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Renal Stephanuriasis: Gross and microscopic findings in naturally-infected pigs from St. Kitts, West Indies

Danielle Morosco, Oscar Illanes, Carmen Fuentealba*

ABSTRACT. *Stephanurus dentatus*, the kidney worm of swine, is an important nematode parasite in outdoor swine populations worldwide. Infection is most common in tropical and subtropical areas and results in decreased weight gain and condemnation of edible parts invaded by migrating larvae. Worms reach sexual maturity within nodules at the peri-ureteral fat which communicate with the ureter and eggs are eliminated in the urine. At the St. Kitts abattoir, the kidneys of 10 pigs with gross lesions of stephanuriasis were examined microscopically. Parasitic tracts surrounded by areas of hemorrhage and inflammation were present in the fibro-adipose tissue around the ureters, renal pelvis and, rarely, within the renal parenchyma. Morulated eggs were found within nodules containing encysted worms. Due to the lengthy development of the parasite within the definite host, the finding of patent stephanuriasis in slaughterhouse pigs is unusual and likely the result of poor local management practices which lead to reduced weight gains, delays in the attainment of market weight and the frequent slaughtering of one year old pigs.

Key words: kidney worm, pigs, *Stephanurus dentatus*, ureter, St. Kitts.

RESUMEN. El verme renal del cerdo, *Stephanurus dentatus*, es un parásito importante en poblaciones porcinas a nivel mundial. La infección es más común en zonas tropicales y subtropicales y resulta en disminución de la ganancia de peso y el decomiso de vísceras invadidas por larvas migrantes. El verme renal alcanza la madurez sexual dentro de nódulos localizados en la grasa periureteral, los que comunican con los uréteres de tal manera que sus huevos puedan ser eliminados por la orina. En la planta de procesamiento de carnes de St. Kitts los riñones de 10 cerdos con lesiones macroscópicas de estefanuriasis fueron examinados microscópicamente. Trayectos parasitarios rodeados por áreas de hemorragia e inflamación se observaron en el tejido fibroadiposo periureteral, pelvis renal y raramente en el parénquima renal. Huevos morulados se detectaron dentro de nódulos con parásitos enquistados. Debido al largo periodo de desarrollo de las larvas en el hospedador, el hallazgo de estefanuriasis patente en cerdos de matadero es raro y está probablemente asociado con las prácticas de manejo en la isla de Saint Kitts, las que resultan en disminución de la ganancia de peso, retrasos en alcanzar el peso de mercado y el sacrificio frecuente de cerdos de un año de edad.

Palabras clave: verme renal, cerdos, *Stephanurus dentatus*, uretra, St. Kitts.

INTRODUCTION

Renal stephanuriasis, caused by infestation with *Stephanurus dentatus*, the kidney worm of swine, is an important parasitic disease in outdoor swine-rearing facilities and feral swine populations' worldwide (Stewart *et al* 1964, Henry and Conley 1970, Hale and Marti 1983). Infection is especially common in tropical and subtropical areas and is higher in grazing pigs (Cianciolo and Mohr 2016). While overt clinical signs of disease are unusual, heavy infestation results in poor growth and reduced weight gains. In addition, infection with *S. dentatus* can lead to the condemnation of liver, kidneys, and other edible parts invaded by migrating larvae (Hale and Marti 1983). Worms reach sexual maturity within cystic and nodular granulomatous lesions located at the peri-ureteral fat. These parasitic nodules communicate with the ureters, and eggs are eliminated with the urine and released to the environment (Cianciolo and Mohr 2016).

The Caribbean island of St. Kitts has a relative small number of pigs (about 4,000) raised for local consumption.

The most common breed is the creole type, a result of crossing imported Duroc, Landrace, and Landrace crosses with indigenous animals in attempts to diversify the genetic pool. Since pork is an important food source in St. Kitts and pork production has been increasing steadily in the last few years due to the expansion of tourism, it is essential to identify those diseases, including renal stephanuriasis, which pose a threat to the developing local swine production industry.

Although passive surveillance of swine kidneys at the St. Kitts local abattoir has suggested a relative high prevalence of kidney worm, stephanuriasis in St. Kitts pigs has not been properly documented and data on the prevalence of this disease are currently unavailable. The objectives of this study were to confirm the presence of renal stephanuriasis in the swine population of the Caribbean island of St. Kitts; to obtain a rough estimate of its prevalence, and to describe the gross and microscopic findings in affected kidneys.

