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 survive[1]. 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 picture[2] 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 birds[3]. As land snails occur on even the most remote islands, this must be a frequent event, despite the limited number of well documented cases[4].

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 Himalayas[5]. 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 occur[9], 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 Tristaniinae[10], anatomical evidence indicates that *Tristania* and *Balea* belong to the same genus[8]. 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 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).

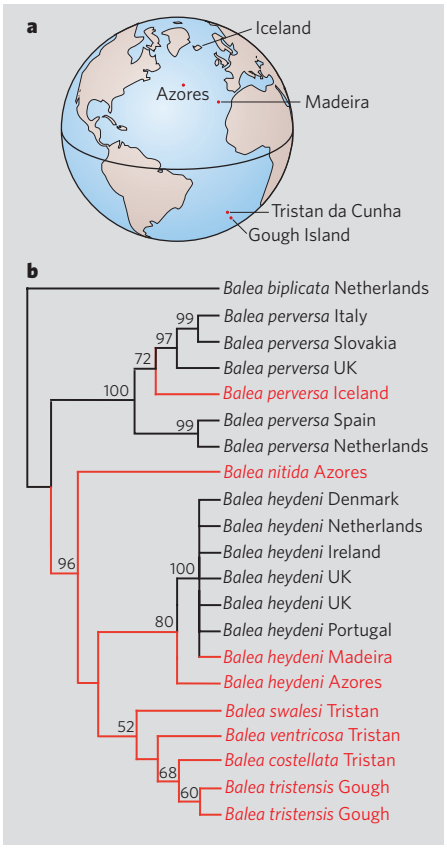

Figure 2 | Distribution of *Balea* species. a, Areas where the snails are found. **b,** Neighbour-joining tree for DNA sequences of cytochrome oxidase subunit I in selected species, with bootstrap support values (1,000 replicates). A smaller International Transcribed Spacer 1 data set corroborates these 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/Gough[8], 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'[2]. 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.

Edmund Gittenberger*†, Dick S. J. Groenenberg*, Bas Kokshoorn†, Richard C. Preece‡
*National Museum of Natural History Naturalis, PO Box 9517, and †Institute of Biology, Leiden University, PO Box 9516, 2300 RA Leiden, The Netherlands
‡Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, UK
e-mail: rcp1001@cam.ac.uk

1. Darwin, C. *On the Origin of Species* (Murray, London, 1859).
2. Gheeraerts, M. *De Warachtighe Fabulen der Dieren* (Pieter de Clerck, Brugge, 1567).
3. Cockerell, T. D. A. *Nature* **108,** 496–497 (1921).
4. Rees, W. J. *Proc. Malac. Soc. Lond.* **36,** 269–282 (1965).
5. Gray, J. E. *Zool. J.* **1,** 61–62 (1824).
6. Boettger, O. *Ber. Thät. Offenb. Ver. Naturk.* **17/18,** 18–104 (1878).
7. Odhner, N. H. *Proc. Malac. Soc. Lond.* **34,** 168–173 (1960).
8. Preece, R. C. & Gittenberger, E. *J. Moll. Stud.* **69,** 329–348 (2003).
9. Backhuys, W. *Land and Freshwater Molluscs of the Azores* (Backhuys & Meesters, Amsterdam, 1975).
10. Schileyko, A. A. *Ruthenica* **2** (suppl.), 437–564 (1999).
11. Nordsieck, H. *Arch. Molluskenk.* **109,** 67–89 (1978).
12. Nordsieck, H. *Arch. Molluskenk.* **109,** 249–275 (1979).
13. Gittenberger, E., Preece, R. C. & Ripken, T. E. J. *J. Conch.* (submitted).

Supplementary information accompanies this communication on *Nature*'s website.
Received 2 August; accepted 22 December 2005.
Competing financial interests: declared none.
doi:10.1038/439409a

BRIEF COMMUNICATIONS ARISING online
www.nature.com/bca see *Nature* contents.