Design Lessons *from* Mother Nature

Saguaros and mesquite are prominent members of the plant community in the Sonoran Desert. The saguaro's shallow, far-reaching root system and the mesquite's deeper roots allow them to grow in close proximity to each other and share in the desert's meager rainfall.

PLANT LOVERS are usually game to try something new. But how do we know a plant won't need constant weeding and feeding, be deer candy, or, as temperatures soar, wimp out in the heat? Many experts claim that you don't really know how to grow a plant until you've killed it at least three times. If we understand the survival strategies that allow a plant to adapt to conditions in its native habitat, however, we can choose plants that will beat those odds by a long shot. There's more to survival of the fittest than meets the eye, but we can tell a lot just by looking.

EVOLVING DIVERSITY

Plants co-evolved with other plants—along with soil microorganisms, insects, birds, and other wildlife—in response to environmental forces. To survive, each species had to develop ways to make the most of available resources—water, light, nutrients, space, pollinators, etc.—to thrive. And they had to avoid being eaten by something up the food chain, at least long enough to reproduce.

Understanding how plants adapt to their ecosystems can give you an edge when designing your garden.

ARTICLE AND PHOTOGRAPHS
BY KAREN BUSSOLINI

If a trait consistently allows an individual to better survive in its environment and out-reproduce its competitors, offspring with the inherited trait will proliferate, generation after generation. This process of natural selection within species enables organisms to claim specialized niches and develop mutually beneficial relationships with other species.

Subpopulations of a species that evolve genetically distinct, heritable adaptations in response to local conditions are called ecotypes. Redbud trees are a good example of this spectrum of change. In the north, the eastern redbud *(Cercis canadensis)*, is a 15-to 30-foot understory tree of moisture-rich deciduous forests, with large, thin, heart-shaped, matte leaves that soak up the sun. At the hot, dry, southern end of the species' range, drought-tolerant Mexican redbud *(C. canadensis* var. *mexicana)* is short and shrubby with very small, glossy, wavy-edged leaves. Texas redbud *(C. canadensis* var. *texensis)*, adapted to conditions between these extremes, is intermediate in every regard.

THE BIG PICTURE

When you look at a wild landscape, you can see patterns in the vegetation. Plants indicate where the water is; where soil is deeper, richer, or rockier; or where there is some shade. Learning to read the native landscape gives us lessons worth taking home and clues for smart selections of plants from anywhere. The more we emulate the structure, patterns, and plant composition of local natural plant communities, the more successful and sustainable our own yards will be.

In the Sonoran Desert, wide-reaching shallow root systems, covered with hairs that can harvest up to 200 gallons of water in a rainfall, anchor the saguaro cactus. Saguaros *(Carnegiea gigantea)* are 90 percent water and can weigh tons. Water from short, intense desert storms runs off fast, so saguaros slurp it up, store it in their tissues and keep their distance from each other.

Top: The ecosystem of the eastern deciduous forest is made of layers of vegetation, with shorter, more shade-tolerant plants growing under taller, sun-loving trees. Above: In this Utah neighborhood, the owner of the garden in the foreground has taken cues from the desert environment and planted cacti and other succulents instead of the water-hungry turf growing in the yard across the street.

But they grow in close association with mesquite *(Prosopis* spp.), desert ironwood *(Olneya tesota)*, palo verde *(Parkinsonia* spp.), and other shrubs whose roots are

In drought-prone environments, spacing plants widely allows each more equitable access to limited available water. In this garden in Idaho, pools of pineleaf penstemon bloom among cacti and other plants. The penstemon has tiny, pine-needlelike leaves that are adapted to minimize water loss.

able to find deeper underground reserves. These feathery-leafed thorny legumes are nurse plants—their canopies form a protective microhabitat essential for the germination and survival of saguaros and many other plants. They moderate temperatures, add structural diversity, improve soil fertility with their leaf litter, and are crucial to untold complex plant-insect-wildlife interactions.

Between these islands, smaller succulents, grasses, resinous small- or leathery-leafed shrubs, and forbs thin out to reveal patches of seemingly barren soil in less hospitable areas. Ephemeral plants emerge from those bare places after winter rains. Many are annuals. Individual plants germinate, bloom (spectacularly under ideal conditions), set seed, and die; but the species live on, dormant in seed form until sufficient rains return.

This particular ecosystem gives good guidance for landscaping and reducing watering in other hot, dry places. Saguaros are endemic only in the Sonoran Desert, but other big desert succulents—including ocotillo, yuccas, dasylirions, agaves, and cacti—benefit from wide spacing and similar plant associations. Xeric places have lots of diversity but can only support so many plants. The lush look requires water and soil high in organic matter.

