THE EXTERNAL PARASITES OF BIRDS: A REVIEW

BY ELIZABETH M. BOYD

Birds may harbor a great variety and number of ectoparasites. Among the insects are biting lice (Mallophaga), fleas (Siphonaptera), and such Diptera as hippoboscid flies (Hippoboscidae) and the very transitory mosquitoes (Culicidae) and black flies (Simuliidae), which are rarely if every caught on animals since they fly off as soon as they have completed their blood-meal. One may also find, in birds' nests, bugs of the hemipterous family Cimicidae, and parasitic dipterous larvae that attack nestlings. Arachnida infesting birds comprise the hard ticks (Ixodidae), soft ticks (Argasidae), and certain mites.

Most ectoparasites are blood-suckers; only the Ischnocera lice and some species of mites subsist on skin components. The distribution of ectoparasites on the host varies with the parasite concerned. Some show no habitat preference while others tend to confine themselves to, or even are restricted to, definite areas on the body. A list of 198 external parasites for 255 species and/or subspecies of birds east of the Mississippi has been compiled by Peters (1936) from files of the Bureau of Entomology and Plant Quarantine between 1928 and 1935. Fleas and dipterous larvae were omitted from this list. According to Peters, it is possible to collect three species of lice, one or two hippoboscids, and several types of mites on a single bird. He records as many as 15 species of ectoparasites each from the Bob-white (*Colinus virginianus*), Song Sparrow (*Melospiza melodia*), and Robin (*Turdus migratorius*). The lice and plumicolous mites, however, are typically the most abundant forms present on avian hosts. A good introduction to this field of investigation is "Medical Entomology" by Matheson (1950).

When collecting ectoparasites, the sooner the bird is examined the better, for the parasites, in particular the mites, are easier to see while they are still alive. If inconvenient to examine the freshly killed bird, it should be wrapped in cotton, placed in a refrigerator, and examined as soon as possible. By then most of the hematophagous ectoparasites will have left the skin, been entrapped by the cotton, and be readily visible thereon. The non-blood-suckers usually remain attached to the skin and feathers. Examination of the specimen should be conducted near a closed window in a strong light and under a binocular microscope. The feathers should be carefully turned back with forceps for inspection. Hippoboscids tend to fly toward the light and will thus be easily captured. The eyes, ears, head, back, legs, tail and wings (in particular the under surface of the remiges and under wing coverts) should be examined systematically. Special attention should be given the ventral body feathers and skin, especially around the vent. The roof of the mouth should be cut so as to expose the turbinals for possible nasicolous mites. The parasites may be removed with fine forceps (mites, with a fine needle previously dipped in alcohol) and preserved in 70% alcohol. Temporary or semipermanent microscopic preparations may be made in PVA-lactic acid medium (Pratt and Lane, 1949), or, if the ectoparasites are delicate and lightly chitinized, in chloral hydrate gum-arabic medium (Doetschman, 1944). Permanent preparations may be made by subjecting the latter to heat, and by soaking the former in water, then proceeding in the usual manner for mounting arthropods.

The Mallophaga (suborders Amblycera and Ischnocera) are obligatory parasites: their life cycle must be spent entirely on the host. Their metamorphosis is incomplete. The forms which parasitize birds lay their eggs on feathers. The author has observed that the eggs of at least ten species (six genera) are distinctive with respect to size, shape, cap pattern, and position and method of attachment. Females probably remain fertile for life (one female was observed to lay fertile eggs for a period of 30 days after her mate had died). In general, the Amblycera possess squat bodies, are quick runners, are usually found between the skin and the quill, and often have red intestines, indicative that blood makes up part of their diet (Boyd, 1951). The Ischnocera have relatively narrow bodies, their intestines are never red,

and they are usually found clinging to their source of food, the feathers themselves. Recent taxonomic studies of lice, particularly those of game birds, have been undertaken by Emerson (1950). The distribution of Mallophaga on the host is often characteristic for each species of louse. Thus on the Common Crow (*Corvus brachyrhynchos*), *Degeeriella rotundata* and *D. secondaria* occur on the flight feathers, while *Myrsidea interrupta* and *Philopterus corvi* are confined to the plumage of the breast (Morgan and Waller, 1941).

