PARASITES OF THE MOURNING DOVE (*ZENAI DURA MACROURA CAROLINENSIS*) IN ILLINOIS*

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Recent concern over the status of the mourning dove (*Zenaidura macroura carolinensis*) in the eastern United States has stimulated considerable research on this bird. The present paper reports the results of a parasite survey made in Illinois during the 7 years, 1948 thru 1954. This was one phase of a broad study of the mourning dove carried out by the Illinois Natural History Survey.

Part of the findings on blood protozoa have been presented in abstract form by Levine, Hanson and Kossack (1952, 1953).

MATERIALS AND METHODS

The mourning doves used in this study were collected in the field by shooting. Most were obtained during the first 2 weeks of the Sept. 1-30 hunting season, but others were collected in late summer or late in the hunting season. A few were nestlings. Blood smears were made from 464 doves. They were usually made within a few minutes after the doves had been taken in the field, altho smears of some of the doves from Cook County were made from the heart blood several hours after death. Upon return to the laboratory, the smears were fixed with methyl alcohol, stained with Giemsa's stain, and searched for 10 minutes under the oil immersion microscope objective.

Sex and age were determined by dissection, and the age of the immature birds was determined more closely by the primary molt stage.

Since a high incidence of *Haemoproteus* was observed in the first year of the survey, a search was made for its probable vector. About 150 doves were placed in tightly sealed envelopes almost immediately after having been killed, and both the doves and the envelopes were examined for hippoboscid flies in the laboratory. In addition, all the birds collected were inspected at least cursorily for ectoparasites while being plucked for weight and fat studies. The plucked feathers of several of them were placed in Berlese funnels to collect ectoparasites. Finally, 42 nests were placed in Berlese funnels to collect their arthropod denizens.

The viscera of more than 50 doves were fixed in formalin for helminth examination.

RESULTS

Blood Parasites. By far the most common blood parasites were *Haemoproteus saccharovi* and *H. macallumi*. The prevalences of these two species in relation to age of host are given for each year in Table I. The prevalence in the 392 immature

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186
doves ranged from 54% in 1950 to 88% in 1952, with a mean of 79.4%; that in the 72 adults ranged from 60% in 1949 to 100% in 1952, with a mean of 72.2%. Even though the mean incidence of infection was almost the same for immature and adult birds, there was a marked difference in the species present. H. sacharovi was twice as common in the immature birds as H. maccallumi, the incidences of the two species being 58.2% and 29.8%, respectively. In the adults, on the other hand, the two species were equally common, being 43.1% for both.

The observed prevalence of each species varied markedly from year to year in both age-groups. That of H. sacharovi in the immatures varied from 45% in 1948 to 78% in 1954; in the adults it ranged from 20% in 1953 to 75% in 1951, but these figures are based on insufficiently large samples. The incidence of H. maccallumi in the immatures ranged from 6% in 1950 and 1954 to 43% in 1952; in the adults it ranged from 30% in 1949 and 1950 to 75% in 1952, but this last figure is based on too small a sample.

The relation of age to prevalence of Haemoproteus is broken down by primary-feather molt classes for the immature doves in Table II. It is seen that after the first feather was dropped, the incidence of H. sacharovi did not vary markedly. That of H. maccallumi, on the other hand, increased steadily from 7–8% to 70%. This latter rate was even higher than the 44% found in the adults.

In Table III are given the prevalences of Haemoproteus infections in different parts of Illinois. Marked differences were found, particularly for H. maccallumi, in various parts of the state. While causes of these variations are not entirely clear, age of the sample was undoubtedly an important factor.

Leucocytozoon marchousi was found in the blood of 10 (2.1%) of the mourning
doves. Five were adults, 1 was a juvenile 3 to 4 months old, and 4 were nestlings. The prevalence in adults was 6.5%, and that in immatures was 1.2%. This latter figure is misleading, however, since 4/5 of the immatures were nestlings, and very few birds of this age were included in the whole group.

