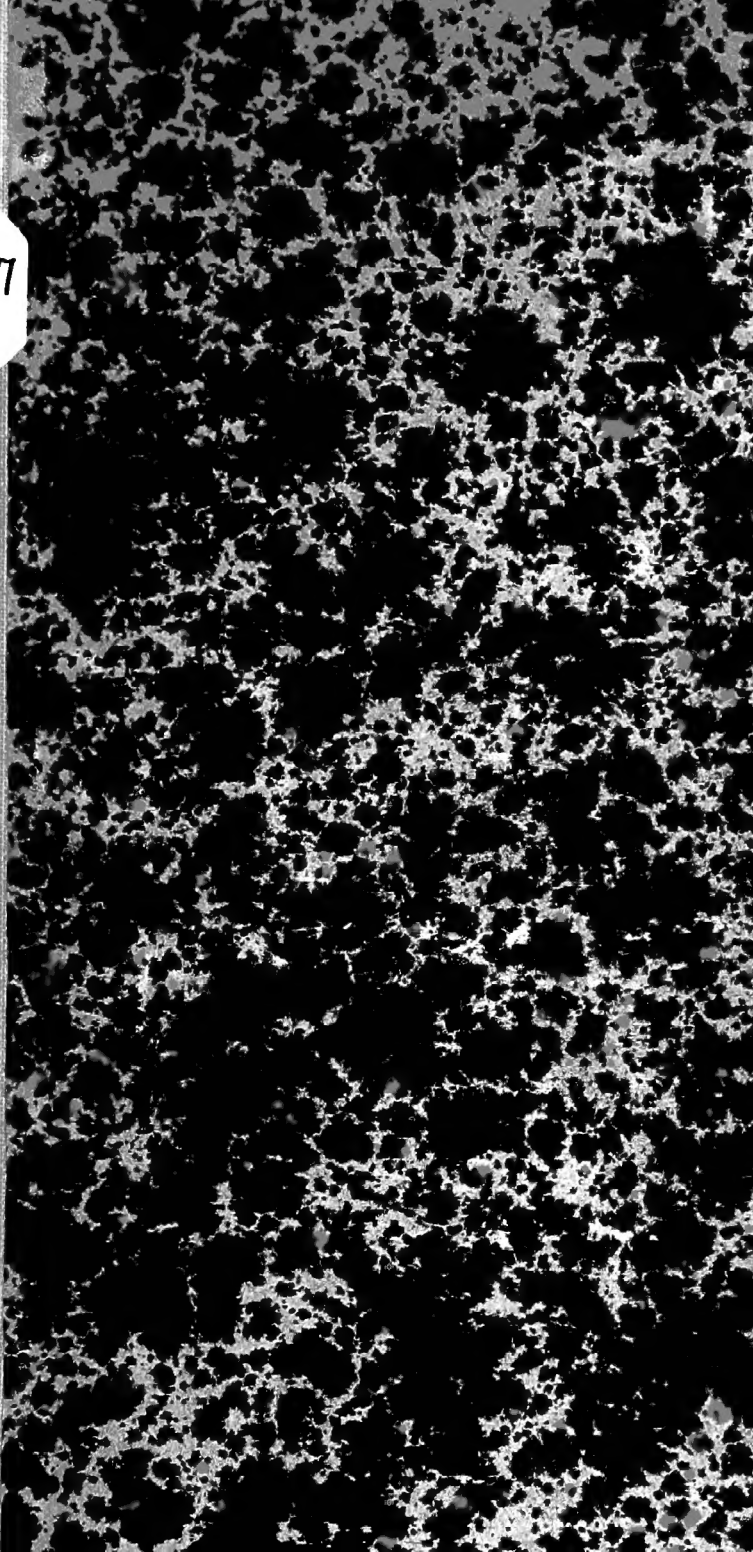

NORTH AMERICAN PHYLLOXERINÆ AFFECTING HICORIA (CARYA) AND OTHER TREES.

