

Exploring animal behavior through eight eyes

Eight-legged schedules

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Grade level(s) targeted: High school

List the National Science Standard(s) addressed by the activity.

Behavior of organisms

Abilities necessary to do scientific inquiry

List the Entomology Literacy Element(s) and Supporting Concept(s) addressed by the activity.

Element II: Develop ability to use insects in inquiries and provide examples of insects' investigative value.

Supporting Concepts: Scientific Method

Element V: Appreciate that insects have aesthetic value.

Supporting Concept: Insects (and spiders) are cool.

Observations

The goal of this lesson is to teach one of the oldest skills in science, the art of observation. This exercise will demonstrate the foundation of the ethological study of an organism, which is generating a list of behaviors and the time spent on those behaviors. This exercise will train students in their observational skills. Though not experimental in nature, observation is a necessary precursor to experimentation.

Just as true in behavior science as it is in any of the other sciences, observation is at the heart of the first steps in scientific discovery. In the study of behavior, this type of exercise is referred to as "creating an ethogram," which is a list of behaviors recorded as they occur in time. Students will observe jumping spider behaviors over a period of thirty to forty minutes. Many informational resources on jumping spiders are freely available (public license) through the Peckham Society web page (<http://peckhamia.com/>).

Question

What does a jumping spider spend the majority of its time doing?

Materials needed for 24 students working in groups of 4

Using spiders in the classroom

Item	Quantity	Cost
Jumping spiders in clear containers	5	
Clear containers*	10	< \$15
Timekeeping method (stopwatches)**	5	
Small sticks that will fit in clear containers	5	
Tree leaves (optional)	5	

* Almost any transparent container will work; my favorite is disposable plastic cups inverted on a paper plate. For something more secure, any kind of clear food storage container will work so long as you poke air holes in the lid with a thumbtack or needle. Avoid very large containers like aquariums, or containers with really narrow openings like soft drink or water bottles.

** Many students will have cell phones, and only one is needed per group of students. Most phones will work as timers or stopwatches. However, depending on your group of students, this may be more distracting than useful. Therefore it is recommended that you use stopwatches if available, or a large sweep-hand clock that allows students to check the time at a glance.

Material and preparation

You will need six or seven jumping spiders (extra just in case), or at least one for every group of students. You will need twice as many clear containers (such as specimen jars), one for each of the spiders to reside in and a fresh one to transfer the spider into at the start of class. It is best to add a stick or dowel rod running through the middle of a leaf to simulate a relatively normal habitat. Spiders can easily be captured locally (see appendix for more information), and in this case species is not vital to the success of the exercise. This exercise will take about 50 minutes to complete.

Experiment procedures

Step 1

Collect spiders locally and store them in clear containers. Make sure that the containers have at least a few small ventilation holes in them so that the spiders have fresh air. If keeping the spiders for more than two to three days, you should provide them with water. Details about collecting and maintaining jumping spiders can be found in the appendix.

Step 2

On the day that class is to be held, preferably a couple hours before, transfer the spiders into fresh clear containers. These containers should include a stick with a leaf or two (but not so much stuff that the spider could hide from view). The reason for transferring the spiders to new cages is that they will likely have built silk hiding places in their initial containers. Occasionally spiders will hide in their silk nests waiting for conditions to change, and this makes for uninteresting ethograms. By placing the spiders in fresh containers, you force a change in conditions that will result in all the jumping spiders doing something, making student observations much more engaging.

Step 3

At the start of class, discuss the importance of observation in science. Give sufficient background that students can properly interpret what they observe in the jumping spiders. Explain the concept of ethograms. Break up the students into groups of three or four. Students will take turns making observations and recording data in a timely manner.

Step 4

Give each student a jumping spider contained in a clear viewing container with a stick or similar object in it. To discourage distraction, it is best to give students a stopwatch, rather than let them use their cell phones as timekeeping devices. It is important that students sit relatively still and not move the spider’s container.

