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Pasteurella multocida Infections in Rockhopper Penguins (*Eudyptes chrysocome*) from Campbell Island, New Zealand

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ABSTRACT: During an investigation into the population decline of rockhopper penguins (*Eudyptes chrysocome*) on Campbell Island, New Zealand, avian cholera (*Pasteurella multocida*) was found in dead adults and chicks. An RNA enveloped virus was isolated from *Ixodes uriae*, a tick which commonly parasitizes rockhopper penguins on the island. It is not known whether this virus is virulent for penguins. No evidence was obtained to suggest that avian cholera was the principal cause for the decline in the rockhopper penguin population.

Key words: Rockhopper penguin, *Eudyptes chrysocome*, avian cholera, *Pasteurella multocida*, virus, field study.

Campbell Island (52°33'S, 169°09'E) formerly had the largest population of rockhopper penguins (*Eudyptes chrysocome*) in the Australasian region. During the 1940's there were probably >1,000,000 breeding penguins on the island (Moors, 1986). However, during the last 40 yr there has been a marked decline in numbers and now only about 100,000 rockhopper penguins breed there. Moors (1986) suggested several possible causes for the reduction in penguin numbers. These included (1) predation by introduced Norway rats (*Rattus norvegicus*) and feral house cats; (2) disturbance of colonies by feral sheep or humans; (3) disease; or (4) marine factors affecting the food supply. Observations of the rats (Moors, 1986) and previous studies of the diet of cats (Dilks, 1979) indicated that predation was not a significant problem. Also, penguin numbers have declined in colonies which are inaccessible to sheep and people.

In the summer of 1985–1986 we investigated whether changes in the penguins' food supply and disease were causes of the decline in bird numbers. These studies concentrated on the breeding success and feeding habits of adults, and the growth and survival of chicks. Many dead chicks and a few dead adults were found in the main study colony on the west coast of the island at Penguin Bay. These birds died after a short illness. Most were in apparent good body condition, often with full stomachs. At necropsy the chicks had extensive areas of hemorrhage in the pectoral and thigh muscles. *Pasteurella multocida* was isolated in pure culture using previously described procedures (Weaver et al., 1985) from the lungs of an adult and seven of the 12 chicks sampled. Three of these infected chicks were in a group of five from neighboring nests. They were observed in apparent good health the day before they were found dead. The full significance of these *P. multocida* infections was not determined because birds were not examined for viruses and parasites, and there was only limited histological examination of tissues.

The following summer an investigation was conducted at Penguin Bay to determine the significance of *P. multocida* as a cause of penguin mortality and to examine birds for the presence of other bacteria, viruses and parasites. The remoteness of the study area on the western coast of Campbell Island severely hampered the collection of specimens for microbiological examinations, especially virus isolation. Formalin fixed tissues were collected from all birds at necropsy but fresh samples were taken only when the samples could be frozen within 24 hr of collection. Prior to the start of the breeding season Norway rats in the Penguin Bay colonies were poisoned with brodifacoum (Talon, Imperial Chemical Industries Ltd., Wellington, New Zealand) to reduce scavenging of penguin carcasses and possible predation on newly hatched chicks.

In the 1986–1987 breeding season the number of deaths of chicks in the main study area was less than that of the previous year. Necropsies were conducted on 42 chicks. The majority of these deaths appeared to be due to a combination of trauma, predation of skuas (*Catharacta lonnbergi*) and starvation. However large numbers of *P. multocida* were isolated in pure culture from two chicks. Gram negative bacteria were present in peripheral blood smears from both chicks, indicating that they were bacteraemic when they died. These isolates were serotyped by R. B. Rimler (United States Department of Agriculture, Ames, Iowa 50010, USA) as belonging to the capsule serogroup A and somatic serotype 1. This is the predominant serotype involved in epornitics of avian cholera in wildfowl in North America (Heddleston et al., 1972; Zinkl et al., 1977).

The most striking histological change in the chicks infected with *P. multocida* was in the spleen which contained multiple colonies of bacteria, approximately 50 μm in diameter. These colonies were surrounded by a zone of necrotic tissue and only small numbers of heterophils. Colonies of bacteria and an associated inflammatory response also were present in the liver and small intestine. They were smaller and less numerous than those in the spleen. These are features of an acute bacterial septicemia.

Tissue samples were collected from five freshly dead rockhopper penguins (three adults, one subadult, one chick) in two other colonies on the southwestern coast of Campbell Island, where the rats had not been poisoned. The remoteness of these colonies prevented the collection and preservation of samples for microbiological examination. However, each of these penguins had histopathological lesions similar to those from which *P. multocida* had been isolated and seemed to have died of septicaemia. The apparent higher prevalence of the disease in these colonies suggested the possibility that the number of penguin mortalities associated with *P. multocida* in the study area at Penguin Bay in 1986–1987 may have been affected by reduction of the rat population by poisoning. Norway rats have been recorded as reservoirs of *P. multocida* (Curtis, 1983), but isolates were not obtained from the bacteriological examination of 13 rats from Penguin Bay in 1986–1987.

This is the first report of avian cholera (*P. multocida*) in rockhopper penguins. However, this pathogen has been isolated from brown skuas in Antarctica (Parmelee et al., 1979) and is known to cause sporadic epornitics with high mortalities in waterfowl from North America (Montgomery et al., 1979; Zinkl et al., 1977). *Pasteurella multocida* could be a natural infection in rockhopper penguins on Campbell Island, or it could have been introduced with the rats, domestic poultry, cats, dogs and/or livestock which are now, or were once, prevalent on the island.

Viruses were not isolated from the samples taken during the summer of 1986–1987 from healthy chicks or dying birds. However, an RNA enveloped virus (100 nm diameter) was isolated from a pool of ticks (*Ixodes uriae*) collected from moulting subadult penguins. These ticks commonly parasitize rockhopper penguins (Dumbleton, 1953). A similar virus was isolated from four of 12 pools of ticks collected during the following summer. These isolates are morphologically similar to, but serologically distinct from, the avian corona virus causing infectious bronchitis. The significance of this virus as a cause of disease in penguins has not been determined. Arboviruses also have been isolated from *I. uriae* from MacQuarie Island (Doherty et al., 1975; St. George et al., 1985) but they were not associated with a naturally occurring disease of birds. Sera collected in February 1988 at Campbell Island from 15 rockhopper and 18 yellow-eyed penguins (*Megadyptes antipodes*) gave no antibody response to infectious bronchitis virus, reticuloendotheliosis virus, Newcastle disease virus, infectious laryngotracheitis virus, avian encephalomy-

elitis virus, infectious bursal disease virus, avian influenza, Marek's disease virus, fowl pox virus or the virus isolated from the ticks.

Rockhopper penguins infected with *P. multocida* have been found in four separate colonies along about 4 km of the coast of Campbell Island. We expect the infection to be present to some degree in all colonies on the island. However, at present we have no evidence to suggest that the decline in rockhopper penguin numbers is due principally to this pathogen. Investigations are continuing into a link between the reduction in numbers of penguins and changes in the marine environment around the island.

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