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PARASITES, DISEASES AND HEALTH STATUS OF SYMPATRIC POPULATIONS OF SAMBAR DEER AND WHITE-TAILED DEER IN FLORIDA

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ABSTRACT: From December 1983 to December 1984 a study on parasites, diseases and health status was conducted on sympatric populations of sambar deer (*Cervus unicolor*) and white-tailed deer (*Odocoileus virginianus*) from St. Vincent Island, Franklin County, Florida. Ten sambar and six white-tailed deer were examined. White-tailed deer had antibodies to epizootic hemorrhagic disease virus and bluetongue virus. Serologic tests for antibodies to the etiologic agents of bovine virus diarrhea, infectious bovine rhinotracheitis, vesicular stomatitis, parainfluenza 3, brucellosis, and leptospirosis were negative in both species of deer. White-tailed deer harbored 19 species of parasites; all were typical of the parasite fauna of this species in coastal regions of the southeastern United States. Sambar deer harbored 13 species of parasites, which apparently were derived largely from white-tailed deer. The only exception was *Dermacentor variabilis* which occurs frequently on wild swine on the island. The general health status of sambar deer appeared to be better than that of white-tailed deer. This was hypothesized to result from the sambar deer's utilization of food resources unavailable or unacceptable to white-tailed deer and to the absence and/or lower frequency of certain pathogens in sambar deer.

Key words: White-tailed deer, *Odocoileus virginianus*, sambar deer, *Cervus unicolor*, parasites, diseases, survey, Florida.

INTRODUCTION

The sambar deer (*Cervus unicolor*), the largest species of deer native to southeast Asia, is a member of the rusine deer group. It is closely related to the red deer (*C. elaphus elaphus*) of Asia and Europe, the rusa deer (*C. timorensis*) of Asia, and the Rocky Mountain elk (*C. e. nelsoni*) of North America (Whitehead, 1972). Sambar deer have been introduced successfully to numerous locations outside their native range in Asia including San Luis Obispo County, California (Presnall, 1958), the Gulf Prairies and Edwards Plateau regions of Texas (Ables and Ramsey, 1972), and on St. Vincent Island, Franklin County, Florida (Newman, 1948).

In 1983 a study was initiated on the ecology of the sambar deer population on St. Vincent Island. This afforded an opportunity to compare the parasites, diseases, and health status of sambar deer with those of a sympatric population of native white-tailed deer (*Odocoileus virginianus*). This comparison was part of a continuing effort to evaluate such interactions among white-tailed deer and other ungulates. It was designed to complement similar studies on disease and parasite interactions of white-tailed deer with feral cattle and wild swine (Prestwood et al., 1975), domestic sheep (Prestwood et al., 1976), sika deer (*C. nippon*) (Davidson and Crow, 1983), and fallow deer (*Dama dama*) (Davidson et al., 1985).

MATERIALS AND METHODS

Data for this study were collected between December 1983 and December 1984 on St. Vincent National Wildlife Refuge, Franklin County, Florida. St. Vincent Island is a 4,943 ha barrier island in northwestern Florida and is the westernmost of a series of islands separating the Gulf of Mexico from Apalachicola Bay. The western portion of the island is separated from the mainland by a narrow (400 m) inlet; the eastern end of the island is approximately 14 km from the mainland. The topography is dominated by a series of roughly parallel ridges and dunes which extend east to west across the island. The interdune and lower areas vary from an interwoven set of ponds and sloughs on the east to dry upland sites on the west. Approximately one-third of the island is under water to some shallow depth during most years. The general climate is mild, with relatively few days per year having temperatures below freezing. Predominant habitat types include scrub/liveoak (*Quercus* spp.) dunes, slash pine (*Pinus elliottii*)/cabbage palm (*Sabal palmetto*)/saw palmetto (*Serenoa repens*) upland associations, sawgrass (*Cladium* spp.) emergent freshwater marsh, and tidal marsh.

