The amazing diversity of migratory and incubation strategies of shorebirds

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Shorebirds mostly use coastal wetlands along continental land masses during winter while in summer, the vast majority of these species profits from the arctic bonanza to breed and raise young. However, in order to reach such high latitudes, shorebirds must undertake long distance flights typically traveling thousands of kilometres in their migrations. Given the distances involved, it is no surprise that the migratory routes of these species tends to follow the shoreline, so that they can find shelter in suitable habitats to rest and refuel, particularly when encountering adverse weather conditions such as strong headwinds. Our most recent tracking of these migrations revealed that the whimbrel (*Numenius phaeopus*), a shorebird that breeds in Iceland and winters in West Africa, completes direct flights in excess of 5500 km between these locations, flying non-stop over the ocean (an unsuitable habitat for the species), when an alternative mainly overland route is available and is used by other bird species along the same flyway. Contrary to previously tracked shorebirds breeding in Iceland, the whimbrel flies continuously during five days and five nights achieving maximum speeds of ca. 86 km/h to reach their wintering areas. This study revealed a new migratory strategy which involves undertaking direct flights over oceanic waters when alternative costal routes are available, and was published in the open access journal of Nature group, *Scientific Reports* (Alves et al. 2016). The individual trade-offs and demographic consequences of such extreme migratory strategy are currently being studied by PhD student Camilo Carneiro (DBio & CESAM), who has already unravelled direct flights of even longer distances.

Still in Iceland, we collaborated in a large study involving 76 researchers from 69 institutions that described for the first time the wide diversity of incubation patters found on shorebird species, by analysing 729 nests from 91 populations breeding across the globe. Most shorebirds are ground nesting species, with some using the short arctic and sub-arctic vegetation as well as their feather patters to camouflage their nests. Generally both parents incubate the eggs which require their body heat in order for the embryo to develop. Such parental care implies high synchronization between couple members, so that one adult is continuously warming and protecting the eggs while the other can go forage. Given the very low temperatures in these habitats the most likely driver of incubation rhythms was believed to be energetic depletion of incubating adults, that is, the need to feed in order to maintain body temperature. However, some species are able to incubate for long periods, commonly of 19 consecutive hours with the most extreme case being over 50 straight hours. Contrary to previous knowledge, we found that it is in fact predator pressure that determines incubation rhythms. Species that rely on crypsis (by concealing theirs nests) have long incubation shifts in order to minimize partner exchange and thus reduce the likelihood of nest detection by predators; conversely, species that have open nests make short incubation stints and readily leave the nest when the vigilant partner warns about predator presence. This key study in the area of chronobiology was published in *Nature* (Bulla et al. 2016).