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Pathological changes associated with paramphistomosis in the gastrointestinal tissues of indigenous cattle slaughtered at Jos abattoir, Nigeria

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Abstract

Diverse gastrointestinal parasites, such as trematodes, cestodes, and nematodes, pose a threat to ruminants. Paramphistome, a trematode also known as rumen fluke, affects both domestic and wild ruminants, causing significant economic losses in the dairy and meat production industries. Tissue samples (rumen, reticulum, and small intestine) from 40 cattle slaughtered at the Jos abattoir were examined grossly and microscopically for paramphistomosis, with associated gross and histopathological changes recorded for a period of 4 weeks. From the 40 cattle examined, 23(57.50%) were positive for paramphistomosis with several gross lesions. The gross lesions observed were hyperemia, mucohaemorrhagic enteritis, and mucoid enteritis, with frequencies of 2, 2, and 6, respectively. However, among the positive samples, 2 lesions were common; mucohaemorrhagic enteritis and mucoid enteritis, each with a frequency of 1 and 4, respectively. This study established a moderate prevalence of paramphistomosis in cattle slaughtered at the Jos abattoir. The gross and histopathological changes in tissues from cattle infected with *Paramphistomum* have provided useful information to aid diagnosis.

Keywords: Abattoir, Cattle, Gross pathology, Histopathology, Jos, Paramphistomosis

Introduction

Ruminants are infected by diverse gastrointestinal parasites such as trematodes, cestodes and nematodes (Sykes, 2004). *Paramphistomum* species with worldwide distribution constitute an important

parasite of many ruminal species, especially in the tropical and subtropical areas (Taylor *et al.,* 2007). Paramphistome, a trematode responsible for paramphistomosis, also known as rumen fluke disease or amphistomosis, affects domestic and wild ruminants. In sub-Saharan Africa, Nigeria is ranked among the first four leading livestock producers, contributing about 12.7% of the country's total agricultural gross domestic product (Fowowe, 2020). Cattle rearing in the tropics is mostly done by a transhumance husbandry system with little supplementary feeding, this result in decreased productivity and increased calf mortality. This compels farmers to move their animals to find adequate grazing around water bodies heavily infested with trematodes, hence causing infections, among which is paramphistomosis (Ulayi *et al.,* 2007; Elelu & Eisler, 2018).

Paramphistomosis, a pathogenic ailment affecting domesticated ruminants, results in significant economic losses within the dairy industry and meat production sector. The disease is caused by several genera (*Calicophoron, Cotylophoron, Explanatum, Gigantocotyle*), amongst which is *Paramphistomum* (Gupta & Gupta, 1978; Wang *et al.,* 2006), belonging to the *Paramphistomatidea* superfamily. There are several species of *Paramphistomum* in cattle, which include *Paramphistomum microbothium*, *P. ichikawai* and *P. cervi* (Urquhart *et al*., 2008).

Calves and lambs are most susceptible, especially weaners. Adult animals can also be affected, particularly if they have had no prior exposure to the parasite or are immunosuppressed by other factors such as nutritional imbalance, disease, etc.

Prevalence and severity of the disease vary according to countries, climate and humidity. The impact of paramphistomosis is more intense in extreme climates like those in the tropics and subtropical regions than in temperate regions because of favourable environmental conditions, particularly temperature and rainfall, which accelerate the life cycle and promote the survival and reproduction of the intermediate host snails (Postal, 1984). Paramphistome burdens also vary with the number of infected host snails. In Nigeria, paramphistomosis has been reported in some states like Sokoto, Imo, Edo, Ebonyi, and Kwara States by Bunza *et al*. (2008), Njoku-Tony & Nwoko (2009), Edosomwan & Shoyemi (2012), Nwigwe *et al*. (2013), and Elelu *et al.* (2016), respectively.

Adult *Paramphistomums* are found in the rumen, while the immature worms are found in the small intestine, mainly in the duodenum and jejunum (González *et al.,* 2013). De Waal (2010) reported that the migration of the immature fluke in the intestinal mucosa causes more severe damage to the mucosa than that caused by the adult worms in the rumen and reticulum. After migration of the immature flukes back to the rumen, the adult parasite attaches itself to the ruminal wall with its large posterior suckers known as acetabula to feed on the ruminal content. The adult fluke does not cause serious damage or affect production in infected animals like the immature flukes that cause clinical signs such as weight loss, diarrhoea and sometimes death (Adane & Demelash, 2020). The mature flukes inhabit the rumen of livestock and do not show glaring lesions (Rolfe *et al.,* 1994; Zintl *et al.,* 2014). In their immature stage, these flukes reside in the small intestine (duodenum or ileum) and abomasum, where they cause severe irritation as they burrow deep into the mucosa and submucosal layers. Subsequently, they migrate to the rumen, where they ultimately establish themselves as adult trematodes. The pathogenic nature of *Paramphistomum* spp. is linked to the presence of adult flukes and their adherence to the ruminal papillae (Love & Hutchinson, 2003).

