adult plumage. One would certainly expect that at least half of the individuals of an average flock in September and October would be birds of the year, and since all were in adult plumage, the postjuvenal molt must have been complete by that time for the particular flock observed. It therefore appears to me that the individual under consideration, No. 55-127606, is a bird from a rare second brood, a second attempt to rear a brood or from a very late first nesting.

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BIRDS AND SOME HUMAN DISEASES

BY ELIZABETH M. BOYD

The subject of birds and some human diseases may be grouped under four subheadings: ectoparasites of birds attacking humans; the indirect effect of birds on certain human diseases; birds as biological distributors of specific human diseases; and lastly birds as successful experimental animals in the investigation and control of human diseases.

The ectoparasites of birds that may attack man are blood-suckers that exhibit, to a varying degree, slight host specificity. Some species of mosquitoes prefer avian blood to that of human, but if necessary will resort to *Homo sapiens* for their blood meal. Similarly bedbugs, and occasionally fleas, if stranded by the southward departure of their hosts for the winter, have been known to leave nests of swallows or swifts and invade houses and molest people in their search for a food supply. Disturbance of their homes often results in their attacks on the human intruders. Added to the discomfort that they may cause is always the danger of infection, for any break in the skin acts as a portal of entry for bacteria, especially if augmented by irritation. Chicken and related blood-sucking mites may be the cause of another type of irritation to man. Poultry-keepers working in mite-infested hen houses often discover tiny creatures, mites, crawling over their hands and up their arms. Repeated exposures to these mites may result in an allergic reaction in the form of an uncomfortable skin rash on the person.

"Swimmer's itch" may be classified under this subheading but only as an appendix since it is due to the presence not of an ectoparasite but of the immature stage of a parasitic worm, a non-human blood-fluke. This skin rash or schistosome dermatitis is also an allergic response to repeated infections. These schistosome flukes live as adults in the blood of birds and other animals, but pass their immature stages in snails. The larva escapes from the snail into the water and bores its way into the skin of its final host. If these immature stages accidentally enter the wrong animal, for example man, they will wander aimlessly

in the skin until they die, unable to develop further, but meanwhile setting up an unpleasant rash. Cases of schistosome dermatitis from avian blood-flukes are known from several inland lakes and recently from ocean beaches of both eastern and western United States. Outbreaks are frequently seasonal, occurring in spring and fall, and correspond with the presence of migratory birds such as ducks and shorebirds.

The indirect role that birds may play in human diseases is evident with Rocky Mountain Spotted Fever. This fever occurs only in man, though the micro-organism that causes it, *Rickettsia rickettsii*, is present in a wide variety of animals. Transmission has now spread to several species of ticks, whereas previously the wood tick, *Dermacentor andersoni*, was the sole vector. It is not pathogenic to ticks, which pass on the rickettsiae to their eggs, so that on hatching the larvae will harbor the organism. The immature stages, larvae and nymphs, feed mainly on rodents, but ground-nesting birds may also act as hosts. These in turn are a source of infection to non-infected immature ticks that derive their blood meal from them. Thus many animals and some birds form a natural reservoir for Rocky Mountain Spotted Fever. In the same manner, birds may act as reservoirs of plague, since on occasion some rodent and avian fleas will infest bird and rodent hosts respectively.

Birds are important as biological distributors for several specific human diseases, the best known being Psittacosis. In each case, the disease-producing organism lives and multiplies in the body of the bird. Psittacosis is caused by a relatively large virus, *miyagawanella psittaci*, resident both in body cells and free in the host, particularly the intestinal region. It appears to be especially prevalent in parrots and related birds; the disease from this source is called parrot fever. The term ornithosis is given to cases from other infected birds such as ducks, grouse, pheasants, chickens, pigeons, English sparrows, finches and canaries. Many birds show no apparent symptoms and merely act as carriers. However, under poor conditions that may result during shipment or from over-crowding in pet shops, individual birds may get sick as their antibody production becomes curtailed. The virus readily escapes in the nasal secretions and droppings of the bird, and it does not succumb to desiccation. Thus transmission to man is not just by direct contact when handling contaminated birds or from their bites, but also by inhalation of the air-borne virus through the preening habit and wing flapping of the animal. There have been a few cases of direct infection from person to person.

