



PLANT SCIENCE BULLETIN

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1ST PLACE
TRIARCH BOTANICAL IMAGES
STUDENT TRAVEL AWARDS

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IN THIS ISSUE.....



*PlantingScience Wins prestigious
SPORE Award from AAAS. Page 49*



*Matthew Koski wins the
J. S. Karling Student Research
Award. Congratulations
Winnerspg 42*



*BSA Election Results -
Congratulations all!..... Page 48*



REPORTS AND REVIEWS



Market Botany: A plant biodiversity lab module

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ABSTRACT

Market Botany is a variation on an approach many instructors of plant diversity have employed: using the grocery store as a teaching space (see Appendix A). This version, included as a module in my Field Botany (BIO 345) course at the State University of New York at Plattsburgh since 2007, meets experiential curriculum objectives by employing a group research experience during which the grocery store is used as "the field" for a biodiversity survey. Students are introduced to general concepts in community ecology, in concert with learning objectives related to plant diversity and economic botany.

OBJECTIVES:

- Students recognize the diversity of plant species/groups we use as foods and in other products through an experiential learning process.
- Students evaluate the importance of certain plants over others in terms of human usage.
- Students become familiar with the taxonomic hierarchy of the Plant Kingdom, including key families and orders.
- Students learn to compute and compare measures of species richness and relative abundance.
- Students access and utilize current hard copy and electronic resources for taxonomic information.

CENTRAL CONCEPTS:

Humans use an impressive number of species, but we also rely heavily on only a small number of species/families for much of our caloric intake.

The importance of certain taxonomic groups above others is perhaps less about chance than it is related to the combination of evolutionary history within lineages and thousands of years of agricultural and horticultural activities (including the selection of desirable characteristics within crops) by humans.

Communities of organisms (the market plant "community" used as a proxy) can be quantified in terms of the taxa of which they consist. These calculations can be useful in drawing comparisons within and between communities, and can generate new hypotheses.

MATERIALS:

- Recording materials (notebooks/writing boards, pencils/pens)
- Taxonomic resources (books and computer access)
- Excel or other spreadsheet software
- Transportation to site (we use institutional vans)

INTRODUCTION

The Market Botany lab module has been run with up to 20 students at a time. The activity can be used as a field trip in any botany course above the 100 level or modified and used as a lab-based activity (and then perhaps serve a larger class size). As presented here, the module consists of three parts, the first two completed during a 3-hour lab period and the third done for homework.

An underlying pedagogical concept here is one I try to employ in all of my botany coursework: Students are more likely to remember subject matter if they have a personal connection with the material. The value of this approach was impressed on me as an undergraduate student by Dr. Roger Locandro, Rutgers University, who never missed an opportunity to feed to us the very things we were learning about. Although students are not eating from the shelves during this module, per se, this activity does connect taxonomic/biological concepts and names with their personal experiences of familiar foods and products.

Permission from the store should be sought for the market survey. I contact the manager of our local grocery store a few weeks before our scheduled visits so that he can clear the activity with the chain's corporate office. I have never been denied permission, in part because we do not violate the three main requests of the store manager: 1) No photos are taken in the store, 2) The activity should not interfere with customer access to products (time of day can be an important factor), and 3) When we leave, shelves and displays look the same as they did when we arrived. The latter request is easily met by reminding students to put products back exactly as they were found, including facing the fronts of packages/cans out.

ACTIVITY:

PART ONE (STORE SURVEY) 60-80 MINUTES (NOT INCLUDING TRAVEL TIME):

Summary: Students explore the diversity of plant-based products available for sale at a local grocery store by recording the names of plant products they encounter. How botanically diverse are the products we use everyday?

METHODS:

After a brief introduction to the activity and the goals of the visit, students/teams are given pre-assigned sections of the store (usually by aisle). This is easiest to do if you are already familiar with the store you visit for class, something that is possible through one pre-class visit. Deciding who to assign where and who will work individually is an important step and should be done based on your knowledge of each student's ability and personal interests – and with some attention to who works well with who.

Students are told to keep a cumulative list of the species they encounter in their assigned aisle by reading labels and ingredient lists. Given the content of my course, the students already know something about the use of common versus Latin names – including how to properly format the latter. Because of this they quickly recognize the inconsistencies in the way plant names are included in product ingredient lists (the bane of nomenclaturally-inclined botanists everywhere!).