The island was acquired for the National Wildlife Refuge System in 1968 by the U.S. Fish and Wildlife Service (FWS). Prior to FWS ownership, the island had been under various private ownerships. Historical records indicate that cattle, swine, and horses were maintained on the island in the 1800's and early 1900's. Sambar deer and sika deer were released on the island in the early 1900's, and black buck (*Antilope cervicapra*), eland (*Taurotragus oryx*), and two species of zebra (*Equis* spp.) were released after 1948. With the exception of sambar deer and wild swine, all of these species were either removed from the island or had disappeared by 1968 (Smith, 1969). Currently the island supports estimated ungulate populations of about 100 to 200 sambar deer, 450 white-tailed deer, and an unknown number of wild swine (Flynn, 1986).

Sambar deer examined during this study were acquired in three ways: (1) one animal was found dead in December 1983; (2) four animals died during chemical immobilization and radio-collaring activities in May and December 1984; and (3) five adult (>1 yr of age) animals were collected by shooting in the cervical spine in October 1984. Six adult white-tailed deer also were collected by shooting in October 1984. Blood samples (with and without anticoagulant) were obtained by cardiac puncture immediately after death from all animals collected by shooting, and the carcasses were refrigerated prior to necropsy within 18 hr. The five sambar deer not obtained by shooting were either frozen intact (three animals) and examined later or refrigerated (two animals) and examined within 24 hr.

Ages of white-tailed deer were determined by the methods of Severinghaus (1949), and ages of sambar deer by a combination of the methods of Quimby and Gaab (1957) and Low and Cowan (1963). Physical condition was assessed by the method of Stockle et al. (1978). Detailed necropsy examinations (Nettles, 1981) of each animal included the following: (1) examinations of macerated lung tissue and feces by the Baermann technique, (2) abomasal parasite counts (APC), (3) $NaNO_3$ flotations of feces for coccidian oocysts, and (4) examination of longissimus dorsi muscles for muscleworms, *Parelaphostrongylus andersoni*. Sections of all major organs and any lesions were examined by standard histologic procedures, including special staining techniques where appropriate. Serum samples were tested for antibodies to the etiologic agents of the following: bovine virus diarrhea, infectious bovine rhinotracheitis, parainfluenza group 3, and vesicular stomatitis (Ind and NJ serotypes) by serum neutralization; blue-tongue (BT) and epizootic hemorrhagic disease (EHD) by agar gel immunodiffusion; brucellosis by the card test; and leptospirosis by microscopic agglutination. Serologic tests for leptospirosis included the *pomona*, *hardjo*, *grippotyphosa*, *icterohemorrhagiae*, and *canicola* serovars.

The sambar deer found dead and those that died during immobilization also were examined closely to determine the cause of death. Voucher specimens of parasites have been deposited in the U.S. National Parasite Collection under Accession Numbers 79361–79374.

RESULTS AND DISCUSSION

The overall physical condition of the sambar deer was better than that of the white-tailed deer. Sambar deer condition ratings were good (four animals) and fair (six animals) whereas white-tailed deer were rated fair (five animals) and poor (one animal).

Serologic tests disclosed antibodies to EHD virus and BT virus in two and one white-tailed deer, respectively. Results of serologic tests for the remaining infectious agents in white-tailed deer and all serologic tests in sambar deer were negative. Antibodies to EHD and BT viruses have been detected frequently in sera of white-tailed deer in the southeastern United States including deer from several areas in Florida (Couvillion et al., 1981).

Parasitologic studies disclosed a total of 21 species of parasites including two protozoans, 12 nematodes, and seven arthropods (Table 1). White-tailed deer harbored 19 species and sambar deer harbored 13 species. The parasites found in both white-tailed deer and sambar deer were species typical of the parasite fauna of white-tailed deer in the southeastern United States (Davidson et al., 1981) with the exception of the tick *Dermacentor variabilis* found on one sambar deer. Previous studies by our laboratory (SCWDS, unpubl. data) revealed a prevalence of 70% for *D. variabilis* on wild swine from St. Vincent NWR in June 1981. Thus, the parasite fauna of the sambar deer population on St. Vincent Island appears to have been derived mainly via cross-transmission from white-tailed deer along with at least one species from wild swine. Although data on parasitism are not available for any of the other introduced populations of sambar deer in North America, reviews of parasitism in sambar deer in Southeast Asia and Australia include several species known from North America including *Theileria cervi, Fasciola hepatica, Fascioloides magna, Echinococcus granulosus, Taenia hydatigena, Oesophagostomum venulosum, Trichostrongylus axei, Spiculopteragia asymmetrica, Trichuris discolor,* and *Boophilus microplus* (Presidente, 1984a, b).