MATERIAL AND METHODS

As part of a concurrent pathogen surveillance study, kidneys with gross lesions (areas of discoloration on the cortical surface) from 59 pigs slaughtered at the St. Kitts abattoir were collected over a 9 month period (from July 2012 to March 2013). Ten of these animals presented gross

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findings characteristic of stephanuriasis and were selected for the present study. The gross (macroscopic) diagnosis of renal stephanuriasis was based on the findings of fibrotic and/ or cystic nodular lesions within the renal pelvis, peri-ureteral fat, and the presence of adult nematodes and/ or larvae encysted within these lesions. Immediately after the collection of affected kidneys, samples of the cortex, medulla, and parasitic nodules located in the peri-ureteral fat and renal pelvis were fixed in 10% buffered formalin and later trimmed, routinely processed and embedded in paraffin, cut at 5 micrometers, mounted on glass slides and stained with hematoxylin and eosin for microscopic assessment.

RESULTS AND DISCUSSION

Grossly, affected kidneys presented moderately firm, nodular, thick-walled cystic lesions within the fat surrounding the renal pelvis and ureters. These lesions contained adult nematodes up to 3.5 cm in length and/ or larvae (figure 1A). Abscessation of the renal pelvis associated with the presence of adult nematodes was seen in the kidney of one pig (figure 1B).

Microscopically, parasitic tracts characterised by serpentine areas of haemorrhage, erythrophagocytosis, haemosiderosis, inflammation and fibrosis, often around granular eosinophilic necrotic cellular debris, were found within the peri-ureteral fat and rarely within the renal parenchyma (figure 1C). Inflammatory cell infiltrates around parasitic tracts and migrating larvae had an interstitial and often perivascular distribution (figure 1D) and were composed of variable numbers of lymphocytes, plasma cells, macrophages, eosinophils and occasional multinucleated giant cells (figure 2A). Fibroplasia, neovascularization and occasional granulomatous inflammatory response were particularly prominent around encysted parasites in the renal hilus and proximal ureters (figure 2B and 2C). Morulated thin-shelled ellipsoidal eggs, about 100 micrometers in length were occasionally found within the renal pelvis and peri-ureteral cystic granulomatous nodules containing adult worms (figure 2D). Histomorphologic features of the nematodes observed within peri-ureteral lesions; presence of platymyarian musculature, vacuolated lateral chords, convoluted intestine with prominent brush border, cup-shaped chitinised oral cavity and muscular

