A REVIEW OF PATHOGENS OF AGRICULTURAL AND HUMAN HEALTH INTEREST FOUND IN BLACKBIRDS

LARRY CLARK, U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, Fort Collins, CO 80521

ROBERT G. MCLEAN, U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, Fort Collins, CO 80521

Abstract: Because of their numbers and close association with humans and agriculture, the role of blackbirds in disease transmission has been of concern. Unfortunately few systematic and quantitative studies have been carried out that bear on this issue. We review the extant literature on zoonoses and pathogens of agricultural concern where there is documented evidence for the involvement of blackbirds and starlings. It is clear that blackbirds can exacerbate levels of risk for failures in agricultural biosecurity and human health. To what degree these levels of risk are raised is largely unknown and should be the focus of future studies because this information will prove vital in the assessment of management options.

Key words: agricultural biosecurity, blackbirds, disease, pathogens, starlings, wild birds, zoonoses.

Because of its economic importance, the most detailed information about avian disease is derived from the poultry and pet industries. The primary concerns in these industries are to understand the etiology of disease, prevent infection, and develop effective treatments. The study of wildlife disease has primarily focused on how pathogenic agents impact the health of individuals and wildlife populations. The emphasis on treatment is understandably of less focus given the difficulty in treating a temporally and spatially diffuse noncompliant population. However, understanding the factors that would lessen infection rates, has been of concern, e.g., habitat management to reduce risk of conditions that promote exposure to avian botulism. Lists of avian pathogens are readily available (American Association of Avian Pathologists 1998, Friend and Franson 1999). The focus of this paper is to report on those pathogens that are of zoonotic or domestic animal health concern, and where blackbirds have been implicated as a reservoir or involved in disease transmission.

It is clear that the relationship between wild birds and domestic stock in disease transmission is not intensively studied. However, there are a sufficient number of studies to indicate a relationship exists. What remains to be documented is the contribution and economic importance of wild birds to domestic livestock and poultry disease.

Generally, the producer is concerned with risks contributing to mortality, morbidity, decreased growth and feed conversion efficiency, and costs of medication. Where information is available each of these considerations is elucidated for each disease considered. We have not endeavored to list all diseases of zoonotic or animal health concern, principally because the role of blackbirds in transmission is not known. However, absence of reporting should not be construed that a potential relationship does not exist. Rather, it reflects an absence of credible research on the topic.

BACTERIAL DISEASES

Bovine Tuberculosis (TB).—The most common infectious disease of cattle, bovine TB caused by *Mycobacterium bovis*, has been nearly eradicated in the United States. However, endemic areas are still affected and eradication has proved difficult. Wildlife, especially white-tailed deer (*Odocoileus virginianus*) have been implicated as a host-reservoir system that can serve as a source for reinfection of cattle herds. Birds also may be involved in the disease transmission cycle of *M. bovis* (Butler et al. 2001), but their relative importance in not well established. Starlings (*Sturnus vulgaris*) and American crows (*Corvus brachyrhynchos*) were experimentally challenged (intraperitoneally and orally) with *M. bovis* (1×10^5 cfu) derived from a white-tailed deer. The birds developed lesions consistent with mycobacteriosis. Shedding was not studied. Once bovine TB has been identified in cattle, the USDA recommends herd destruction to insure local eradication. Given the significant economic impact of this practice, it is critical to minimize transmission risks associated with contact with free-ranging wildlife, including birds.