The eastern deciduous forest provides a model for sustainable landscaping where trees dominate. With more rainfall, nutrients, and moderate temperatures, plants can grow larger and closer. Forest structure is layered. Tall canopy trees shade understory trees, which shade understory shrubs that top ground layer plants. Canopy trees grab most of the light, so understory plants need to get along with less. Each leafy layer breaks the force of rain, limiting soil erosion and runoff. Each autumn, year after year, leaves fall to earth. This moisture-absorbing leaf layer decomposes, building soil, recycling nutrients that, with the aid of a robust community of macro- and microorganisms, become available to roots of forest plants.

Mature trees shade many neighborhoods across the continent. Yards are all too often carpeted with labor and resource-guzzling lawns, with the middle layers missing. Homeowners who plant regionally appropriate understory trees, shrubs, and ground layer plants can let the layers do the work. Filling all the niches doesn't leave much room—or light—for weeds and reduces the need for mulching; letting leaves decompose in place greatly reduces the need to apply water and fertilizer. Even small trees moderate climate and can foster self-sustaining communities of plants while welcoming wildlife.

LOOKING AT LEAVES

While leaves need to collect sunlight for photosynthesis, many adaptations protect them from sunscald, moisture loss, insects, and other herbivores. Leaf size, shape, color, and arrangement give a lot of clues about where a plant grows. Most desert plants have small leaves. When temperatures soar, the less surface area exposed to sun and drying winds, the more protection from overheating and desiccation. Many fine-leafed pea-family plants, including *Acacia, Cassia, Lespedeza, Dalea* and *Lupinus* species, are adapted to dry areas. Relatives native to more temperate prairies and woodland edges, such as false indigo *(Baptisia australis)*, can afford to have larger leaves.

Even outside the desert, small leaves are usually a good indication of relative heat and/or drought tolerance and/or need for well-drained soils. If you compare narrow-leafed mountain mint *(Pycnanthemum tenuifolium*), a perennial found in fairly dry, upland soils from Maine to Texas, with wider-leafed *P. muticum*, a meadow-dweller, it's not hard to guess which one to plant in fertile moist garden soils and which would favor a dry spot with good drainage. The same goes for fine-textured pineleaf milkweed *(Asclepias linaria)* as compared with swamp milkweed *(A. incarnata)*, which has more substantial leaves.

During the growing season, water-rich landscapes are overwhelmingly green, but dry places have a more muted palette. The coloration of grayish and silvery-looking plants comes from protective adaptations that give leaves a shimmering, ghostly look. These plants thrive in forbidding conditions—deserts, windswept plains and rocky cliffs, salt-sprayed coastlines, and frigid mountaintops—because they evolved in response to these challenging environments by becoming silver.

Downy silver leaves are covered with fine, light-colored hairs that shade otherwise green leaves and/or stems. These hairs reflect

In deciduous forests, understory plants have adapted to maximize their access to sunlight on the shady forest floor. The layered leaf arrangement of maidenhair fern, top, allows light to fall on its lower branches; Canada ginger, bottom, has large dark leaves held horizontally to soak up light.

Resources

Botany for Gardeners by Brian Capon. Timber Press, Portland, OR, 2010.
Ecology for Gardeners by Steven B. Carroll and Steven D. Salt. Timber Press, Portland, OR, 2004.
Plant Survival by Brian Capon. Timber Press, Portland, OR, 2009.

The contrasting leaf shapes of swamp milkweed, above left, and pineleaf milkweed, above right, reflect their adaptations to very different regional climate conditions—one being temperate and moist while the other is hot with strong sun and extended periods of drought.

sunlight and cool the leaf, keeping moisture close to its surface—and have little appeal to leaf-munching animals. Tender silver ponyfoot *(Dichondra argentea)* makes an incandescent creeping groundcover in warmer parts of Texas to New Mexico. Sand sage *(Artemesia filifolia)* found on dunes and sandy soil in Texas through Wyoming, withstands extremes of heat, cold, and wind, yet tolerates decent garden soil. Drive across the open high plains on a moonlit night where prairie sagebrush *(A. frigida)* or Great Basin sage *(A. tridentata)* dominate and the entire landscape glows silver.

Some downy silvers have the coloration but not the fuzzy appearance. Quaking aspen *(Populus tremuloides)*, whose leaves flicker silver when the wind reveals their undersides, and epiphytic "air plants" such as Spanish moss and ball moss *(Tillandsia* spp.) have scales comprised of collapsed hairs.

Other silvers are covered with a waxy layer, something like the bloom on a plum, or a mealy coating. Rub the needles of a blue spruce *(Picea pungens* var. *glauca)*, from cold, windy mountainous regions, or leaves of the prairie plant known as rattlesnake master *(Eryngium yuccifolium)*, or *Agave parryi*, a desert-dweller, and the coating comes right off, revealing a green leaf. Like the hairs on downy silvers, these coatings protect the leaf from extremes of heat, cold, drought, wind, salt spray, and sun. And like them, they're only as silver as they need to be. Intensity of color indicates amount of protection; more benign locations or times of year don't compel the plant to expend energy protecting itself.

