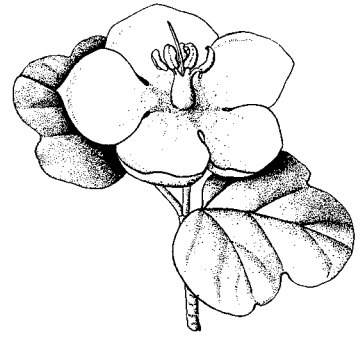


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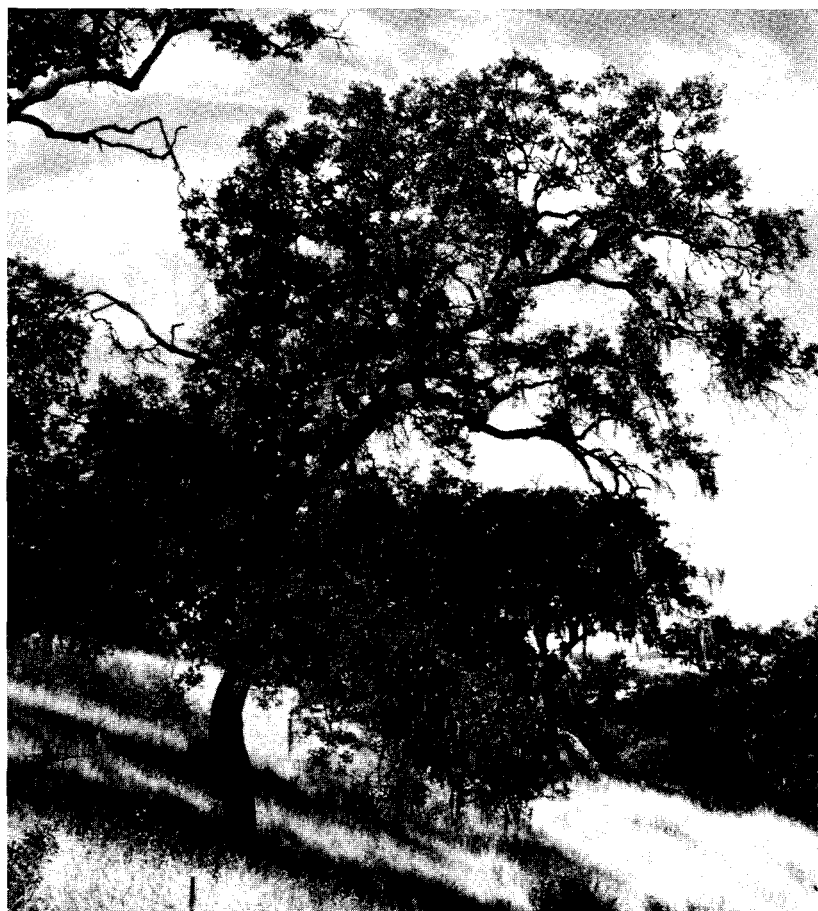
GALLS—SURREAL ORNAMENTS ON BLUE OAKS

by Ron Russo

Along the narrow, winding roads that lead to “Gold Country,” where there are towns like Ione, Shingle Springs, Railroad Flat, and Sheep Ranch, it is possible to think that it’s Christmas in August and September. Throughout the dry, grassy, interior foothills of California, hundreds of thousands of blue oaks (*Quercus douglasii*) are decorated each summer and fall in festive fashion. The ornaments are a seemingly infinite variety of oddly shaped and brightly colored swellings attached to the branches and leaves. There are shapes resembling goblets, stars, urchins, clubs, and cups and saucers in wild hues of red, orange, yellow, and purple. These tumor-like swellings are galls—the plants’ response to invading organisms.

