

Parasites and Host Social Structure: An Experimental Analysis

Phase One: May 1999-February 2001

Final Report to the Black Rock Forest Consortium

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Project Title: Parasites and Host Social Structure: An Experimental Analysis (Phase One)

Summary: The ability to avoid parasites is intricately associated with the social structure of hosts, which in turn may be influenced by a broad array of parameters such as the need to avoid predators and the ability to gain access to resources. Evidence suggests that variation in the extent to which hosts are parasitized can be accounted for by variation in the degree of host sociality. However, much of the evidence is correlational, the direction of the relationship is usually unknown, and the interactions of parasite communities and host social structure have not been well tested. Whether the shift from an asocial to a social life carries with it an increased parasite or pathogen burden has also not been examined intraspecifically. This ongoing research examines parasite costs of sociality and asociality in an experimental analysis of free-ranging raccoons (*Procyon lotor*) inhabiting Black Rock Forest. During phase one of the study baseline information was gathered on the raccoon population, their movements and denning ecology, and their parasites communities. In phase two of the study, social contact will be induced at areas of clumped resources. Paired comparison of control (augmented resources are dispersed; raccoons remain solitary) and experimental (augmented resources are clumped; raccoons become social) populations will elucidate the influence of social structure on parasite abundance, prevalence, intensity, diversity, and transmission, both within populations and within focal individuals. In addition, in a final third phase, the genetic relatedness of associating individuals will be assessed to quantify its role (1) in structuring raccoon societies and social behaviors, (2) as a potential mechanism underlying routes and rates of parasite transmission, and (3) in delineating patterns in parasite faunal similarity of individuals within populations.

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Project Duration: Phase one of the study ran from May 1999-February 2001. Phase two commences March 2001

Background: Social organization reflects evolutionary pressures to maximize fitness, and thus, as applied to parasite-host interactions, to avoid, minimize or eliminate parasitic infections. Cross-species studies suggest that parasites can exert selective pressures on host social structures and intraspecific studies generally show positive correlations of group size, number of parasite species per host, and infection intensities. The general cause of these relationships is the increased social contact that occurs within groups, and thus, the increased opportunities for parasite transmission. Sociality can also result in decreased parasitism if group-living allows more efficient vector-avoidance behaviors such as grooming, or if living with other potential hosts creates a dilution effect which decreases the chance of a particular individual being singled out by a vector or parasite.

Thus, intraspecific variation in host parasitism can be accounted for by intraspecific variation in the degree of host sociality. However, the evidence is mainly correlational and the causal direction of this relationship is typically unknown. That is,

what is the independent variable: extent of parasitism or degree of sociality? While some researchers suggest that group size is limited by parasite abundance and impact on host fitness, the associated question of whether the evolution from an asocial to a social life carries with it an increased parasite or pathogen burden has not been examined intraspecifically. To better understand the interactions between the parasite fauna and the host social structure requires (1) an experimental approach that manipulates host social structure, (2) simultaneously examining a broad array of parasites, and (3) focusing on the defining characteristics of social groups – the genetic relationships between group members.

Long-term objectives of this proposal are to:

- (1) experimentally compare parasite abundance and prevalence between control (resources dispersed; raccoons remain solitary) and perturbed (resources clumped; raccoons become social) populations;
- (2) examine changes in the abundance and impact of specific parasites on known host individuals during the process of a change from asociality to sociality;
- (3) determine the importance of specific social behaviors for avoiding or increasing the costs of specific parasites;
- (4) examine the importance of host genetic relatedness for discerning patterns of parasite faunal similarity between individuals, and patterns in parasite transmission rates among interacting individuals.

During the first phase of this study (1999-2000) baseline information was collected on raccoon population biology and the parasite community infecting raccoons at the study site. During the second phase of this project we will augment resources for a subset of Black Rock Forest raccoons, thereby altering social structure and contact rates of the raccoons. The behavior and parasite community of these perturbed animals will be monitored and compared to control animals inhabiting a different area in BRF.

Progress to date: Work on phase one was successfully executed during 1999 and 2000, in preparation for phase two of the study. The primary objectives of phase one were to assess the size and make-up of the raccoon population, radiocollar selected individuals to monitor baseline levels of social behaviors, and assess the parasite community found in this raccoon population.

➤ **Trapping success and Population Size**

Trapping efforts have focused on two sites, Glycerine Hollow and the Jim's/Sutherland Pond area. The two sites are separated by only about 5-8 km., but are found in separate watersheds and are isolated by a series of large ponds as well as rocky peaks and cliffs. Forty-two individuals were trapped and processed a total of 65 times at these two sites during 1999-2000. Mark-recapture analyses at each site revealed similar population densities of approximately 5.5 – 6.0 individuals/ km². At both sites sex ratios are not significantly different from 1:1. There was no indication of movement of individuals between the two sites.

