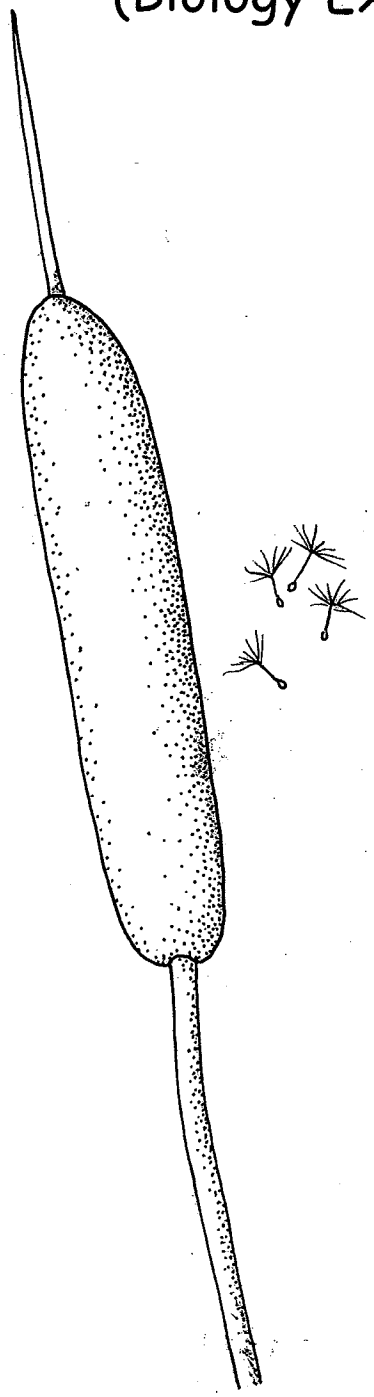
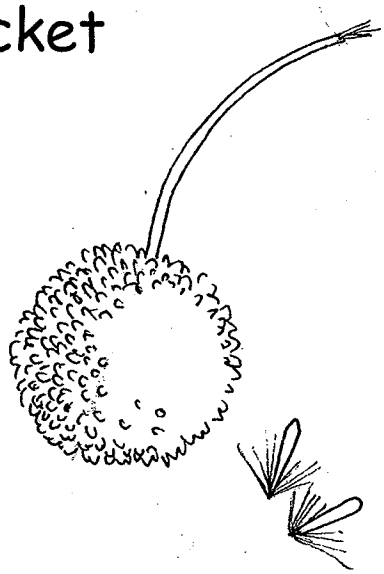
Seed dispersal: wind-blown seeds

BEES Program
(Biology Experience for Elementary Students)

Teacher packet





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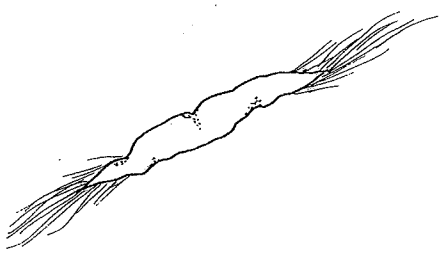


Seed dispersal

Overview: This life science unit investigates how most plants move – which is by having seeds dispersed by animals, wind, water, or set in motion by the parent plant. A variety of student activities are included, in which students describe attributes of seeds and fruits, run experiments, measure attributes of dispersal (distance, size, weight, and force), design seeds, collect and plant seeds, and summarize data with graphs and tables.

Detailed background

Most animals move around. They may walk, swim, fly or even burrow through the ground. The movement of animals to a new area (to them) is called dispersal. Plants also disperse. Dispersal requires movement, and growing plants usually can't disperse because most are rooted in the ground (or attached in trees or on rocks) and many are large (think: trees). Instead, most plants rely on seeds for dispersal.

Question: What are seeds and what do they do?
Seeds are packages with a wrapper on the outside and a baby plant and its food on the inside. The wrapper protects the seed (from damage; from being eaten), and may help in its dispersal. Seeds may be packaged singly or together in fruits (note: fruits are seed(s), plus the tissues surrounding or between the seeds; some are sweet, like the fruits we eat, others are not: like coconut husks). Fruits have various roles to play in seed dispersal.

The seed is one of the dispersal stages of a plant. The other is pollen. Pollination involves the dispersal of genetic material prior to seed formation, but not dispersal of the whole plant.

Why disperse?

