The ongoing role of bird ringing in science – a review

MARK BROWN[1] & H. DIETER OSCHADLEUS[2]

[1]School of Biological & Conservation Sciences, University of KwaZulu-Natal, Pietermaritzburg 3201, South Africa. brownma@ukzn.ac.za
[2]Animal Demography Unit, Department of Zoology, University of Cape Town, Rondebosch 7701, South Africa Dieter.Oschadleus@uct.ac.za

Brown, M. & Oschadleus, H.D. 2009. The ongoing role of bird ringing in science – a review. pp. 6–8. In: Harebottle, D.M. Craig, A.J.F.K., Anderson, M.D., Rakotomanana, H. & Muchai, M. (eds). *Proceedings of the 12th Pan-African Ornithological Congress, 2008.* Cape Town, Animal Demography Unit.

Keywords: bird ringing, avian flu, climate change, migration

This paper presents a brief review of the use of bird ringing as a research tool in both the past and the present. Interestingly, although in some circles bird ringing is seen as obsolete, it appears that the uses of ringing in science has increased into several new areas in the last few years, with traditional uses still contributing meaningfully too. Currently, bird ringing is playing an important role in studying avian flu in wild birds, and investigating various effects of global climate change on birds.

INTRODUCTION

This year (2008) sees the celebration of 60 years of bird ringing in South Africa. It provides an opportunity to reflect on the past, current and future role ringing has, is and will play in ornithological studies in Africa.

Historically, bird ringing played a major role in our understanding of bird migration. Indeed, the roots of bird ringing globally came from a desire Hans Christian Cornelius Mortensen had to find out where "his" birds went to. He first started ringing Common Starlings in 1890 in Viborg, Denmark (see Preus 2001 for a summary of his life). Africa played a major role in the first few years, with a White Stork being recovered in Himeville in 1909 (Underhill *et al*. 1999), one of the first records of intercontinental, cross hemisphere migrations ever conclusively documented by science. Apart from migration studies, ringing became a useful tool in studying longevity, and other life history traits such as morphological variation between species and sexes, patterns of breeding and moulting, and in establishing presence/absence data, particularly in forest species.

The increased use of tracking technology (radio, satellite, cell phone, geo-loggers, etc.) and the advent of stable isotope analysis (and its application to bird studies) has led to some people perceiving that the age of ringing is coming to an end. Indeed, in some circles it is seen as an irrelevant activity not worthy of funding or future investment. This paper aims to address such misconceptions, by examining the growing role ringing is playing in ornithological research today. We review the current use of ringing, by providing examples from the global literature to show that ringing is still an essential research tool for the modern day ornithologist.

PAST USES OF RINGING

Historically, bird ringing data was heavily utilised in terms of the following: longevity and survival (North & Cormack 1981, Goede 1993, Lebreton 2001, Clarke *et al*. 2004), movements (including dispersal – Paradis *et al*. 1998), morphometrics (Brown *et al*. 2001, Brown 2003, Ward *et al.* 2003, Morgan 2004), moult (Symes *et al.* 2001, Brown & Brown 2003, Summers *et al*. 2004, Oschadleus & Underhill 2006a, b, Underhill *et al.* 2006), population dynamics (Hjort & Lindholm 1977, Osterlof & Stolt 1982), and presence/absence data, both in terms of migratory species (Huin & Sparks 1998) and in terms of forest fragmentation research (Brown 2006). The references supplied here are merely examples, and literally thousands of references using ringing data in these categories have been published. These studies have been applied to birds in the full range of conservation status, from threatened African Penguins (Barham *et al*. 2006) to extreme pest species like the Red-billed Quelea (Bruggers & Elliott 1989).

This list of areas where bird ringing data is utilised is far from exhaustive, but merely highlights the main fields where bird ringing contributes the majority of data to publications. The list excludes other fields where bird ringing techniques are commonly used, but where the emphasis of the work is elsewhere. For example, bird-pollination biologists use bird ringing techniques to trap birds to collect pollen samples (Johnson & Brown 2004, Johnson *et al.* 2006).

