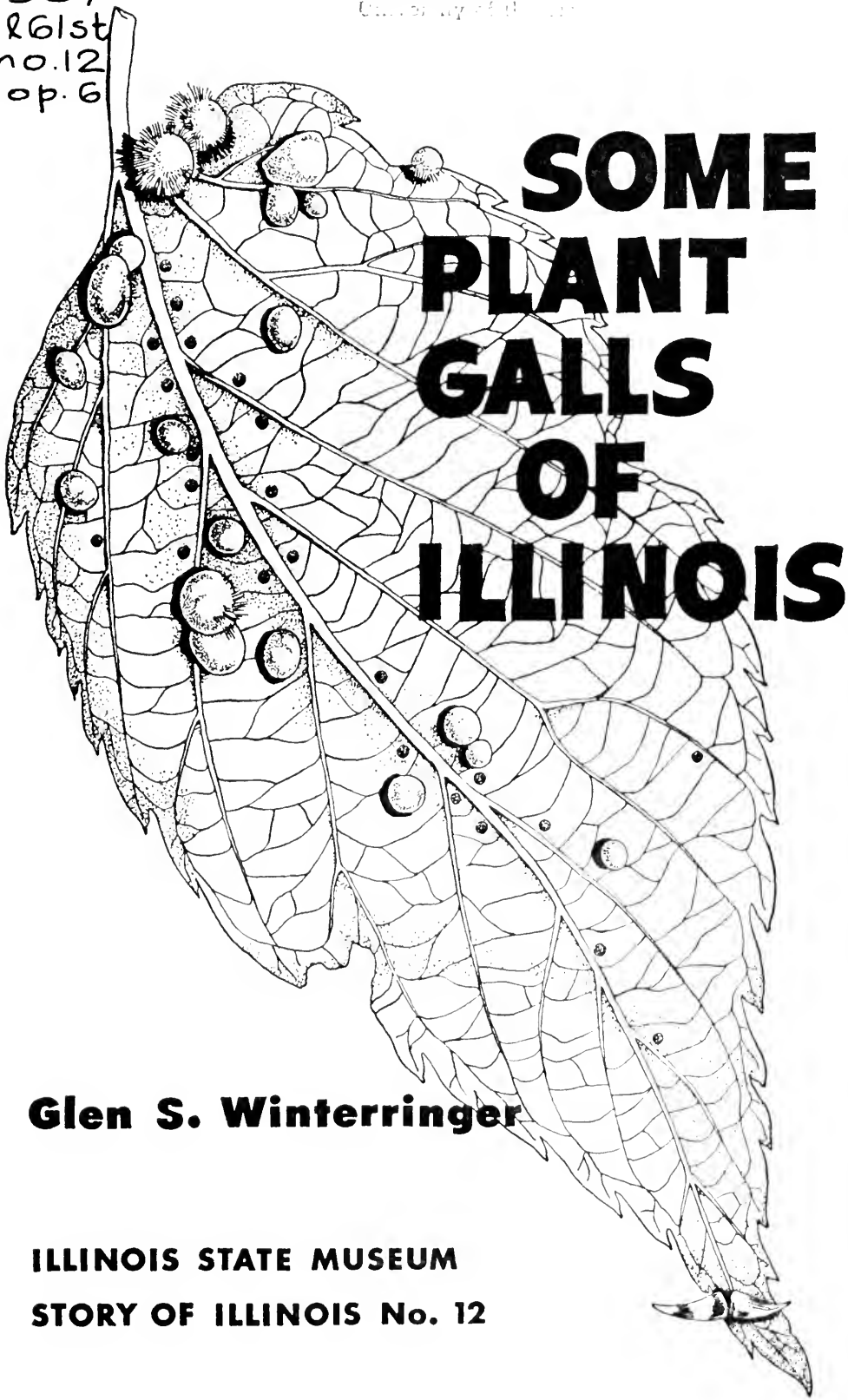

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Glen S. Winterringer

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STORY OF ILLINOIS SERIES, NO. 12

SOME PLANT GALLS OF ILLINOIS

by
GLEN S. WINTERRINGER

[Printed by authority of the State of Illinois.]
1961

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SOME PLANT GALLS OF ILLINOIS

Contents

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A number of sources have been used for information contained herein. The publications are included in the list of references. Special use, for identification, was made of PLANT GALLS AND GALL MAKERS by E. P. Felt, Comstock Publishing Co., Ithaca, New York. Permission granted by several publishers to redraw certain figures is appreciated. Fig. 1, No. 2 is redrawn from Kinsey, THE ORIGIN OF HIGHER CATEGORIES IN CYNIPS, page 89, permission of the Department of Zoology, Indiana University. Fig. 1, Nos. 1, 3, and 4 are redrawn from Comstock's AN INTRODUCTION TO ENTOMOLOGY (9th revised ed.), pages 411 and 423. Fig. 1, No. 6 is redrawn from Comstock, Comstock and Herrick's A MANUAL FOR THE STUDY OF INSECTS, (revised ed.), page 19, by permission of Cornell University Press. Fig. 1, No. 5 is redrawn from Metcalf and Flint's DESTRUCTIVE AND USEFUL INSECTS, (2nd ed.), page 232, permission of McGraw-Hill Book Company. Figs. 2 and 3 are redrawn from Kinsey, THE GALL WASP GENUS CYNIPS, frontispiece and page 511, permission of the Department of Zoology, Indiana University.

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INTRODUCTION

Galls are abnormal growths of plant tissue often found on roots, stems, leaves, flowers and seeds. These growths result from a stimulus supplied by external sources. These sources are generally insects or, in some cases, fungi, viruses, bacteria, nematode and eel worms, and perhaps other agents.

Galls and gall insects, as well as the other organisms which stimulate their formation, may be found all over the earth wherever the host plants are growing. This does not mean that the range of gall insects and other organisms coincides exactly with the range of the host plants. To the botanist galls are interesting because they represent abnormal plant growth. He wishes to know more about the insect secretions and their effects on growing plant tissues which are important in studies of plant physiology and anatomy. The entomologist is concerned with the life cycles of gall insects and the variations in form shown by many of these insects. Home gardeners and horticulturists wish to know how to recognize and control the galls which cause damage to landscape plantings.

There has been no attempt to include, in this booklet, all of the thousands of kinds of known galls. Only those commonly seen in Illinois have been photographed and described. A list of references is provided for use of those who become interested in further studies of galls and gall insects. The Latin or scientific names of both galls and insects are based largely on terminology used by E. P. Felt in PLANT GALLS AND GALL MAKERS, (Comstock 1940). In the gall photographs the common name is given first, followed by both common and scientific names of the gall insect which produced it. The common and scientific names of the plant upon which the gall was found are also included. This arrangement of information has been used for all of the gall photographs in the booklet. Plant deformities are not usually given scientific names; hence the name of the insect which *caused* the deformed plant tissue is also the name of the gall.

Group names are often used in identification of galls such as: rosette, oak apple, bud, leaf, bullet, roly-poly, and pouch. Galls may be classified by the plants upon which they are found in which case we might refer to maple leaf, goldenrod, oak, hackberry, elm, willow, and sunflower galls.

It is hoped that this publication will stimulate an interest in those outdoor activities which will lead to the discovery of galls and gall insects.

HISTORICAL SKETCH

Plant galls and gall insects are not a recent discovery. They were observed during the time of ancient Greek and Roman naturalists and historians as shown by recorded works. We do not know that galls were actually named as such by the earliest writers, but they surely observed malformed growths on plants about which they did write. Theophrastus (372-288 B.C.) is credited with at least two important botanical works, one with the title a HISTORY OF PLANTS and another the CAUSES OF PLANTS. Pedanios Dioscorides (40-90 A.D.) was a Greek who wrote about plants mainly from a medicinal standpoint, and his MATERIA MEDICA contained many descriptions of plants used in early medical practice. Pliny the Elder (23-79 A.D.) was a Roman naturalist who described plants in his NATURAL HISTORY. Through these past centuries the writers were interested in uses of plants rather than in their abnormal growths. However, in the seventeenth century Marcello Malpighi, an Italian physician, included an account of plant galls in his ANATOMIA PLANTARUM. It is not known with certainty that Malpighi established the final relationship between an insect and the gall it produced on a plant.

During the Middle Ages galls were associated with superstitions and omens in foretelling future events. This was often accomplished by observing various types of grubs as well as adult insects found inside a gall. All insects found in a gall may not be responsible for its formation, for some are "guests"; others are transients or even parasitic insects which devour the gall-former. Thus insects in a gall, phases of the moon, and signs of the Zodiac may have been considered important to those attempting to foretell future events but they did very little to advance a study of relations between insect, plant, and the gall.

At the present time galls, insects, and the host plants are considered important enough to be the subject of research in scientific institutions. Dr. William Hovanitz, in his studies at Earhart Plant Research Laboratory of the California Institute of Technology, has used sawflies and willow leaves in experiments to discover what actually goes on during the formation of plant gall tissue. Glandular fluid produced by larvae and adults of these sawflies has been analyzed in an attempt to find the activating substance which causes plant cells to multiply rapidly in its presence. So from ancient days to the present both galls and insects continue to capture the eye and the mind of man.

GALL PRODUCERS AND HOW GALLS ARE FORMED

(a) Insects and Allies

In this booklet we are concerned with those insects known to produce galls illustrated in the following pages. In Fig. 1 the drawings intend to illustrate, in a general sense, what is meant when we refer to such typical gall insects as: jumping plant louse, gall wasp, aphid nymph and adult, gall gnat, and pear-leaf blister mite. Less important gall insects such as: long-horned beetle, gall moth, and other kinds of mites could be added to the list. Mites are not true insects but are more closely related to spiders. Many other insects

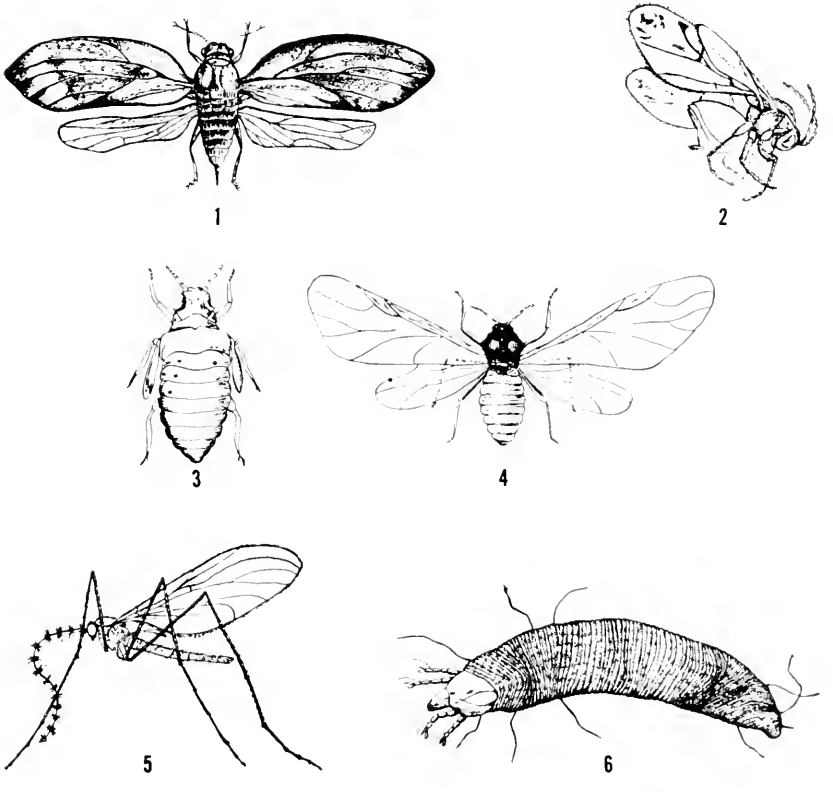


Fig. 1. A Group of Gall-producing Insects Very Much Enlarged.

1. Adult jumping plant louse, *Pachypsylla celtidismamma* (From Packard). 2. Female gall wasp, Cynips (From Kinsey). 3. Aphid nymph, *Colopha ulmicola* (From Riley). 4. Adult, winged aphid *Colopha ulmicola* (From Riley). 5. Male gall gnat, *Hormosomyia oregonensis* (From Cole & Lovett). 6. Pear-leaf blister mite, *Eriophyes pyri*.

may be gall producers and only study and observation will reveal them. Insects assigned to the Order Hymenoptera, a very large group in which bees and wasps are included, are highly specialized. By specialized we mean that certain parts of their bodies are well adapted for doing special work in collecting pollen, cutting leaves, collecting mud particles, and constructing honeycomb. Dr. Alfred Kinsey made excellent and extensive studies of particular gall wasps, and references to some of his works are given at the conclusion of this booklet.

