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be devoted to a more detailed analysis of additional serum samples from these and other wolf populations in the state.

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Avian Tuberculosis and Salmonellosis in a Whooping Crane (*Grus americana*)

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The whooping crane has been the subject of intensive scientific study and management because it is an endangered species and has high public interest. Programs have been developed to identify critical habitat, to increase production through captive breeding, and in recent years, to use sandhill cranes (*Grus canadensis*) as surrogate parents in establishing new populations of wild whooping cranes. Only a few reports describing diseases and parasites in wild whooping cranes appear in the literature because opportunities to secure specimens are limited for this rare, protected bird (for review, see Carpenter and Derrickson, *In* Proc. International Crane Workshop of 1983, Bharatur, India, in press). Avian tuberculosis and concurrent salmonellosis in a wild whooping crane are described in this case report.

A 3-yr-old male whooping crane was found dead on 15 July 1982, on a private marsh near Monte Vista National Wildlife Refuge, Rio Grande County, Colorado. In August of 1979, the bird had been radiotagged by biologists at Grays Lake National Wildlife Refuge near Wayan, Idaho. Its movements were also closely monitored by visual observations from mid-March 1982 until its death.

Early in mid-June 1982, the crane was observed limping and was reported to have a swelling on its right leg. It was described as lethargic and would allow people to approach within 20 m. The crane frequented a 16.2 ha area comprised of a small marsh and a barley field. The bird was last observed alive on 14 July at 5:30 a.m. about 250 m from an open grain bin which contained barley and was an occasional feeding site for the crane and other birds. On 15 July, the crane was found dead about 50 m from the bin. The carcass was frozen and sent to the National Wildlife Health Laboratory (NWHL), Madison, Wisconsin, for examination.

Four clusters of firm, white-to-cream caseous nodules, 2 to 10 mm in diameter,

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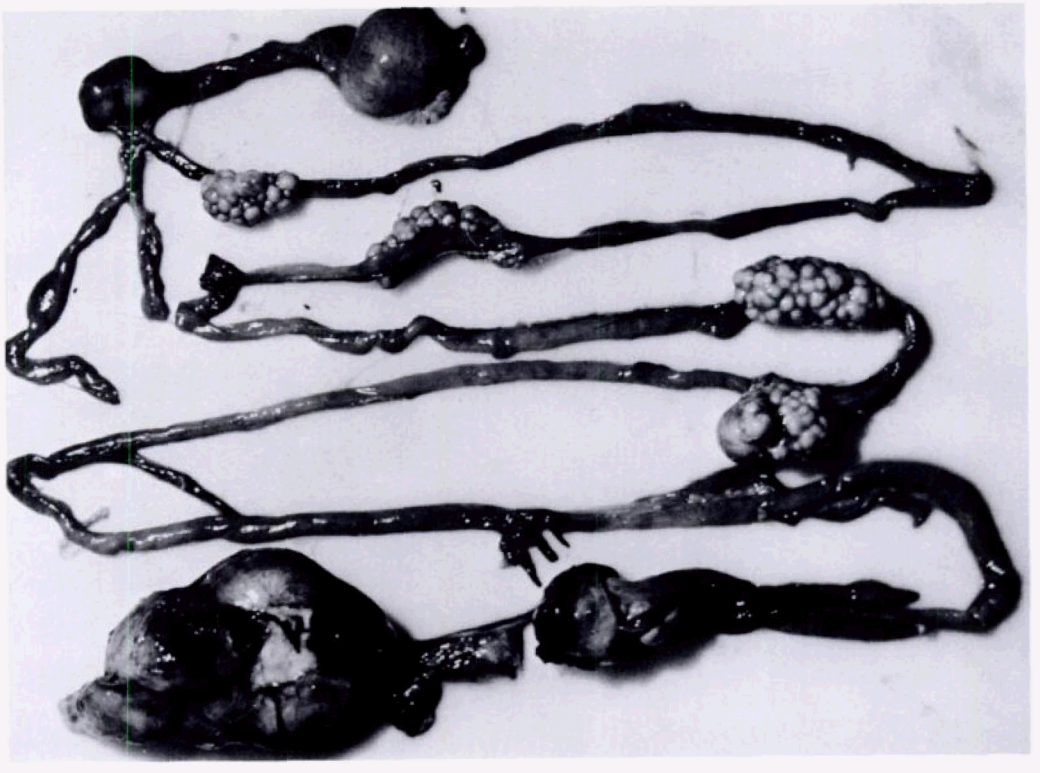

FIGURE 1. Clusters of granulomas containing acid-fast bacilli along the intestine of a whooping crane. (Photo by James Runningen.)

were found along the small intestine (Fig. 1). The lumen of the intestine was occluded partially by several of the nodules.

