Zoogeography

Lesson 7

Topographical Limits and Endemisms

- The longer an area has been isolated, the higher the taxonomic rank of its endemic organisms is likely to be, and vice versa

  - after 2 million years the biota of an isolated area might contain only a few endemic species.

  - after 10 million years, the descendants of these species might be so unlike their nearest relatives in other areas that they might be placed in one or more endemic genera.

  - After 35 million years, these genera might appear to be sufficiently different from their nearest relatives as to be placed in a different family, and so on.

Factors influencing endemism

‘fossil endemism’ is called **palaeoendemism**, in contrast to **neoendemism** resulting from recent surges in the evolutionary process and the generation of new species that have not yet had an opportunity to spread beyond their current limits.

Physical factors

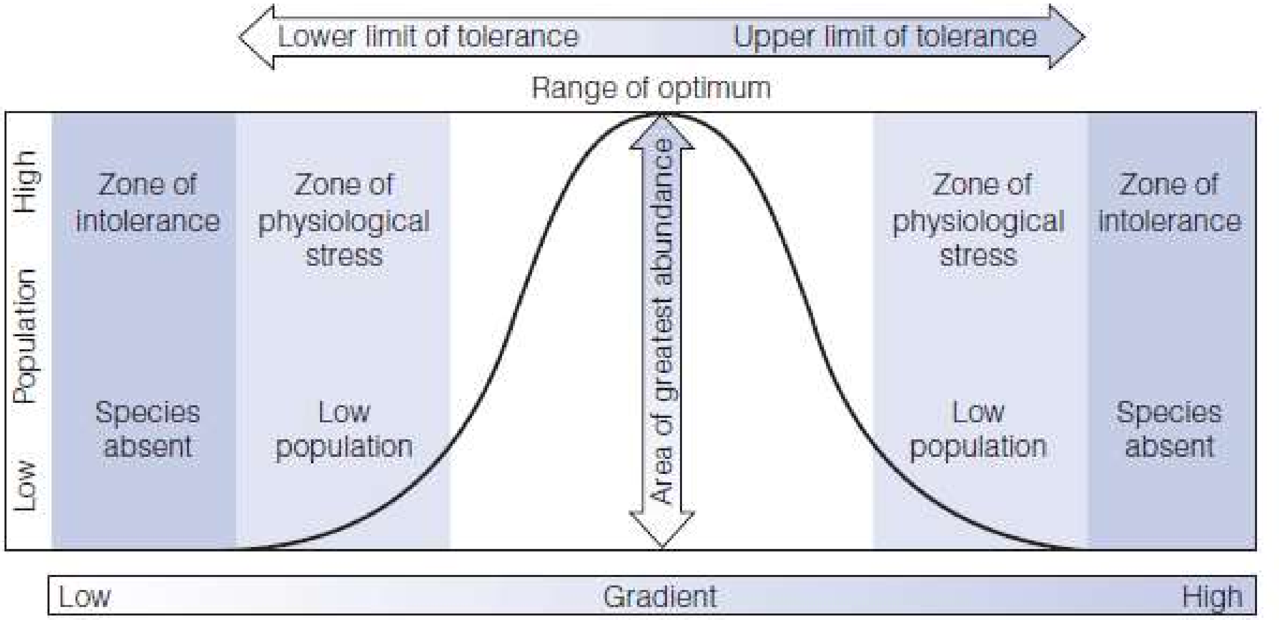


Figure 2.27 Graphic model of the population abundance maintained by a species of animal or plant along a gradient of a physical factor in its environment.

Limiting Factors

Birds have their limits

Concept Box 2.2

Even mobile animals, like birds, may have their distributions closely linked to temperature, as in the case of the eastern phoebe (*Sayornis phoebe*), a migratory bird of eastern and central North America. Analysing data collected by ornithologists of the National Audubon Society, ecologist Terry Root has been able to check the winter distribution of this bird against climatic conditions [37]. She found that the wintering population of the eastern phoebe was confined to that part of the United States in which the mean minimum January temperature exceeded –4°C. The very close correspondence of the bird's winter range to this isotherm, shown in Figure 2.29, probably relates to the energy balance of the birds. Warm-blooded animals, such as birds, use up large quantities of energy to maintain their high blood temperature, and in cold conditions they can lose a great deal of energy in this way, which means they therefore have to eat more. Terry Root found that birds in general do not occupy regions where low temperature forces them to raise their resting metabolic rate (i.e. their energy consumption) by a factor of more than 2.5. In the case of the eastern phoebe, this critical point is reached when the temperature falls below –4°C, so the bird fails to occupy colder regions. Other birds have different temperature limits because they have different efficiencies in their heat generation and conservation, but they still seem to draw the line at raising their resting metabolism by a factor of more than 2.5.