➤ **Social Behavior-**

We observed no indications of social behaviors amongst adult raccoons, with the exception of communal denning in the winter of 1999. While raccoons are traditionally considered asocial, they have been shown to exhibit flexibility in social structure. We radiotracked 24 raccoons between the November 1999 and February 2000. All animals were communally denning throughout the 1999 winter in a limited number of dens that were used repeatedly. The composition of communally denning groups was fluid, with individuals moving between dens independent of one another. From spring through fall all raccoon dens involved solitary individuals that rarely used dens for multiple nights. In contrast to the winter of 1999-2000, during the winter of 2000-2001 we found no evidence of communal denning. We hypothesize that this seasonal social tolerance during winter 1999-2000 was a thermoregulatory strategy for dealing with decreased temperatures and snowpack relative to winter 2000-2001.

➤ Ectoparasites –

Initial analyses of raccoon ectoparasite communities also revealed no qualitative difference between the two sites. Preliminary analyses of ectoparasites collected from trapped adults (n = 20) have revealed several intriguing patterns. While there was no significant difference in the prevalence or abundance of ticks on adult males and adult females, this was not the case for lice and fleas. Lice were present on 55% of individuals, but males, for whom prevalence was 73%, dominated this category of parasitized individuals. Lice did not parasitize most adult females. A similar pattern emerges for parasitization by fleas. Most adult females were not infected by fleas (prevalence = 11%), but 50% of adult males were infected. These sorts of sex-biased skews in parasite burdens are similar to that observed by Gompper for lice and chiggers parasitizing coatis (*Nasua narica*) in Panama (Funk et al. 2001). In that case the skews were associated with the interaction of parasite transmission mechanisms and host social structure.

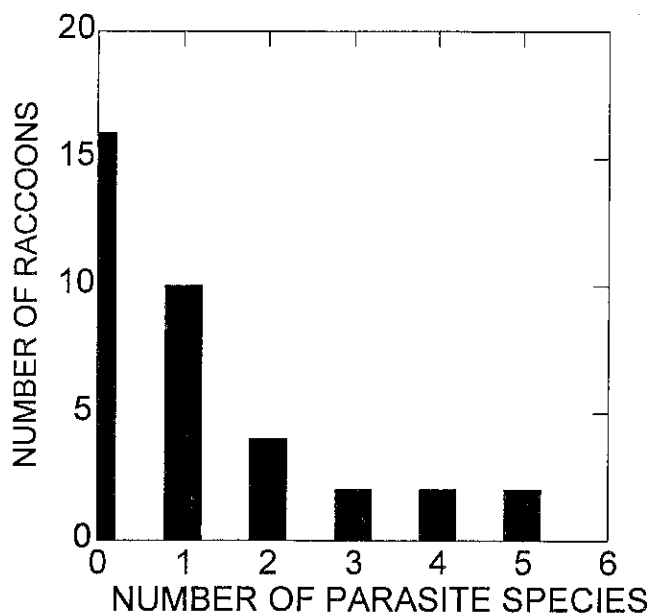
➤ Gastrointestinal Parasites –

To date, full diagnostic analyses have been performed on feces from N = 36 raccoons. Eleven gastrointestinal parasites were identified, with prevalence in the population of 3-31%.

Species	Prevalence
<i>Eimeria nutalli</i>	0.22
<i>Eimeria procyonis</i>	0.31
<i>Capillaria plica</i>	0.03
<i>Capillaria procyonis</i>	0.03
<i>Capillaria aerophilia</i>	0.08
<i>Capillaria putorii</i>	0.25

<i>Digenea</i> (flake sp.)	0.06
<i>Strongyles</i> sp.	0.08
<i>Crenosoma</i> sp.	0.06
<i>Macracanthorhynchus ingens</i>	0.03
<i>Placoconus lotoris</i>	0.03

Sixteen individuals were negative for gastrointestinal parasite ova. All animals tested were negative for *Giardia* spp. and *Baylisascaris procyonis*. This is surprising given that both are typically considered ubiquitous in northeastern raccoon populations, and the high prevalence of *Baylisascaris* is generally considered as the cause for the decline of the Alleghany woodrat (*Neotoma magister*). Number of parasite species per individual varied from 0-5, with most parasitized individuals harboring 1-4 species.



Account of funds spent:

Lodging at BRF	\$1480.00
Veterinary supplies and parasite analytical costs	\$ 679.90
Map software and Compasses	\$ 149.45
Radiotelemetry receiver	\$ 900.00
Raccoon Radiotelemetry collars (35)	\$8620.00

(actual cost to grant = \$1090.65. Remaining costs of radiocollars paid by Gompper's start-up funds from Columbia University)

Total funds spent from BRF grant:

\$4300.00

Goals for the coming year:

- Commence experimental perturbation – In March 2001, feeding stations will be erected in Glycerine Hollow as we commence efforts to perturb social structure.
- An expanded effort to trap and radiocollar additional raccoons will commence in April/May 2001 and run through November 2001.
- Continued examination of social interaction at den sites will occur. We will also commence nocturnal radiotracking to identify possible social dyads in the populations.
- Processing of fecal samples will continue through the coming year.
- In late 2001/early 2002 we will commence initial efforts to characterize the genetic relationships of individuals in the population