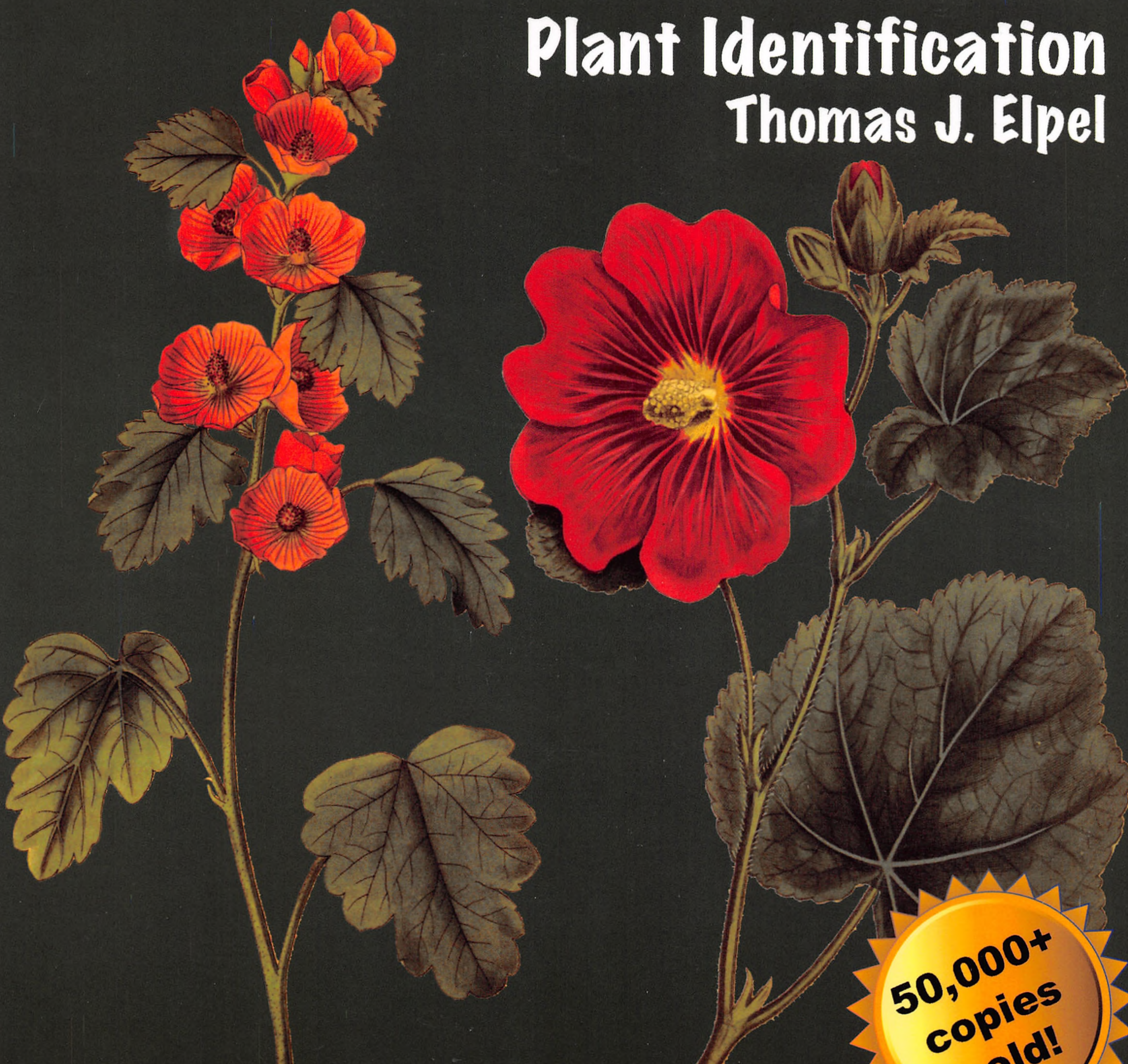
BOTANY IN A DAY APG

The Patterns Method of Plant Identification

Thomas J. Elpel



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AN HERBAL FIELD GUIDE TO PLANT FAMILIES OF NORTH AMERICA

Quick Guide to Flower Terms

Words in **bold** are used frequently throughout this text.

