Working With Data from *Principles of Life* by Hillis

Habitat Corridors

Introduction

Ecologists often use small ecological systems, called *microcosms*, to investigate ecological processes experimentally in a natural setting. The study of effects of habitat fragmentation on moss micro-arthropods presented in Figure 43.11 provides one example of this approach; the study of *Daphnia* populations in rockpools presented in Apply the Concept, p. 855, provides another example (see Bengtsson 1989).

Microcosms are useful because they are subject to the same basic ecological processes that govern large ecological systems. They have the added value in that it is feasible to set up replicated experiments in nature and obtain results in relatively short periods of time, because small organisms have short life cycles (see Srivastava et al. 2004).

Andrew Gonzalez and Enrique Chaneton (see Gonzalez and Chaneton 2002) used the tiny arthropods that inhabit moss carpets on rocks to study how habitat fragmentation affects animal populations. When habitats are destroyed, fragmentation of a formerly extensive habitat divides a species that lives only in that habitat into subpopulations that are smaller than the original population. Fragmentation also isolates subpopulations because the unsuitable habitats that surround habitat fragments are often barriers that prevent dispersal among them. As we saw in Concept 43.5, the persistence of the subpopulations that result from fragmentation is expected to depend on subpopulation size and isolation.

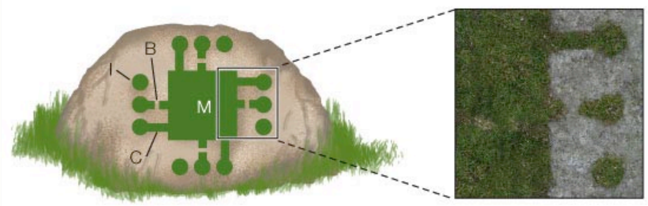
INVESTIGATION

HYPOTHESIS

Subpopulations of a fragmented metapopulation are more likely to persist if there is no barrier to recolonization.

METHOD

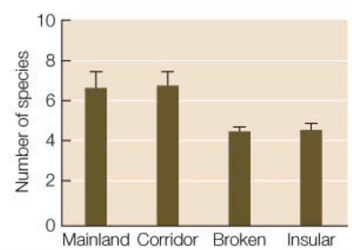
1. On replicate moss-covered boulders, scrape off the continuous cover of moss to create a "landscape" of moss "mainland" with patches surrounded by bare rock. A central 50 cm × 50 cm moss "mainland" (M) is surrounded by 12 circular patches of moss, each 10 cm^2 (subpopulations). In the "insular" treatment (I), the patches are surrounded by bare rock (which is inhospitable to moss-dwelling small arthropods, and thus a barrier to recolonization). In the "corridor" treatment (C), the patches are connected to the mainland by a 7 × 2 cm strip of live moss. In the "broken-corridor" treatment (B), the configuration is the same as the "corridor" treatment, except that the moss strip is cut by a 2-cm strip of bare rock.



2. After 6 months, determine the number of small arthropod species present in each of the mainlands and small patches.

RESULTS

Patches connected to the mainland by corridors retained as many species as did the mainland to which they were connected. Fewer species remained in the broken-corridor and insular treatments.



CONCLUSION

Barriers to recolonization reduce the number of subpopulations that persist in a metapopulation.

ANALYZE THE DATA

A. What percentage of the species present in the mainlands was lost, on average, in the corridor patches?

B. What percentage of the species present in the mainlands was lost, on average, in the insular and broken-corridor patches? What does this percentage tell you about the average risk of extinction for the subpopulation of each arthropod species in each patch?

C. The broken-corridor treatment controls for another factor that can affect extinction risk. What is this factor?

To test these two expected effects of fragmentation, Gonzalez and Chaneton scraped off continuous carpets of moss growing on rocks. In the first experiment, they tested the effect of subpopulation size. To do so they left a large carpet of moss on half of replicate large boulders and scraped away moss on the other half to create circular fragments 20 cm^2 in size and isolated by 15 cm of bare rock (see Figure 1c of Srivastava et al., 2004, for a picture of the experimental setup). Every two months, they collected one of the replicate fragments, and equal-sized areas from the continuous moss patch, from each replicate boulder and counted all the arthropods in each sample. In the second experiment, illustrated in Figure 43.11, they tested the effect of isolation. To do so, they scraped away moss on replicate boulders to create a large central "mainland" patch of moss surrounded by 12 small, circular moss "islands". Some of the islands were completely isolated from each other and the mainland by bare rock; some were connected by a 7 cm wide corridor of moss; and some were connected by a moss corridor that was broken by a 2 cm wide strip of bare rock (see Figure 43.11). Sample patches were collected after three and six months, and the arthropods in them were counted.

