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Ecto- and Endoparasite occurrence in wild hog deer (*Axis porcinus*) from a reserved forest of Assam in Northeast India: Updation of parasitological records and comparison with captive counterpart

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Abstract
The present communication provides record of parasitic infection in free ranging wild hog deer which fell victim of hunting while coming out from a reserved forest in North Lakhimpur district of Assam to graze on domestic animal grazing peripheral land.
Ante-mortem examination of animals' body surface revealed presence of two different arthropod parasites which were identified as the deer-ked belonging to the genus *Lipoptena cervi* and hard tick, *Haemaphysalis bispinosa*. Three different types of endoparasites were recovered at the post-mortem examination of animals. Examination of viscera revealed presence of few nematodes in the peritoneal cavity and they were found morphologically indistinguishable from *Setaria digitata*, a common mosquito borne filarial parasite of domestic cattle and buffaloes in India. There was presence of three bladder worms attached to the diaphragm and omentum and these were identified as *Cysticercus tenuicollis*, a long necked larval stage of tape worm *Taenia hydatigena*, commonly found in domestic dog and wild foxes. Rumen and reticulum were infested with snail borne *Paramphistomum* species of trematodes.
Update of information with present supplementation reveals that free living wild hog deer suffer from multiple parasitic infection similar to their captive counterpart. However, compared to captive animals, mortality due to parasitic infection is least reported.

Keywords: Wild hog deer, parasite, Northeast India

1. Introduction
Hog deer (*Axis porcinus*), a small deer species belonging to the family Cervidae prefers riverine moist grasslands as its natural habitat. In India, this wild animal species has been found in the terrai grasslands along the Himalayan foothills and flood plain grassland along the Ganga and Brahmaputra rivers [1]. However, threatened by rampant poaching for meat and habitat loss due to annual flood, forest degradation and other reasons, the hog deer population has undergone a sharp decline [2]. This animal species considered as endangered is now primarily restricted to different protected areas including reserved forests. The North East India is now a major stronghold of this animal species with largest subpopulation found in the Kaziranga National Park and different riverine reserve forests of Assam [3].
Death of hog deer due to reasons other than natural one and poaching may be spontaneous parasite and infectious microbial pathogens in their natural habitat. These pathogens can also be significant for causing diseases in other wild animal species, surrounding domestic animal population and also humans through cross transmission [4]. Parasitism of free ranging hog deer is not systematically studied [5] although such information from their captive counterpart in different zoos and zoological parks from different countries including India has been adequately reported [6, 7]. The present communication focuses on identification of ecto- and endo- parasites from free ranging hog deer from a reserved forest of Assam and updation of existing information in comparison to those recorded from their captive counterpart.

2. Materials and Methods

2.1 Case description

On a day of March, 2018, one adult female hog deer with multiple lacerated injuries on different parts of the bodies was rescued by forest staff and brought for treatment to the Teaching Veterinary Clinical Complex (TVCC) of Lakhimpur College of Veterinary Science, Joyhing, North Lakhimpur, Assam. The injured animal as reported, was chased by the villagers while straying out of a reserved forest under North Lakhimpur Territorial Division and grazing in the fringe area of Khabalu village under Lakhimpur circle. On physical examination, the wounded animal was found to be fatigued due to overexhaustion and diagnosed to suffer from capture myopathy, a muscular disease associated with stress of capture [8]. Despite symptomatic treatment, the animal succumbed to its injuries two days after.

Another adult male hog deer, on a later date of the same month was rescued with similar injuries by the forest staff from the same locality but died while on the way to the TVCC for treatment.

2.2 Ectoparasite collection

The body surface of both live and dead hog deer was searched thoroughly for the presence of ectoparasite. A large number of insects seen actively moving through the bases of the hairs on the skin of the face, neck and sides of the body were picked up and put in 70% alcohol. A few ticks found attached to the ears of the animals were also collected carefully and preserved similar way in alcohol. The specimens were brought to the laboratory and cleared in lactophenol mixture for detailed morphological study in temporary mount preparations. Identification of the specimens was performed by studying the morphological characters as per the keys and descriptions [9, 10].