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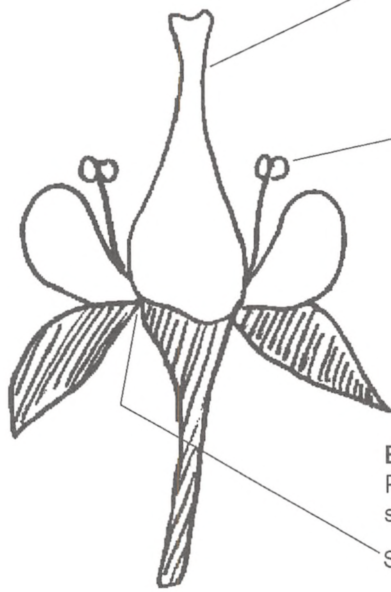


female: **Pistil** | **stigma** | **style** | **ovary** | ovule

After fertilization, the ovule develops into a seed.

male: **Stamen** | pollen | anther | filament

Tip: To remember which is male and which is female, keep in mind that the stamens always "stay men."

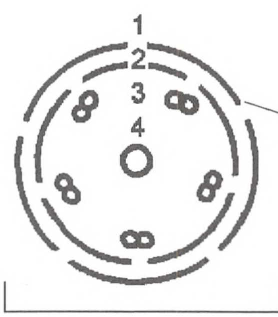
Petals/corolla (The corolla is the sum of all petals).
Sepals/calyx (The calyx is the sum of all sepals).
The perianth is the calyx and corolla together.

A complete flower has sepals, petals, stamens and a pistil.
An incomplete flower lacks one or more of the above.

Bisexual flowers have both male and female parts.
Plants with **unisexual** flowers have male and female flowers appearing either separately on the same plant (monoecious) or on separate plants (dioecious).

Sepals, petals, and stamens are attached below a **superior** ovary.
(Also described as hypogynous.)
Sepals, petals, and stamens are attached above an **inferior** ovary.
(Also described as epigynous.)
If the parts are attached in the middle of the ovary, the flower is perigynous.

The word **numerous** is often used where there are more than 10 parts in a set, for example, numerous stamens.



regular flower

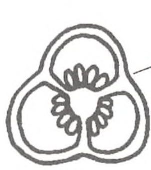
1. sepals/calyx
2. petals/corolla
3. stamens—male
4. pistil(s)—female

In a **regular** flower, the individual parts of a set are all identical in size, shape, and color. For example, the petals are all the same.
In an **irregular** flower, some of the individual parts of a set are different. For example the petals may be different sizes.

Progressive Fusion of the Pistils

Making sense of carpels, chambers, and partition walls.

A **simple pistil** has a single-chambered ovary called a **carpel**. Plants with primitive traits, like this larkspur, typically have multiple simple pistils (**apocarpous**), often in a cone-like form. Tip: try associating "carpel" with "carport," like a docking station where the ovules (egg cells) are parked.



Evolution has led to fusion of the parts so that most plants today have one compound pistil consisting of several **united carpels**, also called **syncarpous**. A compound pistil consisting of two carpels is bicarpellate, while a pistil of three carpels is tricarpellate. In this illustration, the partition walls are present, making a three-chambered ovary.

Further fusion of the carpels may eliminate the partition walls, leading to a compound pistil that has only one **chamber** (also known as a locule). In this picture, the ovules are attached in three points, indicating that it is composed of three carpels.

The **styles** and **stigmas** of the pistil reveal hints about the inside of the ovary. As shown here, a pistil with three separate styles indicates that the ovary consists of three united carpels. If the styles are fused together, too, then look at the stigmas. The four-parted stigma shown here suggests that there are four carpels in the ovary. Read more on page 18.

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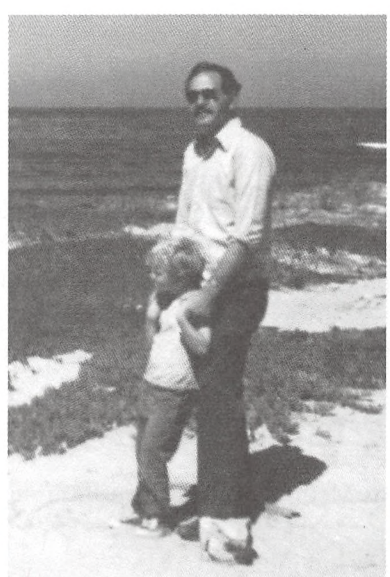
An Herbal Field Guide to Plant Families of North America

6th Edition

clasping pepperweed
Lepidium perfoliatum
Mustard Family



Dedicated to Dad
Thank you for showing me
my first edible wild plants.