BY THEO. PERGANDE.

INTRODUCTION.

In the course of my studies of the Aphides of the United States, occupying more or less of my time during the past twenty-five years, I became much interested in our native Phylloxerinæ as well as the curious galls or deformations produced by them, and have consequently made a few interesting observations, detailed in the present paper.

Early in the spring of 1889 the late Dr. C. V. Riley received a letter from Dr. Dreyfus, Wiesbaden, Germany, announcing his intention of monographing the Chermesinæ of the world, outlining his plan and progress of the work, accompanied by examples of the nature of the illustrations prepared for it, and urging Prof. Riley to assist him in this work with notes and figures of the species of Phylloxerinæ occurring in North America on our native hickory trees.

Dr. Riley, at the time of the receipt of this communication, was in Paris, acting as the representative of the Secretary of Agriculture in connection with the installation of the American agricultural exhibit at the Universal Exposition of 1889, charged with the duties of Assistant Commissioner in Group 8. It was, therefore, out of the question for him to undertake the work himself, as desired by Dr. Dreyfus, and he directed the writer to draw up descriptions of all of the known and new species and to prepare the necessary drawings for the contemplated work. This work was at once taken up energetically and thoroughly.

In compliance with this request I restudied, as far as possible, all the previously described species, of which, fortunately, many

of the types, or typical specimens, or their galls had been preserved in Dr. Riley's private collection, now forming a part of the collection of Aphides of the United States National Museum, besides all those discovered by me, while studying this interesting group.

After the completion of these investigations and the numerous drawings by myself and Miss L. Sullivan, the manuscript was transmitted to Dr. Dreyfus in expectation of speedy publication. Unfortunately, however, it has been lying idle for these many years, with little or no prospect that it ever will be published, due, apparently, to financial and other troubles, which tend to postpone its publication indefinitely.

Under these circumstances and in justice to myself and in the interest of American students of entomology, I deem it proper to have this part of our Phylloxerinæ published independently of Dr. Dreyfus.

Lacking time to study as thoroughly as possible the various species of this difficult though highly interesting group of plant-lice, I was able to work out the complete history of but one species, viz., *Phylloxera perniciosa* n. sp., which may be considered typical of the majority of the species inhabiting the different kinds of hickory.

All species of this group, as in many other gall-producing insects, hatch and form their galls at the earliest possible moment in spring, or, at about the time when the buds commence to burst and the young growth of twigs pushes out. After a leaf or section of a young twig has ceased its growth, no galls can be formed.

In accordance with this law of plant-growth there is, as a rule, but one series of gall-producing Phylloxeræ each year, composed of the stem-mother, the migrants and the sexual generation, the latter producing eggs which remain dormant until the following spring, to start a new cycle of life. According to my observations there is at least one, *Phylloxera deplanata* n. sp., which differs remarkably from the rest, since the stem-mother frequently or more commonly produces no winged migrants, but directly the sexual generation, as observed by me during earlier studies. However, in the spring of 1902, when the galls of this species were extremely abundant on certain trees, I discovered also in a few of them, besides the stem-mother and sexed individuals, a few

migrants, whereas in the majority which were opened, only the stem-mother and sexes were found. In the case of another species numerous pupæ were found with the old mother and but two or a few winged migrants in but a very few galls; in all of these galls, occupied by the pupæ, were also observed large numbers of the sexes, as progeny of the pupæ; whereas in *Ph. c.-venæ* Fitch, all of the sexuparæ, which usually are winged, are wingless, resembling in this respect the stem-mother.

The conclusions arrived at are that, as a rule, the great majority of the species produce large numbers of the migratory form and that but few exist in which the stem-mother or pupæ are able to produce a sexed generation, and that but occasionally some migrants are developed to guard against the possibility of extermination.

