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HELMINTH AND ARTHROPOD PARASITES OF EXPERIMENTALLY INTRODUCED WHOOPING CRANES IN FLORIDA

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ABSTRACT: Nine species of nematodes, unidentified larval nematodes, three species of trematodes, two species of acanthocephalans and a single species of chewing louse were collected from 1993 to 1995 from 25 introduced whooping cranes (*Grus americana*) in Florida (USA). In spite of a quarantine procedure involving anthelmintic therapy, three helminth parasites may have been introduced from captive populations. Other parasites acquired were similar to those found in a local congener, the Florida sandhill crane (*Grus canadensis pratensis*), or only occurred infrequently.

Key words: Parasites, whooping crane, *Grus americana*, introduction.

INTRODUCTION

In spite of its long-term status as an endangered species, we could only find reports of a single helminth parasite (Tuggle, 1983) and three parasitic arthropods (Emerson, 1964; Price, 1970; Windingstad, 1978) in free-ranging whooping cranes (*Grus americana*). There have been several reports of helminth infections and diseases of captive whooping cranes (Carpenter et al., 1980; Carpenter and Derrickson, 1981).

The introduction into central Florida (USA) of a closely monitored experimental population of captive-raised whooping cranes, with rapid recovery of dead birds, gave us the opportunity to study the parasites of an introduced population. Whooping cranes were last observed in Florida in the 1930's (Nesbitt, 1982). The introduction into Florida was an attempt to establish a non-migratory population as a part of the overall recovery plan (U.S. Fish and Wildlife Service, 1994). Parasites of the two subspecies of a congener, the sandhill crane (*Grus canadensis*), have been relatively well studied in Florida. Helminth and arthropod parasites found in Florida sandhill cranes (*G. canadensis pratensis*), a non-migratory subspecies, and the wintering greater sandhill cranes (*G. canadensis tabida*), a migratory subspecies, have been described (Forrester et al., 1974, 1975). Our objective was to document the parasites found during the first 2 yr after introduction of whooping cranes (1993 to 1995) and to provide a baseline for future studies.

MATERIALS AND METHODS

The whooping cranes in this study were reared by parent birds, surrogate parents, or by costumed caretakers from eggs either laid in captivity or collected from nests in Wood Buffalo National Park, Canada, at Patuxent Environmental Science Center (PESC), Laurel, Maryland (USA) or at the International Crane Foundation (ICF), Baraboo, Wisconsin (USA). At 6 to 11 mo of age they were transported to Kenansville, Florida (Osceola County) by airplane and released into a holding pen for 3 to 4 wk before they were allowed to fly freely. Birds were fitted with a leg mounted radio transmitter with mortality switches (Telemetry 2000 Inc., Columbia, Maryland and Advanced Telemetry Systems Inc., Isanti, Minnesota, USA) and monitored daily. Prior to transportation, the birds were subject to a 60-day quarantine which included feed that contained 90 mg/kg monensin (Coban® or Elancoban®, Elanco, a Division of Eli Lilly and Co., Indianapolis, Indiana, USA) (PESC and ICF) or 0.0125 mg/kg amprolium ethopabate (Amprol-25®, MSD Agvet, Rahway, New Jersey, USA) (ICF only). They also received subcutaneous treatment with 0.2 mg/kg ivermectin (Ivomec®, MSD Agvet), and 100 mg/kg oral fenbendazole (Panacur®, American Hoechst Corporation, Somerville, New Jersey) for helminth parasites (only when fecal examinations were positive at ICF, all birds at PESC). Dusting with 5% carbaryl powder (Vet Kem®, Division of Zoecon Corporation, Dallas, Texas, USA) was used for ectoparasites (PESC only, ectoparasites have

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not been seen at ICF). Upon arrival in Florida, birds received feed containing monensin in the pen, and were provided with the same feed in the area of the release pen for as long as they returned to it. Birds were re-examined upon release from the pen, opportunistically when captured for other reasons, or upon death. A complete postmortem examination was performed to determine the cause of death. A skin wash and screening of tissues for parasites followed the methods of Kinsella and Forrester (1972). In addition to specifically mentioned papers, Yamaguti (1971) and Anderson et al. (1980) were used to identify parasites. Feces were collected when live birds were handled for examination, and opportunistically, and were stored in 2% potassium dichromate, concentrated with Sheather's sugar solution (Sloss, 1975), and examined for parasite eggs by scanning at 100× power. Live birds were examined visually for arthropod parasites.