Table III.—Prevalence of Haemoproteus in mourning doves in different parts of Illinois, 1948–54

<table>
<thead>
<tr>
<th>County</th>
<th>Region of State</th>
<th>Number Birds Examined</th>
<th>Percent Infected</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Cook</td>
<td>Northeast</td>
<td>30</td>
<td>32</td>
<td>59</td>
<td>34</td>
<td>12</td>
<td>28</td>
<td>(3)</td>
</tr>
<tr>
<td>Champaign</td>
<td>East central</td>
<td>79</td>
<td>20</td>
<td>41</td>
<td>50</td>
<td>11</td>
<td>55</td>
<td>(4)</td>
</tr>
<tr>
<td>Mason</td>
<td>Central</td>
<td>58</td>
<td>11</td>
<td>59</td>
<td>45</td>
<td>31</td>
<td>78</td>
<td>(13)</td>
</tr>
<tr>
<td>Hancock 1952–53</td>
<td>West central</td>
<td>196</td>
<td>9</td>
<td>60</td>
<td>56</td>
<td>42</td>
<td>78</td>
<td>(22)</td>
</tr>
</tbody>
</table>

Unsheathed microfilariae were found in the blood of 2 (0.4%) of the doves. Seven individuals measured 46 to 62 microns long by 3 to 4 microns in diameter, with a mean of 51.4 by 3.8 microns.

Intestinal helminths. No helminths were found in the intestines of more than 50 doves examined under the direction of Dr. Lyell J. Thomas, Dept. of Zoology, Univ. of Illinois. However, adult tapeworms were found in the body cavity of 2 out of over 1000 doves in the course of examinations for sex and body fat. These have not yet been identified.

Ectoparasites. Five species of ectoparasites were found commonly on the feathers of the doves, but no quantitative information was obtained as to the number of individuals or species on each bird. It seems probable that many doves regularly carry most of these species.

Three of the ectoparasite species were Mallophaga, i.e. Columbicola macrourae (Wilson), Physconelloides zenaudurai (McGregor) and Colpocephalum sp. They were identified by Dr. K. C. Emerson, Oklahoma A. and M. College, Stillwater, Oklahoma. The Colpocephalum is apparently a new host record.

The other 2 species of common ectoparasites were the mites, Falculifer sp. and Megninia sp. Their identifications were confirmed by Dr. W. E. Baker, U. S. National Museum, Washington 25, D. C. Because the taxonomy of the feather mites is in great need of revision, it was not possible to determine the species of these mites with certainty. However, they were similar to if not identical with Falculifer rostratus (Buchholz) and Megninia columbae Buchholz. This is apparently a new host record for Megninia.

In addition to the above ectoparasites, nymphs of the birdnest mite, Bdellonyssus sylvianum (Canestrini and Fanzago) were found on the feathers of 2 doves.

Although the writers handled over 1000 freshly killed doves in the field and placed more than 150 of them immediately in sealed envelopes for thorough examination in the laboratory, not a single hippoboscid fly was ever seen.

In a further attempt to catch hippoboscid flies, a funnel trap, using live ring doves (Streptopelia risoria) as bait, was operated for several weeks in a Scotch pine planting heavily frequented by mourning doves. It was lighted at night as an additional attraction. No hippoboscids were trapped.

The only ectoparasite found in the 42 mourning dove nests was the bird-nest
mite, *Bdellonyssus sylviarum*. No mites were found before the dove eggs were laid in the few newly completed nests examined. The mites were rarely found in the nests during the egg-incubation period, but more than half the nests containing young doves were infested. Most of the nests contained less than 100 mites, although one had over 500. *Bdellonyssus* was not found in what appeared to be very old, weathered nests.

Eventually, dove nests become inhabited by various inquilines. Among those found were several mesostigmatid, oribatid, and tetanychid mites, other mites, thrips, psocids, Collembola, Homoptera, Hemiptera, Hymenoptera, Lepidoptera larvae, Coleoptera larvae, Diptera larvae, Neuroptera larvae and spiders. None of the dipterous larvae or pupae were those of hippoboscids. Ants of the genus *Crematogaster* were found in several instances, presumably in nests containing broken eggs. In general, the older the dove nest (up to the time it was deserted by the birds or shortly thereafter), the more inquilines were found.

