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PREVALENCE OF SEROLOGIC TYPES OF *PASTEURELLA MULTOCIDA* FROM 57 SPECIES OF BIRDS AND MAMMALS IN THE UNITED STATES

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ABSTRACT: The serologic types of 265 isolates of *Pasteurella multocida* collected from 50 species of wild birds and seven species of wild mammals over a 22-yr period were determined with the gel diffusion precipitin test. Antigens prepared from these isolates reacted with reference *P. multocida* antisera representing serotypes 1, 2, 3, 4, 5, 6, 7, 8, 12, and 15. Antigens from some isolates reacted slightly with antisera from more than one serotype. Overall, gel precipitin reactions involving serotype 1 (65%) and 3 (20%) were the most prevalent.

INTRODUCTION

Pasteurella multocida infects many species of wildlife, producing pneumonia, hemorrhagic septicemia, and other infections in mammals (Rosen, 1981; Thorne, 1982) as well as cholera in birds (Rosen, 1971; Heddleston et al., 1972). Pasteurellosis can often have a devastating effect during periods of environmental stress, seasonal overcrowding, or predation, producing large epizootics in waterfowl (Zinkl et al., 1977), and other species of wild birds (Heddleston et al., 1972; Taylor and Pence, 1981) as well as mammals (Rosen, 1981; Thorne, 1982). Efforts to control these epizootics are often futile and consist mainly of picking up dead carcasses, destroying clinically ill animals, or harassing migrating species so that they move away from infected areas (Zinkl et al., 1977). However, studies on the serologic and immunologic characteristics of *P. multocida* have lead to successful prevention programs of pasteurellosis in wild mammals particularly the American bison (*Bison bison*) (Heddleston and Wessman, 1973) and other mammals in reserves (Rosen, 1971). Additional information on the serologic types of *P. multocida* from other species of wildlife may eventually lead to similar programs, especially as the number of endangered species increases.

Serology is used in the routine identification and taxonomic grouping of *P. multocida* (Blackburn et al., 1975) and can be used to determine relationships among isolates of different epizootics (Heddleston et al., 1972). This report compares the serological types of 265 isolates of *P. multocida* collected from wild animals from a variety of geographic sources over a 22-yr period.

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MATERIALS AND METHODS

Isolates were collected from 1960 to 1981 from samples (cultures and organs) sent to the National Animal Disease Center by various federal and state agencies as well as individuals investigating outbreaks of pasteurellosis or unusual deaths of birds and mammals. The 265 isolates were from 22 species of waterfowl (Table 1), 28 species of other birds (Tables 1, 2), and seven species of mammals (Table 3). Although these isolates have a variety of geographic origins, with no more than a few isolates from any one source, they are not valid statistical samples.

The gel diffusion precipitin test as described by Heddleston et al. (1973) was used to serotype the isolates. This test has been used successfully to serotype isolates of *P. multocida* regardless of the host species from which they were isolated (Blackburn et al., 1975). Standard antisera to each of the 16 serotypes of *P. multocida* were prepared as previously reported (Brogden et al., 1978).

RESULTS AND DISCUSSION

Antigens from the 265 isolates reacted with antisera prepared from type cultures of *P. multocida* representing serotypes 1, 2, 3, 4, 5, 6, 7, 8, 12, and 15. Antigens from some isolates reacted slightly with antisera from more than one serotype. Overall, gel precipitin reactions involving serotype 1 (65%) and 3 (20%) were the most prevalent.

The serotypes of 186 isolates of *P. multocida* from the 32 species of waterfowl, shore birds, wading birds, and gulls are presented in Table 1. Isolates associated with any reported epizootics of avian cholera are also shown. Precipitin

TABLE 1. Serotypes of *Pasteurella multocida* isolated from waterfowl, shore birds and wading birds, and gulls.