The other insects parasitizing birds and also having incomplete metamorphosis are bugs of the order Hemiptera. They resemble their close relative the bedbug in habit, except that they live in birds' nests rather than in human dwellings. Species of bugs have been collected from nests of the Chimney Swift (*Chaetura pelagica*), from nests of certain swallows (Hirundinidae), and from henhouses.

Fleas undergo complete metamorphosis and the larvae are non-parasitic. Since their immature stages are associated also with the homes of the respective hosts, it is not surprising to find fleas in birds' nests. The flea most commonly found thus is *Ceratophyllus gallinae.*

Hippoboscid flies are also obligatory parasites. They die usually within two or three days when removed from the host. Peters lists seven genera parasitizing birds. The three commonest species are *Ornithoica vicina, Ornithomyia fringillina* (syn. *O. anchineuria*), and *Lynchia americana*, the first two infesting mainly passerines. *Ornithoica vicina* has been recorded from at least 27 passerines, especially the Song Sparrow, and also from owls, hawks, the Mourning Dove (*Zenaidura macroura*), and Downy Woodpecker (*Dendrocopos pubescens*). Very similar to this species is *O. confluenta* from wading birds. About double the size of *Ornithoica vicina*, and brown to dark green, is *Ornithomyia fringillina*, which has been found on 30 passerines, principally the Cowbird (*Molothrus ater*) and Red-wing (*Agelaius phoeniceus*), and also on the Marsh Hawk (*Circus cyaneus*), Downy Woodpecker, and Bob-white. Herman (1937) states that it is unusual to collect a Cowbird in August that does not harbor at least one *O. fringillina.* Five species of *Lynchia*, all much larger than those of the two previous genera, have been recorded from avian hosts. *L. americana* occurs on eagles, hawks and owls, as well as on the Egret (*Casmerodius albus*) and Ruffed Grouse (*Bonasa umbellus*). Hippoboscids have been collected between April and November, the majority in July and August. They attack more juveniles than adults—89% juveniles and 11% adults in an instance reported by Thompson (1940). The parent fly probably dies after giving birth to its two larvae, which almost immediately pupate. The insects apparently winter-over as puparia in the hosts' nests. (Dr. J. C. Bequaert of Harvard University desires specimens of this family for his collection. The data should include, of course, a careful identification of the host.)

Dipterous larvae that attack nestlings include those of the calliphorid genera *Protocalliphora* and *Apaulina.* The adults are blowflies. They lay their eggs in birds' nests up until the time the nestlings are half grown. Typically, the larvae are nocturnal and feed intermittently, attacking the legs, base of the primary feathers, and rarely the crown or ear cavity. Pletsch (1948) reported that they occur on or in wounds of the body or head and even in the nasal cavity. Species of *Apaulina* have been found on the abdomen and in the ear but also embedded beneath the skin (George and Mitchell, 1948). When ready to pupate they seek a quiet part of the nest or leave it altogether. They probably winter-over as adults.

Ticks (larvae, nymphs and adults) are completely hematophagous and tend to attack the head of the host, especially the eyes. Their egg production is enormous. Most of them are able to winter-over at any stage if unfed; many, such as the fowl tick *Argas persicus*, can survive three to four years without a blood-meal. They may remain on one host or attack two, three, or many hosts throughout their life history. The majority are 'three-host ticks,' e.g., the common rabbit tick, *Haemaphysalis leporis-palustris.* The Argasidae are many-host ticks with bedbug-like habits. A bird may act as host to ticks in larval, nymphal or adult stages. One of the more unusual life cycles is that described by Baerg (1944) for *Ixodes baergi.* This animal lives on nestling Cliff Swallows (*Petrochelidon pyrrhonota*). Since male ticks have been found

still attached to engorged females, mating probably occurs after the female has deserted the host and is on her way to the egg-laying site. The larvae are 'on hand' in the nests when the swallows return in April. For identification of ticks, the reader is referred to the monographic series on New World ticks prepared at the Rocky Mountain Laboratory by Cooley and Kohls (1945). In these and other works, the following forms are reported from birds: *Ixodes* (14 species); *Ornithodorus* (4 species); *Amblyomma* and *Haemaphysalis* (3 species each); *Argas* and *Dermacentor* (2 species each). *Ixodes brunneus* is the commonest, having been collected from at least 64 species of birds.

