Spatial Heterogeneity as a Genetic mixing mechanism in highly philopatric Colonial Seabirds

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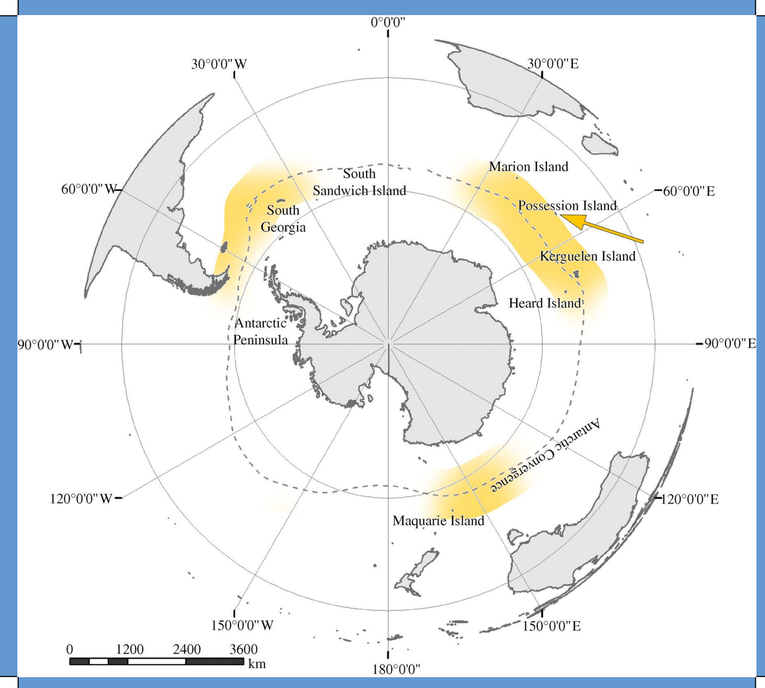
Background.

- How is genetic diversity maintained in philopatric colonial systems such as in dense penguin colonies?
- Philopatric behaviour has several selective advantages, yet its possible consequence, inbreeding depression, may cause entire populations to crash.
- In the **King penguin *Aptenodytes patagonicus***, return rates of chicks to their natal sub-colony are remarkably high. And when starting to breed in an area, adults tend to return year after year to their previous breeding territories.
- In order to assess the importance and consequences of this phenomenon, we present the first fine-scale study of the genetic structure in a king penguin colony.



Methods.

- 175 chicks were sampled and the nests precisely geolocated, during the early 2010 breeding season, on Possession Island, Crozet Archipelago (*fig. 1*).
- Tick infestation, chick survival rate, and site occupancy chronology were assessed for several years.
- Samples were genotyped at 8 microsatellite loci.
- Heterogeneous patterns were investigated through spatial distribution of individual inbreeding and pairwise relatedness, both using continuous, and clustered analysis methods.

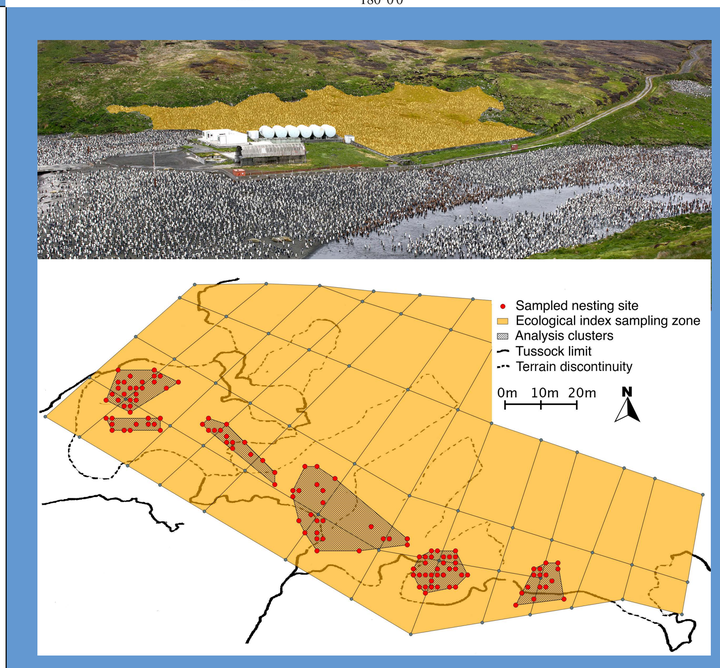


Fig. 1. Sampling design. Sampling was restricted to the periphery of the colony. Orange zones boundaries are marked on the ground for remote parameter assessment. Shaded clusters run from C1 (north-west) to C6 (south-east).