The liver was enlarged and had numerous white-to-cream caseous nodules, 2 to 3 mm in diameter, throughout the parenchyma (Fig. 2). Likewise, the spleen was enlarged markedly and was comprised almost entirely of coalescing caseous nodules, 2 to 10 mm in diameter (Fig. 3). Additional caseous nodules were present in the kidneys and on the serosal surface of the trachea. A caseonecrotic plaque, 10 to 15 mm in diameter, was present on the dorsal aspect of the oral cavity near the epiglottis. Acid-fast bacilli were observed in fresh tissue smears of all of these lesions.

A crateriform ulcer, 20 mm in diameter, was also found between the proventriculus and the ventriculus. The lesion was firm, with a caseonecrotic central area that had been hollowed partially and impacted with vegetation.

Other observations included a complete absence of subcutaneous and mesenteric fat, severe pectoral muscle atrophy, a necrotic tract in the esophagus (associated with a nematode), and enlarged, light-yellow colored adrenal glands. Lesions that could account for the observed limping were not present on the legs at necropsy.

Tissues for histological examination were fixed in 10% formalin. Paraffin sections were cut at 4 μm, stained with hematoxylin and eosin, and the Ziehl-Neelson acid-fast staining methods.

Microscopic lesions observed in the liver, spleen, intestine, and trachea were typical of granulomatous tubercules described frequently in avian species (Montali et al., 1976, J. Am. Vet. Med. Assoc.

FIGURE 2. Granulomas 2 to 3 mm in diameter throughout the liver of a whooping crane. (Photo by James Runningen.)

169: 920–927). The central areas of the granulomas contained caseous debris. Throughout the debris were vacuoles containing myriads of acid-fast, short, rod-shaped bacteria. These clusters of acid-fast organisms were relatively sparse in vacuoles from the lesions in the intestine, but more numerous in lesions of the liver and spleen. The vacuoles originated presumably from preexisting macrophages that had engulfed the bacteria. Giant cells, often observed in granulomas, were not observed in any of the tissues examined. There was a thin, fibrous capsule around some, but not all granulomas. Small areas of focal necrosis with minimal or no evidence of inflammation were also present in the liver. Larger, nonacid-fast bacilli were present within these foci. These bacteria were not contained in discrete intercellular vacuoles.

Salmonella enteritidis (serotype, agona) was isolated on blood agar from the liver. Isolates from the caseous lesion in the naso-pharynx included: *Streptococcus fecalis, St. sanguis, St. morbillorum*, and *Staphylococcus* sp.

The crateriform ulcer observed at the proventricular-ventricular junction did not contain acid-fast bacilli. The microscopic character of this lesion was that of caseous necrosis with surface bacterial contamination.

For isolation of mycobacteria, lesions from the liver and spleen were collected in a saturated solution of sodium borate. Mycobacteriologic examinations were conducted as previously described (Thoen,