Since the species treated of in this paper comprise but a fraction of those inhabiting the United States, there remains still a large field for fruitful investigation which may amply occupy a lifetime of those selecting it as a specialty.

In order to facilitate the study of the known species, inhabiting hickory trees, I have divided the various galls into groups, based principally on the location and shape of the galls on the parts infested.

SYNOPTICAL TABLE OF GALLS.

Group I.

Galls thin, paper-like, more or less transparent.

The galls produced by the species of this group are quite variable, both in shape and coloration, and often difficult to separate, especially when several galls of closely related species grow upon the same leaf. So far twelve distinct forms belonging to this group have been discovered, of which seven have been found growing upon *Hicoria alleci* and *glabra* in the vicinity of Washington. The fully developed forms of most of them are quite readily separated, though intermediate or dwarfed forms occur frequently.

Section 1. *Opening above.*

1. Projecting more or less conically above and beneath; both nipples surrounded at apex by a fringe of long filaments.
   Ph. c.-septum (Shimer).
   Both cones very much elongated, slender and toothlike.
   var. *perforans*, n. var.
2. Conical above, flat beneath; splitting into several bracts above when mature; with slender filaments at the centre beneath.
   Ph. c.-foliæ Fitch.
3. Similar to *c.-septum;* smaller, more flattened, but slightly convex above and beneath; opening round or oval, surrounded by short, recurved pubescent bracts; a minute closed nipple beneath ..... *Ph. picta* n. sp.
4. Smaller, though similar to *c.-picta;* more convex, and often with a slight depression above; no opening above before maturity; a minute closed nipple beneath .... *Ph. intermedia* n. sp.

Section 2. *Opening beneath.*

5. Convex, more elevated above than beneath, with a reddish or crimson fovea or dimple above, varying in depth. The orifice beneath small and surrounded by a fringe of short, flat bracts ..... *Ph. foveola* n. sp.
6. Concave above, convex beneath. The nipple formed of rather long, slender filaments. The depression above as well as the surface beneath, including the filaments, provided with long white hairs ..... *Ph. pilosula* n. sp.
7. Size small, slightly convex above, more prominent beneath. Usually with a small, shallow depression toward one side, above. Nipple short, without bracts; the orifice more or less oval and fringed with short pubescence..... *Ph. deplanata* n. sp.

8. Size medium; slightly convex above and beneath, with a short nipple, having a round orifice, surrounded by a burr-like fringe of many filaments..... *Ph. depressa* (Shimer).
9. Size medium; quite flat above, with a dimpled depression, the opening beneath round and with a downy orifice. *Ph. foveata* (Shimer).
10. Size medium; convex and considerably elevated above and more prominent than beneath; quite hard, smooth and shining. Orifice beneath round and closed. Resembling the galls of *Ph. c.-semen*..... *Ph. minima* (Shimer).
11. Minute; red, more convex and more prominent above than beneath, with a dimpled depression, The nipple short and surrounded by short, hairy bracts..... *Ph. c.-semen* Walsh.
12. Size medium; conical above and much more prominent than beneath; convex beneath, the nipple short, with an oval orifice, fringed with short hairs..... *Ph. c.-fallax* Riley.

SECTION I.

PHYLLOXERA CARYÆ-SEPTUM (Shimer).

Plate i., figs. 1-6; Plate ix., fig. 46.

Dactylosphœra c.-septum Shimer. Trans. Am. Ent. Soc., II., p. 389.
Phylloxera c.-septa Riley. 7th Ann. Rep. Nox. & Ben. Ins. of Mo., p. 118.
Phylloxera c.-septa Thomas. 8th Rep. Nox. & Ben. Ins. of Ill., p. 164.

