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Detection of *Ascaris suum* on Visayan warty pig *Sus cebifrons* in Negros Island, Philippines: A case report

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ABSTRACT

This paper presents a report on the occurrence, gross pathology and transmissibility of *Ascaris suum* on Visayan warty pig in Negros Island, Philippines. An approximately 3-year-old Visayan warty pig was presented for death examination. History revealed that the animal was rescued from the local hunters, and is enclosed in a pen with soil flooring, fed with fruits and root crops, and, without veterinary care, was given even prior to the onset of the disease. Gross pathology revealed extensive ecchymoses in the left dorso-caudal lung lobe and multifocal fibrosis on other parts. Multifocal splenic infarctions, empty stomach, and mild fibrosis in the liver parenchyma were observed. The entire small intestine displayed catarrhal enteritis, accompanied by mucosal reddening, and numerous adult stages of *Ascaris suum* were identified. The results of the case showed that the transmissibility of *A.suum* in Visayan warty pig is generally the same on what is reported on domestic pigs. Furthermore, this case poses a public health threat due to its zoonotic potential, which is of greater concern compared to the transmissibility of the parasite in domestic pigs due to the nature of living by the Visayan warty pig. As a result, various preventive measures involving innovations in agriculture in rural areas and modifications in the attitude of every person living in the vulnerable place are formulated. To the author's knowledge, this is the first report of *A.suum* infection in Negros Island, Philippines, and this should raise awareness among veterinarians, animal conservationists, and public health experts to consider *A. suum* infection as part of differentials whenever the same case will happen.

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INTRODUCTION

The intestinal nematode parasite *Ascaris suum*, also referred to as the "large roundworm of pigs," is a soil-borne parasite that primarily affects the hosts' small intestine. This parasite is classified as a member of the *Ascarididae* family, which includes parasites like *Parascaris equorum* in horses, *Toxocara canis* in dogs, *Toxocara vitulorum* in large ruminants, and *Ascaris lumbricoides* in humans (Soulsby, 1982). The majority of pigs infected with the parasite show no symptoms; however, heavily infected pigs may exhibit symptoms such as weight loss, unthriftiness, delayed weight gain, trouble breathing (thumps), and excretion of adult worms accompanied in feces (Ballweber, 2022; CDC, 2020; Soulsby, 1982).

The occurrence of *A.suum* in pigs was reported globally, especially in areas where backyard-raised pigs are common, resulting in significant production losses. (Baker, 2003; Ballweber, 2022; Soulsby, 1982; Thamsborg et al., 2013; Zajac & Conboy, 2008). In addition to these direct effects, the nematode's migratory and immune-modulatory actions may have indirect consequences that increase susceptibility to or pathogenicity to bacterial or viral infections. Pigs with ascariasis experience the following losses: (1) farm financial losses due to decreased growth and feed conversion efficiency, as well as control costs; (2) abattoir operator losses due to liver downgrading or condemnation and decreased product quality; and (3) potential interference with vaccinations and increased co-infection risk (Thamsborg et al., 2013). On the other hand, due to the lack of soil access in commercial pig farms compared to pigs grown in backyard settings, the parasite is rarely to nearly never detected (Boes et al., 2010). Various literature regards the parasite to be zoonotic (Baker, 2003; Ordoñez et al., 2018; Pineda & Ramos, 2012; Soulsby, 1982). Furthermore, in an *Ascaris*-infected host, co-infection with different pathogens is common (Abanyie & Lamb, 2013). In fact, the pig-to-human infection has been documented, and it primarily affects youngsters due to their propensity of playing in soil that could be contaminated with eggs, as well as inadequate hygiene (Paller & de Chavez, 2014). This fact underscores that the parasite is not only an issue in the animal sector but also a public health risk; as a result, preventive actions to limit its spread focused not only on pigs but also on vulnerable human groups like children and pig farmers (CDC, 2020).

In the Philippines, *A. suum* was reported in domestic pigs especially those that were raised in backyard operation (Padilla & Ducusin, 2017; Ybañez et al., 2017). Reports on its occurrence in humans were also documented, particularly among backyard pigs and schoolchildren (Alba et al., 2009, Betson et al., 2014; Ordoñez et al., 2018; Pineda & Ramos, 2012). Unfortunately, there are few published reports on it, making it underreported (Alba et al., 2009). *A.suum* in non-domestic pigs is uncommonly documented and underreported. In the Philippines, one of the endemic species of non-domestic pigs found in the country is the Visayan warty pig (Cox, 1987). The animal was reported to be found particularly in the islands Biliran, Bohol, Cebu, Guimaras, Masbate, Panay, Negros, Siquijor, Leyte, and Samar (Cox, 1987; Wikramanayake et al., 2002) and there are different names for the said animal, depending on the place or language. It is known as "Baboy Talunon" in Hiligaynon, which stands for forest pig; "Baboy Ilahas" in Cebuano, Hiligaynon, and Waray, which stands for wild pig; "Baboy Sulop" in Cebuano, which stands for dark pig; and "Baboy Ramo" in Waray, which stands for wild boar (Wikramanayake et al., 2002).

