Chapter 3

Weed Classification

FUNDAMENTAL CONCEPTS

- The order in the world of weeds is recognized through systems of classification.
- Weeds can be classified in at least four ways. The most important and oldest system is based on phylogenetics or evolutionary ancestry.

OBJECTIVES

- To learn the fundamentals of weed classification based on phylogenetics or ancestral relationships.
- To learn why and how other weed classification systems are used and why they are important to weed management.
- To understand the unique habitat and role of parasitic weeds.
- To know the major groups of parasitic weeds.
- To understand the importance of a plant's scientific name.

One of the great, often unspoken, hypotheses of modern science is that there is order in the world. With careful study, scientists believe they can discover and describe the order. With each discovery and consequent description science will improve our understanding of how our world functions. Among those who study the order in the natural world are taxonomists, who describe and classify species. Although not everyone agrees on whether or not a particular plant is a weed or exactly what a weed is, most weeds have been classified, as members of the plant kingdom, by plant taxonomists.

There are at least 450 families of flowering plants and well over 350,000 different species. Only about 3,000 of them have been used by humans for food. Fewer than 300 species have been domesticated and of these, there are about 20 that stand between us and starvation. About 15 plants have provided most of our food for many generations. There are at least 100 species of great regional or local importance, but only a few major species dominate our food.

Twelve plant families include 68% of the 200 species that are the most important world weeds (Holm, 1978). These weeds share some characteristics including the following:

1. Long seed life in soil,
2. Quick emergence,
3. Ability to survive and prosper under the disturbed conditions of a cropped field,
4. Rapid early growth, and
5. No special environmental requirements for seed germination.

They are also competitive and react similarly to crop cultural practices. Weeds are usually defined only by where they are and how that makes someone feel about them. The fact that they may have shared characteristics means we may be able to define and classify them based on what their genotype enables them to do. Some characteristics that weeds share are discussed in Chapter 8.

Table 3.1 shows 12 families that include 68% of the world's important weed problems. The Poaceae and Cyperaceae account for 27% of the world's weed problems, and when the Asteraceae are added, 43% of the world's worst weeds are included. Nearly half of the world's worst weeds are in only three families, and any two of these include over a quarter of the world's worst weeds. The Poaceae is the family with the most weedy species, yet it includes wheat, rice, barley, millet, oats, rye, corn, sorghum, and sugar cane: all important crops.

About two-thirds of the world's worst weeds are single-season or annual weeds. The rest are perennials in the world's temperate areas, but in the tropics they are accurately called several-season weeds. The categories annual and perennial do not have the same meaning in tropical climates, where growth is not limited by cold weather but may be limited by low rainfall. About two-thirds of the important weeds are broadleaved or dicotyledonous species. Most of the rest are grasses, sedges, or ferns. The United States has about 70% of the world's important weeds, and they are classified in many ways.

Table 3.1
Families of the World's Worst Weeds (Holm, 1978)

Family	Number of species[a]	Percent		
Poaceae	44			
Cyperaceae	12	27%		
Asteraceae	32		43%	
Polygonaceae	8			
Amaranthaceae	7			
Brassicaceae	7			68%
Leguminosae	6			
Convolvulaceae	5			
Euphorbiaceae	5			
Chenopodiaceae	4			
Malvaceae	4			
Solanaceae	3			

[a]47 other families have three species or less.

I. PHYLOGENETIC RELATIONSHIPS

Weeds are classified by taxonomists and weed scientists in the same way all other plants are: based on phylogenetic (Gk. *phylo* = *phulon* = race or tribe plus Gk. *gen* = be born of, become) relationships, or a plant's ancestry. All good identification manuals include a key to the species, and all keys are based on a classification developed over many years and, for plants, brought near its present form by the Swedish botanist Carl von Linné (Linnaeus, 1707–1778) who established the binomial system of nomenclature (Genus + species) that is based, primarily, on floral characteristics, especially the presence, number, and characteristics of stamens and pistils.

Phylogenetic keys to plant species, based on ancestry and ancestral similarity, include division, subdivision, class, family, genus, and species. A brief description of a plant key for weed species follows:

Division I: Pteridophyta

Description Fernlike, mosslike, rushlike, or aquatic plants without true flowers. Reproduce by spores.