Female insects often possess an ovipositor which is made up of modified or specially shaped abdominal segments. By means of this ovipositor the female can pierce tender plant tissue and deposit an egg. As the egg is pushed into the cells of the plant tissue, a small amount of the insect's body fluid accompanies the egg and thus enters some of the plant cells. Dr. Hovanitz, in his studies, found that female sawflies whose ovipositor merely broke the tissue of willow leaves used in the experiments did not produce gall growth at all. Those sawflies which did inject some body fluid, but had not deposited an egg, stimulated the beginning of gall development. Hovanitz also observed that areas of a willow leaf in which fluid from the insect was present differed from those areas in which an egg was *also* present only in size of the gall-growth region. Recent experiments and investigations show that the glandular fluid produced by the adult insect as it deposits an egg, and by the larva which develops from the egg, is the stimulus which starts abnormal plant growth and the formation of a gall. It must always be kept in mind that the living plant cells into which the insect fluid is injected play an important part in the final form and shape of the gall.

The similarity of the glandular secretions of adult and larval insect has not been proved, but they are thought to be very much alike. These secretions are chemically complex substances of high nucleic acid-protein content and have been difficult to analyze. The presence of a virus or a fungus may require investigation and consideration in gall formation. However, these agents and their influence must await further research.

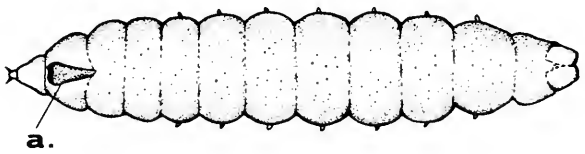


Fig. 2. Very Much Enlarged Drawing of a Cecidomyid Larva.

The larvae or grubs of many gall insects are most important in identification. The drawing is intended to show at (a) the presence of a "breast bone" which is an identifying mark of the cecidomyid (midge) larvae. The larvae of cynipids (gall wasp) do *not* have the "breast bone". Thus by examination of gall grubs one can separate at least two large groups of gall insect larvae by the presence or absence of this "breast bone".

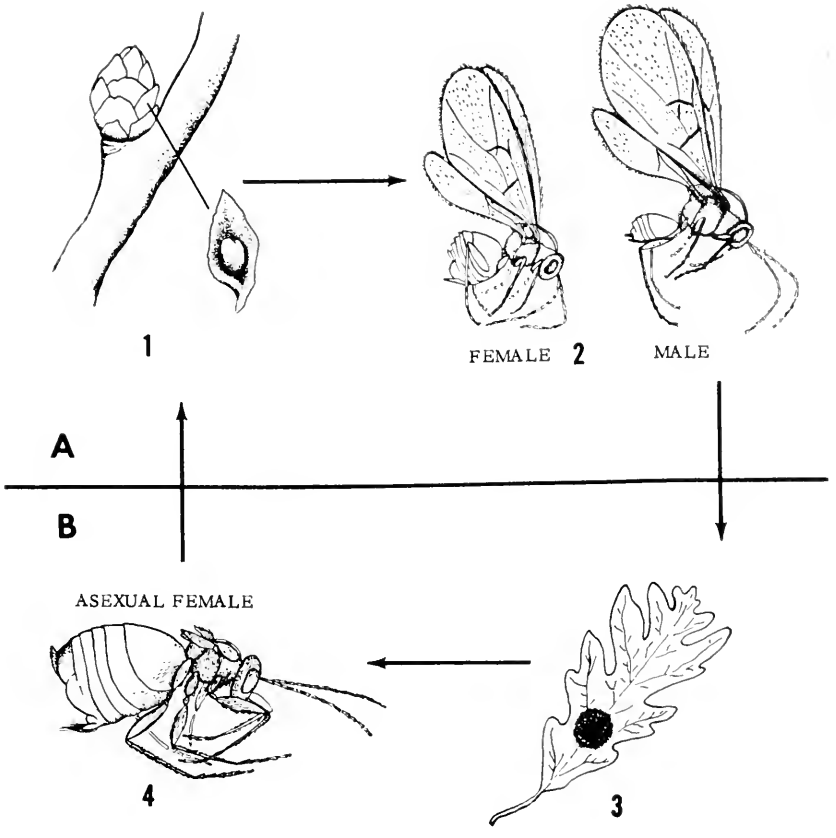


Fig. 3. Explanation of Alteration of Generations.

Part "A" of the diagrammatic sketch is the sexual generation of gall and gall insect. Both male and female wasps (2) grow from larvae hatched from eggs which are deposited in the bud of white oak (1). The tiny galls are found on the inner bud scales (1). In late May or early June the adult wasps (2) emerge and mate. The female wasp then lays eggs generally along the midrib or main veins of a white oak leaf upon which the Hedgehog Gall develops (3).

Part "B" is the asexual or agamic generation of both gall and gall insect. The Hedgehog Gall on a white oak leaf (3) grows and contains a fertilized egg laid by a *female* wasp. In early autumn larvae from these Hedgehog Galls produce agamic or asexual females. These agamic wasps (4) then lay unfertilized eggs in buds of white oak late in October or early November. The following spring both male *and* female wasps will develop from larvae in the bud scale galls and the cycle begins again.

Most gall insects, if one includes the total range in size, are small and fragile. They would seem small even if you looked at one on the tip of your finger. The insects and their life histories are as fascinating as the variations in gall forms themselves. Gall insects, besides being small, may have their appearance changed by several other factors for example: (a) sex differences in which the male can be distinguished from the female, (b) variations, (c) mutations, and (d) alternation of generations (Fig. 3). A brief account of the last three of these factors will help the reader with some idea of their meaning. Variations occur when the insect is not exactly like its parents but shows some slight differences. Mutations, however, are sudden and new variations not previously known to occur before in the species. Mutations may sometimes occur in the offspring of both plants and animals. An explanation of alternation of generations, stated in simple terms, is that succeeding generations (in this case both the gall and the gall insect) are not alike at all even if slight differences are taken into account. Let us say that insects of one generation, instead of looking exactly like their parents, more strongly resemble their grandparents. The diagram in Fig. 3 will help to illustrate this.

Among some gall wasps the differences between two succeeding generations is great enough to have caused them, at one time, to be incorrectly named as separate species or kinds. Where alternation does occur, one generation may be made up of agamic females. The term "agamic" means that they have not developed from union of male and female reproductive cells, but grow from *unfertilized* eggs (Fig. 3 Part B). The eggs of these agamic females, however, develop or hatch to become *either* male *or* female individuals (Fig. 3 Part A). The next generation, therefore, is composed of both female and male insects which produce eggs (female) and sperm (male). The young from these fertilized eggs develop into agamic females again and the full cycle is repeated by these alternating generations. The alternate parts of generations of both insect and corresponding plant gall may occur at different seasons of the year which makes necessary a careful study and observation of the *entire* life cycle. As shown in the explanation accompanying Fig. 3, the galls produced by alternating generations, as well as the insects, do not look alike and are found on different parts of the host plant. In 1873 H. F. Bassett is credited with having observed the variation and alternation of generations in galls and gall insects, and in 1875 Dr. H. Adler explained its true nature.

Life cycles of some gall insect species may require four years for completion. In view of this time requirement there is little doubt that errors in identification could have been made. A further difficulty encountered in a detailed study of gall insects is the presence of "guest" flies or other "guest" insects often found inside a particular gall. Such insects, especially the flies, do not attack the gall-producing individual, but make use of living space and take some advantage of the food supply. We must distinguish parasitic and predacious visitors from the "guests". When parasites or predators are present they may actually feed upon the larva of the gall-producing insect. Larvae of some gall midges, according to E. P. Felt,

are often present in galls in whose formation they are not known to have played a part. The factual knowledge of the biology of many gall insects is not well known, and the study of their life histories is a challenge to both amateur and professional students.

(b) Plants

A gall is made up of plant cells which have been stimulated to undergo rapid division and growth by the presence of insect secretions. The plant therefore furnishes most of the material which makes up the gall while the insect supplies the secretion which stimulates growth. Galls develop in very young plant tissue which is generally found in buds or in rapidly growing tips of branches, (Fig. 4). These buds and growing tips are made up of unspecialized plant cells which under ordinary, normal conditions continue to grow into leaves, stems and flowers. Fully mature, hardened plant tissues are unsuitable places in which a gall insect may de-

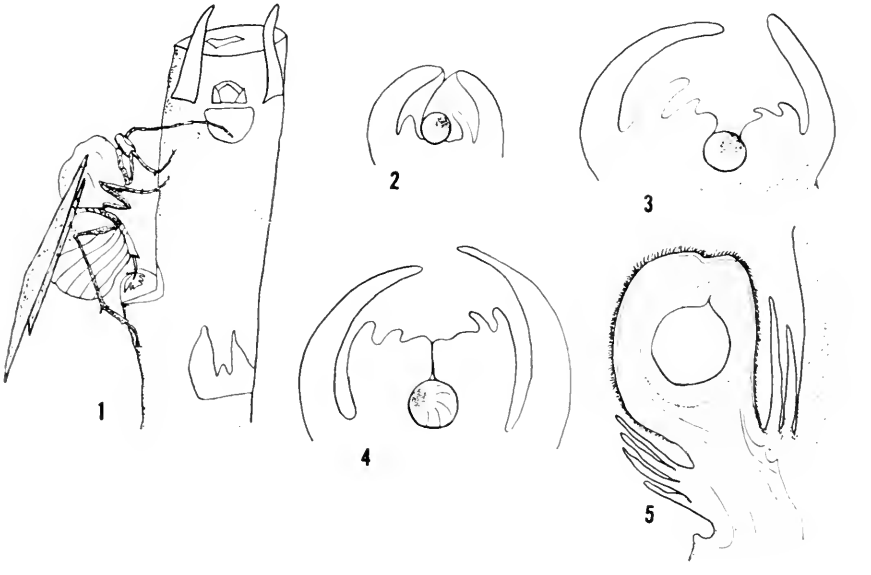


Fig. 4. How a Gall is Formed.

(1) A diagrammatic sketch to show how a gall insect selects a bud in which it deposits an egg. (2) Enlarged drawing of a bud to show position of egg within overlapping scales of the bud. (3) The plant cells of the bud have begun to grow thus enclosing the insect egg. (4) Later stage in which a larva may have developed from egg. The bud is now deformed into an early stage of the gall. (5) The gall has matured and a larval chamber is shown in the center. After the gall develops, the bud no longer performs its function of producing normal leaf, stem, or flower.

posit an egg. Selection of new plant growth areas by the insect is important for two reasons: (1) the tissue is soft and easily penetrated by the female insect ovipositor, and (2) the new cells are generally dividing and growing.

The different kinds of gall insects will not deposit eggs in any plant, but select certain plant species. For example, the insect may prefer the leaf of white oak; or another kind of gall insect may select the stem of goldenrod. Various factors such as color, odor, condition of the outer cell layers, and perhaps other things, influence the insect to seek the plant best suited to egg-laying and the grub-developing part of its life.

In plant tissues the cells adjoin each other; thus it is possible for dissolved substances contained in one cell to pass through cell walls and membranes of other cells. The membrane lining the interior of a cell controls the ease or difficulty the materials in solution have in passing from one cell to another. This is important since we must consider the parts played by both the gall insect secretions plus the reaction of such compounds with the contents of living plant cells. As the insect deposits an egg in rapidly growing parts of a plant, it may inject some of its own body fluids at the same time. Experimental studies have shown that a fluid of glandular origin is injected into the hole or wound made by the insect's ovipositor as the egg is pushed through. The stimulating fluid introduced by the insect brings about a rapid, and abnormal, division and growth of plant cells in the immediate vicinity of the insect egg. This egg, as it "hatches" and continues developing into a larva, also secretes fluids from its body cells. Thus the plant tissue in the area surrounding the egg, and finally the developing larva, becomes by cell division and growth distorted into a characteristic gall. The plant cells making up the gall continue growth which ceases when the larva inside has completed its feeding. After the larval stage the less active pupa develops, and finally the adult insect is ready to leave the gall. The shape, size, and form of the gall is determined not only by the gall insect, but also by the plant selected by that insect for its egg laying.

It was once believed that the mechanical disturbance or injury caused by the insect breaking the plant tissues or by the motion stimulus of a growing larva on the plant cells started formation of a gall. At present this idea is not accepted and most investigators have found that chemical compounds contained in secretions of the adult insect and the living grub excite increased growth of plant cells and bring about gall formation.

Examination will actually show that a gall is made up of plant tissue. An old gall may have a fibrous or spongy interior with one or more larval chambers embedded within it. Exit holes, from which the adult gall insect emerged, can be seen in many galls. These exit holes are known to have been prepared, in most cases, by the larva chewing its way to the surface before it pupates. The exit hole and tunnel are temporarily closed by the larva until, after completing pupation, it becomes a young adult and is ready to leave the gall, (Figs. 5, 6, 7, and 8). It can be seen from the above discussion

that galls represent a complex relationship between plant and insect, but at the same time a strange biological association. It cannot be said that there are mutual benefits to both plant and the insect which produced the gall. The insect evidently benefits at the expense of the host plant.

To give some idea of the number and variety of plants visited by insect gall makers, E. P. Felt has listed eighty plant families which are known to include species which develop galls as a result of insect visitation. Ferns, sedges, rushes, as well as grasses, roses, legumes, mints, and sunflowers are some of the families of plants where galls may be found. In the large Sunflower Family galls are often found on goldenrod, aster, ironweed, blazing star, and various species of sunflowers themselves. In Illinois some willows, hackberries, hickories, walnuts, poplars and oaks are often host plants for a variety of galls. Among the oaks, especially, a rich representation of gall forms may be found on catkins, acorns, leaves, twigs, and even roots.

