Texas Agricultural Extension Service
The Texas A&M University System

MP-1315

7/78

# The Mealy Oak Gall on Ornamental Live Oak in Texas

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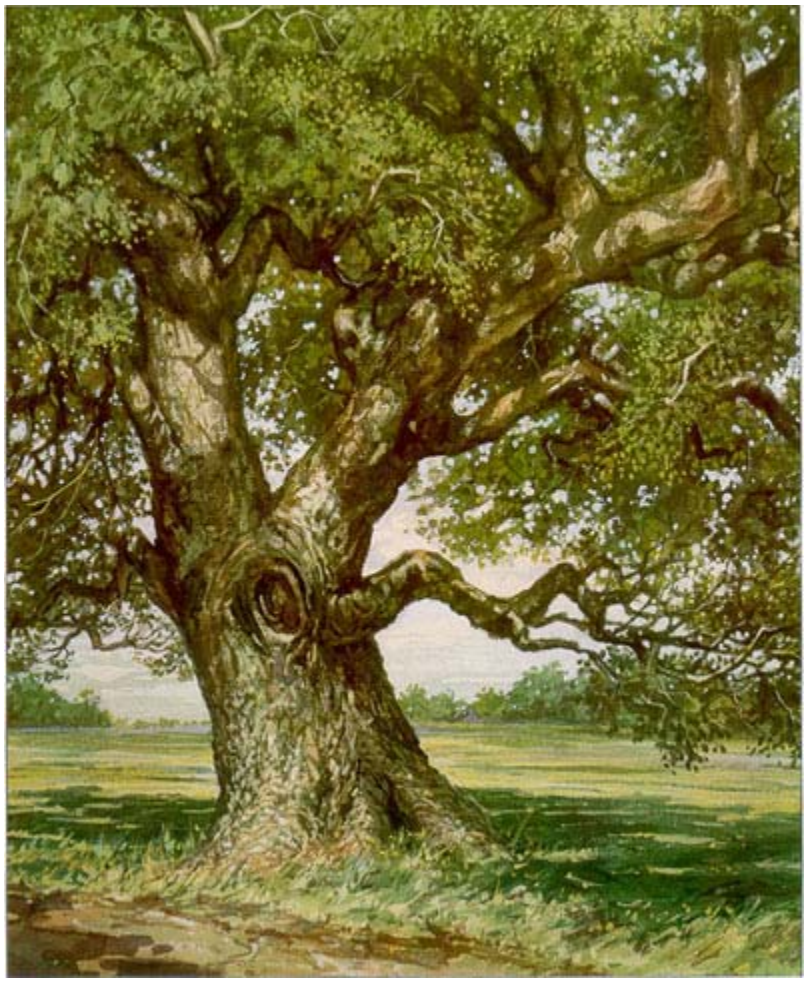

## *What are Galls?*

Galls are abnormal swellings of plant tissue induced by insects, bacteria, fungi, mites and nematodes. Insect-induced galls are the most common galls in urban areas. Among the insects causing galls are certain moth caterpillars, beetles, flies, aphids and small wasps.

The gall growth provides residing insects with food and shelter during certain developmental stages. Galls have characteristic sizes, shapes and colors. In early days, when little was known about galls, naturalists named and described some galls according to plant growth patterns rather than by the insects causing them. This practice has changed because some insect species induce more than one type of gall.

## *Formation of Insect-induced Galls*

*Gall tissue* is a plant product formed in response to a specific stimulus received from an insect. The stimulus is thought to occur either when insect eggs are deposited in host plant tissue or when eggs hatch and larvae feed on the plant (type of stimulus depends on the insect species). In either case, chemicals, which are thought to secrete from special internal glands, interact with certain plant chemicals to produce abnormal plant growth. After a brief period of cell growth, gall development stops completely. The insect lives within the gall and feeds on gall tissue during its development. Once formed, these growths discontinue utilizing host plant nutrients. Insect-induced galls are considered harmless to the growth and development of almost all ornamental plants.