Plants from this blue end of the silver spectrum blend right into dry landscapes and provide lovely color accents in greener gardens. The silvery-blue-hued grasses such as widely distributed little bluestem *(Schizachyrium scoparium)* and blue fescue *(Festuca idahoensis)*, a western cool-season bunchgrass, are especially valuable in low-water gardens. Several intensely blue selections of native grasses are popular. These include little bluestem cultivars 'The Blues' and 'Standing Ovation', blue fescue selections like 'Siskiyou Blue', and switchgrasses *(Panicum virgatum)* 'Heavy Metal' and 'Prairie Sky'.

Downy silver hairs protect the green leaves of *Artemisia stelleriana* from intense sun and other inhospitable conditions, such as those found on this windswept Nantucket sand dune.

In the woodland, some plants that emerge before overhead trees leaf out, or grow on exposed woodland edges or rocky outcrops, benefit from silvery variegation. Populations of alumroots *(Heuchera* spp.) can be variably mottled in silver and gray. Native gingers may display beautiful silvery veining patterns. Noteworthy selections of southeastern *Hexastylis* species, commonly sold as *Asarum shuttleworthii* var. *shuttleworthii* 'Carolina Silver', *A. arifolia* 'Silver Spreader', and *A. lewisii* 'Carolina Carpet', will light up a woodland garden.

Light is the key limiting factor for understory plants. Leaves under those sun-hogging canopy trees must take up the sun's energy early, develop enhanced light-gathering ability or make do with less. Thinner, broader leaves collect more light for photosynthesis. Leaves of the striped maple *(Acer pensylvanicum)*, a small understory tree of cool moist woods throughout the East, are almost twice as big (and less glossy) as those of sugar maples overhead. Shadblow *(Amelanchier* spp.) trees bloom and leaf out early, before canopy trees cast their shade. Dark-needled hemlocks *(Tsuga canadensis, T. caroliniana)*, require a tiny fraction of the light needed by other trees. The broad leaves of evergreen rhododendrons *(Rhododendron* spp.) and mountain laurels *(Kalmia latifolia)* capture the sun's energy year round.

On the forest floor, the amount and the wavelengths of light change as the canopy closes in. Many plants arrange their leaves flat to the sun for maximum benefit. Others utilize normally unusable parts of the light spectrum or respond to changes in light by initiating or suspending growth.

DORMANCY–TIMING IS EVERYTHING

In the plant world, the balance between investing energy in growth or protection tips toward protection in resource-poor environments. When the going gets too tough for growing, some plants go dormant, temporarily suspending active growth to conserve energy.

Bulbs, corms, rhizomes, and tubers are swollen underground organs that allow a plant to store water and nutrients and wait out seasons of drought, excessive heat or cold. Seeds are semi-dormant embryonic plants programmed to germinate when conditions are favorable. A seed that is fooled by a sprinkle of rain in the desert or one warm winter day is unlikely to survive.

Deciduous plants that drop their leaves in fall are slowing down to weather low temperatures and light. Palo verde defoliates during extended drought instead, continuing photosynthesis in green bark on trunk and branches. Ocotillo *(Fouquieria splendens)* is a woody succulent with vicious thorns and no apparent leaves—until it rains, when clusters of small oval leaves can emerge from dormant buds within 48 hours of a downpour.

Woodland spring ephemerals are actually long-lived, colony-forming perennials. They emerge and bloom early, quickly collect and store a season's energy in roots or bulbs, then go dormant, to be succeeded by ground-layer plants that require less light. *Erythronium* species, commonly known as trout lilies, adder's tongue or dogtooth violets, are a sure sign of spring. Colonies of Virginia bluebells *(Mertensia virginica)* turn moist woods and forested floodplains throughout the east and Midwest into a sea of blue with clusters of bell-shaped flowers. They're a welcome sight in the spring garden, where they enthusiastically self-sow, but not so pretty when foliage dies back unless followed by plants tall enough to cover the mess. Virginia bluebells are ideal for naturalizing in shady damp areas with ostrich ferns *(Matteuccia strupthiopteris)*, which emerge as bluebells go dormant and benefit from the mulch of dead foliage.

In woodland gardens, early spring is a key time for understory plants like spicebush *(Lindera benzoin)*, center, and ramps *(Allium tricoccum)*, foreground, to shine before canopy trees leaf out.

We can learn much by observing natural landscapes, even at 60 mph from our cars. But better yet, take a closer look on a leisurely hike or visit a botanical garden or nature center to get a feel for the characteristics of the plants that live there. With an educated eye, we'll recognize—and plant—survivors when we see them.

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