Parasitic mites vary greatly in habits. Avian mites belong to the superfamilies Parasitoidea, Trombidoidea and Sarcoptoidea. Among the Parasitoidea are numerous forms that live on bird as well as mammalian blood (Strandtmann, 1949). The two commonest bird species are the chicken mite, *Dermanyssus gallinae*, and the northern fowl mite, *Liponyssus sylviarum*. Unlike the former, which is similar to the bedbug in habit, *L. sylviarum* remains on its host most of the time and lays its eggs either on or off the host. The larvae do not feed but molt into the nymph within a day; both the nymph and adult depend on blood and survive less than two weeks off the host, but in laboratory dishes live as long as 60 to 80 days at a temperature of 7° C. The hematophagous mites live on the bird's skin, on the wing, or in the vicinity of the vent, where their eggs are often to be found loosely attached to the calami or skin. Among the Parasitoidea are the Rhinonyssidae, which inhabit the nasal cavities of birds (Crossley, 1950; Strandtmann, 1951).

The Trombidoidea attack many parts of their hosts. The chiggers, larvae of the trombiculids, whose adults are free-living, are blood-suckers and attack the legs of birds and mammals (Wharton, 1947). Other forms spend their entire life among the feathers and on, or even in, the hosts' skin, e.g., *Harpyrynchus*, *Cnemidocoptes* and *Cheyletus* (Baker, 1949; Turk, 1950). Still others are resident in the nasal chambers of birds (Boyd, 1951). The Sarcoptoidea include the true plumicolous mites (Analgesidae and related families). These spend their entire lives in intimate association with the feathers, from which they derive their nourishment. Most forms live on the under surface of the remiges and under wing coverts, but in heavy infestations they spread to the general body plumage. Eggs are laid singly in the interbarb area with the long axis of the egg parallel to the barb. No species characters are discernible in the eggs.

The prevalence of parasitism is dependent on numerous factors including the activity of the host and the degree of host specificity exhibited by the parasites concerned. A heavily infested bird is apt to be a center for dissemination of ectoparasites to other animals. Birds may partly control vermin by means of dust and water baths, by preening, and possibly, as suggested by Groskin (1950), by 'anting.' Through observation and experimentation it has become evident that the bird's beak plays an important role in the control of ectoparasites (Boyd, 1951; Kartman, 1950). Fleas and Mallophaga have been found in the stomach contents of birds. A Starling (*Sturnus vulgaris*) with deformed bill and a Junco (*Junco hyemalis*) with the tip of its upper mandible missing were exceptionally heavily infested with lice. When preening is prevented or inhibited through experimental removal of part of the bill, lice increase enormously. Molting influences the abundance of ectoparasites in birds. A decline of vermin observed on Starlings in July and August coincided with their molt. Similarly, in ducks, a before-molt 100% infestation by the feather mite *Freyana anatina* dropped to 52% after the molt; and the mites on each bird dropped from 500–600 to 100 or less (Ginetzinskaya, 1942).

Temperature may be a factor controlling the incidence of ectoparasitism as well as distribution of the parasites on the host. The temperature of birds varies a few degrees during the day and in different parts of the body, but it may remain relatively uniform throughout the year provided the birds are able to control the amount of food intake as is the case for *Passer domesticus* (Seibert, 1949). On this host the monthly infestation of lice is consistent, but for some species of birds lice and plumicolous mites are less numerous in cold weather. Experiments by the author, using isolated feathers, have proved that low temperature reduces the

longevity of lice, prolongs the incubation period of their eggs, and reduces their viability; on the other hand, a temperature of 7°C. merely lowers the metabolism of mites; the viability of their eggs remains unimpaired. Depending on the circumstances, therefore, lice and mites may winter-over in the egg stage on the host.

The degree of host specificity is slight for most parasitic bugs, fleas, ticks, and blood-sucking mites; that is, avian forms may frequently attack mammals, and mammalian forms, birds. Consequently the host-list for such parasites is usually large and varied. To cite two examples: the hen flea *Ceratophyllus gallinae* has been recorded for many birds as well as the chipmunk (*Tamias striatus*), while the rabbit tick *Haemaphysalis leporis-palustris* has been reported from 46 species of birds. Other avian ectoparasites infest only birds, and some of them infest only those belonging to the same order or family as that of their principal host. Mallophaga display marked host specificity: although the Cowbird is known to come in contact with some 158 species of birds through its egg-laying habit, the eight species of lice collected from numerous Cowbird skins are all typically parasitic upon the Icteridae (Ewing, 1933). In fact, classifications of birds have been based to some extent on a study of their parasites—in particular the Mallophaga and certain mites (Hopkins, 1942). The mite *Eupterolichus bicaudatus* is found only on the African Ostrich (*Struthio camelus*) and South American Rhea (*Rhea americana*).