The Visayan warty pig is a critically endangered species in the Philippines (Alipo-on et al., 2022; Linkie et al., 2017; Nuijten et al., 2016). The significant predisposition attributed to the species' vulnerability is mainly due to hunting and the destruction of their natural habitat (Cox, 1987; Tanalgo, 2017). In addition, diseases can also contribute to the conservation status of wild animals (Portugaliza et al., 2015); however, there are limited reports documented on diseases in Visayan warty pigs (Chatterton et al., 2017). Because there is currently little literature on the disease in the Visayan warty pig, this paper covers the incidence of *A.suum* on the said animal, its pathology, and transmissibility on the said animal. The information in this study will guide veterinarians, animal conservationists, and public health experts on what to do when the disease is discovered.

CASE PRESENTATION

The Department of Environment and Natural Resources - Community Environment and Natural Resources Office (DENR-CENRO) of Negros Occidental, Philippines, brought a 3-year-old Visayan warty pig for death inquiry. The said pig had been saved from local hunters in the previous six months and was being cared for by the said agency, according to the records. The pig's native habitat and footprints were frequently observed, tracked, and reported in the forested sections of the Northern Negros Natural Park (NNNP).

The pig was declared dead in its pen last May 5, 2021, at 3 am. Prior to its death, the caretaker told that the animal became weak, anorexic, emaciated, and demonstrated diarrhea for two weeks. Its typical diet was fruits such as papaya, banana, watermelon, and rootcrops such as cassava and sweet potato with deep well as the water source. The animal was enclosed in a pen with soil flooring. No veterinary care was given to the animal from the time it was rescued. Necropsy was performed, which started at 10 am on the same day. Upon physical assessment, the pig demonstrated a body condition score (BCS) of 1 out of 5, which indicates that the pig was extremely emaciated (Figure 1). Gross pathology showed extensive ecchymoses in the left dorso-caudal lung lobe and multifocal fibrosis on other parts. The spleen was also examined and found to have multifocal infarctions. Upon further examination, the stomach was empty, and mild fibrosis was observed in the liver parenchyma. Catarrhal enteritis was observed in the entire small intestine with reddening of the mucosa, and about 50 adult-stage *Ascaris suum* were found with a length ranging from 15 to 30 cm (Figure 2). Furthermore, a direct microscopic inspection of its feces was performed by diluting a fecal sample in saline solution, depositing a drop of the solution in the microscope slide, covering it with a cover slip, and examining it under the microscope at 100x magnification. The procedure revealed that eggs of the parasite in question during the necropsy were present (Figure 3). The morphology of the adult parasite and the structure of its eggs were confirmed using the morphological and parasite egg descriptions of Soulsby (1982).

Figure 1. The Visayan warty pig

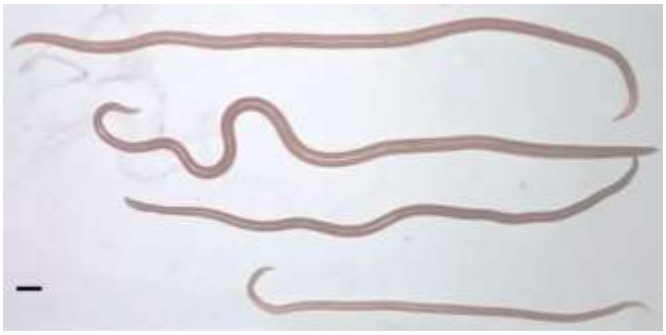

Figure 2. Adult stages of *Ascaris suum* showing its various length (scale bar: 1cm)

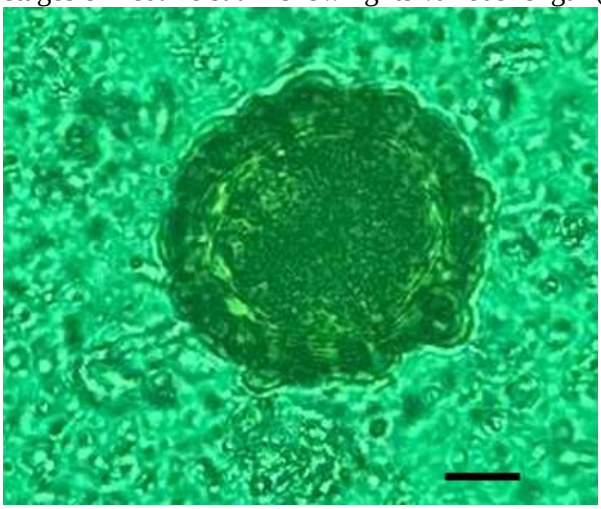

Figure 3. *Ascaris suum* egg (scale bar: 10µm; photo courtesy of Dr. Elyn Mae Fegidero - de la Torre)

