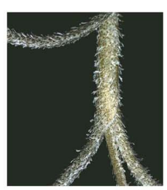
PLANT ADAPTATION UP CLOSE

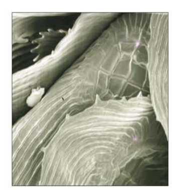
A Biological and Artistic Interpretation

THE BOTANIC GARDEN OF SMITH COLLEGE

Earth's diverse environments create challenges for plant survival. Special adaptations allow some plants to thrive in conditions that are unsuited for most. This exhibit highlights several of these adaptations. As we look closer, and closer, and closer, they are revealed as marvelous works of art.







PLANT ADAPTATION UP CLOSE

A Biological and Artistic Interpretation

THE BOTANIC GARDEN OF SMITH COLLEGE

SCRIPT
Michael Marcotrigiano, Director, Botanic Garden of Smith College

PRODUCTION
Madelaine Zadik, Manager of Education and Outreach
Botanic Garden of Smith College

EDITORS
Madelaine Zadik, Botanic Garden of Smith College
Connie Parks, Free-lance editor

ENHANCED ELECTRON MICROGRAPHS
Joan Wiener, Artist

ELECTRON MICROSCOPY SUPPORT
Judith Wopereis, Microscopy Facility Manager, Smith College

3-D IMAGES
Joan Wiener, Artist
Judith Wopereis, Microscopy Facility Manager, Smith College

LIVING PLANT PHOTOGRAPHY
Madelaine Zadik, Botanic Garden of Smith College
Michael Marcotrigiano, Botanic Garden of Smith College
Judith Wopereis, Microscopy Facility Manager, Smith College
Joan Wiener, Artist
Dan Nickrent, Department of Plant Biology,
Southern Illinois University at Carbondale
Rafflesia arnoldii, stinking corpse lily
J.S. Peterson, USDA-NRCS PLANTS Database
Tillandsia usneoides, Spanish moss
Fred Baker, Utah State University, www.forestryimages.org
Phoradendron pauciflorum, mistletoe

COMPUTER SLIDE SHOW AND DISPLAY CASE
Judith Wopereis, Microscopy Facility Manager, Smith College
Richard Briggs, Director of Microscopy Facility, Smith College

CONSULTING
Richard Briggs, Professor and Director of Microscopy Facility,
Department of Biological Sciences, Smith College
Carolyn Wetzel, Assistant Professor,
Department of Biological Sciences, Smith College

DESIGN
Lisa Carta, Northampton, Massachusetts

LIVING PLANT CARE
Rob Nicholson, Steve Sojowski, Nate Saxe,
Botanic Garden of Smith College

PLANT DONATIONS
Black Jungle Terrarium Supply, Greenfield, Massachusetts
Atlanta Botanical Garden, Atlanta, Georgia
Frank Caruso, University of Massachusetts
Cranberry Experiment Station, East Wareham, Massachusetts

FILM DONATION
Polaroid

MICROSCOPY AND IMAGING FACILITY
Department of Biological Sciences, Smith College
Clark Science Center, Smith College

Drifters

Floating aquatic plants have structural adaptations that prevent them from sinking. By staying afloat they are able to absorb maximum sunlight and can easily exchange gases with the atmosphere. In addition, floating plants may heavily shade the water below, reducing the number of submersed species that compete with them for nutrients.

Salvinia minima, water fern

Salvinia is a genus of free-floating **water ferns**. Their fronds (leaves) stay afloat because they have wettable hairs on the underside and water-resistant hairs on the top side. *Salvinia minima* is rootless—highly modified, submersed fronds look like and function as clumps of roots.

Water-resistant hairs of water fern frond

Swollen petioles of water hyacinth

Water hyacinth, *Eichhornia crassipes*, floats because its inflated leaf petioles have air-filled tissue called aerenchyma. They are so buoyant that waves from nearby boats cannot sink them. Native to the Amazon basin, water hyacinth is a rapidly growing species that becomes invasive when introduced into waterways in warm climates.

