

Zoogeography

Lesson 5

From Populations to Species

- However great may be the area of land (or water) within which a **particular species** is found, it is **not present everywhere there**.
- Any area is a **patchwork quilt of differing environments**.
- As a result, the **species is broken up into many individual populations** that are separate from one another.
- no two patches of woodland, **no two freshwater ponds**, will be **absolutely identical**, even if they lie in the same area of country.

- **Each population independently responds** to the particular **environmental changes** that take place in its own location.
- **The response** of each population **dependents** on the particular **pattern of new mutations and of new genetic combinations** that have taken place within it.
- **Each population** will therefore **gradually come to differ** from the others in its genetic adaptations.
- Provided that the **barriers between the two populations are great enough to prohibit genetic exchange between** them, the foundations for the appearance of a new species have now been laid.

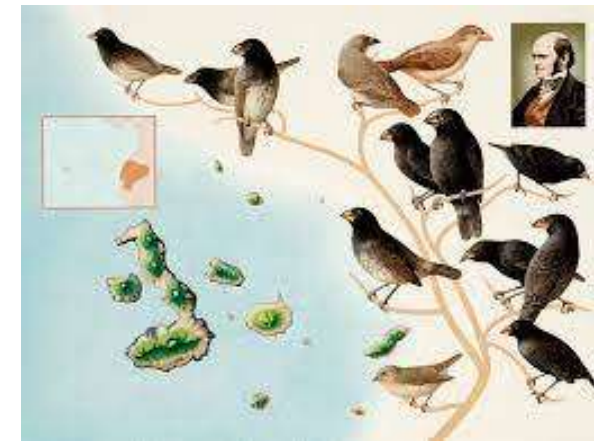
- **If two** such **divergent populations** should **meet again** when the **process of divergent adaptive change has not gone very far**, **they may simply interbreed** and merge with one another.
- If they have become **significantly different** in their adaptations, they may still be able to mate and have fertile offspring, known as **hybrids**; these are likely to have a mixture of the characters of their two parents.

Isolating mechanisms

- evolution will then favour the appearance of any characteristics that reduce the likelihood of hybridization:
 - 1) systems that prevent mating between related species from taking place, **Pre-mating isolating mechanisms**.
 - 2) systems that lead to reduced fertility if such mating does take place, **Post-mating isolating mechanisms**.

