

The significance of olfaction in the Brown Kiwi

Assignment for Wildlife Ecology

Kristine Long

The Kiwi (*Apteryx australis*) is a flightless, nocturnal bird indigenous to New Zealand. There are five recognised species, “Great Spotted”, “Little Spotted”, “Okarito Brown Kiwi”, “Brown Kiwi” and the “North Island Brown Kiwi”.

Morphologically, the Kiwi is quite unique relative to other avian species. Similar in size to the domestic chicken, females are larger than males and lay eggs up to a quarter of their weight. Owing to the size of the egg which has been likened to that of an ostrich egg, the female is forced to fast three to four days before laying in order to accommodate the egg.

Adorned with thick brown feathers, the Kiwi is tailless and possesses extremely strong feet, ideal for burrowing. An exceptional feature exclusive to the Kiwi is its distinctive beak which is up to one third the length of its body, and proves useful for finding and digging up food. Interestingly, it is the only bird with nostrils at the end of its beak. The Kiwi can often be heard “snuffling” during the night, as it rids its nostrils of debris.

Kiwis are monogamous, some having been together for more than twenty years. New Zealand’s isolated location accounts for the preservation of the species, as it provides a secure environment free of predators.

The kiwis vision is significantly reduced which necessitates a heightened auditory and olfactory acuity. Currently, the importance of olfaction has come under scrutiny.

For the most part it was believed that birds had a relatively underdeveloped sense of smell. Recent studies however have led us to believe that the olfactory capabilities of some avian species, particularly that of nocturnal species is outstanding and has been likened to that of mammals.

An article by Silke S. Steiger, published in 2009, describes a study undertaken, aimed at investigating the OR gene receptor repertoire of two closely related species. One species was nocturnal, therefore depending on olfactory cues, and the other diurnal. Steiger hypothesised that the nocturnal species had evolved more OR genes and more intact OR genes than their diurnal relatives.

Apteryx australis, (Brown Kiwi), and *Strigops habroptilus* (Kakapo) represented the nocturnal species. *Dromaius novaehollandiae* (Emu) and *Nestor meridionalis* (Kaka) served to represent their diurnal relatives respectively.

The nocturnal species are flightless and have poor vision and hearing. Their sense of smell however is relatively well developed and may be akin to that of mammals. Southern Hybridisation was used to uncover the number of OR gene sequences within the genomes. PCR was then used to distinguish whether the sequences were intact or pseudogenes. A sequence was deemed to be “intact” if an uninterrupted coding region was uncovered. While an interrupted coding region signified a pseudogene. Calculations to compare the quantity of “intact” OR genes between the diurnal and nocturnal species were carried out using Chi square tests. An estimation of the functional OR repertoire size was not carried out as the calculation of which would have yielded considerable error. In place of this, the total number of OR genes was used as a substitute for the number of functional genes as there is a positive correlation between the two.

The results of the study demonstrated that the total number of OR genes in each genome varied between fifty five and four hundred and seventy eight. In the case of the nocturnal species, the OR gene repertoires were five to eight times greater than those of their diurnal relatives. Interestingly the kiwi’s results were considerably more elevated than that of its relatives.

Estimating the proportions of potentially intact OR genes reflected that with regard to the paleognath species used in the study, the proportions did not differ drastically. However, they differed appreciably among the psittacine species. Using Southern blot hybridisation of the paleognathic genomes the comparison of OR gene repertoires was made. By and large, the kiwi DNA was much more rigorously labelled than the other species.

Of the OR partial coding sequences amplified in the study the bulk of them did not have stop codons. This perhaps signifies that they were derived from potentially functional OR genes. If the proportion of intact OR genes are believed to reflect the olfactory ability this would lead us to believe that nocturnal birds would encode a higher percentage than their diurnal neighbours. However, this was not the case as the Kiwi showed no difference compared to that of its relatives. The estimated total number of OR genes on the other hand was five to eight times larger in the nocturnal species. In concurrence with a previous study undertaken by Steiger, the information

collected proposes that there is a positive correlation between the relative size of the olfactory bulb and the total number of OR genes. The results imply that it is the total number of OR genes rather than the proportion of intact genes that is most closely linked with olfactory dependency. This dismisses the percentage of intact OR genes as an adequate measure for the study of the evolution of OR genes. Recent evidence demonstrating the expression of OR pseudogenes in the olfactory epithelium in humans supports the concept that pseudogenes may have a biological purpose. It has been hypothesised that the more OR gene receptors encoded on an animals genome the more proficient they are at distinguishing between odours. In keeping with this, nocturnal birds that have developed more OR genes might be able to distinguish between a larger assortment of odours than a diurnal bird in the same habitat. However, OR gene number alone is unlikely to be sufficient. The number of olfactory neurons and the size of the olfactory epithelium probably play an important role, though little information is available on these characteristics at this time.

Steigers study concludes that the OR gene repertoires are greater in the genomes of the nocturnal bird species compared to their diurnal counterparts. The results support previous studies that have suggested that nocturnal bird species have a well developed sense of smell, and like mammals, may rely on same for survival. This is particularly interesting in the case of the Kiwi whose auditory and visual capabilities are significantly reduced. A heightened olfactory capacity would account for the bird's ability to exist in the nocturnal milieu to which it is accustomed.

