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CESTODE AND ACANTHOCEPHALAN INFECTIONS IN CAPTIVE BUSTARDS: NEW HOST AND LOCATION RECORDS, WITH DATA ON PATHOLOGY, CONTROL, AND PREVENTIVE MEDICINE

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Abstract: Bustards are large terrestrial birds that inhabit open plains, deserts, and dry bush country. The helminth parasites of captive houbara bustards (*Chlamydotis undulata macqueeni*), rufous-crested bustards (*Eupodotis ruficrista*), and kori bustards (*Ardeotis kori*) have been investigated at the National Avian Research Centre (NARC) and the International Institute of Parasitology. The cestode species recovered include *Hispaniolepis falsata, Ascometra vestita, Ascometra choriotidis, Otiditaenia conoideis, Otiditaenia macqueeni, Raillietina neyrai,* and *Idiogenes* sp. The acanthocephalans *Mediorhynchus taeniatus* and *Centrorhynchus lancea* were also recovered. A host–parasite list is presented here. *Chlamydotis undulata macqueeni* is a new host for *A. choriotidis, C. lancea,* and *R. neyrai,* and *E. ruficrista* is a new host for *O. macqueeni. Ascometra choriotidis, R. neyrai, O. macqueeni, H. falsata, M. taeniatus,* and *C. lancea* records are new for the United Arab Emirates. Cestodes were recovered from 18 of 78 houbara bustards, two of three kori bustards, and four of 10 rufous-crested bustards. Pathologic findings in the intestinal tract associated with cestode infection included inflammation, mild atrophy, collapse, and fibrosis of the intestinal mucosa. In some birds, the number of parasites was sufficient to partially obstruct the intestinal lumen. Administration of a single oral dose of 10 mg/kg praziquantel was effective in treating kori bustards known to be infected with the cestode *O. conoideis.* Importation of stock for captive breeding programs may introduce parasites from one region into another.

Key words: Birds, cestodes, acanthocephalans, pathology, bustards, anthelmintics.

INTRODUCTION

Bustards are medium-sized to very large terrestrial birds which mainly inhabit open plains and semi-desert regions.[26] About 22 species in eight genera occur in Africa, Europe, Asia, and Australia. Most species migrate between their breeding grounds and winter ranges. They are strong fliers but generally walk rather than fly. Their shy behavior and extremely cryptic plumage enable them to avoid detection, but they are vulnerable to predation, hunting, and loss of habitat to agriculture. Some species, such as the great Indian bustard (*Ardeotis nigriceps*) and the Arabian bustard (*Ardeotis arabs*), are now endangered.[35] The houbara bustard (*Chlamydotis undulata macqueeni*) occupies a vast range from the Canary Islands in the west to China and Mongolia in the east. It migrates through the Middle East from October to March, where it is hunted.[26,35]

Captive breeding programs have been established for many species.[17,21,35,37,40] The National Avian Research Centre (NARC) in the United Arab Emirates (UAE) has captive breeding programs for the houbara, rufous-crested (*Eupodotis ruficrista*), and kori (*Ardeotis kori*) bustards. NARC aims to conserve and increase numbers of bustards by maintaining healthy populations in captive breeding schemes, by reintroduction of captive-bred bustards, by habitat restoration, and by studying the diseases of wild and captive birds.[21]

Before captive-bred birds are released into the wild, a thorough survey of wild and

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captive bustard disease is needed to minimize the introduction of new diseases into free-ranging populations.[13,32] Reports of bustard biomedicine are scarce, and there are no published data on the parasites of captive middle eastern bustards or on the control and treatment of cestodes in any bustards. The helminth parasites of houbara, rufous-crested, and kori bustards were examined as part of NARC's Veterinary Science Department research program. In this report, we discuss routine preventive protocols for cestode infections in captive bustards and present data on praziquantel efficacy.