DISCUSSIONS

Ascaris suum, a parasite found in pigs, is both prevalent and dangerous (Baker, 2003; Ballweber, 2022; CDC, 2020). Ascaridoids are around 30 cm long, white to cream in color, and have three large lips. Although the effects of *A. suum* infection in the small intestine are less striking than those of larval migrations, they are unquestionably substantial (Soulsby, 1982).

In terms of how the pig acquired the disease, it can be because the animal was raised in a pen with soil flooring, and was fed with rootcrops. Various literature mentioned that the said parasite could be transmitted through soil, and its infective stage can be found isolated in rootcrops (Baker, 2003; Cosico et al., 2017; Ordoñez et al., 2018; Paller & de Chavez, 2017; Soulsby, 1982) as known that rootcrops are considered one food source for pigs (Kayombo et al., 2022). The parasite's transmissibility poses a hazard not just to wild pigs but also to domesticated pigs. The majority of pigs in the Philippines were raised in backyard operations (Andico & Peña, 2019; Bernardes & Peña, 2020), which predisposes the pigs to contract the disease because pigs raised in the country were more likely caged in a pen with soil flooring and fed swills and rootcrops, giving them access to the parasite's infective stage. The said facts is reinforced by the findings of Padilla and Ducusin (2017) and Ybañez et al. (2017), who discovered that the identification of *A.suum* in domesticated pigs was linked to the type of flooring used by farmers in the pigs' rearing. This means that whether the pig species is domesticated or not, the way in which it is contained as well as the type and manner of its feeding present a risk for the parasite's spread.

The clinical signs presented by the Visayan warty pig infected by the said parasite coincide with the description of the following literature (Baker, 2003; Ballweber, 2022; CDC, 2020; Soulsby, 1982). However, given the approximate number of adult parasites found in the animal, it is not enough to cause such signs

compared to domestic pigs infected by the same parasite load. The primary thing that influenced the appearance of clinical signs was that the pig was not in its natural habitat, which influenced its immune system to alter. As detailed by Soulsby (1982) in the development of the disease, the animal's nutritional and veterinary needs were not met, predisposing the animal to grow more vulnerable to the sickness. Furthermore, despite the lower parasite burden, alterations in gut microbiota could be the cause of clinical symptoms. According to Wang et al. (2019), *Ascaris* infection was linked to a significant shift in the gut microbiome, particularly near the site of larval infection, which could worsen the infection of the said nematode. This shows that the environment and the animal's physiological state at the time of infection have an impact on the pathogenicity of *A.suum* in pigs, either domesticated or non-domesticated, not just depending on the parasite load.

In terms of its gross pathology, significant lesions were found on an infected Visayan warty pig's lungs, spleen, liver, and small intestine. The said findings coincide with the pathogenesis of *A. suum* in domestic pigs stated by Soulsby (1982). The occurrence of lesions can be due to the migration of larval stages in the lungs, spleen, and liver resulting in pneumonia, splenic infarction, hepatic fibrosis, respectively, and adult stages in the small intestine resulting in catarrhal enteritis. Occurrence of distinct "milk spot" lesions in the liver, which was considered a feature but not a pathognomonic lesion of *A. suum* infection in domestic pigs, was not found in the liver of infected Visayan warty pig. The possible explanation for it is that the occurrence of the lesion was significantly correlated to the density of infection (Hale et al., 1985; Kano & Makiya, 2001), which in this case, the parasite load was not that much to cause the said lesion. For the same reason, odd occurrences in infected domestic pigs, such as occlusion of the bile duct or perforation of the gut wall brought on by wandering ascarid, were not seen in the infected Visayan warty pig. This shows that the gross lesions of *A.suum* in an infected Visayan warty pig are the same compared to what is reported in domestic pigs infected by the said parasite.