This section on plants should not be closed without some comment regarding plant malformations which have been caused by agents other than gall insects. Many gall-like growths, not brought about by gall insects at least directly, are often found on plants. Abnormal growth, caused by mechanical injury to stem and tree trunk, may result when they are girdled by cutting away bark and outer layers, or by binding with wire or rope. The binding and girdling damages conducting tissues located in the outer layer of woody stems just under the bark. Damage or interruption of function of the cells and tissues results in enlarged, gall-like growth, and finally in death of the plant. Burls, large woody growths, from which burlwood veneer is made, are often found on various species of trees, (Figs. 65 and 66). Cedar "apples" develop from a fungus which in turn causes the knotty growth or "apples" common on red cedar. These growths, are galls but they are not insect galls, (Fig. 64). The swollen, distorted appearance of some plants after being sprayed with chemical weed killers may assume gall-like form. All of these above malformations are not insect-caused galls in the sense in which we have used the term in this booklet.

USES OF GALLS

At the present time galls are of less importance as a source of commercial products than they were several hundred years ago. Man once used many things produced naturally which modern chemical and biological laboratories now supply with more convenience and less expense.

One of the galls mentioned in ancient writings is the Aleppo Gall, *Cynips gallae-tinctoriae,* found on species of oak in Asia and Europe. The Aleppo Gall contained about 65 percent tannic acid which made it valuable in the production of astringent preparations used in treatment of burns, mouth infections and toothache. The Morea Gall, which is found on the European oak *Quercus cerris* L., was used to adulterate Aleppo Galls as a source of tannic acid em-

ployed in tanning and dyeing processes. Ink made from some galls was a permanent writing fluid used at a time when most government records were kept as written accounts and not on punched cards as in modern record systems.

Chickens, turkeys, cattle, hogs, and sheep, in some parts of the United States, use the deciduous black oak gall, *Dryocosmos deciduous*, as food. The little galls resemble dark grains of wheat. Birds have an interest in galls because of the grubs contained inside. Damaged exit holes often seen in old galls are the work of birds, notably woodpeckers. Mice and squirrels are known to visit galls possibly for the purpose of using as food the nutritive vegetable matter of the gall itself as well as the grub or insect inside. Galls are frequently found with quantities of sweet honeydew which attracts large numbers of ants, bees, wasps, and flies. Honeybees are known to visit galls evidently for the purpose of securing the sticky liquid which they finally convert into honey. Beekeepers consider galls an important source of potential honey. A use of gall grubs, not commonly known in many parts of the country, is made by ice fishermen who find them available in winter when other natural bait is scarce.

DAMAGE DONE BY GALLS AND GALL INSECTS

In general the damage done to plants by the presence of galls is principally that of disfiguration. The gall-producing insects such as midges, gall-flies and mites cause considerable damage to commercial crops because of abnormal growths which these insects initiate on various parts of the crop plants. Fruit growers, and those who deal with floricultural crops, are no doubt acquainted with pear-leaf blister mites, apple leaf midges, and rose and chrysanthemum midges. These insects cause considerable damage to commercial crops. Trees, as well as shrubs, annual and perennial plants, and evergreen conebearers are all subject to damage by galls. Norway spruce may become infested with cone galls which are the work of the spruce gall aphid, and Colorado blue spruce is often disfigured with a similar gall.

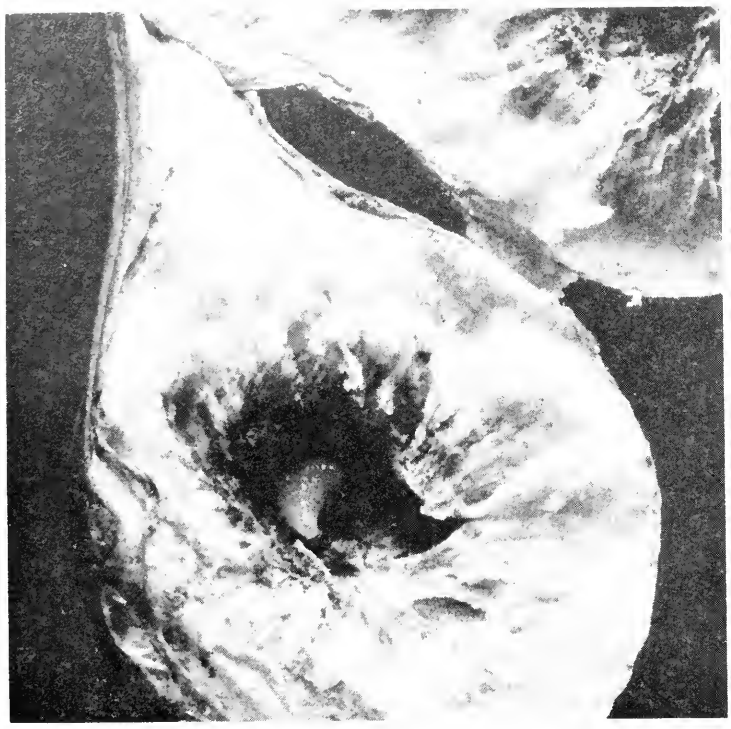
Galls may become abundant to the extent that they interfere with normal functioning of green leaves in the process of food manufacture or photosynthesis. At the same time flowers and fruit fail to develop normally as a result. Woody galls often found on hickories and oaks may persist for years becoming unsightly and detracting from the beauty and usefulness of ornamental trees and shrubs. The witches' broom often seen on American hackberry, (Fig. 63), is probably caused by a gall mite plus a powdery mildew fungus. This "broom" causes twig distortions which disfigure the trees, and the bunching of twigs may interfere with normal production and distribution of leaves. Use of modern insecticides and crop rotation have done much to diminish losses caused by galls and gall insects.

SUGGESTIONS FOR GALL STUDY AND COLLECTING

If you wish to study galls and gall insects as well as collect specimens, it is not necessary to have elaborate equipment. Patience and care are as important as the materials you may use. Observation of the gall insects will require a microscope or at least a very good hand lens. A reference book with keys for identification such as PLANT GALLS AND GALL MAKERS by E. P. Felt will be helpful and advisable.

Dry, woody galls will present no problem in collecting and they can be stored in any suitable small boxes. In the case of delicate or soft galls it may be necessary to preserve these in small glass containers with some liquid preservative such as a weak formalin or a 50 percent alcohol solution. It is always desirable to record the kind of plant on which the gall was found, or to collect enough of the host plant for later identification. Labels giving the date and collection locality will make the specimens more useful to both collector and those who may want to study the galls and insects later. By keeping records of observations it is possible to add to the information presently available concerning galls and gall insects.

For the purpose of studying and observing the gall insects themselves, it is best to collect the galls just prior to the time the adult insect will emerge. It is fairly easy to secure the freshly formed galls in early spring and summer. These galls can be placed in a large glass jar or plastic container with a cloth-covered opening for air. The plant stem must be placed in a small container of water for the plant must be kept alive if the galls and insects are to survive. A large, wide-mouth jar can be a good cage if the top is covered with cloth to admit air and at the same time the cloth prevents escape of the insects. Light wood frames can be covered with plastic to furnish cages for rearing and observing galls and gall insects. This method may not always be satisfactory if galls are collected in the autumn for at that time of year it is advisable to keep them over winter in jars or cages under conditions which are similar to those out-of-doors. A source of moisture will be needed within jars or cages and since some gall insects pupate in soil it will be necessary to sterilize a small amount of soil to be used in the jar or cage. The soil can be kept moist but not wet. Most amateur collectors will be sufficiently rewarded by watching the emergence of adults and in observing these fragile and interesting insects. The value of your work and your personal satisfaction will be far greater if you can succeed in describing a complete life cycle of a gall insect through all of its varied stages.



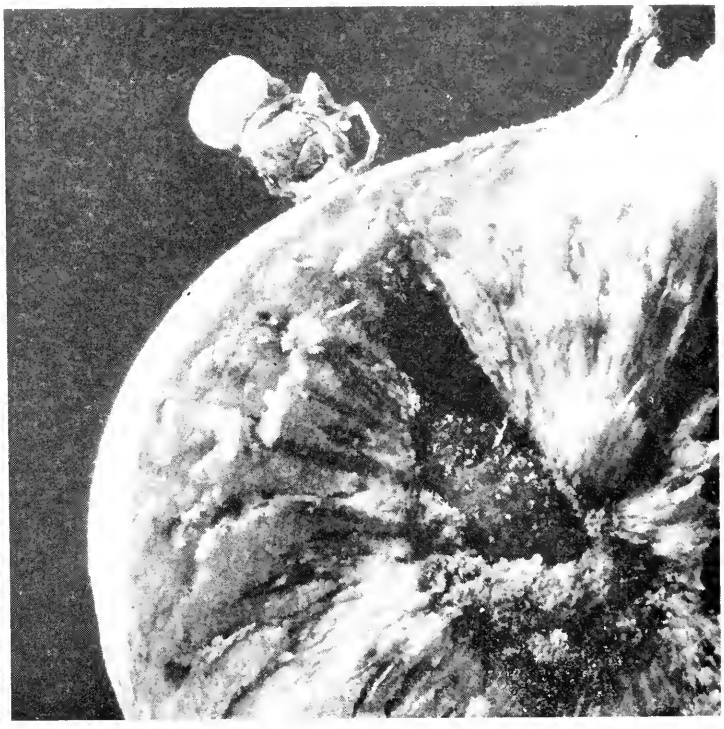


Fig. 5. (left) This series of four photographs illustrates the development of a gallfly, *Eurosta solidaginis*, from the larva in the photograph to the adult in Fig. 7. In this photo the white, grub-like larva lies in the center of the pithy gall. There is need for the larva to chew its way to the surface thus forming an exit tunnel. The gall has developed on a goldenrod stem. (GSS)

Fig. 6. (right) The larva has changed or metamorphosed to the adult stage. The pupal shell can be seen in the tunnel. The adult insect could not escape from the gall had a tunnel not been prepared by the larva as it chewed its way toward the surface. The exit opening is not broken until the adult is ready to emerge. (GSS)

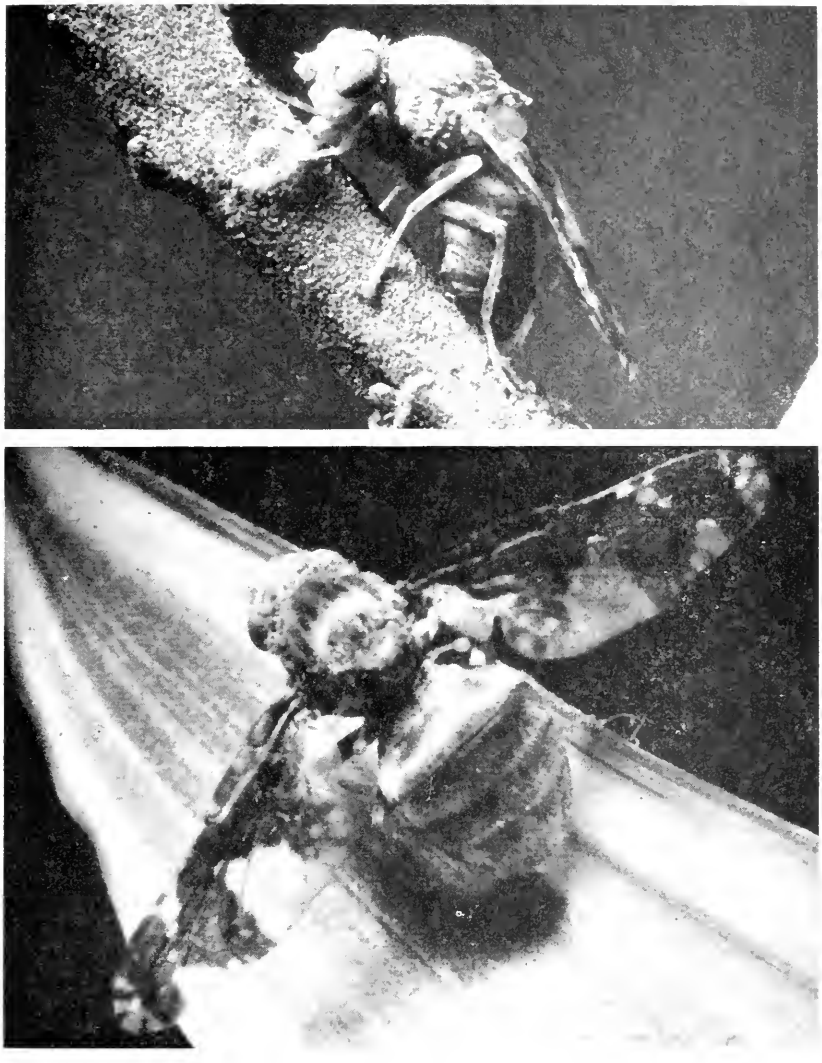


Fig. 7 (above). This gallfly has just emerged from a gall. The body appears as a moist and somewhat bedraggled individual. The folded wings will soon become dry and inflated as the fly pulsates and moves legs, wings, and entire body. (GSS)