Lesions attributable to parasitism were noted in both white-tailed deer and sambar deer. White-tailed deer had the following parasite-induced lesions: (1) mild pneumonitis and pleuritis associated with protostrongylid larvae (presumably larvae of *P. andersoni*), and *D. viviparus*; (2) mild focal to diffuse fibrinous peritonitis associated with *Setaria yehi*; and (3) mild focal cutaneous and subcutaneous inflammation associated with attachment sites of ticks. A 4.5-yr-old white-tailed doe had peridontal disease, a missing lower molar (M_1), and an impaction of food material and hair in the missing tooth space. Although no arterial worms (*Elaeophora schneideri*) were found in this animal, the age of the deer and lesions observed were characteristic of a syndrome of oral food impactions that has been associated with elaeophorosis in white-tailed deer from coastal areas in the southeastern United States (Couvillion, 1985). Sambar deer only had lesions attributable to tick bites consisting of mild focal cutaneous and subcutaneous inflammation.

TABLE 1. Parasites recovered from sambar and white-tailed deer from St. Vincent National Wildlife Refuge, Franklin County, Florida.[a]

Parasite	Sambar deer	White-tailed deer
Theileria cervi	—	50, L, L[b]
Trypansoma cervi	—	33, L, L
Elaeophora schneideri	10, 2, 2	17, 5, 5
Dictyocaulus viviparus	—	83, 2, 3
Protostrongylid larvae	—	83, M, M
Setaria yehi	10, 2, 2	100, 10, 35
Gongylonema pulchrum	90, 17, 58	100, 23, 40
Gongylonema verrucosum	30, 10, 15	83, 41, 75
Paramphistomum liorchis	70, 582, 2,000	100, 106, 413
Apteragia odocoilei	—	17, 178, 178
Apteragia pursglovei	—	100, 1,894, 2,846
Trichostrongylus askivali	30, 19, 26	100, 200, 446
Capillaria bovis	20, 1, 1	—
Trichuris sp.	20, 2, 2	17, 1, 1
Amblyomma americanum	90, L, M	100, L, L
Amblyomma maculatum	30, L, M	17, L, L
Dermacentor variabilis	10, L, L	—
Ixodes scapularis	40, L, L	100, L, L
Eutrombicula splendens	20, L, L	17, L, L
Tricholipeurus lipeuroides	—	67, L, L
Tricholipeurus parallelus	—	33, L, L

[a] Figures in columns are prevalence, mean number per infected deer, and maximum intensity of infection.
[b] Actual counts not made; intensities rates as low (L) or moderate (M).

In addition to lesions attributable to parasitism, pathologic studies disclosed a variety of additional conditions and diseases. The sambar deer found dead in December 1983 was a 6-mo-old, 58 kg male in fair physical condition. It was found on the bank of a lake, and the immediate vicinity showed evidence that the deer had struggled from the lake, collapsed and died on the bank. The previous day a cold front had passed the island and ambient temperatures fell to an abnormally low level (−9 C). Necropsy revealed approximately 25 healing ulcerations (≤2 cm) on the ruminal pillars, patches (≤6 cm) of stubby necrotic to healed fibrotic rumen villi that covered about 50% of the rumen surface, and separations of the hoof wall at the coronet on all four feet. Cause of death was attributed to malnutrition as a consequence of chronic rumenitis/laminitis of undetermined cause. Exposure and hypothermia were considered contributory factors as well. Lesions noted in single sambar deer were bilateral renal calculi, infected fistulous tracts underlying an abrasion on the thorax, mild fibrinous pleuritis, mild fibrinous peritonitis, and mild peribronchitis.