Chlamydiosis.—Avian chlamydiosis was originally called "parrot fever." However, recent studies have shown that "parrot fever" and ornithosis are the same disease manifested in different species and are all caused by the bacterium, *Chlamydophila psittaci* (Andersen and Vanrompay 2000). Chlamydial infections have been identified in more than 150 species of wild birds (Burkhart and Page 1971, Brand 1989). Generally, these wild birds are asymptomatic. Bacteria are shed sporadically in nasal secretions and feces. Although the natural host reservoir systems are unknown, its wide occurrence in wild bird populations and the intermittent infections of farm stock are consistent with exposure to wild birds. Sporadic shedding was seen in experimentally inoculated great-tailed grackles (*Cassidix mexicanus*) and brown-headed cowbirds (*Molothrus ater*), indicating their potential as host-reservoir systems (Roberts and Grimes 1978). The most probable risk to farm stock and poultry is when wild birds gain access to feed bins and contaminate the bins with their feces. Infection usually occurs through exposure to contaminated aerosol dusts (Page 1959). Turkeys can become infected by exposure to starlings, common grackles (*Quiscalus quiscula*) and brown-headed cowbirds (Grimes 1978, Grimes et al. 1979). Serovars D and E can result in 50-80% morbidity and 5-30% mortality in turkeys (Andersen 1997). In ducks the economic impact is also significant, with morbidity and mortality ranging from 10-80% and 0-30%, respectively (Andersen et al. 1997). Infections to mammalian farm stock can also be a cause of health and economic concern (Shewen 1980). Wild avian strains also can infect mammals, including humans, and can cause severe disease or death (Andersen and Vanrompay 2000).

Johne's Disease.—Johne's disease is caused by *Mycobacterium avium* subsp. *paratuberculosis*, (MAP). This disease costs the United States dairy industry an estimated $200-250 million annually due to lost milk production, treatment, and culling (Ott et al. 1999). At the herd level, economic losses per cow per annum are $200 inclusive of lost production of 700 kg of milk per cow per annum (Chiodini et al. 1986, Ott et al. 1999). Moreover, the impact of Johne's disease is not restricted to the United States. Other countries report decreased dairy production and lost export opportunities attributable to infection (Zhilinskii et al. 1986, Gill 1989, VanLeeuwen et al. 2002). Prevalence of a diversity of *M. avium* strains in wild bird populations is high (Tell et al. 2001), and it has been shown that wild birds can infect cattle with MAP (Matthews and McDiarmid 1979, Collins et al. 1985). While *M. avium* has been isolated from starlings (Bickford 1966), it is not generally known what role blackbirds have in carriage and infection of cattle herds. However, a variety of epidemiological studies have concluded that wild birds associated with dairies are a high risk factor for dissemination (Viallier et al. 1975, Morita et al. 1997) and infection of cows with MAP (Nechval and Sviridov 1980, Keymer 1997).

Avian Cholera.—Birds usually acquire the bacteria (*Pasteurella multocida*) by ingesting contaminated food or water and the disease can result in explosive outbreaks in free-ranging birds, primarily in waterfowl, and historically in poultry flocks (Friend and Franson 1999). Improvements in husbandry practices in the poultry industry have greatly reduced the disease incidence and the exposure of free-ranging birds previously associated with poultry operations. Blackbirds nesting and roosting in wetlands with dense aggregations of waterfowl that experience outbreaks are at increased risk of acquiring disease but are minor in importance in comparison to waterfowl disease.

Salmonellosis.—Avian salmonellosis (*Salmonella typhimurium* and *S. gallinarum*) occasionally occurs in blackbird species throughout the United States primarily at sources of environmental contamination and is an emerging disease in suburban/urban environments associated with bird feeding stations (Friend and Franson 1999). Improved poultry production operations have nearly eliminated the interaction of infected free-ranging starlings and grackles with poultry species.

VIRAL DISEASES

West Nile Virus (WNV).—WNV is a *Flavivirus* that emerged in North America in 1999. Since its emergence WNV has spread throughout the eastern, central, and mountain regions of the United States. As of December 2002 there have been 14,045 equine cases of WNV (U. S. Department of Agriculture [USDA] 2002). There have been 3,737 reported human cases with 214 deaths during 2002 (Centers for Disease Control and Prevention 2002). Although the data are not available, earlier indications from fall banding stations suggest that WNV may have had a devastating impact on migratory bird populations. Thus, WNV represents a serious threat to natural resources, agriculture, and human health.