Clinical manifestations of the disease range from digestive irregularities (severe watery diarrhoea) to polydipsia and unthriftiness, anorexia, submandibular oedema, and rough hair coat. Symptoms including bloating and loss of condition have been reported in infected cattle (Alzieu & Dorchies, 2007; Malrait *et al.,* 2015; Bellet *et al*., 2016). Grossly, lesions of severe enteritis, necrosis and intestinal haemorrhages occur. The attachment site of the flukes results in distortion and impairment of the papillae, leading to compromised feed uptake. This, in turn, contributes to a reduced growth rate and, in some cases, ulceration accompanied by gastrointestinal bleeding. The migration of adult flukes to the duodenal mucosa induces severe enteritis, destroying both mucosa and submucosa. This process is characterised by profuse bleeding, giving rise to symptoms such as anorexia, polydipsia, diarrhoea, muscle weakness, and, ultimately, mortality (Rolfe *et al*., 1991; Dorchies *et al.*, 2002). Adult paramphistomes, being the primary parasites in the rumen and reticulum of ruminants, induce localised loss of rumen papillae. Conversely, juvenile flukes penetrate the mucosa of the duodenum and upper ileum to feed, resulting in necrosis and haemorrhagic ulcerations. These processes lead to significant pathological changes, illustrating the detrimental impact of paramphistomes on the

gastrointestinal health of the affected animals (Soulsby, 1982). Muscular atrophy, subcutaneous oedema, accumulation of fluid in body cavities, duodenal mucosa thickening, mucohaemorrhagic enteritis and sometimes, ulcer have been recorded in the bowel mucosa (Mason *et al.,* 2012; Devos *et al.,* 2013). Parasitosis can result in extensive mortality.

Histologically, study of the small intestine has been shown to reveal dilatation of intestinal glands, destruction of superficial glands, replacement with fibrous connective tissue, diffuse infiltration of inflammatory cells and fibrinonecrotic enteritis (Rizwan *et al*., 2022). Other changes are congestion and haemorrhages in the small intestines. Atrophy and ulceration of the ruminal papillae have also been associated with the disease (Rolfe *et al*., 1994; Fuertes *et al.,* 2015).

In view of the pathology and attendant economic losses associated with paramphistomosis in cattle, it is pertinent to understand the gross and histopathological changes in tissues associated with the disease in cattle slaughtered in Jos abattoir. This study provides epidemiological data on paramphistomosis in cattle at the Jos abattoir with associated gross and histopathological changes in tissues that would greatly help with diagnosis.

Materials and Methods

Study area

Jos is the capital city of Plateau State. The area is located in the North-Central geo-political zone of Nigeria and shares geographic boundaries with Bauchi, Kaduna, Nassarawa, and Taraba States at its North-Eastern, North-Western, South-Western and South-Eastern boundaries, respectively. The State is situated within the Guinea Savannah region of Nigeria, and it is made up of seventeen Local Government Areas, covering an area of about 30,913 km^2. The average temperature ranges between 18℃ and 22℃. There are two seasons within the year: dry (November-April) and rainy seasons (May-October). The main occupation of the local indigenes is crop and animal farming. The population of domestic ruminants in Plateau State is estimated to be 1.3 million cattle, 1.8 million goats and 1.2 million sheep (NBC, 2025).

Sample collection

Tissues (rumen, reticulum and small intestine) from 40 cattle of different ages and breeds slaughtered at the Jos abattoir were collected. The 40 cattle were grouped into 2, i.e, control group (GP 1) and infected group (GP 2). Ten cattle were used in GP1 and 30 cattle in GP2. The criteria for selection in group 1 were apparently healthy animals and those with no visible *Paramphistomum* attached to the rumen or reticulum, both grossly and microscopically, while for group 2 were cattle with severely pale mucous membrane, emaciation, rough hair coat, profuse diarrhoea, and presence of the flukes identified microscopically.

Experimental design

Gross lesions in tissues based on the parasite burden were examined and documented.

Gross pathology

Tissues (rumen, reticulum and small intestine) with lesions from infected cattle were harvested and stored in 10% neutral buffered formalin until the time for histopathology processing.

Histopathological changes in tissues (rumen, reticulum and small intestine) of infected cattle were also assessed and documented.

Histopathology

Samples of the small intestine, rumen and reticulum for histopathological examinations were collected. Tissue specimens taken from the small intestine were from areas with lesions in the entire length of the small intestine of each animal. Tissue specimens were fixed in 10 % neutral buffered formalin and embedded in paraffin wax, sectioned at 4–5 µm, and stained with hematoxylin and eosin (H&E) for histopathological examination. The tissues were processed according to the method outlined by Rolls (2005). The prepared sections were examined under a light microscope at different magnifications; tissues (small intestine, rumen and reticulum) of cattle were examined for the presence of lesions and/or adult paramphistomes.

Level of severity

The level of severity of the observable lesions was deduced based on the frequency of occurrence of the severity of the lesions in the study population.