**DISCUSSION**

*Haemoproteus* has been frequently found in mourning doves, usually in surveys of a miscellany of birds. *H. sacharovi* has been reported from *Zenaida macroura carolinensis* 10 times: from 4 birds in Illinois by Huff (1931, 1932), from 2 birds in Nebraska by Coatney and Roudabush (1937), from all of 13 birds in Nebraska by Coatney and West (1938), from 7% of 86 birds on Cape Cod, Massachusetts by Herman (1938), from 56% of 188 birds, mostly from Illinois, by Huff (1939), from 67% of 18 birds in Nebraska by Coatney and West (1940), from 40% of 5 birds in the District of Columbia and vicinity by Wetmore (1941), from 27% of 213 birds in Texas by Couch (1952) and from 50% of 206 birds in Illinois by Levine, Hanson and Kossack (1952).

*H. sacharovi* was reported from 41% of 27 *Zenaida macroura marginella* in Arizona and California by Wood and Herman (1943). It was reported from 2 *Z. macroura* in Michigan by Novy and MacNeal (1904a, b, 1905a, b), and from 1 of 4 *Z. macroura* in northern California by Herms et al (1939).

*H. maccallumi* has been reported from *Z. macroura carolinensis* 8 times: from 75% of 4 birds in Illinois by Huff (1932), from 2 birds in Nebraska by Coatney and Roudabush (1937), from 4 birds by Coatney and West (1938), under the name *H. columbae* from 8% of 86 birds on Cape Cod, Massachusetts by Herman (1938), from 47% of 188 birds, mostly in Illinois, by Huff (1939), from 20% of 20 birds in Nebraska by Coatney and West (1940), from 56% of 213 birds in Texas by Couch (1952), and from 25% of 206 birds in Illinois by Levine, Hanson and Kossack (1952). It was reported (as *H. columbae*) from 93% of 27 *Z. macroura marginella* in Arizona and California by Wood and Herman (1943). It was reported from *Z. macroura* in Michigan by Novy and MacNeal (1904a, b, 1905a, b) and from 33% of 6 *Z. macroura* in California by Herms et al (1939).

In addition to the above, *Haemoproteus* sp. has been reported in *Z. macroura carolinensis* from 5% of 188 birds, mostly in Illinois, by Huff (1939), from 20% of 5 birds in the District of Columbia and vicinity by Wetmore (1941), from 33% of 6 birds from Georgia by Thompson (1943), and from 18% of 213 birds from Texas by Couch (1952). The last author also reported a "questionable form" having rounded gametocytes and containing granules resembling those of *H. mac-
callumi in 74% of the doves he examined. 

_Haemoproctes_ sp. was reported from 60% of 5 _Z. macroura marginella_ in southern California by Wohnis and Ryerson (1941) and from 25% of 65 _Z. macroura_ in Georgia by Love, Wilkin and Goodwin (1953).

Both _H. sacharovi_ and _H. maccallumi_ have been well described by Huff (1932), Coatney and Roudabush (1937) and Coatney and West (1940), and their papers may be consulted for complete descriptions. The gametocytes of _H. sacharovi_ differ from those of most other species of the genus in that they enlarge and distort the host erythrocytes, often pushing the nucleus to the edge of the cell, and in that they contain little pigment.

The gametocytes of _H. maccallumi_ partially encircle the host cell nucleus but do not push it to the periphery of the cell, do not enlarge the host cell, and contain relatively large pigment granules. They are morphologically indistinguishable from those of _H. columbae_ from the pigeon, and as a matter of fact Herman (1938) considered _H. maccallumi_ a synonym of _H. columbae_. His view may well be correct. However, Coatney (1933) was unable to transmit _H. columbae_ from the pigeon to the dove by means of the hippoboscid fly, _Pseudolynchia canariensis_ (= _P. maura_), and until more is known of the schizogonic stages, life cycles and host-parasite relations of the two species, it is more convenient to retain the name _H. maccallumi_ for the mourning dove form.

The literature on the prevalence of _Leucocytozoon_ in the avian order Columbiformes has been reviewed by Levine (1954). _L. marchouxi_ was reported from 2 of 5 _Z. macroura carolinensis_ from the District of Columbia and vicinity by Wetmore (1941), from 1 of 206 mourning doves in Illinois by Levine, Hanson and Kossack (1952), from the 10 doves included in the present survey by Levine, Hanson and Kossack (1953) and Levine (1954), and from 4 of 27 _Z. macroura marginella_ in Arizona and California by Wood and Herman (1943). In addition, _Leucocytozoon_ sp. was reported without any morphological information from 2 of 6 _Z. macroura carolinensis_ in Georgia by Thompson (1943).