The mealy-oak gall is one of the most common galls on live oak in Texas (figure 1). The gall is induced by a small wasp, *Disholcaspis* cinerosa (figure 2). Gall-infested live oak trees occur throughout Texas in natural and planted situations. The gall wasp also is reported from the same host in certain parts of Mexico and from western Louisiana. The following account summarizes 5 years of research on the biology, ecology and control considerations of *Disholcaspis* cinerosa on ornamental live oak in several Texas cities.

Figure 1. Mealy-oak or spherical galls of *Disholcaspis*. Left: Developing galls of asexual generation. Right: Old, vacated spherical galls. Holes in top two galls made by emerging *Disholcaspis* adults.

*Disholcaspis cinerosa* has 2 generations annually, each producing a different type of gall on live oak.

*Asexual generation.* The asexual generation develops within mealy-oak galls on branches and branchlets of host trees (figure 1). These spherically shaped galls are familiar to people who live in cities where live oaks commonly are planted as ornamentals. Galls range from 1/8 to 1 inch in diameter and are first noticed in late summer or early fall, depending on locality. When first formed, they are small, light pink to pinkish brown and the internal tissue is soft (figures 1 and 3).

*Disholcaspis* larvae are believed to secrete chemicals that stimulate the plant to produce the spherical swellings. From late summer to late fall (figure 4) developing *Disholcaspis* larvae eat plant tissues within galls. From August to mid-October, internal gall tissue is yellow-green and moist (figure 3), while during late October and November the tissue turns brown and begins to dry (figure 4). During November, pupation occurs and shortly thereafter transformation to the adult stage takes place. During December and the first part of January, adults emerge by chewing holes at gall bases (figure 1).

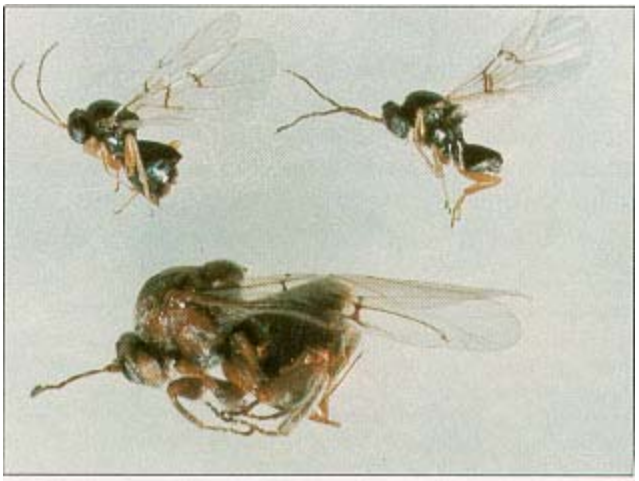

Figure 2. *Disholcaspis* adults. Top: Female (left) and male (right) of sexual generation. Bottom: Female of asexual generation.

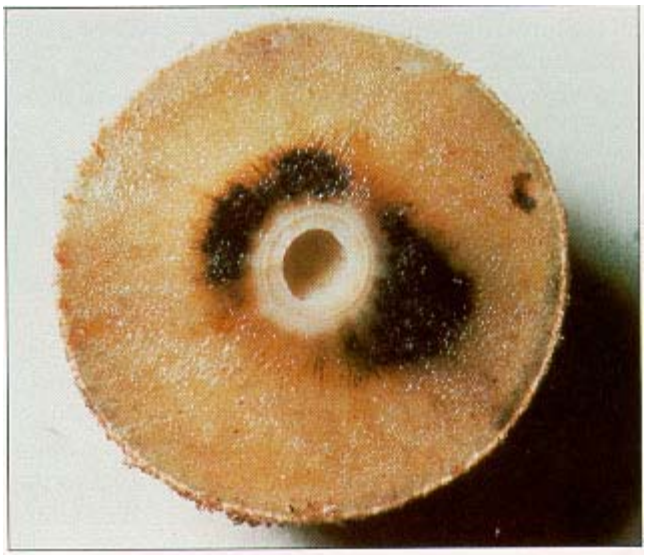

Figure 3. Spherical gall in October. Center cavity, which is occupied by developing *Disholcaspis*, surrounded by soft, moist tissue. Darkened areas indicate first signs of drying.

