RIGHT: **Figure 1.** A stand of Koa reaching for sunlight in the forest canopy.

ABOVE: **Figure 2.** A *Pritchardia* palm, an integral part of Pacific Island landscape.

Photos: J. B. Friday, Extension Forester, University of Hawaii Cooperative Extension Service.

DO YOU BELIEVE IN PALM TREES?

BY KEVIN T. SMITH

Palms are real, but are they really trees? The answer depends on definitions. As usually tall, perennial plants with roots, stems, and leaves, palms seem to qualify. Palms should also qualify because arborists care for them, and arborists care for trees, right? My introduction to botany class defined trees as plants that produce wood. Unraveling the question of whether palms are trees helps explain how the diverse plants in our landscape develop and thrive.

Whether a green plant is a single-celled alga, a stately Koa (Figure 1), or a native palm (Figure 2), each plant cell has a cell wall and at least some of those plant cells contain the biological processes to convert solar energy into the chemical energy of the chemical bonds of sugar. That sugar is then used either as fuel or as a feedstock for the biosynthesis of many different organic compounds in the plant.

In current botanical thinking, a small multi-celled fresh-water green alga was the forerunner of today's green landscape plants that include palms and trees. As green plants colonized the land, the ability to resist drying and to compete for sunlight granted a big advantage. Plants that were just a little bit taller were able to escape the shade of their neighbors and to acquire more energy for further growth. Mosses were more sophisticated than algae and concentrated their cells capable of division and growth into specific regions or *meristems* at the apex or tip of the shoot. *Primary growth* or tip growth is produced by the apical meristem. Even with an *apical meristem* for height growth, exploitation of sunlight is limited because the moss cells need to be close to a continuous source of moisture.

Ferns are less limited in height growth because of a specialized plumbing or *vascular system* that contains *xylem* and *phloem*. Xylem

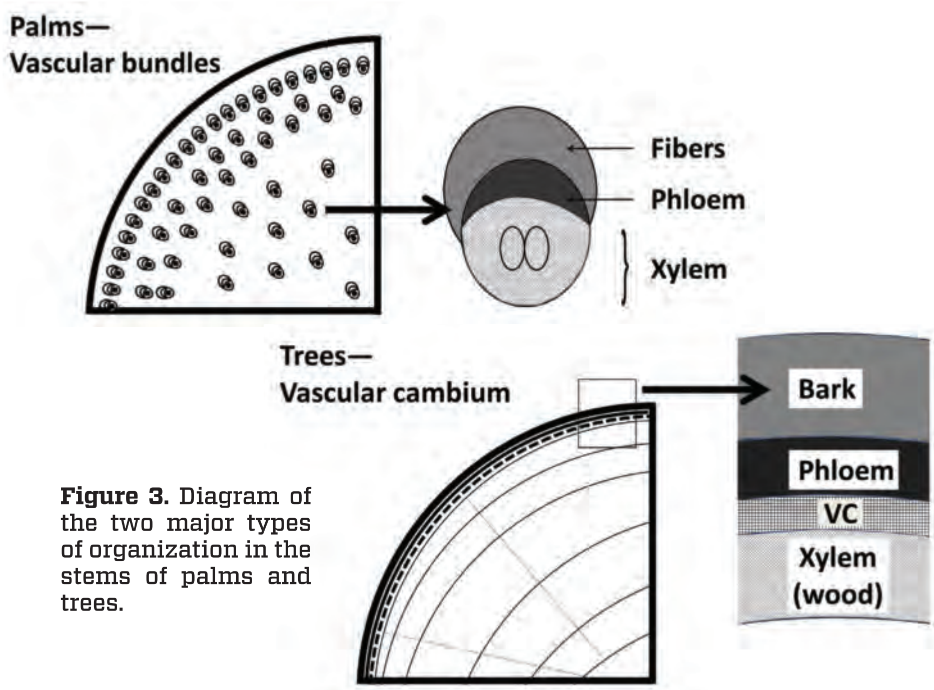

Figure 3. Diagram of the two major types of organization in the stems of palms and trees.

consists of various types of cells including thick-walled piping that at maturity contains no living contents but can efficiently conduct water and dissolved mineral elements. Phloem also consists of several types of cells including those cells with living contents that carry sugar and other biomolecules from where they are formed to where they are needed within the plant. The natural selection of traits including the details of the vascular system results in different organizational plans for cells among groups of plants. Given the advantage of a vascular system to grow up and away from moist surfaces, the challenge remains as to how to have the structural strength to stand tall.

