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Prevalence of Gastrointestinal Parasites of Wild Warthogs and Domestic Pigs living in and Around Mole National Park, Ghana.

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ABSTRACT

Warthogs and pigs harbour intestinal parasites which are pathogenic to humans due to the interaction between humans and non-human animals. This study delves into the prevalence of parasitic infestations in domesticated pigs (Sus domesticus) and wild Warthogs (Phacochoerus aethiopicus) living in and around the Mole National Park. Fourteen domesticated pigs and wild warthogs were randomly selected for faecal sampling and subsequent parasitological analysis. Key parasite load and prevalence rates were assessed using the Floatation Technique and Mc Master Counting Chamber. There was no significant difference ($p>0.05$) between pigs and warthogs regarding FEC of Strongyle sp, Strongyloides, Trichuris trichuria, Schistosoma mansonii and Taenia sp. However, pigs had significantly higher ($p<0.022$) average FEC of Nematodirus (1050.0 ± 429.3 EPG) compared to the warthog which recorded none. In domesticated pigs, Strongyle sp showed the highest prevalence rate of 71.4% while the Trichuris trichuria had the least prevalence rate of 14.3%. However, Ascaris sp and Schistosoma mansonii were not detected in domestic pigs. In the warthog group, Strongyle sp had the highest prevalence of 85.7% while Schistosoma mansoni had the lowest prevalence rate of 14.3%, but Trichuris trichuria and Nematodirus were not observed in wild warthogs. The intensity of Ascaris was high (14.3%), medium (21.4%), and low (28.6%) while 35.7% reported none for the warthog group while all the pigs recorded none. A contrasting trend was recorded for Nematodirus where 28.6 recorded high intensity, 21.4, 14.3 and 35.7 % for medium, low and none respectively for the pigs while none was recorded for the warthog. Also, moderate intensity was recorded in both groups for the intensity of Schistosoma mansonii while the intensity of Strongyloides was high. The observed differences in prevalence rates highlight the potential influence of ecological factors and host specificity on parasitic dynamics. The study provides insights into the prevalence of parasitic infestations in wild warthogs and domesticated pigs living in and around the Mole National Park as they live close to each other which can have implications for local wildlife management.

Keywords: *Warthogs; prevalence; pigs; gastrointestinal; parasites*

INTRODUCTION

The Mole National Park is an environment that allows direct or indirect contact between wild warthogs and domestic pigs reared in and around the adjoining communities and the inhabitants. This phenomenon increases the risk of transmission of diseases and pests. Infections caused by gastrointestinal parasites have become a growing threat to public health, capable of causing infections in humans, animals and non-human primates (Jourdan et al., 2018). The huge inflow of tourists, visitors

and students to the Mole National Park requires a control of zoonotic diseases.

Parasites in wildlife animals present an important field of investigation as they may have vital conservation and zoonotic implications. Contact between wild animals, domestic animals, and humans is increasing due to several agricultural expansions, excessive deforestation, and unplanned urbanisation (Chomel et al., 2007). The presence of helminth and protozoan parasites in wild and domestic animals (host), may induce morbidity and mortality (Nath et al., 2012). These parasites are capable of causing infections in humans and non-human primates (Jourdan et al, 2018). Warthogs and pigs can harbour and also serve as a source of intestinal parasites which are pathogenic to humans (Mafuyai et al, 2013). It has been reported that most emerging human infectious diseases are zoonotic and over 70% of these infections originated from wildlife (WHO, 2010). Cunningham et al. (2017) also reported that interaction between humans and non-human animals is known to lead to the development and transmission of zoonoses. Parasites might be introduced into the wild by several means through contaminated food (fruits, vegetables, infected water or fish), water running into the wild during rainy seasons, intermediate and paratenic hosts (snails, ants, cockroaches, insects and rodents), wildlife staff, illegal hunters and visitors (Panayotova-Pencheva, 2013). A previous study showed that there is a high prevalence rate of intestinal parasites in warthogs sampled from the Mole National Park some of which are known to infect humans (Ryan et al, 2012). Therefore, understanding the nature of zoonotic disease transmission is important in these areas where human-animal interaction is frequent as it contributes to decision-making in wildlife conservation and management. However, there is little information on the comparison of gastrointestinal parasites of wild warthogs (*Placochoerus aetheopicus*) in the Mole National Park and domestic pigs (*Sus domesticus*) living in fringe communities around the park. Hence this study aims to determine the load, prevalence rate and multi-parasitism of helminths in warthogs in the Mole National Park and domestic pigs in fringe communities around the park.

