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Short Note
Southerly breeding in gentoo penguins for the eastern Antarctic Peninsula: further evidence for unprecedented climate-change

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Introduction

Population studies of gentoo penguins (*Pygoscelis papua* Forster) over the past 30 years indicate a gradual movement southwards, with the establishment of new breeding and nesting sites along the Western Antarctic Peninsula (WAP) paralleling patterns of recent climate warming (Ducklow *et al*. 2007, McClintock *et al*. 2008). This southern range extension has occurred despite gentoo penguins being classically considered a sea ice independent, sub-Antarctic species (Fraser *et al*. 1992, Williams 1995). Importantly, where the precise dates of gentoo occupation is known, such as near Palmer Station, Anvers Island, on the north central WAP (64°46'S, 64°11'W) (the species first began breeding in 1993 and monitored populations have increased rapidly to 2,401 breeding pairs, Fraser unpubl. 2009 census), their appearance has foreshadowed significant coherent changes in ecosystem dynamics (Ducklow *et al*. 2007). Until the late 1990s breeding populations of gentoo penguins had not been reported along the Eastern Antarctic Peninsula (EAP), and indeed, their range appeared to extend no further south than the north-east tip of the Antarctic Peninsula (AP), with some of these records actually being of questionable accuracy (reviewed in Woehler 1993). Here we report the encroachment of nesting gentoo penguins into an Adelie rookery at Brown Bluff on the Weddell Sea side of the AP. Although this observation complements the documentation of a gentoo penguin colony at this site for at least the past decade, the available literature does not acknowledge this as being at the southernmost periphery of their range in the EAP (cf. Woehler & Croxall 1997, Lynch *et al*. 2008). This is important because as shown for the WAP breeding populations of gentoo penguins that appear suddenly and grow relatively quickly (by historic standards) appear to be indicative of threshold changes in the ecosystem that signify a transition from a more polar to a more sub-polar marine environment (Ducklow *et al*. 2007).

Observations

Observations of gentoo penguins were made on 12 December 2009 at Brown Bluff, Antarctic Sound, in the Weddell Sea on the EAP (63°32'S, 056°55'W). Parallel to a rocky beach that faces north-east, and below the large bluff, resides a long-standing Adélie penguin rookery comprised of approximately 20 000 breeding pairs (P. Silva, unpublished). In the south-west corner of this Adélie rookery we discovered that gentoo penguins had successfully invaded the margin of this Adélie colony (Fig. 1), and a number of individuals had nesting sites. Pygoscelid penguins such as gentoos and chinstraps often establish colonies by invading colonies of other established species including the Adélie penguin (Trivelpiece & Volkman 1979). All the nesting gentoo penguins were incubating eggs. We conducted a systematic count of every nesting penguin in this particular section of the Adélie rookery. Of 70 nesting individuals, 15 (21.4%) were gentoo penguins. A qualitative survey of the balance of the Adélie rookery indicated that other margins of the rookery had yet been invaded by gentoo penguins.

Discussion

Recent studies indicate that populations of sea ice-dependent marine sea birds and marine mammals are suffering reductions along the WAP (Ducklow *et al*. 2007). This is correlated with the unprecedented rapidity of rising air and sea temperatures (Vaughan *et al*. 2003), rendering the WAP the most rapidly warming region of the earth. The most poignant example is the demise of the sea ice-dependent Adélie penguin that has suffered from increased egg mortality caused by unseasonable spring snowfall and the loss of the annual sea ice as a platform to migrate to rich offshore krill grounds (Ducklow *et al*. 2007, McClintock *et al*. 2008). Gentoo penguins, in contrast, are characterized by sea ice avoidance and nest later in the spring, thus avoiding the pitfalls of increased snowfall. As climate warming has reduced the extent and duration of the annual sea ice some 40% over the past 30 years along the WAP (Smith & Stammerjohn 2001, Ducklow *et al*. 2007) there has been a concomitant increase in the range extension of nesting gentoo penguins, as well as other sub-Antarctic species (e.g. the chinstrap penguin *Pygoscelis antarctica*). This has occurred despite a palaeoecological record that

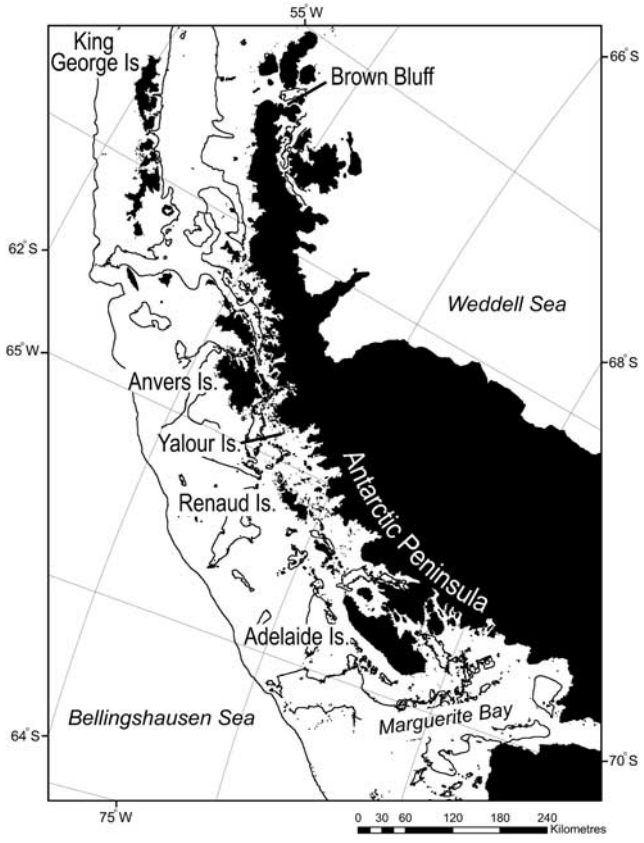

Fig. 1. Map of the Antarctic Peninsula showing locations of new southern breeding distributions of gentoo penguins in the EAP (Brown Bluff) and WAP (Yalour Islands). Although in the WAP breeding attempts have been noted as far south as Renaud Island (WRF, personal observation), it is only in the Yalour archipelago that colonies seem reasonably established (Lynch *et al*. 2008).

indicates gentoo penguins have been absent from WAP latitudes in which they now occur for at least 700 years (Emslie *et al*. 1998, Ducklow *et al*. 2007). That gentoo penguins are similarly colonizing the EAP as sea ice retreat and ice sheet break outs increase in this region supports the hypothesis that rapid climate warming is causing unprecedented southerly shifts in nesting gentoo penguins, and that this shift may be indicative of further changes in the structure and function of the northern EAP marine ecosystem.

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