Bodily contact is of prime importance in transmission of ectoparasites, especially among those with slight host specificity, and the habits of the bird have a marked bearing upon the matter. Parasitism by the tick *Ixodes brunneus* runs higher in migratory than in nonmigratory birds; and the same holds true for most hippoboscids. Similarly, Geist (1935) found louse infestations high on gregarious birds (61%) as compared with non-gregarious forms (41%)—particularly the large land birds (65.1%) as compared with aquatic Ciconiiformes, Anseriformes, Charadriiformes, and Gruiformes (57.7%) and small cuculiform, piciform and passeriform land birds (40.4%). Among passerines, incidence is heaviest in the gregarious Hirundinidae, Corvidae, Sturnidae, and Icteridae, and in the non-gregarious Laniidae and Vireonidae. The brooding of young and the roosting side by side of adults must certainly aid dissemination of parasites. This accounts for the interchange of parasites between the Starling and certain native American birds: the louse *Degeeriella nebulosa* on *Turdus migratorius*, the mite *Speleognathus sturni* on the Great-tailed Grackle (*Cassidix mexicanus*), and the icterid louse *Degeeriella illustris* on the Starling (Boyd, 1951). Predators and ground-feeding animals help in spreading numerous ticks and other ectoparasites. The Cooper's Hawk (*Accipiter cooperi*), Bob-white and other birds may, along with the horse, dog, cat, fox and many rodents, harbor the flea *Echidnophaga gallinacea*. Similarly may the presence on the Marsh Hawk of *Ornithomyia fringillina*, a hippoboscid ordinarily found on passerines, be accounted for.

Dispersal of parasites is probably at its peak during the nesting season. Ectoparasites tend to desert parent birds and to attack nestlings, and some are left in the nest when the young birds fledge. Position and type of nest play a part in the degree of parasitism. Low nests of the Cliff Swallow appear to be more susceptible to attack by the tick *Ixodes baergi* than high ones (Baerg, 1944). Mud-constructed nests and nests in holes are favorable abodes for parasitic bugs, fleas, hippoboscid flies and *Protocalliphora*, for the life cycle of these may be passed within the nest itself. The single finding of *Ornithomyia fringillina* on an adult Black-capped Chickadee (*Parus atricapillus*) was correlated with the parasitic nesting habit of the Cowbird, for this hippoboscid was collected also from two young Cowbirds in this particular chickadee's nest (Herman, 1937). The usurping of nesting-holes accounts for much interchange of ectoparasites. *Ceratophyllus fringillae*, a flea of the English Sparrow (*Passer domesticus*), has been found in nests of the House Martin (*Delichon urbica*) and Barn Swallow (*Hirundo rustica*). The hen flea *C. gallinae* has been collected from nests of the House Martin, Barn Swallow, Bluebird (*Sialia sialis*), Tree Swallow (*Iridoprocne bicolor*), and Starling, and also from the chipmunk. Peters reported the hippoboscid *Ornithoica vicina* not only from certain passerines but also from the Screech Owl (*Otus asio*) and Downy Woodpecker. The tick *Ornithodorus*

parkeri has been taken from burrows of rabbits, nests of Burrowing Owls (*Speotyto cunicularia*), and directly from mice, as well as from man. Among the mites, *Atricholaelaps megaventralis* has been found on foxes, squirrels, many woodpeckers, the Starling and English Sparrow, and in nests of the Cliff Swallow.

Hippoboscids are believed by Herman to be unimportant as disseminators of Mallophaga, though such dissemination has been reported repeatedly. Other factors determining host-parasite relationships are the mechanical limitations of the host and the availability of food provided by the host. Eichler (1939–40) demonstrated that the presence of certain lice and mites may depend upon the dimensions of the various components of feathers and hair. A certain louse has been successfully reared on isolated feathers of its own host, but not on feathers from a different species of bird.

