Study of birds' sense of smell reveals important clues for behavior and adaptation

July 29 2015

From slight sparrows to preening peacocks to soaring falcons, birds have long been known to possess distinct abilities in their sense of smell, but little has been known about the evolution of olfaction.

Now, a large comparative genomic study of the olfactory genes tied to a bird's sense of smell has revealed important differences that correlate with their ecological niches and specific behaviors.

Authors Agostinho Antunes et al., in a new study published in the advanced online edition of *Molecular Biology and Evolution*, analyzed olfactory receptor genes (OR gene families) from 48 ecologically diverse bird and two reptilian genomes. The study suggest that specific OR genes are used not only to detect a range of chemicals governing a bird's ability to smell, but that in birds, specialized olfactory skills, such as those found in birds of prey or aquatic birds, was mirrored by the genetic diversity of their OR gene families.

In vertebrates, ORs are considered to be one the largest multi-gene families, ranging from a single gene in elephant sharks to more than 1,000 genes in some mammals. In the study, drastic expansion of specific OR's gene families, such as OR51 and OR52, were seen in sea turtles and aquatic birds, which the author's proposed are use to detect water-loving (hydrophilic) compounds. OR families 2, 13, and 52 were more common in aquatic birds. In contrast, the expansion of OR14 was found in the birds that could smell volatile compounds (terrestrial birds). OR 6 and 10 were associated with vocal learners. Birds of prey had a comparatively high percentage of OR families 5, 8 and 9. These were also the largest OR families observed in alligators, which like birds of prey, depend on hunting or scavenging for food, which also suggests that these genes are needed for adaptation in carnivores.

Overall, different ecological partitioning and specialized groups of birds, such as vocal learners, birds of prey, water birds and land birds, was strongly correlated with OR differences suggesting that the OR families may contribute towards olfactory adaptations.

Finally, the research team related the genetic differences to bird anatomy, and the size of the olfactory bulb, the main neurological structure involved in smell. The relative size of the olfactory bulb in birds was found to correlate with ecological adaptations, including habitat association (e.g. water birds), type of nesting strategy and diet. For example, birds of prey, including vultures and seabirds, hunt and recognize food by smell, and have relatively large olfactory bulbs, whereas song birds that rely more on cognitive abilities helpful in tool making, vocal learning and feeding innovations have reduced olfactory bulb sizes.

Overall, the role of ecological adaptation in shaping the OR gene families has been found to be consistent in both birds and mammals, indicating the importance of a sense of smell to an animal's fitness, survival and niche.

Provided by Oxford University Press