Data analysis

The data collected for gross and histopathological analyses were expressed as mean and subjected to a chi-square test. Values of $p< 0.05$ were considered statistically significant.

Results

Demography of cattle slaughtered at the Jos abattoir from the 40 cattle examined, 23 (57.50%) were positive for *Paramphistomum* spp. infection with paramphistomums visibly attached to the reticular or

ruminal walls (Plates I & II). Based on sex, 25 females were sampled, which accounted for a prevalence of 16 (64.0%), while out of the 15 males sampled, 7 (46.7%) were positive for *Paramphistomum* spp. In terms of age, 4 ≥ - 5-year cattle were the most examined (20) with a prevalence of 12 (60.00%), while 5 ≥ - 6-year cattle recorded the lowest number examined (2), with both the samples being positive. Based on the breed, White Fulani were the highest sample examined (38) with a positive prevalence of 21 (55.3%). Sokoto Gudali and Red Bororo had only 1 sample each, and both cases were positive for *Paramphistomum* spp. infection (Table 1).

The variation recorded with respect to all the variables examined was found to be statistically not significant (p-value >0.05), and the odds ratios recorded were found to be low except for age, which recorded the value of 3.201 (Table 1).

Gross lesions associated with Paramphistomum specie infection in cattle slaughtered at Jos abattoir

Out of the 40 cattle sampled, 11 were observed to have one or several gross lesions, while 29 were without gross lesions (Table 2). Of the 11 with gross lesions, 6 (54.5%) were found to be positive for *Paramphistomum* infection, while of the 29 without gross lesions, 17 (58.6%) were positive for *Paramphistomum* infection. Statistics, however, show the probability of occurrence of cattle with gross lesions being positive with *Paramphistomum* is 0.138, which was found to be statistically not significant (p>0.05) (Table 2).

The gross lesions observed were hyperemia, mucohaemorrhagic enteritis and mucoid enteritis (Plates III & IV), which recorded a frequency of 2, 2, and 6, respectively (Figure 1).

Table 3 shows the occurrence of paramphistomes based on the various tissues examined. The intestine was found to show no parasite, while the rumen recorded the highest prevalence with a frequency of 23(57.50%), which was found to be statistically significant (p<0.05), while the reticulum showed a

Plate I: Reticulum of a cattle slaughtered at the Jos abattoir showing *Paramphistomum* parasites (arrow)

Plate II: Rumen of a cattle slaughtered at the Jos abattoir showing *Paramphistomum* parasites (arrows)

Table 1: Demography of cattle slaughtered at the Jos abattoir for 4 weeks

	Number Examined	Positive (%)	OR (95% confidence interval)	P-values
Sex				
Female	25	16(64.0)	0.786(0.112-5.490)	0.808
Male	15	7(46.7)		
Age				
2 ≥ - 3 years	4	1(25.0)	3.201(0.686-14.933)	0.139
3 ≥ - 4 years	14	8(57.1)		
4 ≥ - 5 years	20	12(60.0)		
5 ≥ - 6 years	2	2(100.0)		
Breed				
Sokoto Gudali	1	1(100.0)	NA	
Red Bororo	1	1(100.0)		
White Fulani	38	21(55.3)		

Table 2: Gross lesions associated with *Paramphistomum* specie infection in cattle slaughtered at Jos abattoir over 4 weeks

	Number Examined	Positive (%)	OR (95% confidence interval)	P-values
Cattle with Lesions	11	6(54.5)	0.138(0.012-1.565)	0.11
Cattle with No Lesions	29	17(58.6)		

p <0.05 is considered statistically significant

Plate III: Intestinal mucosa of cattle slaughtered in Jos abattoir showing mucohaemorrhagic enteritis

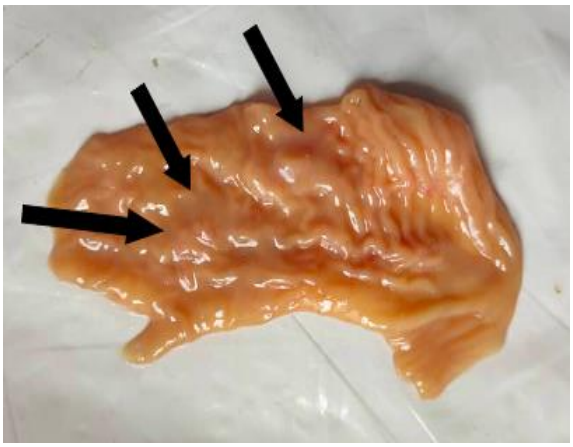

Plate IV: Intestinal mucosa of cattle slaughtered in Jos abattoir showing mucoid enteritis (arrows)