CURRENT AND FUTURE USES OF RINGING DATA

All the uses listed above are ongoing, and we cannot foresee any changes in their importance in the near future. Hence we predict an ever increasing number of studies published in these fields that utilises bird ringing data. However, several new research areas, some developed relatively recently, are using bird ringing data, and we predict massive growth in these, which will ensure bird ringing contributes in ever increasing measures to ornithological research. These new research focuses can be separated out into two broad themes, namely avian influenza research and climate change research.

Avian Influenza research

The widespread initial panic of many governments to the discovery of Avian Influenza (H5N1) infecting humans in Vietnam in late 2003 and early 2004 has thankfully subsided.

The first cases of transmission of H5N1 to humans occurred in Hong Kong in 1997 (Stohr 2005, Webster *et al.* 2006), and since then, fingers have pointed at migratory birds as "potential" vectors of the disease (Li *et al.* 2004, Kilpatrick *et al.* 2006, Normile 2006), leading to widespread speculation on the possibilities of a global pandemic (Horimoto & Kawaoka 2001, Tran *et al.* 2004, Fouchier *et al.* 2005, Stohr 2005). Since 2004, confirmed reports of H5N1 in migratory birds have been received (Guan *et al.* 2004, Normile 2006) including birds from Asia, Russia and Kazakhstan. Fortunately, early on, in August 2005, the World Health Organization (WHO) came out strongly supporting research that suggested that no action be taken to attempt to control avian influenza infections in wild bird populations (Olsen *et al.* 2006). Instead, monitoring programs were initiated in several countries (Li *et al.* 2004, Kou *et al.* 2005, Munster *et al.* 2005, Olsen *et al.* 2006), and bird ringers were suddenly in huge demand. Indeed, even though enough evidence is present to conclude that migratory species have been found infected with H5N1 (Webster *et al.* 2006), the exact role these species have in transmission and spread of the viruses is still unclear (Webster *et al.* 2006). It is here that ringers have a major role to play. By assisting health workers to collect cloacal swabs and blood samples, large data sets can be gathered to try map the occurrence of H5N1 in different parts of the world.

Climate change research and bird ringing

Ornithologists studying species' reactions to climate change are currently utilising bird ringing data in the following areas:

Phenology

A large body of literature exists documenting and examining the effect of climate change on Northern hemisphere bird species migration arrival and departure dates – commonly termed phenology (Crick 2004, Wormworth & Mallon 2006, Knudsen *et al.* 2007). Across Europe and America, rapid advances in arrival times over the last 40 years has been well documented, and appears to be distinct at both population and species levels (Jonzen *et al.* 2004, Miller-Rushing *et al.* 2008a, b). Miller-Rushing *et al.* (2008a) concluded that bird ringing data is the preferred data to be used in such studies.

Protandry

Jonzen *et al.* (2004) discuss several studies results of the differential effects that climate change can have on arrival dates of males and females in a species. In some species, similar phenotypic responses of males and females to climate change has resulted in advanced spring migration in both sexes, with no resultant change in protandry (Raino *et al.* 2007). Significantly, no clear trends have been found, indicating more research in this area is needed (Jonzen *et al.* 2004).

Changing moult

The onset of moult is often linked to the end of the breeding season for many bird species. Breeding seasons have been shown to already be affected by climate change for several species (Coppack & Both 2002, Visser *et al.* 2004), so it seems logical to expect moulting patterns to change too (Dawson 2005, Hedenstrom *et al.* 2007). Surprisingly, little data to support this appears to be published, and ringers could well lead the way here.

Adult survival

Of interest are predictions that for some European species, adult survival will increase, due to warmer winters placing lower starvation risks on birds (Wormworth & Mallon 2006). The converse is true for species adapted to cold conditions, where increased temperatures have led, in some cases, to decreased adult survival (Crick 2004). Bird ringing data is commonly used to assess survival (North & Vormack 1981, Lebreton 2001).

Body mass changes

Bergmann's rule states that populations of warm-blooded animals will exhibit smaller body sizes in warmer areas than colder areas (Yom-Tov *et al.* 2006). Recently, an extension of this theory has been applied to determining effects of climate change on bird populations, and several papers now document declining body sizes of several species over the last forty years or so, presumably as a direct response to global warming (Yom-Tov 2001, Millien *et al.* 2006, Yom-Tov *et al.* 2006).