Microfilariae were reported from one _Z. macroura carolinensis_ from Nebraska by Coatney and Roudabush (1937), from 2 _Z. macroura_ from Georgia by Robinson (1954) and from an unspecified number of _Z. macroura marginella_ from Mexico by Saunders (1955). Only the first authors gave any morphological information. They stated that the microfilariae had a blunt anterior end, that their posterior region tapered to a point, that no sheath was visible, and that their mean length was 80.3 microns and their maximum width 4.36 microns. Our microfilariae were considerably shorter than these (46 to 62 microns, with a mean of 51.3 microns), but appeared similar otherwise.

An important factor which deserves mention in connection with the parasite incidences reported in this and other surveys is that these figures are markedly dependent upon the thickness and evenness of the blood smears and the method used in examining them. Even assuming that all microscopists are equally adept at finding the smallest and faintest parasite stages, the time spent on each smear, the magnification used and the size of the microscope field are important. In the present survey, the smears were examined under the oil immersion objective. Had different times been used, the reported prevalences would undoubtedly have been different.
The importance of the magnification employed is well illustrated by our observations on the incidence of microfilariae in Canada geese (Branta canadensis interior). In a survey of 353 birds at the Horseshoe Lake Game Refuge, Illinois, in which the blood smears were examined for 10 minutes under the oil immersion objective, microfilariae were found in 1.1% of the birds by Levine and Hanson (1953). However, in a later survey of 306 Canada geese at the same place in which wet blood smears were examined for about 3 minutes under the low power (100×) of the microscope, microfilariae were found in 23.9% (Hanson, Levine and Kantor, 1956). Perhaps a similarly higher incidence of microfilariae would be found if mourning dove blood were similarly examined. Undoubtedly, too, the incidence of Leucocytozoon marchouxi would have been higher if the stained smears had been examined under low power, since the mature gametocytes of this species can be seen quite easily with this magnification.

Perhaps the most important unsolved problem regarding mourning dove parasites is the identity of the natural vector of Haemoproteus. The only proven vectors of this genus are hippoboscid flies. Microlychnia pusilla, Pseudolynchia canariensis (= P. maura), P. brunea, P. capensis and Lynchia hirsuta have been employed in the experimental transmission of Haemoproteus columbae in pigeons (see Huff, 1932). Huff (1931, 1932) transmitted both H. sacharovi and H. maccallumi from the mourning dove to the pigeon by means of Pseudolynchia canariensis (= P. maura).

In view of the high incidence of Haemoproteus in mourning doves, one would expect that if hippoboscid were the natural vectors, they would be common parasites of doves. This is far from the case. There are relatively few records of hippoboscid on these birds. Herman (1937) found Ornithoica confluenta on 4 of 100 mourning doves in Massachusetts, Coatney (1938) found a single Stilbometopa podopostyla on a mourning dove in Nebraska. Bequaert (1939) reported Microlychnia pusilla from a western mourning dove in Idaho, and Herman (1945) found a single M. pusilla on a western mourning dove in southern California. The most notable record is that of Brennan (1938). Between Sept. 2 and 12, two to three dozen mourning doves were killed in Bexar County, Texas, almost all of which carried one or more M. pusilla; one bird had as many as 10 hippoboscid. S. podopostyla was found less frequently on these birds.

On the other hand, Taber banded 1100 mourning doves in Illinois and never saw one of these flies (Huff, 1932). McClure (1943) found M. pusilla on only 7 of 1700 young mourning doves and none on adult doves in Iowa. Herman (1945) found no hippoboscid on mourning doves in northern California, and as stated above, the authors handled over 1000 freshly killed doves in the field and made a special search for hippoboscid without finding any. It would seem evident that the natural vector is some other ectoparasite, but it is hardly worthwhile to speculate on its identity.

