THE ROLE OF VACCINATION IN THE MAINTENANCE OF CAPTIVE BIRDS OF PREY

by
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ABSTRACT. The diseases of raptors against which vaccination is or could be practicable are discussed. Particular mention is made of Newcastle disease and agian pox. Other diseases discussed in the context of vaccination are pasteurellosis, salmonellosis, tuberculosis, bumblefoot, aspergillosis, Marek's disease, and inclusion body hepatitis. The need for more research on this topic is emphasized.

Introduction

There has been great interest in the breeding of captive birds of prey in the past five years. As a result, the numbers of birds maintained in captivity have increased, and there has been a marked awareness of the potential dangers of disease.

Despite great advances in hawk medicine in the last decade, many diseases remain a threat to captive raptors. The relatively intensive systems used for captive breeding increases the risks of epizootic disease and build-up of parasites. Prophylactic vaccination has proved invaluable in the prevention of epizootic disease in intensively reared poultry and could possibly be of use in captive raptors (Cooper 1972a). However, little work has been carried out on this topic.

In this paper I discuss raptor diseases against which vaccination might be practicable. Where appropriate, results and conclusions are recorded. Clinical signs and other features of the diseases are not given; these data are available elsewhere (Hofstad et al., 1972; Davis et al., 1971).

Materials and Methods

The birds I vaccinated were captives maintained at the Veterinary Research Laboratory, Kabete, Kenya, East Africa (Table 1). Techniques of vaccination are discussed under each disease.

Results and Discussion

Newcastle Disease. This viral disease is a definite threat to birds of prey, having been reported on a number of occasions from a variety of species (Keymer and Dawson, 1971; Schoop et al., 1955; Zuydam, 1952). As with other such diseases, there is no specific treatment; control in domestic birds rests upon prophylactic vaccination with either killed (inactivated) or living (attenuated) vaccines.

The various types of Newcastle vaccine were discussed by Lancaster (1966). Vaccination of raptors with an inactivated Newcastle disease (ND) vaccine (Cooper, 1972a) and with an attenuated vaccine (Hornbuckle 1972) have been reported. However, while reporting the safety of the vaccine used, these authors made no mention of the efficacy of vaccination either in terms of immunogenicity or protection.

Subsequently, I had the opportunity to carry out a small number of trials with inactivated Newcastle disease vaccination of raptors in Kenya. The vaccine was a B-propiolactone vaccine prepared in embryonated hens' eggs, a technique used extensively to immunize poultry in Kenya. Injection was subcutaneous, usually over the pectoral muscle or leg, at a dosage of 1.0 ml. To test for safety of the product, the birds received a clinical examination daily, and the site of inoculation was palpated and observed. The birds showed no generalized or localized ill effects other than slight swelling and, in some cases, caseation at the site of vaccination.

Later, the serological response to the vaccine was studied. It was impracticable to challenge vaccinated birds; therefore, the haemagglutination inhibition (HAI) titre to the virus was used as an indicator of immune status. This test has been used extensively in work with poultry in which the HAI titre is believed to correlate closely with protection. In the raptor work, blood samples were taken from the brachial vein at the time of vaccination and at weekly (or in some cases twice-weekly) intervals for six weeks. At least 1.0 ml of blood was taken from each bird and allowed to clot. The resulting serum was used for an HAI test using avian red blood cells and a Newcastle disease virus of known HAI titre.

A very poor response to Newcastle vaccine resulted. The majority of birds either showed a negative titre prior to vaccination or a low titre of 1/10 or 1/20. Following one dose of vaccine the titre rose in approximately 50 percent of cases, but the majority of these showed only a one or two cell difference (e.g., from 1/10 to 1/20 or 1/40). This was not considered significant. The highest titre reached was 1/160, 3 weeks after vaccination of a Tawny Eagle which initially had a titre of 1/20. Even this titre returned to 1/80 in the fourth week and thereafter remained constant.

Subsequent doses of vaccine were given to the Tawny Eagle at varying intervals following the first injection. On no occasion was a significant rise in titre observed.

To check the efficacy of the vaccine in poultry, samples were also inoculated into three-week-old chickens; similar serological tests were performed. The results contrasted markedly with those in the raptors. There was a rise in titre after two weeks, in some cases to 1/1280 or 1/2560. Subsequent vaccination produced a further rise in titre.

