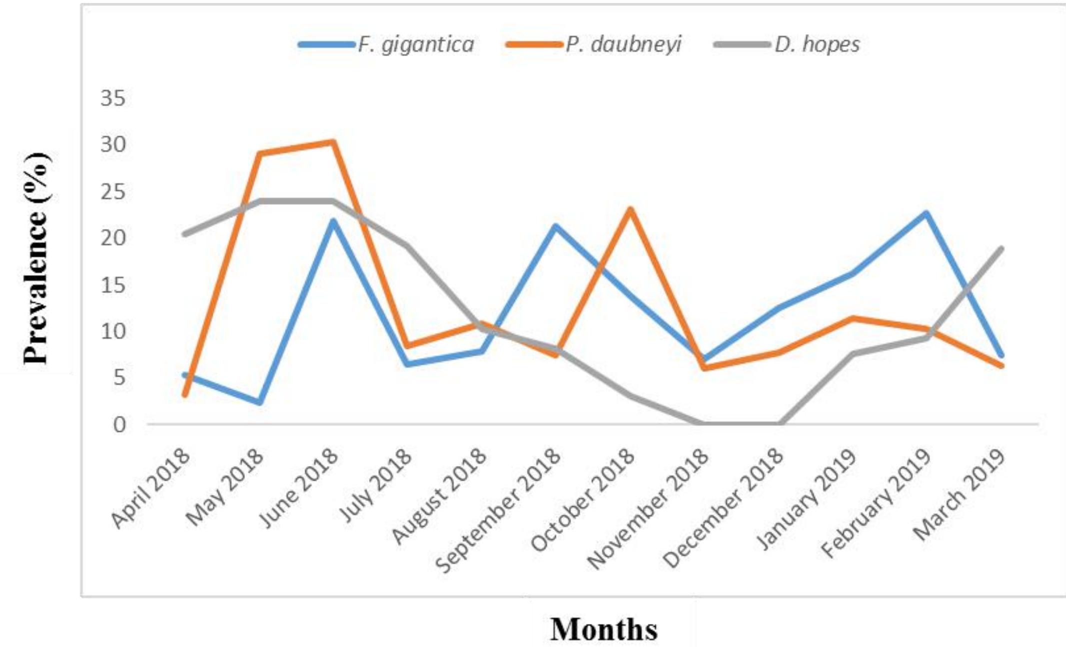

Figure II: Monthly variation in worm prevalence in cattle

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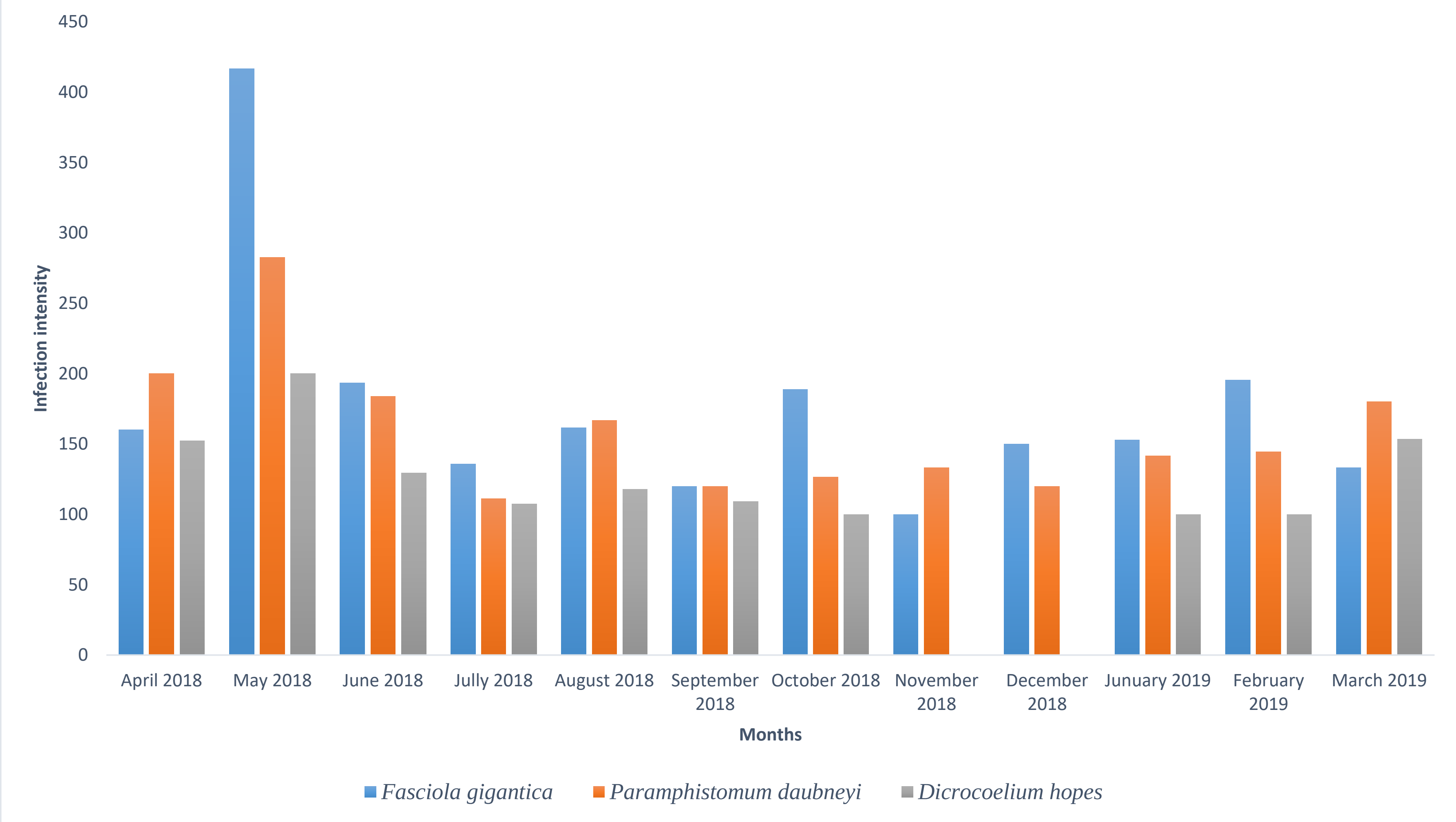