As so often in nature, there is more than one way to grow tall! Seed plants hit on two major strategies, one for both conifers and broad-leaved "dicots" (softwood and hardwood trees) and another one for the "monocots" (e.g., palms, grasses) (Figure 3). The perennial dicots produce a second type of meristem, the *vascular cambium* (VC), a few millimeters to a few inches below the apical meristem, beneath the bark, and extending over all of the woody parts of the plant. The VC is a distinct tissue of dividing cells that produces a layer of phloem to the outside of the woody stem and xylem which adds to the woody stem. When mature, this *secondary xylem* is *wood*. The seasonal layers of mature xylem produced by the VC appear as the annual rings for trees in the temperate zone and provide for the increased girth of trees. For tropical trees, rings may not be visible although wood production is still usually periodic rather than continuous. This strategy of wood production occurs across the broad range of conifer and dicot plant families. The thick-walled piping allows the trees to grow tall, avoid shade, and chase the sunlight. The formation of new wood around the stem circumference enables the tree to be self-supporting, even if the interior core of the trunk decays away. Of course, there are limits to how much a tree can decay before structural failure occurs!

Just as successful in subtropical and tropical settings is the strategy for monocots including palms. Unlike dicots with a VC and distinct, continuous layers of xylem and phloem, perennial monocots have discrete vascular bundles of xylem and phloem as well as strong fibers that are highly resistant to tearing (Figure 3). The monocot vascular bundles develop within a cellular matrix or *ground tissue* that is produced by a broad apical meristem, usually nestled in and protected by the foliage. That meristem is the "heart of palm" used in cooking. Each palm stem has only one apical meristem and unlike dicots, they cannot form a new one if the apical meristem is injured. Unlike dicot trees, when the apical meristem of a palm dies, the stem dies as well.

Based on a single basic plan of root initiation near the base of the stem, palms show a great variety of root tissues and form. The distinctive root characteristics are used by experts to identify family and species relationships in palms. Because palm roots live an average of three years, injury to the root initiation zone can impair palm health and may lead to structural failure.

New leaves or fronds produced from the top of the monocot stem are connected with vascular bundles, resulting in a greater frequency of vascular bundles towards the outer circumference of the palm stem. These vascular connections are essential to move water, essential elements, sugar, and other organic compounds through the plant. There is no organized vascular cambium or secondary growth in palms. Rather, there is sustained, diffuse primary growth accompanied by continued lignification of the ground tissue near the base of the stem. Recent research indicates

Photo: Carol Kwan

Glossary:

Perennial—a plant that in nature lives for more than two years

Biosynthesis—the work of cells to produce complex chemical from simpler starting materials

Apical—refers to the growing tip of roots and shoots

Meristem—unspecialized plant cells that divide to form new cells

Vascular system—specialized cells to transport water and nutrients

Xylem—specialized "plumbing" cells that transport primarily water and dissolved minerals

Phloem—specialized "plumbing" cells that transport primarily sugar and other organic materials

Dicots—flowering plants with two embryonic leaves in the seed including magnolias, legumes, and roses

Monocots—flowering plants with one embryonic leaf in the seed including palms, lilies, and orchids

Vascular cambium—the meristem beneath the bark of woody dicots that encircles the roots, stems, and, branches

Ground tissue—the cellular matrix formed by the apical meristem

Vascular bundle—discrete assemblies of xylem, phloem, and fibers

Lignification—a complex chemical compound that strengthen cell walls of both monocots and dicots

Petioles—the "leaf stem" which in palms is inserted into the leaf or frond sheath that encircles the stem

