Title: Genetic Dissection of Mate Recognition in *C. Elegans*

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Abstract: Mating is one of the social behaviors conserved among metazoans to exchange genetic variations that maintain phenotypic plasticity during evolution. Animals utilize arrays of sensations to decode information about sex, species and developmental stage to precisely and efficiently recognize conspecific and reproductive mates. While *C. elegans* males have been shown to recognize different sexes by displaying distinct locomotory patterns to search for potential mates, the genetic and neural mechanisms are still unclear. Consistent with previous studies, we showed that *C. elegans* males alone displayed the exploration behavior, and this behavior was drastically suppressed by the presence of conspecific hermaphrodites but not males. The ability of male retention by hermaphrodites was gradually acquired from L3 larvae to adult stage, as adult hermaphrodites showed the strongest attractiveness to males**.** In addition, the attractiveness of hermaphrodites in different species aligned with the evolutionary distance, for the evolutionarily distant species significantly lost the ability to retain *C. elegans* males. This mate recognition did not require known attractants for males, such as secreted ascaroside pheromones, vulval cues and germline signaling in hermaphrodites. Interestingly, we showed that the sexual identity and developmental stage of hypodermis and seam cells are critical for the attractiveness of hermaphrodites. Together, these data indicate that males are able to recognize potential mates based on their sex, species and developmental stage through accessing unidentified hermaphroditic cues. To search for the neural mechanism by which males recognize mates, we performed candidate screening and found that mate recognition likely depended on chemosensation but not mechanosensation. The neural processing of mate recognition relies on *mab*-21 (which encodes a novel protein), as the mutant showed the completely opposite behavior compared to the otherwise wild type. In sum, these results establish a useful genetic framework to understand the sensory cues and the sensation mechanisms of mate recognition in *C. elegans*.