Emerging *Disholcaspis* adults of this generation are all females (figure 2) which do not require mating to lay viable eggs; hence they are asexual. Interestingly, this unique reproductive habit also is found in many common and beneficial parasitic wasps and in most aphids.

Figure 4. Mature *Disholcaspis* larva within spherical gall in November. Brown mantle color indicates gall growth has stopped.

Figure 5. Kernel-like gall of sexual generation *Disholcaspis*. Hole in gall made by emerging *Disholcaspis* adult.

The newly emerged *Disholcaspis* female seeks out swollen leaf buds on live oak branches in which to deposit one or possibly two eggs per bud. Females may live 2 to 6 weeks during which time each individual may lay up to 20 viable eggs. The frequently harsh weather at this time of year appears to have little adverse effect on the egg-laying

activities of most females. Females die after eggs are deposited. Eggs remain in a dormant state during the remainder of winter (January and February).

During the first winter, recently abandoned spherical galls begin to weather and in the process change from pink to grey and become dry and hard (figure 1). If left undisturbed, they may persist on host trees for several years. In essence, grey galls are inactive structures that serve to remind one of a past event. They actually assume a nonliving status about 1 month (November) before adults begin emerging from galls.

*Sexual generation.* As mentioned, females of the asexual generation lay their eggs in swollen leaf buds. These eggs hatch in early spring as leaf buds begin to open. Resulting larvae develop quickly in new leaf tissue, and in the process they induce the formation of a second type of gall. This new growth is beige and resembles a kernel of wheat in size and shape (figure 5). Larvae, pupae and adults complete development in a few weeks within these small, obscure galls. The sexual generation differs from the asexual generation not only in gall type but also in that the spring galls produce adults of both sexes. Sexual generation adults are about 1/3 the size of the asexual generation adults (figure 2).

Immediately after emergence, male and female wasps mate; males then die. Mated females may live up to a week during which time each individual deposits about 15 eggs in the branches of live oak. The eggs pass through a 3- to 5-month dormant period. After this period, larvae hatch and begin development in certain outer branch tissues, which leads to formation of pink spherical galls (figure 1). Thus the annual cycle of *Disholcaspis* is completed.

## *Relation of Disholcaspis Development to Seasonal Changes in Live Oak*

The seasonal activity of *Disholcaspis* may be followed partially by observing certain obvious seasonal changes in the live oak tree. Simultaneously occurring seasonal events between *Disholcaspis* and live oak are shown in figure 6.

*Early winter (late November to early December).* By early winter, freezing weather has occurred in most Texas areas. Leaf buds are swollen on most live oak trees although the old leaves have not begun to drop. These general climatic circumstances and host plant conditions coincide with the emergence of adults of the asexual generation.

*Late winter to early spring (February to March).* Depending on locality, most live oaks are partially leafless by March and leaf buds have begun to break open. At the bases of

expanding new leaves, rapidly developing *Disholcaspis* larvae are found. When new leaves are about three quarters expanded, the kernel-like galls of the sexual *Disholcaspis* generation may be observed on certain leaf terminals. Oftentimes galled leaf terminals may be recognized since infested terminals produce extra leaves, which are clustered around the bases of galls. Once the leaves are expanded fully (late spring), most of the sexual generation *Disholcaspis* adults emerge and most of the egg-laying stops.

*Summer to early fall.* After new leaves are produced in spring (short shoots), an elongation of new branchlets takes place. Generally, the degree of shoot elongation depends on the yearly rainfall pattern. Numerous long shoots usually result when rainfall has been abundant during the year. At some time during shoot elongation, new asexual spherical galls begin forming on branches; however, no obvious tree activity pattern corresponds in time with the formation of these curious pink growths.

In summary, most of the annual life cycle of *Disholcaspis* can be followed by merely observing changes in seasonal development of live oak trees.