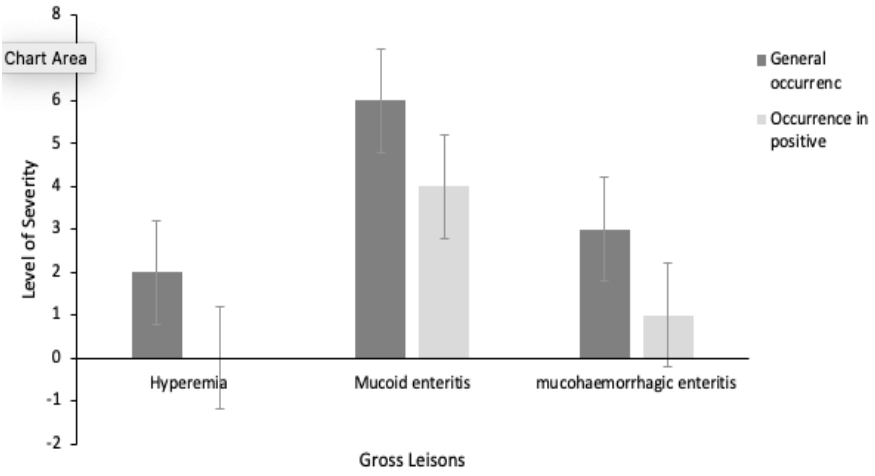

Figure 1: Occurrence of gross lesions in *Paramphistomum* specie infected cattle slaughtered at Jos abattoir

frequency of 11(27.50%), which was statistically not significant (p >0.05).

Histopathological changes in tissues associated with Paramphistomum spp. infection in cattle slaughtered in Jos abattoir

Thirty-six (36) of the intestinal tissues were observed to have one or several lesions (Plates V, VI, VII & VIII), while the remaining 4 recorded no lesions (Plate IX). Out of the 36 intestines with histopathological changes, 21(58.33%) were from cattle positive for *Paramphistomum* spp, while out of the 4 that recorded no lesion, 2(50.00%) were from *Paramphistomum*-infected cattle (Table 4). The odds ratio (OR) was observed to be 8.000, which is statistically significant (p-value = 0.000088).

A total of 6 histopathological lesions were observed in the intestine, as shown in Figure 2, with multiple lesions occurring in a single tissue. Generally, cellular infiltration and necrosis of the villi were observed to be the most common. However, the occurrence of hyperplasia of fibrous connective tissue (FCT) (Plate

Table 3: Prevalence of *Paramphistomum* specie infection in tissues of cattle slaughtered in Jos abattoir for 4 weeks period

Tissues	Result	Occurrence	P-value	Chi-square
Intestine	Positive	0	NA	
	Negative	40(100)		
Rumen	Positive	23(57.50)	0.004	8.100
	Negative	17(42.50)		
Reticulum	Positive	11(27.50)	0.343	0.900
	Negative	29(72.50)		

p <0.05 is considered statistically significant

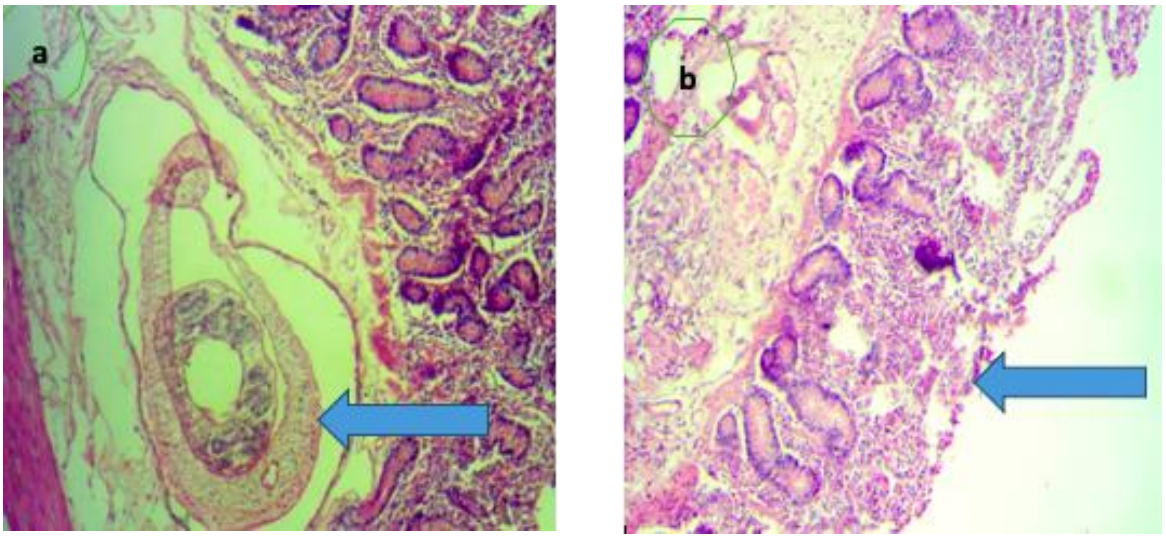

Plate V: (a) *Paramphistomum* specie in the submucosa of the intestine (duodenum) (arrow). H&E x100. (b) Photomicrograph of the intestine of cattle positive for *Paramphistomum* specie showing necrosis of intestinal villi (arrow). H&E x100

