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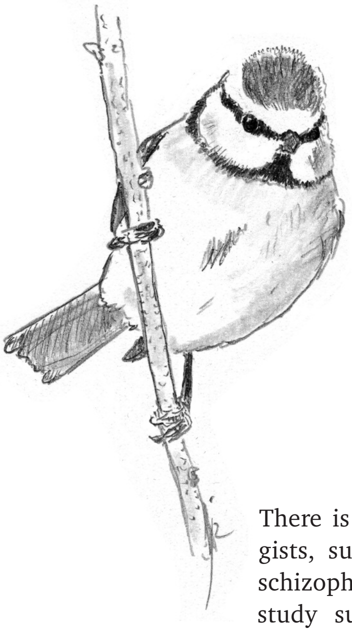

Ornithology from the lakeshore

There is no denial. We, ornithologists, suffer from a mild form of schizophrenia. Most of us love our study subjects, and many of us actively work to protect them. But most of us also harm them, at least somewhat. If you want to study birds in the wild, if you want to learn something about their behaviour, about their nests, their eggs, their young, or even simply about their presence, it is almost impossible to do so without disturbance. Just finding a nest can become the end of it, as I painfully found out in the summer of 2004. I was resting on a pingo in the tundra near Barrow, Alaska, smugly smiling because in the previous hour I had found and marked four sandpiper nests with freshly laid clutches, when I observed an Arctic Fox retracing my steps, and consuming the little birds' reproductive effort of that season.

Modern methods in ornithology go far beyond simple observing and searching for nests. It is an exciting time, because never before have we had so many tools at our disposal to learn a thing or two about birds that had previously remained invisible, or not amenable to study. Starting with the use of aluminium numbered rings at the end of the 19th century, the toolbox of bird-mounted devices has strikingly expanded to include radio-transmitters, passive integrated transponder (PIT) tags, light-sensor geolocators, satellite tags, GPS tags, accelerometers, heart-rate monitors, electromyogram and electroencephalogram (EEG) recording devices, microphones and cameras. Fast miniaturization in combination with increased energy-efficiency and data-storage capacity has made the impossible possible. It requires singular stamina or a large team of observers to watch the behaviour of one individual around the clock, but radio-transmitter technology allowed us to measure activity patterns of more than 100 individuals continuously for weeks (Lesku *et al.* 2012). It is inconceivable for us to follow small birds as they disperse or migrate across the globe, but ~1-g geolocators revealed that Wheatears *Oenanthe oenanthe* travel more than 14,000 km from eastern Africa to northern Alaska in a period of less than two months (Bairlein *et al.* 2012), and that a male Red-necked Phalarope *Phalaropus lobatus* that bred in Scotland wintered somewhere between the Galapagos Islands and the South American coast (Smith *et al.* 2014).

Just as the discovery of ingenious bio-imaging techniques is Nobel-prize worthy because these tools disclose processes inside living cells, so is the new arsenal of monitoring equipment enthusiastically embraced by ornithologists because it allows us to 'observe' behaviour at an unprecedented scale and in unprecedented detail. For example, attaching geolocators with a leg-loop backpack harness to hundreds of Purple Martins *Progne subis* allowed the study of whether pair members had similar fall migration timing or destination, and whether wintering in closer proximity or in similar habitats was linked to more synchronous spring migration (Stutchbury *et al.* 2016a). The same technique also allowed an in-depth analysis of the causes and consequences of long-distance movements after individuals arrived in their tropical wintering grounds in north-western Brazil and surrounding countries (referred to as intra-tropical migration; Stutchbury *et al.* 2016b). Another example is a recent study that used a combination of EEG sensors, a three-axis accelerometer and a GPS data logger to show that Great Frigatebirds *Fregata minor* sleep during their long (up to 10 days) foraging flights, although much less and less intensely than when they are sleeping on land (Rattenborg *et al.* 2016). The study also showed that these flying birds can sleep with both hemispheres simultaneously or unihemispherically, whereby the latter was linked to circling flight. Presumably the birds want to watch where they are going: the more awake side of the brain was opposite the direction of the turn, suggesting that the birds were keeping the eye towards the direction of the turn open.