## *Variation in annual seasonal history of Disholcaspis*

*Within the same year.* Seasonal history development of *Disholcaspis* in a given year differs from locality to locality. The difference is most noticeable between cities located in the northern versus southern parts of the state, and it is related to the general climatic conditions and associated plant growth in the respective cities. Basically, southern Texas cities experience more favorable growing conditions earlier in the year than the more northern cities. For example, populations of spring generation *Disholcaspis* begin development earlier in the year in Houston than in Dallas. Also, new pink spherical galls of the asexual generation always make their appearance earlier in Houston than in Dallas. However, adults of the same generation emerge from galls about the same time each year in both cities.

*Year to year.* In addition to difference among cities in a given year, the development of *Disholcaspis* populations may vary by a month or more between years in a particular city. This difference is related t plant growth. When plant growth begins “early” in a given year, this means that certain associated insects will also usually be “early.” For example, in 1974 in Dallas, live oaks begin their seasonal changes “early” in the year. The “early” signs were noted in March when trees began flushing new spring leaves. At this time, the sexual generation of *Disholcaspis* also was beginning to develop. In 1975, Dallas live oak trees did not begin flushing new leaves until April, which is considered “late” for that city. This “late” seasonal development of Dallas live oaks was accompanied by a

corresponding “late” seasonal development of *Disholcaspis*.

## *Frequency of Gall-infested Trees*

All live oak trees are not alike in their capacity to produce *Disholcaspis* galls. A total of 170 live oak trees from city and shopping plazas in Dallas, Houston and San Antonio were randomly selected to examine this possibly inherited capacity. The classes, light, moderate and heavy, were established arbitrarily to rank infestations of each tree. Infestation class was determined by sampling and counting all spherical galls (asexual generation) on 12 randomly selected branches (each ½ yard in length) from each tree. Survey results are summarized below. Numbers in parenthesis indicate range in numbers of galls recorded for each class:

| **Infestation classes** | **Number of trees recorded in each infestation class** |
|---|---|
| *Light (0 to 50)* | 132 |
| *Moderate (51 to 200)* | 28 |
| *Heavy (201 to 1,000)* | 10 |
| *Total* | 170 |

The survey revealed that most trees (132 out of 170) were only lightly infested. In fat, 118 out of the 132 trees in the light group had fewer than 25 galls per sample. Of the remaining two groups, usually only the heavy group causes concern to homeowners. In this group, only 10 out of 170 trees had high numbers of galls. The survey also indicated that trees classified as heavy usually are younger and smaller (less than 10 inches in trunk diameter at breast height).