Representative families
Salviniaceae
Equisetaceae
Polypodiaceae

Division II: Spermatophyta
Description Plants with true flowers with stamens, pistils, or both. Reproduce by seed containing an embryo.

Subdivision I: Gymnospermae
Description Ovules not in a closed ovary. Trees and shrubs with needle-shaped, linear, or scalelike usually evergreen leaves.

Representative families Pinaceae, Taxaceae.
Almost no weedy species.

Subdivision II: Angiospermae
Description Ovules borne in a closed ovary that matures into a fruit.

Class I: Monocotyledoneae
Description Stems without a central pith or annular layers but with woody fibers. Embryo with a single cotyledon and early leaves always alternate. Flower parts in threes or sixes, never fives. Leaves mostly parallel veined.

Representative families
- Poaceae
- Cyperaceae
- Juncaceae
- Liliaceae
- Commelinaceae

Class II: Dicotyledoneae
Description Stems formed of bark, wood, and pith with the wood between the other two and increasing with annual growth. Leaves net-veined. Embryo with a pair of opposite cotyledons. Flower parts mostly in fours and fives.

Representative families
- Polygonaceae
- Chenopodiaceae
- Convolvulaceae
- Asteraceae
- Solanaceae

All classified plants have a genus and specific name. By convention the genus is always capitalized (e.g., *Amaranthus*) and is commonly written in italics or underlined. The species name is not capitalized.

II. A NOTE ABOUT NAMES

The first question one asks or is asked about a weed is: What is it? The expected and best answer is its name. But what name? Most plants have several names. Each has its own, distinctive scientific name plus one to several common names. Common names vary between languages and between regions that share a language. For example, *Zea mays* is the plant Americans call corn, but the British, and most of the rest of the world's people, call the plant maize or (in Spanish) maíz. In England, wheat and other small grains are known as corn.

Reluctantly, and for the reader's convenience, common names have been used throughout this book. The scientific name for a plant (see Appendices A and B) is the name that is known throughout the world, or, at least, is the name that will clear up the confusion that often occurs when just the common name is used.

Students resist learning scientific names because they are regarded as useless, boring, and perhaps even nonsense words designed to confuse them. The arguments against learning them are manifold. The first defense is that the names are difficult because they are in Latin, which after all is a dead language. Outside of the Roman Catholic Church, few speak it at all, and knowing Latin certainly doesn't score many points with one's peers. Besides, the argument continues, common names are widely accepted and convey real meaning.

Latin is difficult, but difficulty should be dismissed as an objection not worthy of one engaged in higher education. Like most worthy goals, obtaining an education will not be achieved without some effort. Latin is dead, but therein lies its advantage as a medium to name things. A dead language doesn't evolve and assume new forms as daily usage modifies it and introduces variation. The rules are fixed, and while the language can be manipulated, it is not pliable as is a living language (Zimdahl, 1989).

As opposed to common names, scientific names have a universal meaning. Those who know scientific names will be able to verify a plant's identity by reference to standard texts or will immediately know the plant in question when the scientific name is used. Those who do not share the same native language can make use of Latin, an unchanging language, to share information about plants.

Scientific plant names have been derived from a vocabulary that is Latin in form and usually Latin or Greek in origin. Other peculiarities that make scientific nomenclature difficult are the frequent inclusion of personal names, Latinized location names, and words based on other languages. Taxonomists have developed and accepted rules for name creation that provide latitude for imagination and innovation, but not license for their neglect (Zimdahl, 1989).

III. CLASSIFICATION METHODS

Other common, and less systematic classification methods for weeds are based on life history, habitat, morphology, or plant type. Knowledge of classification is important because a plant's ancestry. length of life, the time of year during which it grows and reproduces, and its method or methods of reproduction provide clues about management methods most likely to succeed.

A. Type of Plant

The type of plant or general botanical group is an essential bit of knowledge, but not very useful as a total classification system. It is important that we know whether a weed is a fern or fern ally, sedge (Cyperaceae), grass (monocotyledon), or broadleaved (dicotyledon). One should not even begin to attempt control or try to understand weedy behavior until this information is available. However, when one knows the general classification, other questions about habitat or life cycle must be answered to acquire necessary understanding to control the weed or to create a weed management system.