In the first experiment, the researchers found that the number of species in large patches did not decrease over time. The number of species in the 20 cm^2 patches was equal to that in the large patches after two months, but declined to about 60 percent of that in the large patches after six months. Thus, populations in small, isolated patches were more likely to become extinct than those in larger patches.

As we see in Figure 43.11, small moss patches that were connected via corridors to a large mainland moss patch did not lose species, whereas isolated moss patches did lose species. These findings indicated that even a small barrier between patches was sufficient to increase the rate of extinction and decrease species richness.

Original Papers

Gonzalez, A. and E. J. Chaneton. 2002. Heterotroph species extinction, abundance and biomass dynamics in an experimentally fragmented microecosystem. *Journal of Animal Ecology* 71(4): 594–602. http://www.blackwell-synergy.com/doi/pdf/10.1046/j.1365-2656.2002.00625.x

Bengtsson, J. 1989. Interspecific competition increases local extinction rate in a metapopulation system. *Nature* 340: 713–715.
http://www.nature.com/nature/journal/v340/n6236/abs/340713a0.html

Srivastava, D. S., J. Kolasa, J. Bengtsson, A. Gonzalez, S.P. Lawler, T.E. Miller, P. Munguia, T. Romanuk, D.C. Schneider, and M.K. Trzcinski. 2004. Are natural microcosms useful model systems for ecology? *Trends in Ecology and Evolution* 19(7): 379–384.
doi:10.1016/j.tree.2004.04.010

Links

(For additional links on this topic, refer to the Chapter 43 Investigation Links.)

McGill University: Department of Biology: Andrew Gonzalez's Web Page: Ecology Letters: Community relaxation in fragmented landscapes: the relation between species richness, area and age (pfd)
http://biology.mcgill.ca/faculty/gonzalez/PDF/EcoLetts.pdf

McGill University: Department of Biology: Andrew Gonzalez's Web Page: Gonzalez Lab
http://biology.mcgill.ca/faculty/gonzalez/

Swedish University of Agricultural Sciences: Jan Bengtsson's Web Page
http://www.slu.se/sv/fakulteter/nl/om-fakulteten/institutioner/institutionen-for-ekologi/hemsidor/jan-bengtsson/

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Analyze the Data

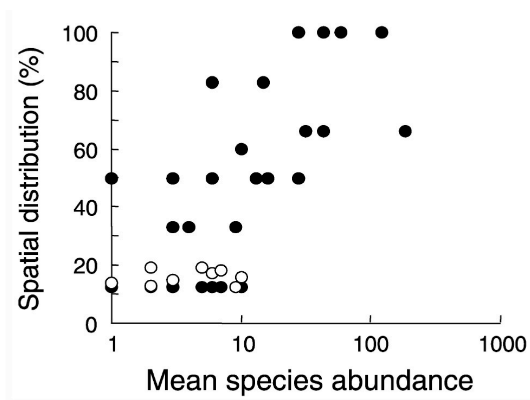
Question 1 (from textbook Figure 43.11)

A. What percentage of the species present in the mainlands was lost, on average, in the corridor patches?

B. What percentage of the species present in the mainlands was lost, on average, in the insular and broken-corridor patches? What does this percentage tell you about the average risk of extinction for the subpopulation of each arthropod species in each patch?

C. The broken-corridor treatment controls for another factor that can affect extinction risk. What is this factor?

Question 2
In their first experiment, Gonzalez and Chaneton found that 40 percent of small arthropod species went extinct in small isolated patches after 12 months. Were these species different in any way from those that persisted? To answer that question, they analyzed the data from their two-month samples. They characterized the average number of individuals of each species per small patch (mean species abundance), and the fraction of replicate small patches in which each species occurred (spatial distribution). They summarized these data in the following figure, which is taken from Figure 2b of Gonzalez and Chaneton (2002). Open circles indicate the species that later went extinct, and filled circles indicate species that persisted for 12 months.



A. In what ways did extinct species differ from species that persisted?

B. Compare and contrast these results with those presented in Apply the Concept, p. 855 of the textbook, which are taken from Bengtsson 1989.