



Do Parasite Infections Affect Fighting Ability in Beetles?

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Abstract

Parasites, by definition, subsist off their host's resources, which can drain host energy reserves. This can have negative consequences for the host, especially during energy-intensive activities. Fighting is common in most animals that are territorial, or that are protective of young. Few studies have examined the effect of parasites on fighting capacity in animals. The bess beetle (*Odontotaenius disjunctus*) is a saprolytic insect common in forests within the eastern United States, and it is susceptible to a naturally-occurring nematode parasite (*Chondronema passali*). **We examined the effect of infections on the outcome of staged fights** in this beetle. Using locally-captured beetles, we created random pairings based on weight (so that each pair contained similarly-sized individuals), then placed pairs in a small wooded arena to observe fighting behavior. A video camera recorded 3 minutes of fighting. Beetles were killed and dissected to determine gender and parasite status. From the videos, an external observer recorded the number of bouts, wins and losses for each pair, and the overall winner. A total of 78 beetles were used in the experiment; 40% were infected with *C. passali*. Infected beetles were the overall winner in 52% of their matches, while uninfected beetles won 48% of fights (this was not significantly different, $p=0.817$). However, when fights were grouped by infection severity, we found that beetles with the highest infection score (thousands of nematodes) won 71% of their battles, while the least-infected beetles only won 25% of the time. This is counter-intuitive to the idea that infection has a negative energetic effect on host fitness.

Background



- The bess beetle (left) is found in rotting logs throughout forests in the Eastern United States
- Beetles form cavities in logs and rear up to 10 young during summer
- The beetle is commonly infected with a naturally-occurring nematode parasite *C. passali* (see figure on left)
- Bess beetles engage in territorial behaviors defending their cavities against intruders.

Based on our review of the literature, the fighting ability of parasitized animals has rarely, if ever, been empirically examined

Methods

Beetles ($n=78$) were collected by hand from wooded areas surrounding Athens, GA. Beetles were assigned pairs based on their weight (all contests contained beetles of the same size). Each pair was placed in an arena we designed from glued wooden blocks (dimensions, see Figure 1). To differentiate between the two beetles, one was marked with a dab of white-out. A video camera was above the arena to record contests



Figure 1. Wooden arena designed to record beetle fights.