Figure 2.29 Northern boundary (solid line) of the distribution of the eastern phoebe (*Sayornis phoebe*) in North America in December and January, compared with the –4 °C January minimum isotherm (dashed line). From Root [37].

Zonation

True freshwater species

Moderate tolerance of saltwater

Estuarine species

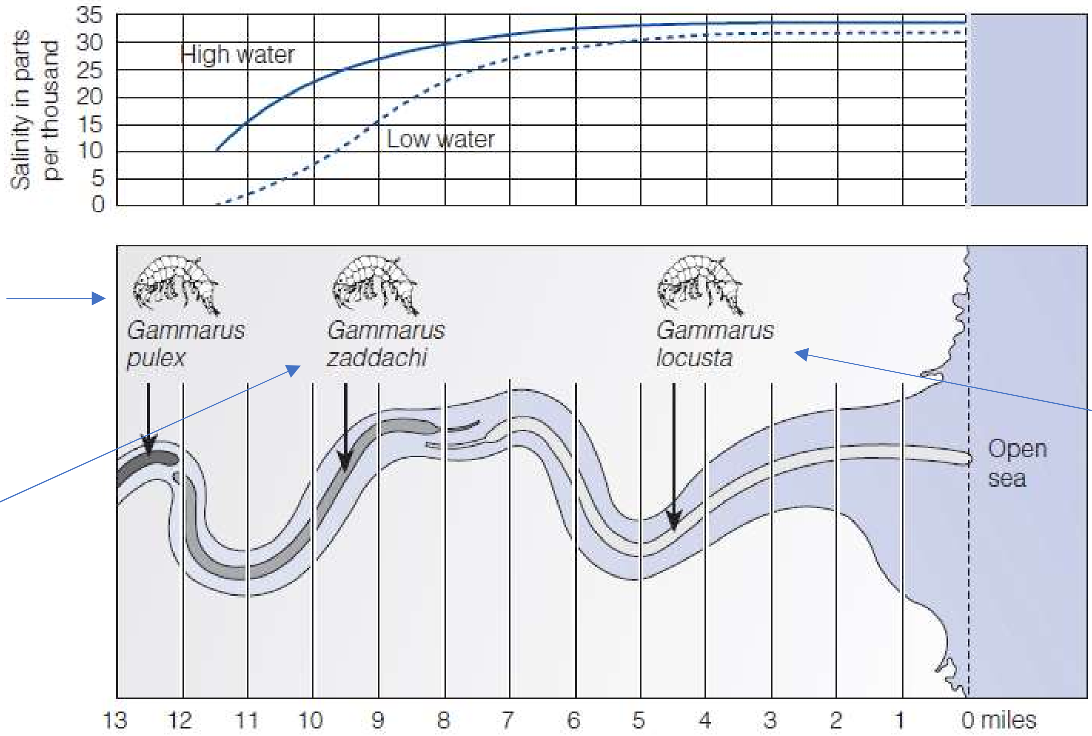
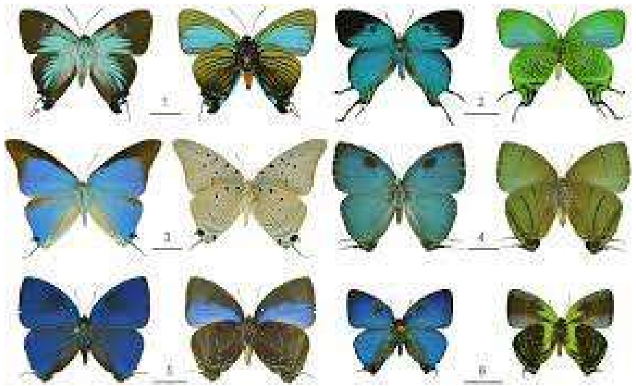