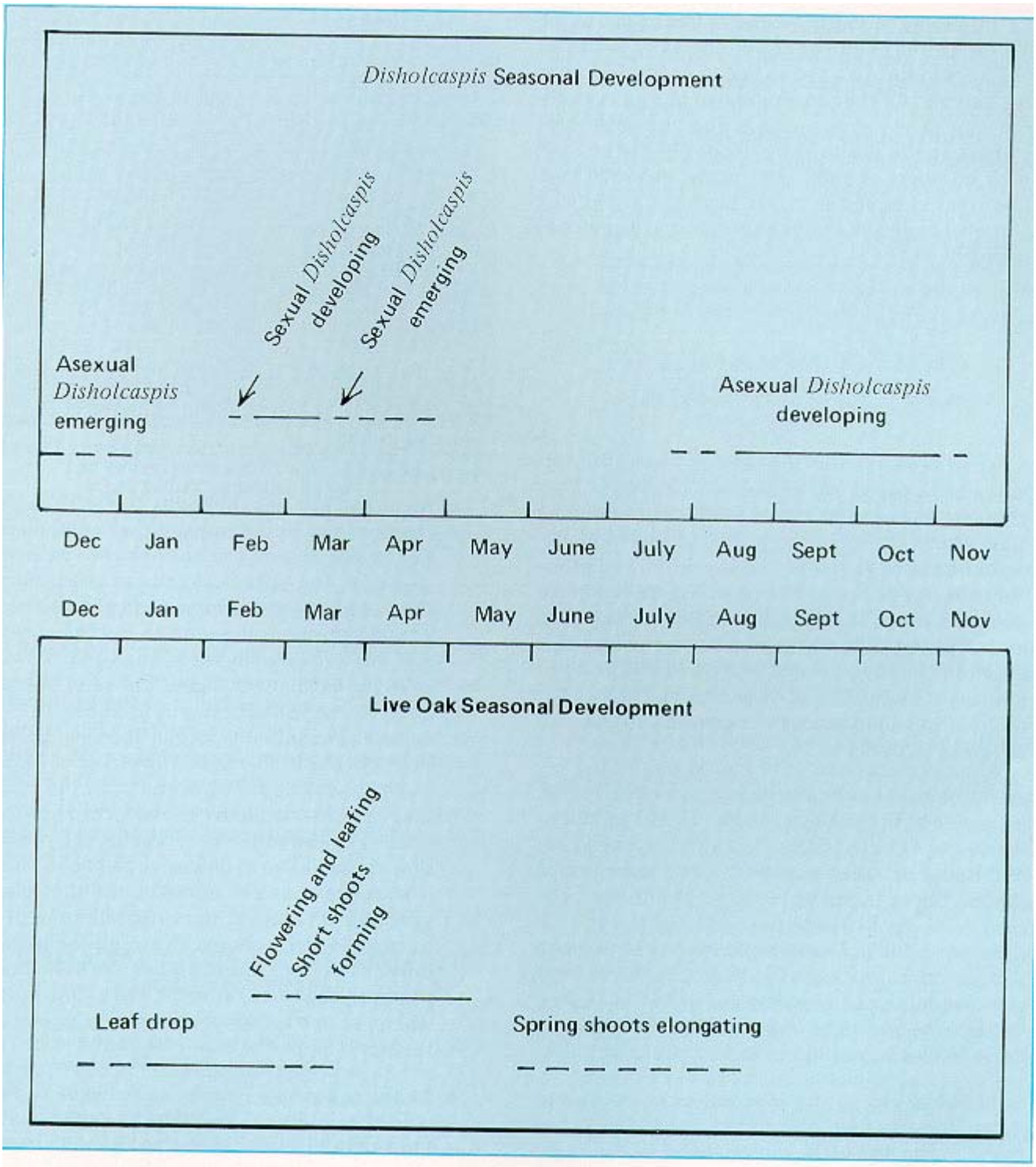


Figure 6. Seasonal history development of *Disholcaspis cinerosa* and live oak in Texas.

## *Cycle of Abundance on Susceptible Trees*

Experimental studies indicate that the gall-forming capacity of relatively nonsusceptible trees (light class) to *Disholcaspis* may be quite constant year after year. That is, if a tree shows little or no inclination to form galls after 2 to 4 years, it will probably never

produce galls. In contrast, trees that are potentially capable of producing galls (mostly trees in the heavy class) may experience a change in infestation class over several years. In this case, a potentially susceptible tree may pass through cycles of great gall abundance interspersed with periods of few or no galls.

Long-term studies on highly susceptible trees (heavy class) suggest that a cycle of great gall abundance may last 2 to 3 years. Periods of decline in gall numbers then ensue for 1 to 3 years. At the end of the decline period, trees may not produce any *Disholcaspis* galls in a given year. Length of the decline period is unknown; however, it is assumed that an appropriate period must pass before the gall-forming capacity of susceptible trees returns. Because of the cyclic nature of gall production, these trees are considered potentially susceptible.

It is relatively easy for inexperienced persons to determine the state of infestation on an affected tree. In late fall-early winter, select about eight branches from the outside of oak crown (each branch should be about ½ yard in length and should be selected from a different side of tree). Remove all attached galls and divide into two groups: pink gals (new) and grey galls (old). Estimate the specific stage of the cycle by comparing the number of pink to grey galls:

- If the sample consists of mostly new pink galls, the infestation cycle is just beginning.
- If most galls are grey, the tree is in a declining period of gall production
- If there are about equal numbers of pink and grey galls, the infestation is either just beginning to increase or is in the early phases of decline. If most of the new pink galls in this group are large (3/4 inch to 1 inch diameter), the infestation is just beginning on the tree (see below for further information on this last pattern).

Two combined factors may be responsible for the decline in *Disholcaspis* galls on potentially susceptible trees.