Fig. 8 (below). The gallfly's spread wings are now dry. This tiny insect has a wing spread of less than half an inch. The wings are marked with brown and these same wings will soon carry the insect to other gallflies and goldenrods. (GSS)

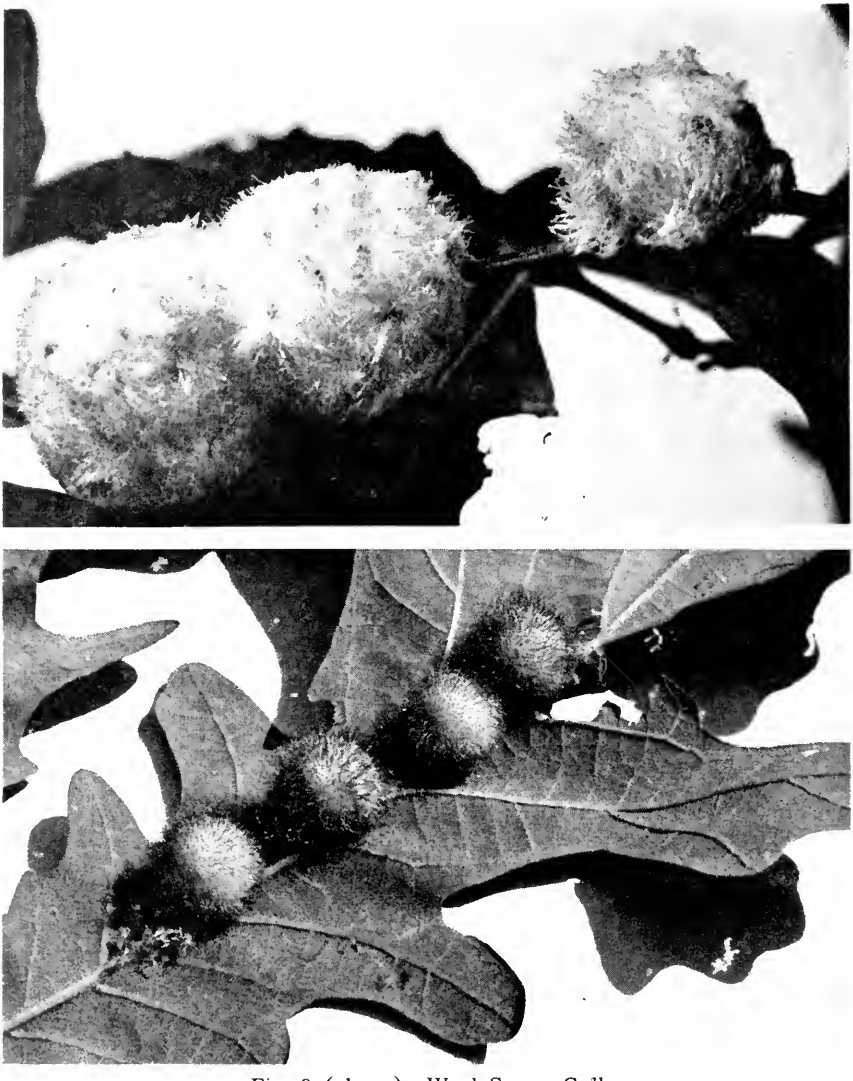


Fig. 9 (above). Wool Sower Gall
Gall Wasp (*Callirhytis seminator* Harris)
White Oak (*Quercus alba* L.)

A showy and attractive gall growth on oak twigs. The large number of small, hairy galls are attached to a common point to form this pinkish-white, wooly growth. A gall with a similar appearance may be found on several other species of oak. The Wool Sower was called by E. P. Felt ". . . one of the finest of natural objects." (CH)

Fig. 10 (below). Oak Hedgehog Gall
Gall Wasp (*Acraspis erinacei* Beutm.)
White Oak (*Quercus alba* L.)

Oak leaf galls are often observed since species of oak are favorite hosts of gall wasps. The Acraspis Galls are complicated because of the sexual and agamic forms (See Fig. 3 and discussion of alternation of generations). These reddish-green Hedgehog Galls are the agamic form and may be spiny or nearly smooth. (CH)

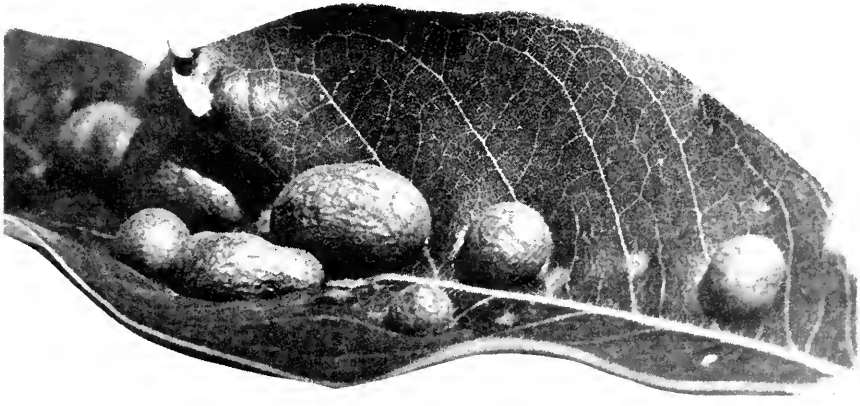


Fig. 11 (above). Oak Potato Gall
Gall Wasp (*Callirhytis seminosa* Bass.)
Pin Oak (*Quercus palustris* Muench.)

Hard, woody knots mark the appearance of this gall on twigs of pin oak, and they are sometimes described as resembling a strawberry. These galls have been cut lengthwise to show the interior structure and the larval cells. (KB)

Fig. 12 (below). Oak Pill Gall
Gall Midge (*Cincticornia pilulae* Walsh)
Shingle Oak (*Quercus imbricaria* Michx.)

These Pill Galls are rounded and sometimes nearly globular in form. They appear as dark red growths on the upper side of the shingle oak leaf. There are many kinds of Pill Galls and some of them are found only on the underside of the leaves. (CH)

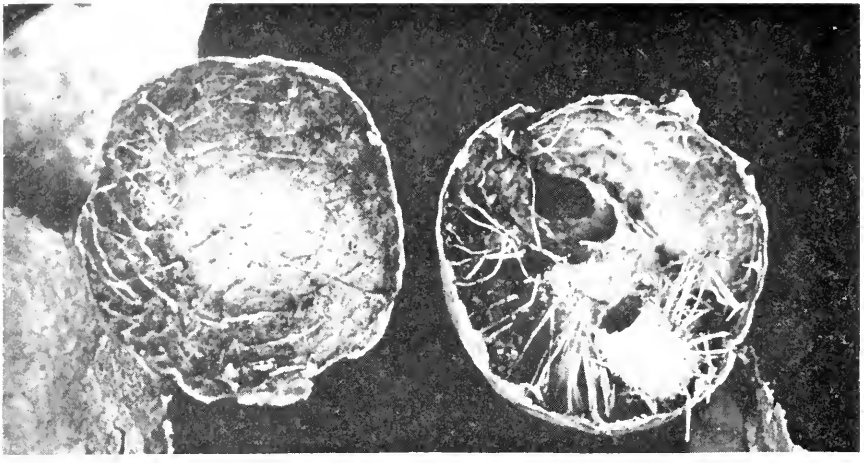


Fig. 13 (above). Small Oak Apple
Gall Wasp (*Andricus singularis* Bass.)
Red Oak (*Quercus rubra* L.)

In autumn it is easy to find the Small Oak Apple on fallen oak leaves. The photograph shows opened galls with slender fibers which support the larval cell inside near the center. In diameter this oak apple is about one inch, and while young it is light green. Later in summer it will become thin walled, brittle and brown. (KB)

Fig. 14 (below). Bassett's Oak Gall
Gall Wasp (*Disholcaspis bassetti* Gill.)
Shingle Oak (*Quercus imbricaria* Michx.)

The flask-shaped galls are light green and hairy in early summer. Later they will become brown like the twig from which they developed. Bassett's Oak Gall is found as a single or clustered growth. (CH)

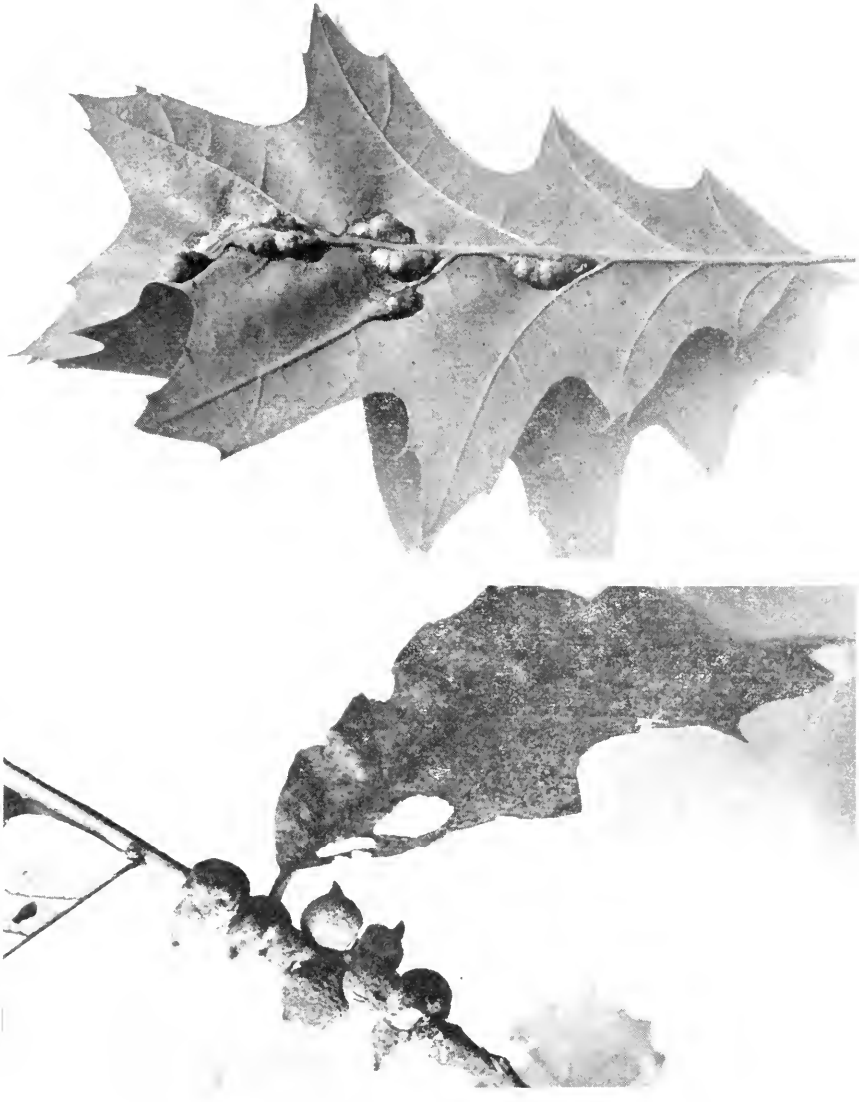


Fig. 15 (above). Black Oak Gall
Gall Midge (*Cecidomyia Sp.*)
Black Oak (*Quercus velutina* Lam.)

Since the species of fly-like midge which is responsible for this gall is not known, it will serve to show how much work is needed in the study of galls and gall insects. These dark brown galls are found on the underside of the black oak leaf very near the main veins. (CH)

Fig. 16 (below). Rough Bullet Gall
Gall Wasp (*Disholcaspis mamma* Cresson)
Swamp White Oak (*Quercus bicolor* Willd.)

These round, nipple-tipped galls are found on several species of oaks. They are colored green and red when young, velvety to touch, later becoming red or dark brown. In winter the galls are very hard and may be cut with difficulty. Rough Bullet Galls are generally found on young shoots of oak. (CH)

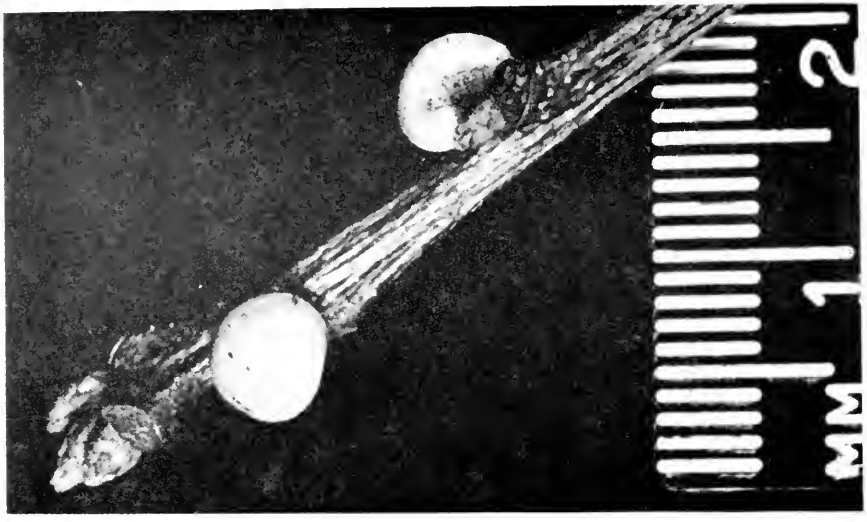


Fig. 17 (above). Marbled Oak Gall
Gall Wasp (*Andricus pisiformis* Beutm.)
White Oak (*Quercus alba* L.)