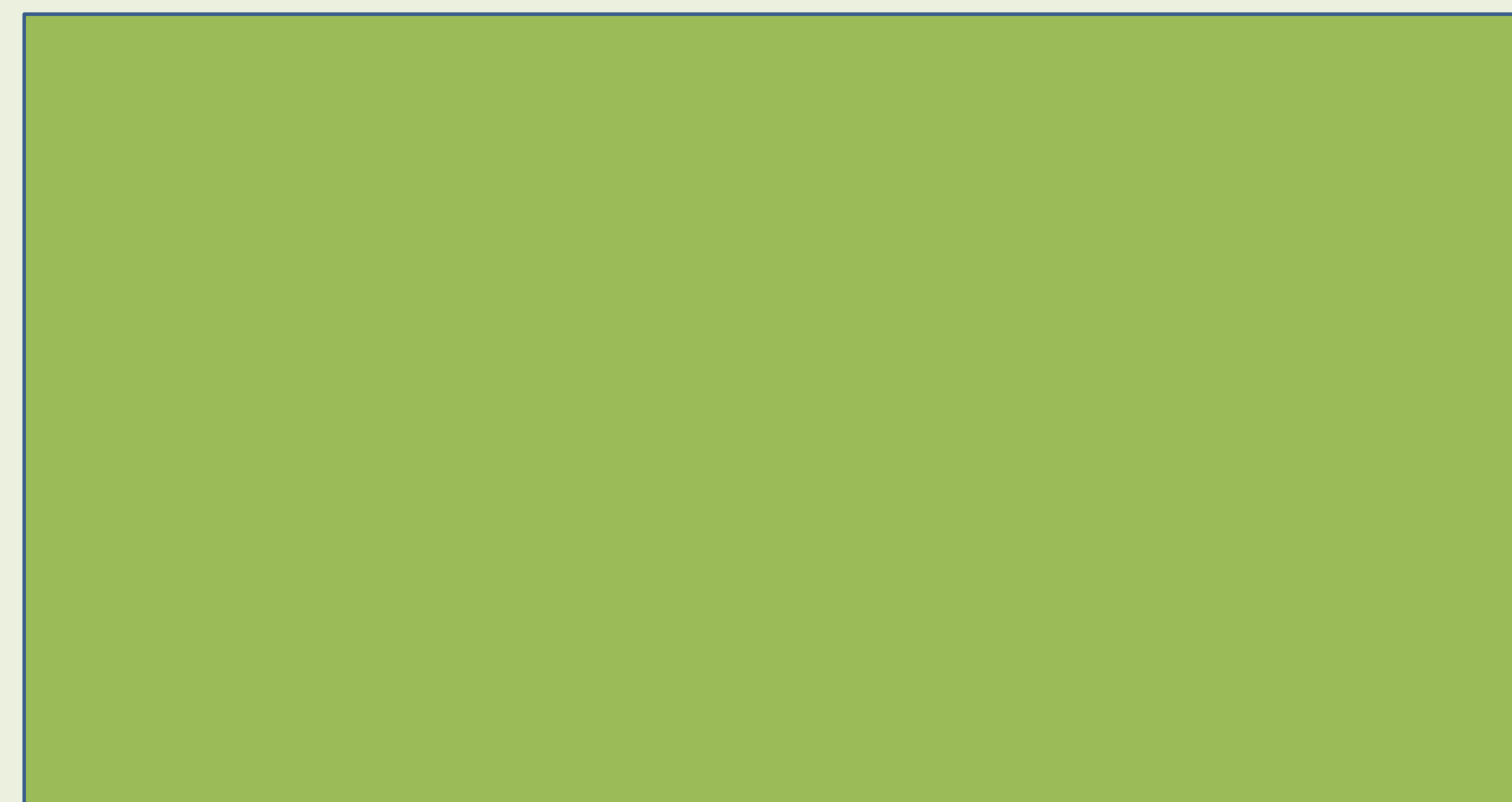


Figure 2. Aggressive behavior displayed in a staged fight between two beetles. A flip, or 'suplex' is the ultimate sign of aggressive behavior. Note that all pairs contained similarly-sized beetles, to eliminate the effect of body size

Beetle fights were video-taped for 3 minutes. After the fights, beetles were killed and dissected to determine gender and parasite status. We recorded infection severity using a 1-3 scoring system, with 0 being less than 10 nematodes and 3 being up to or greater than 1000.

A volunteer observer (Anna Willoughby, who had no knowledge of infection status) viewed the videos and recorded the number of bouts and the number of wins, losses, or draws for each beetle. In 3 minutes, most pairs had 7-10 bouts. Wins were determined based on known behaviors such as biting, flipping, or other forms of aggression (**see Fig. 2**). The observer determined the overall winner of each pairing based on the number of fights won. We converted this to a percentage based on the number of bouts. To determine the effects of infection, we compared the frequency of wins between infected and uninfected individuals using chi-squared tests.

Results

Table 1. Frequency of wins and losses for infected and uninfected individuals. There was no difference in fighting success between infected and uninfected beetles (Chi-square test, $p=0.817$).

Infection Status	# Fights Lost	# Fights Won	Total Beetles	% Wins
0	24	23	47	49%
1	15	16	31	52%

Table 2. Frequency of win and losses for infected and uninfected beetles grouped by infection severity. The most severely infected beetles (~ thousands of nematodes) tended to win more fights compared to less infected individuals (<10 nematodes).

Nematode Score	# Fights Lost	# Fights Won	Total Beetles	% Wins
No worms	24	23	47	49%
<10 worms	6	2	8	25%
10-100 worms	5	4	9	44%
1000+ worms	4	10	14	71%
Total	39	39	78	

Discussion & Conclusions

- Based on the data collected so far, the answer to the original question appears complex; while overall infection does not lead to lower fighting success, **the most heavily infected** beetles tended to win most of their fights.
- This is counter-intuitive to the idea that parasites drain energy from their host (since having more parasites should drain more energy).
- Parasite severity could be related to age ; older, more infected beetles may win more fights from experience.
- Alternatively, the nematode could hijack the endocrine system, leading to a higher release of hormones triggering more aggressive behaviors.
- We have additional beetles that have not yet been used in fighting trials and we plan to continue increasing our sample size before running final analyses.

Acknowledgements

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