A 1-yr-old male white-tailed deer was found to be emaciated (weight 19 kg). This deer had six healed fractured ribs and hemosiderosis in all reticuloendothelial tissues examined. The condition was attributed to a prior traumatic injury. Other lesions noted in white-tailed deer were mild chronic interstitial nephritis (two deer) and small multifocal renal cysts (one deer).

The APC (2,123), physical condition ratings, body weights (18.9–35.6 kg), hematologic values (PCV = 21–49%; Hb = 6.5–15.1 g/dl), and other herd health parameters suggested that the white-tailed deer population was experiencing a marginal nutritional status and that risk of mortality due to disease was relatively high (Eve, 1981). Sambar deer had relatively few parasites, higher physical condition ratings, less evidence of infectious diseases, and generally appeared to be in a better overall health status. Interpretation of data on sambar deer is less precise, however, due to a lack of comparative baseline information.

Other workers (Harmel, 1979; Armstrong and Harmel, 1981) have shown that certain exotic deer (sika deer, axis deer (*Axis axis*), and probably fallow deer) have a competitive advantage over white-tailed deer by being able to sustain body condition and health status in situations that have proved to be nutritionally deficient for white-tailed deer. Studies in Australia and New Zealand suggest that sambar deer are less specialized in their food requirements than most ungulates (Downes, 1983). Studies on food habits conducted on sambar and white-tailed deer from St. Vincent Island revealed that sambar deer utilized many forage sources not eaten by white-tailed deer (Shea, 1986). Thus, sambar deer also may have a similar competitive nutritional advantage over white-tailed deer. The present and earlier studies (Davidson and Crow, 1983; Davidson et al., 1985) suggest that the competitive advantage of exotic deer over sympatric populations of white-tailed deer also may often be enhanced by less parasitism and disease. However, the competitive advantage of exotic deer can be totally or partially nullified by certain pathogens. The most notable of these pathogens is *Parelaphostrongylus tenuis*, the meningeal worm of white-tailed deer, which often produces fatal neurologic disease in other ungulates (Anderson and Prestwood, 1981).

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BOOK REVIEW . . .

Zoo and Wild Animal Medicine, 2nd ed., Murray E. Fowler (ed.). W. B. Saunders, Philadelphia, Pennsylvania 19105, USA. 1986. 1152 pp. $85.00 U.S.

The second edition of Zoo and Wild Animal Medicine comes eight years after the initial publication, which was the first major text in English on the subject of captive wild animal medicine. The book has been expanded in terms of length, detail and the number of contributing authors, many of whom are the pre-eminent authorities in their field.

Several chapters have been added to the general information section, with new contributions on behavior, dentistry, poisoning, inhalation anesthesia, zoonoses and wildlife medicine. A wealth of literature has been published since the earlier edition and, although not all of this has been incorporated into the text, the reference lists are generally extensive. Most chapters have been updated or expanded but, by the editor's own admission, there are still deficiencies in the coverage of several animal groups, in many cases a result of the paucity of available information.

The avian section has been enlarged and rearranged with new, separate chapters on avian nutrition, infectious diseases, clinical pathology and surgery. Several avian and mammalian orders previously lumped together now receive individual attention. Another welcome addition is the chapter on terrestrial invertebrates, an area that has been badly neglected in veterinary literature. There is, however, still no consideration given to fish which outnumber all other captive animals combined.

While the book is mainly concerned with the health of wild animals in captivity, the problems of free-living animals are also considered. The brief chapter on wildlife medicine succinctly discusses the differences in philosophy and approach between the two disciplines.

There still remain some major discrepancies in the space and detail devoted to some subjects compared with others. For example, there are 23 pages on reptile anatomy alone, but only eight pages in total on amphibians. The general chapter on restraint has not been expanded apart from the subsequent consideration of inhalation anesthesia and there is little detail on some of the restraint drugs and techniques developed in the past ten years even in the special medicine chapters. This is disappointing, considering that this is such an important feature of wild animal husbandry. One important topic eliminated from the new edition is the discussion of sanitation and disinfection.

Despite any shortcomings this book is the best and most comprehensive text available on wild animal medicine. It is an invaluable reference for anyone who may be involved in the management and care of both free-living and captive wild animals.

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