Wing length changes

Coupled with expected Bergmann's rule adjustments in body size, researchers have studied whether applications of Allen's rule to climate change research will also apply. According to Allen's rule, appendage size is reduced in cold climates (Crick 2004, Yom-Tov *et al.* 2006). Climate change theory therefore predicts that wing length in populations should increase in response to global warming. Indeed this has been shown for several northern hemisphere species (Crick 2004, Yom-Tov *et al.* 2006).

Changes in distribution

Some of the most striking patterns of species being affected by climate change are species range-shifts (Crick 2004, Jonzen *et al.* 2004, Wormworth & Mallon 2006). Typically species appear to be moving their ranges pole-ward, and tropical species are shifting to higher altitudes (Crick 2004, Wormworth & Mallon 2006).

Assessing rate of adaptation

Visser (2007) introduces the theoretical possibility of assessing a species rate of adaptation to climate change, by analysing various components of its life history, ecology, etc.

Of interest, little to no work of this nature has been published from data in Africa, although Africa has been identified as the continent most at risk from climate change (Wormworth & Mallon 2006). It is imperative that African ornithologists start utilising the long term data-sets available through bird ringing schemes in order to determine if trends found in European species are similar to ours. In particular, the use of long term data sets to examine changes in species body mass, wing length and moult over time should be something we can readily do, given the large datasets available. The SAFRING dataset (60 years) should be completely electronic by the end of 2008, and is as good a starting point as any. This way we can begin examining if climate change is having similar "Bergmann's rule" and "Allen's rule" effects on our birds as to some European species (Yom-Tov 2001, Yom-Tov *et al.* 2006).

In conclusion, we hope we have adequately pointed out that bird ringing is still an invaluable tool that ornithology needs. Indeed, of all the talks presented at PAOC 12, at least 48 (26%) oral presentations and five round table discussions have utilised bird ringing techniques in data collection.

REFERENCES

Barham, P.J., Crawford, R.J.M., Underhill, L.G., Wolfaardt, A.C., Barham, B.J., Dyer, B.M., Leshoro, T.M., Meÿer, M.A., Navarro, R.A., Oschadleus, D., Upfold, L., Whittington, P.A. & Williams, A.J. 2006. Return to Robben Island of African Penguins that were rehabilitated, relocated or reared in captivity following the *Treasure* oil spill of 2000. *Ostrich* 77: 202–209.

Brown, M. 2003. Biometrics of dusky indigobirds in Pietermaritzburg, KwaZulu-Natal, in 2000 and 2001. *African Zoology* 38: 396–399.

Brown, M. 2006. Annual and seasonal trends in avifaunal species richness in a coastal lowlands forest reserve in South Africa. *Ostrich* 77: 58–66.

Brown, M. & Brown, K.J. 2003. Garden ringing – a heap of information waiting to be harvested. *Afring News* 32: 2–5.

Brown, M., Symes, C. & Downs, C. 2001. Biometrics and moult of the Thickbilled Weaver in Pietermaritzburg. *Afring News* 30: 60–63.

Bruggers, R.L. & Elliott, C.C.H. 1989. *Quelea quelea: Africa's bird pest*. Oxford University Press, Oxford.

Clark, J.A., Robinsons, R.A., Balmer, D.E., Adams, S.Y., Collier, M.P., Grantham, M.J., Blackburn, J.R. & Griffin, B.M. 2004. Bird ringing in Britain and Ireland in 2003. *Ringing & Migration* 22: 85–127.

Coppack, T. & Both, C. 2002. Predicting life-cycle adaptation of migratory birds to global climate change. In: Both C. & T. Piersma (eds). The avian calendar: exploring biological hurdles in the annual cycle. Proc. 3rd Conf. European Orn. Union, Groningen, August 2001. *Ardea* 90(3): 369–378.

Crick, H. 2004. The impact of climate change on birds. *Ibis* 146: 48–56.

Dawson, A. 2005. The effect of temperature on photoperiodically regulated gonadal maturation, regression and moult in starlings – potential consequences of climate change. *Functional Ecology* 19: 995–1000.