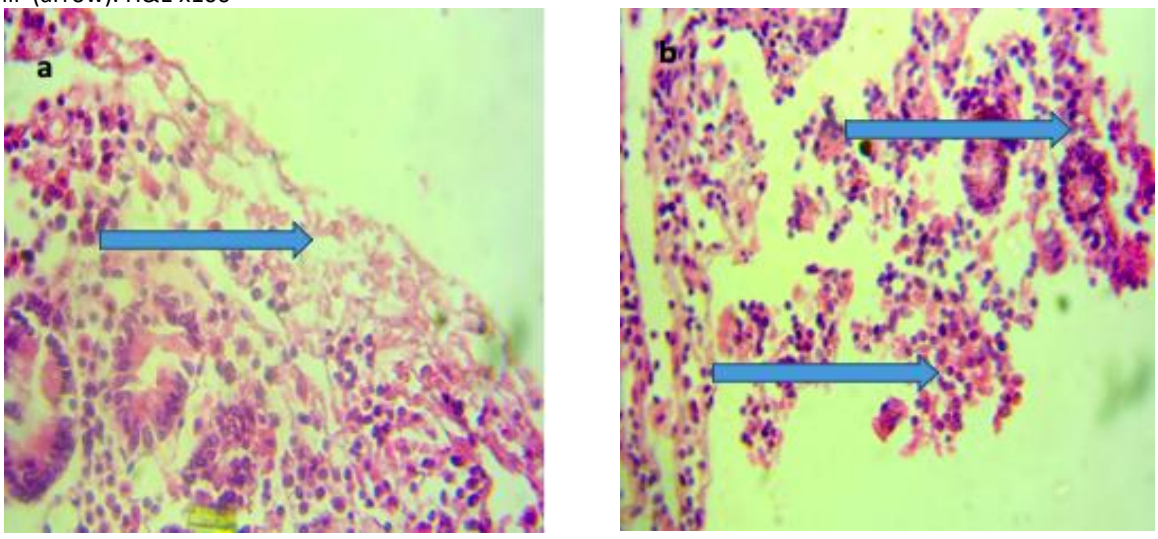

Plate VI: (a) Photomicrograph of the intestinal mucosa of cattle positive for *Paramphistomum* specie showing necrosis of intestinal villi. H&E x400. (b) Photomicrograph of the intestinal mucosa of cattle positive for *Paramphistomum* specie showing haemorrhage (arrows) H&E x400

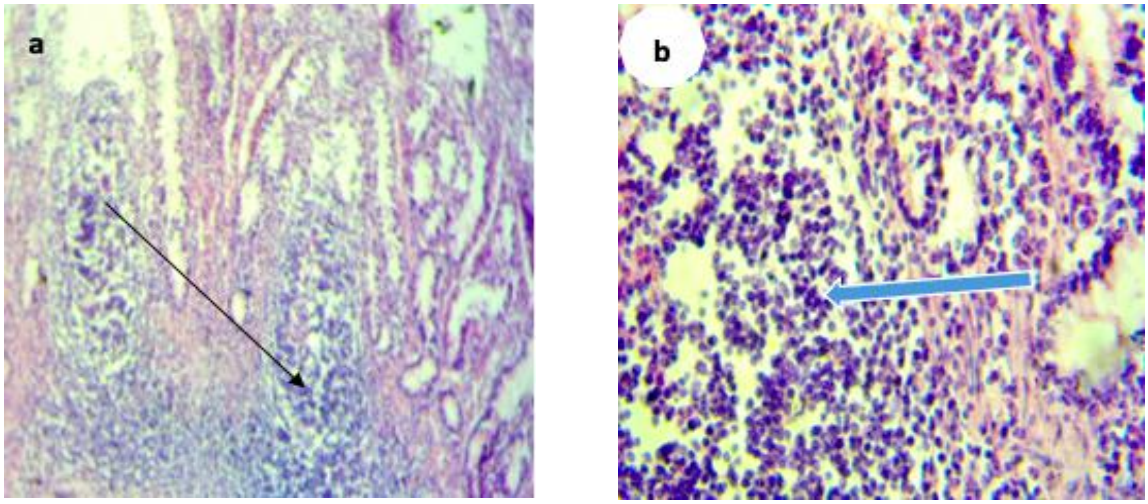

Plate VII: (a) Photomicrograph of the lamina propria showing severe infiltration of mononuclear cells (arrows). H&E x100 (b) Photomicrograph of the lamina propria showing severe infiltration of mononuclear cells (arrows). H&E x400