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In Memory of Frank Cook
1963 - 2009

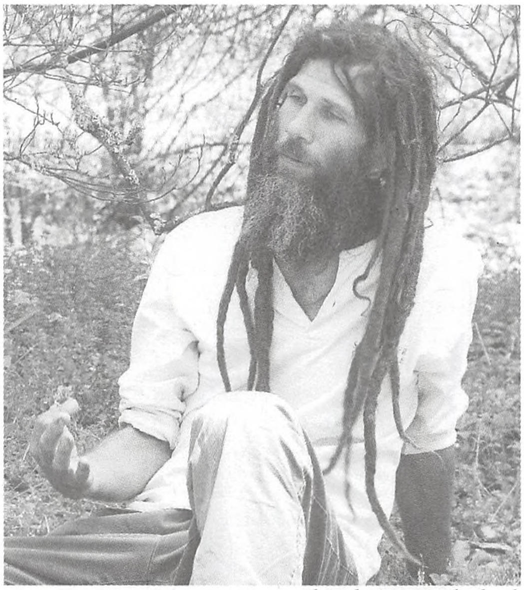


Photo by Zen Southerland.

I "knew" Frank Cook for seven or eight years via extensive email correspondence. Frank helped edit the fifth edition of *Botany in a Day*, and he used it as a guide in his plant classes around the world. Every time he would place an order for the book he would provide a new address "in care of" someone on the East coast, the West coast, or occasionally overseas.

Frank also led online discussion groups using *Botany in a Day*. I enjoyed reading his emails about getting to know the plants, and I was constantly amazed to hear about his adventures as he wandered all over the world discovering new plants and meeting new people. Frank used my book more than I have and clearly knew more about plants than I ever will. Although I never met Frank, nor spoke with him on the phone, I came to think of him as a friend.

Frank was like a grapevine, reaching out this way and that with his tendrils, making connections with people all over the world. I was one of those connections, and I felt connected through him to other people he met in his travels, as well as the plant people he discovered along the way. I also connected with his globe-trotting wanderlust in a vicarious way via his letters. My own life is very rooted in place with projects and family commitments, and I somehow felt freer just knowing that Frank was out there, exploring the world and getting to know the plant people. I will greatly miss Frank's presence, his correspondence, and his wandering spirit.

—Thomas J. Elpel

Looking for an online community of plant enthusiasts?
The Frank Cook tradition is being continued by Marc Williams:
www.botanyeveryday.com | www.plantsandhealers.org


yellowbells
Fritillaria pudica
Lily Family

Foreword

Path of Discovery

Grandma Josie loved to walk her dogs in the meadows, following cow trails through the willow thickets and junipers along the creek. I loved to walk with her, and together we collected wild herbs for teas, including yarrow, blue violets, peppermint, red clover, and strawberry leaves. We drank herbal tea every day. When I was sick she gave me yarrow tea with honey in it, plus she buried cloves of garlic in cheese to help me get them down. Grandma kindled my passion for plants. She taught me the plants she knew, and then I wanted to learn about all the rest.

We collected unfamiliar flowers on our walks and paged through books of color pictures to identify them. It was not a fast process, but I was a kid and had the luxury of time. If I could not find the name of a specimen in our books, then I brought it to the herbarium at the university and asked for help. Botanists keyed out the plant and gave me a botanical name for it. At home I researched the name through all of my books to learn anything I could about the uses for that species.

There are hundreds of thousands of species of plants in the world, and I approached them one-by-one, as if each one had nothing to do with any others. It seemed like there should be some rationale to the plant world, but I did not find it in my library of plant books. Nevertheless, I learned most of the significant plants of southwest Montana before graduating from high school, or so I thought.

Years later, married and with our house half built, I launched a nature education school and hosted an herbal class at our place. I thought I "knew" most of the plants discussed in the class, but the herbalist, Robyn Klein, used an approach I had never seen before. We found several members of the Rose family, and Robyn pointed out the patterns—that the flowers had five petals and typically numerous stamens, plus each of them contained tannic acid and were useful as astringents, to help tighten up tissues. An astringent herb, she told us, would help close a wound, tighten up inflammations, dry up digestive secretions (an aid for diarrhea) and about twenty other things, as you will learn through the pages of this book. In a few short words she outlined the identification and uses for the majority of plants in this one family. On this walk she went on to summarize several other families of plants in a similar way. She cracked open a door to a whole new way of looking at plants.

Some of my books listed family names for the plants, but never suggested how that information could be useful. I realized that while I knew many plants by name, I never actually stopped to look at any of them! This may sound alarming, but it is surprisingly easy to match a plant to a picture without studying it to count the flower parts or notice how they are positioned in relation to each other. In short, Robyn's class changed everything I ever knew about plants. From there I had to relearn all the plants in a whole new way. I set out to study patterns among related species, learning to identify plants and their uses together as groups and families.

