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Cattle Egret *Bubulcus ibis* interactions with large mammals in the Tarangire-Manyara Ecosystem, Northern Tanzania

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Summary

While Cattle Egrets *Bubulcus ibis* are globally widespread, their ecology is not fully understood. Surveys of the species were undertaken in November 2012, and April 2013, in Lake Manyara National Park, Manyara Ranch, and outside the two protected areas. We investigated the effects of host identity, habitat type and host animal behaviour on Cattle Egret numbers and distribution. Cattle Egrets associated more with grazers than with mixed-feeders or browsers, and chose large-bodied animals over small-bodied ones. They preferred wetland and grassland, over bushland. These findings underscore the importance of wetland management and the maintenance of healthy grasslands for the future of Cattle Egrets. Declines in large-bodied mammal species are likely to negatively affect them.

Introduction

Cattle Egrets *Bubulcus ibis* are small, widely distributed herons that usually nest in large colonies, prefer habitats near water, and typically feed in grasslands (Telfair 1994, Seedikkoya *et al.* 2005, BirdLife International 2014). They prey on insects and other invertebrates, especially those that fly after being disturbed by associated large mammals (Seedikkoya *et al.* 2005, Kour & Sahi 2012). They also eat ticks, flies and other ectoparasites found on mammals (Siegfried 1971). In Africa, they forage with cattle and a range of other large mammals by following the animal closely, usually near its head (Heatwole 1965, Kour & Sahi 2012). In order to catch their prey, they must keep up with their host, and they often switch animals when the host speed is no longer within their optimal range (Burger & Gochfeld 1982). Bigger herds of large mammals tend to be associated with more Cattle Egrets, presumably because they flush more prey and provide more feeding opportunities (Wahungu *et al.* 2003). Such large groups of egrets can reduce the vigilance needed by the associated mammals, increasing foraging efficiency for both species (Seedikkoya *et al.* 2005).

Understanding the associations between Cattle Egrets and large mammals is important considering the declines of wild mammals (Msoffe *et al.* 2011; Ogutu *et al.* 2014) and ongoing rangeland degradation in East Africa (Kioko *et al.* 2012). We investigated the effect of habitat characteristics, host choice, feeding guild, body size and host behaviour on Cattle Egret distribution within Lake Manyara National Park, Manyara Ranch and adjacent community land.

Methods

The study was conducted in northern Tanzania, within the Tarangire-Manyara

Ecosystem (TME). The study sites were: Lake Manyara National Park (LMNP) (3°30'S, 35°50'E), Manyara Ranch (MR) (3°58'S, 36°00'E) and adjacent areas under human use (e.g., cultivation, homesteads and livestock grazing). Annual rainfall is approximately 650 mm per year (Morrison & Bolger 2012), with a short rainy season (Nov–Dec) and a longer rainy season (Mar–May). The habitat is typical savanna, dominated by *Acacia-Commiphora* bushland and open grasslands. Lake Manyara (200 km²) was a dominant feature within the study area. Much of the area has limited perennial freshwater sources, but there are a few perennial rivers and dams that help to sustain wildlife and livestock. Domestic livestock included cattle, goats, sheep, and donkeys. Common wild mammals included Thomson's gazelle *Gazella thomsonii*, Kirk's dik dik *Madoqua kirkii*, wildebeest *Conochastes taurinus albojubatus*, Burchell's zebra *Equus burchelli*, impala *Aepyceros melampus*, Cape buffalo *Syncerus caffer*, and hippopotamus *Hippopotamus amphibious*. The wildlife is mostly found within the protected areas, except for a few species that disperse into adjacent human-settled areas. LMNP is bordered by farmlands that largely rely on furrow irrigation. The irrigated farms are associated with aggregations of waterbirds, including Cattle Egrets.

We walked or drove 2 km transects that were 500 m apart during the dry season (April 2012) and during the short rainy season (November 2013). We noted the location of Cattle Egrets, and the number and associated species of large mammal. Large mammals were defined as any mammal species bigger than a Kirk's dik dik. Sheep and goats were grouped together as 'shoats' as they were often mixed. We also recorded the activity of Cattle Egrets and large mammals. Egret activity was classified as stationary, flying, foraging, or vigilant, while large mammal activity was classified as resting, walking or vigilant. Fifty-three transects were undertaken in LMNP, 97 in MR, and 63 in the human-use areas. Cattle Egrets within 50 m of a large mammal (Heatwole 1965) and seemingly responding to the animal were considered to be associating.