Among all of the western species of oaks, blue oaks are host to the most dazzling array of galls. A single tree can support thousands of galls belonging to as many as thirty species of gall organisms. Most of the galls induced on blue oaks belong to tiny wasps of the family Cynipidae. Chemical messages produced by the larvae program the host oak to create swellings of a particular size and shape, specific to each wasp species. Galls become the nurseries for the developing wasp larvae, providing them with all of the food they need and some protection from predators and climatic changes. So intricate is this relationship between oaks and the cynipid gall wasps, that the insects are not only restricted to related species of oaks but also to specific parts of the host trees. Thus, blue, valley (*Quercus lobata*), and other white-oak species in California do not support the same species of gall wasps as do other sub-generic groups of oaks. Also, unless a second, alternate, generation of wasps is involved, most species

Four different species of cynipid gall wasps have laid their eggs on the same leaf.



Because winds carry gall-producing wasps, isolated trees like this blue oak have more galls than trees sheltered in woodlands.

that cause galls on leaves do not cause galls on flowers, fruit, petioles, or branches.

All parts of an oak are subject to galls, including the roots. More than half of the known galls that occur on oaks are found on the leaves owing to high synthetic activity in leaf tissues. With leaves, rapid growth and a constant, strong food supply make them more suitable on galling sites than the tougher, slower-growing woody tissues.

Damage by Galls

Because leaf galls are nourished through an intricate network of fine veins, tissues beyond the galls are generally robbed of sufficient nutrients to sustain cellular life. The damage caused by re-directing food

into galls is normally slight and restricted to areas near or just beyond the galls. Usually, stressed cells die and brown leaf discoloration develops locally. Even leaves that appear smothered with galls often remain green and continue to photosynthesize. In these cases there is not complete disruption of the flow of nutrients through the veins. However, this is not the case with integral stem galls, which cause an entire section of a stem to become abnormally swollen and distorted and little nourishment passes beyond the galls. The branches usually die by the time the galls mature. In general, however, galls do not cause serious damage to a host tree. Gall insects probably do not account for any more damage to an oak than any other group of insects that chew, suck, mine, or roll leaves. Trees heavily or permanently damaged through gall activity are exceedingly rare in nature. In fact, I don't recall ever seeing a tree that had died from excessive gall damage. I have seen oaks on the University of California campus at Berkeley that were heavily attacked by a stem galling wasp and were in poor health. But these trees were also irrigated all summer. Since, during the big drought, the overall vigor of these trees improved because of reduced irrigation, I became convinced that the gall population was only a contributing element, not the deciding factor.

Life Cycle of Wasps

Conveniently the emergence cycles of many gall wasps are directly influenced by the same rising temperatures that affect bud development and leafing in

The bright-red urchin gall of *Antron echinus* is found on the underside of leaves. A single larva occupies each gall.



The galls of *Disholcaspis canescens* exude a sweet "honeydew" that attracts ants, bees, and yellowjackets.

the spring. As the gnarled, naked branches of blue oaks leaf out each spring, thousands of gall wasps emerge from last season's galls and their winter sleep. Unless blown off course by stiff breezes, they rise into the canopy in search of tender shoots, buds, and leaves. Once they have selected the right spot, they puncture the plant tissue and deposit one or more eggs. With cynipid wasps, gall formation does not begin until after the eggs have hatched and the larvae have provided the appropriate chemical stimuli.

Gall wasps have quite complex life cycles. Many species comprise females only with no known males in the population. In these species females generally appear in the spring, chemically fertilize their eggs internally, and deposit them in the appropriate plant part. The galls that develop produce only females the following season. A single generation is produced each year. Another group of species has both males and females in a spring generation and females only in a summer-fall generation. Thus, a spring bisexual generation alternates with a summer-fall unisexual generation. Each generation produces a unique gall usually on a different part of the plant than the alternating generation. Because galls are so specific to each species, this alternating-generations situation often has led to the mis-identification of species, creating two separate species where, in fact, there was actually a single species.