MATERIALS AND METHODS

Postmortem survey

The birds examined in this survey included 78 houbara, three kori, and 10 rufous-crested bustards. All postmortem examinations were conducted between August 1992 and December 1993. All of the birds were adults maintained in aviaries, and all died of natural causes except one bird, which was euthanized. Nineteen houbara bustard carcasses were frozen for up to 4 mo before examination, but all other carcasses were examined immediately after death. Standard avian postmortem examination techniques[14,33] were used, and endoparasites were preserved in 5% buffered formalin. The parasites were submitted to the International Institute of Parasitology (St. Albans, U.K.). Samples of intestine showing pathologic changes were preserved in 10% formalin and submitted to Cambridge Veterinary School (Cambridge, U.K.) for histopathology.

Parasite identification techniques

Specimens were washed in distilled water, stained in an aqueous solution of acetoalum carmine, dehydrated in a graded series of alcohols, cleared in clove oil, and mounted on slides as permanent whole mounts in Canada balsam. To facilitate observation of internal organs, some cestodes were hand-sectioned[27] and mounted as described above. Some cestode scoleces were cleared and mounted in Berlese's fluid to facilitate counts and measurements of the rostellar hooks.

Histopathology techniques

Samples of tissues were fixed in 10% neutral buffered formalin, embedded in paraffin, sectioned at 4 μm, and stained with hematoxylin and eosin.

Anthelmintic trial

The Veterinary Science Department of NARC has established a preventive program to control the major diseases of bustards in the UAE. In May 1994, infection with the cestode *Otiditaenia conoideis* was detected in a flock of 24 captive kori bustards (cestode proglottids were observed in four of seven random fecal samples). All the birds were captured and treated with praziquantel (Droncit, Bayer UK, Eastern Way, Bury St. Edmunds, Suffolk IP32 7AH, U.K.) tablets at a dosage of 5–10 mg/kg p.o. before translocation into new aviaries. No clinical signs associated with cestode infections were observed in these birds. Two of the bustards subsequently died. One was found dead in the aviary 48 hr after handling, possibly from capture-related stress (bird 1). The other (bird 2) was euthanized 6 days after handling because of a severe musculoskeletal injury. Data from birds 1 and 2 are not presented here.

RESULTS

Parasite identification

Cestodes or acanthocephalans were found in 18 houbara, two kori, and four rufous-crested bustards. The species are listed in Table 1.

Otiditaenia conoideis was found in nine houbara and two kori bustards, *O. macqueeni* was found in two rufous-crested bustards, *Ascometra vestita* and *A. choriotidis* (Fig. 1) were found in one and five houbara bustards, respectively, *Hispaniolepis falsata* was found in seven houbara bus-

Table 1. Host–parasite list of helminths recovered from houbara, kori and rufous-crested bustards.

Bustard	Parasites
Houbara	Cestoda
	Davaineidae
	Otiditaenia conoideis (Bloch, 1782)
	Raillietina neyrai Baer, 1955
	Idiogenes sp.
	Paruterinidae
	Ascometra vestita Cholodkowsky, 1912
	A. choriotidis Adams and Rausch, 1986
	Hymenolepididae
	Hispaniolepis falsata (Meggitt, 1927)
	Acanthocephala
	Gigantorhynchidae
	Mediorhynchus taeniatus (Linstow, 1901)
	Centrorhynchidae
	Centrorhynchus lancea (Westrumb, 1821)
Kori	Cestoda
	Davaineidae
	Otiditaenia conoideis (Bloch, 1782)
	Acanthocephala
	Gigantorhynchidae
	Mediorhynchus taeniatus (Linstow, 1901)
Rufous-crested	Cestoda
	Davaineidae
	Otiditaenia macqueeni (Woodland, 1930)
	Raillietina neyrai Baer, 1955

tards, and *Raillietina neyrai* was found in one houbara and one rufous-crested bustard. A single specimen each of *Idiogenes* sp. and *Paroniella* sp. were recovered from one houbara and one rufous-crested bustard, respectively. The gigantorhynchid acanthocephalan *Mediorhynchus taeniatus* (Linstow, 1901) occurred in eight houbara and one kori bustard. Two houbara bustards harbored another acanthocephalan, the centrorhynchid *Centrorhynchus lancea* (Westrumb, 1821). (For the davaineid cestodes, the genus-level taxonomy[28] and identification to species[1,2,4,5,29] followed previous reports. For the acanthocephalans, previous taxonomic systems were followed.[16,36,47,50])