The galls of this species, especially those of the more typical form, are the handsomest and largest of this group. Their transverse diameter at the plane of the leaf ranges from 5 to 12$^{mm.}$ and their vertical diameter from 4 to 6$^{mm.}$. They are quite convex on both sides and generally more conical and more prominently projecting above than beneath, especially so in the smaller specimens. All are provided with a nipple on both sides, the upper one stouter and more prominent, with its base more or less sunken below the plane of the gall. Both nipples, particularly the lower one, lean frequently somewhat towards one side. Both openings are either round or oval and fringed by about eight stout or slender filaments. The opening on the under side closes gradually so that the insects are compelled to leave from above. The consistency of the galls is dense, though rather thin, paper-like, and more or less transparent, crisp, and stoutest at the junction with the leaf. The cavity, if cut vertically, appears to be more or less hexagonal at the central portion, more or less pointed towards the nipples, and quite flat at the median circumference, with the exception of a ridge which indicates the former division of the gall into two compartments while young. The color above is variable. Some are of a darker or lighter bright red or pale rose, with a pale greenish margin around the base, while others are pale yellowish green, the nipple more or less brown, surrounded at base by a pale reddish ring. The color of the under side corresponds either more or less with that of the upper side or is of the same color as the leaf, or paler. In its younger stage, while still quite small, it is most beautiful and has very little resemblance to the fully grown gall.

STEM-MOTHER.—Length 0.6–1$^{mm.}$; diameter across the thorax about 0.7$^{mm.}$. Pyriform, the older ones shorter and more globular. Color pale yellow, the older specimens somewhat darker, with the head slightly dusky. Antennæ and legs blackish. Eyes small and dark purplish. Between the eyes are two small though rather deep dusky punctures or foveæ; two or three subdorsal dusky spots or punctures each side of the prothorax, and a more or less distinct, transverse, dusky spot each side in the sutures of the thoracic segments. Surface of body quite distincly though rather sparsely and irregularly tuberculate, the tubercles minute and pointed, more numerous around the margin and denser and somewhat coarser on the head. Front of head gently arched and slightly notched at middle. Antennæ rather stout, joint 1 stoutest, about equal in diameter, longer than wide, rounded at apex; joint 2 somewhat longer and more slender, thinnest at base, the apex rounded and apparently divided by three to four quite distinct, scaly annulations; joint 3 much the longest, and divided by six or more rather coarse scaly annulations, its base forming, in some specimens, a distinctly thinner and well separated petiole.

EGG.—Length about 0.2$^{mm.}$, regularly ovoid, white, polished and ornamented with regular, large, hexagonal facettes.

LARVA.—White or pale yellow, rather broadly ovoid, with stout antennæ and legs. Eyes red. Surface of body very sparsely and indistinctly granulate. Two transverse rows of minute dusky warts on the prothorax and a row of six similar warts on all other segments. Front of head quadrangulate, the angulations quite prominent, each bearing a short hair at tip. Rostrum long and stout, reaching beyond the end of the body.

PUPA.——Elongate, ovoid. Color orange, the head with a slight dusky tinge; meso- and meta-thorax paler, the wing pads and end of body almost white and with the external margin of the wing pads, especially in more mature individuals, blackish. Eyes brown, ocellar spots red or brownish. Antennæ and legs dusky. The whole surface of the body is densely covered with minute, conical, blackish points.

MIGRATORY OR WINGED FEMALE.—Length of body 0.8-1.2$^{mm.}$. Expanse 2.4-3$^{mm.}$. Color quite dark orange. Head, meso- and meta-thorax, scutellum and sternal plate black. Antennæ and