Figure 2.32 Distribution along a river of three closely related species of amphipod (Crustacea), relative to the concentration of salt in the water. *Gammarus locusta* is an estuarine species and is found in regions where the salt concentration does not fall below about 25 parts per thousand (ppt). *Gammarus zaddachi* is a species with a moderate tolerance of saltwater and is found along a stretch of water between 11 and 19 km (8–12 miles) from the river mouth, where salt concentrations average 10–20 ppt. *Gammarus pulex* is a true freshwater species and does not occur at all in parts of the river showing any influence of the tide or saltwater. From Spooner [41].

Species Interaction: a Case of the Blues

- One species may depend strictly on another for food

  i.e. blue butterflies (Lycaenidae)



- 5000 species They are found in both the Old and New Worlds. Several of the species of blue butterfly have complex relationships with other organisms

Example 1

- central and sout
  and from France

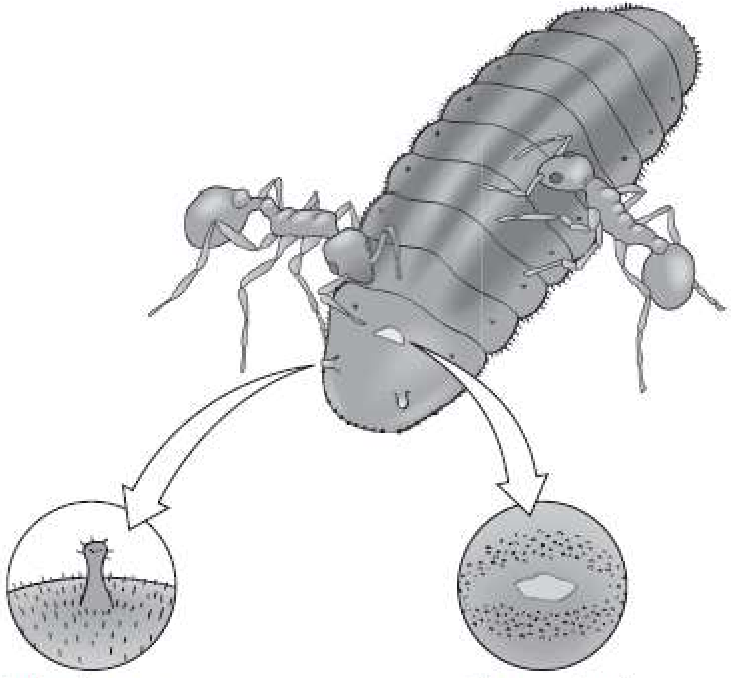


Figure 2.33 Ants attending the caterpillar of an Adonis blue butterfly. Also shown are the two types of gland, the tentacle organ that secretes volatile attractants, and the honey gland that secretes honeydew. After Thomas and Lewington [43]. (Reproduced with permission of Bloomsbury Publishing plc.)

- The caterpillars f the horseshoe vetch (*Hippocrep* alk or limestone, so the distributi eding requirements an

Example 2

the large blue (*Maculinea arion)*

- It is found from Scandinavia, to Spain, and Italy

and Greece, and Russia and Siberia, Mongolia, China and Japan.

- The larvae feed on various species of wild thyme (*Thymus spp*.), which between them cover a very wide range of geology and habitat, from acid to alkaline.
- its caterpillars have a honey gland that secretes honeydew and this is attractive to ants, but in this case it is just one genus of red ant, Myrmica, that takes charge of them

Competition

Chthamalus stellatus

- It is found in the upper zone of the shore
- larvae settle over the upper part of the shore above mean tide level.

Balanus balanoides

-It occupies a wider zone, down to the low-water mark
-larvae settled between high and low water, including the area occupied by the adults of *C. stellatus*

Reducing competition

- Considerable advantage in avoiding competition, whether with other species or other member of its own species.

→species with similar food or space requirements exploit the same resources at different seasons of the year, or even at different times of day.

Compromises are favoured than direct competition!

Temporal separation

vs

i.e. [1] Many species of owl hunt at night, judging the location of their prey mostly by ear, whereas the hawks and falcons are daytime hunters with extremely keen eyesight, especially adapted for judging distances accurately

Temporal separation

i.e. bats are night-active insectivores, avoiding competition for prey with insectivorous birds during the day, and also avoiding the predatory attention of day-active hawks and falcons.

