Items of interest from recent ornithological literature

Perspectives from long-term ornithological research in the Taita Hills

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History of ornithological science in the Taita Hills

The Strategy Conference for Management and Protection of Kenya's Plant Communities held in 1984 identified the indigenous forest fragments of the Taita Hills as one of the habitats in urgent need of inventorisation and protection (Beentje & Ndiang'ui 1988). Indeed, apart from an initial survey by Dr. Thomas Brooks (Tennessee University, USA) in 1996 (Brooks *et al.* 1998), very little was known on the status of the Taita Hills avifauna apart from few anecdotal sighting reports (e.g., Turner 1979). In 1996, the National Museums of Kenya (NMK), Kenyatta University (KU) and the University of Antwerp (UA) initiated the Taita Hills Biodiversity Project (THBP). This project was funded by the Directorate General for International Cooperation (DGIS) through the Flemish Interuniversity Council (VLIR). Its main goal was to improve the human resources and research infrastructure of the Department of Zoology of KU and NMK, through training of their scientific personnel and improving existing scientific facilities (Bytebier 2001). *More specifically, the goal was to improve the existing ability to conduct modern scientific research in the field of biodiversity, systematics, ecology and conservation.* The realisation of this main objective was through a study of the effects of forest fragmentation on the biodiversity of the Taita Hills in the Southeast of Kenya (03°20'S 38°15'E).

The Taita Hills are the northern-most point of the Eastern Arc Mountains, a global biodiversity hotspot that boasts an outstanding diversity of flora and fauna with a high level of endemism (Myers *et al.* 2000, Burgess *et al.* 2007). In addition to historical deforestation, a total of 260 ha (50%) of indigenous tropical cloud forest was lost to agriculture and bushland in the Taita Hills between 1955 and 2004 (Pellikka *et al.* 2009). Presently, from what was likely to be a much greater cover by humid cloud forest, only 12 fragments remain with a total of less than 400 ha, the largest continuous patch (Mbololo) being only 179 ha (Pellikka *et al.* 2009).

Whilst habitat fragmentation studies were fairly well developed in the temperate woodlands of North America and Europe (Matthysen *et al.* 1995, Fahrig 2003), as well as in some tropical areas of South America (Laurance & Bierregaard 1997, Laurance *et al.* 2004), fragmentation studies in Africa remained scarce. Yet, now, with a growing amount of literature on the effects of habitat loss and fragmentation on birds globally and in Africa (Githiru 2008b), new knowledge is being published on the patterns of persistence of species in fragmented landscapes and drivers of these patterns. For instance, while the impact of habitat loss is on populations of forest-dependent species is usually negative, the impacts of fragmentation, *per se*, are usually not as easily measurable and hence not as clear, being even positive sometimes (Newmark 1998, Cordeiro & Howe 2003, Measey *et al.* 2007, Sekercioḡlu 2007, Newmark & Stanley 2011).

As such, though some patterns are emerging (Githiru 2008b), the main drivers and mechanisms of species persistence as forest loss and fragmentation grows remain unclear, especially for Afro-tropical landscapes. Here, we highlight two key publications from the long-term Taita fragmentation study that demonstrate a progressive change in our understanding of the key determinants of bird species persistence across this landscape:

Lens, L., Van Dongen, S., Norris, K., Githiru, M., & Matthysen, E. 2002. Avian persistence in fragmented rainforest. *Science* 298: 1236-1238

Callens, T., Galbusera, P., Matthysen, E., Durand, E.Y., Githiru, M., Huyghe, J.R., & Lens, L. 2011. Genetic signature of population fragmentation varies with mobility in seven bird species of a fragmented Kenyan cloud forest. *Molecular Ecology* 20: 1829-1844.

The major findings

In the first paper (Lens *et al.* 2002c), we asked which species are likely to persist and which are likely to be lost when the habitat is fragmented to the extent that has occurred in the Taita Hills. Using data on eight forest-dependent bird species (Stripe-cheeked Greenbul *Andropadus milanjensis*, Taita Apalis *Apalis thoracica*, Olive Sunbird *Nectarinia olivacea*, Cabanis's Greenbul *Phyllastrephus cabanisi*, Yellow-throated Woodland Warbler *Phylloscopus ruficapillus*, White-starred Robin *Pogonocichla stellata*, Taita Thrush *Turdus helleri* and Taita White-eye *Zosterops silvanus*), our analysis revealed that more mobile bird species (such as the sunbird, robin and white-eye) fared the best, but equally important was the sensitivity of species to the environmental deterioration that occurs within fragments. The index of sensitivity was based on a comparison between the asymmetry in left and right tarsus lengths of birds living in the most degraded forest fragment, and that of museum specimens collected several decades before habitat deterioration: *the larger the departure from historical asymmetry, the more sensitive is the species to habitat change*. This link is based on previous studies showing that the bilateral traits of birds living in more degraded habitats are more asymmetric (Lens & Van Dongen 2000), and that birds with asymmetric characteristics have diminished survival and lower overall fitness (Lens *et al.* 2002a, Lens *et al.* 2002b). Two points are worth noting from this study: first, that the model devised to explain the fragmentation problem incorporated only two parameters (ability to disperse and sensitivity to fragmentation), and second that this simple model explained a huge amount (88%) of the variation in our eight-species dataset. *This gave the model great predictive power* (Côté & Reynolds 2002).