MATERIALS AND METHODS

Study Area

This study was carried out at Mole National Park which is located in the West Gonja District of the Savanah Region in Ghana. Mole National Park is the largest and most prestigious wildlife-protected area in Ghana covering an area of 4,840 km^2. The Park is home to many kinds of mammals, birds, reptiles, amphibians, insects, and most plant species (www.britanica.com). The domestic pigs were sourced from a community called Yipala located about 3 km away from boundaries of the Mole Park. The choice of Yipala was because it was the only fringe community where domestic pigs are kept and its proximity to the National Park also allows occasional interaction between the warthogs and domestic pigs which live under the semi-intensive system. From personal observation, the proximity allows close interaction between warthogs and domestic pigs in nearby communities with humans as they benefit from feeding on human kitchen waste.

Study Animals and Sample Collection

The study was carried out on warthogs (*Pharchocoerus aethiopicus*) within the Mole National Park and domestic pigs (*Sus domesticus*) reared in Yipala, a community close to the park. For the domestic pigs, 2 samples each were taken from 14 randomly selected pigs from seven different farmers (two pigs per farmer in the Yipala community. Samples were also taken randomly from fourteen (14) free-roaming warthogs within Mole Park. About 20 g of faecal matter was taken per animal into well-labelled pale boxes, covered and stored immediately in a cold container packed with ice packs to break the chain of hatching eggs. The warthogs were

trailed and faecal matter was picked immediately after dropping under the guidance of a Tour Guard. Care was taken to avoid duplication. The collected faecal samples were preserved in 10% paraformaldehyde and transported to the laboratory for analysis.

Laboratory Analysis

The Improved Floatation Technique was used to extract ova of the gastrointestinal parasites and eggs/g of each faecal sample quantified using the Mc Master Counting Chamber. Briefly, about 3g of each faecal sample was emulsified with tap water using a laboratory mortar and pestle. The emulsified faecal solution is transferred into plastic test tubes for centrifugation at a speed of 2000 rpm for 5 min. The supernatant was poured off and replaced with saturated sodium chloride solution having a higher specific gravity than water and therefore can float ova present in the sample. The samples were re-centrifuged at the same speed and allowed to stand for 8 to 10 min. The surface fluid was drawn using a Pasteur pipette onto the Mac master counting chamber. After allowing it to stand for 2 to 3 min, the chamber was mounted on the stage of a compound microscope at a magnification of ×40. The eggs counted in the chamber were multiplied by 100 to get the number of eggs per gram of faeces (EPG). Finally, the identification of the parasites was performed. Identification of various eggs was done based on their egg size and morphology with the aid of charts, books and pictures and books at the Central Veterinary Laboratory in Pong-Tamale, Ghana. Each sample was replicated thrice.

Data Analysis.

The data was done using the GenStat Version 12.1. Coprophogic egg count was determined using a T-test, while the prevalence was determined using the chi-square at a significant level of 5%. Data was presented as Mean ± SD in tables. Animals with EPG of Zero (0 EPG) were classified as negative, those with faecal egg counts (FECs) between 1 to 500 EPG were classified as having a low intensity of infection, while those with FECs between 501-1000 EPG were classified as having a medium intensity of infection, and those with FECs of over 1000 EPG (>1000 EPG) were classified as having a high intensity of infection, in line with the standard established grouping of the infection intensity by (Soulsby, 1982).

Loads of some intestinal parasites in Pigs and Warthogs

There was no significant difference ($p>0.05$) between pigs and warthogs in terms of FEC of *Strogyle* sp*, Strongyloides* and *Taenia* sp (Table 1). However, no eggs were found for *Trichuris trichuria and Schistosoma mansonii* among the pigs. Also, FEC for *Nematodirus (*1050.0 ± 429.3) and *Trichuris Trichuria (*64.29 ± 46.42) were found in the pigs while none was found for the warthog. Also, there was a high average load of *Ascaris sp* and *Schistosoma mansonii* FEC in the warthog while domestic pigs recorded none.