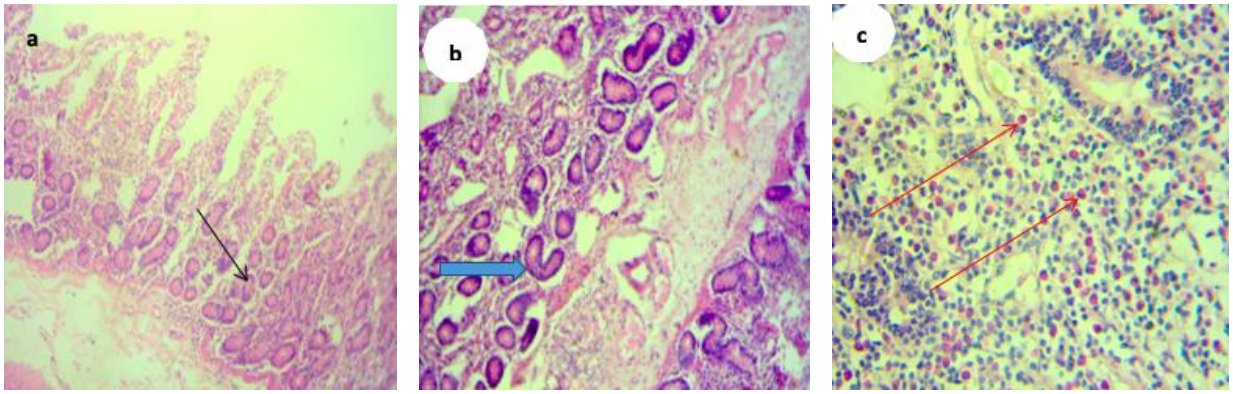

Plate VIII: (a) Photomicrograph of a normal intestine in cattle slaughtered from the control group (GP1) showing normal glands (arrow). H&E x100. (b) Photomicrograph of the intestinal mucosa and submucosa showing severe dilation of glands (blue arrow). H&E x100. (c) Photomicrograph of the intestinal mucosa showing severe eosinophilic infiltration in a cattle positive for *Paramphistomum* specie (red arrows). H&E x400

Table 4: Histopathology of tissues associated with *Paramphistomum* specie infection in cattle slaughtered at the Jos abattoir for 4 weeks

Tissues	Lesion status	Number Examined	Positives (%)	OR	P-value
Intestine	Cattle with Lesions	36	21(58.3)	8	0.000088
	Cattle with No Lesion	4	2(50.0)		
Reticulum	Cattle with Lesions	23	14(60.9)	1.5	0.24
	Cattle with No Lesion	17	9(52.9)		
Rumen	Cattle with Lesions	26	17(65.4)	2.182	0.032
	Cattle with No Lesion	14	6(42.9)		

X) was found to be majorly associated with positive cases (Figure 2).

The reticulum was observed to record a high prevalence of lesions, with 23 of the samples containing 1 or more lesions. Out of the 23 with lesions, 14(63.64%) were positive for *Paramphistomum* spp, while of the 17 samples without lesions, 9(52.94%) were positive. The odds ratio of occurrence of lesions in a positive case was found to be 1.500, which was found to be statistically not significant ($p>0.05$). Furthermore, the lesion associated with the reticulum is necrosis of the villi enterocytes (Plate XI).

For the histopathological changes in the rumen, 26 of the 40 samples examined were found to contain lesions, with 17 (65.4%) being positive for *Paramphistomum* spp, while 12 rumen out of the 40 cattle sampled were without observable lesions from

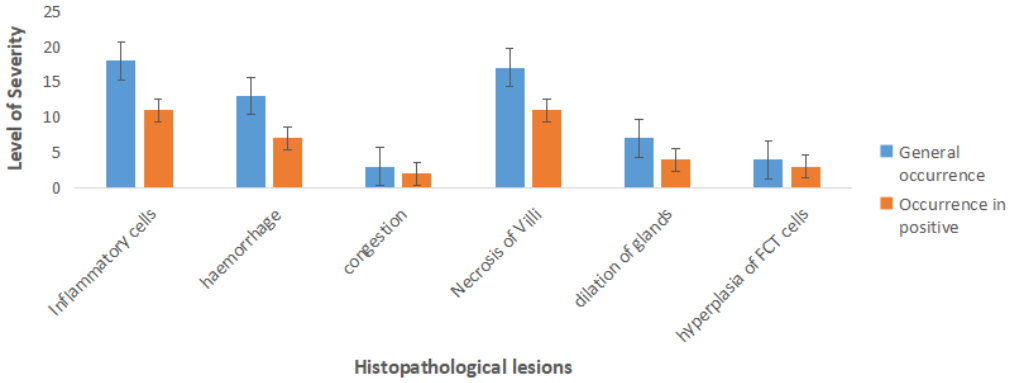

Figure 2: Microscopic lesions of the small intestine of cattle slaughtered in Jos abattoir

which 6(42.9%) were positive for *Paramphistomum* spp. The odds ratio of the occurrence of a positive case with lesions associated was observed to be 2.182, which was found to be statistically significant ($p<0.05$). Necrosis of the intestinal villi was the common lesion; however, congestion and infiltration by inflammatory cells in the lamina propria were observed to be more common with positive cases of *Paramphistomum* spp. infection (Figure 3).