Representative material has been deposited in the National Parasite Collection, Beltsville, Maryland (USNPC Nos. 84560-84569).

RESULTS

Fifty-two whooping cranes were released in central Florida between January 1993 and March 1995. The 27 birds examined at death had been in Florida for 1 to 28 mo and ranged in age from 7 to 36 mo of age. We speculate that the cause of death in all cases was predation by bobcats (*Felis rufus*). Postmortem examinations of all birds, including one observed to be killed by a bobcat were characterized by broken necks, a pattern of flesh consumption, and carcasses were often covered by vegetation. In no case did helminths or ectoparasites appear to have caused death or significant disease. Six of the birds, all in Florida for less than 5 mo, were free of parasitic helminths and arthropods. The cranes utilized foraging sites in Osceola, Lake, Orange, and possibly Brevard Counties, and commonly shared foraging sites with both Florida and greater sandhill cranes.

Nine species of nematoda as well as unidentified larval nematodes were found (Table 1). *Ascaridia pterophora* was the most prevalent and abundant helminth and was present in birds just 1 mo after arrival. Ascarid eggs were found in 12 (9%) of 129 fecal samples examined. Capillarid nematodes were first detected as eggs in the feces of cranes collected from the pen just 16 days after their arrival. In spite of the common finding of capillarid eggs in the feces (22% of 129 samples), adult parasites were found in only five of the 25 cases examined at necropsy. *Eucoleus obtusiuscula* was found under the gizzard lining of four cranes (from ICF and PESC), the first infection being recognized in a bird 1 mo after arrival. A female *Capillaria* sp. found in the small intestine of one whooping crane, also at 1 mo after arrival, could not be identified to species. Capillarid eggs were common in feces of sandhill cranes in the area of the release pen and in feces of captive whooping cranes (from PESC and ICF), but whether their source was *Capillaria* spp. or *E. obtusiuscula* could not be determined. A species of *Strongyloides* appeared in cranes at 2 mo after arrival. Other nematodes occurred infrequently (Table 1).

Three species of trematoda were identified (Table 1). One specimen of *Lyperorchis lyperorchis* was found in a crane 2 mo after arrival, and a gravid specimen in another crane 4 mo after arrival. A gravid specimen of the eyeworm, *Philopthalmus gralli,* and two immature specimens of a species of *Brachylaima* were found in the body wash of a crane 7 mo after arrival. The immature flukes were not sufficiently mature for further identification. Unidentified trematode eggs were only observed in the feces on two occasions.

Two species of acanthocephala were identified (Table 1). Both were immature and found in the small intestine 28 mo after arrival.

Two female chewing lice, *Heleonomus assimilis,* were found on one whooping crane that died 10 mo after arrival (Table 1).

DISCUSSION

Although the cranes released in Florida underwent a quarantine period with examination of feces and treatment with ant-

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TABLE 1. Helminth and arthropod parasites from 27 introduced whooping cranes from central Florida, 1993 to 1995.

Parasite (location)[a]	Prevalence		Number per infected bird		Abundance[b]	First detection[c] (mo)
	Number infected	%	Mean	Range		
Nematoda						
Ascaridia pterophora (Si, Li)	13	48	18.5	1–61	9	1
Strongyloides sp. (Si)	5	19	24.2	1–102	5	2
Eucoleus obtusiuscula (V)	4	16	3.5	1–10	<1	1
Dispharynx nasuta (E, V)	3	11	1	1	<1	1
Hystrichis tricolor (P)	2	7	1.5	1–2	<1	1
Capillaria sp. (V)	1	4	1	1	<1	1
Contracaecum multipapillatum (Si)	1	4	1	1	<1	7
Cyathostoma variegatum (O)	1	4	1	1	<1	1
Physaloptera sp. (V)	1	4	1	1	<1	7
Unidentified larva (Lsi, Cl)	2	7	1.5	1–2	<1	1
Trematoda						
Brachylaema sp. immature (Lsi)	1	4	2	2	<1	7
Lyperorchis lyperorchis (Lit, I)	2	7	1	1	<1	4
Philopthalmus gralli (S)	1	4	1	1	<1	7
Acanthocephala						
Centrorhynchus kuntzi immature (Si)	1	4	1	1	<1	28
Southwellina sp. immature (Si)	1	4	1	1	<1	28
Arthropoda						
Heleonomus assimilis (S)	1	4	2	2	<1	10