Results.

- The Colony is in equilibrium, genetically diverse, and no global processes (such as colony-wide autocorrelation) are visible - yet **no global process does not mean no structure!**

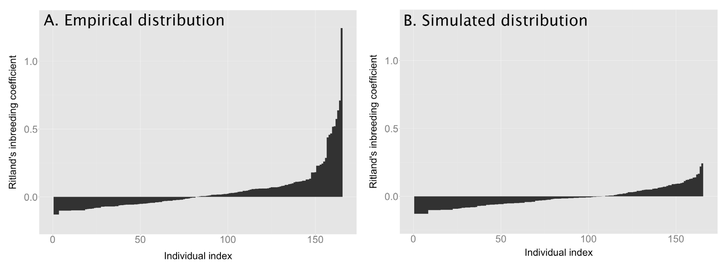


Fig. 2. Individual inbreeding distribution deviates from expectations. A. Observed individual inbreeding distribution (Ritland's coefficient). **B.** Simulated distribution for a population of non-related individuals.

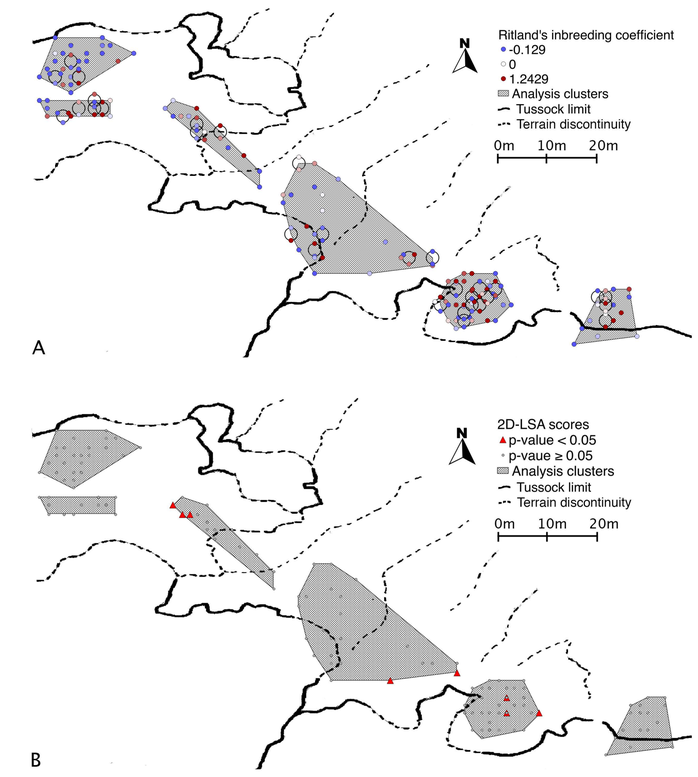
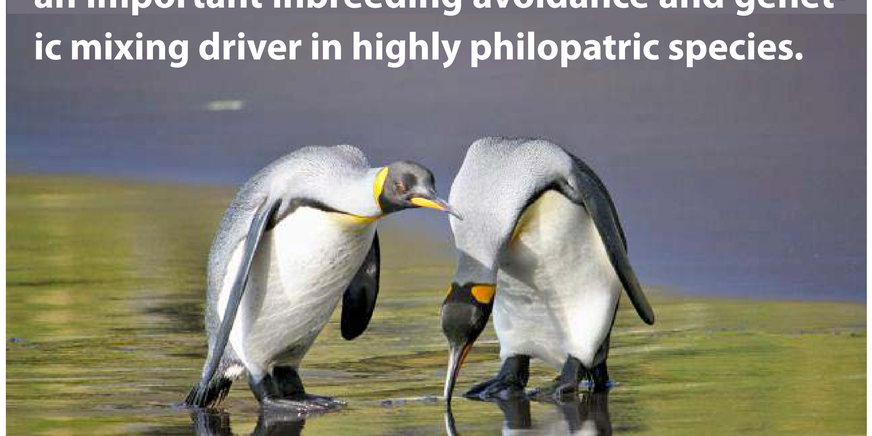


Fig. 3. Individual inbreeding and nearest-neighbour-relatedness tend to cluster. A. Distribution of Ritland's individual inbreeding coefficient along the sampling area. Shaded zones: clusters C1 to C6. **B.** 2D-LSA scores. Red triangles represent individuals that are significantly more related to their 9 nearest neighbours than to random individuals.