Step 5

Each group should record their observations every two minutes on the ethogram sheet at the end of this exercise. The total time that students should make observations is variable and depends on the academic setting. Normally a forty-minute period is recommended, but for a high-school level this is probably unrealistic. Obviously, less than fifteen minutes will not produce much in the way of data. The observations that are recorded should be concise but detailed.

Data

Collection

Data should be collected on the ethogram chart at the end of this exercise. This chart can be modified to include all the categories of behavior, thus simplifying the student’s task, or students can be require to develop their own, thus requiring more from the student. A printer-friendly version is in the appendix.

Data Sheet

Species: Observers:
Date: Time:
Conditions: Comments:

Time (min.)	Observation (Ask yourself, “What is the spider doing?”)
0	
2	
4	
6	
8	
10	
12	
14	
16	
18	
20	
22	
24	
26	

28	
30	

Expected results

Most jumping spiders will actively explore their new enclosure, some will spend time cleaning themselves, and a few may even begin making a new nest. A few species may remain motionless for the first five or ten minutes before they begin to look around, which will be followed by a cautious exploration of the new surroundings. If students do not heed instructions to remain still and leave the jumping spiders alone, the students' observations will include more about the spiders turning and facing the motion or activity. When using shorter timespans, it is reasonable to expect variation in ethograms.

Interpretation

After all of the student groups have collected data for the allotted time, the data should be analyzed. This analysis involves each student group taking their observations and categorizing them. If possible the observations should be sub-categorized. If students failed to record enough detail for sub-categorization of their observations, then a great opportunity is available for teaching the importance of attention to detail in science. After organization of data, a pie chart should be made describing the relative proportions of time spent on each major category of behavior.

Discussion (Suggestions for presenting the findings)

Findings are best presented as a group. They can be presented using popular forms like PowerPoint presentation, or the data can easily be presented on a chalk or dry erase board. One way to present the data is in a pie graph illustrating the division of time the spider devotes to certain tasks.

Expansion (optional segway into experimental inquiry)

The observations that the students make lead readily into hypothesis-based inquiry. A number of questions can be raised based on direct observation of the spider's behavior. Here are a few generalized, testable examples of questions that could be asked and the accompanying observation:

Observation: Jumping spiders groom their feet, and there is a difference in grooming between spiders.

Possible question: Does grooming frequency relate to "dirtiness" of the container?

Possible hypothesis: Jumping spiders in "dirty" (floured) containers groom more frequently than spiders in clean containers.

Observation: Jumping spiders stop and "stare" through their clear container at the student.

Possible question: Is there a limit to how far the jumping spiders can see?

Possible hypothesis: Jumping spiders' response to visual cues is limited by distance.

References (annotated)

BugGuide, Salticidae page. Retrieved August 31, 2013, from <http://bugguide.net/node/view/1962>
BugGuide is an excellent way to quickly ascertain whether or not the spider you found is a jumping spider. Additionally it has a “data” tab that will allow you to identify the range and time of availability.

Peckham Society. Retrieved August 31, 2013, from <http://www.peckhamia.com>
The Peckham Society page is a beautiful website that spans the gap between the science of jumping spiders and the casual naturalist. The web page has links to more than a thousand freely available peer-reviewed journal articles as well as many videos and images available for educational use.

Internet archive. Retrieved August 31, 2013, from <http://www.archive.org>.
The archive has a great number of useful and scholarly references related to jumping spiders. Simply enter “salticidae” into the search bar and it will return all the relevant entries, including a number of very useful videos and self-publications by David E. Hill (one of the world’s few salticidologists) not found anywhere else. Materials on this page are typically free for educational use.

Estimated time required and cost to conduct the experiment.

Time

In class: This exercise is designed to use utilizes a single two-hour period where the experiment is conducted in the first half, and the results are organized and presented in the second half. However, its design is also suitable two separate one-hour class periods where the experiment is conducted the first day, and the data is presented and discussed on the second day.