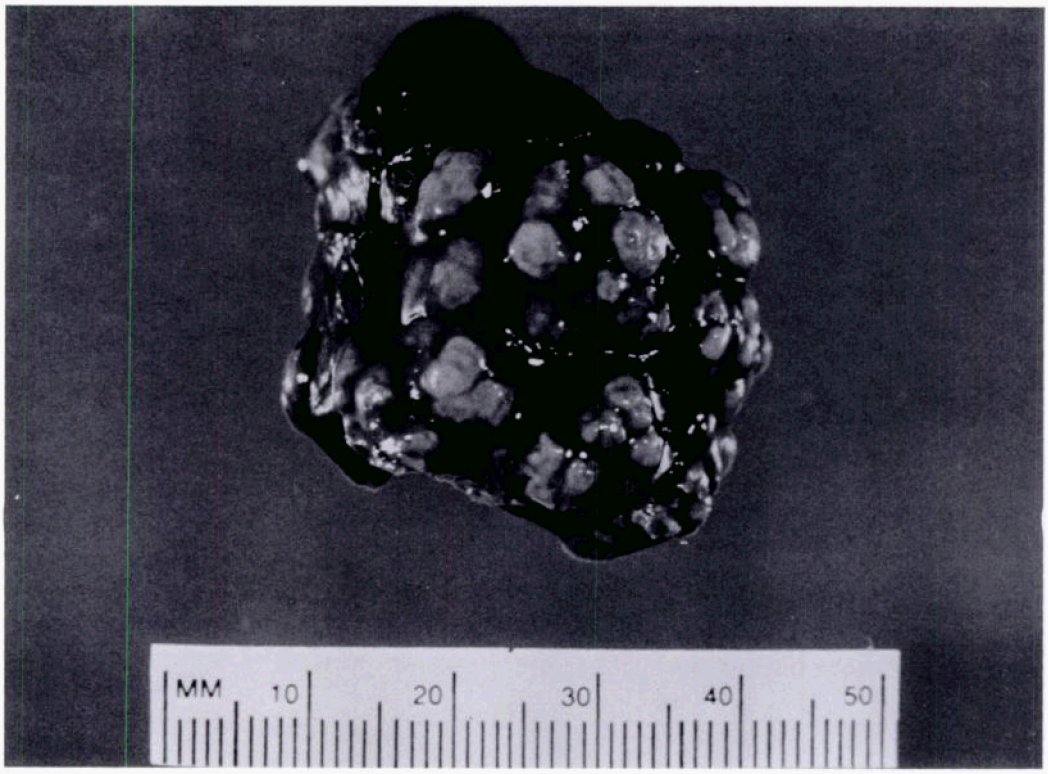

FIGURE 3. Coalescing granulomas 2 to 10 mm in diameter in a markedly enlarged spleen of a whooping crane. (Photo by James Runningen.)

1984, *In* Diagnostic Procedures in Veterinary Bacteriology and Mycology, 4th Ed., Carter (ed.), Charles C. Thomas Publ., Springfield, Illinois, pp. 219–228; Thoen and Karlson, 1980, *In* Isolation and Identification of Avian Pathogens, Hitchner et al. (eds.), Am. Assoc. Avian Pathol., Texas A&M University, College Station, Texas, pp. 36–39). A nonphotochromogenic, slowly growing, acid-fast isolate was identified by biochemical and sero-agglutination tests as *Mycobacterium avium* serovar 1. Pathogenicity tests were conducted in chickens by inoculating 0.1 ml of culture intraperitoneally. Gross lesions were observed on necropsy at 8 wk postinoculation (Thoen and Karlson, 1984, *In* Diseases of Poultry, 8th Ed., Hofstad et al. (eds.), Iowa State University Press, Ames, Iowa, pp. 165–177; Thoen et al., 1984, *In* The Mycobacteria: A Source Book, Kubica and Wayne (eds.), Marcel-Dekker, Inc., New York, pp. 1251–1275). Microscopic examinations of representative tissues revealed granulomas with acid-fast bacilli.

The acute focal necrosis with nonacid-fast bacilli observed in the liver and the isolation of *S. enteritidis* suggest terminal salmonellosis as the final cause of death. However, the emaciated condition of the bird was due to chronic avian tuberculosis.

Tuberculosis has been described in a free-ranging sandhill crane from Alaska (Thoen et al., 1977, J. Wildl. Dis. 13: 40–42). *Mycobacterium avium* is relatively non-host specific and has been isolated from many species of wild birds main-

tained in captivity where crowding and sanitation may contribute to the disease cycle (Montali, 1976, op. cit.). The organism also is found commonly in wild birds such as sparrows, pigeons, and starlings. According to unpublished diagnostic records from the NWHL, avian tuberculosis is a frequent finding in waterfowl species from some western waterfowl refuges.

Microscopic examination of tissue from the esophagus and intestines revealed that the crane shed organisms into the environment. Although not considered highly contagious, the organism, *M. avium*, is relatively stable in the environment, persisting in the soil for months or even years (Karlson, 1978, *In* Mycobacterial Infections of Zoo Animals, Montali (ed.), Smithsonian Institution Press, Washington, D.C., pp. 21–28). The source of the infection in this case is unknown. Increasing contamination of the environment presumably would be related directly to an infected individual using the area and shedding *M. avium* in the feces and to organism resistance to environmental degradation. Field observations on the crane prior to its death indicated extensive use of a relatively small area near a grain bin that also attracted other species of birds. Avian tuberculosis and salmonellosis are frequently associated with crowding and/or a contaminated environment and should be recognized as potential dangers where birds congregate.

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Isolation of *Listeria monocytogenes* from an Eastern Wild Turkey

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Listeria monocytogenes, a bacterium which causes listeriosis, has a worldwide distribution, but only sporadic occurrence (Gray, 1958, Avian Dis. 2: 296–313; Gray, 1964, Proc. N. Am. Wildl. Nat. Res. Conf. 29: 202–213; Hofstad et al., 1984, *In* Diseases of Poultry, Iowa State University Press, Ames, Iowa, pp. 261–263). The disease has been isolated from at least 42 mammalian and 22 avian species. The most common avian hosts are chickens, canaries and geese, all of which appear to be the most susceptible (Hofstad et al., 1984, op. cit.). Other species such as grouse, partridges, eagles, sparrows and starlings have been found to be infected (Gray, 1958, op. cit.; Hofstad et al., 1984, op. cit.). The isolation of *L. monocytogenes* from domestic fowl, with mortality up to 40% (Hofstad et al., 1984, op. cit.) has been reported practically worldwide. However, in wild birds isolations have been limited to Europe, with the single exception of an apparently normal snowy owl (*Nyctea scandiaca*) shot in Ontario, Canada (Gray, 1964, op. cit.). The purpose of this report is to document an in-

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