Fouchier, R., Kuiken, T., Rimmelzwaan, G. & Osterhaus, A. 2005. Global task force for influenza. *Nature* 435: 419–420.

Goede, A.A. 1993. Longevity in homeotherms, the high lifespan and lifespan energy potential in Charadriiformse. *Ardea* 81: 81–88.

Hedenstrom, A., Barta, Z., Helm, B., Houston, A.I., McNamara, J.M. & Jonzen, N. 2007. Migration speed and scheduling of annual events by migrating birds in relation to climate change. *Climate Research* 35: 79–91.

Hjort, C. & Lindholm, C.G. 1977. Annual bird ringing totals and population fluctuations. *Oikos* 30: 387–392.

Horimoto, T. & Kawaoka, Y. 2001. Pandemic threat posed by avian influenza A viruses. *Clinical Microbiology Reviews* 14: 129–149.

Huin, N. & Sparks, T.H. 1998. Arrival and progression of the Swallow *Hirundo rustica* through Britain. *Bird Study* 45: 361–370.

Johnson, S.D. & Brown, M. 2004. Transfer of pollinaria on birds' feet: a new pollination system in orchids. *Plant Systematics and Evolution* 244: 181–188.

Johnson, S.D., Hargreaves, A.L. & Brown, M. 2006. Dark bitter-tasting nectar functions as a filter of flower visitors in a bird pollinated plant. *Ecology* 87: 2709–2716.

Jonzen, N., Ergon, A., Linden, A. & Stenseth, N.C. 2007. Bird migration and climate: the general picture and beyond. *Climate Research* 35: 177–180.

Kilpatrick, A.M., Chmura, A.A., Gibbons, D.W., Fleischer, R.C., Marra, P.P. & Daszak, P. 2006. Predicting the global spread of H5N1 avian influenza. *Proceedings of the National Academy of Sciences* 103: 19368–19373.

Knudsen, E., Linden, A., Ergon, T., Jonzen, N., Vik, O.J., Knape, J., Roer, J.E. & Stenseth, N.C. 2007. Characterizing bird migration phenology using data from standardized monitoring at bird observatories. *Climate Research* 35: 59–77.

Kou, Z., Lei, F.M., Yu, J., Fan, Z.J., Yin, Z.,H., Jia, C.X., Xiong, K.J., Sun, Y.H., Zhang, X.W., Wu, X.M., Gao, X.B. & Li, T.X. 2005. New genotype of avian influenza H5N1 viruses isolated from Tree Sparrows in China. *Journal of Virology* 79: 15460–15466.

Lebreton, J.D. 2001. The use of bird rings in the study of survival. *Ardea* 89: 85–100.

Li, K.S., Guan, Y., Wang, J., Smith, G.J.D., Xu, K.M., Duan, L., Rahardjo, A.P., Puthavathana, P., Buranathai, C., Nguyen, T.D., Estoepangestie, A.T.S., Chaisingh, A., Auewarakul, P., Long, H.T., Hanh, N.T.H., Webby, R.J., Poon, L.L.M., Chen, H., Shortridge, K.F., Yuen, K.Y., Webster, R.G. & Peiris, J.S.M. 2004. Genesis of a highly pathogenic and potentially pandemic H5N1 influenza virus in eastern Asia. *Nature* 430: 209–213.

Miller-Rushing, A.J., Primack, R.B. & Stymeist, R. 2008a. Interpreting variation in bird migration times as observed by volunteers. *Auk* 125: 565–573.

Miller-Rushing, A.J., Lloyd-Evans, T.L., Primack, R.B. & Satzinger, P. 2008b. Bird migration times, climate change, and changing population sizes. *Global Change Biology* 14: 1959–1972.

Millien, V., Lyons, S.K., Olson, L., Smith, F.A., Wilson, A.B. & Yom-Tov, Y. 2006. Ecotypic variation in the context of global climate change: revisiting the rules. *Ecology Letters* 9: 853–869.

Morgan, J.H. 2004. Remarks on the taking and recording of biometric measurements in bird ringing. *Ring* 26: 71–78.