Once the students record a species they should not do so again. While many plant names will be obvious, others might be more difficult to recognize. I tell them it is better to record something they think could be a plant name than to leave it out; quality control can wait until the master list is compiled back in the lab. Although they are sent blindly into the data collection, there is a benefit to this approach (see later). My role during the survey is to move throughout the store, checking on each group/student and occasionally offering assistance or making sure that they have recorded rare-occurrence species that might otherwise be missed (e.g., "Did you get this guarana soda over here?").

The students are highly unlikely to catch every species, given the short timeframe and their varying levels of knowledge. My goal in the activity is not to make an exhaustive list, but to gather enough data points such that the results can be accepted with confidence.

I prefer to let the students record their data in the fashion they find most agreeable, but a standardized datasheet could just as easily be generated and provided. The keys are to gather the data quickly, prevent your participants from feeling frustrated or overwhelmed, and encourage them to become invested in the quality and comprehensiveness of their datasets.

The class is typically divided among the following aisles of the store (and these then become categories of use to be evaluated later):

1. Deli/bakery
 2. Produce
 3. Pharmacy and health
 4. Beauty/cleaning
 5. Pet and baby
 6. Chips/soda/seasonal
 7. Candy/nuts/crackers
 8. Pasta/canned vegetables/condiments
 9. Tea/ethnic/soups
 10. Baking, spices + Dairy/beer (2 aisles)
 11. Cereal/juices/canned fruits
 12. Bread/jellies/frozen desserts
 13. Frozen vegetables/entrees
- Not assigned: Floral (plenty of interesting things, but too many species without identification labels).

Some sections are more challenging than others, whether by the volume of products or diversity of ingredients they contain (e.g., pharmacy, ethnic). The produce section has many species, but they are all obvious and easy to record. Other sections might be more difficult, so I find it best to try to match those assignments to students with a strong botanical background or specific interests. Pharmacy/health is both rich in plant products and inclusive of "oddball" species that may not be recognizable to all students; this is a good assignment for the student(s) with an interest in pharmacology, medicine or other health-related fields. Pet Food is surprisingly species-rich and a good match for the student with an interest in veterinary or animal science. Well-travelled students, lovers of ethnic food and international students do well in the Tea/Ethnic section. The beer section..... Well, that one isn't hard to find a match for (actually, it's a great assignment for a home-brewer).

My students are usually wrapping things up within about an hour and will record on the order of 230 species in that time. This may seem surprisingly rapid, but the cumulative nature of the lists makes for many unrecorded repeats. The first students to finish their sections are sent to assist classmates who are still working. Once most groups are done, I send them to the coffee counter (store managers like it when you also spend some money before you leave) and help anyone still recording to finish up.

Once all of the data are collected and just before we leave the store I ask them to spend the trip back to campus discussing what they observed and what they think the most important groups might be. Then we're in the vans and back to the classroom for Part Two (which could just as effectively be done on a later class day).

If transporting your class to a store is problematic, here are two options: 1) Collect the data yourself (or offer extra credit for a group of students to gather the data), then start the process at Part Two, or 2) Create your own "market" in the lab by stocking selected products in the teaching space, an approach by which one could limit the number of species recorded and/or drive the direction of the analysis.

PART TWO (TAXONOMIC RESEARCH AND DATA ENTRY), 45-80 MINUTES:

Summary: Students research the taxonomy of the plants they recorded during the survey and enter that information into a common spreadsheet. Do our data support the observations/assumptions we made while recording?

METHODS:

In the classroom/lab, the list of species is now actively entered into a common spreadsheet managed by the instructor and projected onto a screen so the class can follow along. The spreadsheet has the following headings: species name, family, order, upper taxonomic group (see below), and one heading per category of use (in this case, each use category is an aisle of the store).

TASKS:

Record the occurrence of each species (and the sections in which each was recorded) on the common spreadsheet, using one row per species and one column per survey team (so one column per store aisle). An individual species may thus be recorded (by entering a "1") in more than one survey column, thus providing us with both a list of species and a record of the total occurrences of each species. Using a "1" for each occurrence allows the students to easily sum up columns later (just by clicking the column). As each student/team reports this information to the instructor, the class starts searching for and recording:

- Latin name for each species.
- Family each species belongs to.
- Order each family belongs to. (It is worth noting here that Family and Order definitions may vary depending on the resources the students use. My tendency is to lean towards the designations used in the latest edition of the textbook I use in our plant systematic course (currently Judd, et al.) in order to maintain consistency.
- "Upper Taxonomy" of each Order (Algae, Bryophytes, Fern Allies, Ferns, Gymnosperms, Monocot Angiosperms, Non-monocot Angiosperms. (It is a given that "algae," "fern allies," "ferns," and "dicots" are all problematic names. "Non-monocot angiosperms" can be used in place of the now-obsolete term, "dicots," but the others are still used here - and addressed by me in this and other courses as appropriate.)

