# APPENDIX I.

## GALLS AND INSECTS PRODUCING THEM.

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### PART I. MORPHOLOGY OF LEAF GALLS.

#### 1. GALLS OF THE APHIDIDAE.

The gall of Pemphigus vagabundus Walsh (Fig. 112) is evidently formed as a result of the distortion of a large number of bud leaves. My specimens of these galls were mature, so I was unable to follow its development. Small fibro-vascular bundles were numerous and tannin was formed in great abundance. The structure was so modified that the leaf characters were lost; the cells were uniform in character, but were slightly smaller near both the exterior and interior surfaces.

The galls of Pemphigus rhois Fitch (Fig. 113) are large, bladdery and evidently the pocketing of a single leaflet of the host plant, Rhus glabra or R. typhina. My specimens of these galls were fully mature, and I was therefore unable to follow the line of development. The leaf structure was modified into the characteristic Aphididae gall structure. Fibro-vascular bundles were numerous and near the inner surface of the gall. Opposite each bundle was a large cavity filled with some substance which I was unable to determine.

#### 2. GALLS OF CECIDOMYIDAE.

The galls of Cecidomyia pellex O. S. (Figs. 114a, b) are formed by a thickening of the petiole, giving it the appearance of a long fleshy bean pod with a slit along the upper side. This gall shows three well defined zones; an inner nutritive zone of small cells, a parenchyma zone of larger cells and the epidermal zone. The fibro-vascular bundles are numerous and are located between the nutritive and protective zones and arranged around the larval cavity and opening, the largest one just below the larval chamber and corresponding to the mid-rib of the leaflet.

Cecidomyia impatientis O. S. (Fig, 115) is a fleshy gall occurring on the leaves of Impatiens fulva. Some of my specimens had the appearance of deformed flower buds, but upon this point I was unable to decide. This gall showed two well defined zones; a zone of small cells lining the larval chamber and making up about one half the thickness of the gall, and an outer zone of large cells. Small fibro-vascular bundles were formed between the zones.

The galls of Cecidomyia holotricha O. S. on Hicoria ovata (Figs. 116a, b, c) are small and very firm. My specimens were

mature, but the cells lining the larval chamber were well supplied with protoplasm, and numerous short trichomes were developed from the dorsal surface and extended into the chamber. Tannin was very abundant.

The gall of Cecidomyia tubicola O. S. on Hicoria ovata (Figs. 117a, b, c) is very similar to C. holotricha, except that the amount of tannin is not so great. The upper wall of the gall is much thicker than either the side or lower wall. The point of attachment is not so large, but the gall is protected by a growth producing a cup-shaped cavity in which the gall is developed (Fig. 117a). The inner layers of cells are very rich in protoplasm. The cells are elongated in the long axis of the gall and fibro-vascular bundles are more numerous than in C. holotricha, but are very small. The cup-shaped structure (117c) in which the gall is formed is composed of elongated cells. The palisade cells in that part of the leaf opposite the gall are unaffected.

Cecidomyia viticola O. S. (Fig. 118) has the same general character as C, tubicola, but is much longer.

Sciara ocellaris O. S. is one of the simplest of the Cecidomyidae galls. The larva does not penetrate the tissues of the leaf, but confines its attack to the outside, causing an indentation on one surface of the leaf and a corresponding elevation on the opposite surface (Fig. 119a) and also causing a very slight thickening. The structure (Fig, 119c) when compared with that of the normal leaf (Fig. 119b) shows the palisade transformed into ordinary mesophyll and the intercellular spaces entirely obliterated. It therefore corresponds in structure to the simple leaf-curl galls produced by some of the Aphididae (e. g., Schizoneura Americana Riley, Part 1, Fig. 12).

### 3. GALLS OF THE CYNIPIDAE.

My specimens of Rhodites bicolor Harris (Fig. 120) were well developed when collected. I was therefore unable to determine the early structural characters. The structure in these galls evidently does not show the four well defined zones so characteristic of this family. The inner cells are well supplied with nourishment for the large number of larvae.