Data analysis was done in SPSS Statistics 17.0 (SPSS 2009). Jacob's Index (Jacobs 1974) was used to determine Cattle Egret host preference. Jacob's Index scores were calculated based on mammal feeding guilds: grazers, browsers, and mixed-feeders; and a higher score indicated a more highly preferred host (Blondel 2003). Habitat preference was determined using Ivlev's Selectivity Index (Ivlev 1961). The index has a possible range of -1 to +1, with negative values indicating avoidance and positive values indicating preference. Higher scores indicate a highly preferred habitat. The relationship between mammal group size and the number of Cattle Egrets was determined using Spearman's rank correlation. A linear regression was used to determine the effect of host body size (average log body mass) on Cattle Egret host choice (based on Jacob's Index score). Chi-square cross tabulation was used to evaluate the extent of association between Cattle Egrets and large mammal species. A Kruskal-Wallis Test was used to determine whether flock sizes of egrets varied across different habitats.

Results

Influence of habitat type and surface water on distribution of egrets

The three study sites consisted of woodland (18%), closed bushland (10%), open bushland (31%), scrubland (17%), wetland (4%) and grassland (20%). Cattle Egret group size did not vary across habitat types (Kruskal-Wallis, $\chi^2=1.254$, $df=3$, $p=0.740$). However, Ivlev's Index values showed that wetlands (0.84) and grasslands

(0.42) were preferred, while open bushland (-0.70) and closed bushland (-0.70) were avoided. Cattle Egret presence was not dependent on the presence of water, but was positively related to the distance from the nearest water point ($r_s = 0.534$, $p < 0.001$).

Egret host selection based on feeding behaviour and activity pattern

Cattle Egrets completely avoided all browsers – bushbuck, dik dik, giraffe and lesser kudu. Among mixed-feeders, they associated with elephants, impala and shoats. Of the pure grazers studied, buffalo, cattle, donkey, wildebeest, zebra, hippopotamus and warthog, only warthogs were not selected (Fig 1).

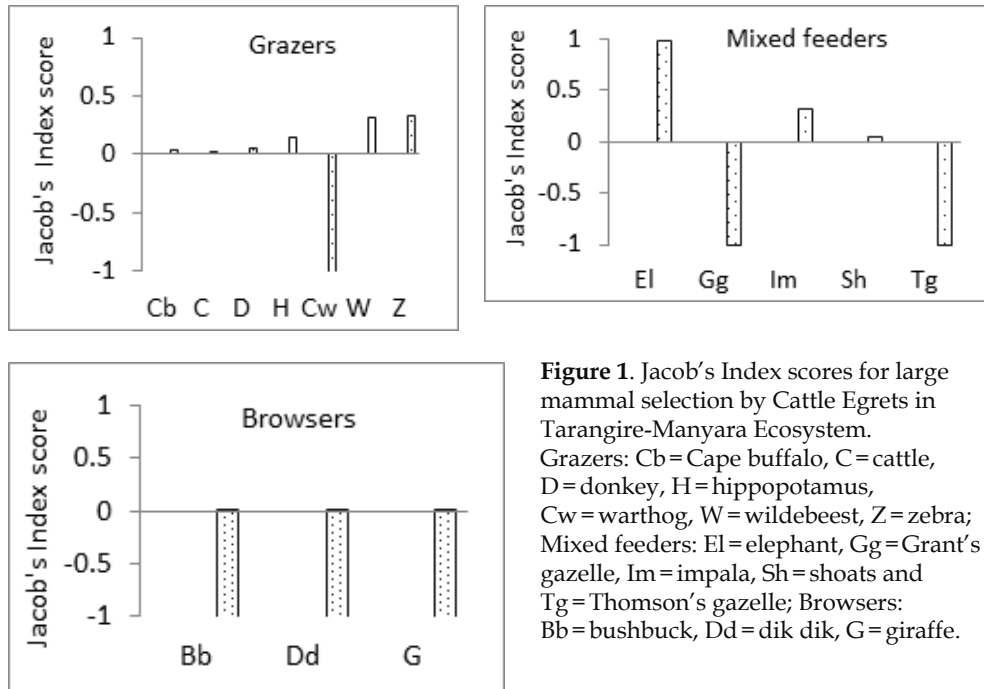


Figure 1. Jacob's Index scores for large mammal selection by Cattle Egrets in Tarangire-Manyara Ecosystem. Grazers: Cb = Cape buffalo, C = cattle, D = donkey, H = hippopotamus, Cw = warthog, W = wildebeest, Z = zebra; Mixed feeders: El = elephant, Gg = Grant's gazelle, Im = impala, Sh = shoats and Tg = Thomson's gazelle; Browsers: Bb = bushbuck, Dd = dik dik, G = giraffe.

There was a significant relationship between the behaviour of large mammals and that of Cattle Egrets ($\chi^2 = 15.936$, $df = 2$, $p < 0.001$). Egrets primarily associated with cattle when they were grazing (85%). They foraged most often (75%) when large wild mammals were also foraging. When large wild mammals were resting, Cattle Egrets were rarely seen foraging (7%).

Relationship between large mammal body size, group size and association with egrets

There was a significant and positive correlation between associated large mammal body size (kg) and preference by Cattle Egrets ($r_s = 0.578$, $p = 0.008$, $n = 20$). (Fig. 2). This suggests that larger bodied mammals are more likely to be selected.

