BIRDS AS A FACTOR IN THE CONTROL OF A STOMACH WORM OF SWINE.[1]

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Introduction.

A GROUP of roundworm parasites known as spirurids, the name being derived from the superfamily name Spiruroidea, occur as adults in a wide variety of hosts, including mammals, reptiles and birds. These parasites have an indirect life history, that is one in which there is involved an intermediate host. This intermediate host is usually a small arthropod, such as an entomostracan or insect; encysted in the body tissues of the arthropod, the larval form of the parasite develops to a stage which is infective for the final host. Birds which feed on arthropods in large numbers, such as water birds which eat entomostracans and insectivorous birds which eat insects, are therefore liable to infection with such parasites and it is not surprising that a great variety of adult roundworms of this group is found to occur in such birds.

However, the arthropods which are eaten by birds may be infested with roundworm larvae which as adults parasitize a group of animals other than birds, such as mammals. The fate of such larval parasites which are thus introduced into the wrong host has been studied by earlier workers, notably the French parasitologist Seurat, who found that the larvae migrate into the tissues of such a host and again encyst.

The present investigation resulted from the discovery made by H. L. Stoddard several years ago that the Loggerhead Shrikes (*Lanius ludovicianus ludovicianus*) in northern Florida, chiefly in Leon County, and in southern Georgia, chiefly in Grady County, were infested with large numbers of roundworms encysted in the walls of the digestive tract. These parasites were identified by the writer as spirurid larvae and the infestation as a case of aberrant parasitism such as that mentioned above, the larvae being in a

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host other than the correct final host and therefore incapable of further development. As the larval forms of these parasites have been little studied, identification was thought impossible from morphological examination, but an opportunity was later presented for a more extensive investigation of the life history of the parasite by means of feeding experiments.

Findings of present investigation.—During a two months period, May and June, 1928, twenty-one Loggerhead Shrikes from Leon County, Florida, were examined by the writer and each bird was found to be infested with large numbers of the encysted larval parasites. The roundworms were located in the walls of the digestive tract, near its outer surface, and also in the mesenteries. All parts of the digestive tract were found to be parasitized, from the upper end of the esophagus, near the mouth, to the lower end of the intestine. As regards the stomach, the wall of the proventriculus was more heavily infested that that of the gizzard. However, the concentration of the infestation was observed to be always at the posterior end of the digestive tract, in the rectum and its mesenteries; here the larger number of larvae and the thinner walls of the tract greatly facilitated the finding of the parasites. There was no visible evidence of damage to the wall of the digestive tract from these massive invasions of small roundworms; due to the fact that one hundred per cent of the Shrikes of that vicinity appeared to be infested, judging from a considerable number of examinations made by H. L. Stoddard during a period of five years, and from the twenty-one examinations made by the present writer, no comparison was possible of an infested with a non-infested bird, to judge of clinical or pathological results of the parasitism.

Desiring, as a first step in the unravelling of the life history of this parasite, to discover the arthropod intermediate host which was responsible for the infection of the Shrikes, the writer was struck by the fact that the stomach contents of the birds in a large percentage of cases showed the brightly colored parts of the dung beetle, *Phanaeus carnifex*, and attention was accordingly directed toward this beetle as a possibility. Examination of specimens of *P. carnifex* in the same vicinity revealed the fact that practically one hundred per cent were heavily parasitized with the same larval roundworm as was found in the Shrikes. A second dung beetle,

Canthon laevis, was also found to be infested, although to a lesser degree.

Examination of birds other than the Shrike, which would probably feed on these beetles, resulted in the finding of similar natural infestations of the larval roundworm in three Screech Owls (*Otus asio asio*) and one Red-tailed Hawk (*Buteo borealis borealis*) taken in Grady County, Georgia.

In an attempt to determine the final host of the parasite, feeding experiments were undertaken; larvae derived from Shrikes and also those from the arthropod hosts, were fed to a series of experiment animals, representing birds, mammals and reptiles, with the following results:

Reëncystment of larvae derived from the Shrike was experimentally produced in the digestive tracts of one Turkey, two Chickens, two Red-tailed Hawks, one skunk, one oppossum, two rats, three mice and one black snake.

Reëncystment of larvae derived from the dung beetle (*Phanaeus carnifex*), was experimentally produced in the digestive tracts of one Screech Owl, three Turkeys, three Bobwhites, three Chickens, one Pigeon, one skunk, one opossum, one mouse, two rats, one rabbit and one guinea pig.