Species	Status[a]	Geographic location (year of isolation)	Number of isolations	Serotypes
Waterfowl				
Cygnus columbianus (Whistling swan)	F	California (1972)	1	1
	F	Wisconsin (1976)	1	1
	F	California (1980)	1	1
	U	California (1982)	2	1
	F	Wisconsin (1976)	1	3
Anser albifrons (White-fronted goose)	F	Nebraska (1975)[b]	1	1
	F	Nebraska (1976)	4	1
	F	Wisconsin (1976)	2	1
	F	California (1979)	2	1
Anser caerulescens (Snow goose)	F	California (1971)[c]	1	1
	U	California (1971)[c]	1	1
	F	Wisconsin (1976)	2	1
	F	California (1976)	2	1
	F	California (1977)	1	1
	C	California (1977)	1	1
	F	Iowa (1978)	4	1
	F	California (1978)	2	1
	C	California (1978)	1	1
	F	California (1979)	2	1
Anser rossi (Ross' goose)	F	Wisconsin (1976)	1	1
	F	California (1979)	2	1
Branta canadensis (Canada goose)	F	Utah (1971)	2	1
	F	Utah (1972)	1	1
	F	Utah (1973)	1	1
	F	South Dakota (1975)	2	1
	F	Missouri (1975)	1	1
	F	Nebraska (1975)	3	1
	F	Wisconsin (1976)	1	1
	F	Nebraska (1976)	1	1
	F	California (1977)	1	1
	F	Nebraska (1977)	6	1
	C	California (1978)	1	1
	F	California (1980)	1	1
	U	Missouri (1968)	1	3
Anas crecca (Green-winged teal)	F	California (1979)	1	1
	F	California (1980)	1	1
	F	California (1979)	1	3
Anas platyrhynchos (Mallard)	F	Utah (1972)	2	1
	F	California (1972)	1	1
	F	Utah (1973)	4	1
	F	Nebraska (1975)[b]	2	1
	F	Nebraska (1976)	9	1
	F	Wisconsin (1976)	3	1
	F	California (1976)	1	1
	F	California (1978)	1	1
	F	California (1979)	3	1
	F	California (1980)	2	1
Anas acuta (Northern pintail)	F	Utah (1972)	1	1
	F	Wisconsin (1972)	1	1
	F	Nebraska (1975)[b]	2	1
	F	Wisconsin (1976)	2	1
	F	Nebraska (1976)	4	1
	F	California (1978)	1	1
	C	California (1978)	2	1
	F	California (1979)	1	1
	F	California (1980)	2	1
	F	California (1978)	1	3
	F	California (1979)	1	3
Anas discors (Blue-winged teal)	F	Nebraska (1975)[b]	2	1
Anas clypeata (Northern shoveler)	F	Nebraska (1975)[b]	1	1
	F	California (1979)	3	1
Anas strepera (Gadwall)	F	Nebraska (1975)[b]	1	1
	F	California (1979)	1	1

TABLE 1. Continued.

Species	Status[a]	Geographic location (year of isolation)	Number of isolations	Serotypes
Anas americana (American wigeon)	F	Nebraska (1975)[b]	1	1
	F	California (1972)	1	1
	F	Wisconsin (1976)	3	1
	C	California (1977)	1	1
	C	California (1978)	1	1
Aythya valisineria (Canvasback)	F	Nebraska (1976)	2	1
	F	California (1976)	1	1
	C	California (1978)	1	1
	F	California (1979)	1	1
Aythya americana (Redhead)	F	California (1977)	1	1
Aythya collaris (Ring-necked duck)	F	California (1979)	1	1
Aythya affinis (Lesser scaup)	F	Nebraska (1975)[b]	2	1
	F	California (1976)	1	1
Somateria mollissima (Common eider)	F	Maine (1976)[d]	2	3
	F	Maine (1981)	4	3, 12
	F	Maine (1974)[d]	10	4, 12
	F	Maine (1981)	1	3, 4
	F	Maine (1982)	2	4
Clangula hyemalis (Oldsquaw)	F	Maryland (1970)[c]	1	1
Melanitta fusca (White-winged scoter)	F	Maryland (1970)[c]	1	1
Mergus merganser (Common merganser)	F	California (1979)	1	1
Oxyura jamaicensis (Ruddy duck)	F	Wisconsin (1976)	1	1
	F	California (1978)	1	1
	F	California (1979)	1	1
	F	California (1976)	2	6
Aechmophorus occidentalis (Western grebe)	F	California (1979)	1	1
Shore birds and wading birds				
Ixobrychus exilis (Least bittern)	F	California (1979)	1	1
Casmerodius albus (Great egret)	F	California (1979)	1	1
Egretta caerulea (Little blue heron)	F	Wisconsin (1976)	1	1
Gallinula chloropus (Common moorhen)	F	California (1979)	1	1
Fulica americana (American coot)	U	Missouri (1964)	1	1
	F	Wisconsin (1976)	1	1
	F	California (1976)	3	1
	F	California (1978)	2	1
	F	California (1979)	3	1
	F	Maryland (1975)	2	3
	U	Virginia (1975)	3	3, 4, 12, 15
	U	Maryland (1975)	1	3, 12, 15
Tringa melanoleuca (Greater yellowlegs)	F	California (1979)	1	1
Limnodromus scolopaceus (Long-billed dowitcher)	C	California (1978)	1	1
Gulls				
Larus canus (Mew gull)	U	California (1964)	1	1
	F	New York (1971)	1	7
Larus delawarensis (Ring-billed gull)	U	California (1982)	1	1
Larus argentatus (Herring gull)	U	Maine (1981)	1	3, 12
	F	New York (1971)	1	7