- Apparent live oak immunity to *Disholcaspis*. Experimental studies suggest that a potentially susceptible tree (as evidenced by the presence of old or new spherical galls) may be highly susceptible to gall formation for 2 to 3 years, after which the tree seems to lose most of its gall-forming capacity for a 2- to 3-year period. It is believed that a change in the tree's chemistry may be responsible partly for differences in annual susceptibility to gall formation. Possible chemical changes in live oak have not been investigated; however, if they do occur, they may be related to cycles of acorn production (this cycle varies from year to year) or possibly to a

build up of defensive plant chemicals from a previous gall infestation. Other plant species react against insect infestations by producing defensive chemicals in high concentrations. Only long-term studies, such as those presently underway at Texas A&M University, will reveal the causes of this change in live oak susceptibility.

- Parasites. Parasitic insects are believed to significantly reduce *Disholcaspis* populations. Most parasitization takes place on individuals of the asexual generations spherical galls. The effect of the parasites is observed in the next generation when fewer *Disholcaspis* are left to reproduce. Approximately 12 parasitic wasp species have been reared from spherical *Disholcaspis* galls (figure 7). This is an impressive total since virtually all of the same parasites have been reared from *Disholcaspis* galls in native stands of Texas live oak. The degree of parasitization (percent parasitized *Disholcaspis* varies considerably from one tree to the next. However, if the parasites occur in a particular area, they may parasitize up to 90 percent of the gall wasps on a given tree.

Parasitized spherical galls can be recognized easily by their smaller size. Parasitized galls generally measure 1/8 to ½ inch in diameter, while unparasitized galls are ½ to 1 inch in diameter. *Disholcaspis* usually are parasitized during the larval stage, at which time galls are small. A parasitized *Disholcaspis* larva stops producing chemicals that stimulate the tree to form gall tissue, thus stopping gall growth.

Figure 7. Female torymid parasite drilling hole through mantle of mature spherical gall. Upon reaching center cavity of gall, torymid parasitizes *Disholcaspis*.

## *Galls are More Abundant on Isolated Trees*

Isolated live oaks in urban environments often have greater infestations of

*Disholcaspis* than live oaks occurring in groups. For example, young, potentially susceptible oaks planted in shopping plaza parking lots often are very heavily infested with galls. Reasons for this pattern are not fully understood. However, when oak trees are first planted, the following ecological imbalance occurs. Before introducing potentially susceptible live oaks into urban landscapes from nurseries, the trees have been carefully examined in accordance with state inspection standards and treated for any symptoms of insect infestation or disease. When these "clean" oaks are planted in urban environments, they immediately become exposed to a wide variety of insects. In the case of *Disholcaspis* on an isolated oak, the gall inducers arrive before their natural enemies (wasp parasites). A year or more may be required before enough parasites find the galls and begin controlling *Disholcaspis*. Thus, a cycle of initially high gall numbers followed by subsequent reduction in gall numbers can be expected when susceptible host plants are moved from relatively insect-free situations to isolated urban landscapes. In essence, when man isolates live oaks he is creating an island which is ecology imbalanced from the standpoint of associated insects.

## *The Spherical Gall Insect Community*

Figure 8. Broken spherical gall showing relative positions of developing *Disholcaspis* (center capsule) and "guest" larvae (outer gall mantle).

Figure 9. Honeybee feeding on sweet secretions of spherical gall during early fall.

In addition to the gall inducer and its parasites, the spherical gall has other interesting insects associated with it. Collectively, all of these insects are said to form a community. Like all communities (plant or animal), the community of insects associated with *Disholcaspis* has its own unique organization. The organization can be described by examining the various stages of gall development and the insects associated with each stage.

- Stage 1: Newly developing spherical gal (August to early October). Several species of small wasps are known to parasitize *Disholcaspis* larvae when the pink spherical galls first appear around August. Shortly after this period, a group of plant-feeding wasps or "guests" begin to lay eggs in developing mantle tissues of the gall. The larvae hatching from these eggs feed and develop in outer gall tissue without harming *Disholcaspis* (figure 8). From September through December, many of these plant-feeders transform into adults and emerge from the mantle. It is not known where they go after leaving the gall. During stage 1, another group of insects is associated with the galls. Develop gall tissue secretes sweet exudations which accumulate on the outer gall surface. These secretions are rich in sugars and serve as a food source for a wide variety of insects including small flies, large predatory wasps, butterflies and honeybees, with the latter usually the most abundant (figure 9). All of these gall

visitors feed on the secretions until galls begin to dry in late fall.