B. Habitat

1. Cropland

The first, and most important, weedy habitat is cropland, where many annual and perennial weeds occur. Although it is important to know the crop and whether it is agronomic or horticultural, that knowledge is not particularly useful. It tells us where the weed is, but it doesn't tell us much about it. It is not a precise way to classify because there is so much overlap among crops. There are few, if any, weeds that occur exclusively in agronomic or in horticultural crops or in just one crop. Redroot pigweed, velvetleaf, Canada thistle, and quackgrass are commonly associated with agricultural crops. Others such as crabgrass, common mallow, prostrate knotweed, dandelion, and wood sorrel commonly associate with horticultural crops. Each can occur in many different crops and environments.

2. Rangeland

Some weeds are almost exclusively identified with rangeland, a dry, untilled, and extensive environment. Sagebrush and gray rabbitbrush are rarely weeds in corn or front lawns. Only the worst farmer or horticulturalist would create an environment in which these weeds could thrive. Range weeds include those shown in Table 3.2. Although the list is not exhaustive, it shows that rangeland weeds are commonly perennial and include many members of the Asteraceae. There are poisonous weeds such as locoweed and larkspur on rangeland, and many others including thistles (of several species), dandelion, groundsel, buttercup, and vetch, but these also occur in other places.

3. Forests

There are over 580 million acres of forest in the United States, and in addition to common herbaceous annual and perennial weeds, there are others unique to the forest environment. The woody perennials such as alder, aspen, bigleaf maple, chokecherry, cottonwood, oaks and sumac, and the herbaceous perennial bracken fern (common in the acidic soils of Pacific Northwest Douglas fir forests) are unique forest weeds.

Red alder was eliminated by herbicides from Douglas fir forests in the 1970s. Red alder can fix atmospheric nitrogen, and in soils quite deficient in nitrogen, Douglas fir will grow better with than without red alder. In the 1990s, red alder wood increased in value, and some companies now

Table 3.2
Rangeland Weeds

Weed	Life cycle	Family
Big sagebrush	Perennial	Asteraceae
Sand sagebrush	Perennial	Asteraceae
Fringed sagebrush	Perennial	Asteraceae
Broom snakeweed	Perennial	Asteraceae
Gray rabbitbrush	Perennial	Asteraceae
Yucca	Perennial	Liliaceae
Greasewood	Perennial	Chenopodiaceae
Halogeton	Annual	Chenopodiaceae
Mesquite	Perennial	Leguminosae
Locoweed	Perennial or annual	Leguminosae
Larkspur	Perennial	Ranunculaceae

plant it. Some weeds do so well they become crops! Red alder has been the target of biological control with a fungus (Dorworth, 1995).

4. Aquatic

Agriculture is the largest user of fresh water in the world, and crops are sensitive to supply variation. Most of the world's major cities are located on a lake, an ocean coast, or a major river. Water, a finite resource, has been, and will continue to be, essential for urban and agricultural development. Aquatic weeds (Table 3.3) interfere with crop growth because they impede water flow or use water before it arrives in cropped fields. They can interfere with navigation, recreation, and power generation. Free-floating plants (e.g., waterhyacinth) attract attention because their often massive infestations are so obvious. They move with wind and floods and some have stopped river or lake navigation. They float free and never root in soil. Submersed plants (e.g., Hydrilla) complete their life cycle beneath the water. Emersed aquatic weeds (e.g., cattail) grow with their root system anchored in bottom mud and have leaves and stems that float on water or stand above it. They grow in shallow water, but all can impede flow, block boat movement, clog intakes of electric power plants and irrigation systems, and hasten eutrophication.

5. Environmental Weeds

This category includes plants particularly obnoxious to people, such as poison ivy and poison oak, both of which cause itching and swelling for

Table 3.3
Aquatic Weeds

Growth habit	Weed	Life cycle	Family
Free-floating	Waterhyacinth	Perennial	Ponterderiaceae
	Salvinia	Annual/perennial	Salviniaceae
	Waterlettuce	Perennial	Araceae
	Duckweed	Annual	Lemnaceae
Submersed	Hydrilla	Annual/perennial	Hydrocharitaceae
	Elodea, Western	Perennial	Hydrocharitaceae
	Pondweed	Perennial	Potamogetonaceae
	Eurasian watermilfoil	Perennial	Haloragaceae
	Coontail	Perennial	Ceratophyllaceae
Emersed	Cattail	Perennial	Typhaceae
	Alligatorweed	Perennial	Amaranthaceae
	Arrowhead	Perennial	Olismataceae

many people who touch them. Other plants in the environmental group are goldenrod, ragweed, and big sagebrush, primary causes of hay fever.

