The role of MHC and olfaction in mate choice in Leach's storm-petrels

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My work on major histocompatibility complex (MHC) regulation after infection in Scott Edwards' lab has sparked my interest in the effect of MHC on mate choice. Individual scent is influenced by MHC, a highly polymorphic cluster of genes encoding cell-surface molecules crucial in producing an immune response and regulating self-nonself discrimination (Penn & Potts 1999). MHC-associated odors affect mating preferences in various vertebrates (Penn & Potts 1999; Reusch et al. 2001; Wedekind et al. 1995). Selection for mates with many MHC alleles is thought to be adaptive in that they produce offspring with more effective immune systems; selection for MHC-dissimilar mates is a mechanism of inbreeding avoidance (Reusch et al. 2001). Some birds have been shown to exhibit MHC-based disassortative mating (Bonneaud et al. 2006), but the mechanism of the discrimination remains unknown.

Leach's storm-petrels (*Oceanodroma leucorhoa*) are a species of procellariiform ("tubenose") seabird common to the Northern Hemisphere. These long-lived seabirds are highly pelagic and philopatric to remote islands, which suggests that there exists some mechanism for inbreeding avoidance. Pairs are socially and genetically monogamous, and return to their burrow nests only at night (Huntington et al. 1996). It is widely known that procellariiforms have well-developed olfactory bulbs and use their excellent sense of smell in locating prey (Nevitt 1999; 2000) and relocating the nest site (reviewed by Nevitt and Bonadonna 2005). Recent studies found evidence for odor-based individual recognition in Antarctic prions (*Pachyptila desolata*): birds were able to distinguish their own odor or their mate's odor from conspecific odor (Bonadonna & Nevitt 2004). These results suggest that olfaction may play an important though commonly overlooked role in procellariform mate choice.

Besides the work by Nevitt and Bonnadonna, few investigations have addressed the possible function of olfaction in mate choice in birds. I propose to explore the role of MHC-associated odors in mate selection in Leach's storm-petrels. I will characterize MHC diversity in a colony of Leach's storm-petrels, then test for MHC-based disassortative mating and the ability to distinguish between individuals of differing MHC allele number and similarity based on odor.

Methods

To test for MHC-based disassortative mating, a thorough characterization of the MHC class I and II genes is required. I will collect blood from birds at Bon Portage Island in Nova Scotia and construct a cosmid library and screen it with probes designed from MHC class I and II sequences in Genbank. Positive clones will then be shotgun sequenced. MHC genotyping of 200 individuals will provide an estimate of overall MHC diversity in the colony.

Characterization of MHC loci will allow determination of MHC allele number and composition in individual birds. I can thus test whether MHC plays a role in mate choice. I will weigh and collect blood samples from ~100 breeding pairs of Leach's storm-petrels. Each bird will also be molecularly sexed and banded for re-identification later. Number and similarity of MHC alleles will be determined for each bird and evidence of mate choice based on those two factors will be investigated. As birds may evaluate MHC genotype by other means, I will also look for any correlations between MHC genotype and visual cues of fitness such as body mass and condition.

If disassortative mating with respect to MHC is detected, I will test whether personal odor cues play a role in this behavior. Using pre-established techniques (Bonadonna and Nevitt 2004), I will conduct a series of experiments to see if Leach's storm-petrels can distinguish

between individual odors. Odor preference tests in adults will be conducted using a Y-maze: odor-donors will be placed in a cotton bag for an hour, then the scented bags will be placed in separate arms of the maze. Air will be blown over the scented bags, and the odor preference of the test bird determined by noting which arm of the maze it walks up.

To test for odor-based sex discrimination, we will see if female birds prefer the scent of a male or that of a female. We will then repeat the experiment with male birds. The two odor-donor birds should have a similar MHC genotype to ensure that the observed preference only reflects a preference for a certain sex. Other choice experiments will be conducted to determine if birds can evaluate the MHC allele number or similarity of potential mates by smell. Female birds will be given the choice of males with a large number of MHC alleles or a small number of MHC alleles. In another experiment, females will choose between MHC-similar and MHC-dissimilar males. Both experiments will be repeated for test males with female odor-donors.

Anticipated Results

The characterization of MHC Class I and II loci in Leach's storm-petrels followed by MHC genotyping of several individuals should give a basic estimate of the MHC diversity in the colony. If evidence of MHC-based disassortative mating is found from MHC genotyping of breeding pairs, the mechanism of this decision should be revealed in the body size comparisons and odor preference tests. If MHC diversity were low, I would expect that inbreeding avoidance would be a more significant driving force in MHC-dependent mate selection than increased immune function in offspring, and birds will prefer potential mates with maximally dissimilar MHC. If the population is fairly heterogeneous, birds will seek mates with a greater number of MHC alleles. Test birds that already have a large number of alleles will seek mates with fewer alleles than those with few MHC alleles, as an excess number of MHC alleles increases the probability of autoimmune disorders. Insights on MHC diversity and patterns of mate choice may have important ramifications in managing populations of the many procellariiform species endangered by fishing interactions and habitat destruction. I hope to perform this study at UC Davis, which has a strong population biology group and expertise in this area.

References

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