Prevalence of some intestinal parasites in Pigs and Warthogs

Among the pigs, *Strongyle* sp had the highest prevalence (78.57%) followed by *Strongyloides* and *Nematodirus* (64.29%) with the least being *Trichuris Trichuria* (7.14%) (Table 2). However, *Ascaris* sp and *Schistoma mansonii* were not seen in the pigs. In the warthog group, *Strongyle* sp had the highest prevalence rate (85.71%) while *Ascaris* sp, *Schistoma mansonii*, *Taenia* sp, and *Strongyloides* had infestation rates of 64.29%, 7.14%, 14.29% and 57.14% respectively while none was seen for *Nematodirus* and *Trichuris Trichuria* (Table 2). Comparing the prevalence in both species, no significant difference ($p>0.05$) was seen for *Strongyle* sp, *Strongyloides* and *Taenia* sp.

Table 1: Loads of *Strongyle* sp*, Nematodirus, Trichuris trichuria, Ascaris sp, Schistosoma mansonii Taenia* sp and *Strongyloides* in Pigs and Warthogs

Category	*Strogyle* sp (Mean±SEM)	*Strogyloides* (Mean±SEM)	*Nematodirus* (Mean±SEM)	*Trichuris Trichuria* (Mean±SEM)	*Ascaris* sp (Mean±SEM)	*Schistosoma mansonii* (Mean±SEM)	*Taenia sp* (Mean±SEM)
Pig	2721± 1305	2529± 788	1050 ± 429	64.29 ± 46.42	0.0 ± 0.00	0.0 ± 0.00	971.4 ± 793.9
Warthog	2457± 988	4636 ± 1763	0.0 ± 0.00	0.0 ± 0.00	421.4 ± 131.8	28.57 ± 28.57	21.4 ± 15.5
P-value	0.873	0.290	-	-	-	-	0.253

Table 1: Prevalence of *Strongyle* sp*, Nematodirus, Trichuris trichuria, Ascaris* sp*, Schistosoma mansion, Taenia* sp *and Strongyloides* in Pigs and Warthogs

Category	*Strogyle* sp (Mean±SEM)	*Strogyloides* (Mean±SEM)	*Nematodirus* (Mean±SEM)	*Trichuris Trichuria* (Mean±SEM)	*Ascaris* sp. (Mean±SEM)	*Schistosoma mansonii* (Mean±SEM)	*Taenia* sp. (Mean±SEM)
Pig	78.5% ± 0.11	64.29%± 0.13	64.29%± 0.13	7.14% ± 0.07	0% ± 0.00	0% ± 0.00	28.57%± 0.13
Warthog	85.71% ± 0.09	57.14% ± 0.14	0% ± 0.00	0% ± 0.00	64.29% ± 0.13	7.14% ± 0.07	14.29% ± 0.09
P-Value	0.637	0.712	-	-	-	-	0.38

Multiple parasitism infestation

In terms of multiple parasitic infestations, the majority of the pigs (50.0%) were infested with "only 2" parasites while 35.71% and 7.14% were infested with "only 3" and "only 4" parasites respectively whereas none were infested with "At least 5" and "above 5" (Table 3). In the warthogs, 42.86% were infested with “only 2”, 21.43% with “only 3” and 14.29% with “only 4”. However, none of the warthogs was infested with 5 or more parasites. No significant difference ($p>0.05$) was seen concerning multi-parasitism between the two groups.

Table 2: Multiple parasitism infestation

Category	Only 2 (Mean±SEM)	Only 3 (Mean±SEM)	Only 4 (Mean±SEM)	≥5 (Mean±SEM)
Pig	50.0% ± 0.14	35.71% ± 0.13	7.14% ± 0.07	0% ± 0.00
Warthog	42.86% ± 0.14	21.43% ± 0.11	14.29% ± 0.09	0% ± 0.00
P-value	0.717	0.422	0.558	*

The intensity of the various Parasites on the Warthog and Domestic pigs

The data showed that the intensity of *Ascaris* was high (14.3%), medium (21.4%), and low (28.6%) while 35.7% reported none for the warthog group while all the pigs recorded none (Figure 1A). A contrasting trend was recorded for *Nematodirus* where 28.6 recorded high intensity, 21.4, 14.3 and 35.7 % for medium, low and none respectively for the pigs while none was recorded for the warthog (Figure 1B). The intensity was moderate for both groups for intensity *Schistosoma mansonii* for both groups (Figure 1C) while the intensity remained balanced for the *Strongyle* sp in the two species (Figure 1D). However, the intensity of *Strongyloides* was high (Figure 1E) in both groups while almost no intensity existed for in both groups for *Taenia* sp and *Trichuris trichuria* (Figures 1F and 1G).