The zoonotic potential of *A. suum* was previously described by Soulsby (1982). This fact poses a public health concern, especially for the people who hunt them for food, since they can be infected through cross-infection, as described by Alba et al. (2009). However, the taxonomic classification of *A. suum* is yet not fully established and is still under debate, as some literature suggests that the said species is the same as *Ascaris lumbricoides* (Alba et al., 2009; Leles et al., 2012). Long thought to be a subspecies of the morphologically identical human ascarid *A. lumbricoides*, most modern authors regard *A. suum* as a separate species (Alves et al., 2016; Betson et al., 2014). Moreover, *A. lumbricoides* can mature in swine, and *A. suum* can mature in humans. The fact that these two species have separate cycles, with the pig species staying in pigs and the human species in humans even when both hosts live very close together (Soulsby, 1982), this should be considered when dealing with the disease in terms of its transmissibility.

Pigs are notably a potential carrier of zoonotic diseases (Peña et al., 2020) and this includes *A. suum*. *Ascaris* infections remain a serious global public health concern. Enhanced knowledge and understanding of host susceptibility and transmissibility to *Ascaris* infection could lead to new techniques for more effectively targeting existing medications or new targets for therapeutic development (Williams-Blangero et al., 2013). Not only that, preventive chemotherapy should be one of the measures to be considered by developing countries to prevent the transmission of the parasite. As studied by Montresor et al. (2013), periodic anthelmintic treatment to the vulnerable populations in Japan and Korea reduces soil-transmitted helminthiasis (STH) in less than a decade, and these achievements are then maintained by increasing the standards of sanitary measures. The same procedure was already done in the Philippines, especially on school children (Paller & de Chavez, 2014), however, given the new information that *A.suum* also infects wild pigs, and adults living near the rural or forested areas, the same activity should be given to them. The Visayan warty pig can be found on the islands of Biliran, Bohol, Cebu, Guimaras, Masbate, Panay, Negros, Siquijor, Leyte, and Samar (Cox, 1987; Wikramanayake et al., 2002), thus, people who live in these areas, particularly in rural or forested areas, are susceptible to infection, and the government-health sector should devise strategies to prevent the infection from spreading. Though encouraging them to use anthelmintics is beneficial, much more should be considered. Because agricultural crops (particularly rootcrops) are one of the food sources for the Visayan warty pig (Katakam et al., 2016; Ordoñez et al., 2018; Paller & de Chavez, 2014), agricultural innovations to minimize the viability of the infective stage should be pursued. Composting's usefulness in lowering *A. suum*'s viability was investigated by Andes and Paller (2017) and it

produced promising results, thus the procedure could be a good place to start in combating the infection. Furthermore, people's attitudes toward purchasing goods (in this case, agricultural crops/rootcrops) should be assessed and re-calibrated, as a study by Sen (2021) found that the general public prefers to buy goods from rural areas over urban areas, but this does not mean that they will only buy goods from urban areas; rather, a health promotion program to raise awareness of the potential transmission of parasite present should be implemented. Despite this new means of preventing the parasite spread as based on the case reported, basic preventive measures to control *A. suum*, such as the washing of hands by the people, regular deworming in humans and pigs, and intake of vitamin-mineral supplements should also be done to stop the disease from transmitting.

CONCLUSION

In terms of the transmissibility of *A.suum*, it is concluded that Visayan warty pig can be infected by the parasite and its mode of transmission in the said animal is the same as what is reported on domestic pigs. Moreover, despite that there is no difference in the transmissibility of the parasite in either domestic or non-domestic pigs, the latter are more prone to getting infected by the parasite due to its nature how do the animal acquire their food and its free access to soil. Furthermore, in terms of the gross pathology and clinical signs presented by the Visayan warty pig infected with *A.suum*, it is concluded the lesions and clinical signs manifested by the animal is generally the same as what is documented in domestic pigs. In addition, the pathogenicity associated with the physiological state and environmental influence on pigs infected with the parasite also affects both domestic and non-domestic pigs. Lastly, given the free-living nature of the animal and its method of obtaining food, the spread of the infective stage is wider than what can be done by a domestic pig infected with the parasite, it is concluded that there is a greater concern to consider if the parasite is found on Visayan warty pig or any non-domestic pigs than on domestic pigs.

IMPLICATIONS

Ascaris suum can infect both domestic and wild pigs, according to this study. The findings from this case should be used as a reference for veterinarians, animal conservationists, and public health experts to determine whether *A.suum* infection has to be considered in the differential diagnosis when a similar case arises in the wild. Additionally, this is the first account of *A.suum* being found in a Visayan warty pig on Negros Island, Philippines, to the author's knowledge.

LIMITATIONS

This case report only addressed *A.suum*'s propensity for spreading, its gross pathology, and its threat to Visayan warty pigs and potential public health risks. Only the information gleaned from the case's history and the gross lesions discovered during the necropsy was used for the evaluation and analysis of the report.

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