Pathology

Gross pathologic changes were found in the gastrointestinal tracts of five bustards. Each contained cestodes and acanthocephalans. Damage to the mucosa of the large intestine was observed in a houbara bustard infected with the acanthocephalan *M. taeniatus* and with the cestodes *O. conoideis* and *H. falsata.* In two houbara bustards, one harboring the cestode *A. choriotidis* and the other harboring both *A. choriotidis* and *M. taeniatus,* the very large number of cestodes present caused a possibly fatal partial obstruction of the ileal and jejunal lumina. A small number of raised pink nodules, 2–3 mm in diameter, were present on the cecal and rectal mucosa of a rufous-crested bustard infested with *O. macqueeni.* Inflammation of the small intestinal mucosa was observed in a kori bustard infested with *O. conoideis.*

Histopathology

Microscopic examination of the intestinal mucosal tissue of the rufous-crested bustard revealed small raised nodules that were well demarcated and inflammatory and consisted of numerous lymphoid and plasma cells, with occasional clumps of hemosiderin-laden macrophages. In other areas, there was prominent inflammation, with increased numbers of lymphoid cells, plasma cells, and scattered eosinophils. Gut-associated lymphoid nodules appeared enlarged, and some showed lymphocytolysis.

Intestinal tissues from the houbara bustards showed a variety of inflammatory changes, ranging from normal to mildly prominent lymphoid nodules. Many sections included attachment sites of cestodes with little tissue reaction. Although it was not possible to correlate specific inflammatory lesions with the presence of specific parasites directly, cestode attachment sites showed very little inflammatory response.

Figure 1. Houbara bustard gut infested with *Ascometra choriotidis.* Scale in mm.

One houbara bustard had mild fatty changes in the liver, with numerous foci of hemosiderin accumulations. Fatty change is common in captive houbara bustards (Nicholls, unpubl. data) and should not necessarily be linked with parasitism. A section of intestine from a kori bustard showed atrophy of the upper mucosa with collapse and fibrosis of the stroma, presumably representing more chronic changes than the primarily inflammatory lesions found in the houbara and rufous-crested bustards.

Anthelmintic trial results

Whole cestodes were observed in feces of the surviving kori bustards for 2 days following anthelmintic treatment. Bird 1 had nine unattached curled cestodes in the rectum postmortem. Bird 2 had a single dead unattached cestode in the lumen of the small intestine immediately following euthanasia. It was not possible to determine how many of the birds were still infected following treatment because the birds were housed as a flock in a large aviary (750 × 75 m).

DISCUSSION

This report is the first in the UAE of *O. macqueeni, A. choriotidis, R. neyrai, H. falsata, M. taeniatus,* and *C. lancea,* the first record of *A. choriotidis,* and *R. neyrai* in houbara bustards, and the first record of *O. macqueeni* in rufous-crested bustards. *Ascometra choriotidis* was first reported from the kori bustard in Kenya,[1] and *R. neyrai* was first reported from the rufous-crested bustard in South Africa.[4] *Otiditaenia conoideis* has been widely reported from several bustard species in Europe and Africa,[2,41] and *O. macqueeni* has been reported from houbara and other bustard species in Africa.[5,49] *Ascometra vestita* has been recorded from houbara and rufous-crested bustards in