- High mean individual inbreeding level (near half-sib), and some individuals are more related than expected by mere chance (*fig. 2*).
- Higher or lower inbreeding and pairwise relatedness appear to be organized in patches (*fig. 3*).
- These patches correlate with ecological site-quality descriptors: better patches attract early and more successful breeders. They bring about higher individual inbreeding levels in offsprings. Lower-quality sites on the other hand promote outbreeding (*fig. 3 and 4*).

Conclusions.

- Despite highly philopatric behaviour, colonial seabirds such as king penguins manage to keep high levels of genetic diversity and mixing within colonies.
- Our results stress the importance of understanding intra-colonial dispersal and genetic mixing mechanisms in order to better estimate species-wide gene flow and population dynamics.
- **Heterogeneity in nesting-site quality may be an important inbreeding avoidance and genetic mixing driver in highly philopatric species.**



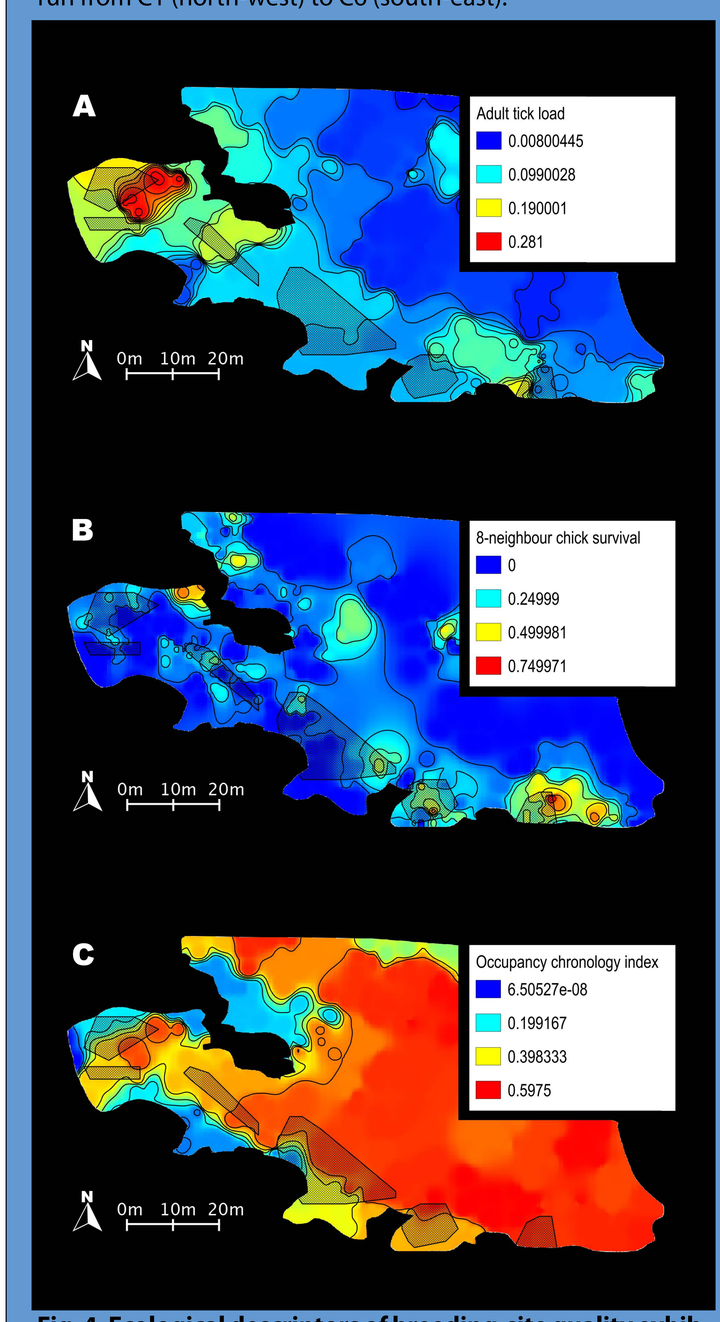


Fig. 4. Ecological descriptors of breeding-site quality exhibit a strongly heterogeneous distribution across the colony. A. Adult tick load, averaged for years 2005-2012. **B.** 8-neighbour chick survival, averaged for years 2010-2012. **C.** Site occupancy chronology, averaged for years 2006-2013. Ratio of brooding birds amongst 50 randomly selected breeders.