legs somewhat paler. Eyes dark brown or purple. Ocelli colorless, clear, bordered along the inner side by a broad, somewhat lunate, black margin. Prothorax marked with two transverse rows of three small and very pale dusky spots. Antennæ slender; basal joint shortest and stoutest, joint 2 somewhat longer, thinnest at base, the apex rounded and divided by five or six more or less distincly scalloped or scaly annulations; joint 3 very long and slender, of almost uniform thickness, rather more than five times the length of the second joint, and usually slightly constricted at about its basal fourth; sharply and quite closely annulated, with the annulations more or less irregular; upper sensorial membrane about two-fifths the length of the joint, the lower one inconspicuous, small and rounded; apical nipple short, truncated at tip, bearing apparently two short, knobbed hairs. Legs rather long and slender. Body stout, covered with minute, obtuse tubercles, though less dense than in the pupa. Head and prothorax rugose and somewhat tuberculated, the rugosity more pronounced on the head. Wings large, broad and pale dusky; stigmata and venation darker; course of stigmal vein in many specimens abnormal, not entering the stigma but curving backward a short distance therefrom and connecting with the discoidal vein. This abnormality sometimes occurs in both wings and at others either in one or the other.

The first observations regarding this gall were made May 13, 1883, and, as it will help to throw some light on the question of the formation of this and many other galls, I will here include the few notes made at the time.

This gall, a very beautiful and curious object, I find, after a careful examination, to be nothing else but an abnormally great enlargement of a pore and the filaments or hairs surrounding same.

From the position of the galls, there can be no doubt whatever but that the young insect, as soon as it finds a suitable place, stations itself directly over a pore on the under side of a young leaf, into which it inserts its proboscis to extract the sap and to remain in this position. The irritation, caused by the sucking, gradually enlarges the pore so that the insect can sink into the opening; the rapid growing of the leaf causes the walls of the pore to prolong and the thus formed cell to widen till a regular cell is formed, enclosing the insect completely.

Remarkable it is, however, that the irritation is not confined to the lower side of the leaf but that it extends also to the upper surface, to the opposite pore, producing a counterpart of that on the underside. Both sides of the young gall at this stage are regularly conical and are fringed at the apex of each cone by about eight or nine very long, slender, backward curved, fleshy filaments which, when compared with the hairs surrounding the other pores, prove them to be identical though greatly enlarged. When some of the galls were opened it was found that they were divided horizontally by a delicate membrane into two compartments in the lower one of which the young stem-mother, already mature at this date, and surrounded by some eggs, had established her home. With her was also found but one cast skin, which seemed to indicate that several skins had been cast before the gall had formed and closed. The color of the young gall above is quite pale green with the filaments bright cherry or pink. The lower side is darker and the filaments white.

Two weeks later the galls had changed so completely in appearance that they could scarcely be recognized as belonging to the same species were it not for the filaments fringing the apex of the nipples, and even these were mere rudiments, much reduced by drying up. They were then fully mature and some of them already empty. When cut vertically it was observed that the dividing membrane had entirely disappeared, except the beforementioned rudiment at the circumference.

PHYLLOXERA C.-SEPTUM, var. PERFORANS n. var.

Plate I., Figs. 7-8; Plate X., figs. 57-60.

A very conspicuous form of the above gall has been occasionally observed in the vicinity of Washington for several years past, occurring usually upon the leaves of *Hicoria glabra*, though always when already deserted. This same form had previously been observed by Dr. A. Fitch in the state of New York, also when deserted. In the place of the rightful occupants he discovered the imago and larvæ of a Phloeothrips, to which he gave the name of *Phleothrips caryæ* (Third Rep. on the Nox. and Ben. Ins. of N. Y., p. 127, No. 165), which he, however, hesitated, and correctly so, to consider as the true architect of these singular galls.