Serious harm may be inflicted on animals by infestations of ectoparasites. Their irritating presence produces a rundown condition in the host, lowering its resistance to disease, and skin lacerations caused by them may act as portals of entry for bacteria. In poultry and other birds parasites may decrease egg-production. Deplumation may result from presence of itch mites (e.g., *Syringophilus bi-pectinatus* and *Microlichus avus*), blood-sucking mites (*Dermanyssus gallinae* and *Liponyssus sylviarum*) and other vermin. Tumor formation around feather follicles may result from attacks of *Harpyrynchus* mites, and a condition of 'scaly leg' on legs and bill from attacks by six species of *Cnemidocoptes* (Turk, 1950). The host has been known to die in the act of swallowing, suffocated through pressure on the windpipe by a dipterous larva (*Apaulina hirundo*) buried in the dermis of the neck (George and Mitchell, 1948).

Animals may suffer seriously from anemia as a result of haematophagous parasites. Anemia in birds may be caused by ticks, blood-sucking mites, Mallophaga, fleas, hippoboscid flies, or dipterous larvae. Death of fledglings from infestations of *Protocalliphora* has been reported repeatedly. A Great Horned Owl (*Bubo virginianus*), believed to have been too weak to hunt normal prey because of a heavy infestation of over 100 hippoboscids, attacked domestic turkeys. The tick *Ixodes brunneus* may be so voracious that the avian host becomes unable to fly and even dies. Webster (1944: 612) reported that 65% of young Prairie Falcons (*Falco mexicanus*) starved during their first month through weakness from tick attacks. Williams (1947) reported young raptors so heavily infested by *Ornithodorus aquilae* that their eyes were almost closed. *Ixodes baergi* appears to cause only slight damage to nestling Cliff Swallows, though as many as 18 have been taken from a single bird (Baerg, 1944). Baerg observed, however, that nestling Starlings reared in holes previously occupied that same year were heavily infested with mites.

Many disease-producing organisms are dependent on arthropods for transmission. Mosquitoes of the tribe Culicini are intermediate hosts for bird malaria, and experimentally *Anopheles* is also. Mosquitoes may transmit trypanosome protozoa and filarial nematode worms. The latter may be dependent on mites, since mites are the vectors for the *Filaria* of the cotton rat (*Sigmodon*). Certain species of hippoboscid and simuliid flies probably act as intermediate hosts for *Haemoproteus* and leucocytozoon protozoa respectively. Ticks such as *Argas persicus* and the mites *Liponyssus sylviarum* and *Dermanyssus gallinae* are known to transmit the spirochaete *Treponema gallinum*. This causes relapsing fever, fowlpox, or spirochaetosis. Mites may also transmit the bird protozoa, *Hepatozoon* and *Toxoplasma*, and the cholera-producing bacterium *Pasteurella*. Toxoplasmosis of birds may be identical to that of mammals. Tularemia is a bacteria-produced disease affecting rabbits and other warm-blooded animals including birds and man. Several species of ticks constitute the primary vectors of this bacterium. Of these, four genera, *Dermacentor*, *Amblyomma*, *Ixodes* and *Haemaphysalis*, have been collected from birds.

Some avian ectoparasites with slight host specificity have been known to attack man. Various bugs at times desert birds' nests and invade human dwellings. The chicken mite and northern fowl mite may cause dermatitis in human beings. Some ectoparasites that are carriers

for disease-producing organisms in humans may attack avian hosts. Birds may harbor the immature stages of ticks responsible, as vectors, for Rocky Mountain spotted fever, Bullis fever and relapsing fever. The reservoir for Tsutsugamushi disease, common in certain parts of the world, may be increased through avian mites, while the virus for equine and St. Louis encephalomyelitis has been isolated from the chicken and northern fowl mites. Bacterial plague may be spread through infected fleas attacking vultures as they devour their prey. In this manner, birds, on occasion, may indirectly aid in the prevalence of certain human diseases through increasing the animal reservoir of the particular micro-organism involved.

Literature Cited

Baerg, W. J.
1944 Ticks and other parasites attacking Northern Cliff Swallows. *Auk*, 61: 413–414.

Baker, Edward W.
1949 A review of the mites of the family Cheyletidae in the United States National Museum. *Proc. U. S. Natl. Mus.*, 99: 267–320.

Boyd, Elizabeth M.
1951 A survey of parasitism of the Starling, *Sturnus vulgaris* L. in North America. *Jour. Parasit.*, 37: 56–84.