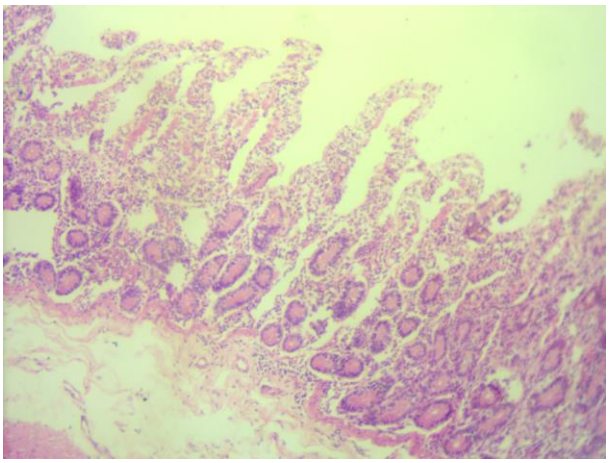

Plate IX: Photomicrograph of a normal intestine in cattle slaughtered from the control group (GP1). H&E x100

Discussion

The overall prevalence of paramphistomosis in cattle slaughtered at the Jos abattoir from this study is higher than the prevalence of 56% in Sokoto (Bunza *et al.,* 2008), 15.4% in Ibadan (Adedipe *et al.,* 2014), 16.1% in Kwara state (Elelu *et al*., 2016), 8% in Kaduna (Benjamin *et al.,* 2025), but lower than the report of Arowolo *et al.* (2020) who reported a prevalence of 59.1% in Abuja; Opara *et al.* (2022), who recorded a prevalence of 62.6% in Akwa Ibom state, and that of Uwalaka *et al*. (2019), who reported a prevalence of 86.36% in Abia state.

Climatic variation could be the reason for the differences in prevalence and the intensity or availability of the intermediate host (snail) in these locations.

Female cattle (64.00%) had higher *Paramphistomum* spp. infections than males (46.67%), and this is in accordance with the reports of Davila *et al.* (2010), Arowolo *et al.* (2020) and Al-Shaibani *et al.* (2008), who also revealed higher prevalence of helminthes in females, which could be attributed to variation in sample size (Bachal *et al*., 2002), and immunosuppression during pregnancy, birth and lactation (Alade & Bwala, 2015). Another reason for the high prevalence in female cattle could be attributed to having more females in the herd and keeping them longer. Although the variation in the prevalence of *Paramphistomum* spp. infections between female and male cattle in this study were statistically not significant ($p> 0.05$), the prevalence of *Paramphistomum* spp. infection by age of cattle examined in this study showed a higher prevalence in adult (63.6%) cattle compared to the young ones (50%).

This corroborates the finding of Arowolo *et al*. (2020) who reported a higher prevalence of infection in adult (62.0%) cattle than in the young (42.1%) ones. This can be attributed to stress in adult cattle over a period of time, such as stress from hunger and thirst, fatigue, illness or tissue lesions, which could inflict physical constraints on the functioning of the body. Transportation stress associated with the loading of cattle into a lorry and subsequently into the abattoir, where the unfamiliar presence of humans and other animals may lead to a disruption in their social rearing group due to separation, could serve as another cause of stress (Terlouw *et al.,* 2008).

Infected cattle from this study showed gross lesions of hyperemia in the intestinal mucosa,

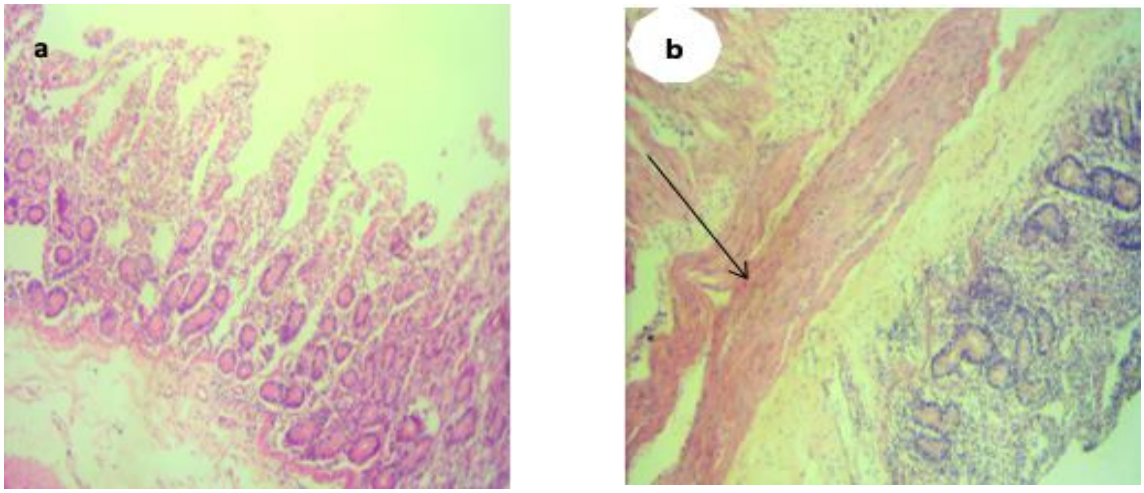

Plate X: (a) Photomicrograph of a normal intestine in cattle slaughtered from the control group (GP1). H&E x100 (b) Photomicrograph of the intestine showing diffuse fibrous connective tissue cell hyperplasia in the muscularis mucosa of a cattle positive for *Paramphistomum* (arrow). H&E x100