With the abundance of birds being tagged, and in excited anticipation of the incoming data, are we forgetting the potential harmful effects of our enterprise? I think not. We learn how to carefully handle birds, we follow courses on animal experimentation procedures, and we are granted permits by committees who agree that the potential knowledge gain outweighs the suffering of the birds. Importantly, many researchers are studying the effects of using common procedures and tools. Some do not seem to cause any harm, at least in the species studied and under the particular ecological conditions of the study (e.g. checking nestboxes and capturing parents inside, Smallwood 2016; frequent handling of chicks, Hunt *et al.* 2013; blood sampling, Redmond & Murphy 2011, Bowers *et al.* 2016, but see Brown & Brown 2009; subcutaneous implanting of a PIT tag, Nicolaus *et al.* 2008, Ratnayake *et al.* 2014), but other procedures can have detrimental effects on reproduction and survival (e.g. wing markers, Trefry *et al.* 2013; radio collars, Gibson *et al.* 2013; geolocator tags, Adams *et al.* 2009; satellite or GPS tags, Dixon *et al.* 2016, Thaxter *et al.* 2016). Understanding these negative effects and considering ways to avoid or minimize them is obviously important. Independent of legal considerations, research ethics and journal requirements, careful consideration of the consequences of our methods is also important and useful for scientific reasons. If we want to understand the underlying causes and fitness consequences of individual variation in behaviour, but our tools to measure behaviour have unknown or unexpected effects, the whole endeavour may be a waste, the results may be biased and our conclusions may be flawed. There are plenty of examples of studies showing such effects. Careful experimental work showed that racing pigeons *Columba livia* with sacral-mounted radio transmitters flew more slowly and lost more weight than control birds or pigeons with tail-mounted radios (Irvine *et al.* 2007), and that externally mounted transmitters with antennas greatly increased the drag coefficient in Rose-coloured Starlings *Pastor roseus* that flew in a wind tunnel (Pennycuick *et al.* 2012). These results are important for studies on flight energetics, migration distance and duration, behaviour at stop-over sites, survival, etc. Methodological issues can also bias results on mating and reproductive behaviour. For example, in Greater Sage Grouse *Centrocercus urophasianus*, males that carried radio collars were either less likely to spend time displaying on the lek, or behaved differently while on the lek (Gibson *et al.* 2013) and King Penguins *Aptenodytes patagonicus* individually marked with flipper bands arrived later at the colony during courtship, at least in some years, were less likely to breed and produced fewer offspring (Gauthier-Clerc *et al.* 2004).

Despite their irrefutable relevance, incentives to conduct studies on the short- and long-term effects of using a particular methodology are limited. Not only can it be hard to find funding for such studies, they also rarely lead to publications in the top journals. Furthermore, the results may not always be welcomed by the community, especially by those that use or have used a method that turns out to have previously unknown (or ignored) effects. We may also be so caught up in our own research that we do not even think about questioning effects of common procedures. My team and I have been capturing, handling and banding Blue Tits *Cyanistes caeruleus* during the nestling period for many years, but it is only recently – and thanks to one of my technical assistants who asked – that we studied the immediate effects of these omnipresent procedures, with surprising results (Schlicht & Kempenaers 2015). I would never have guessed that when parents are captured at the nest when feeding 9–11 day old chicks, they only resumed visiting the nestbox on average 4.2 hours (and up to 18 hours) after release. It was also surprising that parental return latencies were strongly associated with previous capture, such that birds that were previously caught and marked returned much faster. Fortunately, we did not find evidence for longer-term effects of these long return latencies on offspring or breeding success. In any case, Ardea enthusiastically welcomes studies that investigate whether and how commonly used procedures affect any aspect of the study species, short- or long-term.

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