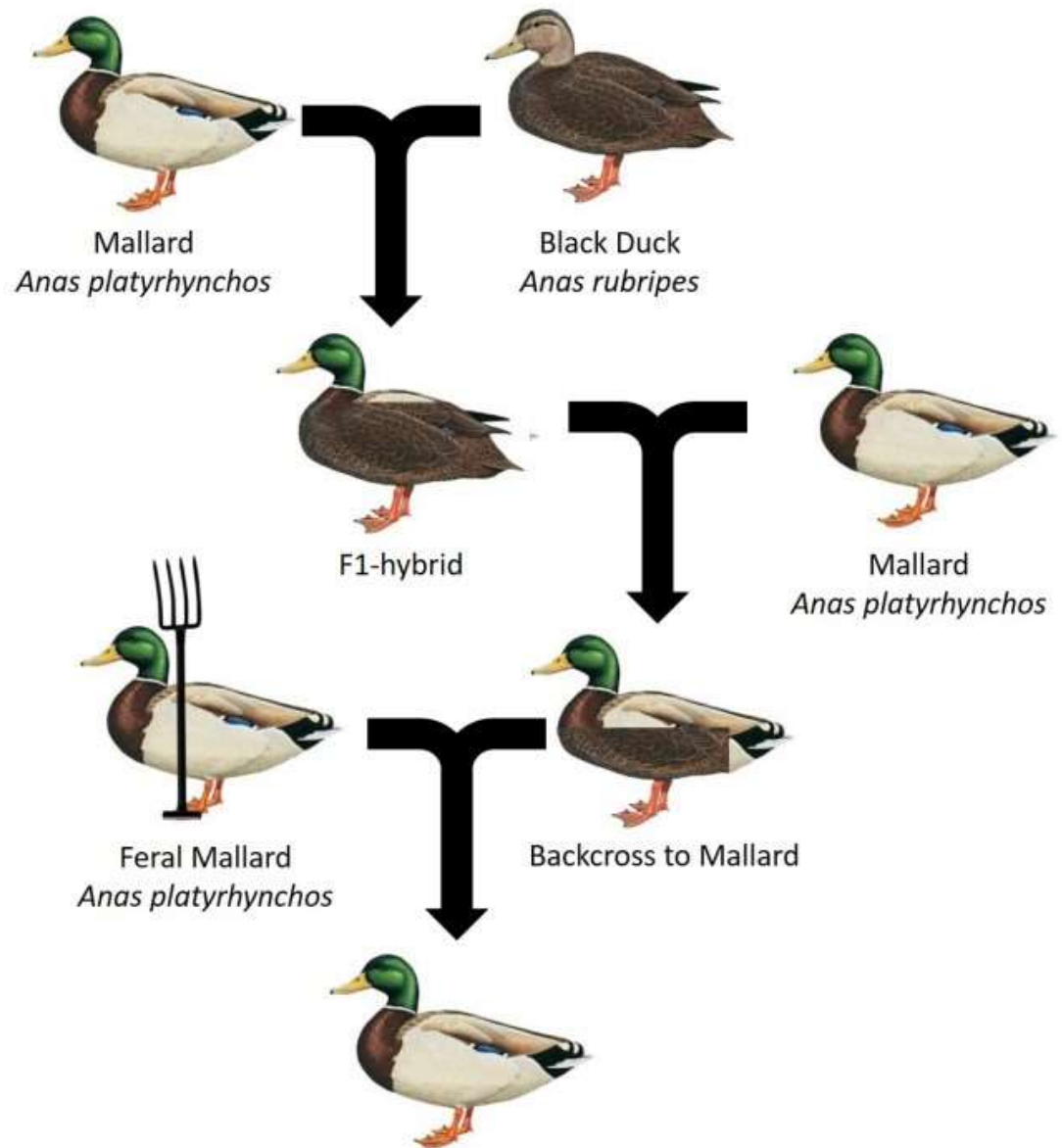
Pre-mating isolating mechanisms

- In the case of Darwin's finches, related species recognize one another because they have different songs, and they do not mate with an individual that sings the 'wrong' song.
- Sometimes the preference for the mating site may differ slightly. For example, the North American toads *Bufo fowleri* and *Bufo americanus* live in the same areas but breed in different places




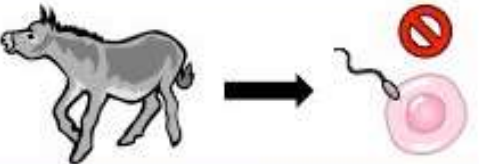
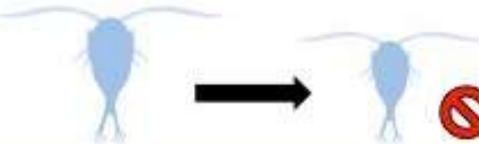
Pre-zygotic Isolating Mechanisms		Example	
Temporal	Occurs when two species mate at different times of year	Frogs live in same pond but breed during different seasons (summer vs spring)	
Ecological	Occurs when two species occupy different habitats	Lions and tigers can potentially interbreed, but usually occupy different habitats	
Behavioural	Occurs when two species have different courtship behaviours	Certain groups of birds will only respond to species-specific mating calls	
Mechanical	Occurs when physical differences prevent copulation / pollination	Certain breeds of dog are morphologically incapable of mating due to size	

- However, where the group concerned is rapidly evolving, such pre-mating barriers may not have had sufficient time to become effective.
- in ducks, where colour pattern and behaviour are the pre-mating barriers, 75% of the British species are known to hybridize.



Post-mating isolating mechanisms

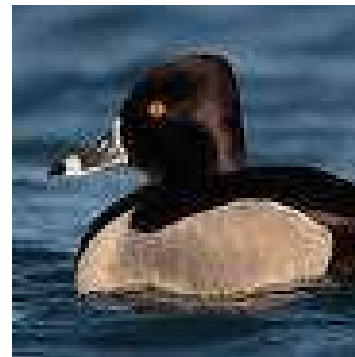
- if pollen of another species does reach the stigma of a flower, in many cases it is unable even to form a pollen tube because the biochemical environment in which it finds itself is too alien. It cannot therefore grow down to fertilize the ovum.
- Similarly, in many animals the spermatozoa of a different species cause an allergic reaction in the walls of the female genital passage, and the spermatozoa die before fertilization.