Spatial separation

- the resources of a habitat are divided up by the restriction of each species to only part of the available area, to specialized microhabitats.
- It means that each species must be adapted to live within the fixed set of physical conditions of its particular microhabitat.
- It also means that such a species is not as well adapted to live in other microhabitats, and may find it difficult to invade them even if they were for some reason vacant and their food resources untapped.

- the oystercatcher (*Haematopus ostralegus*) has a strong predilection for the bivalve mollusc *Cerastoderma edulis*, the common cockle, and this is found mainly on sandy and muddy shores just below the mean high-water mark of neap tides. →Therefore, this is the favourite feeding zone of the oystercatcher

- the mud-dwelling crustacean *Corophium volutator* is a favoured food species for the redshank (*Tringa totanus*), and, because it thrives best in the upper regions of mudflats, usually above the mean high-water mark of neap tides, this is often where large numbers of feeding redshanks can be found.

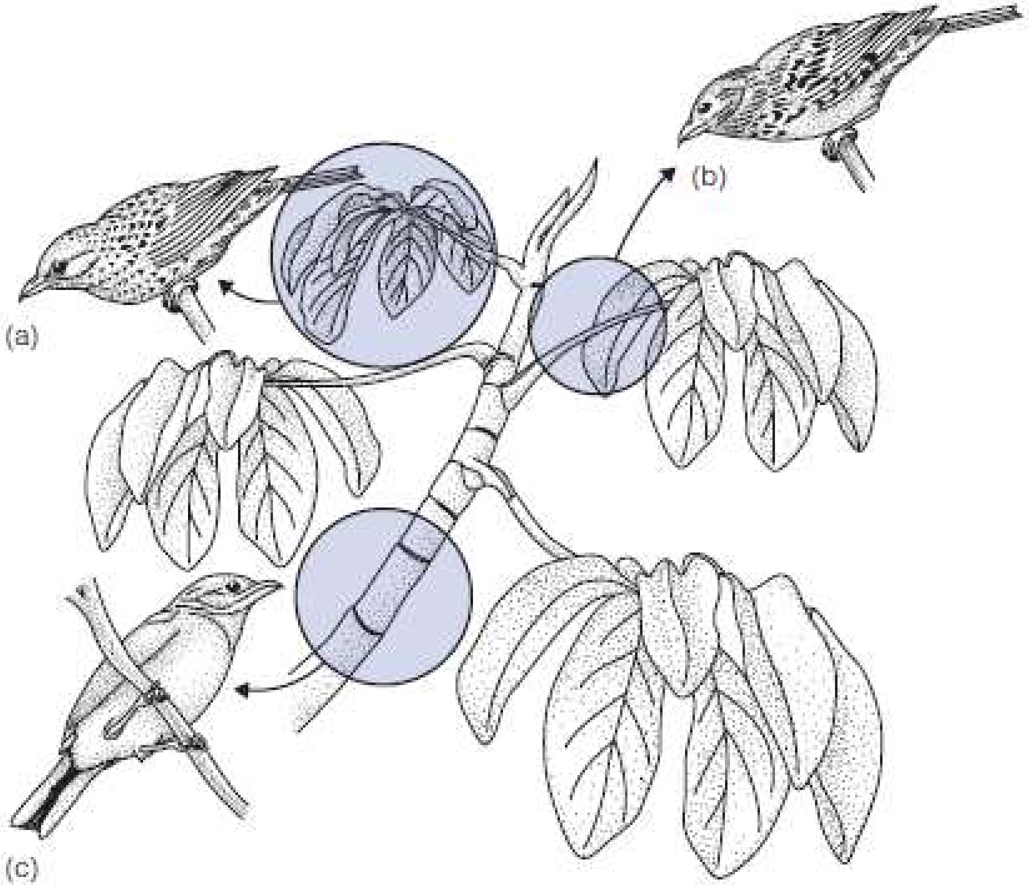


Figure 2.37 Three species of tanager that coexist in the same forest on the island of Trinidad in the West Indies. All feed on insects, but they exploit different microhabitats within the canopy and thus avoid direct competition. (a) The speckled tanager takes insects from the underside of leaves; (b) the turquoise tanager obtains its insects from fine twigs and leaf petioles; and (c) the bay-headed tanager preys upon insects on the main branches.

