Avian pox in Swainson’s francolin in South Africa

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Field trips were undertaken in South Africa from 1997–2001 to determine the prevalence of poxvirus infection in Swainson’s francolin, Francolinus swainsonii. In total, 200 specimens were trapped or shot and examined for external lesions. Selected tissues from three dead specimens were removed for histopathological examination. Eighty-eight (44%) of 200 specimens revealed lesions, the highest compared to other wild bird populations. Other species such as ducks, doves, pigeons, helmeted guinea fowl (Numida meleagris) and other francolin species were also examined for similar lesions. Only one specimen (Coqui francolin, F. coqui) of 673 showed similar signs. This absence in other species suggests that Swainson’s francolin can serve as an indicator species for certain poxviruses in a local or regional context. Swainson’s francolin on the highveld showed a much higher prevalence of poxvirus infection than those in the bushveld. It is suggested that extreme cold conditions and lack of adequate food and cover during winter cause a stressful bottleneck. Swainson’s francolin are dispersed in summer but converge in winter into groups, facilitating the spread of the virus between individuals.

Key words: Avipoxvirus, Francolinus swainsonii, histopathology.

INTRODUCTION

Avian pox is caused by a poxvirus from the genus Avipoxvirus, family Poxviridae, and has been classified into different host-species-related groups on the basis of differential susceptibility and cross-protection studies (Boosingher, Winterfield, Feldman & Dhillon 1982; Winterfield, Reed & Thacker 1985; Ritchie 1995). All species of birds, regardless of age or sex, are considered to be susceptible to some strain of poxvirus that may cause cutaneous, diphtheritic or systemic pathological changes (e.g. Cox 1980; Sileo, Sievert & Samuel 1990; Kreuder, Irizarry-Rovira, Janovitz, Deitschel & DeNicola 1999). The type of disease that develops is thought to be influenced by the strain of the infecting virus, the route of viral exposure, and the species, age and condition of the infected bird and is dictated by the location of the poxvirus-induced damage. Lesions around the mouth or eyes may prevent a bird from eating and/or seeing. Ulcerations in the oral cavity may make an affected bird reluctant to eat or drink, causing dehydration or starvation. Changes in the pharynx, larynx, trachea or lungs may cause dyspnoea, wheezing or gasping for air (Ritchie 1995).

Mortality and diseases associated with avian pox occur regularly in wild bobwhite quail (Colinus virginianus) as well as in pen-raised quail (Davidson, Kellogg & Doster 1980; Poonacha & Wilson 1981). Crawford (1986) described a differential prevalence of avian pox in adult and immature California quail (Callipepla californica) in Oregon, U.S.A. In almost all of these investigations the diagnoses were based on macroscopic, histological as well as occasional electron-microscopic examinations of typical skin lesions.

The study of vectors and diseases that may have a detrimental effect on francolin populations in South Africa has mainly been limited to the identification of ectoparasites, Marek’s disease (Pettit, Taylor & Gough 1976) and haematozoan infections (Shan & Dobson 1975; Jansen, Earle, Little & Crowe, 1998). Otherwise, very little data exist on how diseases affect wild game bird populations in South Africa (Huchzermeyer 1987).

Swainson’s francolin are the most popular francolin in terms of numbers hunted in southern Africa each year. There are no recent records of hunting statistics, but Clinning & Bailie (1987) estimated (extrapolated from hunting license returns) that about 22,000 Swainson’s francolin were shot during the 1981/82 hunting season in the former Transvaal alone. The present study describes the

occurrence of avian pox in Swainson’s francolin, its pathological nature as well as its possible adverse effects on francolin populations. Furthermore it provides an understanding of the disease that is important from a conservation and sporting point of view.

METHODS
Swainson’s francolin were hunted in the Magaliesburg area (Gauteng) from 1977 to 2001. A francolin, shot during 1997, showed clear wart-like lesions (papillae) on the bare facial skin behind the eyes on both sides of the head, which suggested avian pox infection. This occurrence prompted the examination of 148 specimens shot from 1997 to 2001 (Table 1). An additional 52 Swainson’s francolin were trapped with walk-in funnel traps on the farm Nooitgedacht near Heidelberg (Gauteng), marked with plastic rings and examined for lesions and external deformities (mainly nodular, rounded scabs) on their heads and feet, and released again. A total of 673 other bird species including waterfowl, doves, pigeons and other terrestrial gamebirds were also hunted or trapped at the same venues during the same study period and examined for similar symptoms of avian pox infection.