[a] F = Free-ranging, C = Captive, U = Unknown.
[b] Associated with an avian cholera epizootic (see Zinkl et al., 1977).
[c] Associated with an avian cholera epizootic (see Rosen, 1972).
[d] Associated with an avian cholera epizootic (see Korschgen et al., 1978).
[e] Associated with an avian cholera epizootic (see Locke et al., 1970).

reactions involving serotypes 1 and 3 were the most prevalent, occurring 81% and 10%, respectively.

Avian cholera in migratory waterfowl occurs primarily along the Central and Pacific flyways (Stout and Cornwell, 1976). Waterfowl isolates submitted from individuals in states in either of these two flyways were predominantly serotype 1. Occasionally epornitics of avian cholera occur in the Mississippi and Atlantic flyways (Stout and Cornwell, 1976). Waterfowl isolates submitted from individuals in states in the Mississippi flyway were predominantly serotype 1 whereas isolates submitted from the Atlantic

TABLE 2. Serotypes of *Pasteurella multocida* isolated from raptors, columbiforms, passeriforms and gallinaceous birds.

Species	Status[a]	Geographic location (year of isolation)	Number of isolations	Serotypes
Raptors				
Haliaeetus leucocephalus (Bald eagle)	F	California (1971)[b]	1	1
	F	Iowa (1978)	1	1
Buteo jamaicensis (Red-tailed hawk)	U	California (1982)	1	1
Falco sparverius (American kestrel)	F	California (1979)	1	1
Falco mexicanus (Prairie falcon)	C	California (1980)	2	1
Otus asio (Eastern screech owl)	F	Massachusetts (1966)[c]	1	3
	C	South Carolina (1974)	1	3
Nyctea scandiaca (Snowy owl)	F	Wisconsin (1976)	1	1
Athene cunicularia (Burrowing owl)	U	California (1982)	1	3, 4
Columbiforms				
Columba livia (Rock dove)	F	Kansas (1967)	1	5
Passeriforms				
Corvus brachyrhynchos (American crow)	F	Nebraska (1975)[d]	7	1
Turdus migratorius (American robin)	F	Massachusetts (1965)[c]	1	3
	U	Massachusetts (1965)[c]	1	3
	F	Massachusetts (1966)[c]	2	3
	F	Massachusetts (1965)[c]	1	3, 12
Mimum polyglottos (Northern mockingbird)	C	South Carolina (1974)	1	5
Sturnus vulgaris (European starling)	F	California (1979)	1	1
	F	Massachusetts (1965)[c]	2	3
	F	Massachusetts (1967)[e]	1	3
	F	Massachusetts (1967)[e]	2	3, 4
	F	Massachusetts (1967)[e]	1	6
	F	Massachusetts (1967)[e]	1	8
Passerculus sandwichensis (Savannah sparrow)	F	Maine (1981)	1	3, 12
Carduelis pinus (Pine siskin)	U	Massachusetts (1967)[e]	1	8
Coccothraustes vespertinus (Evening grosbeak)	F	Massachusetts (1966)[c]	1	3
Passer domesticus (House sparrow)	U	Missouri (1974)	1	3
Gallinaceous birds				
Phasianus colchicus (Ring-necked pheasant)	F	Massachusetts (1966)[c]	1	3
	C	Iowa (1973)	1	3
	U	California (1975)	2	3
	F	California (1980)	1	3
	F	Kansas (1981)	1	3
	U	New York (1962)	1	3, 4
	C	California (1975)	1	3, 12
	C	California (1976)	1	4, 12
	C	California (1980)	2	4, 12
	U	California (1979)	4	7, 12
Meleagris gallopavo (Wild turkey)	C	South Carolina (1970)	2	3
	C	South Carolina (1970)	2	5

