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HAEMOPROTEUS AND *LEUCOCYTOZOON* INFECTIONS IN BIRDS OF THE OKLAHOMA CITY ZOO

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ABSTRACT: A total of 222 birds, captive or free-flying in the Oklahoma City Zoo, were examined for blood parasites; 31 (14%) harbored *Haemoproteus* and/or *Leucocytozoon*. While 21% of the indigenous avifauna were infected, only 8% of the exotic bird species harbored haemoproteids and these parasites were also exotic to North America. There was no evidence to indicate that exotic infections were transmitted to native birds or vice versa.

INTRODUCTION

The genera *Haemoproteus* and *Leucocytozoon* consist of a large number of primarily avian, intra-erythrocytic protozoan parasites (Bennett et al., 1982). The known vectors of *Haemoproteus* are either ornithophilic species of the biting midge genus *Culicoides* (Diptera: Ceratopogonidae) or louse flies (Diptera: Hippoboscidae). Pathogenicity of *Haemoproteus* species is low (Bennett et al., 1976) and with the exception of reports by Julian and Galt (1980) and Kucera et al. (1982) of lethal infections of *Haemoproteus* in Muscovy ducks (*Cairina moschata*), there are no confirmed reports of mortality directly attributable to members of this genus. The known vectors of *Leucocytozoon* are all ornithophilic species of the black fly family Simuliidae and two species, *Leucocytozoon simondi* and *L. smithi*, are noted for the high mortality they cause in domestic flocks of anatids and turkeys, respectively. Other species of this genus may be pathogenic but the evidence is not well documented.

Zoological Gardens, by their nature, aggregate a number of species of animals in close proximity and many of these animals are exotic to the geographical location of the Gardens. Proximity provides opportunity for the transmission of diseases or parasites to species which would not normally come into contact with these pathogens. Transmissions can be from exotic to indigenous animals or vice versa; frequently the animals involved have had no previous contact with the pathogens and thus are highly susceptible to infection. The mortality of susceptible Australian and New Zealand animals to a variety of insect-borne pathogens in the Malayan National Zoo was described by Bennett (1974).

In the case of avian blood parasites, rarely are birds checked for blood parasites on their arrival at zoos. It is thus difficult to subsequently determine whether a blood parasite infection was acquired at the zoo or at the bird's point of origin. If the former case prevails, it is implicit that local vectors can maintain the infection within the zoo aviary and in the case of pathogenic blood parasites, some form of control measures must be instituted. If the latter case obtains, it is equally important to know whether the blood parasites can, or cannot, be transmitted by indigenous vectors so that appropriate action can be taken to ensure the health of the introduced avifauna.

In December 1976, a male vulture-headed parrot (*Psittrichas fulgidus*) became listless and lethargic, stopped eating and discontinued its normal grooming behavior. The bird was separated from its increasingly aggressive mate and an examination of a peripheral blood smear indicated a 50% erythrocytic involvement by *Haemoproteus handai*. The bird died 1 yr later and, in the absence of any direct evidence of other pathogens, was presumed to have succumbed to the haemoproteid infection. This presumption may be in error, however, as birds dying from hematozoan infections usually do so during the crisis at the onset of infection, not at some considerable time later. Nevertheless, a survey of the blood parasites of the zoo avian species, together with that of indigenous wild birds occupying the zoo grounds, was undertaken to determine the extent and diversity of infections by this genus of hematozoa. This report summarizes the results of this survey.

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MATERIALS AND METHODS

Blood smears were prepared from blood drawn from the brachial vein; the smears were air-dried, fixed in 100% ethanol and stained. Initially, Giemsa's stain was used but later one of the 'fast' stains was used to save time. However, 'fast' stains tend to fade with time and are not advised if permanent preparations are required. Stained smears were sent to the International Reference Centre for Avian Haematozoa for identification of the parasites.

Blood films were prepared from birds during the period May through July 1980. These included both captive and free-flying zoo birds, local wild birds resident on zoo grounds (captured by mist net or sparrow trap) and raptors from the local raptor rehabilitation station. The Muscovy ducks and turkeys were obtained from a homesite approximately 8 km from the zoo. The blood films of this survey represent Accession Numbers 76721–76752 and represent the positive films in the collection of the International Reference Centre for Avian Haematozoa.