The galls of the spring bisexual generations tend to be rather obscure, small, and not colorful. On the other hand, the galls of the unisexual generation tend to be quite obvious in size and color. Thus, the most spectacular galls on blue oaks are found from July through October. The following are a few of the notable species described in greater detail in my book, *Plant Galls of the California Region*.

The urchin galls of *Antron echinus* look like red and



The hairstreak gall of *Dros pedicellatum* has a swollen larval chamber at the end of a stalk too delicate for crawling or flying parasites to land on.

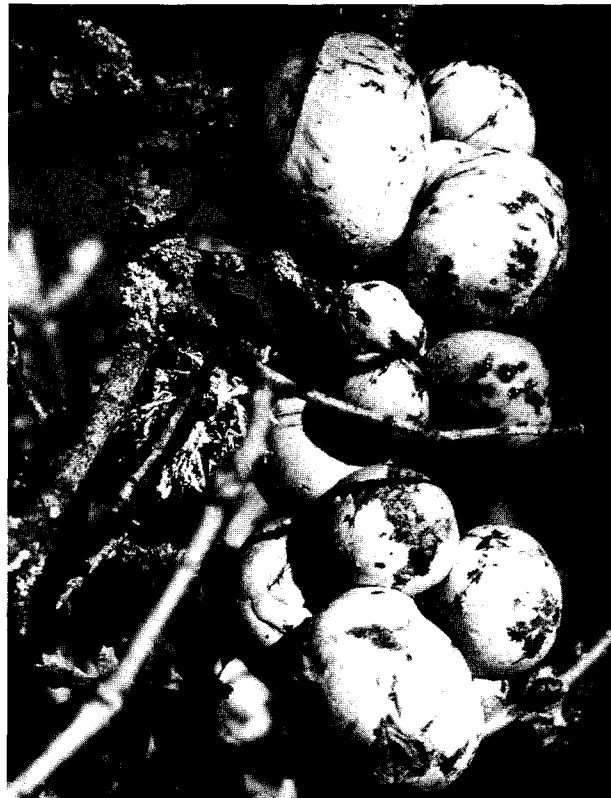
purple sea urchins with their stiff, pointed spines. These galls often cover the entire underside of a leaf. When thousands of these half-inch galls develop on a tree, the tree takes on the appearance of an oddly-shaped Christmas fir in its red and green finery. These urchin galls belong to the unisexual generation found in the summer and fall. The spring bisexual generation galls are rather obscure, swollen buds. The galls of this wasp are common throughout the range of blue oaks but are particularly spectacular in the Martinez and Mt. Diablo areas.

Predators

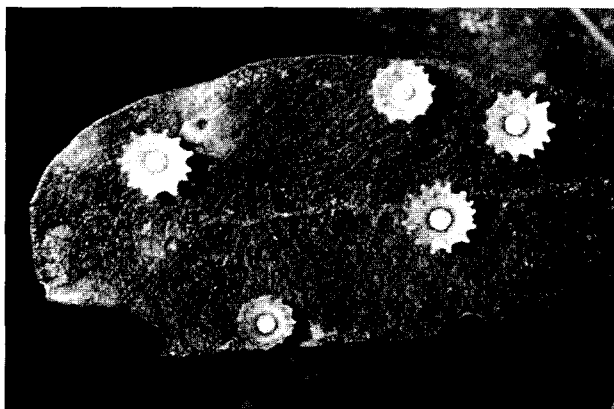
While mice are known to eat even hard galls like those of the preceding species, other animals are attracted to galls in pursuit of their occupants. There has evolved an incredible diversity of specialized insects that parasitize or directly attack and eat the wasp larvae. In some populations of gall wasps these parasites and predators account for extremely heavy losses in the offspring.