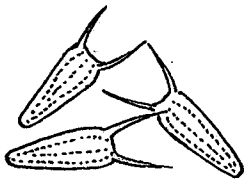
- to get away from adult plants
    - avoid shade; adults may suck up water or nutrients
- spread out → harder for seed predators to find them/get away from predators that may be around the adult plant (for seedlings and seeds)
- try out new habitats
    - may be better than parental habitat
- may be a better place if conditions change
    - examples: less likely to burn if in a rock outcrop, or may be in a wetter spot during a drought
- greater chance of outcrossing (mixing of genetic material during reproduction)

How are seeds dispersed?
Seeds cannot walk or run or fly by themselves, but they can get around by walking, running, flying, gliding, sailing and being 'shot' out. Here's how:

1- by animals: attached to the outside ('hitch-hikers')
2- by animals: eaten (or dispersed in association with eating)

3- wind-blown (with parachutes or wings)
4- water: floating
5- plant dispersed: exploding (seed capsules, usually), dispersal of adult (tumbleweeds)

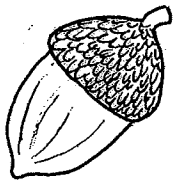
1. attachment to animals ('hitch hikers')



- seeds with spines, barbs and/or hooks (e.g., cocklebur, beggar's lice) (students can measure and/or rank the force of attachment)
- seeds that are sticky; especially when wet (e.g., mistletoe, tomato)
- seeds that clasp (i.e., devils claw)

2. eaten by animals

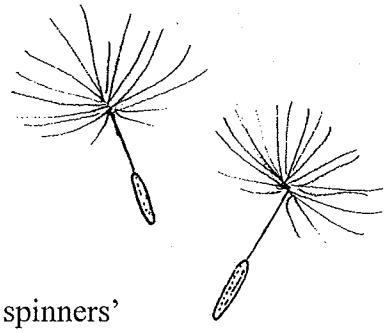
- carried and stored (= cached)/buried/dropped (e.g., acorns by squirrels; sunflower seeds by birds)
- eaten by birds, mammals, reptiles,… (e.g., which plants are found along fence lines? And how do they get there?)
  - fleshy fruit with seed(s) that survive digestion
    - dung may provide fertilizer
  - fleshy fruit that is eaten and the uneaten seed is discarded



  - It's not good for fruits to be eaten before seeds are mature.
    - Why?
    - Because they're not mature enough to be able to sprout
      - young plants are not mature and/or food reserves are not ready.

  - What prevents animals from eating seeds too early?
    - covering the (edible) seed with a hard, thick, bad-tasting, or spiny coat
    - examples:
      - bitterness, hardness, or lack of sweetness of unripe fruit
      - spiny cover over chestnuts: opens when ripe
      - hard, thick, bitter cover over pecan nuts; opened when ripe
      - thick coating over hickory nuts; worn off when ripe

3. wind-blown



- factors affecting wind dispersal: size, weight, ability to float
- adaptations/ characteristics:
  - small seeds
  - seeds with:
    - parachutes (e.g., dandelion)
    - cotton (e.g., cattails, cottonwood)
    - wings (e.g., maples, catalpa): often 'helicopter'; 'spinners'
  - plants that roll (e.g., tumbleweed = Russian thistle; some grasses)
    - (this can also be considered as self-dispersed)