I wrote this book not merely because I wanted to share what I knew about patterns in plants, but also because I wanted to use it myself. One principle I have learned while writing and teaching is that the ease or difficulty of learning a subject is not so much a factor of the complexity or volume of the information, but rather of its packaging. Even the most complex mathematical concepts can be simple to understand if they are packaged and presented well. Similarly, learning a thousand different plants and many of their uses can be a snap when presented with the right packaging. The only way I could really learn plant patterns was to gather all the information I could find into one place and see what patterns were revealed.

This book is designed to shortcut the study of botany and herbology. The beginning naturalist will quickly have a foundation for the future. The more experienced may find their knowledge suddenly snapped into focus with a new and solid foundation under that which is already known.

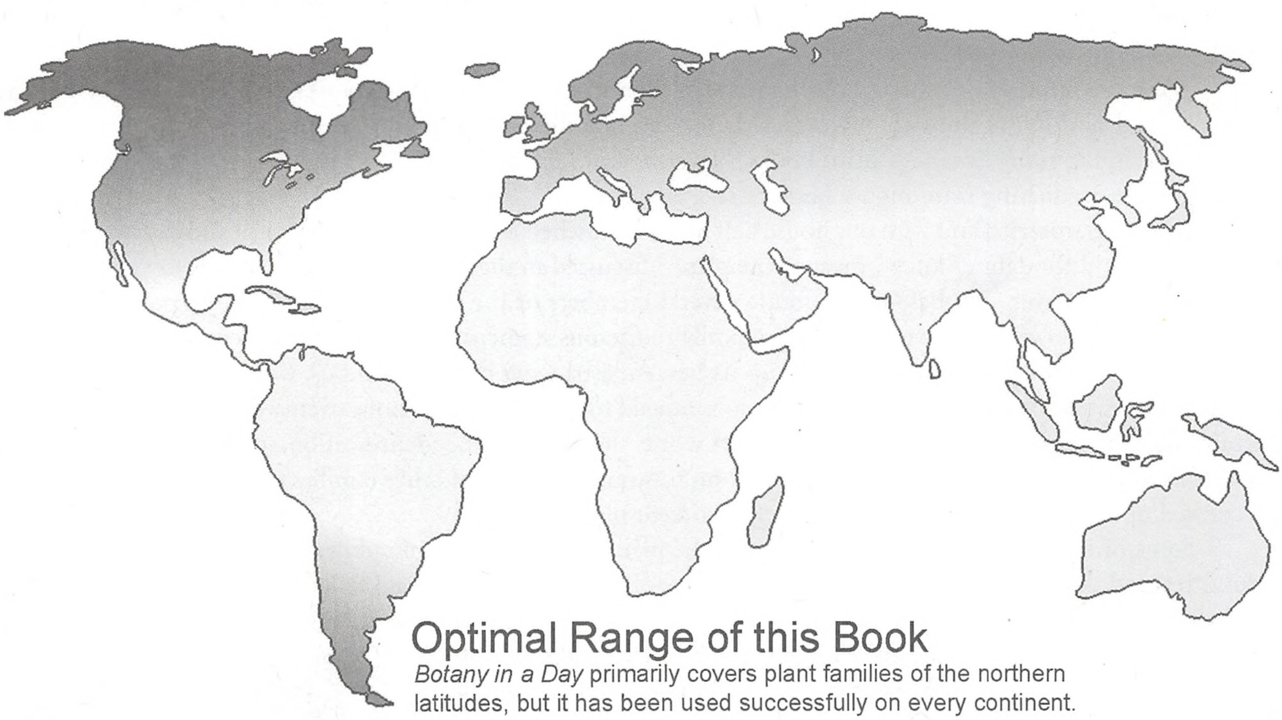
Thomas J. Elpel
Pony, Montana

avens
Geum elatum
Rose Family

Region Covered

Botany in a Day is intended to give the reader the big picture of botany and medicinal plant properties. It deals more with patterns among related plants than with the details of specific plants. Because the book content is broad, the coverage is also broad. *Botany in a Day* covers most plants you are likely to encounter from coast to coast across the northern latitudes of North America, with extensive coverage throughout southern states as well.

In addition, many species in North America are identical or very similar to those of Europe and other countries of similar latitude. Unique plants exist in every locality, yet the majority of plants where you live are likely to be the same or similar to those covered in this text. Basically, any place that has real winters with hard freezes will have a great number of plants in common with this book. The vegetation does not radically change until you travel far enough south and low enough in elevation to drop below the frost belt.



Optimal Range of this Book

Botany in a Day primarily covers plant families of the northern latitudes, but it has been used successfully on every continent.

Below the frost-belt you will continue to find many of the same and similar plants, but you will also find whole new plant families not found in the North. With each revision of the book I have added new plant families and worked to expand coverage across the southern states.