A small oak gall, found in spring, white or pale green often mottled with darker colors. Mabled Oak Galls, which develop from buds, are fleshy at first later becoming dry and hollow. (KB)

Fig. 18 (below). Oak Rosette Gall
Gall Wasp (*Andricus foliosus* Weld)
Swamp White Oak (*Quercus bicolor* Willd.)

Fleshy, green segments of modified leaves enclose this gall which occurs on the upper surface of leaves of young oaks and oak sprouts. Several larval cells may be found inside each gall. (CH)

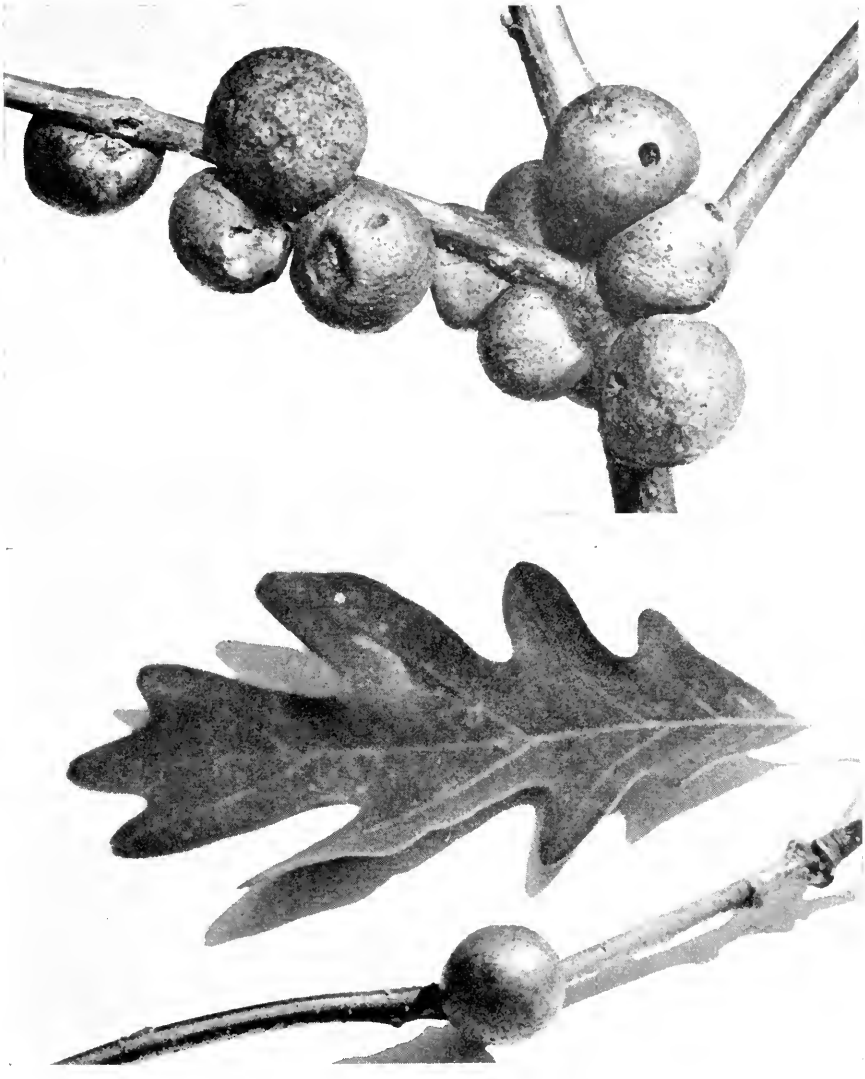


Fig. 19 (above). Oak Bullet Gall
Gall Wasp (*Disholcaspis quercus-globulus* Fitch)
White Oak (*Quercus alba* L.)

Oak Bullet Galls are single or clustered; however they do not have the beaked structure found in the Rough Bullet Gall. These bullet galls may be about two-thirds of an inch in diameter on various species of the white oak group. Freshly formed galls are generally yellowish-red and are often collected from fallen twigs. An exit hole is plainly visible in the uppermost gall on the right. (CH)

Fig. 20 (below). Oak Bullet Gall
Gall Wasp (*Disholcaspis quercus-globulus* Fitch)
White Oak (*Quercus alba* L.)

These oak galls are about three quarters of an inch in diameter and occur singly or sometimes in clusters. The color of the freshly formed galls is yellowish-red and, later in summer, dark red or brown. (CH)

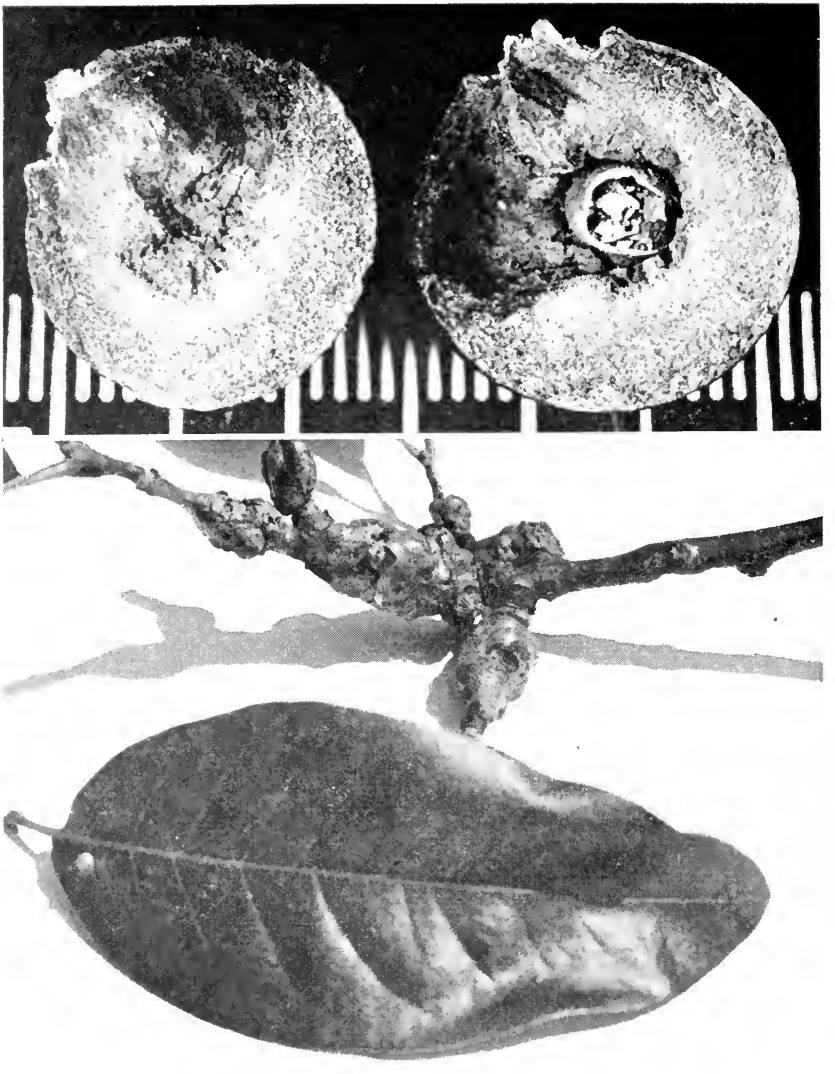


Fig. 21 (above). Oak Bullet Gall
Gall Wasp (*Disholcaspis quercus-globulus* Fitch)
White Oak (*Quercus alba* L.)

A section cut through the middle of an Oak Bullet Gall. The spongy, fibrous interior of the gall can be seen as well as the larval cell in the center on the right. The scale is in centimeters. (KB)

Fig. 22 (below). Woody Twig Gall
Gall Wasp (*Callirhytis tuberosa* Bass.)
Shingle Oak (*Quercus imbricaria* Michx.)

Sometimes every twig on a shingle oak may be distorted by this dark brown, woody gall. It is a many-celled growth and has a warty, potato-like appearance. (CH)

Fig. 23. Gouty Oak Gall
Gall Wasp (*Plagiotrochus punctatus* Bass.)
Shingle Oak (*Quercus imbricaria* Michx.)

Fig. 24. Gouty Oak Gall
Gall Wasp (*Plagiotrochus punctatus* Bass.)
Shingle Oak (*Quercus imbricaria* Michx.)

Fig. 23. The young shingle oak bears a heavy crop of Gouty Oak Galls. The tree has lost its normal number of leaves and those remaining are not healthy, functioning green leaves. The weight of the galls may be one cause of the tree leaning from an upright position. (JG)

Fig. 24. The sexual generation of this gall is found on the leaves and bears very little resemblance to the swollen, woody growth of the asexual generation. (JG)

Fig. 25 (above). Oak Wool Gall
Gall Wasp (*Andricus flocci* Walsh)
Shingle Oak (*Quercus imbricaria* Michx.)

There are many wool galls of different shapes, sizes and color. This gall is grayish-cream when fresh and it is difficult to find except on low growing branches or when twigs or leaves have fallen to the ground. (CH)

Fig. 26 (below). Spiny Rose Gall
Gall Wasp (*Diplolepis bicolor* Harris)
Pasture Rose (*Rosa carolina* L.)

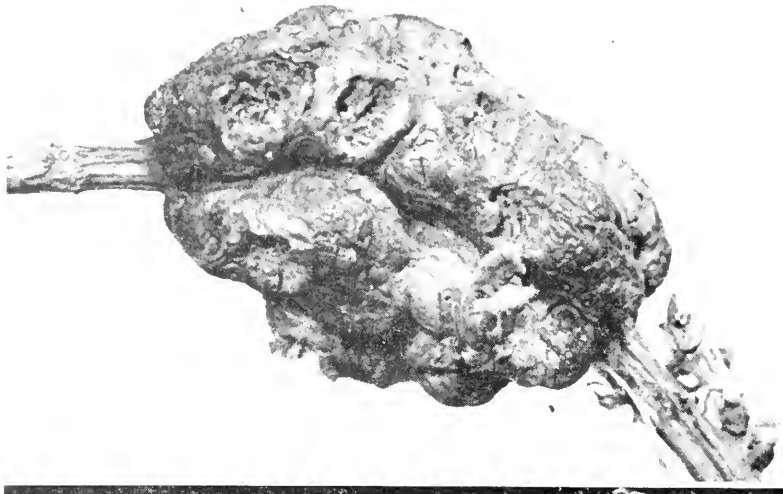
The hollow green and red galls seem to imitate the spiny condition of the host plant. The genus of wasps which produces this gall in spring is so closely associated with the Pasture Rose that the galls are not likely to be found on any other plants. Spiny Rose Galls occur singly or in groups which turn brown and may lose the spines as they become older. (CH)

Fig. 27 (above). Cinquefoil Axil Gall
Gall Wasp (*Gonaspis potentillae* Bass.)
Common Cinquefoil (*Potentilla simplex* Michx.)

The Cinquefoil Axil Gall is green and sparsely hairy in its early development and will turn brown later in summer. Note clusters of modified leaves which are part of the gall itself. This gall is not often found although common cinquefoil is a plant bearing small yellow flowers frequently seen in woods and along roadsides. (CH)

Fig. 28 (below). Blackberry Seed Gall
Gall Wasp (*Diastrophus cuscutaeformis* O. S.)
Blackberry (*Rubus allegheniensis* Porter)

In this "Seed Gall" the cluster is made up of individual galls each of which is hairy and spined near the tip. Note that the spiny growth of the gall simulates the spiny cane of the blackberry. This particular gall is not common although the blackberries and raspberries are frequent hosts for a number of gall insects. (KB)



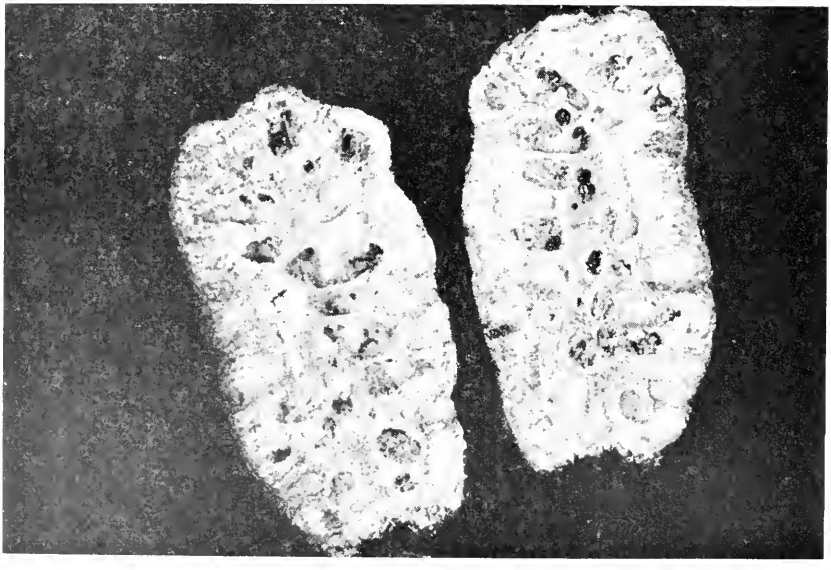


Fig. 29 (above). Blackberry Knot Gall
Gall Wasp (*Diastrophus nebulosus* O. S.)
Blackberry (*Rubus allegheniensis* Porter)

This is a long, stem swelling with a warty appearance. There are generally a number of deep furrows present in the dark brown or purplish gall which may be three inches in length. Some observers maintain that the galls are more likely to be found on plants growing in slightly acid, sandy soil. It is possible that the adult wasp selects these plants in preference to those growing in other kinds of soil. (CH)

Fig. 30 (below). Blackberry Knot Gall
Gall Wasp (*Diastrophus nebulosus* O. S.)
Blackberry (*Rubus allegheniensis* Porter)

A lengthwise cut through a Blackberry Knot Gall to reveal a number of larval chambers embedded in the porous, woody tissue of the gall. (KB)

Fig. 31. Thorn Cockscomb Gall
Gall Midge (*Trishormomyia crataegifolia* Felt)
Redhaw (*Crataegus mollis* (T. & G.) Scheele)

Fig. 32. Hickory Onion Gall
Gall Midge (*Caryomyia holotricha* O. S.)
Hickory (*Carya illinoensis* (Wang.) K. Koch.)