The galls of Amphibolips confluentus Harris are very large and have a single larval chamber in the center. The nutritive and protective zones (Fig. 121a) can be distinguished, but are not so well defined as in the closely related species, A, inanis (Part I, Figs. 28a, b). The parenchyma and epidermal zones (Fig, 121b) are well defined and the space in the parenchyma is filled with a cottony-like substance which upon close examination is composed of fibro-vascular bundles (as in A. inanis, Figs. 28a, b, and H. centricola, Figs. 27a, b, c) and of long, unicellular threads (Fig. 121c), as in C. papillatus (Figs. 30a, b, c and 81).

My specimens of Amphibolips illicifoliae Bassett were too far advanced to admit of sectioning, but a careful examination indicated that the zones were well defined and that the space in the parenchyma zone is bridged by means of fibro-vascular bundles as in A. inanis and H. centricola.

The galls of Amphibolips prunus Walsh (Fig. 122) are very firm and all the zones are well defined except the protective zone, which is entirely absent. The parenchyma zone is very thick and probably compensates for the lack of a protective zone. There are very few small fibro-vascular bundles.

Galls of Amphibolips sculpta Bassett (Fig. 123) were more succulent than other specimens which I have examined. My specimens were mature, but the four zones were well defined. The nutritive zone was almost obliterated, due to the age of the gall. The protective zone was thin and the cell walls not very thick. The parenchyma zone was very thick and composed of large, succulent cells and was probably very important in furnishing nutriment to the larva. Near the outer surface were numerous small fibro-vascular bundles. The epidermal zone was very prominent and composed of small cells.

Andricus petiolicola Bassett is one of the firmest of the leaf galls. It is formed either on the petiole or mid-rib and is composed of very small, firm cells (Fig. 124). The four zones are well defined, but the protective zone is very thin and the cell walls but very little thicker than in the neighboring cells. The parenchyma zone is very thick, composed of very small cells with no intercellular spaces, but with many layers of long fibrous cells.

The galls of Acraspis erinacei Walsh (Fig. 125) are very conspicuous. The galls are always developed on the mid-rib of the leaf, but contain no fibro-vascular bundles. The nutritive zone is thick and very rich in protoplasm. The protective zone is also thick and gradually merges into the parenchyma zone, which is also thick. The epidermal zone is very irregular and is covered with numerous unicellular trichomes.

The galls of Biorhiza forticornis Walsh are fig-shaped and the larval chamber instead of being suspended in the center of the gall, as is many others, is placed at the apex (Fig. 126a) and the space between the protective and parenchyma zones, or rather in the parenchyma zone, extends less than half way round the larval chamber. My specimens were mature and I was unable to make a careful study of the nutritive and protective zones. However, the nutritive zone appeared to be relatively thicker, while the protective zone was thin and merged gradually into the parenchyma zone (Fig. 126b). The parenchyma zone was thick and composed of large cells (Fig. 126c). Considerably more of this zone remained attached to the protective zone than is the case with most galls where this separation occurs. The cavity formed

by the separation of the cells in this zone is bridged by numerous unicellular threads as in C. papillatus (Figs. 30a, b, c). In the outer part of the parenchyma zone, but near the cavity, are formed the fibro-vascular bundles. The epidermal zone is well defined and the trichomes on the surface are uni-cellular (Fig. 126c).

#### 4. GALLS OF TENTHREDINIDAE.

The galls of Nematus pomum Walsh were the only leaf galls of this family that I secured and they were mature. There was no indication of a zonal structure, but the cells were very uniform in size and structure throughout the entire gall (Fig. 127). Many of the cells contained tannin and intercellular spaces were large and evenly distributed.

### PART II. LATERAL BUD GALLS.

Mature specimens of Holcaspis globulus Fitch show the four well defined zones (Fig. 128). The inner nutritive zone is thick, composed of small cells and well supplied with nutriment for the larva. The protective zone is thin and composed of very small cells with thin walls. It gradually merges into the nutritive zone on the one side and the parenchyma zone on the other side. The parenchyma zone is very thick, the cell walls medium in size and the fibro-vascular bundles small and numerous. Further observations upon this gall emphasize the statement previously made that it is the enlargement of an incipient stem.

Further observations upon the gall of Andricus seminator Harris confirm the statement previously made that it is a compound gall produced by the insect depositing an egg in each element of the bud.