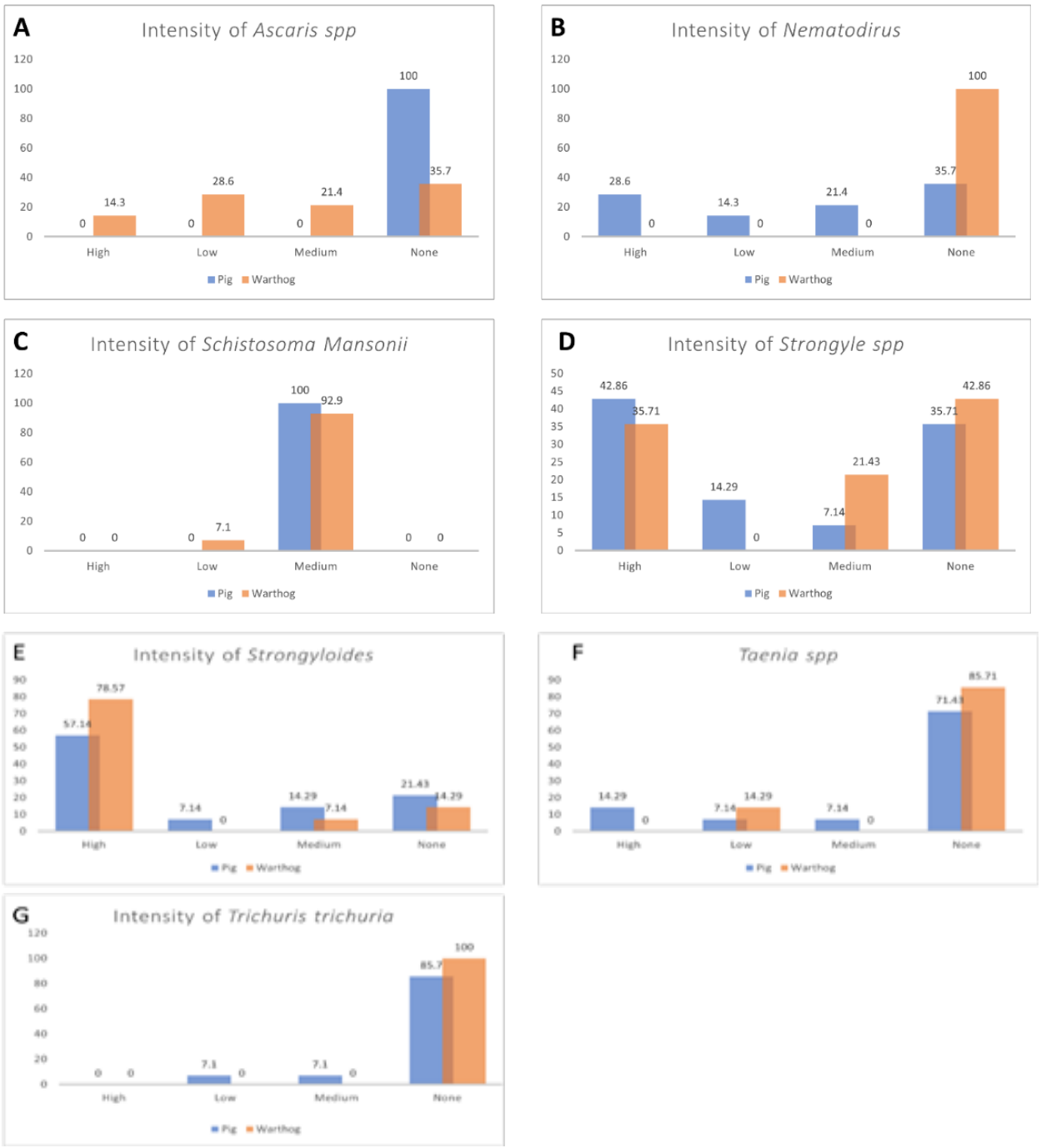

Figure 1: The intensity of the various Parasites on the Warthog and Domestic pigs. The grouping of the infection intensity by Soulsby (1982).

DISCUSSION

This study identified and assessed the prevalence of intestinal parasites in warthogs (*Phacochoerus aethiopicus*) in the Mole National Park and domesticated pigs *(Sus domesticus*) kept in communities around the national park. The findings extend the understanding of the epidemiology of gastrointestinal parasites in these suids and reveal intriguing disparities that warrant examination in the context of ecological and geographical variations.