6. Parasitic Weeds

Parasitic weeds are often placed in other sections in weed science texts. They are here because theirs is a particular and peculiar habitat. Phanerogamic parasites, a word that comes from the Greek *phaneros* = visible and *gamos* = marriage, include more than 3,000 species distributed among 17 families, but only 8 families include important parasitic weeds. The economically important species that damage crop and forest plants are all dicotyledons from five families (Table 3.4) (Sauerborn, 1991). Parasitic weeds from four families will be discussed briefly. Those who want more detailed information are directed to the 1993 book by Parker and Riches.

The Cuscutaceae, dodders, are noxious in all U.S. states except Alaska and are distributed throughout the world's agricultural regions. A mature dodder plant, a true parasite, is a long, fine, yellow branching stem. A single stem of field dodder, one of the most important species, can grow up to 10 cm in one day. It is non-specific regarding hosts and coils and twines on many plants. Dodder is a flowering plant that reproduces by small, sticky seeds. Haustoria penetrate a host's cortex to the cambium and the fine stems dodder (tremble) when the wind blows. Dodder emerges from as deep as 4 feet in soil as a rootless, leafless seedling. The fine, yellow stem, 1 to 3 inches long, emerges as an arch, straightens and slowly rotates in a counterclockwise direction (called circumnutation) until it contacts another plant, which must be within about 1 1/4 inches. Seeds have sufficient resources to search for a host for 4 to 9 days, after which they die (Sauerborn,

Table 3.4
Important Families of Parasitic Weeds

Family	Genera	Species
Cuscutaceae	*Cuscuta*	Dodder
Loranthaceae/Viscaceae	*Loranthus*	Mistletoe
	Arceuthobium	Mistletoe
	Viscum	
Orobanchaceae	*Orobanche*	Broomrape
	Aeginetia	
Schrophulariaceae	*Striga*	Witchweed
	Alectra	

1991). After contact and attachment, the soil connection withers and dodder lives as an obligate stem parasite.

The most important parasite in the Loranthaceae is mistletoe. Mistletoes occur in two families: the Loranthaceae and the Viscaceae. Some taxonomies combine both families in the Loranthaceae. Dwarf mistletoe is a photosynthetic, flowering plant that parasitizes ponderosa pine in the southwestern United States. It occurs on the trunk and branches as a dense tangle of short, brown to yellow-brown stems. Seeds are dispersed by birds or by explosion of seed pods and expulsion of sticky seeds that adhere to adjacent trees. Seeds can travel up to 60 mph over 45 feet. The seeds are usually dispersed in August or early September in the southwestern United States.

Witchweed (*Striga asiatica*) is one of three weedy, hemiparasitic species of the Scrophulariaceae in the world. It is called witchweed because it damages crop plants before it is even visible above ground. There are 35 species of Striga; 23 are found in Africa, and at least 11 parasitize crops (Parker and Riches, 1993). Other most important Striga species are *S. hermonthica,* which parasitizes sorghum, millet, and corn in Africa, and *S. gesnerioides,* the only one that parasitizes dicots, which is important on cowpeas and groundnut in East and West Africa and Asia.

