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Short Communication

Kelp gulls prey on the eyes of juvenile Cape fur seals in Namibia

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The kelp gull *Larus dominicanus* is an abundant and highly successful avian predator and scavenger that breeds along the coastline in the Southern Hemisphere, ranging from Antarctica to the tropics. On account of its dietary breadth, wide-ranging foraging strategies, and acclimation to modified landscapes, this species has received considerable attention within the seabird literature over the past 40 years. Furthermore, owing to its ready habituation to human-dominated environments, the species has been used as a bio-indicator of habitat modification. Here we describe new predatory behaviours of the kelp gull on a larger-bodied sympatric mammal species, the Cape fur seal *Arctocephalus pusillus pusillus*, along the coast of Namibia, and discuss our findings as they relate to food web dynamics and behavioural plasticity.

Keywords: food webs, generalist, plasticity, trophic interactions

Introduction

Behavioural plasticity is the ability to modify, adjust, or change behaviour in response to the environment, and it allows for variation in behaviour to take place (Houston and McNamara 1999). These changes are manifested readily in traits such as decision-making, optimal foraging strategies, and resource/prey selection (Fryxell and Lundberg 1994). One of the best-studied aspects of phenotypic plasticity in free-ranging animals is diet, whereby 'generalist' species gain access to a wide array of resource niches with relatively equal effectiveness (Richards et al. 2006), whereas 'specialist' species remain limited in their diet options. Generalist feeders may also opportunistically encounter and adapt to consume novel prey items, and examples of these types of behaviours are found widely throughout the animal kingdom, ranging from cockroaches (*Blattella germanica*; Raubenheimer and Jones 2006) to tiger sharks (*Galeocerdo cuvier*; Gallagher et al. 2011) and wolves (*Canis lupus*; Darimont et al. 2003).

Coastal and migratory birds naturally encounter a variety of changing and often extreme environmental conditions, as well as disparate pools of resources, due to the nature of their movements and dependence on aquatic ecosystems. Thus, they are an ideal group for investigations into behavioural plasticity, both historically and under contemporary changes, at the population, species and individual level. For example, a longitudinal study of a population of great tits *Parus major* in the United Kingdom showed that changes in their behaviours closely tracked climate change (Charmantier et al. 2008), and these acute behavioural modifications suggest that birds can be highly adaptive to their environment. Considering that seabirds are particularly sensitive to environmental changes in resource availability (Furness and Camphuysen 1997), they are good indicators of environmental change, and it is important to investigate behavioural plasticity in this subgroup.

The kelp gull *Larus dominicanus*, a widely distributed avian predator throughout most of the Southern Hemisphere (Harrison 1985), is regarded as a feeding generalist with a diverse repertoire of foraging tactics employed along intertidal, coastal inshore, and pelagic offshore environments (Steele 1992; Favero et al. 1997; Bertellotti and Yorio 1999). Whereas the gull subfamily Larinae seems historically to have exhibited seasonal shifts in diet (Blight et al. 2015), the kelp gull seems to be particularly responsive to pulses of resources in its environment. For example, kelp gulls regularly forage on the remains of Cape fur seals *Arctocephalus pusillus pusillus* after white shark *Carcharodon carcharias* predation, or consume flesh from the open wounds on injured fur seals that have survived shark attacks (Martin 2004; C Fallows, Apex Expeditions, Cape Town, pers. comm.). Here we present descriptions of new predatory behaviours by kelp gulls on fur seals in

Namibia, southern Africa, and we discuss the implications of our findings as they relate to regional foodweb dynamics and demographic changes of seals.

Methods and study site

The following set of observations were made along a beach located at Pelican Point, Dorob National Park in Namibia (22°53′04.59″ S, 14°26′30.80″ E; Figure 1). From 1999 to 2014, ND seasonally used Pelican Point as a launching point once per week for ocean kayaking excursions and 4×4 vehicle tours that span the desert–ocean ecotone. Observations were focused on kelp gulls and Cape fur seals at Pelican Point. Around 60% of the population of Cape fur seals in southern Africa occurs in Namibia (Kirkman et al. 2007). When ecotourism trips to Pelican Point began in 1995, fewer than 100 Cape fur seals were observed; this number increased to ~5 000 individuals by 1998 (ND unpublished data). The population started breeding regularly around 1999, and has since fluctuated between 20 000 and 80 000 individuals during the winter (ND unpublished data). These demographic changes mirror the overall patterns of variability in annual seal abundance in other parts of Namibia (Kirkman et al. 2007). Recent estimates suggest a population of around 4 000 breeding pairs of kelp gulls along the entire coast of Namibia; at Pelican Point several thousand individuals are present year-round (Kemper 2007), although they breed within 10 km of Pelican Point in a salt works (ND unpublished data). Weekly ocean kayaking trips were made along the 5 km strip of beach at Pelican Point from September to January each year, from 10:00 to 15:30, during which time gull and seal behaviours were observed opportunistically. Observations were also made from 4×4 vehicles that were parked on the beach at Pelican Point.