The biggest challenge with any plant book is in trying to identify a specimen that is not included in the text. There is a human tendency to make a plant fit the available description, even when it is not related to anything in the book. From that standpoint, *Botany in a Day* is most useful in the frost belt of North America where coverage is most complete and slightly less useful as you move farther south. However, readers have successfully used this book all over the world, and many people written to share their experiences and observations.

Readers have provided helpful tips about the identification and uses of related plants from their part of the world. This feedback is incorporated into this ever-evolving book to the greatest extent possible without compromising book quality for North American readers.

In this text, "North America" refers to the United States and Canada—everything north of our border with Mexico. Thus, a plant that is "Native to all of North America." may or may not be found south of the border.

pink turtlehead
Chelone obliqua
Plantain Family

Part I:

Botany in a Day

The Patterns Method of Plant Identification

pinnate
prairie coneflower
Ratibida pinnata
Aster Family

Botany in a Day Tutorial: How to Proceed

1. The study of botany is the study of patterns in plants. Find a comfortable, quiet place to read for a while. You will need to read through the tutorial on *Plant Names and Classification* and *The Evolution of Plants* to understand the big picture of how plants are related to each other and how botanists have sorted them into a filing system based on their relationships. This background is essential for understanding how and why plants are placed in certain groups. Did you know, for instance, that grasses are considered "flowering" plants? After you read these chapters you will be ready to learn some useful patterns for identifying common plants.

2. Read the next section in the tutorial, *Learning Plants by Families,* and learn to recognize some of the most common family patterns found throughout the world. Read about these families to learn their characteristics, then go for a walk and look for plants—wild or domestic—that fit the patterns. The eight families described here (Mint, Mustard, Parsley, Pea, Lily, Grass, Rose, and Aster) include more than 45,000 species of plants worldwide. Learn the basic patterns and you will know something about these plants wherever you encounter them. Do not concern yourself with individual plant names at first; just concentrate on learning the patterns of the families. You will be farther ahead in the long run, and you may be surprised to discover how much you can know about a new plant without even knowing its name. See how many plants you can find in each of the families you are studying. Now you are doing botany!

3. As you become comfortable with the patterns of the plant families from the tutorial, then you can begin studying new family patterns. I've highlighted the most common and easy-to-learn plant families in **bold** in the *Index of Plant Families and Subfamilies by Common Names*. Practice identifying these families until you are comfortable with most or all of them before you start learning the rest. I also recommend reading through *The Medicinal Properties of Plants* section in the back of the book. A basic understanding of plant properties will often aid you in identifying a plant. Please wait on utilizing any plants until you build up confidence in your identification skills.

There are many places to look for patterns in plants. Look at wildflowers and weeds and study the flowers in your yard. Look at pictures in other plant guides and notice those plants that fit the patterns of the families you are studying. Floral shops, greenhouses, nurseries, and botanic gardens are other good places to study plant patterns. Some gardens have living displays of plants from all around the world. There you will recognize plants from other continents that belong to the families you know!

If you are on a nature trail or in a nursery—any place where plants are labeled with their botanical names—you can look up their names in the *Index of Plants by Genus*. Read about the family characteristics and look for those patterns in the specimen before you. You may use the key included in this book at any time, although it is no substitute for learning the patterns of the families. Start with showy, distinctive flowers first—and simply match them against the patterns in the key.

4. As you become confident with a few family patterns then you might start identifying individual plants. The easy method is to search through the drawings and photos of plants *within the proper family*. Instead of randomly searching through hundreds or thousands of pictures, you can narrow it down to a single family. Some illustrations are provided for that purpose in this text, but you should also use this book in conjunction with other picture books.

Many plant guides are organized alphabetically or by the color of the flower; these books can ultimately hinder your progress in learning plants. Look for books that are organized according to plant families. At the very least, make sure the book includes the family name with each plant. A few of my favorite field guides, plus access to hundreds of my own wildflower photos, are available through our web site at **www.wildflowers-and-weeds.com**.

Plant Names and Classification

The Name Game

On picnics with my grandmother, we often picked teaberries, which grew in dense profusion beneath the canopy of lodgepole pine trees. The berries were delicious and infinitely abundant, yet so small that a person could starve to death while gorging on them. Strangely, I couldn't find a plant called "teaberry" in my library of plant books. That's the problem with common names; they vary from place to place and person to person. Even if there was a consensus on a plant name throughout a country or within one language, one would naturally expect different names in different languages. Moreover, unrelated plants might share the same common name, making it impossible to know which plant is the subject of discussion or study. That can become a serious problem when trying to determine the edible or medicinal uses of a plant.