Swainson’s francolin populations at Derby and Boons (North West Province) were hunted during three consecutive winter seasons from 1998 to 2000. Each population was hunted once per year. The birds were hunted on foot traversing the same route with the aid of four pointer dogs. Apart from examining the specimens for avian pox infection, the francolin populations were also estimated during the shoots. Notes on pathological condition, numbers of francolin and flight behaviour were noted in the field during all shoots. Francolin under the age of six months were recorded as such and in some cases males and females were sexed using leg spurs on males as a means of differentiation (Milstein & Wolff 1987).

Three adult specimens were frozen for about one week and then taken to the ARC-Onderstepoort Veterinary Institute for pathological examination. The heads and feet of four infected adult specimens were examined radiologically at the Roodekruijn Animal Clinic in order to determine the effect that heavy wart growths (about 10–20 mm in diameter) might have on underlying bone and tissues of the joints. An X-ray photograph of one specimen with heavy warts (2 × 2 × 2 cm) on its legs was evaluated by a specialist veterinary radiologist. The throats and mouths of 10 adult Swainson’s francolin specimens were examined macroscopically in the field for signs of respiratory infection or lesions that could indicate the so-called ‘wet’ or diphtheritic form of avian pox.

RESULTS
Prevalence of poxvirus infection in South Africa
A total of 200 specimens were examined in the field for poxvirus infection (Table 1). Eighty-eight (44%) showed signs of infection. Of these, 74 (84%) showed lesions or loss of pigmentation on the bare skin behind both eyes. These lesions were of three forms (possibly stages): first, round brownish or blackish soft patches under the epidermis with no elevation or outgrowth; second, heavy black warts; and third, whitish exfoliating warts which were less elevated than the black warts. Some of these specimens showed loss of red pigmentation as the lesions had healed, which is in accordance with the healing of poxviruses on other bird species (Ritchie 1995). Ten specimens (11.4%) revealed wart-like outgrowths on their feet and legs of which some were radical with open wounds and visible fresh blood (not streaming) and yellow pus. All of these specimens had lesions behind their eyes. Five specimens (5.7%) had lesions and some pus that formed part of smallish lesions all over their faces and skin around the mandibles. In three cases (3.4%) heavy wart-like outgrowths were present above the eyes over the crown. In one case the wart measured 1.5 × 1.5 × 1.5 cm. These specimens also had leg warts and lesions behind their eyes.

Thirty-three infected francolins were obtained during three consecutive years of shooting at Derby from 1998 to 2000 (Table 1). Of the 25 birds shot in May and June in all three years, 21 (84%) were infected, which suggests that the disease remained in the population for at least three years. During 1998, a second shoot was conducted in September where of the eight birds shot, only one had the poxvirus infection. The study near Heidelberg revealed a similar pattern. Of 22 francolin trapped from June to August, 17 (77%) were infected. Of 30 francolins trapped in September and October, only 5 (17%) were infected. Of six francolin shot at Reitz, two shot in May (2001) had clear black warts behind their eyes. Four francolin were shot in August 2001, but only showed whitish exfoliating marks.

Of the 88 francolin that were infected, 81 (92%)
were found on the highveld and grasslands of Utrecht (Kwazulu-Natal). Seven (8%) infected francolins were found in the bushveld. In some bushveld areas like Dwaalboom and the Klaserie Game Reserve the populations were completely free of any signs. In the case of the Klaserie Game Reserve the 10 specimens were collected over a period of three years (from 1998 to 2001).

Other patterns of infection investigated included age and sex structure. The poxvirus lesions were found on both sexes. Of the 25 infected Swainson’s francolin sexed, 16 (64%) were adult female and nine (36%) were adult male (Table 1). Six (85.7%) of the seven francolin under the age of six months were slightly infected (Table 1). All of them had a soft, dark-coloured spot (0.3 × 0.3 cm) on the bare patches behind their eyes. These bare patches are naturally present in most francolin chick species after hatching. One chick, seven days of age, caught at Boons during 2000, had no apparent signs of infection. Three 4–6-week-old chicks, which were captive among domestic chickens on a farm near Boons, had wart-like growths with pus on their faces. All three died as chicks in captivity, which suggests that cross-infection between domestic chickens and Swainson’s francolin is potentially possible and dangerous.