Figure III: Monthly variation of worm intensities in cattle

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Table VIII: Types of parasitism, number and prevalence (%) of infested cattle

Worms	Types of parasitism	n(%)	Total number
Fasciola gigantica *Paramphistomum daubneyi* *Dicrocoelium hopes*	Single		280 (66.03)
Fasciola gigantica + Paramphistomum daubneyi		44(10.37)	
Fasciola gigantica + Dicrocoelium hopes	Double	38(8.96)	126(29.71)
Paramphistomum daubneyi + Dicrocoelium hopes		44(10.37)	
F. gigantica + P. daubneyi + D. hopes	Triple	18(4.24)	18(4.24)

Tableau IX : EPG (means± SD) and Prevalence (%) of parasitic association according body score

Infested cattle	BSC		
	[1-2[	**[2-3]**	**[4-5]**
Mono-parasitism	12.26 (173.1±123.78[a])	14.36 (134.13±111.37[a])	10.16 (130.98±79.64[a])
Poly-parasitism	8.41 (203.05±146.23[b])	9.04 (141.02±122.11[a])	4.34 (132.12±81.45[a])
Total	10.33 (188.07±135)	11.7 (137.57±116.74)	7.25 (131.55±80.54)

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

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Table X:Mean values of haematological parameters of infected and uninfected cattle (± SD)

Parameters	Infected cattle n= 50	Uninfected cattle n= 50	Normal mean valours
T.E.C ($\times10^6$/µl)	1.80±0.26^a	2.93±0.31^b	5.51-8.89
M.C.H (g/dl)	9.97±0.22^a	9.72±0.24^a	8.5-13.6
P.C.V (%)	22.36±1.88^a	29.32±1.57^b	30-50
M.C.V (fl)	50.33±1.08^a	44.19±0.9^b	46-56
P.S ($\times10^3$/mm^3)	1338.48±140^a	754.62±107.68^b	100-750

* Numbers followed by the same letter on rows do not vary significantly to P=0.05

Table X: Mean values of leukocyte parameters of infested and uninfected cattle (± SD)

Parameters ($\times10^3$/µl)	Infected cattle n= 50	Uninfected cattle n= 50	Normal mean valours
T.L.C	14.99±1.13^a	11.9±0.5^a	6.3-12.1
Granulocytes	3.91±1.7^a	2.16±0.18^a	3.9-11.1
Lymphocytes	6.2±2.5^a	6.7±0.29^a	2.5-7.5
Monocytes	0.96±1.18^a	1.14±0.13^a	0.83-8.58

* Numbers followed by the same letter on rows do not vary significantly to P=0.05