

## A new high-latitude record for the macaroni penguin (*Eudyptes chrysolophus*) at Avian Island, Antarctica

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report on observations of macaroni penguins at Avian Island (67°46' S, 68°53' W) (Fig. 1) located approximately 400 km south of the Palmer Archipelago along the WAP and 1° south of the Antarctic Circle, near Adelaide Island, during January 2007, a new high-latitude record for the species within this region of Antarctica. We also report more frequent extra-limital sightings of macaroni penguins over the last decade at relatively lower latitudes along the WAP within the Palmer Archipelago near Anvers Island (Fig. 1), including observations of breeding attempts.

## Observations

On 20 January 2007, at an annual field research camp occupied as part of a long-term study on the breeding ecology of Adélie penguins (*Pygoscelis adeliae*) nesting at Avian Island (Fig. 1

whereas breeding adults return to molt by mid-March (Williams 1995). Therefore, the timing of our observations is temporally coherent with the molt process by immature and failed breeders. However, plumage quality of all birds reported here suggested that the molt process had not been initiated at the time of our observations.

Alternatively, we hypothesize that a bio-geographic range shift in response to regional climate warming may be in progress for this species. In addition to our documented breeding attempts by macaroni penguins along the Palmer Archipelago, including the production of at least one chick, all individuals involved in our sightings exhibited the typically large body size and developed head plumes of mature birds of at least 3–4 years of age (Williams 1995) (Fig. 2). As described below, this pattern of occurrence of mature individuals, coupled with repeated, but unsuccessful breeding attempts, closely resembles the well-documented climate-induced shifts in bio-geographic range now occurring among other sub-Antarctic penguins breeding within the WAP region of Antarctica.

Community composition of breeding *Pygoscelis* penguins along the Palmer Archipelago has shifted over the past 30 years coincident with regional climate warming (Vaughan et al. 2003; Ducklow et al. 2007; see Forcada and Trathan 2009 for review), a common biotic response predicted by theory on climate change (Parmesan 2006). Here, breeding populations of the true Antarctic, sea-ice obligate Adélie penguin have decreased by over 65% since the mid-1970s, and their range has contracted. Conversely, sub-Antarctic, sea-ice intolerant chinstrap (*P. Antarctica*) and gentoo (*P. papua*) penguin populations have increased, and their ranges have expanded with nesting colonies established in 1976 and 1994, respectively (Ducklow et al. 2007), representing unique events within the context of paleoecological data on penguin occupation of the region over the last 700 years (Emslie et al. 1998). Similar to the macaroni penguins previously discussed, breeding populations of chinstrap and gentoo penguins along the Palmer Archipelago were initiated by small numbers of individuals

established, these breeding populations were characterized by the increased presence of non-breeding prospectors looking to establish mates and breeding territories (WRF, Pers. Obs.). Of note, declines in numbers of chinstrap and gentoo penguins have been documented at some breeding colonies along the northern WAP (Woehler et al. 2001; Forcada et al. 2006; Sander et al. 2007; Forcada and Trathan 2009). In parallel, numbers of breeding macaroni penguins also have declined throughout the species sub-Antarctic range (Woehler et al. 2001; Crawford et al. 2003), including nesting colonies closer to the WAP such as those at South Georgia (Trathan et al. 1998; Forcada and Trathan 2009).

We cannot distinguish any causal mechanism for the presence of macaroni penguins at uncommonly high latitudes at Avian Island, or along the Palmer Archipelago, over the last decade based on our observations. However, we hypothesize that these extra-limital observations are either related to simple vagrancy or much more complex relationships between ocean-climate, population-demographic processes, and bio-geographic range dynamics. Nonetheless, our observations establish a current baseline for the occurrence of macaroni penguins at relatively higher latitudes along the WAP, now including geographically polar locations, which may prove particularly important should the effects of regional climate warming magnify and continue to influence top predator populations throughout the WAP region of Antarctica (e.g., Ducklow et al. 2007; Trathan et al. 2007; Siniff et al. 2008; Forcada and Trathan 2009).

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