The results in raptors are disappointing and suggest that these birds respond poorly to a β-propiolactone inactivated vaccine. Such a response is well documented in the turkey (Box et al., 1974) and poses problems when this species must be vaccinated. Unfortunately other types of Newcastle disease vaccine are not used in Kenya; further trials could not be performed. A recent report (Chew and Liow, 1974) describes the successful use of live vaccines in psittacine birds. Work on these vaccines in raptors would appear warranted.

Avian Pox. This disease has been reported in raptors on a number of occasions (e.g., Cooper, 1969; Greenwood and Blakemore, 1973). It is probably only rarely fatal but can produce severe clinical signs which may render a hawk unable to feed or otherwise incapacitate it. Certainly avian pox is a potential hazard to captive raptors. In the absence of any specific therapy, vaccination is desirable.

I have found no reports on the use of a pox vaccine in raptors or in other wild birds. However, considerable work has been performed on the vaccination of poultry and other domestic birds, including pheasants (Dobson 1937). The subject is also discussed by Cun-

ningham (1965). However, as Karstad (in Davis et al., 1971) points out, careful consideration must be made of the strain involved, since avian pox viruses show variation in pathogenicity for different species.

I used an attenuated pox vaccine on a Tawny Eagle in Kenya. The vaccine, a pigeon-pox-derived strain, was given by wing stab; 0.1 ml was also injected subcutaneously in the same area. Despite daily examinations, no systemic or local effects were noted. Similar negative results were shown by a Marabou Stork (*Leptoptilos crumeniferus*) inoculated by the same route. Poultry vaccinated by wing stab alone developed a small pustule at the site 5 to 10 days later.

Pasteurellosis (Avian Cholera). This disease has been observed among a number of raptors, both captive and free living, and is discussed in detail by Rosen (in Davis et al., 1971). Free-living birds may contract the infection by feeding upon infected birds or rodents (Rosen and Morse, 1959).

Although treatment of pasteurellosis is possible, the disease is often peracute or acute, and success rates may be low. Vaccination against pasteurellosis is of some historical interest because Pasteur (1880a, 1880b) performed his early immunological experiments with this disease and succeeded in protecting a percentage of chickens with an attenuated strain of the organism. Much work has followed, and both attenuated and inactivated vaccines have been developed, but I have found no record of their use in raptors.

An inactivated *Pasteurella multocida* vaccine was used in three species: Tawny Eagle, African Hawk Eagle, and Black Kite. Again no attempt was made to assess its efficacy, but the birds were observed carefully for systemic or local side effects. None was noted. The dose used was 1.0 ml subcutaneously. No poultry were vaccinated, but the vaccine used is the standard vaccine for poultry in Kenya.

Salmonellosis (Avian Typhoid). Salmonellosis has been reported from a number of raptors but usually only in isolated cases. A recent publication from Hanover (Tabken, 1972) discusses salmonellosis in the context of the conservation of Peregrines. Tabken collates a formidable list of *Salmonella* spp. identified in nest material, castings, and feces from Peregrine eyries. Under the intensive conditions of captive breeding, a *Salmonella* sp. could prove an important hazard. Prophylactic vaccination would seem advantageous.

Numerous attempts have been made to produce a *Salmonella* vaccine for birds but with very little success, despite the production of an attenuated *S. dublin* vaccine for cattle. A killed vaccine against *S. gallinarum* was used to inject a Tawny Eagle, an African Hawk Eagle, and a Black Kite in Kenya. The poultry dose of 1.0 ml was given subcutaneously. No ill effects were noted.

Avian Tuberculosis. This condition occurs in both captive and free-living raptors. The causal organism is relatively resistant to disinfectants and this, coupled with the difficulties of clinical diagnosis, make contamination of aviaries or mews a real hazard.

Vaccination of poultry has been attempted with slight success, but it is usually not recommended. Vizy, Douza, and Pasztor (1964) reported 100 percent success with a killed vaccine in a zoological collection, but no other reports have been traced. Dr. A. McDiarmid of the Institute for Research on Animal Disease, Compton, Berkshire (pers. comm.), reports investigations into the use of BCG as a vaccine in pheasants, waterfowl, and poultry. There is "some evidence to indicate that BCG may be of value." It does not yet appear to have been used in birds of prey.

Bumblefoot. This condition is an important clinical condition of captive raptors. While treatment by medical or surgical means is frequently successful, prevention is preferable. The condition is usually associated with bacteria, especially *Staphylococcus aureus*, and it has

been postulated (Cooper, 1972a) that immunization might prove of value in prevention and treatment.