RESULTS AND DISCUSSION

A total of 222 birds, representing 75 species of 25 families, were examined for blood parasites; 31 (14%) harbored one or more species of hematozoa (Table 1). With the exception of the vulture-headed parrot, no birds showed clinical signs of their infections. Haemoproteids were recorded in 28 of the 31 infected birds, leucocytozoids in nine individuals and six birds harbored mixed infections of both *Haemoproteus* and *Leucocytozoon*. Captive zoo birds (i.e., exotic to North America) were represented by 131 individuals of which 10 (8%) were infected with haemoproteids; 21 (23%) of the 91 local and/or birds native to this continent were infected with species of both *Haemoproteus* (24 birds) and *Leucocytozoon* (9 birds).

Among the 10 exotic zoo birds harboring haemoproteids, *Haemoproteus buteonis* was found in three and *H. elani* in a single *Torgos tracheliotus*. *Haemoproteus antigonis* and *H. balearica* were found in two *Bugeranus carunculatus* and *H. brodkorbi* was seen in three *Leptoptilos crumeniferus*. *Haemoproteus handai* was seen in the vulture-headed parrot and represents the second record of this species in North America; the first was from a parrot in the San Diego Zoo (Bennett et al., 1982) and both records are from birds exotic to the Nearctic. With the exception of *H. buteonis* and *H. brodkorbi*, the other haemoproteids recorded above are all exotic to North America and presumably their hosts were infected in their country of origin. *Haemoproteus buteonis* is prevalent in Falconiformes throughout the world;

TABLE 1. Prevalence of *Haemoproteus* and *Leucocytozoon* in birds in the Oklahoma City Zoo area. Negative birds are listed at the end of the table. (*H.* = *Haemoproteus*; *L.* = *Leucocytozoon*.)

	Total birds		Total birds with	
	Examined	Infected	*H.*	*L.*
Accipitridae				
Buteo jamaicensis	8	6	5	4
Buteo j. krideri	2	2	1	1
Buteo platypterus	1	1	1	
Buteo swainsonii	1	1	1	1
Torgos tracheliotus[a]	9	4	4	
Ardeidae				
Ardeola ibis	2	1		1
Egretta alba	1	1	1	
Nycticorax violaceus	1	1	1	
Cathartidae				
Coragyps atratus[a]	1	1	1	
Ciconiidae				
Leptoptilos crumeniferus[a]	5	3	3	
Columbidae				
Columba livia	3	1	1	
Corvidae				
Corvus brachyrhynchos	1	1	1	1
Gruidae				
Bugeranus carunculatus[a,b]	4	2	2	
Psittacidae				
Psittrichas fulgidus[a]	2	1	1	
Strigidae				
Bubo virginianus	5	4	4	1
Strix varia	2	1	1	
Total negative birds	174			
Total birds examined	222	31	28	9

[a] Exotic to North America.

[b] First recorded examination of this bird species.