I didn't know what a teaberry was until I successfully identified the plant myself in a book, listed under the name "grouse whortleberry," so named because grouse eat the berries. But it wasn't the new common name that mattered so much as having the plant's botanical name, *Vaccinium scoparium*.

Every plant has a unique two-part botanical name or binomial nomenclature, based on a system established by Carl Linnaeus in his 1753 book *Species Plantarum*. Botanical names are primarily formed from Latin and classical Greek roots, as well as Latinized names and phrases from other languages. The first name is the **genus** name (plural: **genera**), and the first letter is always capitalized. The second part is the **species** name, and it is always lowercased. Both are always italicized, as in *Vaccinium scoparium*. I may not know how to pronounce this botanical name, but this one name is used in every book, and by every author on every continent and in every language.

Herbalist Robyn Klein points out that these two-part names are much like our system of first and last names. For example, I belong to the genus *Elpel*, and my species name is *Thomas*. Other "species" of the Elpel genus include: *Cherie*, *Nick*, *Alan*, *Marc*, and *Jeanne*. Species names are meaningless on their own, because many people have the same names around the world. But the names *Cherie Elpel* or *Jeanne Elpel* are quite unique.

common bilberry
Vaccinium myrtillus
Heath Family

Similarly, there are about 450 species of *Vaccinium* in the world, including more than 40 species in North America and 7 species in my home state of Montana. Fortunately you do not have to write out *Vaccinium* for each species. You can abbreviate the genus after the first time you have used it. For instance, other species of huckleberries in Montana include *V. cespitosum*, *V. membranaceum*, *V. myrtilloides*, *V. myrtillus*, *V. ovalifolium*, and *V. uliginosum*. If you want to talk about the whole group at once then you just write out "*Vaccinium* spp." This abbreviation means **species plural**.

It is not necessary to memorize botanical names; you only need to refer to them when communicating about a plant to another person, or if you want to research that plant in other books. But you may be surprised at how many names you memorize just by looking them up in the indexes of other books.

Botanical names are especially useful for emphasizing relationships among plants. For example, *Vaccinium* is the genus name for huckleberries, blueberries, and bilberries. Knowing that instantly redefines what a grouse whortleberry really is. And if you learn a few huckleberries and blueberries, then you will likely recognize any new ones you encounter as well, even if you don't know their individual names. You could be hiking in the middle of Siberia and find a berry bush you have never seen or heard of before, but because you recognize its similarity to other huckleberries, you know you can safely eat it.

What do the numbers and dots mean?

After each plant listed in this book you will see some numbers in parenthesis. The numbers indicate how many species from that genus are present around the world, in North America, as well as in my home state of Montana. For example, "*Rosa*—rose (100/54/6)" indicates that there are about 100 different species of rose in the world, 54 native and/or introduced species in North America, and 6 species just in Montana. Your state may have more or less than this number. Most species within a genus will have similar properties and uses. For example, all 100 species of roses likely produce edible rosehips, or at least it is highly improbable that any of them are seriously poisonous.

The dot "•" after many of the names is my personal checklist of recognized genera. You are encouraged to mark the plants that you learn as well. You might use a high-lighter on the names, and you may want to make a note of the location to help jog your memory the next time you come across the name in the book. You can also highlight the names in the index.

I've been building a gallery of color photos on our web site at **www.wildflowers-and-weeds.com.** If there is a "•" after a name, then there is a good chance we have one or more color photos from that genus posted on our web site. New photos are added each year.

In other words, sometimes it is more important to recognize a plant as a relative of other plants you know, rather than to know its individual name. For that reason, I don't refer to *V. scoparium* as grouse whortleberry or teaberry. Instead, I call it dwarf huckleberry, which succinctly describes what the plant is, how it compares in size to other huckleberries, and the fact that it is edible and delicious. In this sense, standardized common names can be as useful as botanical names for conveying information about plants and their uses. Interestingly, common names are becoming increasingly standardized, at least within the English language, as they are used online in a shared global dialogue. Unfortunately, the opposite is true with formal botanical names, which are multiplying at an alarming rate as botanists attempt to clarify genetic relationships between plants.

Classification Schemes

If you had a few hundred thousand files to organize in a filing cabinet, how would you do it? How would you organize all the information so that you, or anyone else on the planet, could quickly and efficiently find any one file out of the whole bunch? And what if you had a file in hand, but didn't know what it was called or where it fit into the filing system? How would you ever figure it out? In botany, the process can be surprisingly easy, because plants are grouped according to patterns of similarity. Learn the patterns, and you can start with an unknown specimen and track it down through the filing system to learn its identity.

