

*Case Report—*

**An Outbreak of Duck Virus Enteritis (Duck Plague)  
in a Captive Flock of Mixed Waterfowl<sup>A</sup>**

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**SUMMARY**

An outbreak of duck virus enteritis occurred in a flock of captive waterfowl composed of mallards (*Anas platyrhynchos*), black ducks (*Anas rubripes*), and Canada geese (*Branta canadensis*). Although all three species were housed together, morbidity and mortality were confined to the 227 black ducks and Canada geese, of which 180 died and the rest were left in a weakened condition.

Lesions are given for 20 black ducks and 4 Canada geese dying from DVE. In addition, both horizontal and vertical transmission are discussed as possible sources of the virus that caused this outbreak.

**INTRODUCTION**

During the first half of 1977, considerable deaths occurred among black ducks and Canada geese housed in a pen that also contained mallards. Symptoms, which were most apparent in black ducks, included excessive lacrimation, lack of egg production, greenish diarrhea, lethargy, and death.

By June of that year, total losses were 57 black ducks, 15 Canada geese, and 3 mallards. Since birds were dying more frequently and no resolution of the problem was apparent, the owner of the flock sought diagnostic assistance.

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## LABORATORY FINDINGS

The carcasses of 10 black ducks were submitted for examination. Gross lesions observed were epicardial hemorrhages, hemorrhages on the serosal surfaces of the vessels leading to and from the heart, hemorrhagic ("annular") bands in the intestinal tract, pale foci in the liver (approximately 1 mm in diameter), necrosis of the cloacal lining, and raised plaque-like areas in the esophagus. Many of these esophageal lesions were coalesced, giving the appearance of a diphtheritic membrane.

A search was conducted for a bacterial agent using uninhibited aerobic and anaerobic media and selective/enhancement systems for *Pasteurella*, *Erysipelas*, and *Salmonella* species; it was unsuccessful. Also negative were toxicological analyses of selective tissues for lead and arsenic and a screening test for insecticides and pesticides.

Histological examination of the livers revealed many areas of

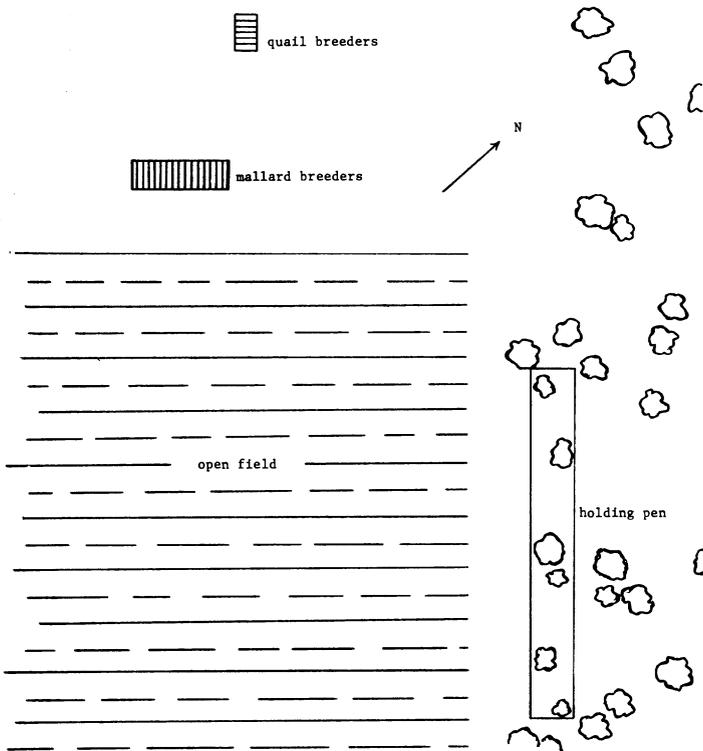


Fig. 1. Diagram of farm housing captive waterfowl and quail during a DVE outbreak. (Scale:  $\frac{1}{2}$ " = 80').

Table 1. Gross lesions of DVE in black ducks and Canada geese.