The desert locust (*Schistocerca gregaria*) gains a great deal of publicity when it swarms in Africa, and massive efforts are made to combat it. However over the years and in any one year, *Striga* species causes more crop losses in Africa than the desert locust. The genus has the narrowest host range of the important parasitic weeds and a narrower range of distribution than the dodders. Witchweed is a root parasite on corn, sorghum, and other grasses in Africa, India, and the far East. In the United States it is limited to parts of North and South Carolina. *Striga* species are widely distributed in the world's tropical and subtropical regions. Secretions from corn (and some other grass) roots encourage germination of seed. After parasitization, corn is stunted, yellow, and wilted because of loss of nutrients and water. Many weeds, including crabgrass, serve as alternate hosts. Witchweed seeds are small (about 0.2 by 0.3 mm); 1000 to 1500 seeds, placed end to end, would be only 1 foot long. They survive up to 14 years in soil, and one *S. asiatica* plant can produce up to 58,000 seeds. It parasitizes corn and its 90- to 120-day life cycle is similar to corn's. One corn plant can (but usually does not) support up to 500 witchweed plants. Witchweed seed will not germinate in soil, in the absence of the host-excreted stimulant. But it may be induced to germinate with the artificial stimulant ethylene gas. USDA regulations currently have witchweed under quarantine in North and South Carolina, to prevent its spread throughout the United States. The quarantine has been successful and the area is decreasing.

The Orobanchaceae (from Latin *orobos* = bitter vetch and Latin *anchein* = to strangle) or broomrapes include over 100 species, five of which are important, obligate root holoparasites (lacking all chlorophyll) that attack carrots, broadbeans, tomatoes, sunflowers, red clover, and several other important, small-acreage crops in more than 58 countries (Parker and Riches, 1993; Sauerborn, 1991). The broomrapes have the broadest host range of the parasitic families. They cause major yield losses and often complete crop loss in many developing countries where control is not possible. Broomrape is found in California but is not important in most of the United States. It is important in South and East Europe, West Asia, and North Africa. Seed of some species lives in soil for up to 10 years. One plant can produce up to 200,000 seeds that are as small as Striga seed; 1 gram of seed contains as many as 150,000. Similar to witchweed, germination of Orobanche seed is stimulated by secretions from the host's root or from roots of nonhost plants. Germination will not occur in the absence of host-excreted chemical stimulants. Most damage from root parasites occurs before the parasite emerges, and only 10 to 30% of attached parasites emerge (Sauerborn, 1991).

An important aspect of parasitic weeds is the present inability to manage them with other than sophisticated chemical technology or extended fallow periods. Many of the world's people live in areas where food is scarce and agricultural technology is not sophisticated. These are the same places where parasitic weeds cause the greatest yield losses. Fields have been taken out of production, and production area of some crops has been reduced severely.

C. Life History

Another way to classify weeds is based on their life history. A plant's life history determines what kinds of cropping situations it might be a problem in and what management methods are likely to succeed. All temperate weeds can be categorized as annual, biennial, or perennial. These groups are easy to define and observe and are very useful in temperate zone agriculture. The concept of perennation really is not useful in tropical zone agriculture, where seasons do not change as they do in temperate zones. It is more accurate to refer to short-season and many-season plants in the tropics than to annuals and perennials.

1. Annuals

An annual is a plant that completes its life cycle from seed to seed in less than 1 year or in one growing season. They produce an abundance of seed, grow quickly, and are usually, but not always, easy to control. Summer annuals germinate in spring, grow in summer, flower, and die in fall, and thus go from seed to seed in one growing season. Many common weeds such as common cocklebur, redroot pigweed and other pigweeds, crabgrass, wild buckwheat, and foxtails are annuals. The typical life cycle of an annual weed is shown in Figure 3.1. Weed ecologists are working to quantify many of the steps in this cycle. The sequence of events is qualitatively accurate, but neither rates nor quantities are defined for most annual weeds. For example, it is known that not all seeds produced by a weed survive in soil. Some die from natural causes at an unknown rate. Others suffer predation by soil organisms or enter the soil seedbank where their life may be prolonged by dormancy. Quantitative understanding of the steps in a weed's life is essential to wise management.

Winter annual weeds germinate in fall or early winter and flower and mature seed in spring or early summer the following year. Downy brome, shepherd's-purse, pinnate tansymustard, and flixweed are winter annual weeds. They are particularly troublesome in winter wheat, a fall-seeded crop, and in alfalfa, a perennial.