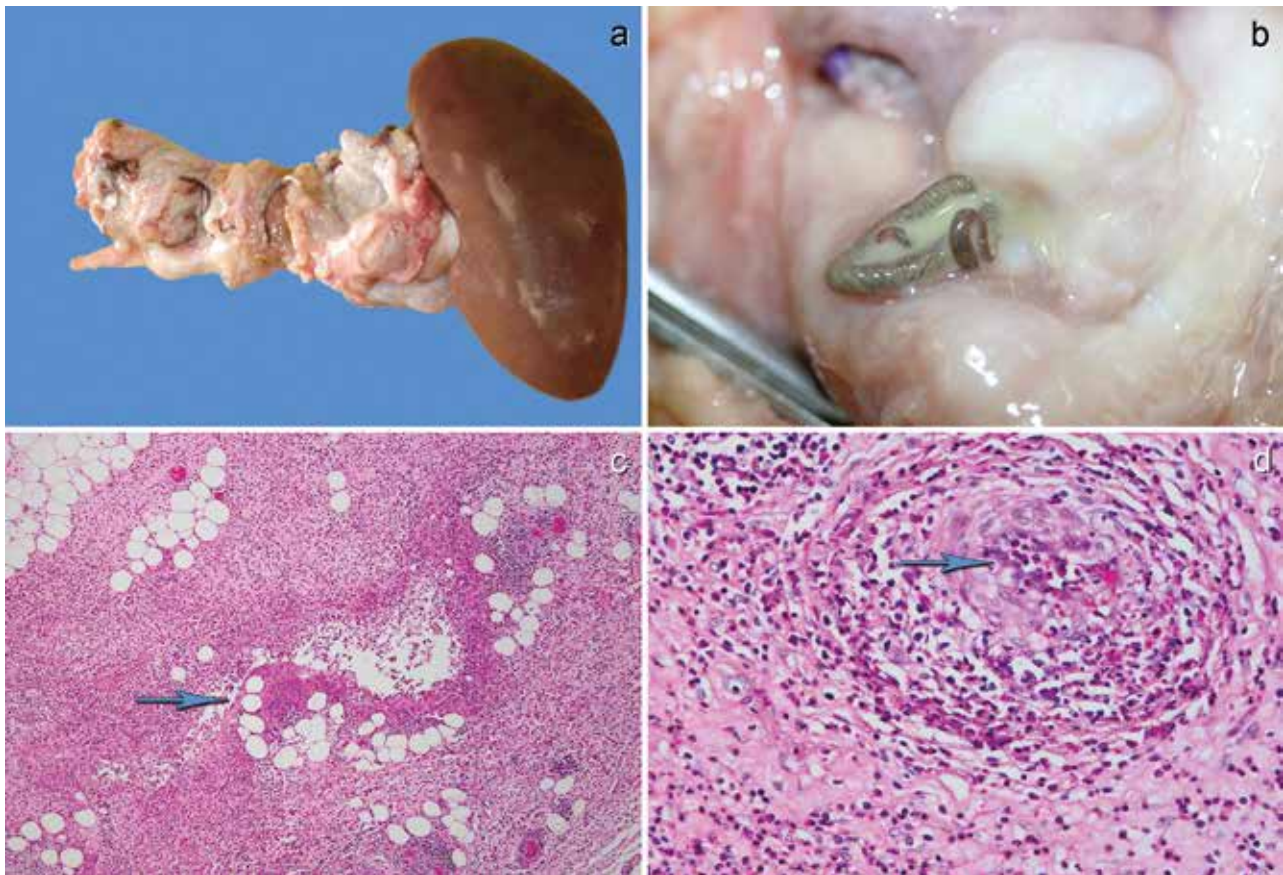


Figure 1. Figure 1a: Adults and larvae of *S. dentatus* within fibrotic perirenal fat, pig 9; Figure 1b: Adult *S. dentatus* admixed with abundant suppurative exudate within a nodular, thick-walled (fibrotic) peri-ureteral cyst, pig 10; Figure 1c: Serpentine parasitic tract (arrow) characterised by areas of haemorrhage, edema, necrosis and severe eosinophilic inflammatory cell infiltration, peri-ureteral fat, 10X, hematoxylin and eosin stain, pig 7; Figure 1d: Severe eosinophilic perivascularitis, peri-ureteral fat. Note margination of eosinophils within the vascular lumen (arrow) and migration through the vascular wall, 40X, hematoxylin and eosin stain, pig 7.