- Stage 2: Mature spherical gall (late October to early January). A second group of wasp species begins parasitizing mature larvae or pupae of *Disholcaspis* before adult emergence of gall inducer in December to early January (see figure 7 for example). *Disholcaspis* adults emerge from nonparasitized galls in December to early January. After this event, the vacated gall is almost immediately taken over by one of the following groups of beneficial insects: lacewing larvae, scavenger ants, small spiders and small predatory wasps. Many of these beneficial insects feed on insects which man considers to be pests of live oak, for example, aphids and small caterpillars.
- Stage 3: Old grey spherical gall (beyond January). The old vacated spherical galls (figure 1) primarily provide space for small scavenger ants. In addition, some of the plant-feeding wasps of the mantle remain in this particular gall tissue for some time after the first of the year. Recently, it has been learned that some grey galls, which bear no adult *Disholcaspis* emergence holes, actually contain dormant parasites of the gall inducer. Some of these parasites emerge the following spring to parasitize other insects in the urban environment. Others do not emerge until the following fall at which time they begin parasitizing the asexual generation of *Disholcaspis*.

## *Does Disholcaspis Cause Plant Injury?*

The presence of spherical galls of *Disholcaspis* usually causes concern to homeowners through fear that these abnormal swellings may increase and endanger plant health. Survey studies throughout the state indicate that trees sustaining very high gall numbers of both *Disholcaspis* generations, suffer no noticeable or measurable damage. It is clear, however, that during periods of gall formation, development of the respective *Disholcaspis* generations requires a transfer of nutrients from host tree to gall tissue. Once these developmental periods are passed, gall growth stops completely. Live oak trees seem to tolerate brief periods when tree nutrients are utilized for gall tissue formation.

The state-wide survey also revealed that not all homeowners are bothered by *Disholcaspis* galls. When informed of the interesting community of insects associated with galls, some homeowners with to preserve these curious, nonharmful insects. Homeowners in other parts of the United States, who are knowledgeable of gall insects associated with certain ornamental plants, seek gall-producing plants, contending that they impart an aesthetically pleasing and unique characteristic to the plants.

## *Control Considerations*

Numerous ornamental insect pests generally are controlled to a greater or lesser extent through use of insecticides. Strong arguments against insecticide use on either *Disholcaspis* or any other gall insect on live oak can be made for the following reasons (1) only about one in 17 live oaks has the capacity to produce *Disholcaspis* galls at levels which cause concern to homeowners; (2) potentially susceptible trees apparently pass through intervals of susceptibility so that in some years these trees will be virtually free of new galls; (3) if a tree passes through an interval of susceptibility, the period of active gall development for each *Disholcaspis* generation is relatively brief. Therefore, once formed, these galls do not continue to utilize host plant nutrients; and (4) economic damage has never been observed even on trees sustaining very high populations of new *Disholcaspis* galls. It seems, therefore, that potentially susceptible trees can tolerate occasional intervals of gall infestations. Finally, trees, which at an early age were considered potentially high gall producers, appear to lose much of their susceptibility as they age.

An important point to reemphasize is that if conditions are favorable, several parasitic wasps will provide effective long-term control against *Disholcaspis*. Since parasites are killed easily with insecticides, exercise care in applying any chemicals around oak trees. Untimely or careless chemical applications can cause an increase in gall numbers by virtue of eliminating the natural enemies of *Disholcaspis*. Once gall tissue begins to form, it is impossible to stop or reverse the growth with chemicals. Chemicals are ineffective because they do not penetrate woody growth and kill the gall-inducer inside.

Precisely timed chemical applications seem to offer a possible means for controlling these insects. However, because of the lengthy adult emergence period in December to early January and the often varying emergence period in spring, the chemical approach alone is currently unreliable. Furthermore, consider the above biological and ecological factors before making any decision to use artificial control procedures.