Large platters of Victoria water lily

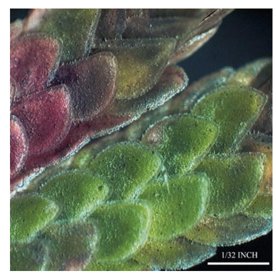
Victoria water lily, *Victoria amazonica,* is the world's largest water lily, with leaves often six feet across. Native to Brazil, the species is a favorite of botanical gardens because of its impressive size. Its flat leaves, called pads or platters, turn up at the edge to prevent surface water from getting on top of the leaf, yet are notched in two places to drain rainwater. The flat bottom allows the leaf to take advantage of surface tension to stay afloat.

Guzzlers

Drought-tolerant plants have adaptations enabling them to live in dry environments. Such adaptations are essential since plants are composed mostly of water. One adaptation is to store water in enlarged organs. Another is to prevent water loss from the leaves or stems. Some plants cease growth or drop their leaves during dry periods.

Resurrection plant after rain

Resurrection plant, *Selaginella lepidophylla*, evolved long before flowering plants. During drought it becomes dry, turns brown, and rolls inward to survive. It can remain dormant for decades, looking dead. After a rain, however, it absorbs water, restores chlorophyll to its leaves, and grows rapidly.



Close-up of leaves of resurrection plant

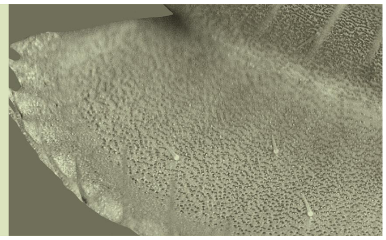
Tuberous root of elephant's foot

Dioscorea elephantipes, a South African yam known as **elephant's foot**, is one of many plants that have a large water storage organ. The leafy, green vine grows out of the yam during the rainy season. Upon drought, the stems die back and the leaves drop off, leaving the corky, brown, tuberous root that conserves food and water for the next growing cycle.

Spiny stem of *Echinocactus grandis*

The basic shape of many cacti is cylindrical or spherical. This gives them a large internal volume where they store water, and reduces the surface area through which they lose water. The absence of leaves and the presence of a waxy surface also enhance water conservation. *Echinocactus grandis*, a **barrel cactus**, is typical of most cacti. The ribbed stem permits an accordion-like expansion when water is available.

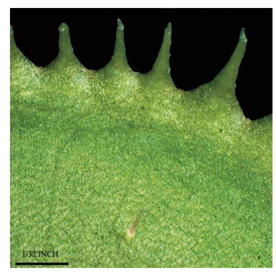
Meat Eaters



Carnivorous plants are adapted to soils that are low in nitrogen, an element that is critical for plants to synthesize protein. Their protein needs are met by consuming insects or in rare cases small animals. Various adaptations have evolved to lure, capture, and digest prey.

Venus flytrap

Venus flytrap, *Dionaea muscipula*, lures insects into colorful, nectar-containing traps, which are remarkable modified leaves. The traps have three trigger hairs on each side, which when touched cause the trap to close suddenly. Interlocking teeth along the edge prevent escape, while digestive fluids break down all but the insect's exoskeleton. Flytraps are native to a very limited region within 100 miles of Wilmington, North Carolina.



Trigger hair inside flytrap and teeth along the trap's edge

American pitcher plant

Species of **pitcher plants** grow in both temperate and tropical zones. Leaves of the American pitcher, *Sarracenia purpurea,* are modified into tubes that attract insects with color and nectar. Prey fall into the tube and are prevented from climbing out by the pitcher's downward-facing hairs. The breakdown of the dead insects provides nutrients to the pitcher plant.

Sticky droplets atop glandular hairs on sundew leaves

Sundews, *Drosera* species, are the most diverse group of carnivorous plants and are found on all continents. Their leaf surface is covered with stalked glandular hairs that look like tentacles. The glands exude sticky droplets, which appear as nectar to insects but are instead a gluelike substance. Once an insect is stuck, the stalked hairs slowly bend over and release enzymes that digest the insect.

Social Climbers

Vines are well adapted to compete with trees and shrubs for sunlight. Rather than having evolved to survive in a shaded understory, vines climb over other plants and objects to position themselves where they receive more sun. Several diverse climbing mechanisms have evolved.