Fig. 31. This Thorn Cockscomb Gall is greenish-red and has a fuzzy "fungus-like" appearance. Nearly every leaf on some redhaw trees may bear these galls which appear in early summer. The gall resembles the Leaf Roll and Cockscomb Galls found on elm. (CH)

Fig. 32. Small, globular, clustered galls, hairy and reddish are sometimes found on the underside of the compound leaves of this hickory (Pecan). The insect selects the mid-rib area of the leaf in which to deposit eggs. (CH)

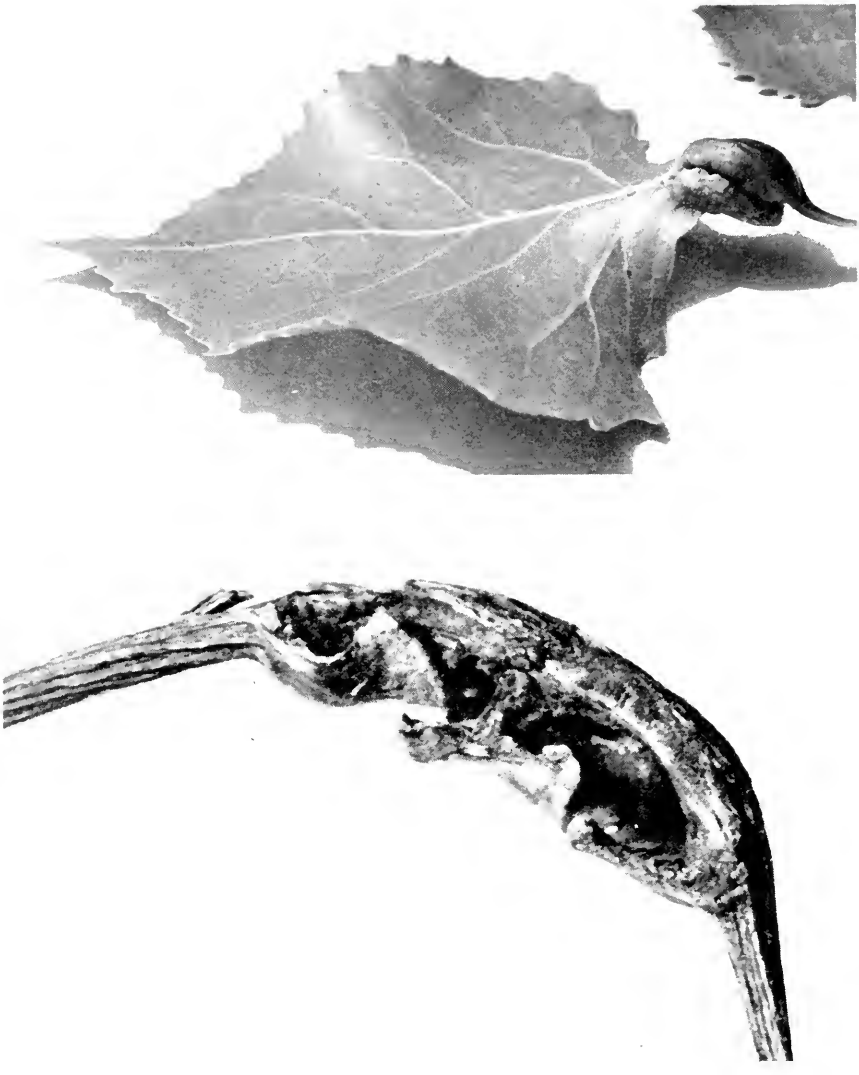


Fig. 33 (above). Poplar Stem Gall
Aphid (*Pemphigus populicaulis* Fitch)
Cottonwood (*Populus deltoides* Marsh.)

Another common gall found on cottonwood leaves where it is located near the base of the leaf or blade. Newly formed galls are reddish-green when young and then turn darker with age. The opening in the gall is a characteristic, elongated slit and the interior of the gall is inhabited by aphids or plant lice. Hundreds of leaves from one tree may bear these galls. (CH)

Fig. 34 (below). Poplar Petiole Gall
Aphid (*Pemphigus populitransversus* Riley)
Cottonwood (*Populus deltiodes* Marsh.)

In contrast with the Poplar Stem Gall this growth appears near the middle of the petiole or leaf stem. This is a photograph of an old gall which is hollow but when fresh would be found to contain plant lice. (CH)

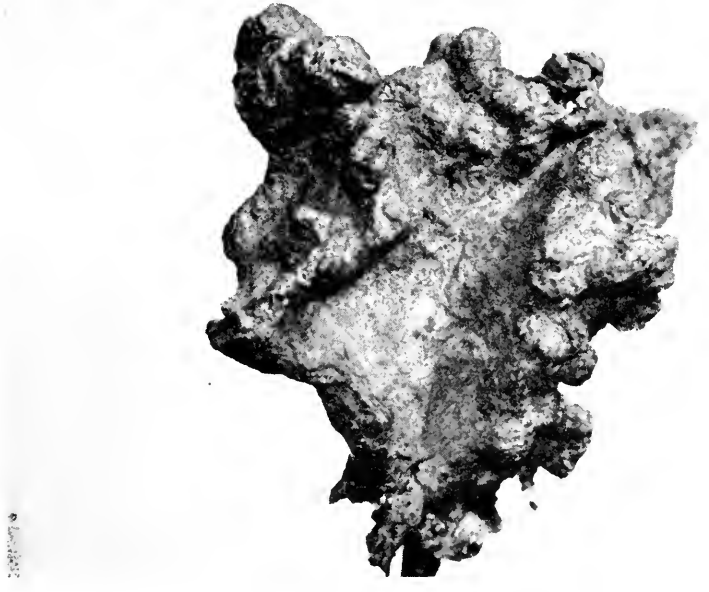


Fig. 35 (above). Vagabond Poplar Gall
Aphid (*Mordwilkoja vagabunda* Walsh)
Cottonwood (*Populus deltoides* Marsh.)

A very apparent deformity of cottonwoods. The gall is said to be found on trees which stand in water part of the time, or on young trees. Plant lice, which stimulate the formation of the gall, attack leaf buds in early spring transforming them into lobed, irregular, hollow masses in which many aphids may be found. The galls, green at first, become dark brown or black. (CH)

Fig. 36 (below). Vagabond Poplar Gall
Aphid (*Mordwilkoja vagabunda* Walsh)
Cottonwood (*Populus deltoides* Marsh.)

An enlarged view of the gall. The growth is not heavy and woody as the photograph might indicate, but spongy and hollow since it originates from young leaves. This gall was a little less than two inches across at its widest point. (CH)

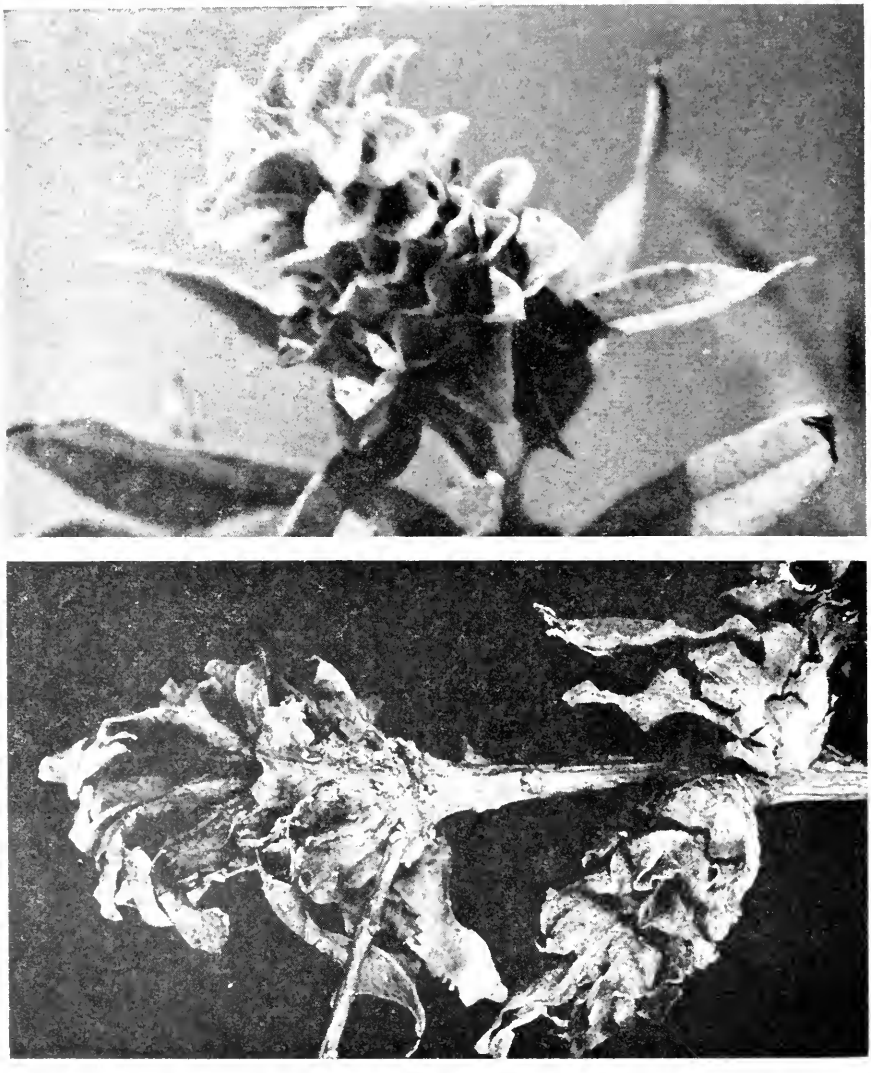


Fig. 37 (above). Willow Cabbage Gall
Gall Midge (*Rhabdophaga brassicoides* Walsh)
Willow (*Salix humilis* Marsh.)

An open, rosette gall found in spring and early summer on shrubby willows. The loose, leafy and bract-like parts of the gall resemble shortened leaves of the willow. This gall is rather hairy and gray-green in color. (CH)

Fig. 38 (below). Willow Cabbage Gall
Gall Midge (*Rhabdophaga brassicoides* Walsh)
Willow (*Salix Sp.*)

An old Willow Cabbage Gall in winter condition. The growth developed from a bud and formed a gall which has a loose appearance rather than the closely-overlapping parts of the Pine Cone Willow Gall. (KB)

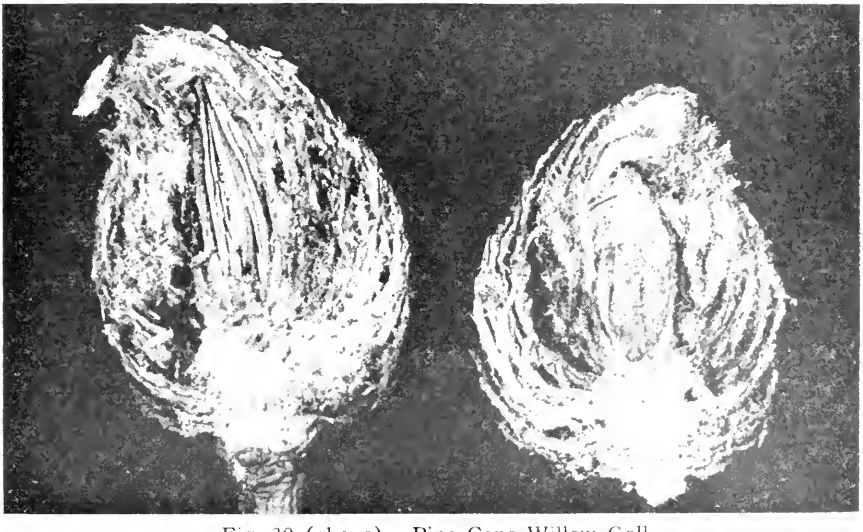


Fig. 39 (above). Pine Cone Willow Gall
Gall Midge (*Rhabdophaga strobiloides* Walsh)
Willow (*Salix Sp.*)

The overlapping, scale-like growths of this gall seem to resemble the seed-bearing cones of pine trees. Separate parts of the gall, which have a gray-green, velvety appearance, look like the leafy bracts which one might find below a flower. The host plant is generally one of the shrubby species of willow. (CH)

Fig. 40 (below). Pine Cone Willow Gall
Gall Midge (*Rhabdophaga strobiloides* Walsh)
Willow (*Salix Sp.*)

A section cut through two Pine Cone Willow Galls. The fibrous structure of the interior of the gall is apparent as well as the cone-like, overlapping "scales". The larval chamber is near the center of the gall. (KB)

Fig. 41 (above). Pine Cone Willow Gall
Gall Midge (*Rhabdophaga strobiloides* Walsh)
Willow (*Salix humilis* Marsh.)

