title	Host-parasite interactions between sand crabs and acanthocephalan parasites: do parasites make crabs easier for birds to eat?
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proj_desc	The complex interplay between parasites and their hosts has consequences for the fitness of both organisms, and may impact population dynamics. Parasites with complex life cycles, in which there are intermediate as well as definitive hosts, are especially influential in shaping the ecology of the area in which they occur. Acanthocephalan parasites (Profilicollis species) infect sand crabs (Emerita analoga) throughout the central coast of California. Infected crabs are eaten by shorebirds (the definitive hosts) and the cycle begins again when crabs ingest parasite eggs in bird feces. Thus, the parasites affect both the crabs and other invertebrates that they infect, and the birds that eat them. Classic experiments on related systems have shown not only that harboring parasites negatively affects crab survival, but that parasites manipulate crab behavior and morphology such that the crabs are more likely to be eaten by birds. However, to date, no one has examined this possibility in the Profilicollis/Emerita analoga system. We propose a series of experiments to explore the effects of Profilicollis on sand crab burrowing behavior, metabolic rate and morphology, with the ultimate goals of determining the effects of parasite infection on crab fitness and the likelihood that parasites manipulate crab behavior and morphology to ease capture by host birds. Our experiments will fall into four categories: 1) Burrowing behavior as a function of parasite infection, sex and substrate type. Burrowing ability will be measured as the time between initiation of burrowing and full disappearance under the sediment surface. Burrowing endurance will be measured as the number of times a crab can burrow following repeated disturbance, before becoming exhausted. Substrate types will reflect the difference in the coarseness of the sand on local beaches. We will examine the behavior of crabs from multiple locations burrowing in multiple sand types. This will allow us to determine whether there is local adaptation to the native sand type, or whether one type of sand (e.g., coarse sand) is easier for all crabs to burrow in. We have anecdotal evidence suggesting that the sand at Avila Beach, which has recently been restored, is more coarse than the sand at Pismo Beach. 2) Resting metabolic rate of parasitized and unparasitized crabs. Resting metabolic rate is an indicator of the energy expended for basic functions, and we hypothesize that parasitized crabs of a given size will have a greater resting metabolic rate than unparasitized crabs. If this idea is supported, it would suggest that parasite infection is energetically costly, such that parasitized crabs are potentially less able to avoid or escape from predators. Metabolic rate will be measured as dissolved oxygen uptake during a fixed amount of time in which the crabs are burrowed beneath the sand. 3) Limb asymmetry and limb morphology. Crab leg and uropod length have been shown to affect burrowing ability. Similarly, asymmetries in limb lengths (due to abnormal molting caused by parasite infection) may result in sub-optimal burrowing abilities. We will measure limb lengths and asymmetries and muscle masses to determine whether these correlate with burrowing ability and parasite status. 4) Crab egg pigmentation and trade-off between egg quality and female quality. Crab eggs are bright orange, and may contain carotenoid pigments. Carotenoids cannot be synthesized by animals, and must be ingested, and carotenoid availability may be limiting in the wild. The same carotenoid pigments are also important immune system enhancers. Therefore, female crabs may face a trade-off between allocating carotenoids to eggs (to enhance egg quality) versus to their own immune systems. We will determine whether the orange color of the eggs is produced using carotenoids, and if so, whether parasitized female crabs sacrifice egg quality in favor of their own immune systems. This type of trade-off is also expected to vary with crab age (as determined by size class) and the number of parasites.

inter_desc	This is a highly collaborative project, involving faculty specializing in parasitology, behavioral ecology and physiology. The results are of interest from the perspective of parasite manipulation of hosts, evolutionary trade-offs in natural environments, and physiological costs of parasite infection. Our research team involves a parasitology graduate student and would ideally involve several undergraduates interested in parasitology and/or the ecological and evolutionary implications of host-parasite systems. We are also closely involved with the Marine Sciences group, and are planning to house the crabs and conduct all lab data collection at the Cal Poly Pier. Students could specialize in working on one of the four categories of experiments described above. Most of the methods involved are familiar to at least one of the faculty members involved in the project, and the crabs (including parasitized crabs) are easily collected from local beaches, using readily available equipment.
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