Post-zygotic Isolating Mechanisms		Examples	
Hybrid Inviability	Hybrids are produced but fail to develop to reproductive maturity	Certain types of frogs form hybrid tadpoles that die before they can become a frog	
Hybrid Infertility	Hybrids fail to produce functional gametes (sterility)	Mules are sterile hybrids resulting from mating between a horse and a donkey	
Hybrid Breakdown	F ₁ hybrids are fertile, but F ₂ generation fails to develop properly	The offspring of hybrid copepods have less potential for survival or reproduction	

Overcoming the Barriers

- The British Isles, for instance, lie within the geographical range of about 220 species of birds, but a further 50 or 60 species visit the region as casual vagrants. These birds do not breed in Britain, but one or two individuals are seen by ornithologists every few years.

i.e. Many of these accidental arrivals in Britain have their true home in North America, such as the ring-necked duck (*Aythya collaris*), a few of which are seen every year,

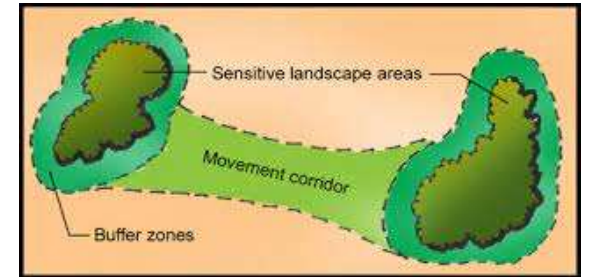


Overcoming the Barriers – when travelers become permanent established -

- Collared dove (*Streptopelia decaocto*) represents perhaps the most dramatic natural change in distribution recorded for any vertebrate in recent times.
- Since its introduction to the Bahamas in 1974, the collared dove has also spread rapidly through North America
- It is unlikely that the collared dove would have been able to take advantage of these changes without a **change** in its own **genetic make-up**, perhaps a physiological one permitting the species to tolerate a wider range of climatic conditions or to utilize a wider range of food substances



Spreading pathway



- **Corridor:** a wide variety of **interconnecting habitats**, so that the majority of organisms found at either end of the corridor would find little difficulty in traversing it.
- The two ends would therefore come to be almost identical in their biota (the fauna + the flora); **for example, the great continent of Eurasia that links western Europe to China has acted as a corridor for the dispersal of animals and plants.**



Spreading pathway

- **Filter:** a region may contain a more **limited variety of habitats**, so that only those organisms that can exist in these habitats will be able to disperse through it.
- i.e. Peculiar tropical lowlands of Central America provide a good example. Not all types of animal and plant are able to traverse this type of terrain.



Spreading pathway

- **Sweepstakes route:** areas completely surrounded by totally different environments, so that it is extremely difficult for any organism to reach them.
- i.e. Islands, the specially adapted biota of a high mountain peak, of a cave or of a large
- The chances of such a dispersal are therefore extremely low, and largely due to chance combinations of favourable circumstances, such as high winds or floating rafts of vegetation.