Ninety seven (14.4%) of the 673 other bird species examined were terrestrial gamebirds, including helmeted guinea fowl (Numida meleagris), Coqui francolin (Francolinus coqui), crested francolin (F. sephaena) and Orange River francolin (F. levallantoides). A total of 133 (19.8%) waterfowl were examined, including white-faced duck (Dendrocygna viduata), Egyptian goose (Alopochen aegyptiacus), yellow-billed duck (Anas undulata), red-billed teal (Anas erythrorhyncha), Cape shoveller (Anas smithii) and spur-winged goose (Plectropterus gambensis). In addition, 443 (66%) doves and pigeons were examined, including rock pigeon (Columba guinea), red-eyed dove (Streptopelia semitorquata), Cape turtle dove (Streptopelia capicola) and laughing dove (Oena capensis). Only one Coqui francolin specimen (0.1%) had wart-like pox marks behind the eyes.

### Diagnoses

Macroscopically the pathological examination at ARC-Onderstepoort Veterinary Institute (Case reference No. 98/1536–98/1537) revealed heavy wart-like lesions behind and around the eye and at the base of the mandibles in two species. Heavy wart-like lesions were also found on the legs and especially on the feet. In two specimens focal bilateral wart-like lesions were found behind the eyes and were about 0.5 × 0.5 × 0.1 cm in size and slightly elevated. The third specimen revealed no macroscopically visible pathological lesions.

Microscopic examination revealed that the epidermal hyperplasia of the postorbital skin of two specimens contained intracytoplasmic inclusion bodies and hyperkeratoses, which is in accordance with a pox lesion. The skin area behind the eyes revealed an extensive region of granulation

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**Table 1.** Localities in South Africa where Swainson’s francolin specimens were shot or trapped to examine the prevalence of avian pox infection. Number, as well as age and sex structure, of specimens examined and infected are shown.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Specimens examined</th>
<th>Specimens infected</th>
<th>Males infected</th>
<th>Females infected</th>
<th>Young infected</th>
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</thead>
<tbody>
<tr>
<td>Klerksdorp</td>
<td>1</td>
<td>1</td>
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<td>3</td>
<td>1</td>
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<td>Potchefstroom</td>
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<td>1</td>
<td>1</td>
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<tr>
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<td>7</td>
<td>6</td>
<td>2</td>
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<td>33</td>
<td>21</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Magaliesberg</td>
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<td>7</td>
<td>1</td>
<td>3</td>
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<td>4</td>
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<td>Dwaalboom</td>
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<td>6</td>
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<tr>
<td>Klaserie</td>
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<tr>
<td><strong>Total (%)</strong></td>
<td>200</td>
<td>88</td>
<td>9</td>
<td>19</td>
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</table>
tissue, fibrous connective tissue and a large number of capillary blood vessels in the dermis. The wart-like lesions on the bare facial area revealed extensive areas with epidermal hyperplasia and hyperkeratosis, with clear eosinophilic intracytoplasmic inclusion bodies, typical of the Bollinger bodies of a pox lesion. The foot and leg lesions of both specimens revealed strong evidence of pox infection. Electron microscopic examination of the outgrowths on their feet revealed a great amount of virus particles that were slightly rectangular in shape (Joklik 1966). No virological growth studies were conducted and no indication was given as to which strain the virus belonged.

The radiological report (reference 006-08) revealed that the lateral aspect of the tibiotarsus/tarsometatarsus joints of one specimen contained uneven thickening of the soft tissue which is caused by the poxvirus. In this specimen there was some subchondral lyses of the adjoining joints. No solidified pus, necrotic foci or diphtheritic membranes or any other oral lesions associated with typical avian disease conditions were found in the mouth or pharynx of the 10 specimens examined in the field.