	No. examined	Epicard. hemorrh.	Liver foci	Esoph. plaques	GI bands (or discs)	Necrotic cloaca
Black ducks	20	10	6	12	4	5 <sup>A</sup>
Canada geese	4	2	3	3	0	3

<sup>A</sup>Only 9 ducks were examined for this lesion.

focal coagulative necrosis. Cowdry type-A intranuclear inclusions were seen in the degenerating hepatocytes surrounding these foci. Inclusions were also seen in the epithelial cells lining the bile ducts and in the mucosae of the esophagus and cloaca. In addition, the esophagus and cloaca had alternating areas of ulceration and swollen epithelial cells.

Day-old muscovy and mallard ducklings were inoculated with a homogenate made from livers taken at necropsy. The muscovies died within 4 days and had prominently inflamed annular bands in the intestinal tract and mucosal erosions at the proventricular/ventricular junction. The mallards survived unaffected for 10 days. A diagnosis of duck virus enteritis (DVE) was made on the basis of the history, gross and microscopic lesions, results of the duckling inoculations, and the lack of a pathogenic bacterial isolate.

Birds dying over the next 4 weeks were 10 additional black ducks, 4 Canada geese, 1 mallard hen, and 22 mallard ducklings hatched from eggs laid on the farm. Gross and microscopic lesions of DVE were found in only the black ducks and Canada geese. Specimens from all 3 species were sent to the National Wildlife Health Laboratory, Madison, Wisconsin, where DVE was diagnosed in both the black ducks and Canada geese by virus neutralizations in muscovy ducklings. No virus was detected in the mallards submitted.

In all, 20 black ducks and 4 Canada geese were examined that had gross lesions of DVE. Table 1 lists these lesions and frequency of occurrence.

#### EPORNITHOLOGY

This outbreak occurred on a farm that produced fertile eggs and offspring for research purposes. Three enclosures housed adult birds at the time of the outbreak (Fig. 1). Two held birds already in production: one held bobwhite quail, and the other 140 mallard breeders. Both were enclosed. The third was a holding pen that contained 841 pinioned birds not in production: 611 mallards, 192 black ducks, and 35 Canada geese. Of the 3 enclosures,

Table 2. Acquisitions of ducks and geese placed in the holding pen.

Date	Source(s)	Black ducks	Canada geese	Mallards	Cum. totals
Sept. 1976	A	192	35	-	227
Oct. 1976	A to B to local auction	-	-	163	390
Nov. 1976	local auction	-	-	76	466
May 1977	A	-	-	375	841
Totals		192	35	614	841

only the holding pen with the mixed waterfowl was ever known to be infected with DVE.

The holding pen measured approximately  $38 \times 270'$  and was encircled by a 4' fence. The sole source of water was a 4-inch-deep,  $4 \times 8'$  basin placed in the middle of the pen. The birds not only used the basin for drinking but attempted to swim and bathe in it as well. Placement was such that the holding pen was both downwind and down-grade of the other enclosures and separated from them by about 240' at the closest point.

The birds placed in the holding pen were acquired from various sources over an 8-month period (Table 2). The black ducks and Canada geese were purchased from out-of-state. Information accompanying the black ducks stated that they were the last offspring from a flock that was subsequently depopulated due to an outbreak of DVE. Most (538) of the mallards also came directly or indirectly (via intermediate owners) from the same supplier. The remaining 76 mallards were purchased at local auctions and believed to have originally come from several independent sources.

Table 3 shows losses in the holding pen due to mortality and depopulation. Deaths due to DVE continued until the end of September 1977, when the surviving black ducks and Canada geese were destroyed. By then, 152/192 (79.2%) of the black ducks and 28/35 (80.0%) of the Canada geese had died of the disease. (No percentage was computed for the 3 mallards that died from causes other than DVE.)

In February 1978, the farm was depopulated of waterfowl by destroying all mallards, including the 140 mallard breeders in the other pen. Although not known to have DVE, these birds were never tested by serology or virus isolation procedures. They were destroyed to preclude any possibility of their asymptotically harboring the virus or further infecting the farm. Following this, powdered lime was spread liberally over the ground and the pens were allowed to stand idle. After one month, the holding pen was

restocked with approximately 700 mallards. These birds, plus numerous others over the intervening years, passed through the pen without any recurrence of DVE.

Although this outbreak had the attention of several federal and state regulatory agencies, no official quarantine was placed on the farm. The only control measures were those exercised by the farm personnel: prompt removal and incineration of dead birds, and the wearing and disinfection of rubber boots.

