

Preliminary Studies on the Pathology Caused by *Mermis nigrescens* Duj. in Orthoptera

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Abstract

Parasitic *Mermis nigrescens* Duj. juveniles may cause tissue damage during migration within the host. As these juveniles develop, they may cause tissue distortion, underdevelopment of structures, and mechanical damage to tissue. Mechanical damage by the parasite may act to reduce the number of eggs laid by the host grasshopper.

Introduction

The importance of mermithids as a possible means of biological control of insect pests has been recognized by a number of investigators (1, 6, 10, 11). The United States Bureau of Plant Industry has used *Agamermis decaudata* and *Mermis subnigrescens* in an effort to control grasshopper populations. The government has also used members of the Mermithidae to control mosquito populations in the Arctic (2). Japanese investigators have reported that mermithids, parasitic in the rice borer, help to keep this pest within bounds (7, 12).

The purpose of this paper is to present some of the initial observations on the damage that *M. nigrescens* causes to the internal tissues of several host species of Orthoptera. These observations will be used to determine the extent of damage caused by the parasite and how this damage may play a role in the biological control of economically important Orthoptera.

Methods

All grasshoppers in this study were sacrificed using ethyl ether, then fixed in Bouin's fixative, washed in several changes of 50% ethyl alcohol, one change of 70% alcohol containing one per cent potassium acetate, and dehydrated according to the Martignoni (9) methyl benzoate method. Specimens were doubly infiltrated in a vacuum paraffin oven. Embedding was done in 56-58°C Paraplast (Fisher Scientific Co.). Specimens were sectioned at eight and ten microns and stained with Heidenhain's iron haematoxylin and eosin or Mallory's triple stain.

Results

Early infections by *Mermis nigrescens* juveniles appear to have little or no visible effect on the behavior of the host grasshopper. A few parasitized hosts showed some signs of immobility. In experimental infections where more than 70 eggs were fed to nymphs, few visible indications of infections were observed. However, it is assumed that numerous perforations of the intestine occur in multiple infections, but apparently these perforations seldom cause any dangerous infection or damage. In one experiment, seventy eggs were fed at one time to 52 host grasshoppers. Since 49 of these hosts survived past the 20th

day of infection, it appears that no major damage occurs to grasshoppers due to multiple penetration of the gut by the parasite. The 49 grasshoppers when dissected had from 1 to 47 parasites present. The largest number of parasite juveniles found in naturally infected grasshoppers was 67 in a female *Melanoplus femurrubrum*.

Generally, there is no macroscopic external indication of an infection. Johnson (8) reported that chironomids parasitized by *Hydromermis contorta* have a pale body instead of the usually bright red body. Christie (2, 3) observed no color change in parasitized grasshoppers, and infected specimens in this study supports that observation. Wheeler (13) noted numerous morphological changes in ants parasitized by mermithids, but apparently none of these changes are present in grasshoppers infected by *M. nigrescens*. A number of exoskeletons of normal and infected grasshoppers were mounted and observed microscopically. No apparent differences were noted.

Parasitic juveniles apparently do not overwhelmingly prefer any particular portion of the haemocoel or other body structures. Johnson (8) reported that *Hydromermis contorta* prefers the posterior portion of the chironomid body until late in the infection when the disappearance of the fat bodies at the anterior end of the host provides the parasite with added space in that region. However, *M. nigrescens* seems to migrate throughout the body of its host. It is not unusual to find young juveniles looped around the tentorial arms, among the mandibular adductor muscles, in the metathoracic leg, and penetrating the dorsal and ventral diaphragms of the insect host.

The mandibular adductor muscle of grasshoppers consists of several bundles of fibers. When a parasitic juvenile is present in the bundles, the bundles appear to be atrophied and highly compressed. In areas where the parasitic juvenile has penetrated the dorsal musculature of the body wall of the abdominal region of the grasshopper, the muscles become compressed or atrophied, and individual muscle fibers may be destroyed.

Often a portion of the parasite's body may be found penetrating the region of the brain. In such cases the protocerebrum or deutocerebrum or both appear atrophied and misshapened. This may affect normal mobility as noted by other workers (2, 8).

Penetration by the parasite of the salivary glands results in these structures being markedly reduced. The destruction of much of the fat body is evident in most infections and may play a role in the metabolism of the parasite (5). Johnson (8) reported similar observations in chironomids parasitized by *Hydromermis contorta*.

When a parasite is lying apposed to the gut wall, that immediate area of the gut appears to be thinner than a comparable area where no parasite is present. There is evidence that the outer layers of the gut have been destroyed due to the parasite's presence. Adjacent areas of the gut often appeared greatly thickened.

Many examples of mechanical distortion of the gut and lateral oviducts were encountered. This distortion consisted of compression and partial closure of the lumen of these structures due to crowding of the parasite against the outside walls.

Christie (2) stated that in every case where he had examined an adult female *Melanoplus femerrubrum* parasitized with *Agamermis decaudata*, the ovaries were reduced in size and in many cases were vestigial. He stated that similar results were found in grasshoppers parasitized by *M. subnigrescens* (3).

Many parasitized female grasshoppers were examined histologically as well as *in toto* in this study. *M. nigrescens* were usually found in the area of the ovaries and were often found threading their way between individual ovarioles. This usually caused individual ovarioles to become reduced in size. In no instance, however, were they ever found in the condition illustrated by Christie (2, figure 13). Nevertheless, it is felt that one of the factors causing a reduction in the number of eggs laid by infected hosts is due to mechanical damage done to the ovarioles by the parasite.

Parasitized males showed very little difference in the development of the testes when compared to normal males. Christie (2) is of the opinion that most, if not all, parasitized male grasshoppers are capable of producing spermatozoa and the evidence from this study tends to support this opinion.

Several specimens of grasshoppers carried a mermithid which had penetrated the neurolemma. In these cases, the parasite was apposed to the nerve cord and some apparent damage to the nerve cord itself was observed. Reports that insects parasitized by mermithids lose their irritability or become immobile may be due to the parasite coming in contact with the nerve fibers by penetrating the neurolemma (2, 8).

Discussion

On the basis of this study, it appears that many internal structures of the host grasshopper suffer some damage due to the presence of *M. nigrescens*. In cases where damage to the reproductive organs occurs, there may be a reduction in the number of eggs laid. Mechanical damage, however, may not be the major cause of reduced egg production as shown by Denner (3). Additional studies, now underway, may indicate other pathological effects of *M. nigrescens* on Orthopterans.

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