Outside of class: it is expected that there will be at least two hours of preparation time for this exercise. This includes collecting spiders and getting materials together. Additional time may be necessary to read about jumping spiders.

Cost

The cost is partially a matter how you want to buy. In theory any variant of this exercise can be conducted with only the cost of printing out the data sheets. In most cases I expect the total cost to be less than \$20.

Appendix

I. Data sheet

II. Simple example: student data

III. Collecting, maintaining, and identifying jumping spiders

Ethogram Data Record

Species:

Observers:

Date:

Time:

Conditions:

Comments:

Time (min.)	Observation (Ask yourself, "What is the spider doing?")
0	
2	
4	
6	
8	
10	
12	
14	
16	
18	
20	
22	
24	
26	
28	
30	

Data is recorded at the time of observation, so at 2 minutes record what you observed most recently, not everything that happened during the two minutes. Use the space below to summarize the result. Use illustrations to show the distribution of behavior.

II. Simple example of student data

Ethogram Data Record

Species: jumping spider species unknown

Observers: Group 2 (Sam, Julie, Betty, Joe)

Date: May 1, 2013

Time: 2:00 pm

Conditions: plastic vial, room lighting

Comments: it was a nice day outside, so it was extra bright in the classroom

Time (min.)	Observation (Ask yourself, "What is the spider doing?")
0	Moving around
2	Rubbing its face with its legs
4	Moving around, jumped once from stick to leaf
6	Moving around
8	Chewing on its foot
10	Turning slowly
12	Sitting still
14	Chewing on its foot
16	Moving around
18	Waving its legs
20	Sitting still
22	Moving around
24	Moving around, jumped at container wall and fell down
26	turning slowly
28	Chewing on its foot
30	Moving around

Data is recorded at the time of observation, so at 2 minutes record what you observed most recently, not everything that happened during the two minutes. Use the space below to summarize the result. Use illustrations to show the distribution of behavior.

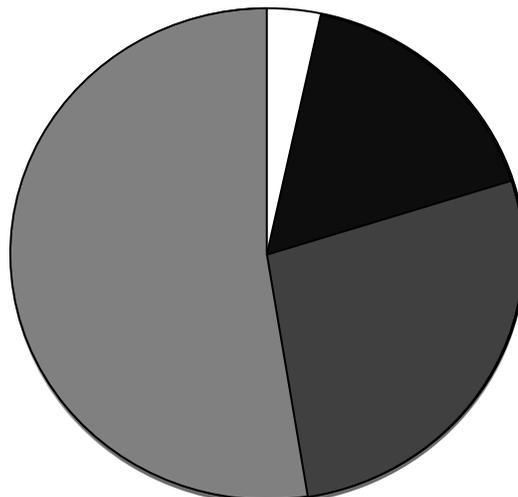
According to the instruction in class, the foot chewing and face rubbing are activities called grooming. Leg waving could be courtship behavior, maybe with its reflection. Sitting still could be rest, or it could be scanning its surroundings. In summary this supports my hypothesis that jumping spiders spend most of their time running around hunting, looking for females, and so forth.

Light gray: moving

Dark gray: grooming

Black: sitting

White: courtship



III. Collecting, identifying, and maintaining jumping spiders

Collecting jumping spiders

Jumping spiders can be found in almost every habitable terrestrial location in the world. Because they are diurnal, they are most easily seen during the day. Additionally, they are considered wandering spiders, so you will never see one sitting in or on a web unless it is hunting a web spider. There are some general categories that may make it easier to find spiders. Some jumping spiders only live at the ground level. These jumping spiders are found in leaf litter and roaming over rocks and sand, looking for prey. Their nests can be found under rocks, fallen leaves, and small sticks. Rock-dwelling species can be found under, on, or near rocks. The author has found established populations of such types of jumping spiders in landscaped areas in urban settings. A fair number of jumping spiders can be found in weedy locations, whether living there or simply hunting in that location. These species can be found searching for food on the stems and leaves of brush, weeds, grass, and annual plants. Their nests can be found in the crown or apex of these types of plants. A number of them inhabit the heads of dry grasses, and their nests are easily located by the webbing in the tops of such plants. The last category of habitat that is readily apparent is that of tree-dwelling. Within this category there are two subgroups—those spiders that live on the trunk and those spiders that live in the periphery of the tree. Periphery spiders can be seen looking for a meal on the upper and lower limbs of trees. Typically these spiders are on the tips of branches, but they can be found further in toward the trunk. They nest in leaves and crooks of the branches. Bark-dwelling species can be found hunting and nesting on and under the bark of trees.