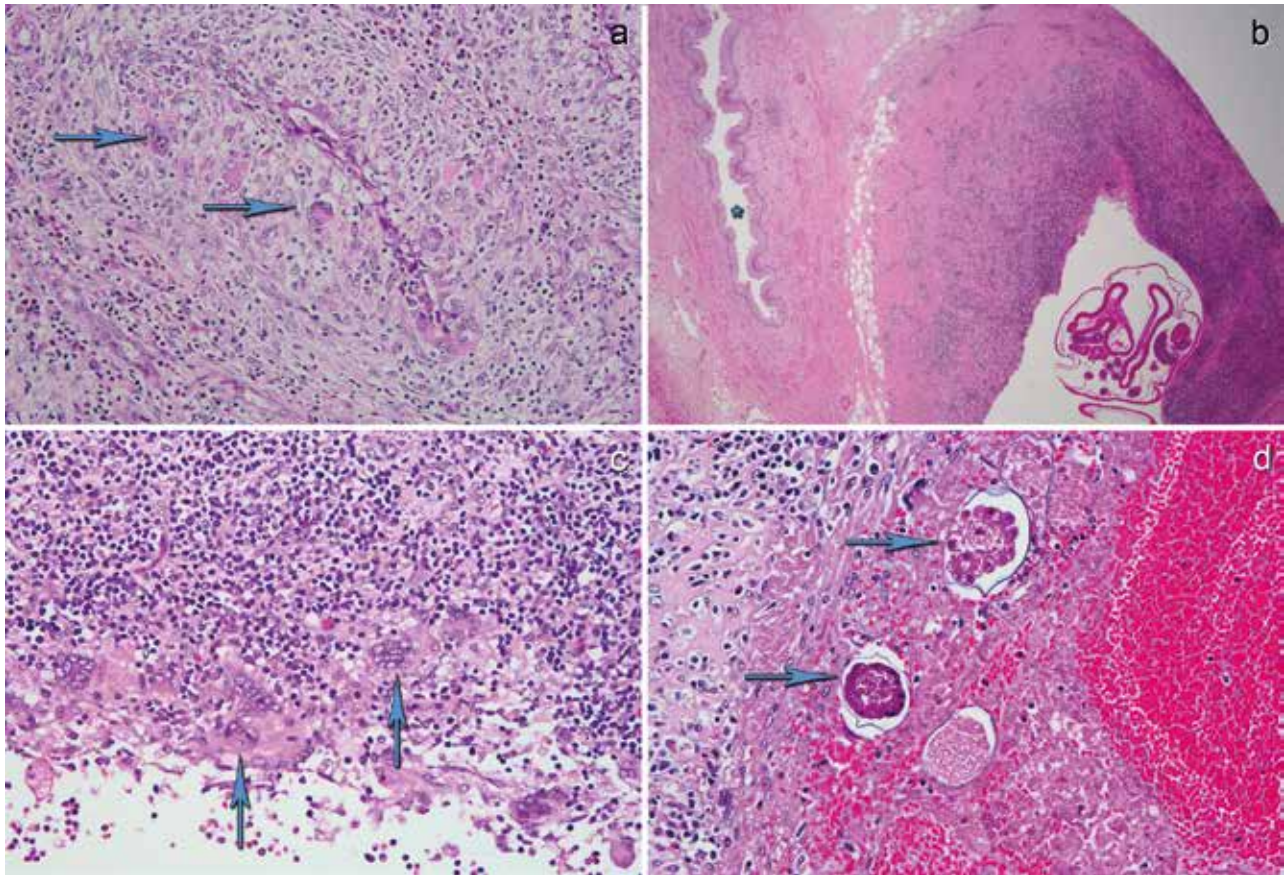


Figure 2. Figure 2a: Multinucleated giant cells (arrows) around a parasitic tract within the renal cortex, 20X, hematoxylin and eosin stain, pig 1; Figure 2b: Parasitic nodule containing a transverse section of an encysted adult *S. dentatus* female. Note adjacent ureter (asterisk), 2X, hematoxylin and eosin stain, pig 10; Figure 2c: Granulomatous inflammatory response containing numerous multinucleated giant cells (arrows) within the wall of a cystic parasitic nodule, 40X, hematoxylin and eosin stain, pig 10; Figure 2d: Thin-shelled ellipsoidal eggs of *S. dentatus* (arrows), evidence of patent infestation, within the wall of a peri-ureteral parasitic nodule, 40X, hematoxylin and eosin stain, pig 8.

esophagus (figures 3A and 3B) were consistent with those of *S. dentatus* (Gardiner and Poynton 2006).

Since infection with *S. dentatus*, a nematode parasite of the Family Strongylidae, occurs by direct oral intake or percutaneous penetration of free-living L3 larvae, or indirectly, by ingestion of infected earthworms, stephanuriasis is particularly important in outdoor swine-rearing facilities and in feral swine populations' worldwide (Stewart et al 1964, Henry and Conley 1970, Hale and Marti 1983). High rainfall and humidity favors the survival of infective larvae so a high prevalence of this nematode parasite has been reported in tropical areas, such as Belize (42%, Gibbens *et al* 1989) and Cuba (12 to 97% prevalence depending on the region, Dyková 1977). However, recognition of the disease and the subsequent establishment of effective control measures are relevant globally. Studies from the southeastern United States identified *S. dentatus* as the most common internal parasite collected from feral hogs and the resultant morphologic changes were more severe than those caused by any other helminth (Henry and Conley 1970).

S. dentatus has been found in at least 19 States and has been reported to cause significant economic losses resulting from condemnation of liver, kidneys, and other edible organs and tissues invaded by migrating larvae (Hale and Marti 1983). The insidious nature of the swine kidney worm causes decreased growth rates and feed efficiency, which further contributes to economic loss (Hale and Marti 1983). Economic losses attributable to *S. dentatus* apply to other species as well. Allowing swine and calves to occupy the same pastures increases the risk for stephanuriasis in cattle, as experimental infection of calves resulted in verminous hepatic and pancreatic abscesses, extensive fibrosis, and marked eosinophilia (Batte *et al* 1960).

Macroscopic findings of renal stephanuriasis in the pigs of this study, including the location of lesions within the ureteral walls, peri-ureteral region and renal pelvis, were consistent with those reported elsewhere (Ashizawa *et al* 1972). Microscopically, fibrosis, granulomatous inflammation, and perivascular cell infiltration by eosinophils were characteristic of those of helminth parasitic migration. In addition, the primarily eosinophilic pattern of inflammation