### PART III. STEM GALLS.

The gall of Diastrophus nebulosus O. S. (Fig. 129a, b) is a very large swelling on the canes of Rubus villosus and is about two or three inches in length. It contains a large number of larval chambers each containing a single larva (Fig. 129a). The four zones are especially well defined. The nutritive and protective zones are composed of a few layers of cells while the parenchyma zone is very thick, composed of smaller cells and more dense than the corresponding zone in most galls of this family.

Andricus cornigerus O. S. (Fig. 130) produces one of the hardest of the stem galls. My specimens of this were gathered in the winter and were fully mature. The horn-like protuberance is a closed tube extending to near the center of the gall. This tube is composed of sclerenchyma tissue and evidently corresponds to the protective zone. Near the base of the tube is a thin partition forming the larval chamber. When mature the

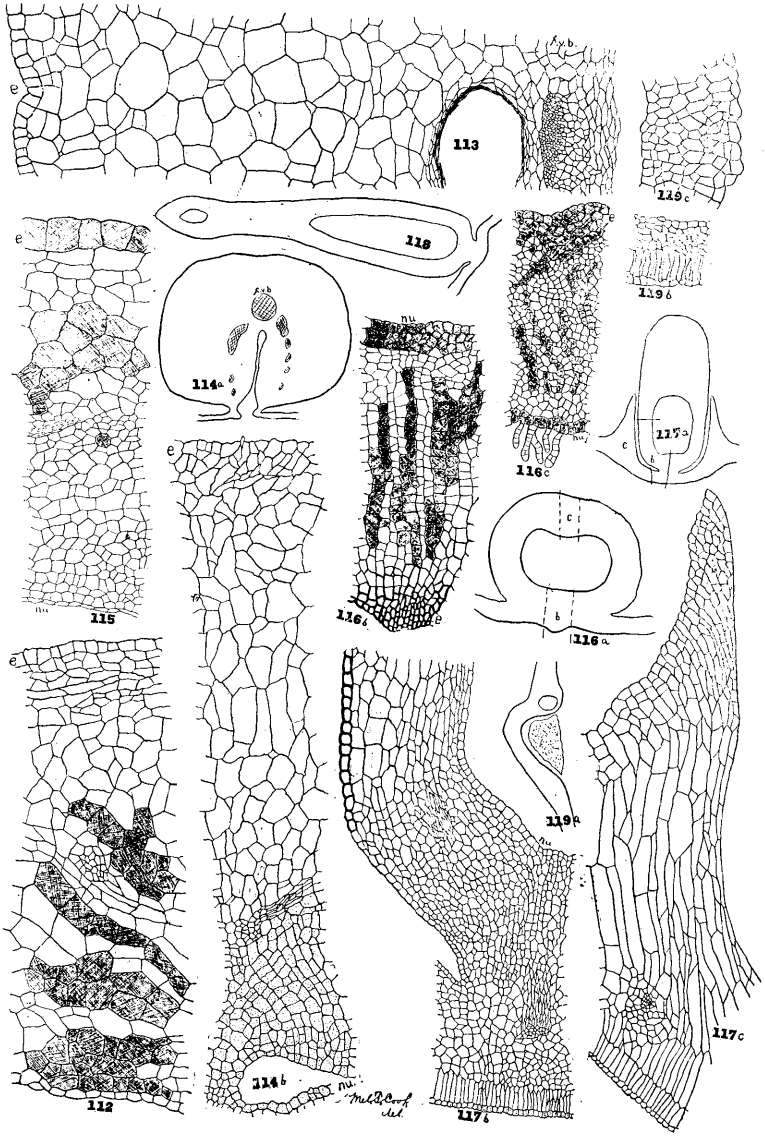
insect destroys this partition, travels to the end of the tube which projects beyond the body of the gall, and there makes an opening through either the end or the side of the tube and thus makes its escape. Examination of young specimens would probably show the four zones as well defined as in Diastrophus nebulosus.

## PART IV. DEVELOPMENT OF GALLS.

Examination of very young specimens of Andricus seminator Harris shows three well defined zones (Figs. 131a, b), the protective zone being undeveloped. The fibro-vascular bundles were very numerous and distributed just beneath the epidermal zone. I have examined a large number of these galls of various ages and have been unable to find any trace of a protective zone. Tannin develops in the outer cells very early and probably helps to form a protection for the larva.