Places they can be found include, but are not limited to, urban yards and gardens, city parks, along roadways, wooded areas, fields and fence rows, drainage ditches, shorelines, rocky outcroppings, on buildings, and even on automobiles (especially when the spiders are ballooning). It should be noted that these spiders are generally inactive at night and during periods of inclement weather (rainy days, very cloudy days, etc.). Early and late in the day jumping spiders can be found in their nests, so at this time they are more likely to be found under stones, bark, or leaves. Spiders can also be collected by systematically searching individual leaves on trees. This method is especially effective for finding *Lyssomanes* on magnolia (Fig. 1), though it is tedious and can be time consuming. The fastest, most reliable method for collecting jumping spiders is to shake tree branches over a white sheet. In the southern United States, this will yield a bright green species (*Lyssomanes viridis*), especially from magnolia.



Figure 1: *Lyssomanes viridis* on the underside of a magnolia leaf. These images taken by the author illustrate the ease with which jumping spiders can be found even in an urban setting. The apartment complex in the upper right is about one block from downtown Athens, GA.

Identifying jumping spiders

Identifying jumping spiders is not hard, but may seem daunting to the newcomer. As a general rule, any spider that is active during the day, that is not found in a web, and that runs or jumps readily is in one of two spider families. It is either a salticid or a lycosid (or

related family). A great aid to spider hunting is starting out with a fair idea of what jumping spiders look like rather than catching spiders and bringing them back to the classroom, only to discover that what was found was something other than what was desired. A great aid to this would be the identification web page known as BugGuide (<http://bugguide.net>). Though the majority of contributors are not taxonomists, those images that are identified are accurate to family, based on the author's experience.

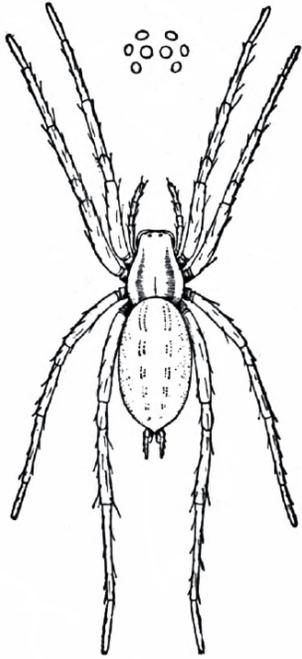
Jumping spiders are readily distinguished from other spiders by the position of the central forward-facing pair of eyes. Using the following diagrams (next page) will allow most people to clearly distinguish jumping spiders from several other spiders that look similar superficially. If the spider in question has a body longer than one and half inches (38mm), it is not a jumping spider—they do not get that big. Generally speaking, jumping spiders have eight eyes (only six of which are easily visible in some jumping spiders) that encircle the head (giving them near 360° vision). Any spider that has all the eyes on its face is not a jumping spider. Any spider in which the central eyes are the same size as the surrounding eyes is not a jumping spider, and any spider with eyes directly under the central forward facing eyes is not a jumping spider.