Staphylococcal toxoid (Burroughs Wellcome & Co.) has been administered by intramuscular injection to both Lanners and Peregrines suffering from bumblefoot, but no obvious value has been noted. No attempt has yet been made to use this toxoid prophylactically. It is my opinion that an autogenous vaccine, prepared from the causal organism, might prove more valuable. However, organisms other than *S. aureus* can also be associated with bumblefoot. Control of this one bacterium will not necessarily, therefore, ensure protection against the disease. Moreover, other factors such as overgrown talons and poorly designed perches predispose raptors to bumblefoot; attention to these aspects may prove of more practical value in disease prevention.

Aspergillosis. This is a common cause of death in captive hawks and frequently supervenes following such factors as loss of condition and intercurrent disease.

Vaccination against aspergillosis has been suggested previously (Cooper, 1972b), following experimental work with mice reported by workers in England. Little is known of the immunological aspects of *A. fumigatus* infection, but the limited work performed to date would suggest that vaccination might prove of value.

Marek's Disease. Marek's disease apparently is not a problem in raptors, though isolated cases have been reported (Halliwell, 1971; Woodford and Glasier, 1955). I mention the possibility of vaccination because of the successful development of attenuated vaccines for poultry. The disease could conceivably prove more of a threat now that captive breeding is widely attempted. An example of an instance when a suitably safe Marek's vaccine might have proved valuable was Dr. Stanley Temple's work with the Mauritius Kestrel (*Falco punctatus*). Marek's disease is enzootic on Mauritius; and Dr. Temple, who fed chicks to his captive pair of Kestrels, feared that the latter might become infected. It appears, however, that the disease is probably not a great threat to raptors, and incubator-hatched day-old chicks are unlikely to carry infection.

No records have been traced of the use of poultry vaccines in birds of prey, and I would not advocate their use until experimental work has shown them to be safe.

Inclusion Body Hepatitis. To date, this disease has been observed only among falcons in the United States of America (Ward, Fairchild, and Vuicich, 1971; Mare and Graham, 1973), but it has attracted considerable interest in all countries where raptors are maintained in captivity. A similar disease is known from owls in Europe (Burtscher, 1968; Burtscher and Schumacher, 1966).

Protection of birds against inclusion body hepatitis would be of considerable potential value, but production of a vaccine would seem unlikely because the causal agent is a herpes virus. Such viruses frequently persist in the presence of circulating antibodies. However, as Mare and Graham (1973) point out, the virus may not be as cell associated as are some other herpes viruses. This could facilitate development of a vaccine.

Conclusions

There have been few attempts to vaccinate birds of prey against disease, and relatively little is known of their immunological response to microorganisms. My limited work with inactivated Newcastle disease vaccine suggests that the raptor's immunological response to this vaccine may not follow that of the fowl.

There have been great advances in the development and improvement of poultry vaccines in the past five years. Increased interest in the maintenance of hawks in aviaries suggests that research on the development of vaccines for these birds may be long overdue.

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TABLE I

SPECIES IN WHICH VACCINES USED

1. Tawny Eagle (*Aquila rapax*) NDV P PS S
2. African Hawk Eagle (*Hieraaetus fasciatus*) NDV PS S
3. African Harrier Hawk (*Polyboroides typus*) NDV
4. African Goshawk (*Accipiter tachiro*) NDV
5. Black Kite (*Milvus migrans*) NDV PS S
6. Augur Buzzard (*Buteo rufofuscus*) NDV
7. Lanner (*Falco biarmicus*) NDV ST
8. Peregrine (*F. peregrinus*) NDV ST
9. White-backed Vulture (*Gyps africanus*) NDV
10. Hooded Vulture (*Necrosyrtes monachus*) NDV
11. Spotted Eagle Owl (*Bubo africanus*) NDV
12. Barn Owl (*Tyto alba*) NDV

Key NDV = Newcastle P = Pox PS = Pasteurellosis
S = Salmonellosis ST = Staphylococcal toxoid

BIBLIOGRAPHY ON THE PEREGRINE FALCON

The U.S. Fish and Wildlife Service is compiling a bibliography with abstracts of English language literature, both books and periodicals, on the Peregrine Falcon (*Falco peregrinus*). Authors who wish to have their articles included in this work should send two reprints, copies, or abstracts to the senior author, Dr. Richard D. Porter, I.F. & R.E.S. Shrub Lab, 735 North 500 East, Provo, Utah 84601.

Articles in which the Peregrine Falcon is mentioned but is not the main subject, and articles in foreign languages with English summaries are also wanted.