Munster, V.J., Wallensten, A., Baas, C., Rimmelzwaan, G.F., Schutten, M., Olsen, B., Osterhaus, D.M.E. & Fouchier, R.A.M. 2005. Mallards and highly pathogenic avian influenza ancestral viruses, Northern Europe. *Emerging Infectious Diseases* 11: 1545–1551.

Normile, D. 2006. Evidence points to migratory birds in H5N1 spread. *Science* 311: 1225.

North, P.M. & Cormack, R.M. 1981. On Seber's method for estimating age-specific bird survival rates from ringing recoveries. *Biometrics* 37: 103–112.

Olsen, B., Munsten, V.J., Wallensten, A., Waldenstrom, J., Osterhaus, A.D.M.E. & Fouchier, R.A.M. 2006. Global patterns of influenza A virus in wild birds. *Science* 312: 384–388.

Oschadleus, H.D. & Underhill, L.G. 2006a. Breeding seasonality and primary moult in weavers in eastern South Africa. *Durban Museum Novitates* 31: 24–34

Oschadleus, H.D. & Underhill, L.G. 2006b. Breeding seasonality and primary moult parameters of *Euplectes* species in South Africa. *Ostrich* 77: 142–152.

Osterlof, S. & Stolt, B.O. 1982. Trends indicated by birds ringed in Sweden. *Ornis Scandinavica* 13: 135–140.

Paradis, E., Baillie, S.R., Sutherland, W.J. & Gregory, R.D. 1998. Patterns of natal and breeding dispersal in birds. *Journal of Animal Ecology* 67: 518–536.

Preus, N.O. 2001. Hans Christian Cornelius Mortensen: aspects of his life and of the history of bird ringing. *Ardea* 89: 1–6.

Raino, K., Totrupp, A.P., Lehikoinen, E. & Coppack, T. 2007. Effects of climate change on the degree of protandry in migratory songbirds. *Climate Research* 35: 107–114.

Stohr, K. 2005. Avian influenza and pandemics – Research needs and opportunities. *New England Journal of Medicine* 352: 405–407.

Summers, R.W., Underhill, L.G., Nicoll, M., Strann, K.B. & Nilseb, S.O. 2004. Timing and duration of moult in three populations of Purple Sandpipers *Calidris maritima* with different moult/migration patterns. *Ibis 1*46: 394–403.

Symes, C.T., Downs, C.T. & Brown, M. 2001. Movements and timing of moult and breeding of the Cape White-eye *Zosterops pallidus* in KwaZulu-Natal. *Afring News* 30: 35–39.

Tran, T.H., de Jong, M. & Farrar, J. 2004. Avian influenza – A challenge to global health care structures. *New England Medical Journal* 351: 2363–2365.

Underhill, L.G., Serra, L. & Brandao, A. 2006. Progress with the statistical analysis of primary molt. *Acta Zoologica Sinica* 52: 440–443.

Underhill, L.G., Tree, A.J., Oschadleus, H.D. & Parker, V. 1999. Review of ring recoveries of waterbirds in southern Africa. Avian Demography Unit, Cape Town.

Visser, M. 2007. Keeping up with a warming world; assessing the rate of adaptation to climate change. *Proceedings of the Royal Society B*: 275: 649–659.

Visser, M.E., Both, C. & Lambrechts, M.M. 2004. Global climate change leads to mistimed avian reproduction. *Advances in Ecological Research* 35: 89–110.

Ward, V.L., Oschadleus, H.D., Symes, C.T. & Brown, M. 2003. Review of ringing and biometry of Forest Canaries *Serinus scotops*. *Afring News* 32: 65–68.

Webster, R.G., Peiris, M., Chen, H. & Guan, Y. 2006. H5N1 outbreaks and enzootic influenza. Emerging Infectious Diseases 12: 3–8.

Wormworth, J. & Mallon, K. 2006. *Bird species and climate change: the global status report.* Climate Risk, Brisbane.

Yom-Tov, Y. 2001. Global warming and body mass decline in Israeli passerine birds. *Proceedings of the Royal Society London B*: 268: 947–952.

Yom-Tov, Y., Yom-Tov, S., Wright, J., Thorne, C.J.R. & Du Feu, R. 2006. Recent changes in body weight and wing length among some British passerine birds. *Oikos* 112: 91–101.