The following diagrams (adapted from Emerton, J. H. 1878. *The Structure and Habits of Spiders*. S. E. Cassino Pub., Salem. 118 pp.) are for distinguishing between jumping spiders and similar spiders they could be confused with. Each diagram represents a dorsal view, and is accompanied by a set of circles intended to reflect the relative position and size of the eyes from a frontal (face forward) view of the respective spider. Please keep in mind that these are generalizations, and do not reflect every species that might be encountered. Jumping spiders are the only common wandering spider where the two large frontal eyes have no smaller eyes above or below them (e.g., Fig. 2).

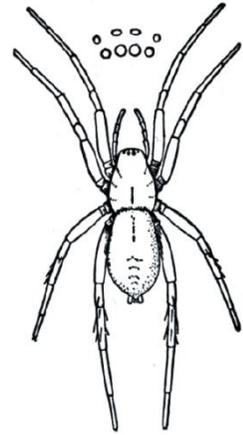


Figure 2: This *Phidippus clarus* illustrates the frontal eye pattern of jumping spiders (author's image).

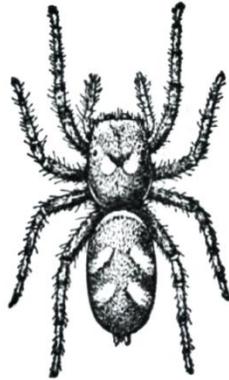
Diagrams by J. H. Emerton (1878)