**SUMMARY**

In a 7-year survey of the parasites of the mourning dove (Zenaidura macroura carolinensis) in Illinois, Haemoproteus sacharovi was found in 58% of 392 immature birds and in 43% of 72 adults; H. maccallumi in 30% of the immatures and in 43% of the adults; Leucocytozoon marchouxi in 1.2% of the immatures and in 6.5% of the adults; and unsheathed microfilariae 46 to 62 microns long in 2 birds. No
helminths were found in the intestines of more than 50 doves. The Mallophaga, Columbicola macrourae, Physconelloides zenaidurae, and Colpocephalum sp. and the mites Falcuifer sp. and Megnimia sp. were found commonly on the doves’ feathers, and the mite Bdellonyssus sylviarum was found on the feathers of 2 birds. No hippoboscid flies were found despite a special search for them. Bdellonyssus sylviarum was the only ectoparasite found in 42 nests; it was present in more than half of the nests containing young doves. The incidence of Haemoproteus sacharovi was 31% in very young doves; in older birds it did not vary markedly, fluctuating between 52% and 69%. The incidence of H. macallumi increased steadily in growing birds from 7–8% to 70%. The incidence of both Haemoproteus species varied markedly in different parts of the state and in different years. In view of the high incidence of Haemoproteus and the absence of hippoboscid flies, it is concluded that the natural vector of the blood protozoon must be some other ectoparasite.

**Literature Cited**


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—.-RESEARCH NOTE—.

OBSERVATIONS ON THE INEFFECTIVENESS OF "POLYBOR-3" IN DESTROYING THE VITALITY OF THE EGGS OF ASCARIS SUUM IN SOIL.

In recent years the writer (1953, Am. J. Vet. Res. 14: 563-570; 1955, J. Parasitol. 41, Suppl.: 50) has reported that "Polybor-3" (Pacific Coast Borax Co., Los Angeles), applied dried or in solution to soil at the rate of 5 pounds per 100 square feet was effective in 20 days in killing most of the larvae of Stephanurus dentatus and Oesophagostomum dentatum in soil up to a depth of 1 inch. "Polybor-3" is composed of a mixture of sodium pentaborate tetrahydrate and sodium tetraborate pentahydrate.

During the months of September-October 1956, small scale experiments were carried out to ascertain any evidence of lethal action of "Polybor-3" on the eggs of Ascaris suum in soil. In starting this experiment, a small outdoor area protected from the sun and rain was chosen. The ground was thoroughly broken, raked, and small stones removed. The area was then marked with wooden borders into six 1-square-foot plots. In the center of each plot a small square wire basket (1 inch wide, 1 inch long and 3/4 inch high) made from galvanized mosquito screening was worked in the soil so that the top of the basket was level with the surface of the ground. Each wire basket was then completely filled with soil which had been thoroughly mixed with numerous ascarid eggs freshly secured from the uteri of adult female worms, Ascaris suum, collected from pigs. Following the above, 3 of the soil plots were sprayed each 22.7 grams of "Polybor-3" in 113 cc of water (equal to the rate of about 5 pounds of the chemical in 3 gallons of water per 100 square feet), and 3 other plots were sprayed with water only and served as control. All the plots were then left undisturbed for 6 weeks, except that, in order to keep the soil from becoming too dry, the plots were lightly sprayed with water once a week.

At the end of the 6-week period, the small wire baskets were carefully pulled out of the ground and the soil within each basket was poured into a sterile dish. Then, about one-half of the amount of soil from each basket was transferred in several small gelatine capsules and force-fed to 1 young guinea pig. In addition, with the aid of a pipette, the guinea pig received a few cc of muddy water from the washing of the remaining half of the soil. Six guinea pigs were thus fed, each with soil from 1 basket. After feeding, each of the guinea pigs was placed in a separate sterilized cage. Within a few days all the animals showed signs of illness and hard breathing, and died on the 4th or 5th day of the experiment. Upon necropsy, the lungs of the 6 animals showed presence of petechial spots and large confluent ecchymotic areas. Press preparations of small pieces of these organs from all animals revealed several developing ascarid larvae. The results therefore indicated that the chemical spray as used had no injurious effects either on the development of the ascarid eggs nor on the infective power of the larvae.—Joseph E. Alicata, University of Hawaii Agricultural Experiment Station, Honolulu, Hawaii.