Guiding Questions for Reading This Article

A. About the Article

1. Give the name of the journal and the year in which this article was published.

2. What is the last name of the first author, and what is her university?

3. The seven authors represent five different universities in what three countries?

4. Specialized vocabulary: Write a brief definition of each term.

   allelopathy

   arbuscular mycorrhizal fungi (AMF)

   invasive species

   mesic

   mutualism

5. The first paragraph of the article gives several reasons why introduced exotic plants can become invasive and disturb native plants in the area. State two of those reasons.

6. Write out the full genus and species name, as well as the common name, of the invasive plant in this study. This species is native to what part of the world?

7. What is the typical habitat of garlic mustard in its normal home range? Garlic mustard has become an aggressive invader in what habitats in North America?

8. Garlic mustard plants do not associate with mycorrhizal fungi. What relationship had been observed, prior to this study, between growth of garlic mustard and growth potential for AMF in nearby soil?

B. About the Study

9. Experiment 1 is a test of whether the ability of native tree seedlings to form mycorrhizal associations is affected by what?

10. Read the first part of the detailed methods for Experiment 1 ("Materials and Methods," p. 730 of the original article), and state where the investigators obtained soil for the greenhouse pots in which they planted seedlings.

11. In Figure 1A (part of Experiment 1), what is represented on the *x*-axis and on the *y*-axis? What do different shades of the histogram bars represent?

12. In Figure 1A, the heights of the bars and lines represent the *mean* and *standard error* of measures for each sample. What do these two terms measure?

13. Summarize the results for red maple seedlings from Figure 1A in a simple sentence.

14. In Figure 1B, what is represented on the *y*-axis? From the detailed methods (p. 730), tell how long the seedlings were allowed to grow in the test soils before roots and shoots were harvested, dried, and weighed to get the data for Figure 1B. How were the "sterile" soil samples treated differently from the other samples?

15. The detailed methods for Figure 1B say investigators used a "complete 4 × 3 factorial design." To what "factors" do the 4 and 3 refer? Name *two* experimental conditions (controlled factors) that were held constant for all samples.

16. For the experiments shown in Figure 1B, how many replicates of each treatment combination were used? What are "replicates," and why should replicates be included in the experiment?

17. The investigators examined two alternate hypotheses for how garlic mustard affected tree seedlings:

    Hypothesis A: Chemicals in soils from areas invaded by the garlic mustard plants affect tree seedlings directly, whether or not mycorrhizal microbes (AMFS) are present.

    Hypothesis B: Chemicals in soils from areas invaded by the garlic mustard plants affect the tree seedlings only if mycorrhizal microbes (AMFS) are present.

    Look at the data in Figure 1B to see how seedling growth varies in sterile and nonsterile soils and in invaded and uninvaded soils. From the data in Figure 1B, which hypothesis, A or B, should be *rejected,* and why?

18. In Experiment 3, the investigators tested the effects of chemical extracts from several different plants on the growth of three tree species (sugar maple, red maple, and white ash). What was the control treatment?

19. Examine the results of Experiment 3 in Figures 3A and 3B (p. 730). What were the main effects of the five different extracts (gm, three tree species, control) on the tree seedling colonization by mycorrhizal fungi? How did the five different extracts affect tree seedling growth in biomass?

20. Make a prediction: What if investigators had used extracts from different ash and maple species that were native to Europe? Would results be similar to the histograms in Figure 3B?

21. In Experiment 4 (Figure 3C, p. 729), investigators collected spores from two common AMF species and grew each on separate agar plates containing the five different types of extracts as in Experiment 3. State the genus names of the two types of AMF that were used in Experiment 4. What was the effect of garlic mustard extract on germination of each AMF spore species, in comparison to spore germination in the control extract? Why was it informative to test the two fungal species separately from each other?

22. Is this an *observational study,* in which quantitative, observational data are taken but no experimental manipulation is made? Or, is this an *experimental study,* in which researchers make manipulations by which the effects of different variables are tested, one at a time?

23. Is this a *field study,* with data collected on organisms in their natural habitat, or is this a *lab study,* in which plants are studied under controlled conditions in the laboratory or greenhouse?

C. General Conclusions and Extensions of the Work

24. What significant, though indirect, impact of an introduced species on native plants is demonstrated in this study?

25. Imagine that you were a member of this research team and involved in these experiments. What could be a possible follow-up test that extends this work? Briefly state another experiment or measurement you would do within this research system.