Negative examinations: Accipitridae: *Aegypius monachus*[a] (3); *Buteo lagopus* (1); *Gyps fulvus*[a] (4); *Ictinia misisipiensis*[b] (1); *Leucopternus albicollis*[a] (2); *Morphnus guianensis*[a,b] (3); *Neophron percnopterus*[a] (6); *Spizaetus ornatus*[a] (3); *Spizastur melanoleucus*[a,b] (1); *Terathopius ecaudatus*[a,b] (2). Anatidae: *Amazonetta brasiliensis*[a] (1); *Anas platyrhynchos* (26); *Anser anser*[a] (1); *A. indicus*[a] (1); *Cairina moschata*[a] (9); *Chloephaga melanoptera*[a,b] (2); *Cygnus atratus*[a] (2); *C. cygnus*[a] (1); *C. melanocoryphus*[a] (1); *C. olor*[a] (1); *Neochen jubatus*[a] (1). Ardeidae: *Nycticorax nycticorax* (1). Caprimulgidae: *Chordeiles minor* (1). Cariamidae: *Chunga burmeisteri*[a,b] (1). Cathartidae: *Cathartes aura*[a] (1); *Sarcoramphus papa*[a] (6). Charadriidae: *Charadrius vociferus* (2). Ciconiidae: *Leptoptilos javanicus*[a,b] (1). Columbidae: *Zenaida asiatica* (1). Corvidae: *Calocitta formosa* (4). Cuculidae: *Coccyzus americanus* (1). Gruidae: *Anthropoides paradisea*[a,b] (2); *A. virgo*[a] (4); *Balearica pavonina*[a] (2); *Grus antigone*[a] (1). Laridae: *Larus pipixcan*[a] (1); *Larosterna inca*[a,b] (3). Meleagridae: *Meleagris gallopavo* (2). Numididae: *Acryllium vulturinum*[a] (1); *Numida meleagris*[a] (1). Otidae: *Choriotis kori*[a] (2). Paridae: *Parus bicolor* (1). Phasianidae: *Gallus gallus* (6); *Pavo cristatus*[a] (2). Ploceidae: *Passer domesticus* (16). Psittacidae: *Ara auricollis*[a,b] (1); *A. ararauna*[a] (4); *A. severa*[a] (3); *A. rubrogenys*[a,b] (3); *Aratinga guaroulba*[a,b] (4); *A. solstitialis*[a,b] (5); *Deroptyus accipitrinus*[a,b] (4); *Rhynchopsitta pachyrhyncha*[a,b] (3). Ramphastidae: *Rhamphastos toco*[a] (2). Sagittaridae: *Sagitarius serpentarius*[a] (2). Strigidae: *Pulsatrix perspicillata*[a] (2). Struthionidae: *Struhtio camelus*[a] (1). Sturnidae: *Sturnus vulgaris* (2). Tytonidae: *Tyto alba*[a] (3).

the infected *Torgos tracheliotus* may have acquired their infection at their point of origin or in Oklahoma where Kocan et al. (1977) reported nearly 50% of the falconids from the Oklahoma City area harbored blood parasites.

Fifteen of the 21 species of birds which were indigenous to North America (Table 1) and which harbored blood parasites, were hawks and owls; seven of the nine *Leucocytozoon* (*L. toddi* in hawks, *L. ziemanni* in owls) and 13 of the 17 *Haemoproteus* (*H. buteonis* and *H. elani* in hawks; *H. celli* and *H. noctuae* in owls) infections occurred in these birds. The remaining haemoproteid infections consisted of *H. herodiadis* in *Nyticorax violaceus*, *H. corvi* from *Corvus brachyrhynchos* and a mixed infection of *H. columbae* and *H. sacharovi* in a *Columba livia*; *Leucocytozoon sakharoffi* was also noted in the same *Corvus brachyrhynchos* and *L. ardea* in *Ardeola ibis*.

It is especially interesting to note the lack of blood parasites in the sample of anatids and house sparrows. The anatids are noted to harbor both *Haemoproteus nettionis* and *Leucocytozoon simondi* throughout North America (Bennett et al., 1982) although transmission of the latter parasite probably does not occur extensively south of the 43° parallel (Herman, 1968; Thul et al., 1980). House sparrows (*Passer domesticus*) frequently harbor a variety of species of *Plasmodium* in the southern United States (Bennett et al., 1982). Absence of blood parasites in these and other local birds suggests that transmission of blood parasites in the Oklahoma City Zoo area is limited. Hence it is unlikely that exotic birds with hematozoan infections will initiate an epizootic within the avian community in this zoo or that local birds will function as a source of infection to exotic stock. This situation is most fortunate, but cannot be expected to happen in every zoological assemblage of avifauna. It is still recommended that all birds in a zoological display be checked for hematozoan parasites and infected birds should only be displayed in areas to which local vectors have no access. While most blood parasites have little clinical effect on their natural hosts, entry into an aberrant host can cause severe problems such as have been frequently recorded with respect to *Plasmodium* in penguins (Stoskopf and Beier, 1977). In a zoological park where birds from many areas of the world are assembled, the chance for such an occurrence increases dramatically. Hence precautionary measures should be instituted and all birds entering a zoo should be checked for hematozoan infections prior to their display in areas to which local vector insects have ready access.

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