When data for all large mammals (including cattle), were grouped, there was a significant positive correlation between mammal group size and the number of Cattle Egrets ($r_s = 0.431$, $p < 0.001$, $n = 117$). There was also a significant positive correlation between cattle group size and Cattle Egret group size ($r_s = 0.381$, $p < 0.05$, $n = 57$). However, there was no significant correlation between Cattle Egret group size and the group sizes of Cape buffalo, zebra, shoats, donkeys and hippopotamus.

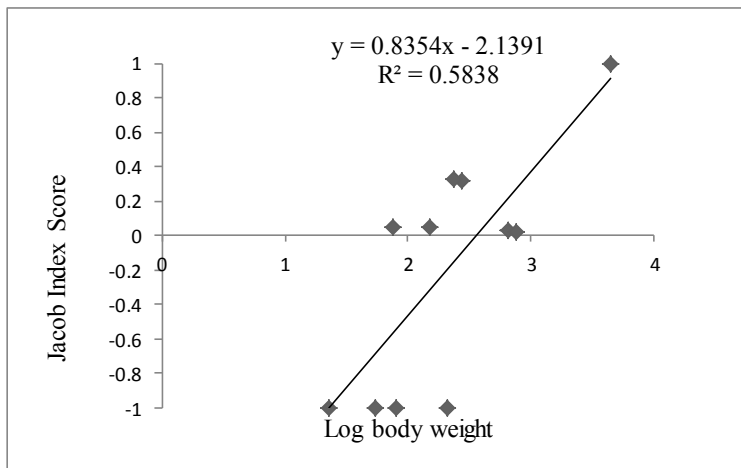


Figure 2. Relationship between host preference by Cattle Egrets and large mammal body size.

Discussion

Cattle Egrets preferred grassland and wetland habitats. Wahungu *et al.* (2003) observed that Cattle Egrets feed efficiently in grasslands, less in shrubland, and the least in woodland habitats. In closed habitats such as woodlands and shrublands, ground layer vegetation is often poorly developed and large mammal grazers are sparse (Dean & MacDonald 1981), thus feeding association is expected to be lower. Cattle Egrets usually use vegetation near wetlands as roosting sites (Zimmerman *et al.* 1996). While Cattle Egrets have adapted to foraging on land and have lost the ability, possessed by their wetland relatives, to accurately correct for light refraction by water (Katzir *et al.* 1999), they rely heavily on wetland as feeding grounds, where they associate with other waterbirds (Kour & Sahi 2012). The lack of a positive relationship between Cattle Egrets and the presence of water suggests that other factors such as associated mammal species may be of greater importance to egret distribution. The positive correlation between Cattle Egrets and the distance from water points suggests that they are likely to move further away from water points in search of potential hosts. Cattle, one of their key hosts (Dinsmore 1973, Grubb 1976) forage widely in savannas.

Cattle Egrets associated with large mammals, both wild and domestic, but preferred grazers over browsers and mixed-feeders. They intentionally approach large mammals where they get an opportunity to feed on insects that are flushed by the grazing animals (Dean & MacDonald 1981), thus spending less energy searching for prey (Seedikkoya *et al.* 2005). The higher association between Cattle Egrets and cattle suggests a selective advantage. When in the company of cattle, their efficiency is 3.60 to 5.20 times more than when they not associated with cattle (Dinsmore 1973, Grubb 1976). Their association with wild large mammal grazers such as Cape buffalo, wildebeest, and zebra is likely to be due to the large aggregations among these species that improves the potential for more insects being flushed. Large mammal grazers

are more likely to be found within grassland habitats that are also the preferred habitat for Cattle Egrets. Their close association with hippopotamus is likely due to habitat overlap, with both having a high affinity for wetlands (Collopy & Jelks 1989). When hippopotamus bask outside water or graze during the day, Cattle Egrets perched on them to serve as vantage foraging points. The tendency for Cattle Egrets to avoid mixed-feeders and browsers is probably because most of these species utilize relatively closed habitats (Burkepile *et al.* 2013) and occur in smaller groups.

Cattle Egrets preferred large-bodied grazers over small-bodied ones. It is likely that large-bodied grazers disturb more prey and also provide vantage points for the birds. An increase in egret group size was concurrent with augmented large mammal group size. However, when examined by species, only cattle group size was significantly correlated with Cattle Egret group size. Burger & Gochfeld (1982) suggest that typical cattle walking speed (10–30 m per step per minute) optimizes Cattle Egret foraging. This suggests that Cattle Egrets select hosts that offer them the best foraging success.

Considering that Cattle Egrets are closely associated with large mammals, a decline in the latter may negatively impact egret populations. Current trends show declines of most large mammals, including livestock, in southern Kenya (Ogutu *et al.* 2014), the Maasai Mara region (Ogutu *et al.* 2011), and in northern Tanzania (Rogers *et al.* 2003). Measures that protect rangelands for both wildlife and livestock can safeguard the future of Cattle Egrets.

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