WNV is a mosquito-borne disease that uses birds as its primary vertebrate hosts. Data are unavailable as to which species are most importantly involved as the reservoir and what species are critical for amplification and geographic spread of the virus. It is conceivable that various species play different roles in the dynamics of the disease. Few data are available that can be used to rank avian susceptibility to the disease, or any other information about the dynamics of infection. However, a few studies have begun to elucidate the natural history of the pathogen (Komar et al. 1999, Hodgson et al. 2001). Starlings, red-winged blackbirds (*Agelaius phoeniceus*), and grackles have all been found virus positive (Bernard et al. 2001) and all exhibit high viremias post infection (Komar et al. 1999) indicating they are reservoir competent hosts to infect mosquitoes and

thus perpetuate transmission. These species, because of their movement patterns and population sizes might be important in continental movement and local exposure of WNV to farm stock and humans (McLean et al. 2001, 2002).

Other Mosquito-Borne Viruses.—Red-winged blackbirds, Brewer's blackbirds, cowbirds, grackles, and other species are susceptible to and are natural hosts for other mosquito-borne viruses (St. Louis encephalitis and western equine encephalitis WEE) of public health and domestic animal health importance in the western United States (Reeves and Hammon 1962, McLean and Bowen 1980). Both viruses are significant pathogens for humans causing morbidity and mortality annually. Only WEE virus causes disease in equines, although the frequency of disease has been greatly reduced through vaccination.

Newcastle Disease.—This, and other paramyxovirus types are highly infectious and widespread in birds (Kaleta and Baldouf 1988). Poultry are particularly susceptible to the potentially devastating effects of Newcastle disease. However, in North America, vaccination of commercial poultry operations and biosecurity measures (i.e., isolation of poultry flocks from free-flying birds) limits the impact of this disease on the poultry industry. Nonetheless, barring these safeguards, this disease remains a serious threat to poultry production. Waterfowl are of primary concern as sources of the disease. In general passerines present a low risk to infect poultry flocks, though Newcastle disease was isolated from starlings in Israel (Lipkind et al. 1987). Red-winged blackbirds shed very little virus and developed only low antibody titers suggesting minimal role in disease transmission (Vickers and Hanson 1979). Blackbirds can become infected with several paramyxoviruses, including Newcastle disease, by exposure to aerosols, but not from eating contaminated food or water (Vickers and Hanson 1980). A survey of 387 sera from red-winged blackbirds and tricolor blackbirds failed to detect exposure to Newcastle disease (Vickers and Hanson 1980).

FUNGAL DISEASES

Histoplasmosis.—This is a zoonotic fungal disease of the lungs caused by *Histoplasma capsulatum*. Persons affected by the pathogen develop respiratory symptoms, general ill feeling, fever, chest pains, and a nonproductive cough. People at highest risk of exposure are those working in agriculture, particularly poultry, or coming in contact with bird and bat roosts. Infants, young, and the elderly with chronic respiratory problems are at highest risk for severe disease. Chronic infection can result in permanent lung damage. People with HIV are most susceptible to the disseminated form of the illness, which can prove fatal (http://www.cdc.gov/ncidod/dbmd/diseaseinfo/histoplasmosis_t.htm).

The accumulated feces at bird roosts has long been known to be a risk factor in human infection by *Histoplasma*. Humans disturbing the soil at blackbird roosts become ill with histoplasmosis (DiSalvo and Johnson 1979, Storch et al. 1980). Soil studies indicate that viable particles of *H. capsultatum* persist over long periods of time (9-13+ years, DiSalvo and Johnson 1979). Moreover, residents living near roosts (1.5-20 km) and who are long-term inhabitants of the affected area show positive histoplasmin skin tests or become ill (DiSalvo and Johnson 1979, Latham et al. 1980, Chick et al. 1981). Even incidental exposure to old blackbird roosts can result in illness. Eighty-one percent (n=85) of participants in a wagon train excursion in Tennessee showed evidence of infection with *H. capsulatum*. The source of the infection was traced to the soil of a park that had been built on a blackbird roost 5 years earlier (Gustafson et al. 1981).