(a) the speckled tanager (*Tangara guttata*)

(b) the bay-headed tanager (*Tangara gyrola*)

(c) the turquoise tanager (*Tangara mexicana*)

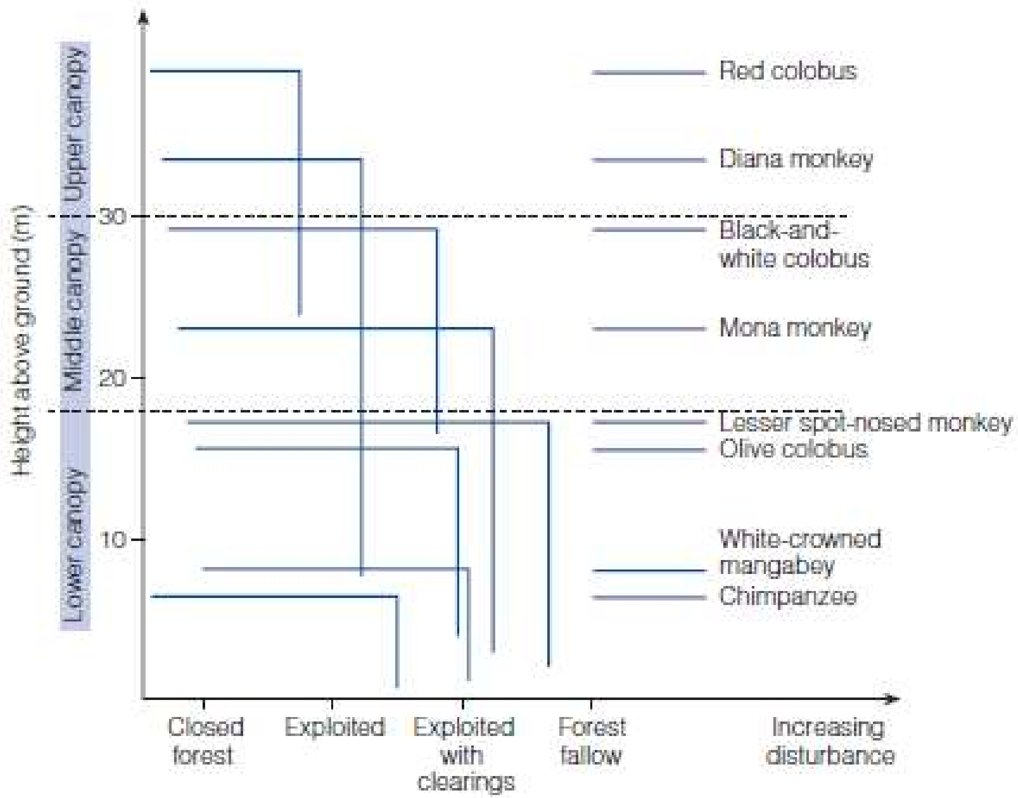


Figure 2.38 Diagram to illustrate the limits to different niche requirements of a range of primate species in the tropical forest of West Africa in relation to canopy height and degree of human disturbance. Each species indicated occupies the space below and to the left of the lines. Although the demands of the various species overlap, each has a particular height in the canopy or a type of site where it is most efficient as a competitor, and therefore more successful. From Martin [49].

Predators and Prey

- Experimentally: predators sometimes eat all the representatives of a species in their environment, particularly when the species is already rare.
- In reality: it is not in the interests of predatory species to eliminate a prey species, because if they do this they destroy a potential source of food.
- No species is preyed upon too heavily, and the predators can always turn to alternative food species if the numbers of their usual prey should be reduced by climatic or other influences (**prey switching**)

<u>Prey switching</u> of this type has been described on the island of Newfoundland, where the **grey wolf** (*Canis lupus*) and the **lynx** (*Lynx lynx*) were major predators in the 19th century, but where the **wolf is now extinct** as a result of human persecution.

The lynx was a rare animal until a new potential prey animal was introduced to the island in 1864, namely, the snowshoe hare (*Lepus americanus*).