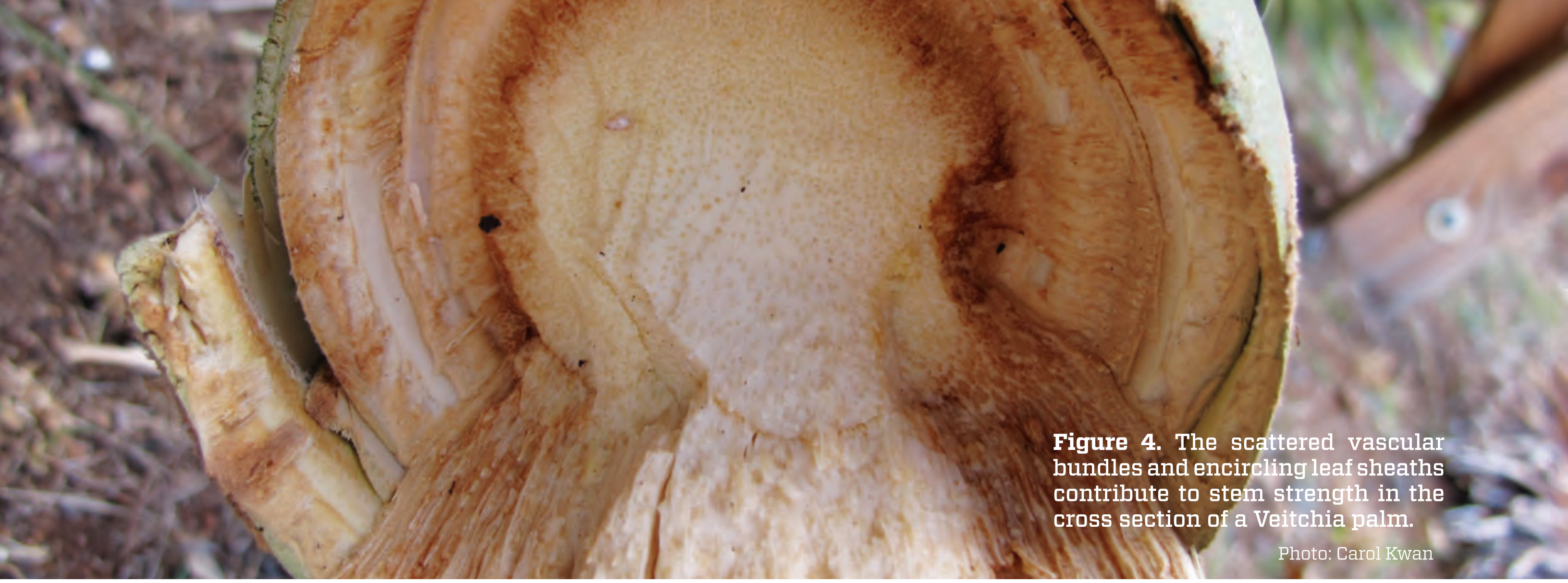

Figure 4. The scattered vascular bundles and encircling leaf sheaths contribute to stem strength in the cross section of a Veitchia palm.

Photo: Carol Kwan

that the bending strength of palm stems is enhanced by having the vascular bundles, including those tough fibers, distributed throughout the palm cross-section. Also, palm stems are strengthened by the crisscrossing and encircling sheaths at the base or petioles of the palm fronds, even when the blade of the frond has long been shed (Figure 4).

Whether or not we consider palms as trees may best be left as a personal choice. I'm going with my old botany class. Trees have a vascular cambium which produces wood, both of which are absent in palms. However, palms share a rich biological heritage with other green plants, and contribute greatly to the beauty and ecology of tropical landscapes.

For more information, please see:

Evert, R. F. (2006). *Esau's Plant Anatomy*. Hoboken, New Jersey: John Wiley & Sons, Inc.

James, K. R., Haritos, N., Ades, P. K. (2006). Mechanical stability of trees under dynamic loads. *American Journal of Botany*, 93, 1522-1530.

Niklas, K. J. (1992). Plant Biomechanics. Chicago, Illinois: University of Chicago Press.

Tomlinson, P. B., Horn, J. W., Fisher, J. B. (2011). *The Anatomy of Palms*. New York, New York: Oxford University Press.

Dr. Kevin T. Smith, *plant physiologist for the Northern Research Station, USDA Forest Service, has published more than 90 journal articles and book chapters on tree biology from his base in Durham, New Hampshire.*

Interested in learning more from ***Kevin Smith****? Attend one of his Tree Biology workshops in Hawaii. The workshop will be offered in Honolulu on Wednesday, February 20, 2013, at the McCoy Pavilion and in Kona on Friday, February 22, 2013, at the Imin Center in Holualoa. These workshops will be co-hosted by Western Chapter International Society of Arboriculture, Aloha Arborist Association, Hawaii Island Landscape Association, and the University of Hawaii Cooperative Extension Service. For more information and for registration, please visit www.wcisa.net.*