Resources (Truncated list; many others appropriate):

Key books in the lab include:

- Judd, et al., Plant Systematics, Sinauer
- Simpson, Plant Systematics, Elsevier
- Zomlefer, Flowering Plant Families, Chapel Hill
- The Complete Food Guide, Könemann
- Mabberley, The Plant Book, Cambridge
- Vaughan and Geissler, New Oxford Book of Food Plants, Oxford U. Press

We also book the departmental computer lab for this period and encourage the use of key web resources, including:

- International Plant Names Index (IPNI)
- USDA PLANTS Database
- Tropicos (Missouri Botanical Garden)

The process of making the list takes time, patience, and organization. I find that the process is done most efficiently if I am the only recorder, with the students reporting to me. I can keep track of what species have been entered, where each species was recorded, and, later, serve as the check point and quality control for taxonomic entries. In cases where the information they find is conflicting, I act as final arbiter.

The research process is where I see the benefit of not telling the students anything about the plants before they started making lists. It is far better for them to discover on their own the several crops that come from *Brassica oleracea*, or the multiple varieties of the same species of *Citrus* or *Malus*, or that cilantro and coriander are the same taxon.

PART THREE – ANALYSIS (HOMEWORK):

Summary: Students quantify their results by calculating measures of species richness and relative abundance. Do some groups contribute more species for our use?

METHODS:

The final Excel datasheet is posted on-line and downloaded by each student. The posted data are used to determine the following:

- Richness: Count the number of species occurring in the community. How many species are recorded for each Upper Taxonomic Group, Order, and Family?
- Relative abundance: Count the number of species occurrences (how many columns each species is recorded in), then calculate the percentage a species contributes to the total number of occurrences. Occurrence in an aisle/section is treated the same as would be the occurrence of an individual of a species in a wild community.

The students are asked to prepare a 2-3-page summary of their results, including a discussion of what the most economically important groups are across all taxonomic levels (as defined by how common they were in the store). They are also asked to compare the conclusions they reach from each of the two community measurements. Do we learn something different if we consider not just whether a species is present (is used by people), but how often it occurs (used in multiple ways)? The concept of the "ecological community" is something we use throughout my Field Botany course, so the students are familiar with it and are able to make the leap required to apply the concept here. In another type of course students may need additional clarification on what communities are and the measurements used to describe them.

OUTCOMES:

Most students expect to find that the grass groups (Poales, Poaceae) will lead the lists for both richness and abundance – in part because of all they have heard about the dominance of corn, rice, and other grains in terms of agricultural input and annual calories consumed. Although they are surprised by the importance of other groups, their awareness of Poales/Poaceae facilitates a better understanding of the differences between richness and relative abundance (see results below). Both Poales and Poaceae move up their lists of most important groups when considering abundance rather than richness. A truly comprehensive survey of every Poales/Poaceae occurrence in the store (by product rather than aisle) would surely send those groups to the very top of the abundance lists.

Many students also casually hypothesize that the number of species encountered should be relatively low, having read books like Michael Pollan's "Omnivore's Dilemma." To their astonishment, my fall 2010 group listed 234 species (even while missing some species that were present). This outcome gave them a greater appreciation for the diversity of plants we use, even though the community calculations provide evidence that much of that use comes from only a handful of taxonomic groups. An additional worthwhile discussion could focus on the fact that the total number of species they encounter in one store, while impressive, is still but a fraction of the potentially-useful plants on Earth.

EXAMPLE RESULTS (FALL 2010 SEMESTER)

Richness:

Total: 234 species (from 78 families)
Upper Taxonomic Group

- Non-monocot Angiosperms: 189 species (80.8% of total)
- Monocot Angiosperms: 37 (15.8%)
- Gymnosperms: 4 (1.7%)
- Algae: 4 (1.7%)

Top Orders

- Asterales: 20 species (8.6% of total)
- Fabales: 20 (8.6%)
- Lamiales: 15 (6.4%)
- Rosales: 14 (6.0%)
- Poales: 13 (5.6%)
- Brassicales: 13 (5.6%)
- Violales: 13 (5.6%)

Top Families

- Asteraceae: 20 species (8.6%)
- Fabaceae: 17 (7.3%)
- Rosaceae: 14 (6.0%)
- Lamiaceae: 14 (6.0%)
- Poaceae: 13 (5.6%)
- Brassicaceae: 12 (5.1%)