4. floating on water

- need to be lightweight and waterproof
  - in the sea: coconut, mangrove

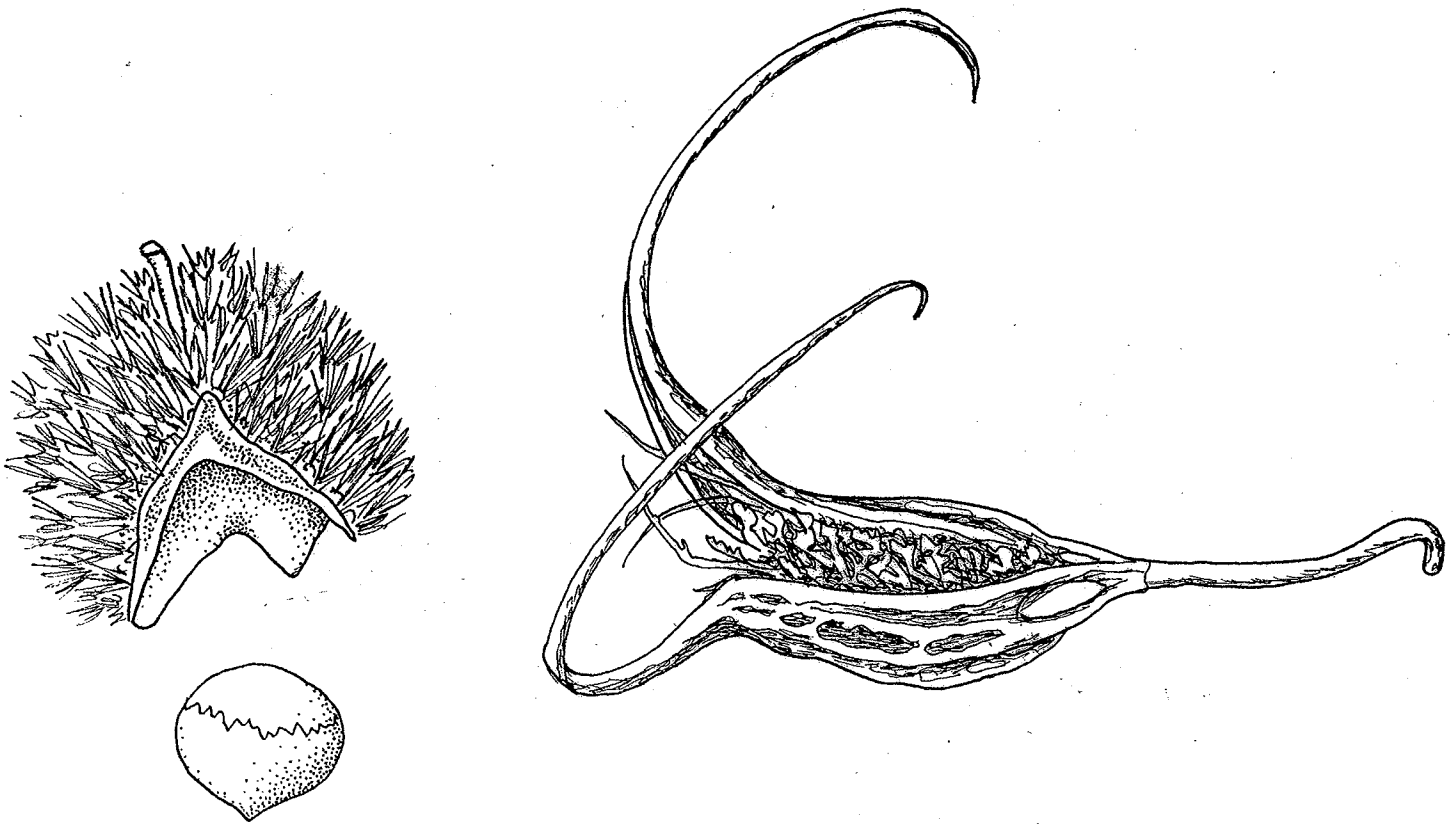
- in freshwater: lotus seed capsules, cottony seeds (e.g., cottonwood)
- many seeds may be caught in floating debris (almost all types)

5. plant dispersal (not common)

- capsule explodes: touch-me-not
- shakes out: poppies

Specific goals of the program:

1. Let students experiment with different types of seeds and experimentally determine attributes that increase dispersal by wind.
2. Encourage problem-solving by students during the experiment by providing non-detailed instructions and having students to decide details of the methods.
3. Have students understand that they are doing all the steps in scientific research (i.e., background knowledge, generating a hypothesis, collecting replicated data, data analysis, and drawing conclusions based on results)..
4. Have students understand that it is normal to have variation in data by comparing data among teams. Students learn that both the methods used by the researcher and experimental conditions can affect results.
5. Make students realize that they are scientists!



Seed dispersal
Activity set 1: Measuring wind dispersal of seeds, characterizing seeds, and inventing seeds

Brief description. This activity is in two parts.

Part A. Students will measure how far a variety of seeds travel with conditions of still air and with air flow from outside breezes or a fan. The data will be pooled, analyzed, and used to determine features that increase dispersal.

Part B. (optional) Using the knowledge and skills learned in Part A, students will invent wind-blown seeds and test their dispersal. This part can be a follow-up activity by the teacher.