Nonchemical gall control methods offer only limited help. For example, spherical galls are detached easily and may be removed by hand from small infested trees, but this procedure is not practical on larger trees. In some cases, consider removing the host tree, particularly when it is newly planted.

Researchers at the Texas Agricultural Experiment Station have been growing oaks

and other ornamentals from stem cuttings of superior plants for several years. Through this vegetative (asexual) reproduction method, genetic identity remains intact. In the case of *Disholcaspis*-induced gall formation on live oak, which is thought to be inherited, cuttings are being propogated from "apparently resistant" trees. If cutting from these trees prove, through intensive testing, to be resistant to *Disholcaspis*, this plant material will be propogated in quantity for distribution to the nursery industry.

## *Questions Commonly Asked About Disholcaspis*

- If one or more live oak trees show signs of *Disholcaspis* infestation, what should be done?
  **Answer:** First and most importantly, be aware that your tree(s) will NOT suffer damage from the *Disholcaspis* infestation alone. Secondly, if, for your own curiosity, you want to know if an individual tree is lightly, moderately or heavily infested, see page (7) for a description of how to make this simple determination. If your tree is small, remove the galls by hand-picking. In general, insecticides do not currently provide satisfactory control for *Disholcaspis* galls.
- If an oak tree is infested with galls 1 year, will it be infested again the following year provided no preventative steps are taken?
  **Answer:** A suspected natural immunity-like reaction in the oaks and a variety of parasitic wasps on *Disholcaspis* work together to reduce populations of this gall insect. However, this reduction takes place over a 1- to 3-year period. Trees can tolerate, without noticeable signs, active periods of infestation.
- Will the *Disholcaspis* gall inducer move from live oak trees to other plants in the yard?
  **Answer:** No, this insect is very specific in its choice of plants. It only infests certain plant parts on live oak trees. The mealy-oak growth is found only on the branches, while the kernel-like growth occurs only at the terminals of new leaf shoots.
- At what age do trees begin showing signs of susceptibility to gall formation?
  **Answer:** Two- to 3-year-old live oaks will form mealy-oak galls.
- If purchasing a young live oak tree, what are the chances of having future bothersome gall infestations on this tree?
  **Answer:** As described in detail on page (11), only one in 17 trees in likely to produce a gall infestation of concern to homeowners.
- What is the difference between the *Disholcaspis* wasp and the wasps that parasitize *Disholcaspis*?
  **Answer:** *Disholcaspis* only feeds on plant tissue of live oaks, and in the process it

induces the formation of abnormal plant tissue. Parasitic wasps of *Disholcaspis* only feed on other insects. Also, these parasites are very specific and only attack gall insects. They never bother humans.

- Will the guest insects associated with *Disholcaspis* spherical galls cause any problems to man?
  **Answer:** No, most of these insects have a very precise role to play in the gall community as mentioned before. In fact, some of the insects probably aid man since they feed on other known pests of live oak.
- What is a large predatory wasp and does it cause problems?
  **Answer:** Large predatory wasps usually are red or yellow striped and occasionally are seen feeding on sweet secretions that exude from newly developing spherical galls. This food source actually is like a bonus since they feed mostly on caterpillars and other soft-bodied insects that may cause problems in the urban environment. On the live oak galls, they are relatively nonaggressive towards humans. They become bothersome only when their nests are close by.
- Will other gall-inducing insects on live oak and other ornamentals cause problems?
  **Answer:** Generally not; however, phylloxerid galls on pecan may cause some economic loss. If you have phylloxerids on your pecans, consult your local county Extension agent.
- When will resistant oak trees be ready for commercial distribution?
  **Answer:** Several years of testing are required before gall-resistant stock will be available commercially.
- How typical of other gall-wasps attacking oaks is *Disholcaspis* cinerosa?
  **Answer:** To answer this questions some interpolation of the biology of *Disholcaspis* cinerosa and other gall-wasps is necessary. It and most other gall-wasps cause only cosmetic damage to oaks and since it is the most commonly found gall-wasp on oaks, other, less commonly found gall-wasps are less of a problem.