Cooley, D. A., and Glen M. Kohls
1945 The genus *Ixodes* in North America. *Natl. Inst. Health Bull. No.* 184.

Crossley, D. A.
1950 A new species of nasal mite, *Neonyssus* (*Neonyssus*) *columbae*, from the Pigeon (Acarina, Mesostigmata, Rhinonyssidae). *Proc. Ent. Soc. Washington*, 52: 309–312.

Doetschman, Willis H.
1944 Some suggestions in microtechnique particularly useful in microentomology and parasitology. *Trans. Amer. Microsc. Soc.*, 63: 175–178.

Eichler, Wolfdietrich
1939–40 Topographische specialisation bei Ectoparasiten. *Zeit. f. Parasiten Kunde*, 11: 205–214.

Emerson, K. C.
1950 New species of *Goniodes*. *Jour. Kansas Ent. Soc.*, 23: 120–126.

Ewing, H. E.
1933 Some peculiar relationships between ectoparasites and their hosts. *Amer. Nat.*, 67: 365–373.

Geist, R. M.
1935 Notes on the infestation of wild birds. *Ohio Jour. Sci.*, 35: 93–100.

George, John L., and Robert T. Mitchell
1948 Notes on two species of Calliphoridae (Diptera) parasitizing nestling birds. *Auk*, 65: 549–552.

Ginetzinskaya, T. A.
1942 A new form of adaptation of feather mite *Freyana anatina* Koch to the moult of the host. *C. R. Acad. Sci.* (USSR), 37: 146–149.

Groskin, Horace
1950 Additional observations and comments on "anting" by birds. *Auk*, 67: 201–209.

Herman, Carlton M.
1937 Notes on hippoboscid flies. *Bird-Banding*, 8: 161–166.

Hopkins, G. H. E.
1942 The Mallophaga as an aid to the classification of birds. *Ibis*, 14: 94–106.

KARTMAN, LEO
1950 On the host-ectoparasite relation. *Jour. Econ. Ent.*, 43: 385.
MATHESON, ROBERT
1950 Medical Entomology. Second edition. Comstock Publishing Company, Inc., Ithaca, New York.
MORGAN, B. B., AND E. F. WALLER
1941 Some parasites of the Eastern Crow. *Bird-Banding*, 12: 16–22.
PETERS, HAROLD S.
1936 A list of external parasites from birds of the eastern part of the United States. *Bird-Banding*, 7: 9–27.
PLETSCH, D. D.
1948 Parasitic larvae from the nasal cavity of a nestling Magpie. *Auk*, 65: 296–297.
PRATT, HARRY D., AND JOHN E. LANE
1949 Polyvinyl alcohol for routine determination of ectoparasites. *CDC Bull.* July, Aug., Sept. Federal Security Agency Public Health Service, Comm. Dis. Center, Atlanta, Ga., pp. 21–24.
SEIBERT, HENRI C.
1949 Differences between migrant and non-migrant birds in food and water intake at various temperatures and photoperiods. *Auk*, 66: 128–153.
STRANDTMANN, R. W.
1949 The blood-sucking mites of the genus *Haemolaelaps* (Acarina: Laelaptidae) in the United States. *Jour. Parasit.*, 35: 325–352.
1951 The mesostigmatic nasal mites of birds. II. New and poorly known species of Rhinonyssidae. *Jour. Parasit.*, 37: 129–140.
THOMPSON, G. B.
1940 The parasites of British birds and mammals. 22. Additional records of *Ornithomyia* spp. from British birds, together with notes. *Ent. Monthly Mag.*, 76: 113–116.
TURK, F. A.
1950 A new species of parasitic mite, *Cnemidocoptes jamaicensis*, a causative agent of scaly leg in *Turdus aurantiacus*. *Parasit.*, 40: 60–62.
WEBSTER, HAROLD JR.
1944 A survey of the Prairie Falcon in Colorado. *Auk*, 61: 609–616.
WHARTON, G. W.
1947 Studies on North American chiggers. 2. The subfamilies and *Womersia strandtmani* n.g., n.sp. *Jour. Parasit.*, 33: 380–384.
WILLIAMS, RALPH B.
1947 Infestation of raptorials by *Ornithodorus aquilae*. *Auk*, 64: 185–188.

ZOOLOGY DEPARTMENT, MOUNT HOLYOKE COLLEGE, SOUTH HADLEY, MASSACHUSETTS