Materials (Part A):

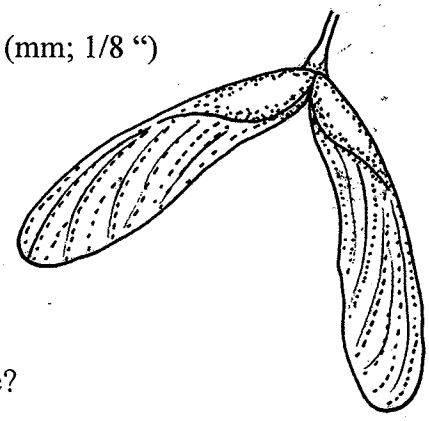
- provided by BEES
    - seed containers and extra seeds
        - each plastic seed container contains 6-8 seed types, and has a guide to seeds (seed drawing and name) taped to the outside. Seeds include:
            - seeds with parachutes: e.g., sycamore, cattail, goat's beard, dandelion, thistle, various composites
            - seeds with wings: e.g., maple, catalpa, elm
            - small seeds: millet, quinoa
            - medium and large seeds: acorns, sunflower seeds, redbud seeds
        - a supply of extra seeds to replace lost or damaged seeds
    - laminated photo sheets, illustrating the plants producing the seeds
    - small plastic cups (targets for aiming dropped seeds)
    - clipboards, pencils, and data/summary sheets for each team
        - (clipboards are optional)
    - measuring tape (English and/or metric): 1/team
    - stickers ('I am a seed scientist')
- provided by classroom
    - board space for writing and markers/chalk
    - indoor (classroom, hallways or gym) and outdoor space for running experiments

Materials (Part B):

- provided by classroom (these are suggestions)
    - 'seeds': various-sized balls of Styrofoam, cork, beads, pom-poms, and beans
    - additions: cotton balls, pipe cleaners, umbrella toothpicks, straws, cardstock, modeling clay
    - razor knife (to be used only by the teacher and assistants)

- glue, scissors, tape

Instructions (Part A):
Set-up:
Have supplies for each team organized.
HINT: For younger grades, it's helpful to pre-write the names of the seeds on the data sheets.
Don't hand out anything until after the Question and Answer session (see previous section).
Find out what length units the students can measure:
- units: inches and centimeters?
- precision: whole units, estimating half units, or all units (mm; 1/8 ")
(this can be asked upon arrival at the classroom)



Running the program
Question & Answer group session

As a class, ask students a series of questions:

- How do you move around? How does a dog, bird,… move?

(Explain that the movement of animals and other organisms to a new place is dispersal.)

- Can a tree move? How about a bush? Or a dandelion?
- Where do new plants come from?
- How do the new plants get to where they grow? (do they walk?...)
- What's a seed?

- Today, we're going to learn about how seeds get around, or how they disperse.
- Let's list the ways: (they should guess the ones in bold; give hints of appropriate plants, if needed)
  - **eaten** or cached (wild grapes, acorns and other nuts)
  - **hitch-hikers** (cockleburs, 'stickers' or sandspurs, beggar's lice)
  - **wind** + spinners, helicopters, parachutes,… (maples, dandelions, cattails)
  - floating (coconut)
  - plant-dispersed (touch-me-not)

- Why do plants and animals disperse?

Tell the students that today they will experiment with a set of seeds, and see what makes seeds good 'wind gliders' and what makes seeds bad 'wind gliders'.
Emphasize that they will be scientists – doing science!
Pre-evaluation: ask students to describe features of wind-blown seeds; write on board and have an assistant record these.
Students should be divided in teams of 2 students (or 3 students, if necessary).

Hand out the containers of seeds and a guide to seeds. The students in each team should go through the container and identify their seeds.

Briefly go over the experiment. (You'll drop seeds and see if they hit a target. If you miss the target, you'll record how far the seed traveled.) We'll do this experiment twice – once inside, where the air is still, and once outside. Everyone will get to drop seeds and measure distances. Will measurements be in centimeters or inches? (This is class and grade dependent).

Hint: Assign each student 2 or 3 seeds to select- that way, everyone in the team participates in the experiment.

Hand out the rest of the supplies (target, clipboards & data sheets, tape measure)

Have each team predict whether, in still air, they expect each seed to land **close** or **far** from the target and write their predictions on the data sheet. Explain that this is hypothesis testing and that they are predicting how they think the seeds will fall.

Students in each team select a place for their experiment – in the classroom or a hallway.

Students will have questions about how to drop seeds, what to do if the target blows away (when outside), and other components of the experiment. DO NOT blurt out an answer; rather guide students in coming up with their own solutions.

Remind the students that they will take turns with the different jobs. (Having each student drop the seeds that they selected takes care of this).

After each team has measured each seed, have them predict how the seeds will behave with wind (and record this on their second data sheet).

Now the teams will run the same experiment in the wind (preferably outside; but fans can be used to mimic wind if weather conditions prevent outside work).

