

MECHANISMS OF INTERCOLONY TRANSMISSION OF *THELOHANIA* *SOLENOPSAE* IN RED IMPORTED FIRE ANTS

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Thelohania solenopsae is a microsporidian pathogen of imported fire ants. Infected queens have lower oviposition rates and die prematurely (Knell et al. 1977, Williams et al. 1999). The pathogen is transovarially transmitted but the natural mechanism of intercolony transmission is unknown. Infections of *T. solenopsae* can be initiated artificially in uninfected red imported fire ant, *Solenopsis invicta*, colonies by introducing live, infected brood (Williams et al. 1999, Oi et al. 2001). Because infected brood can be used for inoculations, we hypothesized that natural mechanisms of brood transfer between colonies can result in intercolony transmission.

Polygyne imported fire ants are not territorial and presumably share brood among colonies. Thus, it was hypothesized that *T. solenopsae* infected brood could be moved to uninfected colonies and serve as inoculum for new infections. Inoculations of *T. solenopsae* in ten southern U.S states in 1998-2000 resulted in infections in 9 of 15 inoculation sites. However, sustained infections, which also spread, occurred only in polygyne *S. invicta* populations. Infections in monogyne colonies generally were not found after initial detection except in Florida where infection has been detected for 3 years, but with little spread. Thus, there is circumstantial evidence that the movement of infected brood among polygynous colonies facilitates infection and spread.

For monogynous imported fire ant populations, we hypothesized that brood raiding may be a mechanism of horizontally transmitting *T. solenopsae*. Tschinkel (1992) described how incipient monogyne *S. invicta* colonies would steal brood from other incipient colonies. In support of our hypothesis, we have documented infection rates of 93 and 75% from male and female adult alates, respectively. Infection rates were obtained from 45 males from 7 colonies and 133 females from 9 colonies that were trapped as they took flight from nests during the initiation of mating flights. In addition, 30 newly mated queens that produced infected colonies have been collected and reared in the laboratory from 1999 to 2001. Average lifespan of these queens was 127 days ranging from 33 to 652 days (n=25) and colonies contained all life stages (i.e. eggs, larvae, pupae, and adults). Five of the 30 queens are still alive after a range of 239 to 1,012 days. Thus, it is evident that *T. solenopsae* infected incipient colonies can be produced.

To determine if imported fire ant colonies can become infected with *T. solenopsae* via brood raiding, 7 pairs of *S. invicta* colonies consisting of a large, uninfected and a small, infected colony were given access to each other in the laboratory. Large colonies contained an average of 5,571 ($\pm 1,134$ SD) adults, 25.7 (± 45 SD) ml of brood and 1 queen while small colonies contained 1,100 (± 412) adults, 6.3 (± 3.9) ml of brood and 1 queen. Small colonies had an infection rate of 30% based on a sample of 10 individual larval or prepupal smears. Queens from each colony were marked with paint to distinguish which colony they were from. In addition, 7 pairs of uninfected large and small colonies were used as controls.

After an average of 8.8 days (± 4.9 SD) all brood was found within a single colony in 6 of the 7 pairs and 5 of 7 of the queens from the small, infected colonies died. *T. solenopsae* infection was detected in 4 of 7 of the large colonies. Average maximum infection rate for these colonies was 80% (± 34 SD). For the controls all brood was found within a single colony after 6.5 days (± 2.3 SD) in 6 of 7 pairs and 6 of 7 queens from the small colonies died. *T. solenopsae* was not detected in any of the control colonies. In the large colonies where *T. solenopsae* was detected brood levels declined an average of 69% after 22 weeks in contrast to an 88% increase in the controls. This further indicated that *T. solenopsae* infection had established and was impacting the fire ant colonies inoculated through brood raiding. In summary, sharing of infected brood and brood raiding are two ways *T. solenopsae* can be transmitted between colonies of red imported fire ants.

References Cited

- Knell, J. D., G. E. Allen, and E. I. Hazard. 1977. Light and electron microscope study of *Thelohania solenopsae* n. sp. (Microsporida: Protozoa) in the red imported fire ant, *Solenopsis invicta*. J. Invertebr. Pathol. 29: 192-200.
- Oi, D. H., J. J. Becnel, and D. F. Williams. 2001. Evidence of intra-colony transmission of *Thelohania solenopsae* (Microsporidia: Thelohaniidae) in red imported fire ants (Hymenoptera: Formicidae) and the first report of a new spore type from pupae. J. Invert. Pathol. 78: 128-134.
- Tschinkel, W. R. 1992. Brood raiding in the fire ant, *Solenopsis invicta* (Hymenoptera: Formicidae): laboratory and field observations. Ann. Entomol. Soc. Am. 85: 638-646.
- Williams, D. F., D. H. Oi, and G. J. Knue. 1999. Infection of red imported fire ant (Hymenoptera: Formicidae) colonies with the entomopathogen *Thelohania solenopsae* (Microsporidia: Thelohaniidae). J. Econ. Entomol. 92: 830-836.