At its most basic level, plant patterns are often quite simple. Suppose you had two different species of wild rose. They clearly look like different plants, and yet, both plants look like roses, so you call one the prickly rose (*Rosa acicularis*) and the other the climbing rose (*R. setigera*). Binomial nomenclature is fairly instinctive in this regard.

Grouping closely related species together into genera like this is the first step in building a filing system. But, let's say you ripped every living plant from the earth and sorted them all into piles by genera. That would still leave thousands of separate piles, with no clear means to organize them. So the next step is to compare genera and lump similar genera together into bigger piles, which we call the **family.** Family patterns are not nearly as close as the patterns within any one genus, but still similar enough that one can learn to recognize many such patterns at a glance.

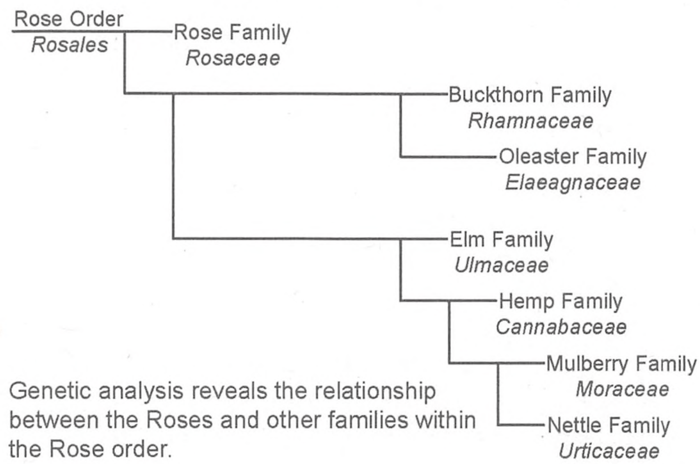
If a family is especially large, or its members sufficiently distinct from one another, then there may be subgroupings within a family, called the **subfamily** and **tribe.** For example, pears belong to the Apple tribe of the Almond subfamily within the Rose family. This indicates that pears are more closely related to apples and loquats than to raspberries, which are of the Rose subfamily of the Rose family. By grouping plants according to family patterns, we reduce the total number of piles to a few hundred, which is far better than thousands, but still too many piles to make an efficient filing system.

prickly rose
Rosa acicularis
Rose Family

A higher level of classification, above the species, genus, and family, is the **order**. For the purposes of field identification, orders are sufficiently different from one another that there are few useful patterns to work with. But that doesn't stop botanists from trying to classify them. For example, based on careful scrutiny, the Saxifrage, Gooseberry, Hydrangea, Pea, and many other families were previously classified as part of the Rose order. However, genetic analysis refuted those associations and instead revealed that the Rose order should include families such as the Hemp, Oleaster, Mulberry, Buckthorn, Elm, and Stinging Nettle—none of which share any obvious resemblance with the Rose family.

Above the level of order, there are (or were) additional levels of classification, some with useful characteristics for identification, and some without. Imagine the entire plant kingdom as a filing cabinet in which botanists identified distinct divisions, classes, subclasses, orders, families, subfamilies, tribes, genera, and species, as outlined here, along with each appropriate suffix:

Phylogenetic Tree of the Rose Order



Genetic analysis reveals the relationship between the Roses and other families within the Rose order.

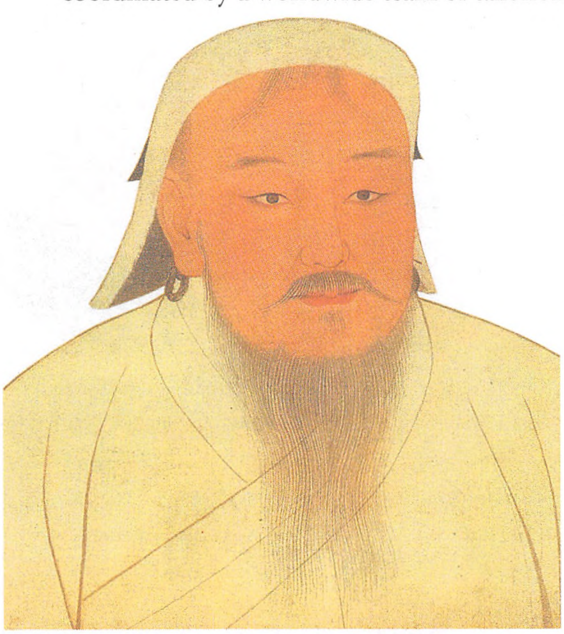
Division (*-phyta*)
- Class (*-eae, opsida*)
  - Subclass (*-ae*)
    - Order (*-ales*)
      - Family (*-aceae*)
        - Subfamily (*-oideae*)
          - Tribe (*-eae*)
            - Genus
              - Species