#### DISCUSSION

Several findings associated with previous DVE die-offs were notably absent in this outbreak. These were serosanguinous discharges from the vent and nostrils of the dead birds, penile prolapse in males (3), and generalized hemorrhagic enteritis (7). Missing in the Canada geese were the hemorrhagic intestinal lymphoid discs often seen in this species (9).

Of the lesions seen, the plaques and diphtheritic-like membranes in the esophagus were encountered most frequently. There is some diversity in the literature over the frequency of this finding, especially in black ducks. Although early accounts mention only limited involvement of the esophagus (7,8,9), more recent reports list this as a common finding (5,10).

Canada geese have been mentioned in several DVE die-offs (4,6,7,9). However, the description of lesions in these reports, when given, usually was confined to individual birds.

The mortality pattern of the birds in this outbreak indicate a difference in the susceptibility to infection among the species at risk. The black ducks and Canada geese appeared to be equally susceptible, and much more so than the mallards. The most substantiative evidence for a differential species susceptibility comes from studies in which several species of waterfowl were chal-

Table 3. Cumulative mortality figures for ducks and geese in the holding pen during the DVE outbreak.

Bird type	Total stocked (9/76-5/77)	Deaths		Destroyed		Total stocked minus total dead/destroyed
		by 6/21/77	6/22-9/26	9/27/77	2/1/78	
Black duck	192	57	95	40	0	0
Canada goose	35	15	13	7	0	0
Mallard	614	3	0	0	611 <sup>A</sup>	0
Totals	841	75	108	40	611	0

<sup>A</sup>An additional 140 breeding mallards were killed on this date.

lenged with various DVE isolates. For example, the Wisconsin-73 strain (from Coloma, Wisc.), a strain initially isolated from black ducks, was highly pathogenic for muscovies and Canada geese, and nearly apathogenic for mallards (13). Additional support comes from reports comparing the susceptibility of mallards with that of black ducks (6,10) and Canada geese (2): the mallard was the species most resistant. Variation among species might also explain the authors' inability to reproduce the disease in mallard ducklings when initially trying to confirm the diagnosis using both mallards and muscovies.

The source of the virus that caused this outbreak could not be determined positively. The recent demonstration that ducks can shed the DVE virus for as long as 4 years (1) increased the difficulty of this task. Speculation, therefore, has to include several possibilities. Three will be discussed, of which the first two are forms of horizontal transmission.

1). It has been suggested that DVE is prevalent in free-flying waterfowl (4,10,12,14). If so, the virus may have been introduced into the pen via these birds. Maryland's Eastern Shore, where the farm was located, serves each winter as foraging grounds for large numbers of migratory waterfowl using the Atlantic Flyway. Although the birds in the holding pen were considered pinioned, a few were occasionally seen flying in and out of the pen, so they could have had contact with free-flying waterfowl.

2). The virus may have been introduced via infected individuals among the occupants of the pen. The source of most of the birds, and especially the black ducks, has the most incriminating background in this regard. The birds acquired locally are also suspect, as several cases of DVE have been diagnosed in this part of Maryland (R. M. Kocan, personal communication; L. N. Locke, personal communication; R. D. Montgomery and G. Stein, Jr., unpublished data). In fact, during this outbreak, several of the authors investigated a report that numerous muscovies had died on a nearby farm. Histological sections of the livers had intranuclear inclusions; DVE was suspected. Although the two farms were separated by only 5 miles, attempts to show any direct connection between them failed.

3). Possibly the most unusual feature of this outbreak is the chance that vertical transmission occurred via the black ducks placed in the pen. Although previously considered to be nonexistent for this virus, transovarial transmission has recently been demonstrated, for the first time, using 2 strains of DVE in 3 types of ducks (E. C. Burgess and T. M. Yuill, personal communication).

The black ducks involved in this outbreak, originating as they did from infected parents, may have introduced the agent.

Regardless of the method by which the virus gained access to the holding pen, once there, it seemed to spread quite easily among the birds. The limited supply of water, as has been mentioned (8,11), and the close confinement of the birds probably contributed to the ease of transmission.

One epornithological concern was that birds that survived this outbreak could infect migratory waterfowl visiting the area the following fall. In retrospect, this seems to be groundless: 3 years (and 3 migratory cycles) have passed without increases in the number of DVE cases locally or in the Atlantic Flyway.

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