Severe infections
Specimens that were found with deformities that altered their bodily condition and/or behaviour were classified as severely infected. Only 11 (12.5%) specimens were designated to this group. Most of the infected birds were shot within approximately 1 km of free-ranging farm chickens. All the severely infected francolins were shot very close (30–200 m) to free-ranging chickens. These francolins were very weak flyers and only flew 10–20 m ahead of the wingshooters before being shot. Normally this flight distance is 30–40 m. All these birds were significantly undernourished, which is in accordance with observed captive and free-ranging quail in the U.S.A. (Poonacha & Wilson 1981). In one case the eyes of the francolin were covered by a wart, which effectively blurred vision. In three cases the warts and wounds on and below their feet would have prevented normal scratching. In two of these cases the upper mandibles were deformed. In one case the mandible was split along the upper curve and in the other case the upper mandible grew 1.5 cm past the lower mandible. In both cases the francolin would have found it difficult to feed normally. Based on spur length and general size all these specimens were relatively old.

DISCUSSION
Swainson’s francolin have decreased in number in the highveld during the past 18 years (Van Niekerk, pers. obs.; P.J. Viljoen, pers. comm.). Currently the causes of this decline are unclear, but avian pox infection should not be ruled out as a possible cause.

In many respects the symptoms of the poxvirus in Swainson’s francolin are similar to the typical symptoms of avian pox found in other birds (McFerran & McNulty 1993; Ritchie 1995). These include wart-like growths on the face, eyelids, legs and feet. The raised scabs are also commonly found in other birds. However, all the specimens of Swainson’s francolin examined for mouth or throat infections showed no such signs. This suggests that francolins do not commonly develop the diphtheritic or respiratory forms of the disease. However, this wet form of avian pox is lethal which might explain the absence of francolins with this form of the disease (Ritchie 1995).

No form of congestive conjunctivitis, commonly found in other bird species, was found in francolins (Blount 1947; Ritchie 1995). The typical cheesy growths associated with avian pox were sometimes present on the faces of francolins and on their feet between the toes. The virus also distorted the upper mandibles of francolins, as found in Cape turtle doves (Middlemiss 1961).

Two aspects of this present survey indicate that most francolins only contract a sub-lethal degree of infection. The population at Derby remained stable throughout a three-year period despite the observed infection prevalence being relatively high (Table 1). Furthermore, three distinctive forms of warts/marks were evident on the faces of infected francolins. The dark, soft colour under the skin probably indicates an early form of infection. This was the only form that was found in francolins younger than six months. The hard, elevated scabs (warts) indicate an advanced stage. Most francolins exhibited this stage, which has been described as highly infectious (Ritchie 1995). Third, the exfoliating of the whitish scabs probably indicates the start of recovery when the hard scabs fall off and some loss of normal pigmentation occurs. This seems to happen during late winter, the driest period of the year, with low numbers of vector mosquitoes present. However, in severe cases of infection (12.5% in this study), francolins will most probably succumb as a result of infection. This situation seems to be restricted to old francolins on the highveld.

Among terrestrial gamebird species studied to
date, Swainson's francolin seems to be highly vulnerable to poxvirus infection. A 44% morbidity of Swainson's francolin over a fairly large geographical area in South Africa is higher than the 1–8% morbidity for bobwhite and California quail in regions of Georgia and Florida, U.S.A. (Crawford 1986). A morbidity of 64% in a local population at Derby and 52% at Heidelberg (see Table 1) is significantly higher than the morbidity of 39% recorded for a local population of California quail in the U.S.A. (Davidson et al. 1980).

If there are mortalities in francolin populations on the highveld due to avian pox infection, the deficit is probably replenished through reproduction within the population (Van Niekerk, in press). The stability of the populations at Derby, Boons and Heidelberg over a three-year period demonstrates this possibility. It is suggested that some old francolins may become severely infected and perish while young francolins which are slightly infected do not perish as a result and could be fit enough to maintain an equilibrium through reproduction for a number of years. Decreased breeding in an affected localized population is not unlikely as it has been reported to happen in flocks of quails. In fact the stress of breeding behaviour may increase susceptibility to the disease (Ritchie 1995).