After a one to two weeks incubation period, chills and fever develop with a temperature of 103° to 105°F, remaining high for one to three weeks. This is accompanied by headache and dry cough. The symptoms are similar to influenza, typhoid or pneumonia, lung lesions being characteristic. The mortality rate is low in people under thirty and has been greatly decreased with the use of the broad spectrum antibiotics; chloretetracycline has proved most effective. Unlike typical pneumonia cases, it is not readily arrested by penicillin treatment.

The epidemics of 1929 and 1930, when the fatality rate reached 20 percent, led to the restrictions on the importation of psittacine birds

and their interstate shipment. As a result the disease became quite rare with an annual incidence of around 22 reports. With the discovery that the virus is not confined to parrots and related birds, but can be lodged in domesticated birds including ducks, the ban on interstate traffic was somewhat eased. At the same time, the aftermath of World War II brought an increase in popularity for parakeets as pets. As a consequence psittacosis is on the increase, with 135 cases reported for 1952 and 444 for 1954. Evidence that resistance is lowered with age is seen in the 1956 annual report (in the J.A.M.A.), referring to a Chicago family of twelve. Psittacosis developed in both parents and the two eldest children aged 18 and 16, and it proved fatal to the father; whereas the eight younger children showed no symptoms though the antibody was recovered from the ten-year-old child. Epidemics sometimes occur in poultry processing plants, for example in a turkey processing plant reported from Texas in 1955, and in 1957 in a Pennsylvania plant that deals in ducks, turkeys, geese, pigeons, and chickens, when twelve of the 89 employees suffered from ornithosis.

Equine and St. Louis Encephalitis are due to small viruses that inhabit wild and domesticated animals, primarily birds, but they appear not to suffer from such infections. The latter occurs only in man; the former attacks both horses and man. Ectoparasites are involved in some way in their transmission; these include mites, ticks and especially mosquitoes. It is known that the virus can be passed on from adult mites to their eggs.

After a short incubation period, the symptoms consist of a high fever, muscular twitchings and convulsions when the nervous system becomes affected and this may lead to a state of coma. There is no known treatment. Outbreaks are seasonal, occurring between August and October, and are localized to swampy districts, the breeding territory of mosquitoes. This late summer period is correlated not only with the peak in numbers of mosquitoes but also with the gathering in flocks of roosting and migratory birds. The 1955 St. Louis Encephalitis epidemic in the Ohio River Valley, when 96 human cases were involved, coincided with the presence of huge flocks of migrating starlings.

Eastern Equine Encephalitis was first recorded in 1933 in Massachusetts and has been reported from the following states: Alabama, North and South Carolina, Connecticut, Florida, Louisiana, Massachusetts, Michigan, New Jersey, Rhode Island; and from Canada, Mexico, Panama, Cuba and South America. Mortality in horses may run as high as 60 to 90 percent. There is a relatively high fatality rate in man, especially in older people.

During the 1938 outbreak in Massachusetts there were 25 deaths among the 38 infected persons. The 1955 epidemic near Taunton involved only horses, but in 1956 in the vicinity of Boston 38 horses were affected and 7 of the 12 humans that suffered from it died. Under the able direction of Dr. Ralph Wheeler[1] a 3-year survey has been undertaken for the presence of the virus in local animals in this state.

[1]In addition to Dr. Richard Hayes, Eastern Equine Encephalomyelitis Laboratory, Taunton.

For 1953 and 1956, 110 birds representing 27 species harbored the virus out of a total of 296 birds examined, approximately 40 percent incidence. Mammals proved negative; however, for 1957 two pigs showed the only positive findings; all the birds lacked any evidence of the organism in 1957.

