windswept

PETER RYAN (2)

The Wandering Albatross *Diomedea exulans*, renowned for having the largest wingspan of any living bird, is also one of the best studied birds. Detailed breeding studies following marked individuals since the early 1960s have provided fascinating insights into ageing and senescence in wild birds. But what albatrosses do at sea, away from their breeding islands, remained little known until 1990, when the first study to track breeding albatrosses with satellite transmitters was published (Jouventin and Weimerskirch 1990, *Nature* 343: 746–748). Since then, the rapid development of biologging technology has provided ever more detailed insights into their behaviour at sea.

Two factors make Wandering Albatrosses ideal subjects for such studies. Firstly, their large size allows them to carry relatively large devices (the first satellite transmitters were about the size of a cell phone). And secondly, they are easily caught – and re-caught – at their nests while breeding. This latter point is crucial for retrieving logging devices that store information rather than transmitting it back to researchers via satellite.

The first tracking studies simply documented albatross movements at sea, both while breeding, when they are constrained to return to the nest to assist with incubating or feeding their chick, and during their sabbatical years between breeding attempts, when they are free to roam the oceans. The studies showed that although some non-breeding birds circumnavigate the Southern Ocean, most remain confined to one or two ocean basins, sometimes returning to their colonies even while not breeding. In this regard Wandering Albatrosses wander less than Grey-headed Albatrosses *Thalassarche chrysostoma*, which are more likely to circle Antarctica after successfully raising a chick.

But most tracking data cover the two-month incubation period, when partners relieve each other every few weeks, making it easy for researchers to deploy and recover dataloggers. Unlike many seabirds that commute directly to and from preferred foraging areas to regain weight after a prolonged incubation shift, Wandering Albatrosses tend to make looping foraging trips, with the direction of the loop depending on the prevailing winds. Birds foraging south of their sub-Antarctic breeding islands typically loop in a clockwise direction, whereas those heading into warmer waters to the north loop anti-clockwise. This allows them to take advantage of the prevailing winds at different latitudes, avoiding headwinds as much as possible. The deployment of miniature heart rate monitors confirmed that Wandering Albatrosses expend little effort when flying downwind or crosswind, but their heart rate increases markedly and their flight speed slows when heading into the wind (Weimerskirch et al. 2000, *Proc. R. Soc. Lond. B* 267: 1869–1874).

Interestingly, male Wandering Albatrosses tend to forage south of the breeding islands, whereas females forage to the north. Males are on average larger than females, with slightly longer wings, but they weigh 20 per cent more than females, resulting in a 12 per cent increase in average wing loading compared to females. This confers a faster gliding speed on males and makes them better suited to operating in the strong winds around Antarctica, whereas the lower wing loadings of females and juveniles are better suited to foraging in less windy, temperate waters. It has thus been suggested that sexual dimorphism in this species is driven at least in part by where they forage (Schaffer et al. 2001, *Funct. Ecol.* 15: 203–210).

Clearly wind speed and direction are crucial for efficient flight by albatrosses. But understanding how wind influences their activity at sea requires fine-scale movement data. Satellite tracking yields only a few fixes per day – more than enough to deduce a bird's general movement patterns, but not sufficiently detailed to understand how foraging trips are structured. The advent of GPS loggers has revolutionised tracking studies, allowing animal positions to be recorded every few minutes or even seconds. By combining such fine-scale data with those from a miniature activity logger attached to a leg ring that records when the bird is sitting on the water, we can infer how albatrosses behave at sea.

A recent study by Tommy Clay and colleagues (2020, *J. Anim. Ecol.* 89: 1811–1823) analysed GPS tracks of Wandering Albatrosses breeding at two colonies to assess how their behaviour changes in response to local wind conditions predicted by global wind models. Birds from the Crozet Archipelago tend to experience slightly stronger winds than those from South Georgia, consistent with the high winds found in the south-western Indian Ocean. Females from both islands forage farther north than males, but contrary to expectations this did not translate into a marked increase in wind speed experienced by males from either island.

While foraging between incubation shifts, Wandering Albatrosses spend roughly one third of the time on the water and two-thirds of the time in flight. Based on the sinuosity of their path at sea, we can subdivide flying time into foraging (when they track back and forth in an area searching for moribund squid and other tasty morsels) and commuting between these foraging areas. Clay's study found that the likelihood of switching between these three activities was influenced by the wind.

The strongest effect was for increasing wind speed to encourage birds on the water to take flight. This effect was much greater for males than females from both colonies, confirming that males are influenced by wind more than females are, as predicted by their higher wing loading. Conversely, birds were less likely to land on the water at higher wind speeds. Wind direction relative to the bird's track also influenced behaviour, with birds more likely to take off when there were head- or side winds than when there was a following wind. And once again, the effect was stronger for males.

The influence of wind strength on foraging versus commuting was less marked, but for Crozet birds, which had by far the larger data set, foraging tended to decrease and commuting increase as winds became stronger. This is to be expected, because stronger winds probably make it harder to locate prey either by sight or scent.

The findings have implications for albatross conservation, given the impact of climate change on wind patterns. We've already seen an increase in wind speeds at high latitudes in the Southern Ocean, with a corresponding shift in Wandering Albatross foraging ranges. The greater wind speeds have allowed breeding adults from the Crozet population to reduce the duration of their foraging trips, increase their body mass and improve their breeding success (Weimerskirch et al. 2012, *Science* 335: 211–214). However, Wandering Albatrosses are the largest seabirds in the Southern Ocean and stronger winds might benefit them at the expense of smaller species. And if winds continue to increase, as predicted by climate change models, they might become so strong as to start to negatively impact the foraging efficiency of even Wandering Albatrosses.

PETER RYAN

above *Wandering Albatrosses revel in strong winds, which are particularly important for males, given their greater wing loading than females.*

opposite *Wandering Albatrosses are more likely to land in light wind conditions. They sometimes use this 'down time' to socialise.*