[a] Location in host S = skin, O = oral cavity, E = esophagus, V = ventriculus (gizzard), P = proventriculus, D = duodenum, Si = small intestine, Lsi = lower small intestine, Li = large intestine, Lit = lower intestinal tract, I = intestine, Cl = cloaca.
[b] Abundance = mean number per infected bird times the prevalence.
[c] Time after arrival in Florida when parasite was first detected in introduced cranes.

helmintics, it is possible that some parasites (*A. pterophora, E. obtusiuscula,* and *C. variegatum*) were introduced since they have not been reported in wild sandhill cranes (Forrester et al., 1974, 1975) or in other hosts from Florida. Capillarid (ICF and PESC) and ascarid (PESC only) eggs were found in feces of whooping cranes in quarantine, and ascarid eggs were found in feces from other crane species at ICF (J. Langenberg, pers. comm.). *Ascaridia pterophora* previously has been known only from a gruiform, *Cariama cristata,* in Brazil (Cristofaro and Feijo, 1975). Although no ascarids have been reported from sandhill cranes in Florida, a 2-yr-old Florida sandhill crane raised at PESC and released in Osceola County in 1990 later was found infected with *A. pterophora. Ascaridia pterophora* was found in four captive whooping cranes that died at PESC (R. Cole, pers. comm.). *Ascaridia* spp. have a direct life cycle (Levine, 1968). The intensities of infection with *A. pterophora* appeared to increase with time since release from a mean (±SE) of 10±14 parasites in birds (n = 10) up to 6 mo after arrival to 45 ± 16 parasites in birds (n = 3) after 6 mo in Florida. Continued use of the release pen area may have exposed birds to fecal contamination in a manner similar to a captive situation. Although *E. obtusiuscula* had not been reported in previous studies of sandhill cranes in Florida, it was found subsequently in a greater sandhill crane from PESC that died 1 mo after release into Alachua County (USNPC Helm. Coll. No. 84570). Sergeeva and Barus (1988) list many gruiform and charadriiform birds as hosts of *E. ob-*

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tusiuscula in Europe and Asia, but these are apparently the first records from any host in North America. The *Cyathostoma* sp. reported from captive whooping cranes by Carpenter and Derrickson (1981) and from captive sandhill cranes by Carpenter et al. (1976) was identified as *C. coscoroba*e. However, specimens from captive sandhill cranes deposited in the National Parasite Collection (USNPC 66545 and 77941) have been determined by us to be *C. variegatum*, the common gapeworm of gruiforms and ciconiforms in Europe and Asia (Ali, 1970). This species caused the death of a sandhill crane transported to Florida in 1991 from PESC, and was found in another PESC-raised sandhill crane released in Alachua County. *Cyathostoma* sp. have been found at necropsy of other crane species at ICF. Only time will tell if these helminths become established with the introduced population of whooping cranes and in wild sandhill cranes. Therapy regimes for these parasites in whooping cranes have not been established and should be evaluated.

Two parasites were shared with both Florida and greater sandhill cranes from Florida. *Dispharynx nasuta* was reported once in each subspecies of sandhill crane, and is a common parasite of various bird species in Florida, and four species of chewing lice, including *H. assimillis*, have been found on sandhill cranes in Florida (Forrester et al., 1974, 1975). Three other parasites not identified to species may be shared with both Florida and greater sandhill cranes. *Brachylaima fuscatum* and *Strongyloides* sp. were relatively common in both sandhill subspecies (Forrester et al., 1974, 1975). Specimens of *Strongyloides* spp. from whooping cranes averaged slightly smaller in total length (2.14 to 2.50 mm) and esophageal length (430 to 560 μ) than those reported from sandhill cranes. An unidentified *Capillaria* sp. was found in the small intestine of both subspecies (Forrester et al., 1974, 1975). Another nematode, a physalopterid larva, may be shared with Florida sandhill cranes (Forrester et al., 1975).