The hares multiplied rapidly, and so did the lynxes in response to the newly available food source.

- The snowshoe hare population crashed to low levels in 1915 and the lynx, faced with starvation, switched its attentions to caribou calves, which had once been a major food source for the wolf.

The snowshoe hare has now developed a 10-year cycle of high and low population levels, and the lynx has continued to switch between hare and caribou depending upon whether the former is in a peak or a trough

Parasites and Hosts

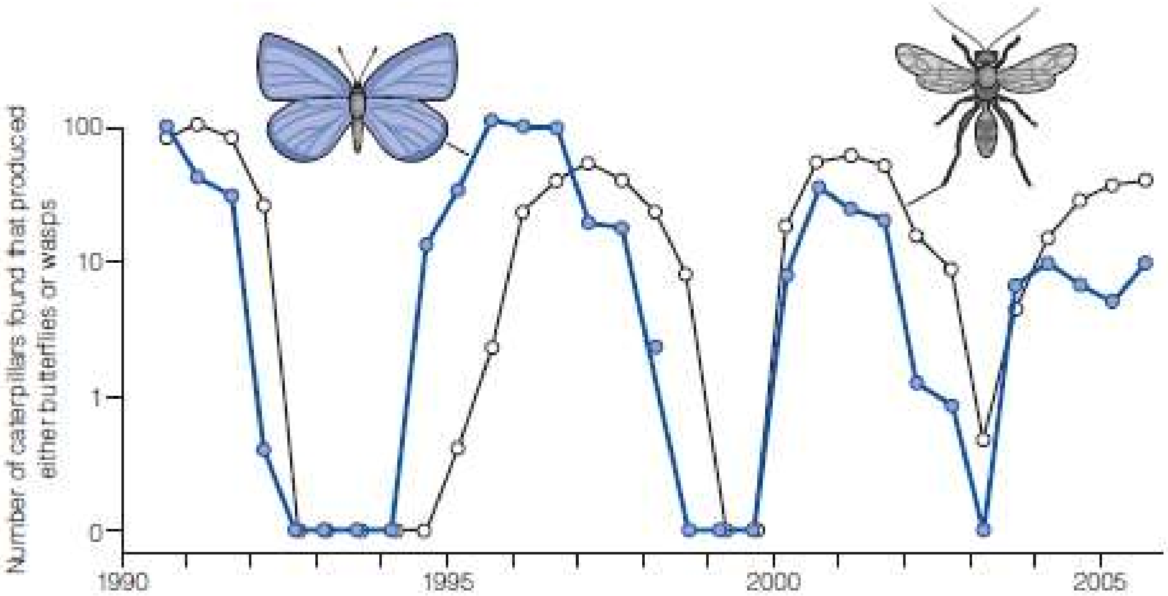


Figure 2.35 Cyclic population fluctuations in the holly blue butterfly and the parasitoid wasp *Listrodomus nycthemerus*. The butterfly population tends to peak every 2–3 years while the wasp population is low. From Thomas and Lewington [43]. (Reproduced with permission of Bloomsbury Publishing plc.)

Although parasitism causes a collapse in the butterfly population, this is only temporary and recovery takes place after the collapse of the parasite population, creating a cycle.

Predatory starfish

Many studies of natural communities have confirmed the hypothesis that predators may increase the number of different species that can live in a habitat. The American ecologist Robert T. Paine made an especially fine study on the animal community of a rocky shore on the Pacific coast of North America [55]. The community included 15 species, comprising acorn barnacles, limpets, chitons, mussels, dog whelks and one major predator, the starfish *Pisaster ochraceus*, a generalist which fed on all the other species. Paine carried out an experiment on a small area of the shore in which he removed all the starfish and prevented any others from entering. Within a few months, 60–80% of the available space in the experimental area was occupied by newly settled barnacles, which began to grow over other species and eliminate them. After a year or so, however, the barnacles themselves began to be crowded out by large numbers of small but rapidly growing mussels, and when the study ended these completely dominated the community, which now consisted of only eight species. The removal of predators thus resulted in the halving of the number of species, and there was additional evidence that the number of plant species of the community (mainly rock-encrusting algae) was also reduced, because of competition from the barnacles and mussels for the available space.