Writing dichotomous keys

Learning to write dichotomous keys encourages looking closely at plants, which aids in learning to identify them. The following steps are one approach that can be used its objectives are:

- Develop understanding of the structure of dichotomous keys.
- Increase awareness of the characteristics of different families and genera.
- Increase ability to use botanical terminology.

Select about 10 plants that are readily available; bring sample material into the classroom (each student should have a complete set (choose species well represented on campus; do not be locusts). With large classes, let students can work in pairs.

Tell students the names of the species. This is not about their DOING an identification but about learning how to write keys. In doing so, they will improve their knowledge of plant families and observational skills.

In introducing the exercise, make it very clear that there is no "correct" key. Good keys make identification easier than bad keys, but there is no right key. Characteristics of good keys are that they:

- Use terms the user group will either know or can easily look up;
- Use easily recognizable features;
- Use features that are available during much of the year;
- Have parallel leads;
- Have a consistent structure;
- Are accurate, enabling users to arrive at the correct identification

It is not always possible to write "easy" keys. Taxa sometimes differ by rather obscure features or features that are only available during a short period. That's life. Strive for the best, but the most important feature of a key is that it be reliable.

For this example, the following nine species are used. T**he goal is to write a key that will enabling determining to which family they belong**.

Vachellia nilotica
Nerium oleander
Commicarpus sinuatus
Senna occidentalis
Prosopis juliflora
Tecoma stans
Cadaba farinosa
Maerua crassifolia
Leucaena leucocephala

Step one

Determine family and then sort the list by family. Paste the names into a spreadsheet. Sort by family, then species.

Apocynaceae	Nerium oleander
Bignoniaceae	Tecoma stans
Capparaceae	Cadaba farinosa
Capparaceae	Maerua crassifolia
Fabaceae	Leucaena leucocephala
Fabaceae	Prosopis juliflora
Fabaceae	Senna occidentalis
Fabaceae	Vachellia nilotica
Nyctaginaceae	Commicarpus sinuatus

Observation: A key that brings out Fabaceae first will split the list almost exactly in half. In theory, all other things being equal, leads that split keys into two equal-sized groups will require fewer steps for more taxa than more unequal splits.

Ask yourself, what features tend to distinguish Fabaceae?

Answers: fruits always legumes (but these are easily confused with follicles); leaves almost always compound, often pinnately compound. Not that many have small radially symmetric flowers with lots fo stamens, others have bilaterally symmetric flowers with 9 or 10 stamens). Let's focus on leaves. They are easy to recognize and present through much of the year.

Add two columns to the table as shown under step 2.

Step 2

Family	Species	Pinnately compound	What they are
Apocynaceae	Nerium oleander	no	Simple, whorls of 3 or opposite*
Bignoniaceae	Tecoma stans	Yes, 1x pinnate	
Capparaceae	Cadaba farinosa	no	Simple, alternate
Capparaceae	Maerua crassifolia	no	Simple, clustered on older branches
Fabaceae	Leucaena leucocephala	Yes, 2xpinnate	
Fabaceae	Prosopis juliflora	Yes, 2xpinnate	
Fabaceae	Senna occidentalis	Yes, 1x pinnate	
Fabaceae	Vachellia nilotica	Yes, 2x pinnate	
Nyctaginaceae	Commicarpus sinuatus	No	Simple, opposite

Looking at the table, We can separate the species into two groups but Bignoniaceae "tests positive" for simple leaves. There are two solutions for this.

Solution 1.

1	Leaves pinnately compound	(Bignoniaceae, Fabaceae)
1	Leaves simple	(Apocynaceae, Capparaceae, Nyctaginaceae)

Solution 2.

1	Leaves pinnately compound; petals separate	Fabaceae
1	Leaves simple or, if pinnately compound, petals united	(Apocynaceae, Bignoniaceae Capparaceae, Nyctaginaceae)

Either solution will work. There are also other possible solutions. Let's go with Solution 1.

Step 3

Look at the first row: the next step for row 1 is to write a pair of leads that will separate Bignoniaceae from Fabaceae – as these families are represented by the species you are looking at. The easiest is probably the corollas:

2	Corollas of separate petals; leaves bi- or once-pinnately compound	Fabaceae
2	Corollas of united petals; leaves once-pinnately compound	Bignoniaceae

Pause for reflection

The next steps on this path will require sorting out the four species of Fabaceae in the key. Before going there, let's pause to look at the structure of the key and its lead (the statements used to sort the taxa out).

- The leads are in pairs. Both members of a pair have the same number in column 1.
- Each lead starts with the name of a feature (structure) followed by a word of phrase describing the condition of the feature for taxa to bring out on that lead.
- If a lead mentions two or more features, individual features are separated by semi-colons.
- Both members of a pair of leads cite the same features, in the same order.