The study revealed that domesticated pigs exhibited a significantly higher average faecal egg count (EPG) of *Strongyle* sp compared to the wild warthogs. This finding agrees with a previous preliminary study in the same location which observed a similar prevalence pattern in *Strongyle* sp EPG between domesticated pigs and wild boars (Owusu et al., 2023). Notably, warthogs showed a high prevalence of *Ascaris* sp while domesticated pigs recorded none. A previous study in the same location also reported a similar prevalence of *Ascaris* sp (64.1%) and *Taenia* sp (48.7%). This suggests that the infestation rate of *Ascaris* sp is similar to our study (64.29 %) while the rate of *Taenia* sp is lower (14.29%) in our study. These patterns may be indicative of distinct host preferences among parasite species. It is worth noting that this distinction may also be attributed to variations in management practices, as domesticated pigs often experience more controlled environments than their wild counterparts (Jufare et al, 2015).

The study identified considerably higher EPG of *Strongyloides* in wild warthogs compared to domesticated pigs. Previous studies also reported a similar higher prevalence of warthogs in the Saadani National Park in Tanzania and the Mole National Park of Ghana (Nonga et al., 2014; Larbi et. al., 2020). The high prevalence of *Strongyloides* found among warthogs within Mole Park could be attributed to the unhygienic sanitary conditions of the study area as these parasites are transmitted via the consumption of food and water contaminated with faeces harbouring the infective stage of the parasite (Greaves et al., 2013). Owusu et al. (2023) observed warthogs roaming around toilet facilities in the community, which could expose them to parasitic infestation. Aside from intake of contaminated water and food, autoinfection can also occur allowing untreated infection to persist accounting for high prevalence rates (Page et al., 2018). Autoinfection is reported among *Strongyloides* sp (CDC, 2019) which could account for the high prevalence rate among warthogs.

Our observation of higher *Nematodirus* EPG (1050 ± 429) in domesticated pigs is consistent with findings from (Larbi et al. 2020) in the same ecological setting. This suggests that *Nematodirus* prevalence may be influenced by a complex interplay of host species, management practices, and regional factors.

The exclusive presence of *Schistosoma mansonii* in wild warthogs agrees with the work of Boomker et al. (1991) who first identified *Schistosoma* exclusively in warthogs in South Africa in 1988. This finding underscores the relevance of host specificity in parasite distribution and hints at potential zoonotic implications.

The prevalence of multiple parasitism infestations in suids in this offers valuable insights. Among domesticated pigs, the majority displayed "only 2" multiple parasitism infestations, with "only 3" and "only 4" occurring in moderate proportions. This finding agrees with a previous study in the same location where fifteen warthogs in the sampled population had two parasites

(65.22%), two warthogs had three parasites (8.69%) and one warthog had four parasites (Larbi et al., 2020). Also, the study is consistent with the findings of Jones et al. (2019) who also reported multiple parasitism in domesticated pigs. The results imply that multiple parasitism infestations may be influenced by ecological factors suggesting that the results may have implications beyond the immediate study area, suggesting that the ecological factors influencing parasitism infestations are relevant at a larger spatial scale.

In conclusion, the high prevalence rates of some pathogenic gastrointestinal parasites in the faecal samples are important for public health as workers within the park risk the chance of zoonotic transmission as we observe their close interaction with humans. This study contributes to the growing body of knowledge on parasitic infestations in suids and underscores the need for comprehensive and multidisciplinary research to unravel the intricate relationships between host species, parasites, and their environments. Further studies are required in ecological trends i.e., the distribution, abundance, or behaviour and infection rates of these parasites across the different species (warthogs and domestic pigs) within the Mole National Park. This would help us understand the underlying causes of the disparities in *Strongyloides* infection rates. These findings have implications for wildlife conservation, livestock management, and public health, particularly in regions where suids interface with human populations. Also, the observed patterns of multiple parasitism infestations within the suids family suggest intricate interactions among various parasite species within host populations, this raises questions about potential health and population consequences. These insights affect wildlife conservation, livestock management, and public health efforts. Our research serves as a valuable foundation for future studies, offering a comprehensive perspective on suid-parasite interactions. Future research should delve deeper into the underlying ecological, genetic, and environmental determinants driving the observed variations in parasite loads, prevalence patterns, and multiple parasitism infestations. Exploring the role of environmental factors, such as climate and habitat, as well as genetic adaptations in host populations, may provide critical insights into the dynamics of suid-parasite interactions.

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Competing interests

The authors declare no competing interest in this work.