Six parasites that occurred in one or two whooping cranes have not been previously reported in sandhill cranes. *Contracaecum multipapillatum* is a common parasite of fish-eating birds in Florida (Courtney and Forrester, 1974; Threlfall, 1982; Sepúlveda et al., 1996). *Hystrichis tricolor* has been reported from purple gallinules (*Porphyrula martinica*), common moorhens (*Gallinula chloropus*), and American coots (*Fulica americana*) in Florida (Kinsella 1973; Kinsella et al., 1973) and is considered a cosmopolitan parasite of ducks and geese (McDonald, 1969). *Lyperorchis lyperorchis* is a prevalent parasite of limpkins (*Aramus guarauna*) in north central Florida (Conti et al., 1985). *Philopthalmus gralli* has been reported in Florida from fulvous whistling-ducks (*Dendrocygna bicolor*) (Forrester et al., 1994) and is found in Florida great blue herons (*Ardea herodias*) and wood storks (*Mycteria americana*) (M. Kinsella and M. Spalding, unpubl.). *Centrorhynchus kuntzi* is a common parasite of hawks in Florida (Kinsella et al., 1995). *Southwellina* sp. may be the same species that occurs in brown pelicans and roseate spoonbills in Florida (Courtney and Forrester, 1974; Sepúlveda et al., 1994). Since both these acanthocephalans were immature, it is uncertain whether they would have established as adult parasites.

Introduced whooping cranes did not have two of the most abundant parasites in greater sandhill cranes (*Tetrameres grusi, Orchipedum jolliei*) and two of the most abundant parasites in Florida sandhill cranes (*Strigea gruis*, and *Stomylotrema vicarium*) (Forrester et al. 1974, 1975). *Tetrameres grusi* and *O. jolliei* were rare or never found in Florida sandhill cranes, and thus, it is possible that the life cycle of these species is not completed in Florida. The failure to acquire *S. gruis*, the most abundant parasite in Florida sandhill cranes, might reflect a difference in choice of food items. *Stomylotrema vicarium* is common in Florida white ibis (*Eudocimus*

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albus) (Bush and Forrester, 1976) and was not seen in greater sandhill cranes. Sandhill cranes and turkeys (*Meleagris gallopavo*) may be accidental hosts of this fluke in Florida (Forrester et al., 1975).

As in any helminth community, sporadic infections derived from less closely related ecological associates contribute a number of species, but are of little importance to the overall community. Probably included in this category are *L. lyperorchis, P. gralli, H. tricolor, D. nasuta, C. multipapillatum* and the larval *Physaloptera* sp. Other such accidental species will no doubt occur in the future.

Little information is available on the impact of these parasitic infections and infestations in cranes. All but three of the birds had abundant body fat. These three birds had greater numbers of parasitic species (two to five species), and greater numbers of the two most abundant parasites (29, 45, 61 *A. pterophora,* and one, 14, 102 *Strongyloides* sp., respectively. *Cyathostoma variegatum* has caused death from suffocation in both captive whooping and sandhill cranes (Carpenter and Derrickson, 1987; M. Spalding, unpubl.), but appeared to be incidental in the case reported here. *Capillaria* sp. caused death and debilitation of captive Mississippi sandhill cranes (*G. canadensis pusilla*) (Carpenter and Derrickson, 1987). *Hystrichis tricolor* and *D. nasuta* have both caused lesions in the proventriculus of various birds (Rickard, 1985; Karmanova, 1968) but, thus far, intensities have been low in whooping cranes.

We identified 14 species of helminths present in Florida whooping cranes within 2 yr of release, a number of which (*C. variegatum, Strongyloides* sp., *H. tricolor, D. nasuta*) could contribute to future morbidity or mortality if prevalence and intensities of infections increase. These data are a baseline with which to evaluate any changes. In spite of attempts to introduce relatively parasite and disease free individuals, it appears that a number of helminth parasites were introduced. The introduction of parasites and diseases can be a consequence of translocation (Castle and Christensen, 1990) whether intentional or not and should be documented when the decision to translocate is made (Spalding and Forrester, 1993).

Since only *T. grusi* (Tuggle, 1983) has been reported from free-ranging whooping cranes previously, all of the helminth parasites reported here are first reports in free-ranging whooping cranes.

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