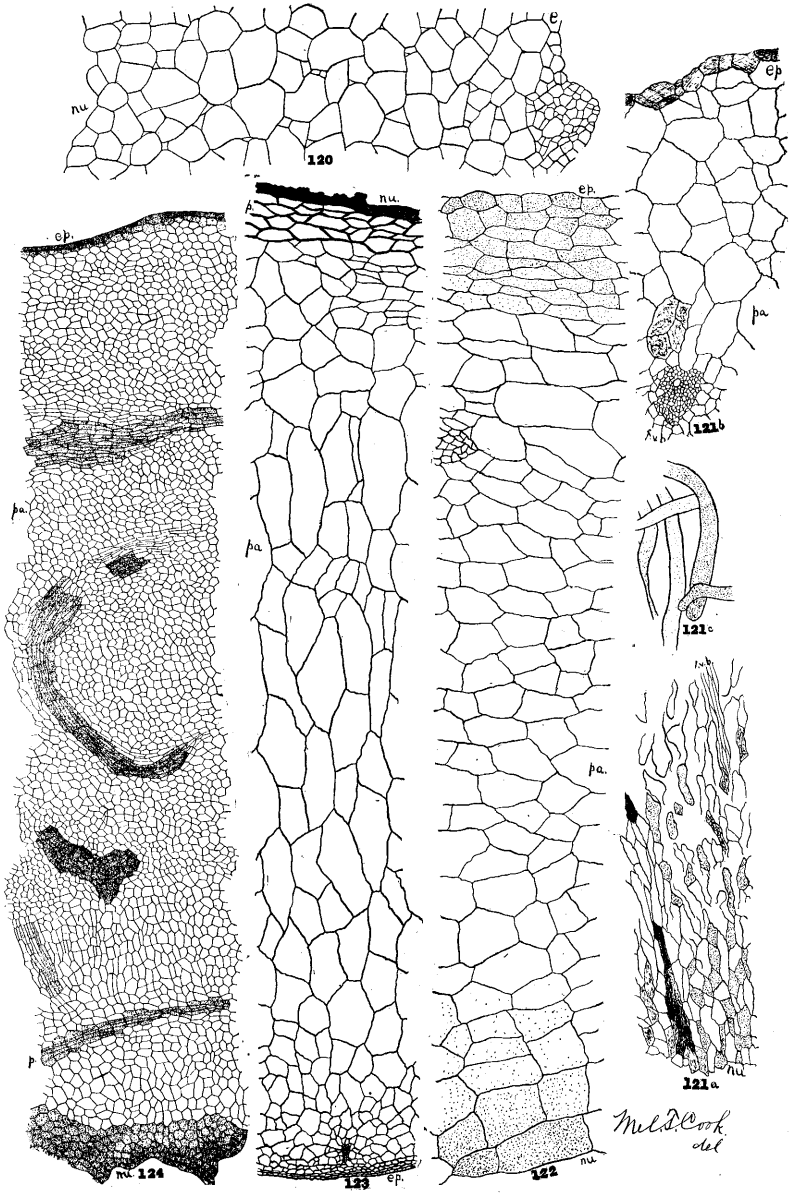
### PLATES XIII–XV.