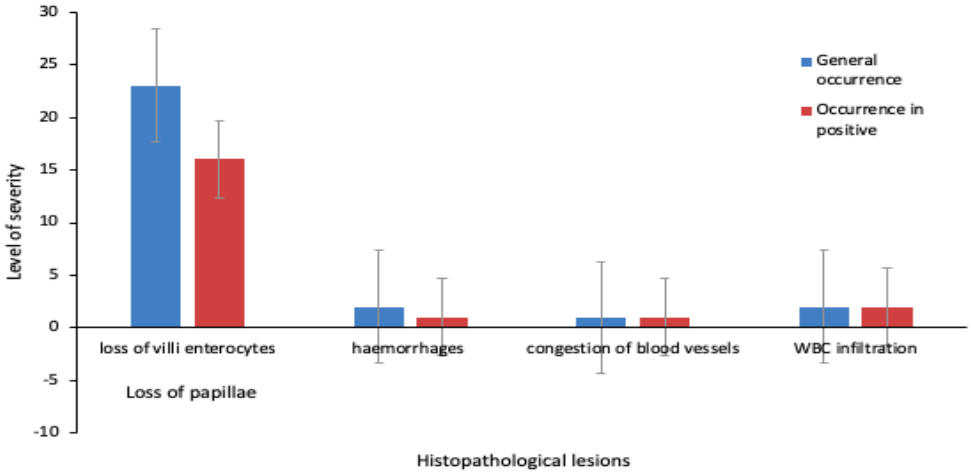

Figure 3. Microscopic lesions in the rumen of cattle slaughtered in Jos abattoir

mucohaemorrhagic enteritis, mucoid enteritis, paramphistomes firmly attached to ruminal papillae and also present in the reticulum, which is similar to the findings of Tehrani *et al*. (2015) and Preethi *et al.* (2019) who observed hyperemia, severe congestion and haemorrhage in the intestinal mucosa of sheep and cattle infected with paramphistomes and the reports of severe haemorrhagic enteritis by Toledo *et al.* (2006) and Millar *et al.* (2012).

Histopathological changes in tissues from this present study revealed *Paramphistomum* spp. in the submucosa of the intestine, severe necrosis of intestinal villi and reticular papillae, severe mucosal haemorrhages, mononuclear cellular infiltration of the lamina propria, severe eosinophilic infiltration of the intestinal mucosa, severe glandular dilatation and vascular

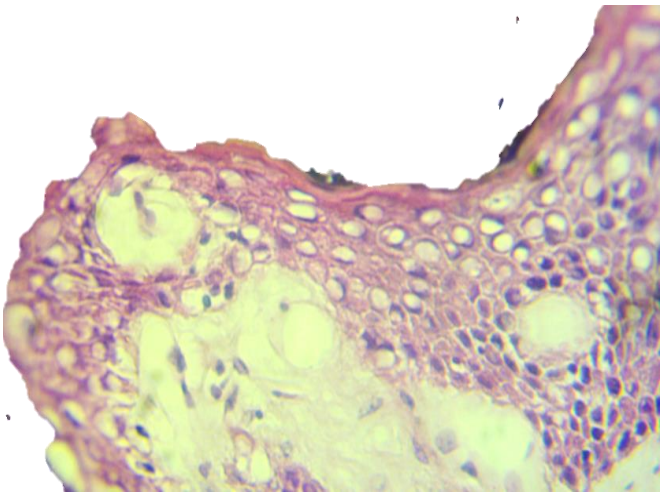

Plate XI: Photomicrograph of the reticulum of a *Paramphistomum*-infected cattle at the Jos abattoir showing severe loss of enterocytes. H&E x400

congestion in the submucosa and hyperplasia of fibrous connective tissue in the muscularis mucosa of the intestine.

The lesions may be caused by the mechanical injury induced by the migration of the flukes and may account for the anaemia that is consistent with this condition in ruminants. The findings from this study are in tandem with the reports of Fuertes *et al.* (2015); Tehrani *et al.* (2015); Rolfe *et al.* (1994); Mavenyengwa *et al.* (2008); Al-Gaabary *et al.* (2009); Rizwan *et al.* (2022); Horak (1971), and Preethi *et al.* (2019). This study has established the presence of paramphistomosis in cattle slaughtered at the Jos abattoir. The gross and histopathological changes in tissues examined in cattle infected with *Paramphistomum* from this study provide useful information that will aid in diagnosis.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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