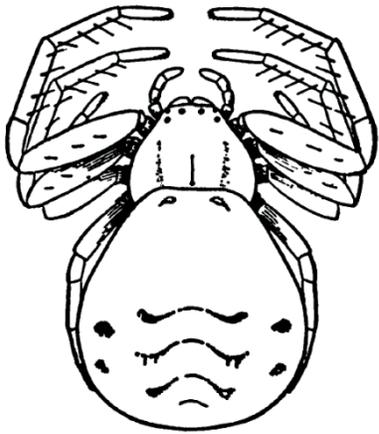
Agelenidae -
Funnel-web
spider



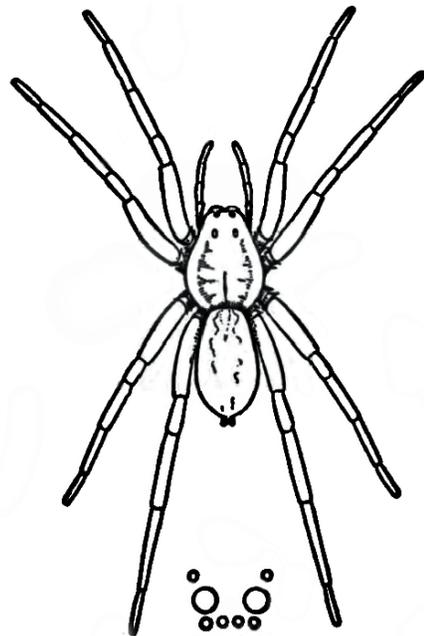
Gnaphosidae
- Ground
spider



Salticidae - Jumping Spider



Thomisidae
- Crab
spider



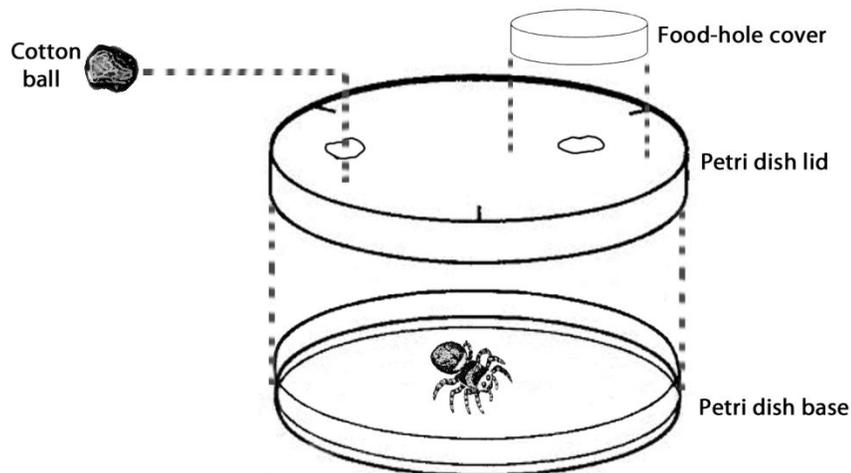
Lycosidae -
Wolf spider

Maintaining jumping spiders

Maintaining jumping spiders is easy to do and not costly. The following instructions are primarily to aid those who intend to keep jumping spiders for longer than a month. It is presented here in full so that the interested student or teacher may have the tools necessary to reach beyond the simplicity of the accompanying exercise. If maintaining the spiders for only a week or so, adding a cotton swab dipped in water to their container every two to three days should be sufficient to keep them alive.

Housing

Almost any container will work. Many researchers have had success with plastic Petri dishes, and the author would recommend them to anyone who has access to them. Plastic Petri dishes are flat, so they can easily be stacked; they are clear, allowing observation of the specimen; they do not seal air-tight, allowing the specimen to breathe; and they are disposable when the experiment is finished. Because they are plastic, extra holes can easily be added with a hot nail or pin (held with pliers or forceps). Petri dishes are not the only functional housing for jumping spiders. Beverage bottles, old food containers, even plastic bags and small finely screened boxes can work as housing for jumping spiders. It is recommended that spiders be housed individually as they will eat each other. The following illustration (by the author) is one simple solution the author has used.



Feeding

Jumping spiders, in general, should be fed once or twice a week. Three to five food items should be introduced at each feeding. Food items should not be larger than the spider's body. Spiders can survive more than a month without food, but this level of fasting is not recommended unless it is intended to impact behavior. The food provided can be almost any kind of insect. It is recommended that for most jumping spiders, fruit flies (genus *Drosophila*) serve as an acceptable food source. Most biological supply companies sell both flies and rearing media. Flies can also be captured locally using an insect net. Or flies can be trapped by leaving fruit in an open jar for a day or two. If it is intended that spiders are maintained for a long period of time, or reared to adulthood from an early juvenile form, regular *Drosophila* are not sufficient. *Drosophila* reared on basic fly media do not supply sufficient nutrition for spiders to thrive. It will be necessary to feed spiders a more varied diet, or to feed the fruit flies a medium that is more

complex. However, altering the flies' diet is only necessary if spiders are young or need to be maintained for longer than a school year (approximately nine months).

Watering

Water can be provided regularly by spraying small amounts on the inside of the spider's habitat. However, it can be sustainably supplied using a sand-filled bottle cap, piece of sponge, or wad of cotton (which is the most recommended). With this type of watering system, the water may only need replaced once a week, depending on relative humidity.

Rearing conditions

Temperature

Jumping spiders in general do best around 70° Fahrenheit, but can be maintained at any temperature from 50-90° Fahrenheit. This temperature is based on temperatures used by experiments where jumping spiders were reared under controlled conditions. It is recommended that either extreme be avoided, as it may shorten the lifespan of the spiders.

Humidity

Humidity can be more important than temperature. At a dry humidity (less than 30%), the spiders can desiccate if they are not provided with enough moisture. A second problem is that they will die while molting if they dry out too quickly while trying to escape their old skin. At very high humidity (greater than 70%), mold can be a problem. Spiders, like many arthropods, do better at moderate to high humidity levels.

Lighting

In a well-used classroom, no special changes are necessary for maintaining jumping spiders. While there is evidence that these spiders can capture prey in the dark, they are primarily diurnal and will do best if light is provided for at least six hours a day. According to one reliable source (spiderpharm.com), bright light is vital to the successful rearing of baby spiders since their small eyes permit them less relative light intake from that which is available. Many researchers studying jumping spider life histories use ten to twelve hours of light in their rearing of jumping spiders. Light regime in behavior studies is important in that it will determine the activity level of the specimens in question. If spiders are used in night classes, it may be necessary to adapt the spiders to activity at night by leaving lights on later in the day.