ScienceWatch - Food is Where You Smell It

In nature certain organisms have a well-documented ability to smell odors. Pacific salmon (*Onychorynchus* sp.), for example, smell the chemical signature of their home stream thousands of kilometers away (one kilometer equals 0.62 miles). Birds, however, were believed to locate their food primarily by vision, depending little, if at all, upon their sense of smell. This conventional wisdom stemmed from the fact that most birds have extremely tiny olfactory bulbs, the brain region responsible for smell. Even John James Audubon thought this was true. He popularized the misconception that vultures don't use smell to locate their food after he conducted an experiment in which he presented black vultures (*Coragyps atratus*) with covered and uncovered reeking carcasses; the birds flocked to meat in plain sight.*

By the 1960's, however, researchers began to question this claim. In 1965 Betsy Bang, at the Woods Hole Marine Biological Laboratory in Massachusetts, found that whereas olfactory tissue comprised only 3% of the brains of small songbirds like the black-capped chickadee (*Parus atricapillus*), olfactory bulbs in pelagic seabirds were the largest of any bird. In the case of the snowy petrel (*Pagodroma nivea*) the olfactory bulb equaled up to 37% of brain weight. This suggested that olfaction plays a fundamental role in the life of these tube-nosed seabirds, known as Procellariiforms.

Procellariiform seabirds (Order Procellariiformis) include the albatrosses, fulmars, shearwaters, large petrels, smaller storm petrels, and prions. They breed on oceanic islands and spend much of their lives out at sea. These seabirds forage over huge areas, traveling as much as thousands of kilometers per trip in search of irregularly distributed food, primarily krill, squid, and fish, which they capture at or near the sea surface. How do they locate distant foraging grounds in a seemingly featureless ocean? Writing in the April 2000 issue of the journal *Biological Bulletin*, Gabrielle Nevitt of the University of California, Davis, shows that some Antarctic procellariiform species living in the South Atlantic ocean locate krill by homing in on a certain chemical, which is generated as the krill feed on marine algae.

Since odors should be widely dispersed by winds, many thought it unlikely that birds could locate food over vast featureless distances by such ephemeral and fragmented cues. But Nevitt used several lines of evidence to postulate how seabirds might use odor cues emitted by prey to locate feeding grounds that are akin to needles moving around in a haystack. First, Nevitt and others had shown that various albatross species were attracted to fishy odors like herring oil or cod liver oil. Second, satellite-tracking data collected in recent years from radio-collared foraging albatrosses revealed that these birds move rapidly and directly to distant locations where they then begin circling in a restricted area. Third, atmospheric data detected odorous sulfur-containing compounds of biological origin, such as dimethyl sulfide (DMS), in areas where krill congregate. DMS is an obnoxious gas that smells like rotten eggs. Humans are sensitive enough to detect less than one part per billion in the air. Fourth, marine algae living in surface waters give off DMS, which is retained by grazing crustaceans and even released as they consume the algae. Finally, atmospheric maps of the region can detect plumes of DMS over zones of upwelling currents where the algae are especially abundant.

Nevitt suggested that the birds travel through an olfactory landscape of low and high levels of DMS to locate food. She tested this by presenting birds with DMS-laced vegetable oil slicks and discovered that the smaller procellariiforms such as white-chinned petrels (*Procellaria aequioctialis*), Wilson's storm petrels (*Fregetta tropica*) and prions (*Pachypilla sp*.) found DMS slicks twice as attractive as plain oil, indicating that they used DMS as a food cue. How could the birds follow a gradient of DMS in an often-turbulent atmosphere? Borrowing from the satellite-tracking results, which suggested the birds begin circling once they reach the vicinity of a feeding area, Nevitt postulated that the odor cue prompts the birds to begin a search pattern by making broad turns in order to follow the DMS gradient. She tested whether DMS could cause the birds to begin turning when they encountered the odor by spraying DMS-containing aerosols into the air near white-chinned petrels. The spray caused the birds to increase their turning rate by 25% just as they would as they neared a feeding area. On the other hand, black-browed albatrosses (*Thalassarche melanophrys*) did not turn any more frequently nor did they show any attraction to the DMS slicks. These results indicate that some procellariiforms follow DMS gradients while others do not. To further test whether certain birds foraged preferentially in areas of elevated DMS, Nevitt did seabird counts and analyzed the local atmosphere for DMS levels. The results showed that blue petrels (*Halobaena caerula*) and prions were most abundant when atmospheric DMS levels were highest. What about the albatrosses that appear not to detect DMS? Nevitt thinks they may depend upon the smaller petrels and prions to act as scouts. Once they locate a feeding ground, the larger birds can displace them.

Nevitt's work is the first to demonstrate an association between a naturally-occurring scented substance and a species of foraging seabird. It is likely that others will be discovered as more studies are done.

*Had he picked turkey vultures (*Cathartes aura*) he would have discovered that they are guided by a keen sense of smell. In fact, crews trying to locate leaks in natural gas lines look for kettles of turkey vultures because the gas is spiked with ethyl mercaptan, a vile-smelling compound resembling the odor of carrion.

Saul Scheinbach