In the second paper (Callens *et al.* 2011), further analyses of the Lens *et al.* (2002) and other data revealed that loss in mobility over time, rather than current levels of mobility *per se*, predicted how well a species survived in a severely fragmented landscape such as that of the Taita Hills. To estimate how much mobility was lost over time, we used a two step approach. First, using small amounts of DNA extracted from blood or feathers, we calculated genetic differences between populations of each species living in separate forest fragments. Substantial differences in the genetic structure of separate populations indicates low mobility over long (historic) times. Secondly, using capture-recapture data obtained from our long-term ringing program, we estimated contemporary levels of mobility for each species amongst the same set of fragments. *Comparing the historic and contemporary levels of mobility revealed that species that used to be highly mobile in the past suffered more from habitat fragmentation than those that have always been more sedentary.* From this study we concluded that conservation tactics that are solely based on estimates of current mobility may underestimate true extinction risks by missing out on those species whose mobility has been more greatly affected by fragmentation though still apparently mobile. This is somewhat analogous to the small and declining populations paradigm (Caughley 1994), where declining populations may merit being considered to be at greater risk even when still more abundant than naturally small populations.

Emphasis on the process and wider application

We would like to highlight two key process issues that underlie the success of this project: international collaboration and interdisciplinary studies. First, the project was borne of a largely international (North-South) collaboration idea for human resource development. To a large extent, the Taita setting was fortuitous. As such, linking or building in conservation matters within broader issues (e.g., infrastructure and human development) is important. Secondly, while it is natural to start from the most familiar, it is essential to quickly build in other facets of the research in order to have a more complete grasp of the mechanisms driving observed patterns. In our case, *both studies demanded data cutting across fields from basic field ecology, behavioural ecology, molecular genetics and GIS* in order to develop our understanding of the system. Unfortunately, this can prove to be a constraint for many studies in Afrotropical forests.

Moreover, broader applicability of models like the ones we develop also depends on how easily the necessary parameters can be obtained. The parameters in our models required several years of labour-intensive fieldwork and the availability of museum specimens to compare levels of fluctuating asymmetry. For instance, between 1996 and 2006, more than 6000 individuals of the eight forest dependent bird species were captured with mist-nets and blood sampled, which formed the bedrock of the analyses for both papers. Amassing this amount of data may also be daunting for most sites in Africa which lack sustained long-term intensive studies.

In sum, though our major conclusions could be seen to be system-specific, or at least restricted to forest fragments that are still close enough together to allow some dispersal, *they do demonstrate the potential for unravelling intricate ecological problems even for complex systems* (Côté & Reynolds 2002). Through the two papers, this long-term study also demonstrates the value of using ecological theory to guide the search for general rules in conservation biology, and suggests that complex problems may sometimes have simple explanations.

From science to conservation

Although we are now starting to unravel how forest birds and other Taita species may be affected and hence be able to cope with alteration of their habitat, translating this knowledge into conservation actions on the ground remains daunting. We have tried to integrate our scientific knowledge on Taita birds into consensually formulated conservation actions (Githiru *et al.* 2011). We integrated GIS-based models, sociological parameters, bird and forest characteristics to determine and prioritise the most appropriate areas for reforestation (Githiru & Lens 2004, 2007). This prioritisation was done through a succession of three on-site workshops used to reach multiple stakeholders, build consensus on conservation actions, and formulate an implementation framework (Morara 2005). The key lesson we learned from this exercise was that bridging the gap between science and conservation demands a very open, inter-disciplinary strategy, initiated and executed jointly by a diverse group of people that includes the Government (policy-makers and implementers), NGOs (conservationists and environmental advocates), scientists (researchers), conservationists and the local community (Githiru *et al.* 2011).

We believe that our long-term Taita study provides a pointer for what it may take to undertake long-term ecological research in Africa. Essentially, *it is important to consider how biological research fits into broader global agendas,* such as bridging the North-South divide, or establishing South-South collaborations. We also point to means by which we can start unravelling mechanisms that drive patterns in population trends observed. A good grasp of mechanisms is critical for environmental management based on scientific knowledge, because they are typically the ones to target for change. Lastly, while ecological research is vital for providing a sound grasp of biodiversity problems, working through other human issues (socio-economic, equity, opinions, fears, cultural etc) will ultimately determine if research findings do lead to improved biodiversity conservation (Githiru 2008a).

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