PARASITIC DISEASES

Lyme Disease.—Bird-feeding *Ixodes dammini* ticks can successfully molt and transstadially pass *Borrelia burgdorferi* spirochetes to mammals, including humans (Anderson et al. 1990). The importance of birds in disease transmission in suburban environments was illustrated by Battaly and Fish (1993). Taking into account the population density of wild bird species and their value as a host for immature *I. dammini*, these authors concluded that the American robin (*Turdus migratorius*), common grackle, and house wren (*Troglodytes aedon*) were high risk species of concern for human health. Free-living birds are implicated in the circulation of *B. burgdorferi* principally as disseminators of infected ixodid ticks to new areas (Hubalek et al. 1996), however, *B. burgdorferi* spirochetes were isolated from birds in rural environments in Wisconsin (McLean et al. 1993) and South Carolina (Durden et al. 1997) indicating their importance in disseminating the disease as well in local maintenance.

Equine Protozoal Myeloencephalitis (EPM).—This is the most common neurologic disease of horses and is caused by the parasite *Sarcocystis neurona*. The disease causes neural degeneration producing symptoms of weakness, muscle atrophy, and ataxia. Approximately 70% of the cases (220,000 in 1998) improve with therapy, but less than half of the horses return to normal function. Based on a 1998 USDA National Animal Health Monitoring System survey it was estimated that EPM resulted in an annual incidence of 0.14 events/100 horses with a fatality rate of 4.7%. The estimated lost use per event was 244 days. The economic costs were estimated to be $16 million in lost use, $11 million in veterinary services, e.g., diagnosis

and treatment, and $1 million in losses owing to death (USDA 2002).

Parasite life-history studies have shown that *Sarcocystis* spp. are parasites that cycle between the definitive opossum host (*Didelphis virginiana*) and a variety of avian intermediate hosts, e.g., brown-headed cowbirds and common grackles (*C. mexicanus* and *Q. quiscula*) (Duszynski and Box 1978, Mansfield et al. 2001). Opossums become infected by scavenging or preying upon birds, and horses become infected by eating food or drinking water contaminated with opossum feces containing the sporocysts. Dame et al. (1995) showed that the DNA from *S. falcatula* sarcocytgs in brown-headed cowbird muscle was identical to *S. neurona*, indicating that these are the same organism and that the parasite cycle between the opossum and cowbird is sufficient to maintain a reservoir from which horses can be infected. Luznar et al. (2001) showed that experimentally inoculated brown-headed cowbirds were infectious to opossums up to 40 weeks post-inoculation, indicating that cowbirds can be a source of infection at both extremes of their geographic migratory range.

Toxoplasmosis.—Toxoplasma gondii is a common single-celled parasite responsible for infection of more than 60 million people in the United States each year. Infection can be acquired via hand to mouth contact with feces, contaminated soil, or raw meat. In most cases, the hosts' natural immune system clears the disease and most healthy humans are rarely aware that they are infected. Symptoms include flu-like symptoms and swollen joints and fatigue. However, people with impaired immune systems, embryos, and neonates are particularly venerable to severe consequences of infection, e.g., eye and brain damage. Birds are included in the extensive list of wildlife species implicated as carriers of this parasite (Dubey 2002). However, infectious strains of Toxoplasma should be noted. Rats inoculated with heart and brain from infected starlings did not test positive for Toxoplasma (Haslett and Schneider 1978). Starlings were infectious to mice in England. Human populations can be affected by exposure to roosts (Peach et al. 1989).

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