**Transmission of disease**

Poxviruses are concentrated in the wartlike or diphtheric lesions when these are formed, but during the preceding 7–10 days of viraeemia, high concentrations of viral particles circulate in the bloodstream, allowing transfer to other susceptible birds via biting insects or through needle passage (chicken pox and pigeonpox) (McFerran & McNulty 1993). The occurrence of lesions on the bare patch behind the eyes of Swainson's francolin could be the result of insect bites. These lesions were already present on francolin at an early age of a few months. The bare patch is one of the few places on the chick's body where the vector insect can reach the soft skin easily (Middlemiss 1961). Alternatively, poxviruses transmitted through biting insects could concentrate at fresh lesions in the oral mucosa after the viraemic phase, causing diphtheritic lesions.

The lesions on the legs of males could very well result from transmission of the virus during fights where open lesions are inflicted enabling the virus to penetrate, possibly viraematophagous insects or flies. Territorial fighting is common among males when they use their spurs during combat. The open scars are probably the most common site of entrance for the virus, which causes severe infection in older francolins as seen by their infected legs and feet. Ritchie (1995) also reported that territorial fighting seems to be an important route of poxvirus transmission in other gamebird species.

The absence of avian pox in Swainson's francolin prior to 1997 in the Magaliesberg area could indicate a general absence of avian pox in free-ranging farm chickens in the area as well as a period of lower poultry densities. The habit of Swainson's francolin to forage and scratch in farm manure dumpsites, in chicken pens and close to farmhouses could very well expose them to transmissible infection from farm chickens (Ritchie 1995). However, further research is necessary to isolate the virus and to typify it correctly to determine if chickens are responsible for the spread of the disease among francolins.

**Prevalence of the disease**

Why francolins contract the virus more often on the highveld than in the bushveld is a matter of speculation. The transmission of the virus from chickens is a possible scenario. Intensive poultry production farms have proliferated on the highveld, especially in the Gauteng region during the past 20 years. These operations are especially evident in and around Boons and Magaliesburg where poxvirus infection in Swainson's francolin was first discovered. Although there are free-ranging chickens on bushveld farms, these seldom wander far from the farmhouses due to predation. Some of the specimens found to be infected at Swartruggens, a bushveld area, could be due to contact with free-range farm chickens that were present during the shoot. However, in the Klaserie Game Reserve, the apparent total absence of the avian poxvirus could be due to the fact that no domestic birds have been permitted on the reserve since the establishment of the game reserve 30 years ago.

Swainson's francolin has extended its range considerably from an area which was formerly restricted to the bushveld north of the Magaliesberg in South Africa (Clancey 1965). Owing to grain production they have encroached onto farmland and became very common in most of the highveld region. Unlike the bushveld, the highveld has cold weather and less food during winter, especially when the fields have been harvested, ploughed and burned. Cover is also reduced to headland patches where the francolins congregate which
are ideal for infectious agents to find more hosts (Ritchie 1995). All these factors exert stress on the highveld birds, which could make them more susceptible to disease. Landowners can reduce these stress factors by assuring that enough edge cover remains alongside crops and by supplying supplementary food in gravity feeders during winter. Domestic chickens should be restricted to cages.

Swainson’s francolin seems less immune to the avian pox virus than waterfowl, doves, pigeons, and other game bird species. The absence of this virus in these birds suggests that Swainson’s francolin contracts a strain that does not affect them to the same extent. It could also be postulated that Swainson’s francolin might have acted as a reservoir host or even a ‘mixing vessel’ for a particular host/parasite selection process, or multiple infections with several poxvirus strains and resultant new strains that could affect close relatives such as Coqui francolin. Unlike guinea fowl and Orange River francolin, Swainson’s francolin forages and scratches around vleis and moist riverbeds. Their chances of being bitten by a vector mosquito are probably higher. The relatively large bare skin patches on the heads of the birds could make them more vulnerable to infection as featherless areas are prime areas for inoculation (Ritchie 1995).

The fact that Swainson’s francolin show symptoms of avian pox while other birds in these sampled areas are free of symptoms, strongly suggests that Swainson’s francolin could serve as an indicator species for poxvirus activity in wild birds in South Africa. Owing to its popularity as a sporting gamebird, Swainson’s francolin are sometimes translocated to replenish depleted populations. This survey reveals that translocation could be harmful to local populations or to other birds species in their new environment and that such movements should be carefully monitored until more research results are available.

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REFERENCES