[a] F = Free-ranging, C = Captive, U = Unknown.
[b] Associated with an avian cholera epizootic (see Rosen, 1972).
[c] Associated with an avian cholera epizootic (see Faddoul et al., 1967).
[d] Associated with an avian cholera epizootic (see Zinkl et al., 1977).
[e] Associated with an avian cholera epizootic (see Heddleston et al., 1972).

flyway involved predominantly serotype 3 or serotype 4.

The serotypes of 55 isolates from 18 species of raptor, columbiform, passeriform and gallinaceous birds and their association with epizootics of avian cholera are presented in Table 2. Again, precipitin reactions involving serotypes 1 and 3 were the most prevalent, occurring 27% and 47%, respectively. A greater diversity of serotypes was observed among these isolates than among isolates in Table 1 and several reacted with antiserums to serotypes 5, 6, 7, and 8.

When isolates from wild birds were compared by region, no obvious relationships were found between the serotype and geographic area from which they were sent. Isolates from shorebirds, wading birds, and gulls had serotypes similar to those of waterfowl in their area. This

TABLE 3. Serotypes of *Pasteurella multocida* isolated from mammals.

Species	Status[a]	Geographic location (year of isolation)	Number of isolations	Serotypes
Lagomorpha				
Sylvilagus floridanus (Eastern cottontail)	F	Pennsylvania (1972)	1	1
Rodentia				
Ondatra zibethicus (Muskrat)	F	California (1972)	1	3
Carnivora				
Ursus americanus (Black bear)	F	Montana (1966)	1	4, 7, 12
Callorhinus ursinus (Northern fur seal)	U	Oregon (1973)	1	3
Zalophus californianus (California sea lion)	U	Unknown (1966)	1	1
	U	Unknown (1966)	1	3
	U	Rhode Island (1980)	3	3
	U	California (1980)	2	3, 4
Artiodactyla				
Antilocapra americana (Pronghorn)	F	Montana (1966)	2	1
Bison bison (Bison)	C	Michigan (1979)	1	1
	F	Montana (1954)	1	2
	F	Montana (1956)	1	2
	F	Montana (1966)[b]	3	2
	U	Unknown (1977)	2	2
	U	Michigan (1980)	2	2
	F	Montana (1966)	1	3, 4

[a] F = Free-ranging, C = Captive, U = Unknown.
[b] Associated with an epizootic of pasteurellosis (see Heddleston et al., 1967).

seems reasonable, for these birds share the same ecological habitat. Isolates from predatory, columbiform and passeriform birds had a wide variety of serotypes including types 1, 3, 4, 5, 6, 8, and 12. Isolates from gallinaceous birds listed in Table 2 were predominantly serotype 3 (53% of 19 isolates).

The serotypes of 24 isolates from mammals are presented in Table 3. These isolates had a variety of serotypes that included types 1, 2, 3, 4, 7, and 12. Twenty-three isolates involved either type 1 (22%), type 2 (39%), or type 3 (39%). When these isolates were compared, no relationships between species, serotype, and geographic area from which they were sent were apparent.

Control of pasteurellosis in wildlife is aimed at preventing transmission and depends upon the scope of the epizootic (Rosen, 1981). While immunization of free-ranging mammals and migrating birds is not practical, vaccination of captive animals and endangered species becomes promising in view of recent work involving cross-protecting vaccines. Previous *P. multocida* vaccines did not protect wildlife from different serotypes, making immunization of questionable value (Thorne, 1982). However, new research on a preparation that provides protection between the predominating serotypes (1 and 3) in this study has been done (Brogden and Rimler, 1982) and may be promising in certain cases.

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