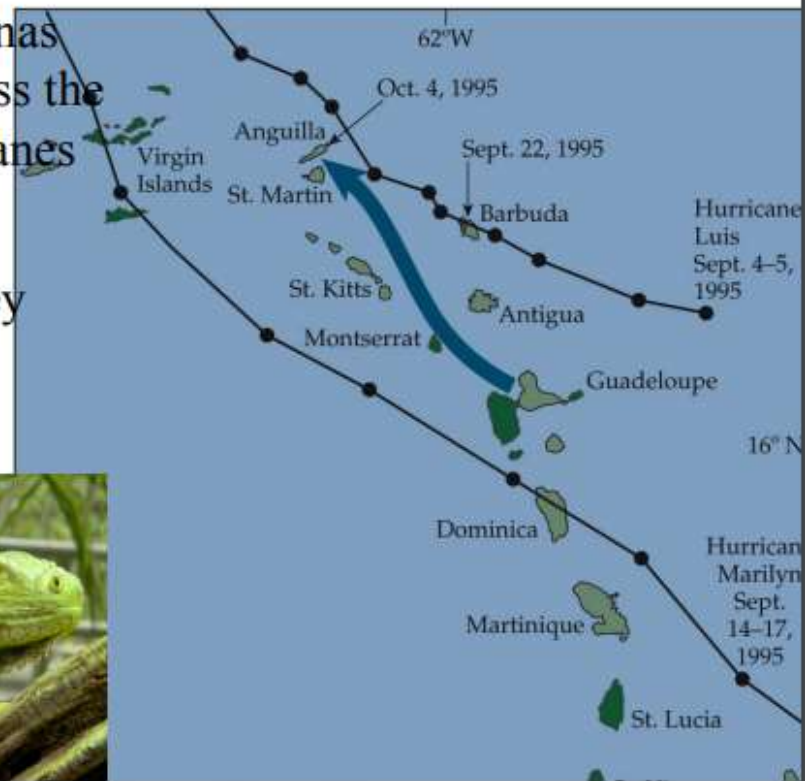


Sweepstakes Routes

Sweepstakes dispersal refers to the crossing of barriers by rare, chance events. Such events, while highly unlikely in the short term, are likely, even probable, over the long term.

Your text tells of 15 green iguanas that were rafted 200 miles across the Caribbean as a result of Hurricanes Luis and Marilyn in 1995.

In essence, they got lucky. They won the “sweepstakes”



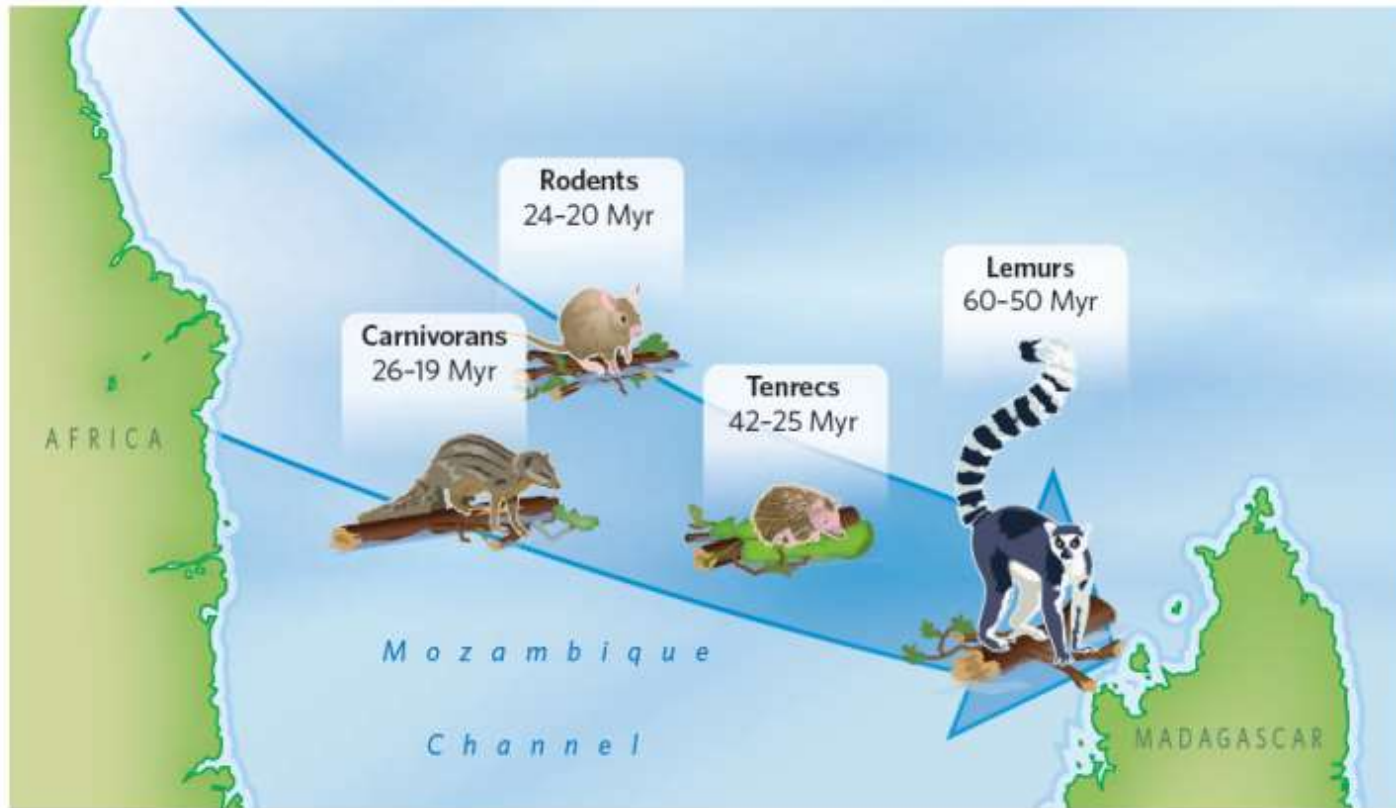
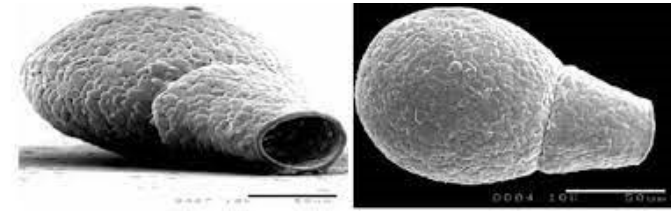