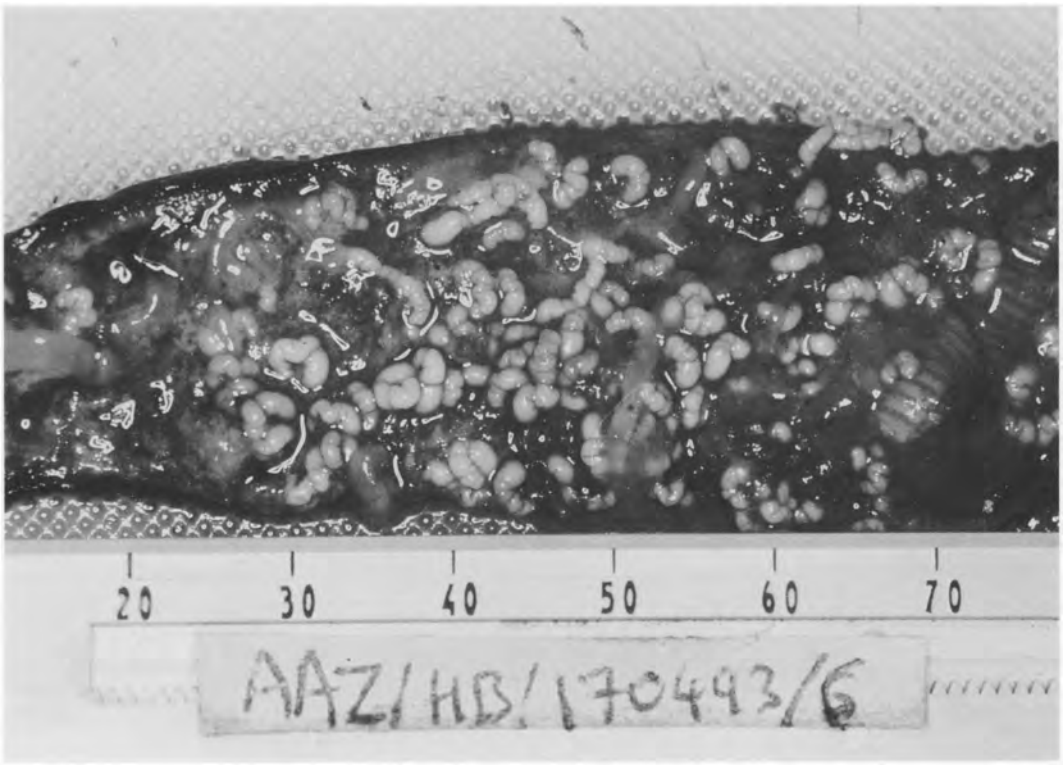

Figure 2. Acanthocephalans (*Centrorhynchus lancea*) and cestodes (*Otiditaenia conoideis*) in the gut of a houbara bustard. Scale in mm.

Africa, Asia, Kazakhstan, and the Urals.[2] Only fragments of the davaineids *Idiogenes* sp. and *Paroniella* sp. were recovered, so they could not be identified to species. *Hispaniolepis falsata* was first reported from the houbara bustard in Egypt.[30] *Centrorhynchus lancea* has been found in charadriiform and gruiform birds in Africa and Europe[47,50] and was recorded from *Otis tarda* and *Burhinus crepitans* in Kazakhstan.[36] *Mediorhynchus taeniatus* has been reported in several species of bustards, including the houbara bustard, and in galliforms in Africa and Turkmenistan.[16,31,36]

Cestodes were found in 25.6% of the bustards, and heavy cestode infections in two houbara bustards may have contributed to morbidity. Heavy infections of cestodes can cause intestinal obstruction in birds.[9,44,47] Intestinal obstruction by massive cestode infections was reported as a cause of 4.8% of bustard deaths at the Al Ain Zoo from 1979 to 1991, and cestode infections were associated with fatal enteritis in other bustards.[6,7] Recently imported bustards are sometimes weakened, dehydrated, and in poor body condition (Bailey, unpubl. data), conditions that may increase susceptibility to the pathologic effects of cestode infections. In a survey of newly imported houbara bustards, cestodes were found in 28% of carcasses.[7] Cestodes are most often found in recently imported birds or in domestic birds that have contact with arthropod intermediate hosts. Most birds do not manifest clinical signs unless heavily infected.[44] Enteric cestodes cause depression, anemia, blood stained feces, hemorrhagic enteritis, debility, diarrhea, wasting, and anorexia in birds.[9,12,44,46,51] The ostrich cestode *Houttuynia struthionis* is a major parasite in range-raised birds in South Africa and pro-

duces gradual emaciation.[25] In poultry, the cestode *Davainea proglottina* causes weight loss, weakness, listlessness, hemorrhagic enteritis, thickening of the intestinal mucosa, and reduced egg production in laying birds.[39,45] Heavy infections with other species of cestodes in poultry can cause caseous nodules in the intestines.[45] Massive infections may reach clinical importance, and cestodiasis can serve as a primary cause of death.[18] Cestodes have been responsible for death in small passerines,[38] and cestode infections associated with high mortality have been regularly found in carcasses of small passerines.[3] Acanthocephalans were responsible for the deaths of two crane chicks; both birds died with peritonitis and ascites resulting from intestinal perforation, and one bird had a concurrent pneumonia.[11]