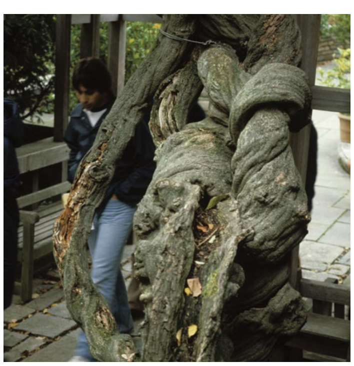
Boston ivy climbing a wall

Boston ivy, *Parthenocissus tricuspidata,* has a unique climbing adaptation. Its disk-tipped tendrils are actually modified leaves. The disks secrete an adhesive substance, allowing the plant to cling to sheer surfaces such as rock cliffs (or Ivy League buildings), an ecological niche not available to most vines.

Disk-tipped tendrils of Boston ivy

Poison ivy adhering to a tree trunk

Poison ivy, *Toxicodendron radicans*, a vining member of the sumac family, is notorious for causing dermatitis. It is well adapted for climbing trees by attaching the hairy rootlets that emerge from its stem to the tree's bark. Climbing into the tree canopy, nearer birds, provides an added bonus since birds eat the fruit and spread the seeds over great distances.



Twining stem of Chinese wisteria

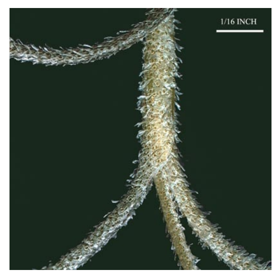
Chinese wisteria, *Wisteria sinensis*, a member of the legume family, is one of many vines that wraps its stems around living or inanimate objects. The vine, which may live over 50 years, can reach enormous proportions and eventually overwhelm its support. Oddly, different vine species consistently wrap either clockwise or counterclockwise; *Wisteria sinensis* twines counterclockwise.

Squatters

Epiphytes are nonparasitic plants that have adapted to grow upon or attach to other living plants without ever having roots in the soil. Positioned in the trees and on cliffs, they escape predation from ground-dwelling animals and receive more light than plants on the forest floor.

Spanish moss hangs on oak, photograph by J.S. Peterson

Spanish moss, *Tillandsia usneoides*, is not a moss at all, but rather a relative of the pineapple plant. Epidermal leaf scales absorb water directly from the atmosphere, a necessary adaptation since Spanish moss is rootless. Nutrients are obtained from mineral-rich water dripping onto it from the trees that above.



Spanish moss leaves with scale

Orchid roots clinging to tree bark

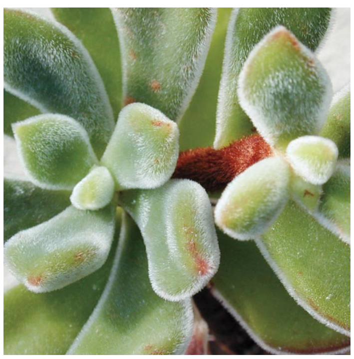
Epiphytic orchids are adapted to clinging to the bark of trees. Their specialized roots are covered with spongy tissue called velamen that has an amazing adhering capacity. In addition, the roots absorb water and nutrients from rain and runoff from the canopy above.

Two types of fronds of staghorn fern

Staghorn ferns, *Platycerium* species, hang from cliffs and trees, anchored by a fine root system that works its way into cracks and crevices in bark. The fern develops two types of fronds (leaves). Cup-shaped fronds curve upward, catching organic debris, which then decays into a rich growing medium. The antler-like fronds capture sunlight and with time may produce reproductive spores.

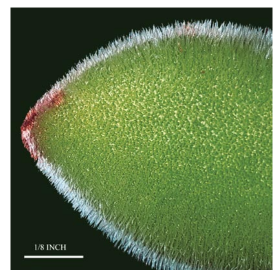
Sunbathers

Desert plants are adapted to living in intense heat and sun. While sunlight is needed for plants to make their own food (carbohydrate), the powerful sun can damage a plant's chlorophyll or DNA. Many plants have adapted by deflecting or blocking sunlight, while a few orient their leaves away from direct sunlight.



