PNAS COMMENTARY

Tadpoles and frogs have a different sense of taste

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Fig. 1. A tadpole (*Upper*) and an adult (*Lower*) of American bullfrog *Lithobates catesbeianus*. Tadpoles are herbivorous living in the water, while adults are carnivorous living partly on land. Hao et al. (6) studied this species and found that tadpoles and adults employ different bitter taste receptor (*Tas2r*) gene repertoires to each other. Photo courtesy: Takahide Sasai.

Animals use sensory systems to perceive their environment, and different species have different sensory capabilities depending on their habitat. However, how an animal adapts its sensory systems as it ages and experiences changes in its environments is not well understood. Anurans (frogs and toads) exhibit a biphasic life cycle comprising both larval (so-called tadpole) and adult morphs (Fig. 1). Tadpoles live only in the water, while adult frogs become more or less terrestrial. The surrounding environment of adult frogs may diverge from that of conspecific tadpoles (1), leading us to postulate that their sensory systems undergo modification

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through metamorphosis. Indeed, extreme remodeling of the olfactory organs occurs during metamorphosis to accommodate aerial olfaction (1–3), and odorant receptor genes expressed in the noses of adult frogs are suggested to differ from those expressed in the tadpole olfactory organs (4, 5). The taste anatomy of adult frogs also differs from that of tadpoles (2). In this issue, Hao et al. (6) report that tadpoles and adult frogs use different bitter taste receptor (*Tas2r*) gene repertoires to each other.

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Anuran tadpoles use taste buds for gustation, which are located on the papillae dispersed throughout the oral epithelium. However, during metamorphosis, the taste buds are replaced by taste discs, and adult frogs employ taste discs situated on the secondary tongue, which also emerges during metamorphosis (2). Hao et al.'s findings (6) suggest that not only do the anatomy but also the sensory function of gustatory systems differ between aquatic tadpoles and semiterrestrial adults of bullfrogs. The transition between aquatic and terrestrial lifestyles is one of the most striking examples of evolutionary adaptations. The repertoire of odorant receptor genes differs significantly between aquatic fishes and terrestrial amniotes (7), reflecting the distinct chemical environments of underwater and land habitats (1, 8). Anurans exhibit terrestrial adaptation through their ontogeny (1), and Hao et al.'s findings (6) imply that aquatic and land animals require different types of the *Tas2r* genes, as in the case of odorant receptor genes.

As Hao et al. (6) suggest, the changes in expression of the *Tas2r* genes through metamorphosis can be explained not only by the habitat shift but also by the dietary shift from an herbivorous tadpole to a carnivorous frog. Ontogenetic dietary shift is observed widely among vertebrates (9), including mammals such as dolphins (10) and humans (11). Humans tend to become more tolerant of bitter compounds and less fond of sweet tastes as they age (11, 12), and it is hypothesized that changes in sensory function associated with aging play a significant role in these shifts in taste preferences (11). Hao et al.'s findings support this hypothesis in frogs, and further studies that build upon this line of inquiry may reveal important insights into the underlying mechanisms of ontogenetic dietary shifts in a wide range of animals, including humans.

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