HINT: Before the wind experiment, discuss with the class what to do if the seeds go very, very far, the students lose sight of the seeds, or the seeds go where they can't follow (e.g., over a fence). (pace or estimate distance; or declare seeds 'out-of-bounds).


Check the wind direction and make sure students know not to run across streets after their seeds.

Data analysis:

The method of analysis is dependent on the mathematical abilities of the students. The following protocol can be used by most age groups.

Ranking

Let the class decide whether '1' is the least distance or the most distance.

Note: there will be some variation in the number of seeds each team does, so use 'lowest' and 'highest' rank rather than '5th ranked'.

Questions

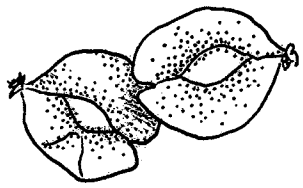
- **Do all seeds travel the same distance inside?**
  - (write the farthest traveled seeds on the board and count how many teams had each seed go farthest)
  - Discuss **variation in results** (between team members and among teams)
    - Why aren't all the distances the same? (let students suggest these)
      - chance way a seed falls
      - variation in seed shape, size and weights

- air currents (outside: gusts and site differences in wind)
- methods:
    - how high up were the seeds dropped?
    - how were they released? (some teams may throw them up)
    - what did you do if a seed bounced out of the cup?
        - (is bouncing and rolling a form of dispersal?)

- Variation in results is normal. That's why we take extra measurements. These are called **replicates** (this extra measuring is what each team did by repeating the seed drop twice for each seed).

- Do all seeds travel the same distance outside?
- How well were your predictions?
- Does wind matter?
- What characteristics of seeds allow them to travel farther in wind? (possibilities: small size or light weight, parachutes, wings

Go over experimental steps:
1. background information
2. hypothesis generation (predictions of close versus far)
3. collect data (drop and measure)
4. analyze results (ranking)
5. draw conclusions (what makes a good disperser)

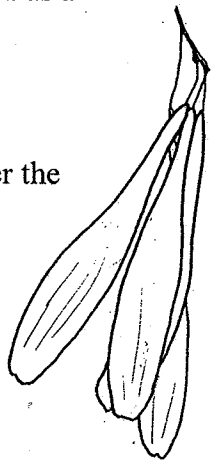


Thought question:
- Wind is needed for good seed dispersal (by wind-dispersed seeds).
    - Are seeds on the ground picked up by the wind?
    - How do seeds get in the wind?
        - seeds are exposed to the wind:
            up in trees (especially before leaves come out)
            on shoots (e.g., dandelions have short stalks as flowers and long stalks as seeds)

Options:
1. Measure the height from the ground to the drop point and record it on the data sheet. Older students can look at the effect of drop height.
2. Have students drop each seed twice. This will highlight variation that occurs in data collection and allow an additional chance to incorporate math. The two measurements for each seed can be summarized by using one of the following methods:

- use the largest number in each pair ('circle the bigger number')
- sum the measurements
- average the measurements

3. Measure the length of the seed (discuss what to measure first: the entire length or the part with the seed. And compare seed size and distance diapersed.
4. Measure wind speed (outside, or with the fan). This allows data to be graphed as a regression (wind speed versus distance), rather than as bar graphs.



Evaluation:

Compare the students' list of features of windblown seeds from before and after the experiment

Give written evaluation forms to students and the instructor

Instructions (Part B): (constructing and testing seeds)

Set-up:

A. Put out construction materials.

Running the program

1. Students should know characteristics of wind-blown seeds and also understand that there is more than one possible adaptation. As a result wind-blown seeds can look very different.
   - review seed characteristics, if appropriate
2. Explain that students will get to design and test their own 'seeds', to see how well they are wind-blown.
   - How will you tell if your design works?
   - How can you test your seed?
   (use the fan or go outside to test)
   (also need to compare: possibilities:
      - to each other's seeds (a 'wind-race')
      - to your own unmodified seed (how much change you made)
3. Let the students make 'seeds'.

ONLY ADULTS MAKE CUTS OR DRILL HOLES IN 'SEEDS'

4. Test seeds using fans, as before (or follow method that the students come up with).
   (Note: testing 'seeds' outside in the wind will be faster: students can release a modified and an unmodified seed – one in each hand - from a play structure platform or other appropriate location.)
5. Discuss what worked and what didn't (facilitate a student group discussion).

Evaluation:

1. Ask students what adaptations they are using. (Record the proportion that gave one or more appropriate adaptations)
2. Determine the proportion of students that made good wind-blown 'seeds' (which blew further than their unmodified 'seeds').