Some parts of the world (southern European and north-African Mediterranean countries) have a winter rainy season, rarely with snow or subfreezing temperatures. This is followed by a long dry period. Crops are planted in the fall when, or just before, the rains begin. The crops and their weeds

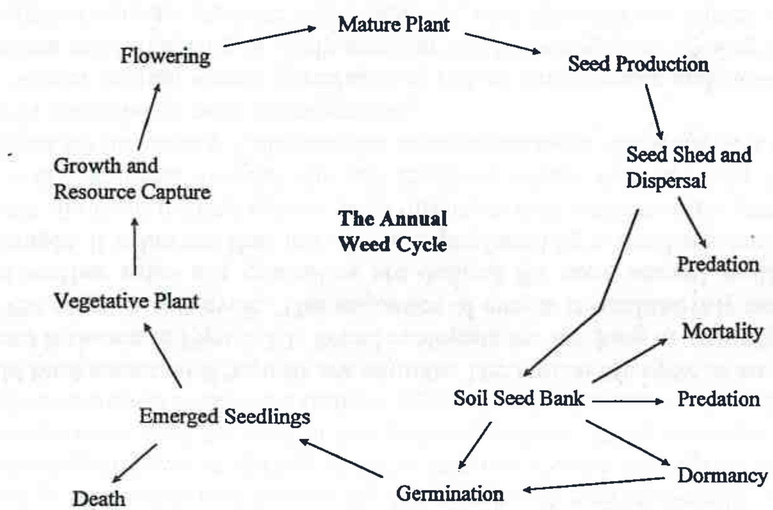

Figure 3.1 Life cycle of an annual weed.

begin to grow with the rain. Because the rains do not begin until late fall, the annual weeds live into the next calendar year and their life cycle fits part of the definition of a winter annual. They are however, best regarded and managed as annuals because their growth is continuous and not interrupted by a cold period when plants live but do not grow.

2. Biennials

Biennials live more than 1, but not over 2 years. They should not be confused with winter annuals, which live during 2 calendar years but not for more than 1 year. Musk thistle, bull thistle, and common mullein are biennials. It is important to know that one is dealing with a biennial rather than a perennial. Spread of a biennial can be prevented by preventing seed production, but this is not true for creeping perennials.

3. Perennials

Perennials are usually divided into two groups—simple and creeping. Simple perennials spread only by seed. If the shoot is injured or cut off, it may regenerate a new plant vegetatively, but the normal mode of reproduction is seed. Simple perennials include dandelion, buckhorn and broadleaf plantain, and curly dock. Creeping perennials reproduce by seed and vegetatively. Vegetative reproductive organs include creeping above-ground stems (stolons), creeping below-ground stems (rhizomes), tubers, aerial bulblets, and bulbs. The life cycle of a typical perennial plant is shown in Figure 3.2. Some of the more important creeping perennials and their mode of vegetative reproduction are shown below:

Canada thistle	Creeping root stocks that give rise to aerial shoots
Johnsongrass and quackgrass	Rhizomes
Field bindweed	Rhizomes
Yellow nutsedge	Rhizomes and tubers
Leafy spurge	Rhizomes
Bermudagrass	Rhizomes and stolons
Russian knapweed	Adventitious shoots from creeping roots

THINGS TO THINK ABOUT

1. How are weed classification systems used?
2. What classification system is most likely to be used by horticulturalists, agronomists, and weed scientists?

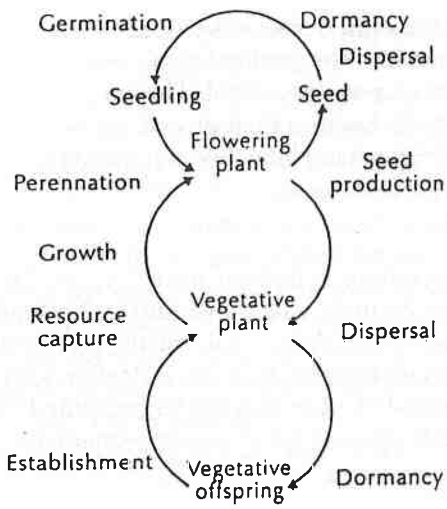

Figure 3.2 Life cycle of a perennial weed that produces seed and vegetative progeny (Grime, 1979).

3. Why are parasitic weeds such difficult problems and where do they exist?
4. If parasitic weeds are not important problems in most developed countries, why do we bother to study them?
5. Why bother to learn the scientific names of plants?
6. How are the scientific names of plants created?

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Chapter 4

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