

BRIEF COMMUNICATIONS

Molecular trails from hitch-hiking snails

Migrating birds may have transported the *Balea* land snail across vast distances to remote islands.

Darwin was fascinated by the transportation of land snails across great swathes of open ocean by birds — he even immersed snails in sea water to see how long they would survive¹. Here we follow a molecular phylogenetic trail that reveals the incredible transequatorial dispersal of the land snail *Balea* from Europe to the Azores and the Tristan da Cunha islands, and back again. This long-distance dispersal is unexpected for what are proverbially considered the most pedestrian of creatures.

An allegorical picture² from the sixteenth century shows a bird carrying a snail (Fig. 1), but it was not until 1921 that the possibility of land-snail dispersal by birds was discussed for *Balea*³. It was suggested that the exceptionally tenacious slime and arboreal habit of *Balea perversa*, an ovoviviparous hermaphrodite, could aid passive dispersal by birds³. As land snails occur on even the most remote islands, this must be a frequent event, despite the limited number of well documented cases⁴.

In 1824, John Gray assigned two new species of land snail from the Tristan da Cunha islands

to *Balea*, a genus of Clausiliidae thought to be restricted to the Palaearctic region, which includes northern Africa and Eurasia to the north of the Himalayas⁵. The Tristan archipelago consists of three main islands situated midway between South Africa and South America at about 37° S, with Gough Island lying about 350 km to the south-southeast (Fig. 2a). It lies 9,000 km and 8,500 km from the Azores and continental Europe, respectively.

On the basis of their extreme biogeographical disjunction, these Tristan land-snail species were subsequently transferred to a new genus, *Tristania*⁶. Additional species of *Tristania* were later described from other islands in the Tristan/Gough group^{7,8}. To reach Tristan from either Europe or the Azores, where two *Balea* species occur⁹, a hostile gap of nearly 9,000 km has to be bridged, which hardly seems possible for a vulnerable pulmonate.

Despite renewed claims for the generic distinctness of *Tristania*, including the erection of the subfamily Tristaniinae¹⁰, anatomical evidence indicates that *Tristania* and *Balea* belong to the same genus⁸. We have analysed mitochondrial DNA sequence data for subunit I of cytochrome oxidase for different *Balea* species and find that they confirm this view: our neighbour-joining phylogenetic tree (Fig. 2b, and see supplementary information) indicates that Azorean and Tristan groups of *Balea* arose from a single ancestral species.

As the Baleinae originally radiated in the western Palaearctic region^{11,12}, the most parsimonious scenario is that first the ancestral species reached the Azores, then, after additional long-distance dispersal, radiations resulted in two species in the Azores and at least eight in the Tristan/Gough archipelago. One of the Azorean species, *B. heydeni*, reached Madeira and then 'returned' to western

Figure 2 | Distribution of *Balea* species. **a**, Areas where the snails are found. **b**, Neighbour-joining tree for DNA sequences of cytochrome oxidase subunit I in selected species, with bootstrap support values (1,000 replicates). A smaller International Transcribed Spacer 1 data set corroborates these results (see supplementary information). Lineages from mid-Atlantic islands are in red. The extent of sequence divergence between *B. perversa* and its sister clade, together with the occurrence of at least eight *Balea* species on Tristan/Gough⁸, rule out human introduction of the snails. The sequences of populations of *B. heydeni* from mainland Europe are extremely similar, suggesting a recent return to the continent.



Figure 1 | Etching from Marcus Gheeraerts' fable 'Pride comes before a fall'. An eagle is depicted here, but is unlikely to be the bird that transported *Balea* (see supplementary information). Waders or other migratory birds, which are regular vagrants on mid-Atlantic islands, are more likely vectors.

Europe, where it exists as a distinct species only recently distinguished from *B. perversa*¹³ (the European *B. perversa* reached Iceland relatively late and remains indistinguishable from conspecific European populations).

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