Hairy leaves of Mexican plush plant

In climates with intense sunlight, many species have adapted by developing dense leaf hairs that block out some light. This **Mexican plush plant**, *Echeveria pulvinata*, glimmers as countless epidermal hairs deflect light away from its leaf surface.



Leaf hairs of Mexican plush plant

Peruvian old man cactus

Several cacti, affectionately called old men cacti, have taken their "hair" to new limits. Waves of silvery hairs, which are highly modified leaves, give these plants an amusing adornment that blocks some of the intense sun. This one is the **Peruvian old man cactus**, *Espostoa lanata*.

Vertical leaf senecio

The leaf orientation of the **vertical leaf senecio**, *Senecio crassissimus*, is an adaptation that minimizes direct sunlight from striking the leaf surface. The indirect light they receive is more than adequate for growth. While protected from the sun's damaging rays, the leaves stay cooler in the hot Madagascar sun.

Vegetarians

Parasitic plants are adapted to live off the hard work of other plants. Using specialized structures they invade the tissue of the host plant, extracting food, minerals and water. While they injure their hosts, they rarely kill them. There are over 3,000 parasitic plant species worldwide, most of which have a narrow range of host species.

Dodder, *Cuscuta gronovii*, producing flowers and fruit

The stem of **dodder**, *Cuscuta* species, slowly circles around searching for a nearby host. If it encounters a suitable one, it coils around the host and produces small appendages on its stem, which are modified roots called haustoria. The haustoria penetrate the host plant and extract food. Mature dodder plants look like yellow-orange spaghetti, with little or no chlorophyll. They flower but remain leafless.

Dodder haustoria penetrating coleus leaf

Fir mistletoe, photograph by Fred Baker

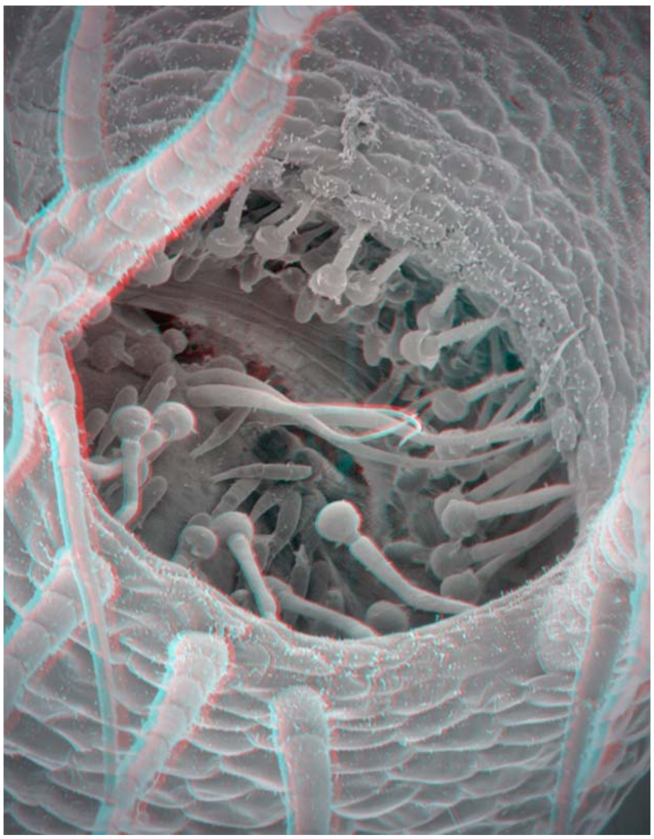
Traditionally used for holiday decoration, **mistletoes** are plant parasites. Mistletoe seeds germinate on a host tree and their modified roots penetrate into the wood. Since mistletoes have green leaves and stems, they produce a small amount of their own food. In this photograph, fir mistletoe, *Phoradendron pauciflorum,* parasitizes white fir, *Abies concolor*.

Flower of stinking corpse lily, photograph by Dan Nickrent

All *Rafflesia* species are parasites, producing no leaves, stems, or roots. They exist as living filaments within the tissues of the host plant. The only visible part to emerge from the host is the occasional spectacular flower. *Rafflesia arnoldii,* the **stinking corpse lily**, produces the largest flower of any plant. Most *Rafflesia* species are endangered, native to highly threatened habitats in Southeast Asia.