2.3 Endoparasite collection

At post mortem examination of the two animals, the body cavities and visceral organs were carefully examined for the presence of parasites. The gastrointestinal tract was cut open lengthwise at different portions for similar examination to collect parasite. Different endoparasites thus collected and separated according to cestode, nematode and trematode were put in specimen tubes containing 70% alcohol. Morphological identification of the specimens was done in consultation with the available literature [10, 11, 12].

2.4 Comparative analysis

The findings of present investigation were analyzed with reference to published records of parasitic infections in free living and captive hog deer.

3. Result and Discussion

Ante-mortem and post-mortem examination of deer revealed collection of 5 types of parasite specimens, which were identified to be *Lipoptena cervi* (*L. cervi*), *Haemaphysalis bispinosa* (*H. bispinosa*) as ectoparasite and *Setaria digitata* (*S. digitata*), *Cysticercus tenuicollis* (*C. tenuicollis*) and *Paramphistomum* sp. as the endoparasite.

L. cervi also known as deer ked was collected from different parts of the body surface. The females measured 5.0-5.5 mm in length and 2.0-2.5 mm in breadth in the broadest abdominal region. The males were smaller than females and measured 4.0 mm x 2.0 mm in size. The insects were dorsoventrally flattened and appeared brown coloured except the leathery abdomen, which looked light yellowish to dark coloured with presence of brown transverse plates on the dorsum of posterior segments (Fig. 1). The head sunken into thorax contained widely separated semi-circular eyes, protrusible curved proboscis and short antennae. The thorax possessed broken off stumpy wings, knob like halters (Fig. 2) and long and stout legs with dark claws. The abdomen in some of the specimens was found distended with blood sucked from the host while one female contained a ready to lay prepupa stage. The puparia, one found already laid and the other dissected out were slightly oval, dark brown seed like with one end blackish and measured 2.0-2.25 mm x 1.5-2.0 mm in size (Fig. 3). The description of the ectoparasite agreed to the earlier reports published elsewhere [13]. The prevalence of *L. cervi* agreed to the earlier reports from different species of deer including hog deer in different parts of India [14, 15]. However occurrence of *Melophagus ovinus* (*M. ovinus*) in hog deer from Kaziranga National Park of Assam has been reported [16]. The insect specimens of the present investigation at a first look also resembled *M. ovinus*. But on close examination these could be differentiated by the presence of broken off wings and halters, which were known to be lacking in *M. ovinus*. On the basis of recorded prevalence including the present one, *L. cervi* is speculated to be widespread among different deer species in India. The haematophagus deer keds have been reported to attack, cattle, sheep, goats and even dogs [17] and humans [18] visiting forests or living in the periphery of the forests. Infestation caused development of skin wounds influencing myiasis [19] and long lasting dermatitis [20]. Several microorganisms like *Borrelia burgdorferi*, *Bertonella schaenbuchensis*, *Anaplasma phagocytophilum* of man and animals were also isolated from the keds [21, 22].

Ticks collected from the deer were partially engorged adults and were found morphologically indistinguishable from *H. bispinosa* (Fig. 4) on the basis of short rostrum, rectangular basis capitulum on dorsal surface, second palpal segment projecting beyond basis capitulum, anal groove posterior to anus, absence of eyes, round spiracle in female and presence of festoon on the posterior margin of abdomen and presence of a median projection at the base of third palpal segment. Morphological descriptions are in agreement with various studies [9, 23]. Available literature does not show the record of tick from hog deer. However, several tick species including *H. bispinosa* were reported earlier from other wild animals of the North East India [24, 25]. Additionally, cutaneous myiasis due to *Hypoderma diana* was reported in a hog deer from this region [26]. However such condition was not seen in the present investigation.