In these experiments check animals held as controls in each case were negative with reference to infestation with the parasite except in the cases of the Owls, Hawks, rats, and snake, in which the check animals were also parasitized. It is possible, therefore, that the findings in these animals, after experimental feeding, represented an experimental infestation superimposed on a natural infestation.

The reëncystment of the spirurid larvae in each of these experiment animals indicated that the final host of the parasite was not included in the series. As the result of an observation made during the collection of the dung beetles, namely that in pastures in which there was a choice of manure from cattle, horses and swine, the beetles showed a decided preference for that from swine, it was concluded that swine were probably the final host of the parasite. Accordingly three young pigs were fed respectively as follows with the results as shown:

Six specimens of the beetle (*Phanaeus carnifex*), with the finding at necropsy two months later of approximately 1700 specimens of

the roundworm (*Physocephalus sexalatus*), in the stomach of the pig.

About one-half the length of the intestinal wall of a Loggerhead Shrike, with the finding at necropsy 80 days later of approximately 800 specimens of the roundworm (*Physocephalus sexalatus*), in the stomach of the pig.

Six specimens of the beetle (*Canthon laevis*), with the finding at necropsy 5½ months later of 12 specimens of *Physocephalus sexalatus* in the stomach of the pig.

This feeding experiment, in contrast to the former series which was carried out at Beachton, Georgia, was conducted at the experiment station at Beltsville, Maryland, the beetles and Shrike viscera having been brought from Florida; the pigs were raised on concrete floors and two of the lot of five pigs were held as check animals, these showing at necropsy an absence of the stomach worms which were present in the experimentally fed pigs.

Discussion.—The identity of the larval roundworms found in cases of aberrant parasitism encysted in the walls of the digestive tracts of Loggerhead Shrikes, Screech Owls and Red-tailed Hawks in southern Georgia and northern Florida was thus established experimentally as *Physocephalus sexalatus*, which in its adult form is a stomach worm of swine. The arthropod intermediate hosts of the roundworm, from which the birds derive the infestation, were found to be the dung beetles, *Phanaeus carnifex* and *Canthon laevis*. It was experimentally established that the parasite would also encyst in Chickens, Turkeys, Bobwhites and Pigeons, as well as in certain mammals and reptiles. However, due to the food habits of the Shrike, that is, habits involving a large consumption of these beetles, and the abundance of these birds in the area involved, the Shrike is probably the most important of the accidental hosts of this parasite in that locality.

The practical significance of these findings is easily seen. Swine being raised in such an area are protected from infection with this roundworm to the extent to which the arthropod intermediate hosts are consumed by birds and other animals which serve as accidental hosts. It was shown that six specimens of the dung beetle (*Phanaeus carnifex*) were capable of infecting a pig with approximately 1700 specimens of this stomach worm. The numbers of these parasites

which are prevented from completing their normal life cycle, because of the ingestion of the beetles by Shrikes and other birds of similar food habits, is therefore evidently enormous, and birds in this manner undoubtedly are an important factor in limiting the degree of infestation of swine with this parasite. A definite correlation may be suspected between these two factors and it is probable that a decrease in such birds would result in an increase in this stomach worm of swine, in a given area such as that considered. While swine would become infested by eating these accidental secondary hosts, and doubtless do in some cases, it seems likely that this would happen only rarely and that the general effect of this biological complex is to diminish infestation in swine.

Summary.—Larval roundworms, found as aberrant parasites encysted in the wall of the digestive tract of Loggerhead Shrikes (*Lanius ludovicianus ludovicianus*), Screech Owls (*Otus asio asio*) and Red-tailed Hawks (*Buteo borealis borealis*) in southern Georgia and northern Florida, were identified by means of feeding experiments as *Physocephalus sexalatus*, the adult form of which occurs in the stomach of swine. The dung beetles, *Phanaeus carnifex* and *Canthon laevis*, were found to serve as the first and normal intermediate hosts of the parasite in this locality. Reëncystment of the larvae was found to occur in a wide variety of animals, including birds, mammals and reptiles. It is pointed out that beetle-consuming animals, of which birds are the most important, are therefore a significant factor in limiting the degree of infestation of swine with *Physocephalus sexalatus* in such an area.

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