Many different classification schemes have been proposed, adopted, utilized, and ultimately rejected as more accurate information becomes available. The latest effort (and hopefully the last) is based on genetic research coordinated by a worldwide team of taxonomists known as the Angiosperm Phylogeny Group (APG). Taxonomists sequence a small part of the genome from a species and map out how closely it is related to other species, producing detailed branching *phylogenetic* trees, as shown above for families of the Rose order. The APG approach is theoretically more accurate, because taxonomists are compiling objective data about genetic relationships, rather than just looking at each species and guessing its relationship to other species.

The APG system recognizes orders, families, subfamilies, and so forth, but doesn't (yet) categorize anything above orders, except as *monophyletic* groups known as *clades*. Monophyletic translates to "one branch," meaning that any group of organisms should include only the genetic descendants (all of them) going back to a particular ancestor.

For example, Genghis Khan fathered several hundred, if not thousands of children, and his sons were also prolific, leading to an estimated 16 million descendents today, nearly 800 years later. Selecting Khan as an arbitrary branching point, a monophyletic group or clade would include all of his descendants.

If any of Khan's brothers' descendants were accidentally included, it would be considered a *polyphyletic* group. On the other hand, if any of Khan's descendants were accidentally classified as descendants of either of his brothers, it would be considered a *paraphyletic* group. But don't panic. These terms are not used elsewhere in this book. Only *phylogenetic tree* and *clade* are used in the text.



A Clade of Khans
Selecting Genghis Khan as an arbitrary branching point, a monophyletic group or clade would include his descendants (all of them), but none from his siblings.

Evolution of Plants

A Puzzle Without All the Pieces

Piecing together the story of evolution is challenging, since 99.9 percent of everything that ever lived is now extinct. Trying to understand evolution through living species of plants and animals is like trying to interpret a novel from the last paragraph. You can see the outcome, but do not know how the story unfolded.

The plot lies hidden in fossil records where plants and animals have been buried and turned to stone over thousands of millenia. Although this story is conveniently laid down in the linear sequence of geologic time, it is unfortunately a very fragmented tale. At best, fossil records are the equivalent of finding a few scattered words and phrases to the story. Most living organisms rot away without leaving a trace. Fossilized specimens are the exception rather than the rule, and evolutionary links connecting one species to another are even more scarce.

Scientists once assumed that the entire gene pool of each species continually underwent gradual change. But mutant genes tend to get diluted away in large populations and fail to spread. And fossil records typically reveal sudden, dramatic changes from one layer to the next, not gradual changes. Researchers now understand that gradual changes and new species evolve "on the margin."

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Imagine a valley hundreds of miles across, surrounded by mountains on all sides. Suppose that only one type of grass seed were deposited into this valley. Coincidentally, the whole expanse of the valley is the ideal habitat for this particular type of grass. The valley fills up and evolution stalls. There are always mutations, but the grass is already optimized for the environment so the mutations fail to spread. However, there is greater habitat diversity around the perimeter of the valley. Individual microclimates might be warmer or colder or more wet or dry than the valley itself. There could also be different soil chemistry. The valley grass might survive in each of these areas, but it wouldn't prosper. Gradual mutations would occur over time, and some abnormalities would be more optimized to conditions on the margin. Given enough time, distinct new species could evolve.

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Then a sudden disturbance comes to the valley. Perhaps the climate changes, causing the valley to become slightly warmer and wetter. The valley becomes more favorable to a grass species from the margin, resulting in an apparent "jump" in evolution from one species to another. The previously dominant species is limited back to habitat on the margin or completely eliminated while the new species suddenly invades the habitat. Thus evolution proceeds both gradually and suddenly. It is revealed in the fossil record as long periods of stability with periodic jumps to completely new species. For example, scientists researching trilobites, an extinct marine arthropod, found a jump in the fossil record from those with seventeen pairs of eyes to those with eighteen pairs of eyes. It took years of searching to find the margin where both types were present.

Similarly, it could be said that stable, balanced ecosystems tend to limit innovations, while major life-killing disturbances—such as meteor impacts—tend to favor them. Eliminating competition greatly increases the odds for all kinds of mutations to survive and fill the void. New species emerge, optimize to fit specific ecological niches, and evolution stalls again. In the fossil record we see it as long periods of stability with sudden jumps to completely new life forms. The geologically brief periods of significant mutant activity are much less likely to be recorded or found in the fossil record.