Four nematodes were recovered from the peritoneal cavity of one deer. These were milky white, thread like with the tail ending in a loose coil. They measured 45 mm to 55 mm with an average 50 mm in length. Anterior end of the worms was provided with a peribuccal crown and a pair of raised lateral lips (Fig. 5). Microscopic examination revealed all the worms to be female which contained developing larvae inside egg case and also some sheathed microfilariae (Fig. 6). Loosely coiled tail possessed a pair of lateral appendages anterior to knob-like tip of tail (Fig. 7). The worms were found to be morphologically indistinguishable from *S. digitata* with a reservation on the length of the recovered worms which were found to be much smaller than those recovered from cattle and buffaloes in India and elsewhere [27]. Morphological descriptions of the parasite identified as *S. digitata* were found in conformity with those provided elsewhere [28]. The female parasite differed morphologically from *Setaria cervi*

(Syn: *Setaria labiatopapillosa*) [27, 29] and *Setaria tundra* [30] recovered from various wild deer by the absence of grooves, pores and row of bosses on the tip of the tail. Record of *S. digitata* from hog deer in the present parasitological investigation appears to be the first report.

One of the two deer showed presence of three *C. tenuicollis* (Fig. 8) cysts attached to the diaphragm and omentum. The cysts with long neck were identified to be the larval stage of *Taenia hydatigena*, which is a well-known cestode of dog and foxes in India [31] with its larval stage reported in wild ruminants [32], sheep and goats [33, 34]. Occurrence of this type of cysts in different species of deer was reported by several workers [31, 35]. This confirms that deer act as intermediate host of *T. hydatigena* of wild canids or dogs, which contaminate the pasturelands with tapeworm eggs.

Examination of gastrointestinal tracts of the two deer revealed presence of only *Paramphistomum* in the rumen and reticulum. Record of this snail borne trematode infection corroborated with the observations reported earlier [35, 36].

Parasitological surveys conducted elsewhere in different captive deer species including hog deer were primarily for detection of gastro-intestinal parasitism by coprological methods [36, 37, 38]. A wide range of parasite species belonging to nematode, trematode and cestodes with variable incidence rates were recorded. Incidence of strongyle and *Strongyloides* nematodes followed by *Fasciola* and *Paramphistomum* trematodes were frequently reported in mixed infections [35, 37, 38]. The intensive husbandry of wild animals in zoos by dense confinement in limited spaces for long periods, environmental contamination, supply of contaminated food and water were reported to play a role in the spread of parasitic infection among the animals with high morbidity and mortality and population decline [38, 39]. *Trypanosoma evansi* [40] and verminous pneumonia due to *Dictyocaulus eckerti* [41] were other parasitological findings recorded earlier in captive hog deer.

Compared to the captive counterpart, information on parasitic infections in free ranging wild animals including hog deer remains largely unknown due to paucity of systematic investigation [42]. There are technical difficulties to access the burden of parasitic diseases in wild animals, which might be a possible reason for the wildlife data still being in infancy in India. Occurrence of *Fasciola*, *Paramphistomum*, strongyles, *Strongyloides* and *Trichuris* worms during coprological examination of free-living herbivores including hog deer reported from Kaziranga National Park, Assam [43]. However, all three helminth types in captive deer were recorded but no evidence of infection in field deer species [38].

Fig 1: *L. cervi* female adult;

Fig 2: *L. cervi* with broken off wings and halters;

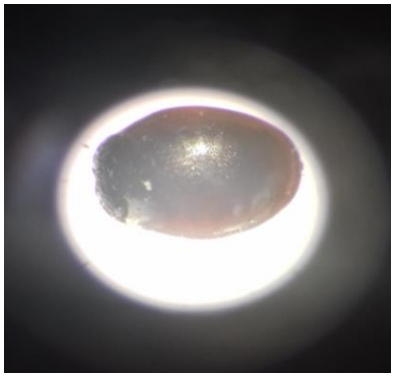

Fig 3: Puparia of *L. cervi* with

Fig 4: *H. bispinosa;*

Fig 5: *S. digitata* (anterior-end);

Fig 6: Sheathed microfilaria of *S. digitata;*

Fig 7: Tail of female *S. digitata* with lateral appendages and terminal knob;

Fig 8: *C.tenuicollis.*

4. Conclusion

The present ante-mortem and post-mortem study conducted in deer revealed detection of *Paramphistomum* in the gastro-intestinal tract, *S. digitata* and *C. tenuicollis* in the peritoneal cavity, all of them as endoparasites besides record of *Lipoptena cervi* and *Haemaphysalis bispinosa* as ectoparasites on the body surface. Record of *Setaria digitata* appears to be the first report in hog deer. These contribute to enrich the parasite prevalence data in hog deer.

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