The life cycles of cestodes and acanthocephalans are indirect, with at least one intermediate host. Little information is available on the life cycles of the parasites reported here, although the intermediate hosts probably are terrestrial arthropods. Bustards are omnivorous, and a significant proportion of the diet of wild birds consists of orthopterans, coleopterans, termites, ants, caterpillars, spiders, centipedes, and snails.[26,35] The length of time in captivity indicates that at least some birds were infected locally. Captive bustards at NARC live in naturalistic aviaries and frequently eat beetles, which are often recovered from gizzards during postmortem examination (Bailey, unpubl. data). Cestode cysticercoids with scoleces similar to those of *Ascometra* have been found in locusts (*Nomadacris septemfasciata*) in Chad.[1,19] Cestode segments have been observed in kori bustard feces 24 hr after niclosamide administration, and juvenile kori bustards have ingested cestode proglottids expelled in this manner (Bailey, unpubl. data). Adult houbara bustards also ingested cestode proglottids expelled after niclosamide administration (Samour, unpubl. data). Because a period of parasite development in an intermediate host is essential for infectivity to the final host, such ingestion of expelled proglottids has no clinical significance for the bustards. Helminth eating has been observed in great crested grebes (*Podiceps cristatus*) and the red-necked grebe (*Podiceps grisegena*)[42] and in blackbirds (*Turdus merula*)[15] but has not been reported in bustards. The life cycles of some species of *Mediorhynchus* are partially known. In Louisiana, larvae of *Mediorhynchus centurorum,* a parasite of the red-bellied woodpecker (*Melanerpes carolinus*), occur naturally in woodroaches (*Parcoblatta pennsylvanica*), and the life cycle has been completed experimentally with these host species.[34] During a severe epizootic of *Mediorhynchus orientalis* infection in starlings at an aviary in Pittsburgh, Pennsylvania, acanthellae were found in two locally abundant cockroach species (*Pycnoscelis surinamensis* and *Periplaneta americana*), which were available to be eaten by the birds.[10]

Conservationists are becoming concerned about the risk of disease in threatened populations, especially where captive animals are involved through reintroduction programs.[14,32] Disease may cause direct mortality or may reduce reproductive success.[24] Knowledge of both wild and captive bustard diseases helps to minimize risk when captive and wild birds come into contact. Helminths may be introduced into captive breeding populations when other birds are imported. They may then become established if conditions are favorable and if suitable intermediate hosts are available.[1] The monitoring and control of parasites within captive breeding and restoration programs are therefore vital. Helminth parasites affect the reproductive productivity of many species of birds, and the control of parasites in captive birds may therefore improve their productivity. The nematode *Trichostrongylus tenuis* can reduce productivity in the red grouse,[22,23] and the removal of helminths has a dramatic effect on the breeding success of male pheasants.[20,48]

A single dose of praziquantel at 10 mg/kg p.o. appears to be effective in eliminating cestodes from the gastrointestinal tract of kori bustards. However, a second dose of praziquantel 14 days after the first dose is recommended. Bustards maintained by NARC receive anti-cestode medication and are treated by flock medication in feed during February and June, with niclosamide (Tapinex, Bremer Pharma GMBH, 27540 Bremerhaven, Germany) at a dosage of 2.5 g/kg of food in two doses 14 days apart and flubendazole (Flubenol 5%, Janssen Pharmaceutical Ltd., Grove, Wantage, Oxfordshire OX12 0DQ, U.K.) at a dosage of 0.6 g/kg of food s.i.d. for 10 days.[8,43] Bustards are routinely captured and treated yearly in October with praziquantel at a dosage of 5–10 mg/kg p.o. Because capture and handling increases risk of injury and paresia, bustards managed by NARC are frequently medicated with anthelmintic tablets in favorite food items such as dead pink mice.

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