Figure 1 | By raft from Africa. On the evidence of molecular systematics, ancestors of the four endemic groups of placental mammal colonized Madagascar in single, separate events — lemurs 60–50 Myr ago, tenrecs 42–25 Myr ago, carnivorans 26–19 Myr ago and rodents 24–20 Myr ago². Ali and Huber’s ocean-current modelling studies¹ support Simpson’s hypothesis³ that they came by sea, on large rafts of vegetation. Examples of extant groups thought to have been unable to cross the Mozambique Channel in this way include elephants, zebras, antelopes and apes.

The case of the Testate Amoeba



- Small organisms tend to be cosmopolitan
- Due to their small size, finding them all over the world is not surprising. The person involved in identifying this protozoan may well be due to its evolution and spread within Gondwana prior to its fragmentation.
- This is not a species with any specific requirements.

one feature that links all the regions occupied by *N. vas* is the fact that they were once part of a huge supercontinent called Gondwana

The strange distribution pattern of this protozoan may well be due to its evolution and spread within Gondwana prior to its fragmentation.

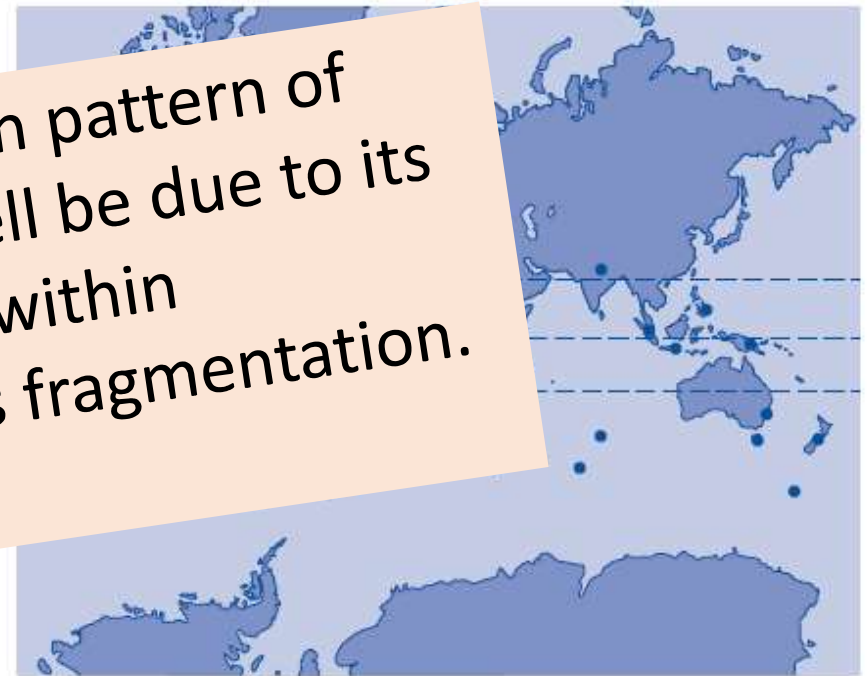


Figure 2.19 Locations around the world where the testate amoeba *Nebela vas* has been recorded. Note its predominantly Southern Hemisphere and tropical distribution. This may be explained by former linkage of the land masses in the supercontinent of Gondwana. From Smith and Wilkinson [23]. (Reproduced with permission of John Wiley & Sons.)

