Mechanisms determining predatory behavior:
insights from an experimental evolution on bank vole

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The major challenge in evolutionary physiology is to explain the mechanisms behind evolution of complex adaptations, allowing realization of the variety of lifestyles, such as those associated with relying on a specific diet, habitats, or modes of locomotion. Evolution of such adaptations is associated with extensive changes at all levels of an animal's organization, from molecules to morphology and behavior. This project is a next step in a long-term research program, in which we ask what proximate mechanisms (genetic, molecular, physiological, and neurobiological) underlay evolution of one of such complex adaptations – the predatory lifestyle. Predatory behavior is important not only from ecological and evolutionary but also from biomedical perspective, because of its plausible relevance to pathological forms of aggression observed in humans. However, surprisingly little is known about the genetic basis and neurological control of predatory aggression, especially in comparison to the large body of knowledge concerning conspecific-directed aggressive behaviors. One of the reasons of this deficiency is a limited range of suitable animal models.

The first step in our research program was creating a unique experimental-evolution model system: lines of a common rodent, the bank vole (*Myodes glareolus*), artificially selected for propensity of predatory behavior toward crickets. To control for random genetic effects, four selected and four unselected, randomly bred control lines are maintained. In the "predatory" lines the proportion of voles attacking crickets is much larger, and the time of catching the cricket is shorter, than in the control lines. The lines differ also in some other behavioral and morpho-physiological traits, as well as in expression level and frequency SNP alleles (single nucleotide polymorphism) in several relevant genes.

The current project has five main specific objectives. First, we will characterize details of the predatory behavior to answer the question whether the selection increased not only the propensity to attack but also the hunting skills. Second, to test a hypothesis that the predatory and conspecific aggression share some control mechanisms, we will check whether the selection for increased predatory behavior resulted also in an increased inter-male and maternal aggression. Third, we will assess the contribution of genetic and maternal postnatal effects to the behavioral differences between the predatory and control lines. In a cross-fostering experiment, newborns will be reared by mothers from the same or the opposite selection lines, and then behavior of the offspring will be analyzed. The experiment will answer a question whether rearing by an aggressive mother alters behavior of the offspring, and particularly whether it enhances the predatory propensity, irrespective of the genetic background of the focal individual. Fourth, we will make a preliminary step towards identification of the neuroendocrine pathways responsible for the predatory propensity. We will analyze several hormone levels in plasma, and serotonin and dopamine (and their corresponding metabolites) levels in two brain structures involved in the control of the distinct aspects of predatory behavior: central amygdala (hypothetically involved in motivation to pursue and attack prey) and ventrolateral caudoputamen (stereotyped sequence of movements necessary to catch, kill and eat the prey). We will also analyze neural circuit activation (expression of C-fos gene) to identify brain regions differentially activated by a recent cricket predation test in voles from the predatory and control lines. Finally, the project will provide tissue samples ready for investigation of the molecular background (gene expression level) of the predatory behavior, which will be undertaken in a prospective next project.

While this project will most imminently enhance our understanding of evolution of predatory behavior, it may also ultimately contribute to our understanding of biological basis of deviant forms of conspecific aggression, such as violent crime or aggression in pathological family. However, we realize that at this stage the translational perspective is distant.

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