This specimen has been identified with the same name as the smooth-tipped gall in Fig. 39. Notice that scale-like bracts have tufts very unlike those of the smooth-tipped Pine Cone Gall. Later during the summer these pale green, velvety gall growths will turn brown. (CH)

Fig. 42 (below). Willow Knot Gall
Sawfly (*Euura propinqua* Rohw.)
Willow (*Salix Sp.*)

An abrupt swelling on willow twigs or small branches characterizes this rather uncommon gall. Its warty appearance resembles, in miniature, the very large gall-like growths sometimes seen on tree trunks. The sawfly responsible for the gall is not a true fly but belongs with the bees and wasps. (KB)

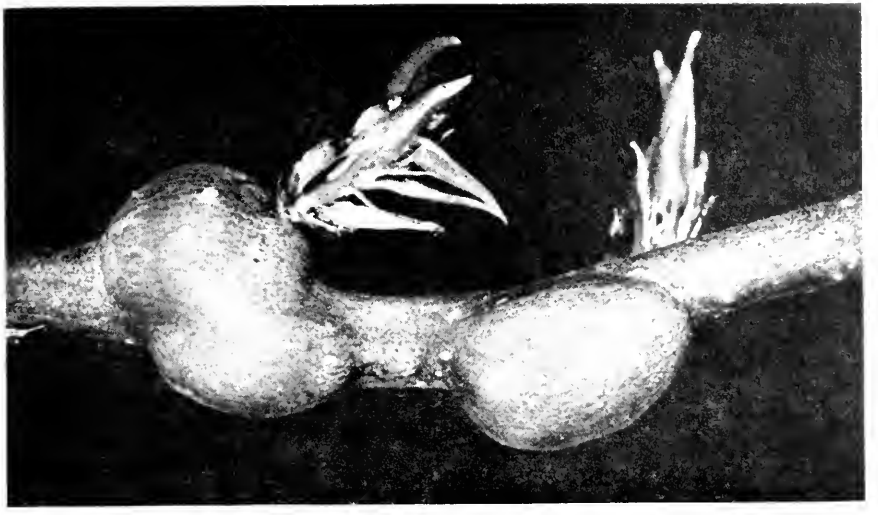


Fig. 43 (above). Poplar Twig Gall
Gall Fly (*Agromyza schineri* Giraud.)
Quaking Aspen (*Populus tremuloides* Michx.)

Although quaking aspen belongs with the Poplars, it is a more common tree in north central Illinois. The gall is a rather irregular, oval swelling on smaller twigs. The gray-green color of these twig galls resembles that of the twigs themselves. Note that the new, leafy shoots appear to grow through the gall itself. (KB)

Fig. 44 (below). Leaf Roll of Elm
Aphid (*Georgiaphis ulmi* Wilson)
Slippery Elm (*Ulmus rubra* Muhl.)

This gall, unlike the Cockscomb Gall on American elm, is found on the underside of the slippery elm leaf. The coarse, rough leaves of the elm curl and roll as the gall develops. Aphids or plant lice are often found inside the gall. The presence of these aphids is a biological characteristic which actually helps to identify the tree. (CH)

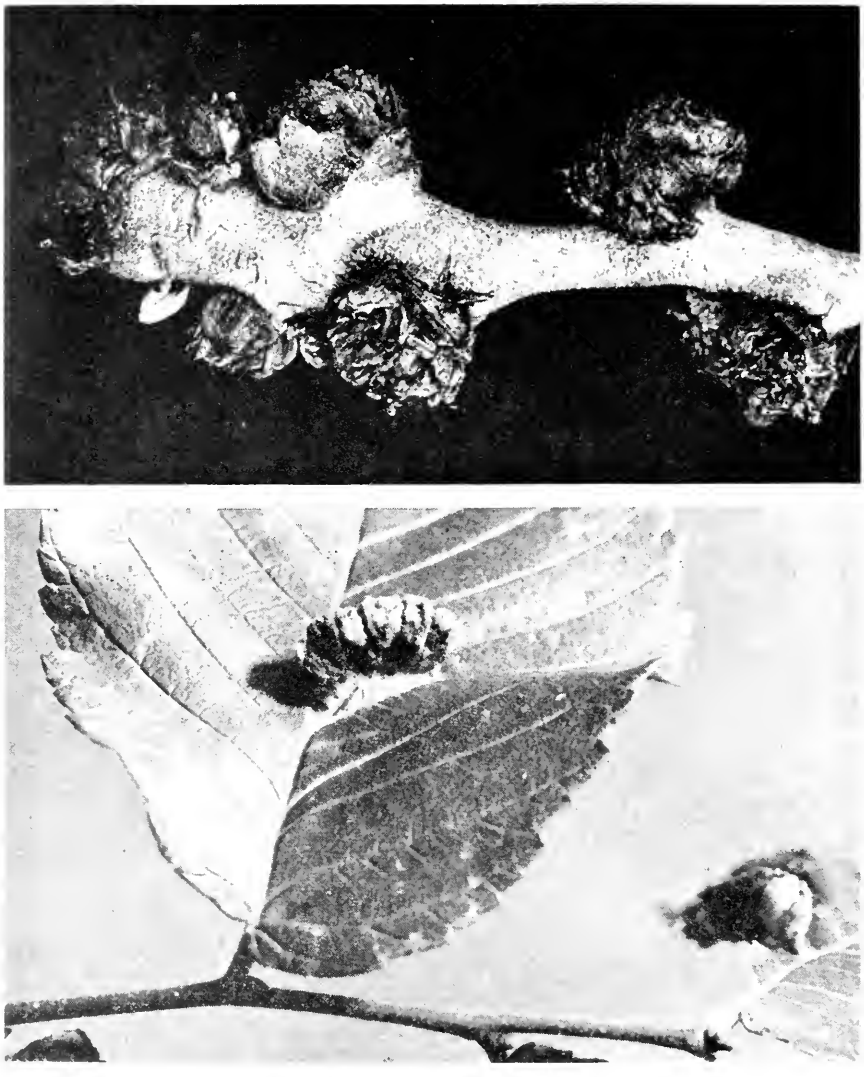


Fig. 45 (above). Elm Bud Gall
Gall Midge (*Dasyneura ulmea* Felt)
Slippery Elm (*Ulmus rubra* Muhl.)

The slippery elm has large, hairy, reddish buds in which the fly-like midge deposits eggs. The galls are made up of a very large number of bud scales and immature leaves in early spring. The Elm Family, which includes hackberries as well as elms, is noteworthy for many galls and gall insects. (KB)

Fig. 46 (below). Cockscomb Elm Gall
Aphid (*Colopha ulmicola* Fitch)
American Elm (*Ulmus americana* L.)

A green and red gall found on the upper side of American elm leaves and named from its fancied resemblance to a rooster's comb. The ridged growths appear between leaf veins, and the gall will contain aphids responsible for its formation. Cockscomb Elm Gall is likely to be found on young trees and those subject to flooding in the early part of summer. (CH)

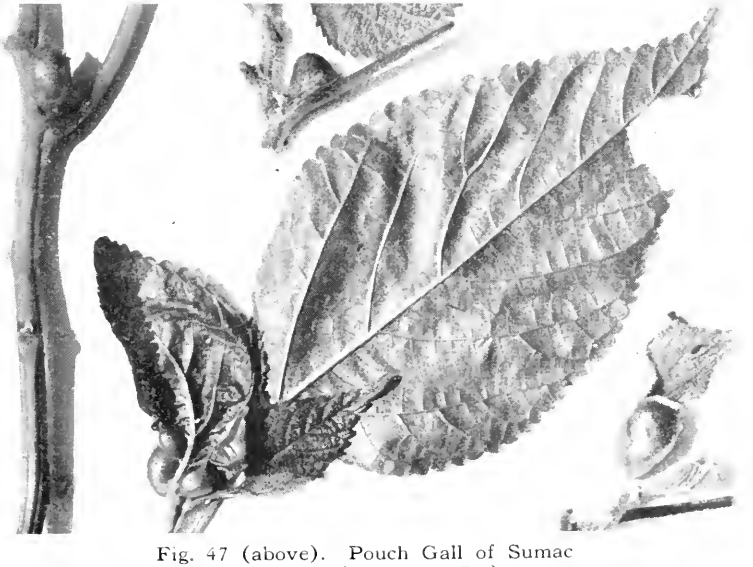


Fig. 47 (above). Pouch Gall of Sumac
Gall Mite (*Eriophyes Sp.*)
Fragrant Sumac (*Rhus aromatica* Ait.)

Some of the sumacs, which include poison ivy and poison sumac, may be toxic to man but they support a number of gall mites and midges. The sumac leaf shown is from one of the harmless kinds often found as a low shrub in Illinois. The mites which produce the reddish pouch or cylindrical galls are individually smaller than the head of a pin. (CH)

Fig. 48 (below). Nettle Bud Gall
Gall Midge (*Cecidomyia Sp.*)
Wood Nettle (*Laportea canadensis* (L.) Gaud.)

The tiny insect which visits this wood nettle is evidently not distracted by the stimulus of stinging hairs of the plant. Anyone who has walked in wet woodlands in summer is likely to see, not only the galls, but make contact with the stinging hairs of wood nettle. These greenish, irregular growths appear in early summer and the midges are fly-like insects. (CH)

Fig. 49 (above). Grape Phylloxera
Aphid (*Phylloxera vitifoliae* Fitch)
Frost Grape (*Vitis vulpina* L.)

The Phylloxera Galls of wild grape are often abundant to the point of distorting the individual leaves noticeably. These galls are the work of plant lice or aphids and they occur on the under side of the leaves. Virginia Creeper or Woodbine, of the same plant family, is often a host for similar galls. (CH)

Fig. 50 (below). Grape Filbert Gall
Gall Midge (*Schizomyia coryloides* Walsh & Riley)
Wild Grape (*Vitis Sp.*)

An uncommon, clustered gall which takes its name from a similar shape of the filbert. These hairy, green bud galls apparently develop from leaf buds since they appear opposite the tendril on the grape twig. Grape flowers may also develop from the same position on the twig. (KB)

Fig. 51. Redroot Bud Gall
Gall Midge (*Asphondylia ceanothi* Felt)
New Jersey Tea (*Ceanothus americanus* L.)

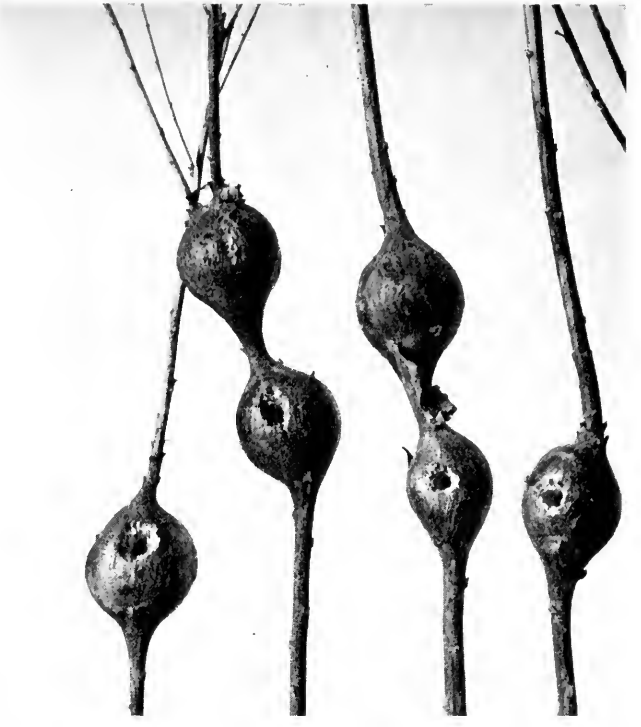


Fig. 52. Goldenrod Ball Gall
Gall Fly (*Eurosta solidaginis* Fitch)
Goldenrod (*Solidago altissima* L.)