It is not required to key through families to genera and then to species. One can key directly to species. The reason this set of instructions keys through families is because one of the goals for teaching how to write keys is to help students become familiar with family characteristics.

Step 4

Back to the key. Let's see how to sort out *Apocynaceae*, *Capparaceae*, and *Nyctaginaceae*. All the species in the list have simple leaves. Some members of *Capparaceae* have digitately compound leaves, but they do not concern us because both species in the list have simple leaves.

Looking at the table in Step 2, there are 4 species to sort out, two bwing members of the *Capparaceae*. Tt seems that leaf arrangement will divide the species in the lead into two groups. Let's construct a table.

	Leaves opposite or in whorls of 3	Apocynaceae
	Leaves alternate or crowded on short side shoots	Capparaceae, Nyctaginaceae

Question: What number should they have? Let's start building what we have done into a key.

Make a table with the first division.

1	Leaves pinnately compound	(Bignoniaceae, Fabaceae)
1	Leaves simple	(Apocynaceae, Capparaceae, Nyctaginaceae)

Add two rows for separating Bignoniaceae and Fabaceae.

1	Leaves pinnately compound	~~(Bignoniaceae, Fabaceae)~~ 2
1	Leaves simple	(Apocynaceae, Capparaceae, Nyctaginaceae)
2	Corollas of united petals; leaves once-pinnately compound	Bignoniaceae
2	Corollas of separate petals; leaves bi- or once-pinnately compound	Fabaceae

Now we need to replace the text in the third column with the number of the pair of leads people need to go to choose whether a plant is a member of the Bignoniaceae.

Now let's add in the lead for sorting the Apocynaceae specimen from those of the Capparaceae and Nyctaginaceae. Those lines will need to be numbered 3, the next available number. AND, the text in column 3 needs to be replaced with the number 3.

1	Leaves pinnately compound	~~(Bignoniaceae, Fabaceae)~~ 2
1	Leaves simple	~~(Apocynaceae, Capparaceae, Nyctaginaceae)~~ 3
2	Corollas of united petals; leaves once-pinnately compound	Bignoniaceae
2	Corollas of separate petals; leaves bi- or once-pinnately compound	Fabaceae
3	Leaves opposite or in whorls of 3	Apocynaceae
3	Leaves alternate or crowded on short side shoots	(Capparaceae, Nyctaginaceae)

Step 5

Another lead, or pair of statements, is needed to sort out the specimens belonging to *Capparaceae* from those of the *Nyctaginaceae.* There are some technical features that can be used, but remember: easier is better, so long as it works. The following table shows one way to separate the two families, at least for the species in the sample provided for this exercise.

	Stamens 3-4; ovaries sessile	Nyctaginaceae
	Stamens 5 or more than 10; ovaries on a long stalk, the *gynophore*, which makes them about level or somewhat above the anthers	Capparaceae

These statements use one technical feature that is not found in many plant families. It is what I mean by a technical character. Counting the number of stamens should be easy. But flowers are not always present. Let's add one more feature that can be used for the species in the list (and will usually work for all members of the two families.

	Stamens 3-4; ovaries sessile; plants erect, trailing, or climbing	Nyctaginaceae
	Stamens 5 or more than 10; ovaries on a long stalk, the *gynophore*, which makes them about level or somewhat above the anthers; plants erect shrubs or trees	Capparaceae

OK, now we are ready for the last step, putting the whole key together. Let's copy the table from the last step, add the new pair of leads, number them new leads correctly, then replace the pair of families listed in column 3 for the second half of lead 3 with the number of the lead that sorts them out.

1	Leaves pinnately compound	~~(Bignoniaceae, Fabaceae)~~ 2
1	Leaves simple	~~(Apocynaceae, Capparaceae, Nyctaginaceae)~~ 3
2	Corollas of united petals; leaves once-pinnately compound	Bignoniaceae
2	Corollas of separate petals; leaves bi- or once-pinnately compound	Fabaceae
3	Leaves opposite or in whorls of 3	Apocynaceae
3	Leaves alternate or crowded on short side shoots	~~(Capparaceae, Nyctaginaceae)~~ 4
4	Stamens 3-4; ovaries sessile; plants erect, trailing, or climbing	Nyctaginaceae
4	Stamens 5 or more than 10; ovaries on a long stalk, the *gynophore*, which makes them about level or somewhat above the anthers; plants erect shrubs or trees	Capparaceae

DONE! Now two more keys are needed, one to identify the four species of *Fabaceae*, the second to identify the two species of *Capparaceae*.