Are the gall wasps totally vulnerable? One defense is seen in those gall species that produce a sweet exudate of the phloem cells, which collects at the

surface of the galls. During the growing cycle of the galls of *Disholcaspis canescens* and *D. eldoradensis*, swarms of ants, bees, and yellowjackets can be found harvesting the sweet phloem "honeydew." If bees collect large quantities of this material they develop a malady called "disappearing disease," which results in



Top: the crystalline gall of *Andricus crystallinus* may cover the entire underside of a leaf; Above: the potato-sized galls of the California gallfly are the largest wasp galls in the west. No males exist in this wasp species.



Top: these fringed saucer-like galls of *Andricus gigas* cover the upper surface of blue-oak leaves. They cause no leaf damage; Above: the star-shaped galls of *Antron douglasii* share a leaf with the midrib galls of *Andricus fullawayi*.

premature death. The cause is thought to be the mineral deficiency of the honeydew. Unfortunately, the presence of large quantities of these galls on blue oaks near picnic tables or in backyards draws hordes of pesty yellowjackets in the late summer. This is one of the few negative aspects of having backyard oaks adorned with galls.

Arguments have raged over the ecological significance of honeydew production. With the dozens of wasps, moths, and weevils that parasitize and eat gall wasp larvae, it seems only reasonable that gall wasps might have a way to protect themselves. Certainly, when these honeydew-producing galls are covered with swarms of aggressive bees or ants, the chances of a parasite getting into position to sting the gall occupant are poor.

A rather strange gall belonging to the wasp *Dros pedicellatum* develops along the margins of blue oak leaves. Resembling the egg of a lacewing insect, the larval chamber of this wasp gall is elevated away from the leaf edge by a thin, wiry stalk. Actually, the gall is an exploded leaf vein that has extended out of its normal confines. At first, the larva hatches in a cavity in a vein at the edge of the leaf. But, as it induces gall formation, the chamber is pushed away from the edge.

This may be an adaptation to make it more difficult for some predators and parasites to reach the gall organism.

During the summer and fall, the hairy gall of *Andricus crystallinus* resembles a fat, sluggish caterpillar more than anything. Actually, upon close examination, the large, bristly mass is composed of several individual galls covered with crystalline fibers. The gall mass appears in pure white, chestnut brown, and strawberry red. These galls often cover the entire undersides of leaves, some specimens measuring over two inches in diameter.

The largest wasp gall in the western states occurs on blue and valley oaks. The responsible wasp, misnamed the California gallfly (*Andricus californicus*), induces potato-sized galls that form in large clusters of up to a dozen or more on the branches. Each gall contains several larvae at or near the center of the gall. The larval chambers are surrounded by a thick, pulpy mass. A single generation of females is produced each year. However, the adults may not emerge for as long as four years after initial gall formation. I once had hanging on a wall a cluster of these galls that released a variety of insects including the gall makers for over three years. To complicate matters even further, the adults emerge at two different times of the year, yet all gall development commences at about the same time.

In the spring when the galls begin development, they are usually green or red and are commonly called "oak apples." During the summer they turn white, then beige by autumn. Old galls remain on the host tree for several years. Eventually, they are covered with a black, sooty mold. Woodpeckers frequently dig into these old galls in search of the tasty occupants within. The tannic acid content of oak apples may reach as high as 60 to 70 percent. I discovered this when, on the advice of a colleague, I curiously bit into a fresh green oak apple. Well, "pucker" isn't an adequate word to describe the experience. However, it was this quality that led southern California Indians to use these galls as a source of an eye wash.

When you find a blue oak covered with the galls described here, as well as the countless others that resemble coral, dunce caps, furry mice, stars, cups and saucers, in red, orange, yellow and purple, you may agree that blue oaks are indeed decorated. Add to this the confusing collection of mosses, lichens, springtails, beetles, spiders, leafhoppers, caterpillars, birds, and undescribed species, well, that is more than the mind can handle at any one reading. Besides, this is another story. Suffice it to say that blue oaks are decorated with life forms that stretch the imagination. Wasp galls stand out as one of nature's most flamboyant expressions. And on blue oaks, the combination of ornaments reaches surreal proportions.