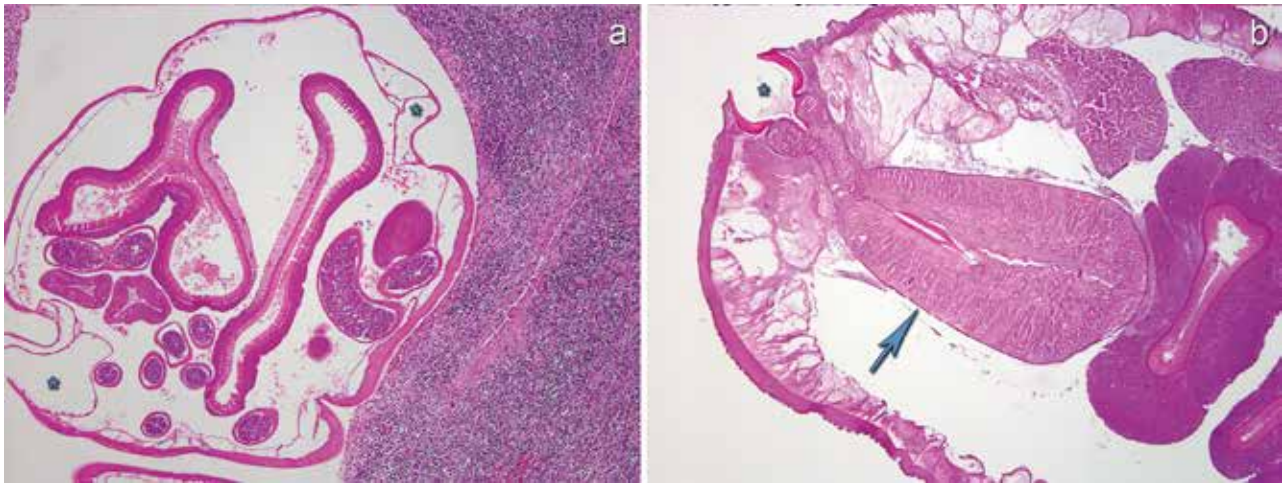


Figure 3. Figure 3a: Cross section of adult *S. dentatus* located within a thick-walled cystic nodule in the peri-ureteral fat, 10X, hematoxylin and eosin stain. Note vacuolated lateral chords (asterisks), pig 9; Figure 3b: Close up of the cranial portion of adult *S. dentatus* found within a parasitic nodule. Note the characteristic cup-shaped chitinized oral cavity (asterisk) and the prominent muscular esophagus (arrow), 10X, hematoxylin and eosin stain, pig 8.

surrounding eggs, larvae and adult parasites in the kidney were consistent with the observations of other studies (Ashizawa *et al* 1972, Hutchinson *et al* 1983). Hepatic migration of *S. dentatus* stimulates production and circulation of eosinophils for extended periods of time and persistent eosinophilia is considered highly suggestive of a prepatent *S. dentatus* infection in pigs from endemic areas (Hutchinson *et al* 1983). The same pattern of inflammation detected in affected kidneys is also observed in the liver, where only small number of larvae survive the host response (Hutchinson *et al* 1983).

The results of the present study suggest a high prevalence of renal stephanuriasis in St. Kitts pigs, since approximately 17% of the pigs (10 out of 59) with kidneys with cortical areas of discoloration had gross and microscopic lesions of the disease. This rough estimation of prevalence was limited by the biased targeting of kidneys with cortical areas of discoloration suggestive of underlying renal disease. Future non-biased surveillance and epidemiologic studies on a larger number of animals are needed to determine the true prevalence of renal stephanuriasis in St. Kitts swine. Nonetheless, the high prevalence of *S. dentatus* in tropical and sub-tropical regions is well-documented and attributed to a combination between an environment which favors the survival of infective stage larvae, and the lack of veterinary care and sound swine management practices.

High rainfall and persistent high humidity provide the optimum requirements necessary for the development of nematode eggs. However, it has been argued that despite the role of tropical climactic differences, management practices are likely the most important factors that determine the prevalence of helminthiasis (Gibbens *et al* 1989).

Due to the lengthy pre-patent period within the host (the kidney worm requires at least 9 months to attain the capability to lay eggs, Batte *et al* 1960), the finding of patent

infection (adults and eggs) within tissues of slaughtered pigs is highly unusual. Patent stephanuriasis, observed in 2/10 pigs of this study, was likely the result of local management practices which include outdoor rearing and grazing and lead to reduced weight gains, delays in the attainment of market weight and the frequent slaughtering of pigs about one year of age. *S. dentatus* is reported to have survival rates beyond 3 years within the host (Cianciolo and Mohr 2016) which creates problems for treatment and control of the disease. Several drugs and a “gilt only” farrowing program can be used to successfully control *S. dentatus* (Stewart *et al* 1964). Future establishment of such prophylactic and therapeutic measures and improvements in husbandry practices should minimize the economic losses currently inflicted by *S. dentatus* to the increasingly relevant swine production industry in St. Kitts.

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