Ocean warming and evolutionary responses: Life history adaptations in two genetic distinct colour morphs of Common Guillemots.

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Summary

The use of colour polymorphism as a phenotypic genetic marker in relation to life-history strategies and climatic factors is a promising way to study the effects of global warming on micro-evolutionary processes within populations and identifying which ecological processes are underpinning the occurring changes. The North Atlantic common guillemot *Uria aalge* possesses two genetically different colour morphs; the bridled and the unbridled morph. The frequency of the two morphs follows a north south gradient, with the frequency of bridled birds increasing with latitude. We show how fluctuations in sea surface temperature affects life-history traits of these morphs differently in two colonies with different frequency; the Isle of May in Scotland and Hornøya in Northeastern Norway. We combined non-breeding distribution data from geolocators, with Sea Surface Temperature and long-term time series data on adult survival (29 and 22 years). Additionally, we analyzed the breeding success over 22 years for different family morph combinations in relation to SST around the colony. We discuss how climate change will alter the bridling frequency and how it is possible to visualize how evolutionary adaptations to global warming will be manifest.

Introduction

A great challenge in terms of climate change is to assess how species are adapting evolutionary and to reveal the underlying processes. Populations with genetically linked colour polymorphism is promising in this respect, since colour polymorphism can be used as a phenotypic genetic marker in relation to life-history strategies. In the North Atlantic the common guillemot possesses different colour morphs; an unbridled morph with an entirely dark head and a bridled morph that has a white eye ring and auricular groove sloping back from the eye. The bridled morph is a recessive variant of the normal form and pairing between the two forms is random. The frequency of bridling follows a geographical cline, with increased frequency of bridling with latitude. Climatic studies that separates the effect of phenotypic plasticity from that of microevolutionary processes are so far scarce (reviewed in Gienapp *et al*. 2008. Three conditions need to be fulfilled in order to demonstrate that a population has responded adaptively to climatic change (reviewed in Parmesan (2006)). 1) Documentation of the selection on a trait related to fitness. 2) Evidence that this trait is linked to climatic change and 3) a demonstration of genetic change in the trait. In this presentation we will focus on studies conducted in two colonies; the Isle of May (56° 11′ 9″ N, 2° 33′ 27″ W) in Scotland, with low frequency of bridling (c. 5-6 %) and Hornøya (70° 23′ 15.72″ N, 31° 9′ 19.08″ E) in Northeastern Norway, with markedly higher frequency (c. 30 %). The aim was to study whether any differences in demographic traits between the two morphs existed and whether these were affected by climatic conditions in breeding and non-breeding seasons, to reveal any different life-history strategies in relation to climate. This was done by combining data of adult survival and breeding success with sea surface temperatures from known non-breeding distribution. Regarding breeding success we analyzed if different pairings of the morph (pure (UB x UB) or mixed (UB x B)) differed in breeding success and if there were any relationship with yearly breeding success in terms of SST around the colony.

Materials and Methods

The study species is the Common guillemot *Uria aalge.* Non-breeding distribution was determined by year-round light-based geolocators. We used long-term time-series data of capture mark recapture (CMR) data and breeding success from both populations. The length of the CMR dataset is 29 years (1982 – 2011) and 22 years (1987 – 2011) long for Isle of May and Hornøya respectively. Breeding success within different pairings of the morphs analyzed for the Isle of May dataset was 19 years (1992 – 2011) long. Sea surface temperature (SST) from the two morphs non-breeding distribution was used as climatic factor. The SST was extracted from an ocean- model based on a two-day ocean forecast from the Norwegian Meteorological Institute.

Results and Discussion

The main results from this study was 1) differential responses of adult survival related to SST for the two morphs. On Hornøya we found a negative relationship between winter SST in the Barents Sea two years earlier and adult survival of the bridled morph, and for the unbridled morph this relationship was slightly positive (Reiertsen *et al*. 2012). Guillemots on Isle of May differed in their distribution in February. And we found differential relationships between SST in the specific areas the two morphs were distributed in February.

2) The yearly differences in breeding success it was closely linked to the SST around Isle of May. The mixed family group (UB x B) had a higher breeding success in years with low SST compared to the UB x UB family group.

These results provides evidence for contrasting effects of climatic fluctuations on the adult survival and breeding success of two genetic morphs, and suggests that the two morphs have different strategies to cope with environmental fluctuations. The results also implies the potential for the predicted warming of the sea to pose directional changes in favour of the unbridled morph in the years to come. Thus revealing the underlying mechanisms and which characteristics are the real target for selection can provides important knowledge of which traits are necessary in order to being able to adapt to climate change.

References

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