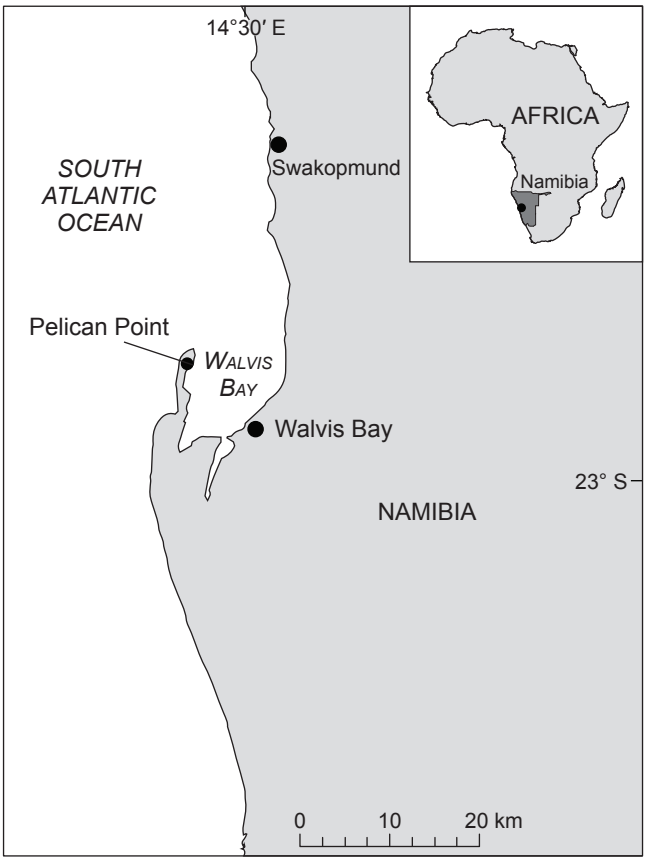

Figure 1: Map of the study area

Results and discussion

The general pattern of predation occurred as follows: kelp gulls within the seal colony at Pelican Point individually approached both newborn seal pups that were wandering or lost from their mothers, as well as juvenile seals that were sleeping (Figure 2a). A single kelp gull then rapidly attacked the ocular region of the seal with its beak, and attempted to remove and consume the seals' eyeballs (Figure 2b). Consumption of the eyeball signified a full, completed attack, which occurred roughly 50% of the time (total number of observations of attacks on apparently healthy seals was estimated at 500 over 15 years). Successful, completed attacks generally lasted two minutes, and resulted in continued consumption (often joined by other gulls) of the body, leading to the death of the seal. Consumption was focused on the soft and exposed dermal regions of the seals (underbelly, anus), and gulls used their beaks to puncture these areas. Partial attacks occurred when a gull did not consume the eyeball on the first attempt and the seal escaped, sometimes with the assistance of a nearby conspecific (e.g. the conspecific would try to bite the attacking gull). Given the distance of the observer from the seal colony, it was not possible to pursue these individuals and track their fitness. Hundreds of seal carcasses can be found year-round on the beach, including pups, juveniles and adults that have had their eyes removed (likely post-mortem, Figure 2c), although information is not available on the differences in attack rates according to size classes of seals. Furthermore, the cause of death of any particular carcass at Pelican Point could not be determined; due to the opportunistic nature of these observations, we can comment only on the behaviours themselves.

To our knowledge, this is the first record of this behaviour in kelp gulls, suggesting that it may be unique to our study area. Previous studies have provided convincing evidence to suggest that foraging behaviour in kelp gulls is highly plastic and that in certain areas behaviours may have developed to compensate for changes in resource availability as a result of human impacts. For example, the diet of kelp gulls living in areas of urbanisation and industrialisation vary throughout southern South America (Ludynia et al. 2005), and seasonal populations of gulls seem to be stabilised by fishery discards and offal (Villablanca et al. 2007). This variation differs compared to those populations living in areas of low human presence (e.g. Antarctica), where their diet is almost exclusively comprised of fish and invertebrates (Favero et al. 1997). Recent work off South America has even shown that kelp gulls are landing on and consuming flesh from southern right whales *Eubalena australis*, a behaviour that has become more frequent over the past 40 years, particularly on juvenile whales (Rowntree

Figure 2: Behavioural ethogram describing kelp gull predatory behaviour on Cape fur seals in southern Namibia: (a) gulls approach small, weak, or wandering juvenile or newborn seals; (b) gulls first target the ocular regions of live or dying seals; (c) still-alive seal pup with its right eye ripped out by a gull attack (photos ND)

et al. 1998; Sironi et al. 2009). The proportion of whales exhibiting gull-induced wounds in this area has increased from 1% in 1974 to nearly 80% in 2008 (Sironi et al. 2009).

It is reasonable to expect the observed behaviour to have been a consequence of an increase in seal numbers. For the past several decades, the abundance of kelp gulls has increased throughout most of their range, including South Africa and Namibia (i.e. Steele and Hockey 1990; Bertellotti and Yorio 1999; Hockey et al. 2005; Kemper 2007). Many populations of seals globally are experiencing population recovery following decades of heavy persecution (Costa et al. 2006). Our study corroborates predictions for increased conflict between seabirds and seals off Namibia made nearly 25 years ago by Crawford et al. (1989), who suggested that the increasing populations of seals and contemporary overfishing were drivers of competition. In this study, the emergence of newborn seal pups in the seal colony represents a dense and predictable pulse of energy for kelp gulls to forage on. The local kelp gull breeding colony is ~10 km south of our study area, however, suggesting that the gulls are not competing with seals for access to breeding areas.

Behavioural plasticity is an important adaptive feature of foraging in vertebrates, and is often manifested via increases in feeding rate and/or dietary breadth (Dill 1983). Owing to their often variable diets and ability to connect marine and terrestrial habitats over long distances, seabirds such as kelp gulls can be used as 'moving laboratories' for understanding the effects of human pressures such as climate change and overfishing. These types of behaviours may serve as bellwethers for future ecological changes if the species are monitored properly over time, and can provide insights into the shifting dynamics between predators and prey. Furthermore, these types of behaviours may be of conservation concern if the prey species is threatened or endangered, as seen with many terrestrial species (e.g. coyotes and endangered birds; Gompper 2002). Although visual censuses and advances in bio-logging technologies allow us to monitor and track the life histories of highly mobile marine species, direct observations of behaviour (e.g Gallagher et al. 2014) can provide important information to drive future quantitative investigations into how animals respond to changes in the environment.

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