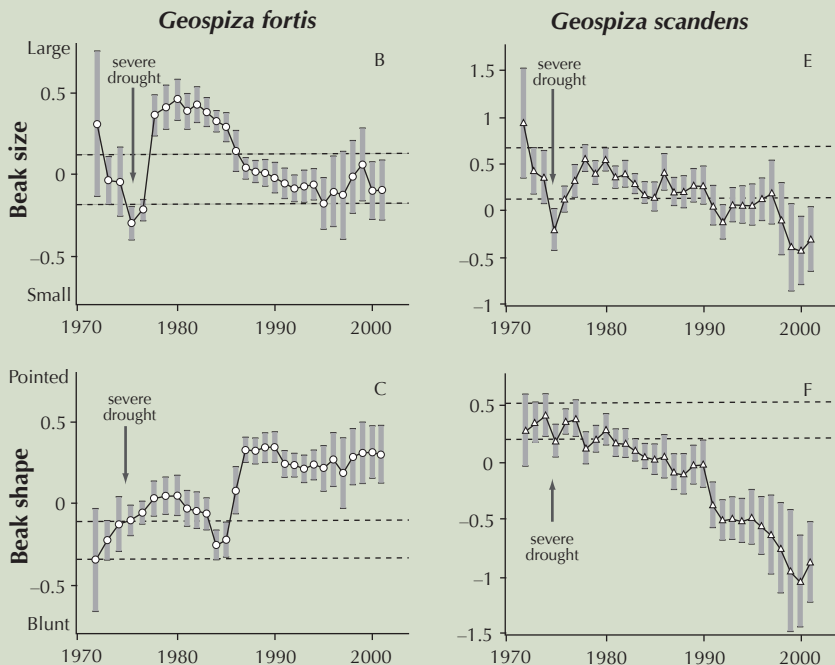


Processes of evolution – extra questions and answers

(Extension material for Level 3 Biology Study Guide, ISBN 978-1-927194-58-4, page 230)

Activity 16: Processes of evolution – extra questions

1. Finches on one of the Galapagos Islands have been studied since 1973. Each year, all birds on the island are (re)captured and identified and data collected on body size, beak size, and beak shape. The graphs show changes in beak size and shape in the species *Geospiza fortis* (B, C) and *Geospiza scandens* (E, F). Note that the y-axis scales for each of the two species are different.





Female *Geospiza fortis*

Over the first 30 years of the study, there was no overall change in beak size for *Geospiza fortis*, but their beak shape became more pointed. During the same period, in *Geospiza scandens*, beak size trended downwards over time, and beak shape became blunter.

Climate on the island is unpredictable, with weather patterns having significant impact on food availability.

There was a severe drought in the mid-1970s (indicated with the grey arrows on the graphs) that killed many plants on the island. Both species of finch rely primarily on seeds for food.

- a. Describe the pattern(s) of natural selection operating on each of these species of finch.
- b. Discuss the causes of any long-term evolutionary changes that have occurred in the two species of finch. In your answer, you should consider:
 - the impact of competition on finch evolution
 - the role of environmental changes
 - a possible impact of prolonged drought on the finch populations.

Answers

1. a. Pattern is directional selection in both species.

Directional selection involves characteristics changing in a consistent manner:

- *Geospiza fortis* – beak shape becomes more pointed
- *G. scandens* – beak size has become, beak shape has become blunter.

- b. **Impact of competition on finch evolution**

This whole question is based upon the fact that *both species occupy the same habitat*, i.e. the same island. This fact is mentioned twice in the source material:

- Finches *on one of the Galapagos Islands* ...
- Climate *on the island* ...

In both species, the evolutionary changes in beak size and shape are driven by interspecific competition.

Both species feed on seeds, but their beaks have become more and more specialised for eating different seeds.

Food supply could have been affected by the severe drought. This could have affected the finches since there would be less water available, fewer plants (due to lack of water or pollinators) producing fewer seeds. Any feature that increased a bird's ability to obtain food would be selected for.

Role of environmental changes

The major environmental influence is the effect of climatic extremes (drought) on food availability (seeds) and the selection effect this has on beak size and shape.

Geospiza fortis

Beak size – no overall trend, but beak size did change over the 30-year period. Drought had a significant effect – immediately after the drought, only large-beaked individuals survived (larger beaks possibly better at opening the seeds available during the drought); smaller beak sizes occurred during non-drought years.

Beak shape showed a trend to being more pointed (directional selection) despite an unpredictable pattern (beak shape became blunter then sharper) during the mid-1980s.

Geospiza scandens

Beak size showed an overall trend to smaller beaks, although oscillations occurred (e.g. immediately following the drought in the mid-1970s (larger beaks needed to crack open harder or larger seeds?).

Beak shape showed a trend to being blunter.

Both species

Beak size and shape show wide variation (i.e. confidence bars on graphs long) before the drought and then again about a decade later after the drought. The gene pools probably suffered a 'bottleneck effect' (i.e. gene pools reduced) from the mid-1970s drought.

Impact of prolonged drought on the finch populations

Gause's competitive exclusion principle – 'no two species can occupy the same niche in the same habitat' – results in either:

- exclusion of one species from a habitat
- niche differentiation – a narrowing of niches or specialisation in opposite directions.

A prolonged drought could result in niche differentiation – what each species feeds on becomes progressively different. This is known as *character displacement* – the differences between two competing sympatric species increase, i.e. both species undergo directional selection in opposite directions.