Climatic Relicts

- Animals widely distributed in the past and today restricted in smaller areas called **climatic relicts**.
- The Northern Hemisphere has an interesting group of **glacial relict** species
- Many species that were adapted to cold conditions at that time had distributions to the south of the ice sheets almost as far as the Mediterranean in Europe.
- Now that these areas are much warmer, such species survive there only in the coldest places (high altitudes in mountain ranges) and the greater part of their distribution lies far to the north in Scandinavia, Scotland or Iceland
- In some cases, species even appear to have become extinct in northern regions and are represented now only by **relict populations** at high altitude in the south, such as in the Alpine ranges.
- The places where relicts have managed to survive through a time of stress are called **refugia**

Springtail *Tetracanthella arctica* (Insecta, Collembola).



- common in the soils of Iceland and Svalbard, and it has also been found further west in Greenland and a few places in Arctic Canada.
- Outside these truly Arctic regions, it occurs in only two locations – the **Pyrenean Mountains** between France and Spain and the **Tatra Mountains** on the border of Poland and Slovakia.
- *T. arctica* has not been found at high altitudes in the Alps (perhaps it has simply not yet been noticed, or perhaps it used to occur there but has since died out).

It is likely a remnant of a much wider distribution in Europe in the Ice Ages

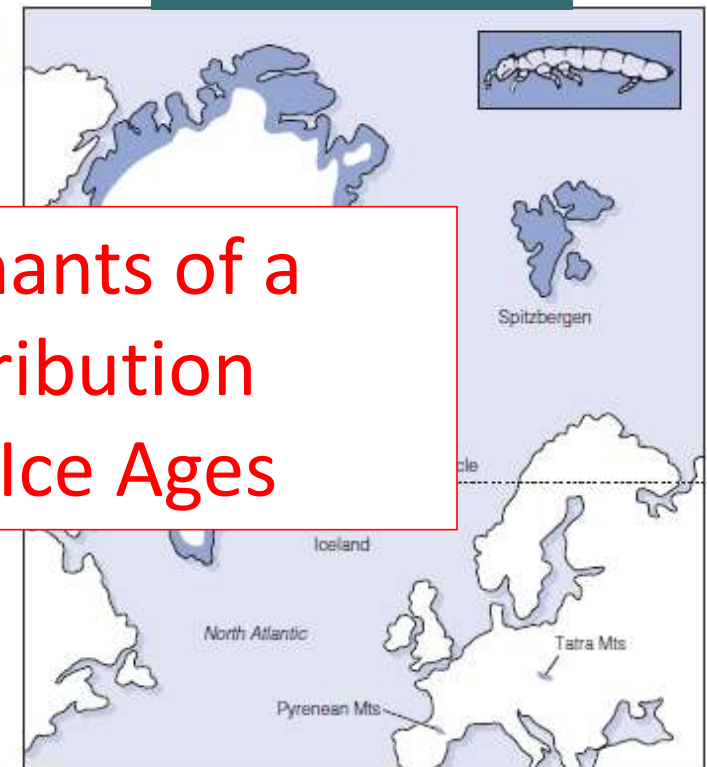


Figure 2.20 The springtail *Tetracanthella arctica*, and a map of its distribution. It is found mostly in northern regions, but populations exist in the Pyrenees and in mountains in central Europe. These populations were isolated at these cold, high altitudes when the ice sheet retreated northward at the end of the Ice Age.

Displaced dung beetle

One very remarkable example of a glacial relict is the dung beetle species *Aphodius holdereri* (Figure 2.22). This beetle is now restricted to the high Tibetan plateau (3000–5000 m), and its southern limit is the northern slopes of the Himalayas. In 1973, G. Russell Coope, of London University, found the fossil remains of at least 150 individuals of this species in a peaty deposit from a gravel pit in southern England [28]. The deposit dated from the middle of the last glaciation. Subsequently 14 sites have yielded remains of this species in Britain, all dated between 25 000 and 40 000 years ago. Evidently, *A. holdereri* was then a geographically widespread species, possibly ranging right through Europe and Asia, but climatic changes, especially the warmer conditions of the last 10 000 years, have severely restricted the availability of suitable habitats for its survival. Only the remote Tibetan mountains now provide *A. holdereri* with the extreme climatic conditions within which it is able to survive, free from the competition of more temperate species of dung beetle.