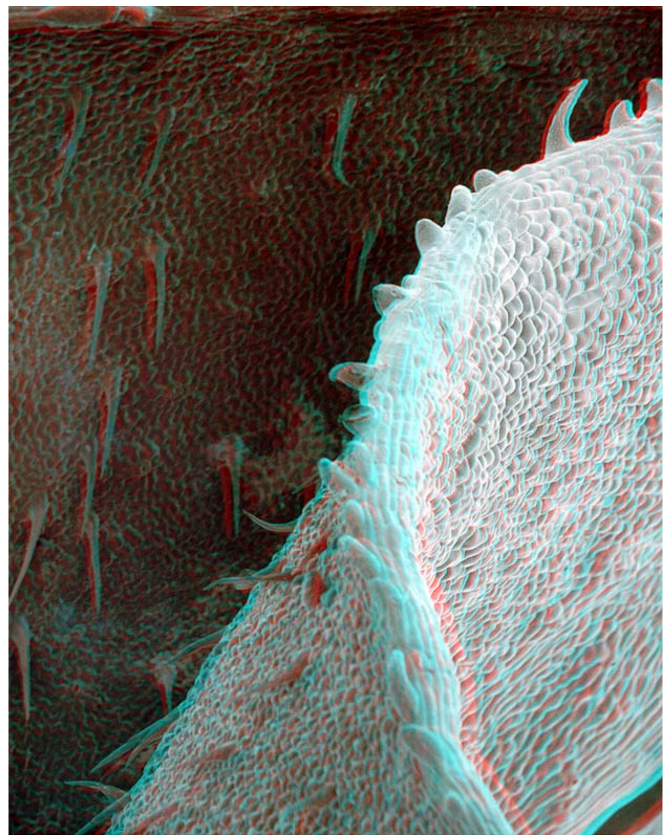
3-D PANELS

(viewed in the exhibition with 3-D glasses)



Bladderwort

Utricularia inflata



American pitcher plant

Sarracenia purpurea

Joan Wiener

Photographer

I have always felt that science and art speak the same language.

Perhaps being the daughter of an artist and a doctor helped me to avoid the artificial separation of two confluent worlds. It is with this premise that I approach my work.

My medium is photomicroscopy—photography using the microscope as the lens. I use both a light microscope and a scanning electron microscope. I begin by obtaining and preparing specimens, a lengthy process. Each picture is shot with a photographic device attached to the microscope. The transparency is then scanned into my computer where I digitally explore and enhance the image. All prints for this show were made on fine art paper using a giclée printer.

Why do I do this kind of work? I can't fully explain. However, there are some things I know for sure:

I love how the boundaries of art and science merge.

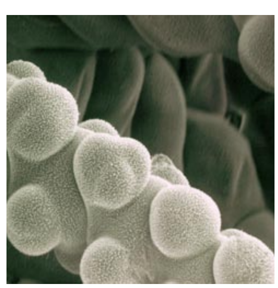
Seeing things on a microscopic level is endlessly fascinating to me.

I hope to convey some of the beauty, intricacy and mystery of what I see and imagine.

Working with the staff at the Botanic Garden and the Microscopy Facility at Smith College has been a pleasure.

Enjoy the show.

Joan Wiener
joanwiener@yahoo.com



The framed prints in the exhibition may be purchased. Please ask for a price list.

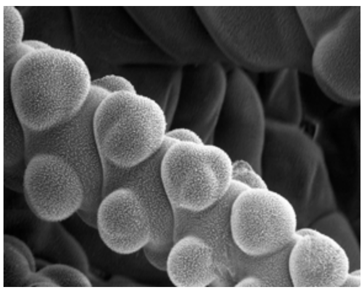
Digitally Colorized Electron Photomicorographs

By Joan Wiener
joanwiener@yahoo.com   413-584-3983   www.joanwiener.com

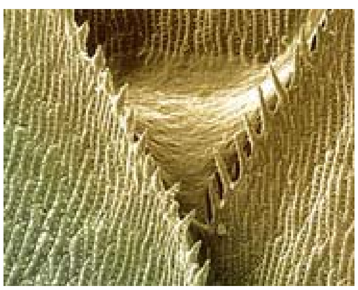
Framed pieces are part of the exhibition. Borrowing institutions may sell unframed prints through their gift shops according to the pricelist below, through arrangements with the artist. Please note, sizes are in inches and the framed prints in the exhibition will be slightly larger since the sizes listed here are of matted, unframed prints.