Fig. 51. Redroot, or New Jersey tea, often grows along roadsides and railroads in Illinois. The gall about one inch long, appears in spring and is considered a terminal bud deformity. Although the galls are not common, several insects—a leaf midge, bud midge, a moth-like stem gall producer, and one of the gall mites—are known to select this plant. (KB)

52. The appearance of two or more galls on the same stem is not considered unusual, but at one time it was thought to be rare. The damaged exit holes are evidence that mice and birds may have been at work to secure grubs. The birds, in this case, were probably woopeckers. A species of very small ant sometimes makes nests in the vacant galls. (JG)

Fig. 53 (above). Goldenrod Ball Gall
Gall Fly (*Eurosta solidaginis* Fitch)
Goldenrod (*Solidago altissima* L.)

A globular stem gall whose interior is filled with plant tissue in which a larval cell is embedded. Although common, this gall is probably less likely to be seen than the Goldenrod Bunch Gall. Since the stem has continued its growth the gall fly apparently deposits an egg in the stem tissue below the growing tip. (CH)

Fig. 54 (below). Goldenrod Ball Gall
Gall Fly (*Eurosta solidaginis* Fitch)
Goldenrod (*Solidago altissima* L.)

The galls are about one inch in diameter with a hard, pithy interior in which a larval chamber occurs. It is the larvae found in these galls which are reportedly used by ice fishermen. Late in summer the galls become light brown and have the same appearance as the goldenrod stem. (KB)

Fig. 55 (above). Goldenrod Bunch Gall
Gall Midge (*Rhopalomyia solidaginis* Lw.)
Goldenrod (*Solidago altissima* L.)

A Goldenrod Bunch Gall as it appears at the growing tip of a main shoot of the plant. In this stage the lateral or side branches have not yet developed. The gall gives the appearance of leaves clustered at the tip instead of being distributed along the normal length of the stem. The cell of the midge larva is in the center of the cluster of shortened, deformed leaves. (CH)

Fig. 56 (below). Goldenrod Bunch Gall
Gall Midge (*Rhopalomyia solidaginis* Lw.)
Goldenrod (*Solidago altissima* L.)

An old Bunch Gall which makes its appearance in autumn. Note the development of many lateral or side branches which may be the result of interference with growth of the terminal bud. In autumn this gall may be found in patches of goldenrod. (CH)

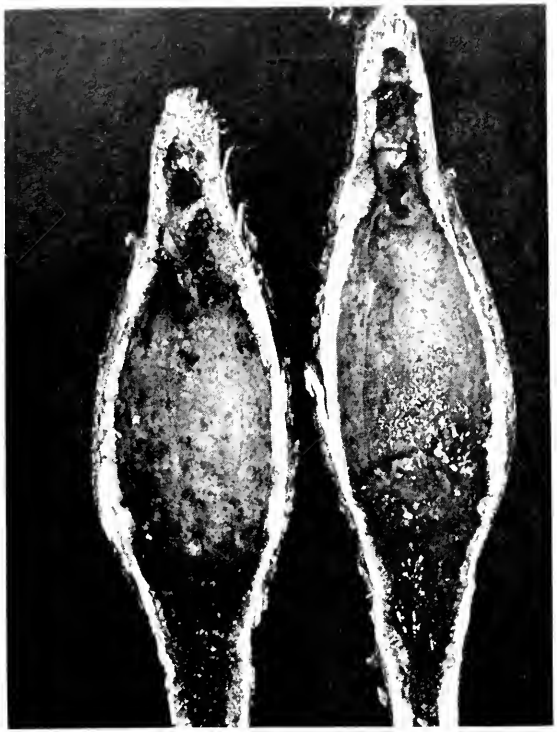


Fig. 57. Elliptical Goldenrod Gall
Gall Moth (*Gnorimoschema gallae-solidaginis* Riley)
Goldenrod (*Solidago altissima* L.)

Fig. 58. Lettuce Tumor Gall
Gall Wasp (*Aulacidea tumida* Bass.)
Wild Lettuce (*Lactuca Sp.*)

Fig. 57. One of the goldenrod galls which is elliptical or spindle-shaped rather than globular. It is unusual in that the gall insect is a moth whose larva keeps the interior of the gall smooth probably by devouring the plant tissue. These long cuts through the galls show smooth interiors from which the insects have escaped. (KB)

Fig. 58. A stem gall found on species of wild lettuce where it may become three inches or more in length and appears as an irregular stem swelling. The protograph shows cuts made lengthwise to indicate the large number of larval chambers or cells many of which contain grubs. Observers have counted as many as 450 plants in a field of 500 which bore these stem galls. (KB)

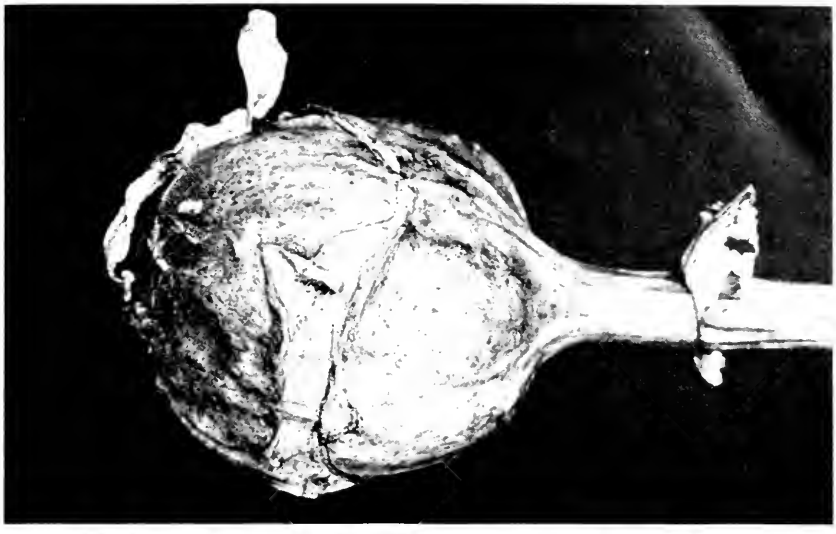


Fig. 59 (above). Apical Stem Gall of Cup Plant
Gall Wasp (*Antistrophus silphii* Gill)
Cup Plant (*Silphium perfoliatum* L.)

This rather uncommon gall appears at the tip of a growing stem of Cup Plant. It is green and often irregular in shape. The gall growth strongly resembles an unopened flower bud. (KB)

Fig. 60 (below). Apical Stem Gall of Cup Plant
Gall Wasp (*Antistrophus silphii* Gill)
Cup Plant (*Silphium perfoliatum* L.)

A cut has been made lengthwise through the galls to show numerous larval chambers and some of the grubs. (KB)

Fig. 61. Abnormal Flower Heads of Sawtooth Sunflower
Gall Midge (*Asphondylia helianthiflorae* Felt)
Sawtooth Sunflower (*Helianthus grosseserratus* Martens)

Fig. 62. Sunflower Stem Gall
Gall Midge (*Cecidomyia thurstoni* Brodie)
Sunflower (*Helianthus Sp.*)

Fig. 61. Flowers, as well as other parts of plants, are used by gall insects as a place to deposit eggs. This gall assumes the general form of the flowers, but they are distorted and look more like miniature artichokes than typical sunflowers. (CH)

Fig. 62. The sunflowers, of the Composite Family, are a favorite group of plants for gall insects. In contrast with the abnormal flower heads of the Sawtooth Sunflower these galls are formed below the heads apparently without causing deformity of the flowers themselves. (KB)

Fig. 63 (above). Witches' Broom on Hackberry
Gall Mite (*Aceria snetsingeri* Keifer)
Fungus (*Sphaerotheca phytoptophyla*)
Hackberry (*Celtis occidentalis* L.)

The "brooms" of hackberry trees (*Celtis occidentalis* L.) result from dwarfed and clustered buds. The twigs are shortened and bunched due to the presence of two agents: a powdery mildew and a gall mite. (JG and CH)

Fig. 64 (below). Cedar "Apples" on Red Cedar

This is not an insect-produced gall but the cedar "apple" rust stage of the fungus *Gymnosporangium juniperi-virginiana*. The disease requires two hosts, the other being redhaw (hawthorn) or cultivated apples and their relatives. On wet days in spring these cedar "apples" will develop yellow, horn-like, gelatinous protuberances which in turn bear spores carried by wind to leaves of redhaw and apple. Yellow-orange spots appear on the leaves and the fungus producing them is *Gymnosporangium globosum*. The spores of this fungus again infect red cedar to continue the cycle. (JG)

Fig. 65 (above). Tumor of Elm

A gall or plant tumor on the trunk of an elm. The twisted, contorted grain of these woody galls is known as "burl" and the finished wood or veneer from such a source is often beautiful and decorative. It may be that such a growth involves a bacterium or even a virus. (JG)

Fig. 66 (below). Tumor of Pin Oak

Plant galls may be regarded as tumors since they represent abnormal growth of plant cells. The photograph shows a large gall or tumor on the trunk of pin oak (*Quercus palustris* Muench.). The swollen, deformed trunk of the oak is obvious, but such a growth may be caused by a combination of several agents including insects, fungi, and mechanical injury. (JG)

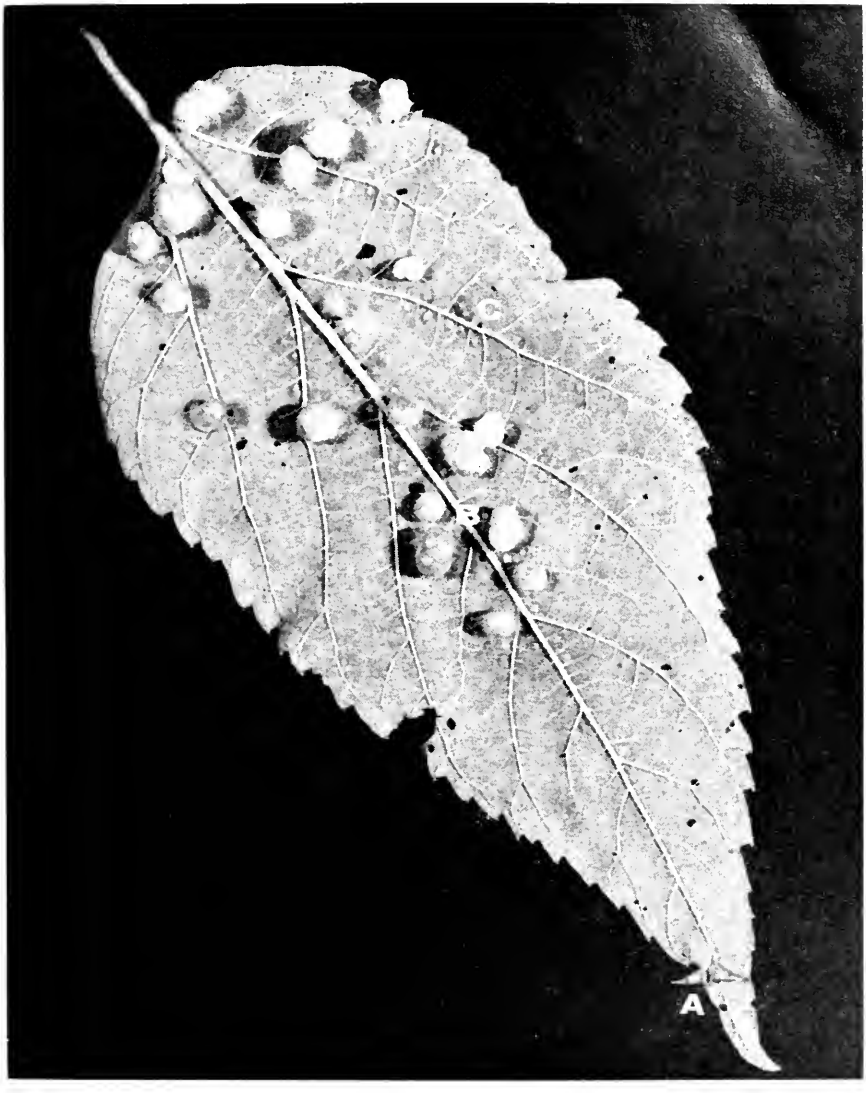


Fig. 67. Three Galls on Hackberry

This single leaf of hackberry (*Celtis occidentalis* L.) is a host for three distinct galls. (A) Spiny Hackberry Gall (*Cecidomyia spiniformis* Patton). The insect stimulating the formation of this growth is a gall midge. (B) Hackberry Nipple Gall (*Pachypsylla celtidismamma* Riley). This gall insect and the following are both jumping plant lice. These lice are not the same as plant lice or aphids. The galls appear in summer after the leaves are grown, but they are not confined to any particular part of the leaf. (C) Hackberry Blister Gall (*Pachypsylla vesiculum* Riley). These small galls may pass unnoticed but careful observation will reveal them on many hackberry leaves. (Photo Courtesy of Illinois Natural History Survey, Wm. E. Clark)

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ILLUSTRATIONS*

* From photographs unless otherwise noted.