Abstracts of Wader Theses

compiled by ROB ROBINSON

As a means of disseminating information about important new wader studies well in advance of formal publication, this series features abstracts from recent wader theses (bachelors, masters and doctoral). Theses authors are invited to submit abstracts to Rob Robinson, BTO, The Nunnery, Thetford, Norfolk IP24 2PU, UK, *rob.robinson@bto.org* or to the Editor.

Migration strategies of Red knots, *Calidris canutus rufa*: parasite effects on immune and energetic investments in non-breeding sites

(2009, Ph.D., Universidad Nacional del Comahue and Centro Nacional Patagónico – Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina)

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Parasitic infections and immune function investments in shorebirds are predicted to play an important role in patterns of habitat selection and spatial behaviour, including long-distance migration. Therefore, it has been proposed that evolution of migration in some shorebird species could be determined by a trade-off between energetic and immunologic investments, the impact of parasites and pathogens being the selective forces that shape migratory strategies. This hypothesis is based on the idea that in marathon migrants, demanding migrations and a history of genetic bottlenecking on an evolutionary time-scale may have led to poor immune resistance that further restricts them to low parasite habitats with less disease risk. Therefore, long-distance migrants might trade-off investment in immunocompetence against energetically costly and prolonged flights to marine-shore wintering sites.

Long-distance migrant Red Knots *Calidris canutus rufa* breed in the Arctic tundra and migrate to different wintering sites in northern and southern South America during the non-breeding season. The pronounced difference in migratory pathways, climates and habitats used by birds wintering in the tropics of Brazil (Maranhão) versus cold–temperate Tierra del Fuego (Río Grande) provide an excellent opportunity to test some of the basic assumptions of the parasite hypothesis at a latitudinal scale. Therefore, the main objective of my study was to evaluate the effects of ectoparasites and blood parasites on physiological processes related to immune and energetic investments at non breeding sites.

Red Knots carried a heavier burden of ectoparasites in tropical Maranhão than cold–temperate Río Grande. However, as both are marine sites, the degree of exposure to blood parasite vectors was very low; consequently no blood parasites were found in samples from either site. Although I expected a higher immune investment in birds from Maranhão; it was actually higher in Río Grande birds. Possibly this is a characteristic of long-distance migrants: long flights can cause muscle damage, recovery from which can lead to an immune response. Birds that spend the non-breeding season at Río Grande have to make a long flight northwards to Delaware Bay on the east coast of the United States, making one or more stopovers in the tropics. Therefore, these birds are equally exposed to parasites as those that spend the northern winter in Maranhão. In Delaware Bay, the abundance of ectoparasites was similar in birds that made the long migration from Tierra del Fuego and those that made the shorter migration from Maranhão. Immune investments were similar in birds with isotopic signatures from northern and southern wintering sites. This suggests on the one hand that short-distance migrants are not detrimentally affected by ectoparasite burdens. On the other hand, birds from Tierra de Fuego have to invest more resources in long-distance flights, so they might be immunodepressed and consequently more vulnerable to infestations during stopovers in the tropics (or they simply cannot avoid being infested by ectoparasites when they roost in mixed flocks with resident birds).

Long flights require more energetic resources, and at stopover sites birds generally carried higher quantities of proteins and lipids, which are essential to fuel such energetically demanding activity. However, glucose levels were higher during winter at Río Grande and decreased during northwards migration. This is to be expected since glucose is consumed very quickly, especially during the first phase of intensive exercise.

It seems puzzling that some knots make a long distance flight to spend the winter at Río Grande, flying about 6,000 km further than Maranhão, but are finally exposed to the same detrimental ecological factors found in the tropics. What is the advantage of make that long migration? Probably, Río Grande offers a good quality food supply and exposure to parasites is low; but these birds have suffered a drastic population decline. It is equally surprising that some knots opt to winter in Maranhão despite the high exposure to parasites. Moreover, recently more knots have been discovered wintering in neotropical sites. Currently, other research groups are carrying out survival analyses of knots from the different wintering sites. These studies may help to elucidate this striking question.

Hidden costs: challenges faced by migratory shorebirds living in intertidal flats

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Many of the world's migratory shorebirds depend on intertidal environments during the non-breeding season and on migratory stopovers. This thesis examines the ploys they use to survive in these dynamic habitats, focussing mostly on one study site, Roebuck Bay in north-western Australia, and on two species, the Red Knot *Calidris canutus* and the Great Knot *Calidris tenuirostris*.

Intertidal feeding areas are submerged by high tides for long periods every day, forcing shorebirds to move to high-tide refuges known as roosts. Automatic radio-telemetry was used to develop spatially explicit roost choice models for knots in Roebuck Bay; factors influencing their roost selection included distance from the feeding areas and from tall cover. By day, microclimate was important as birds needed to avoid heat stress in a tropical environment. At night birds used different habitat selection procedures, selecting safer roosts with light background colours. The models are used to predict roost selection and hence estimate the energetic costs of roosting in knots throughout a tide cycle, allowing examination of the potential costs of increased roost disturbance on the shores of Roebuck Bay, and demonstrating that roost availability may limit shorebird numbers at a site.

The distributions of shorebirds on intertidal flats were mapped at both Roebuck Bay and Eighty-mile Beach. At both sites, the most striking trend in the distribution of Great and Red Knots at low tide was their tendency to follow the receding tide-edge, rather than dispersing broadly over the intertidal flats. Their relative foraging success was higher on mudflats that had just been exposed, because their prey burrowed deeper and became less active as exposure time increased. Foraging distribution of knots is thus driven more by prey availability than absolute prey abundance; an empirical modelling approach for controlling for this problem when predicting low-tide distribution of tide-following shorebirds is proposed.

Finally, I assess whether the costs of intertidal living influence the life histories of shorebirds. Red Knots make extraordinarily late departures from Roebuck Bay when embarking on northwards migration, leaving themselves only 3–4 weeks for the 10,400 km journey to the breeding grounds. They thus need to achieve very rapid pre-migratory mass gain on staging grounds in the Yellow Sea; this is only possible if they increase gizzard size, or stage at sites with much higher prey quality than north-western Australia. The rates of mass-gain in Red Knots worldwide support the latter idea, as they are lower in the tropics than they are in cold temperate habitats, as is prey quality. Finally, a comparative analysis of shorebirds shows that costs of intertidal living influence a life-table variable, the age at maturity: coastal shorebirds are more likely to defer their first northwards migrations than are shorebirds of inland habitats. Some species do not start breeding until their fourth year, missing several breeding opportunities. As fecundity of shorebirds is capped by physiological constraints, shorebirds require superior powers of adult survivorship to live in intertidal habitats, making coastal shorebirds particularly vulnerable to habitat changes that increase adult mortality.