Relative Abundance:

Total occurrences: 868

Top Upper Taxonomic Group:

- Non-monocot Angiosperms: 65.0% (563 of 868)

Top Orders:

- Rosales: 35.0% (82 of 868)
- Poales: 28.6% (67)
- Fabales: 20.5% (48)
- Lamiales: 18.3% (43)
- Asterales: 17.0% (40)

Top Families:

- Rosaceae: 34.1% (80)
- Poaceae: 28.6% (67)
- Fabaceae: 18.3% (43)
- Lamiaceae: 17.9% (42)
- Asteraceae: 17.0% (40)

Top Grocery Aisles (percentage of total species occurring in a given aisle)

- Produce: 38.9%
- Tea/Ethnic/Soup: 33.3%
- Pharmacy/Health: 33.3%
- Cereal/Juices/Canned fruits: 23.9%

FINAL THOUGHTS:

Students in my Field Botany course, a semester-long experience that includes visits to numerous sites in the Adirondack and Lake Champlain regions, consistently rate the Market Botany module as one of their favorite activities. Perhaps more importantly, they also consider it to be one of the course experiences where they learn the most. The module usually changes the students' view of their world, generating comments like, "I will never walk through the grocery store the same way again."

There are numerous potential extensions to this module, including:

- Choose a commonly used family and offer example products for tasting/smelling. Ask the students to consider why this group has become commonly used and whether the reasons are tied to the phylogenetic history of the group (e.g., secondary compounds in Brassicaceae and Lamiaceae and whether the biochemical characters are synapomorphies for each family).

- Closely examine the horticultural history and cultivated varieties of a species like *Brassica oleracea*, using the multiple forms as case studies in plant morphology or breeding.
- Run the same survey and analysis in a second grocery/market in a different geographic, cultural or socioeconomic locality and compare the results; or have a discussion of how the results would differ if the study was done in a different place.
- Reconsider the list of plant species recorded and separate them by whether they are consumed or used in some other fashion. Do the calculations change?
- Discuss the causes and consequences of reliance on a relatively few species/groups, perhaps by integrating films such as "King Corn," or "Botany of Desire."
- Expand the community analysis component by also generating diversity indices and measures of dominance; or compare the results of the market survey with results generated by a true field survey.

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Appendix A. Selected references for previously-published articles relating to the use of markets/stores as learning spaces for biology courses.

Arnott, H.J. 1965. Supermarket plant anatomy. *American Biology Teacher* 27: 104-105.

Burrows, G.E. and J.D.I. Harper. 2009. Supermarket botany. *Teaching Science* 55: 47-50.

Clifford, H.T. 2010. Seeds and shopping centres. *The Victorian Naturalist* 127: 11-14.

Irwin, H.S. 1977. Grocery store botany. *The Curator* 20: 5-14.

Thompson, L.K. 1993. Grocery store botany. *Tested Studies for Laboratory Teaching* 14.

Rahn, J.E. 1974. *Grocery Store Botany*. New York: Atheneum.

Reflections on the life and legacy of Richard Evans Schultes

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For many ethnobotanists, talking about Richard Evans Schultes is like talking about god – and how could one even attempt such a thing, especially so when one has never had the privilege to meet the man? This was a challenge I faced when being asked to contribute a lecture on Richard Schultes to the "Botanists in New England" Symposium of the Economic Botany and History Sections of the Botanical Society of America in 2010. My initial strategy, and perhaps the only way to appreciate Schultes' thinking, was to simply head out into the field, somewhere in the upper Amazon, to collect plants and think about how to meet this challenge.

Apart from "One River", Wade Davis' biography of Schultes (Davis, 1996), astonishingly little has been written about the founder of modern ethnobotany. Even the most complete bibliography in the obituary by Prance (2001) is far from presenting a complete picture of Richard Schultes' extensive writing. How could it happen that the "father of ethnobotany" is nowadays often unknown to students, and maybe only vaguely known to colleagues, despite his reputation as the man who "discovered" almost every single psychoactive species known in the New World?

For example take myself. When starting my ethnobotanical work, a friend asked me "So, do you know Richard Scholtees?" (at least that is how his name sounded to me, and the mispronunciation certainly did not help I simply had no clue who that might be). So, "Richard who?" was my understandable answer. Schultes himself would most certainly have flinched at the mangling of his name. He was very well known for insisting on the correct spelling and pronunciation of Latin, Greek, and any other language.

Who was this man, who collected over 25,000 botanical specimens, wrote two dozen books and almost 500 scientific papers?