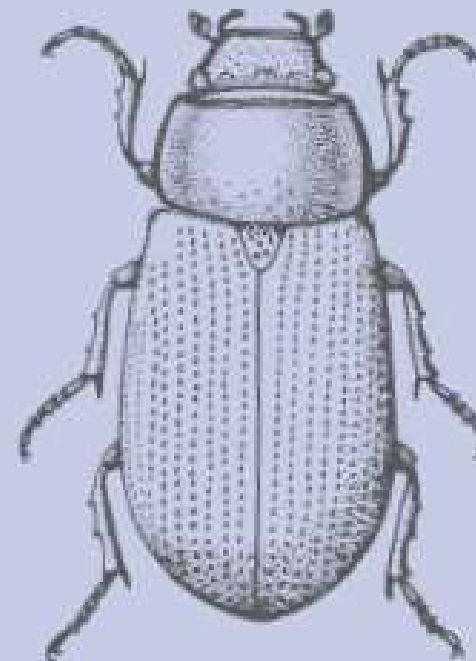


Figure 2.22 *Aphodius holdereri*, a dung beetle now found only in the high plateau of Tibet but which has been found fossilized as far west as Great Britain.

Lusitanian species (example of disjunct distribution)

- disjunct distribution pattern between Spain and Portugal and the west of Ireland



Kerry slug (*Geomalacus maculosus*)

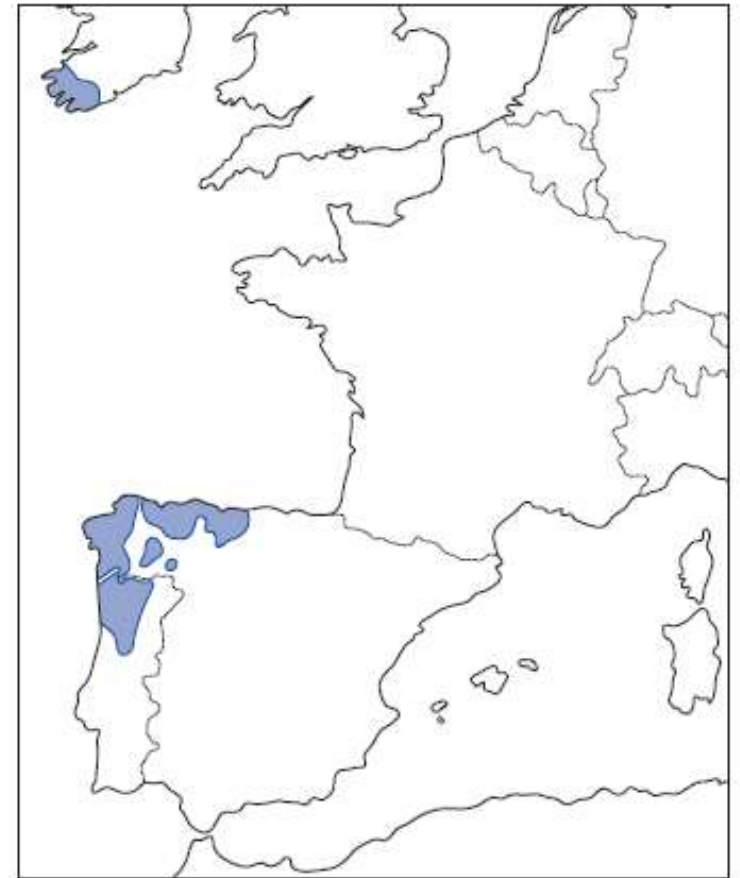


Figure 2.24 Distribution of the Kerry slug in western Europe. Like the strawberry tree, it is a Lusitanian species that is likely to have spread north following the retreat of the glaciers some 10 000 years ago, assisted by much lower sea levels at that time. Rising sea levels have now obliterated any intervening populations. Adapted from Beebee [31].

- The western gorilla (*Gorilla gorilla*) is found in an area of lowland tropical rainforest in the extreme west of tropical Africa. 2 subspecies: *Gorilla gorilla gorilla* (west of its range), and *Gorilla gorilla diehli* (eastern side of the range).
- The eastern gorilla (*Gorilla beringei*), 2 subspecies: *Gorilla beringei beringei* in the mountains, and *Gorilla beringei graueri* in the eastern lowland forest



Figure 2.25 Distribution map of the gorilla (*Gorilla* species), a mammalian genus with a disjunct distribution. The two populations are now regarded as distinct species: *Gorilla gorilla*, the western lowland gorilla, and *Gorilla beringei*, the eastern gorilla, which consists of two subspecies, the mountain gorilla (*G. b. beringei*) and the eastern lowland gorilla (*G. b. graueri*).