Diet and foraging behaviour of Macaroni and Chinstrap Penguins at Bouvetøya, South Atlantic Ocean

by

Onno Adrian Wallace Huyser

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Percy FitzPatrick Institute of African Ornithology
Department of Zoology

Faculty of Science
University of Cape Town
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Abstract


Bouvetøya (Bouvet Island: 54°25'S, 3°21'E) is an isolated island situated in the South Atlantic Ocean. Little biological research has been conducted at this globally important breeding site for seabirds. I aimed to improve our understanding of the foraging ecology of two important consumers of marine resources breeding at Bouvetøya, Macaroni Eudyptes chrysolophus and Chinstrap Pygoscelis antarctica Penguins, during visits in December-February 1996/97 and 1998/99. I studied the diets and foraging behaviour of these species to gain a better understanding of resource use and variability at Bouvetøya, to assess how extrinsic and intrinsic factors influence community organization in this depauperate community of marine predators, to determine the limits to foraging in a specialist consumer of Antarctic krill Euphausia superba, and to satisfy long-term monitoring (and ultimately conservation) objectives. Macaroni Penguin diets were dominated by three prey in both years: the myctophid fish Kreffichthys anderssoni, krill and another euphausiid Thysanoessa macrura. Seasonal effects were strong: above-average representation of K. anderssoni, krill and T. macrura occurred in diets from the first, second and final third of the chick-rearing period, respectively. Mean foraging depth of Macaroni Penguins in 1999 was 38.7 ± 27.7 m, but foraging was focused at two depth modes (5-15 m & 50-70 m; assessed with time-depth recorders), strongly suggesting that euphausiids were eaten during shallow dives, and fish during deeper dives. Adult body condition explained a significant amount of variation in mean sample mass and number of prey, and was positively related to chick condition. Thus parents in better condition may be able to invest more in their offspring. Female Macaroni Penguins adjusted their behaviour at sea to demands from the chick by conducting shorter trips and diving deeper when chicks were small. This probably allowed them to return lipid-rich fish to the chick and limited their horizontal searching, but may be a more costly foraging strategy than feeding on krill alone. Chinstrap Penguins are mainly krill in both years, dived shallower (mean maximum depth 25.5 ± 17.9 m) than Macaroni Penguins, and spent a disproportionately greater amount of time at 20-35 m depths, suggesting a focus of feeding activity and hence krill presence. Both species dived less and to shallower depths at night, but conducted the deepest feeding dives at sunrise and sunset. This may result from rapid vertical migration of prey, which may cause disruption of anti-predator aggregating behaviour, or from penguins maximising short-term rates of prey intake in a rapidly changing light regime. Deep diving in Macaroni Penguins may be ultimately limited by light, but most day-time dives are not light limited, probably because penguins have light levels at, or above which, refer to forage, but can surpass if necessary. Four dive bout types were recognised in Chinstrap Penguins; types were distinguished by length, period since the last dive, bottom time, descending vertical velocity, and mean maximum depth. Type I bouts probably constituted unsuccessful searching behaviour. Type II bouts appeared to be terminated proximately by penguin satiation, and ultimately by prey patch quality. Type III bouts appeared to occur after a long resting or travelling phase at sea. Type IV bouts appeared to be terminated by declining prey capture rates (resource depression), probably resulting from krill escape behaviour. Physiological limitation of diving did not appear to take place, which is inconsistent with the finding that 36.4% of dives exceeded the Theoretical Aerobic Dive Limit, but suggests that Chinstrap Penguins might possess compensating mechanisms that allow them to maximise the amount of serial time underwater over long intervals. This accords with the finding that Chinstrap Penguins search a comparatively small volume of water for prey, yet have a comparatively short fledging period, and accumulate energy rapidly for the brood at Bouvetøya. Inter-bout intervals indicate that Chinstrap Penguins searched for prey at an average spacing of ca. 320 m, but encountered prey at an average spacing of ca. 400 m. Thus penguins can serve as environmental monitors to gauge the dispersion and patch quality of a variable prey resource. This is important, because existing monitoring programmes that are concerned with impacts of krill shortages on predator performance primarily use land-based measures to assess predator performance at sea. Increased investment in direct monitoring of behaviour at sea will enhance our understanding of predator-prey relationships. The three main diving predators at Bouvetøya (including Antarctic Fur Seals Arctocephalus gazella) are ecologically segregated, with some niche overlap. Chinstrap Penguins are predominantly shallow-diving, inshore-feeding, krill specialists; Macaroni Penguins shallow- and deep-diving, offshore, mixed krill and fish generalists; fur seals shallow-diving, offshore, krill specialists. These niches closely resemble those at other sites, including those where greater numbers of sympatric species occur. Interference competition and aggressive interactions on land between fur seals and penguins indicates that intrinsic community interactions do influence community structure at Bouvetøya (primarily penguin demography), but there is little evidence that interactions at sea (predation or competition) structure realised foraging niches. The ecological segregation observed might be an outcome of adaptations by each species to conditions experienced in the centre of their respective ranges. Inferred large-scale environmental variability in marine resources did not exist during the study, but small differences in trip length, prey size distributions and digestion show that small-scale environmental differences did exist.