112. Section of gall of Pemphigus vagabundus.
113. Section of gall of Pemphigus rhois.
114a. Diagram of gall of Cecidomyia pellex.
114b. Section of gall of Cecidomyia pellex.
115. Section of gall of Cecidomyia impatientis.
116a. Diagram of the gall of Cecidomyia holotricha.
116b. Section of the gall of Cecidomyia holotricha.
116c. Section of the gall of Cecidomyia holotricha.
117a. Diagram of the gall of Cecidomyia tubicola.
117b. Section of the gall of Cecidomyia tubicola.
117c. Section of the gall of Cecidomyia tubicola.
118. Diagram of the gall of Cecidomyia viticola.
119a. Diagram of the gall of Sciara ocellaris.
119b. Section of normal leaf of Maple.
119c. Section of gall of Sciara ocellaris.
120. Section of gall of Rhodites bicolor.
121a. Section of gall of Amphibolips confluentus. (Epidermal and parenchyma zones.)
121b. Section of the gall of Amphibolips confluentus. Nutritive and protective zones.)
121c. Section of gall of Amphibolips confluentus. (Elongated cells in the cavity of the parenchyma zone.)
122. Section of gall of Amphibolips prunus.
123. Section of gall of Amphibolips sculpta.
124. Section of gall of Andricus petiolicola.
125. Section of gall of Acraspis erinacei.
126a. Diagram of gall of Biorhiza forticornis.
126b. Section of gall of Biorhiza forticornis. (Nutritive and protective zones.)
126c. Section of the gall of Biorhiza forticornis. (Section of protective and epidermal zones.)
127. Section of the gall of Nematus pomum.
128. Section of the gall of Holcaspis globulus.
129a. Diagram of gall of Diastrophus nebulosus.
129b. Section of gall of Diastrophus nebulosus
130. Diagram of gall of Andricus cornigerus
131a. Diagram of cross section of gall of Andricus seminator.
131b. Section of young gall of Andricus seminator.




COOK on "Galls and Insects Producing Them."

OHIO NATURALIST. *Plate XIV.*

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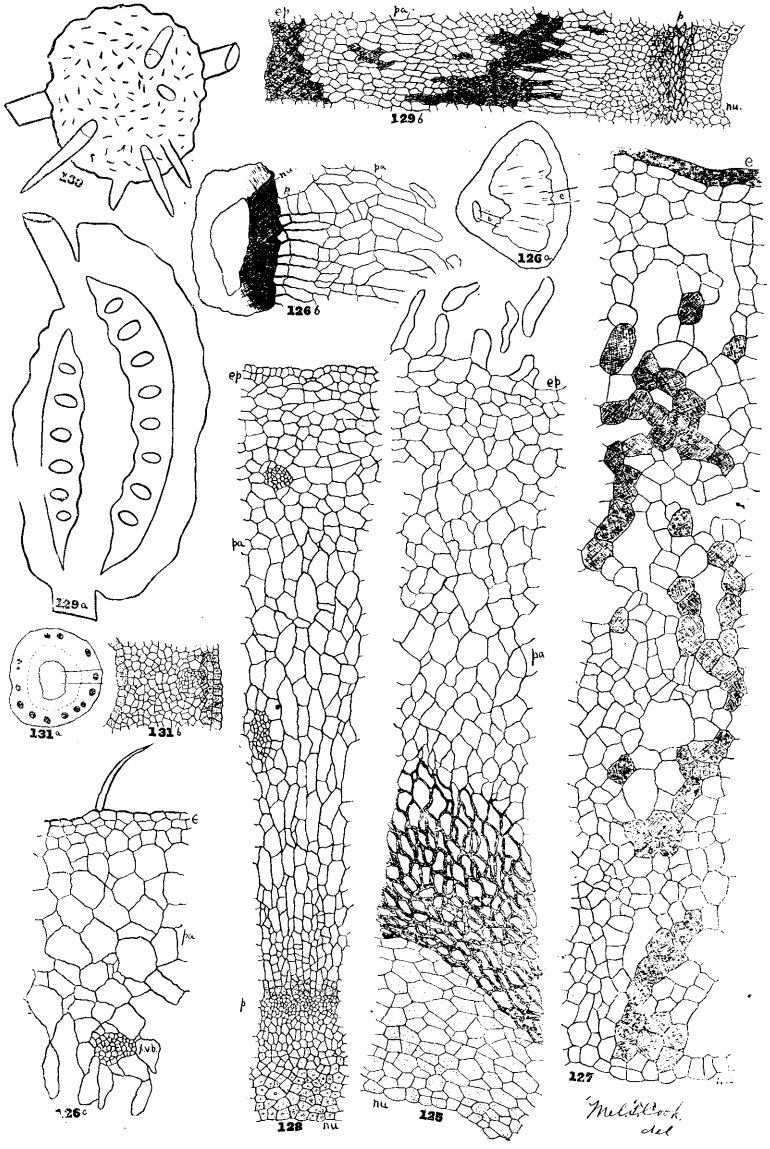


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