Toxoplasmosis is a less well-known disease. Though it has been recognized for some 50 years, it has only recently been accepted as a human disease. It is caused by a protozoa, *Toxoplasma,* in the same class as the malarial organism. It is small, crescentic in shape, and forms a pseudocyst resistant to desiccation. This protozoan is non-specific as to the nature of the cells and the kind of hosts it invades. Numerous animals have been found to harbor *Toxoplasma,* including rodents, canines, cattle, and monkeys among mammals, and pigeons, chickens, English sparrows, song sparrows, and canaries among birds. The precise method of transmission is unknown, though it may be through oral and intranasal contamination, and ectoparasites such as ticks, horse flies, and mosquitoes may play a role. The suggestion that infection can occur through the consumption of poorly-cooked, contaminated pork is based on feeding infected meat to experimental animals. In addition certain cases have been proved to be congenital in origin, and one German researcher has postulated that the disease may account for some cases of Mongolism. Toxoplasmosis brings about an inflammatory condition of the eye and, in children, various manifestations of encephalomyelitis. A person, however, may lack all symptoms and still give a positive antibody reaction. Sulfadiazine and emetine hydrochloride are successful in treatment.

Salmonellosis or food poisoning is due to a bacteria, *S. typhimurium.* It is prevalent in the intestinal flora of birds and may be passed on to their eggs. Transmission to man is oral. The more usual method is through eating insufficiently cooked contaminated eggs, though during the war there were reports of salmonellosis following the consumption of contaminated egg powder. It is possible to contact the disease through handling infected birds. Thus in 1954 the 29 cases of food poisoning recorded for Minnesota came from the purchase of Easter chicks from two supermarkets, which had obtained their supply from the same chick hatchery. Treatment consists of administration of antibiotics such as chloramphenicol.

The fourth and last category, unlike the preceding three where birds play a detrimental role in human diseases, illustrates how birds are instrumental in providing valuable tools in the investigation and control of certain human diseases. The discovery of the life history of the malarial organism was based on avian malaria. Sir Patrick Manson had postulated that the organism entered the mosquito when it took a blood meal from an infected person, and there it formed spores. The spores were released into the water on death of the mosquito and man became infected through drinking this water. With his encouragement, Sir Ronald Ross finally proved the cycle in the mosquito for bird malaria in 1898. Similarly the complete story in the vertebrate host was first worked out in birds, for it was years before it was discovered where the organism disappeared to during the first

10 days following the bite of an infected mosquito. During and since the last war in particular, birds have been used as laboratory animals for the screening of antimalarial drugs.

Lastly, incubated chicks form an excellent method for the manufacture of various vaccines. In 1938 Cox's yolk sac method was adopted for preparing the typhus vaccine. Up to then it took 300 lice to make a single typhus shot, and it involved injecting the typhus rickettsia into the rectum of the lice and rearing them on humans, tedious and dangerous procedure. Since then incubated chicks have proved invaluable in the manufacture of vaccines for many kinds of pathogenic organism.

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RESPIRATION RATES

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Some years ago I attempted to determine the respiration rates of a number of species of birds as they were available in the course of banding. The results were by no means entirely satisfactory, but they serve to show some of the difficulties to be overcome and also the general level and variability of the rates for small- and medium-sized birds.

The method I used was to determine with a stopwatch the time required for a counted (usually 10-40) number of movements of the belly wall. The figures obtained were then converted to respiratory movements per minute. The birds were confined in three ways: (1) held belly up in the hand, (2) placed in a carrying compartment with a transparent end, and (3) placed head first in a conical weighing tube. Methods 2 and 3 were not feasible with all species, and method 3 was finally abandoned when it was certain that it almost always yielded higher rates than the other methods.

One point should be noted. The usual pattern of respiration is several shallow movements followed by a deeper one, much as in man. The shallow movements can be overlooked, especially when watching a caged bird whose position or attitude may be somewhat unfavorable.