- Prices are for matted unframed prints
- Prints made on Somerset Velvet paper using an Iris printer with archival inks
- Limed edition prints available in other sizes
- Framing available — contact Joan Wiener
- % of sales go to hosting institution

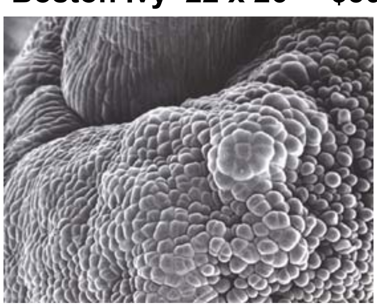
Salvinia 28 x 33 $350



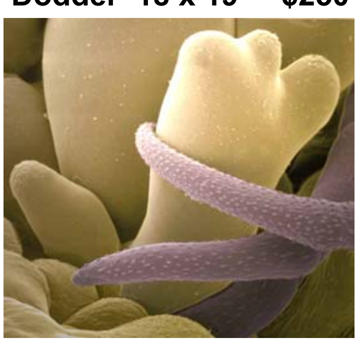
Resurrection 24 x 29 $300



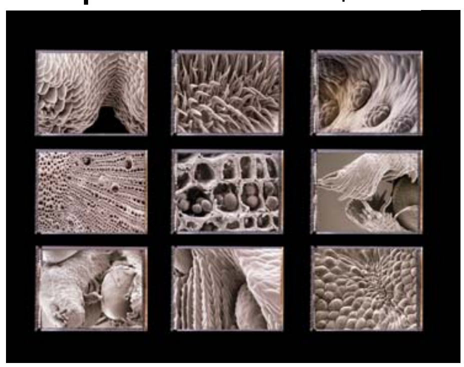
Boston Ivy 22 x 26 $300



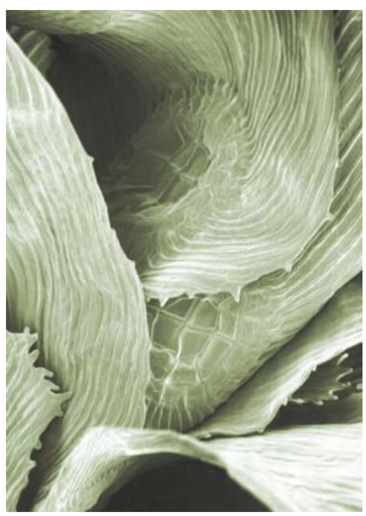
Dodder 18 x 19 $250



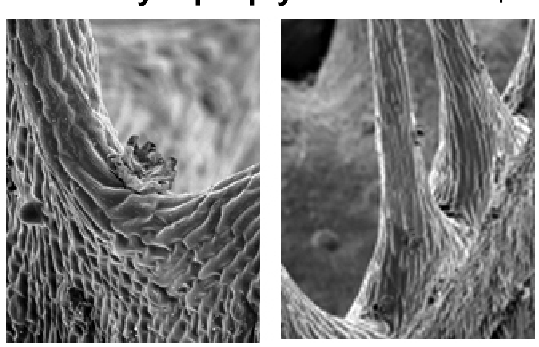
Composite 26 x 32 $325



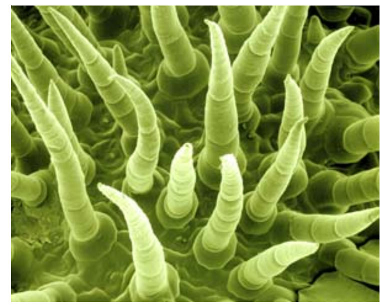
Tillandsia 35 x 29 $350



Venus Flytrap diptych 18 x 27 $300



Echevaria 22 x 24 $300



Trigger Hair 19 x 47
$400