Does inbreeding in bumblebees compromise immunity?

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Summary

This project aims to determine whether the genetic diversity of wild bumblebee populations affects prevalence of parasites and individual immune responses.

Figure 1

- The prevalence of parasites and levels of immunity in *Bombus muscorum* (**fig 1**) from island populations with a known genetic diversity was measured.
- Populations with a lower genetic diversity had a higher prevalence of parasites.

• Individual immune responses differed significantly between islands, but was not correlated with genetic diversity.

Background

Inbreeding and loss of genetic diversity are significant threats to small, isolated populations. One mechanism via which genetically impoverished populations may become extinct is through decreased immune competence and higher susceptibility to parasites. However, studies that have investigated the relationship between inbreeding and parasite resistance in invertebrates have ambiguous results[1,2].

Figure 2

The genetic diversity of Hebridean island populations of *Bombus muscorum* has been measured in a previous study. Genetic differentiation was found between populations, with more isolated populations exhibiting decreased genetic diversity and evidence of inbreeding[3].

Methods

In order to establish whether bumblebee immunity is compromised by inbreeding and a loss of genetic diversity, a sample of the Hebridean island populations were revisited in August 2009 and measures of bumblebee immunocompetence were taken.

Figure 3

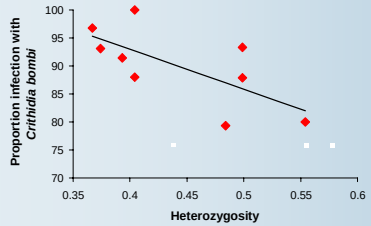
Figure 4

Figure 5

- 267 *Bombus muscorum* workers were collected from 9 island populations in the Inner and Outer Hebrides (Scotland, UK, **figure 2**).
- The immune system of each bee was challenged by inserting a nylon implant (~1.5mm) into its abdomen (**figure 4**). 4 hours later, the bee was freeze-killed in liquid nitrogen.
- The implants were dissected out, mounted on slides, and the amount of melanisation was recorded (ImageJ software measured the mean grey value of each implant; higher values reflect greater melanisation, hence a greater immune response, **figure 5**).
- As a further immune test, the level of the enzyme phenoloxidase was measured, using haemolymph from each bee's thorax. Higher levels of this enzyme reflect greater immune function.
- The presence and load of any other parasites infecting the bees were recorded.
- Finally, the age and size of each bee was recorded.

Results

Figure 6 Prevalence of *Crithidia bombi*



Island populations with lower genetic diversity have higher prevalence of a gut parasite.

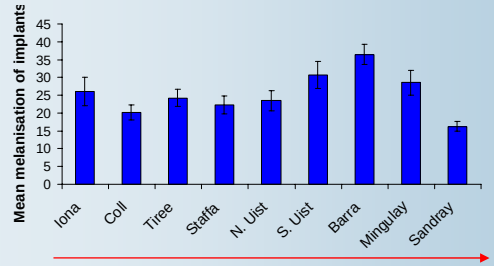


Figure 7 Mean melanisation response by island

There is a significant difference in the melanisation response between islands. Similar between population variation was found in levels of phenoloxidase. However, this variation is not explained by the genetic diversity of the island.

Conclusions

• Inbreeding and a loss of genetic diversity:

- does increase the prevalence of parasites at the **Population level.**
- does not affect immune responses (susceptibility to parasites) at the **Individual level.**

References

1. Spielman, D. *et al.* (2004). Does inbreeding and loss of genetic diversity decrease disease resistance? *Cons gen 5:* 439-448. **2.** Calleri, D.V. *et al.* (2006). Inbreeding and disease resistance in a social insect: effects of heterozygosity on immunocompetence in the termite *Zootermopsis angusticollis*. *Proc. R. Soc. B. 273*: 2633-2640. **3.** Darvill, B. *et al* (2006). Population structure and inbreeding in a rare and declining bumblebee, *Bombus muscorum*. *Mol Ecol 15 (3)*: 601-611.

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