During May of 1890 I have been fortunate, however, to discover

this form in fair abundance upon a single tree of *Hicoria glabra* growing near a small stream in the vicinity of Arlington, Virginia, and widely separated by hills and gullies from trees bearing the genuine or typical gall. They contained (May 16th) besides the other forms a considerable number of the winged migrants which proved, after careful examination and comparison, to be absolutely identical with those of *Ph. c.-septum*. The causes of this remarkable and constant variation are not readily explained except by the fact that the typical form has so far always been found upon young trees with large and succulent leaves of *Hicoria alba*, while those of *perforans* were upon trees of *Hicoria glabra* which had already attained a height of over twenty feet and with the leaves smaller and less succulent. As in the typical form, the gall is mostly single though now and then two, three or even more grow in close contact, generally close to the midrib, near its base, or near the stronger cross-ribs, and, instead of expanding horizontally, they become narrow and considerably elongated above and beneath, resembling a slender spur or nail forced through the leaf. The length of the cones varies from 3-8$^{mm.}$ and the diameter at base from 2–4$^{mm.}$ Both above and beneath, the cones usually lean to one side, those above usually in the opposite direction from those beneath, while cones growing near the edge of the leaf curve outwardly and often to such a degree that both points almost meet. Each cone splits into 6–8 slender bracts, fitting closely together and lined inside with a white, woolly pubescense.

At maturity the bracts of the upper cone separate to allow the insects to escape, while those on the under side remain closed. The inner structure of the galls is very similar to that of the typical form, though its walls are harder and thicker. Its color above and beneath is of a paler green than the surrounding leaf, incling toward the apex to purple or brown. The transverse ribs between which these galls are stationed are, at the point of junction, often considerably angulated, much thickened and of a beautiful red or crimson color.

PHYLLOXERA CARYÆFOLIÆ Fitch.

Plate II., fig. 9; Plate IX., fig. 47.

Phylloxera caryœfoliœ Fitch. Third Rep. Nox. and Ben. Ins. of N. Y., p. 446.

Phylloxera caryæfoliæ Riley. Seventh Ann. Rep. Nox. and Ben. Ins. of Mo., p. 117.

Phylloxera caryæfoliæ Thomas. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 161.

Notwithstanding the apparently wide distribution of this species from New York to Illinois and as far south as Washington, it appears to be nowhere so common or so destructive as some of its near relatives. It is most noticeable during the latter part of May on the leaves of *Hicoria glabra*, and though usually there is but a single gall upon a leaf, as many as four may sometimes be found. Some which were studied on the 23d of May along the Potomac River in Virginia contained already quite a number of winged migrants, though the gall had not yet sufficiently opened at the apex to allow the inmates to escape.

The principal part of the gall is always on the upper side of the leaf and represents a regular, slender cone which often leans slightly over to one side. The transeverse diameter of the gall at the base of the cone is about $3^{mm.}$ and, including the pale ring surrounding it, about $5^{mm.}$; and its vertical diameter is also about $5^{mm.}$. Its surface is more or less pubescent, more densely so beyond the middle. Its color above is pale green, with numerous still paler, extremely fine, radiating lines running from tip to base. The apex is either somewhat somewhat yellowish, pale brownish or pale purplish and the extreme base darker green. The ring surrounding its base is either somewhat projecting and slightly convex or sometimes depressed or saucer-like and of a yellow or greenish-yellow color. The under side of the gall is but slightly projecting and quite flat, with a small elevated ring surrounding a minute central depression from which rises a small nipple, splitting into a number of very fine and slender pubescent filaments. The walls of this gall are very thin and flexible and rather difficult to tear, especially when they commence to shrivel after having been taken off the tree for some time. They are stoutest at base and more or less transparent if held towards the light. That this species is closely related to *Ph. c.-septum* is quite apparent. The younger ones have also, as in that species, a transverse membrane which gradually disappears, leaving a distinct rim to indicate its position.

STEM-MOTHER.—Length about 0.6mm. Shape broadly ovoid or almost globular. Color greenish yellow with a faint dusky tinge. Antennæ and legs blackish, eyes purplish-black. There are two small dusky spots near the front of the head and three at its posterior margin. One or two dusky subdorsal and one lateral spot each side anteriorly, and one transverse subdorsal and a lateral spot each side posteriorly beyond the middle, on the prothorax; also a subdorsal and lateral spot in the sutures of the two following segments. Surface of body densely covered with minute points and sparsely and irregularly tuberculated. Antennæ very short, the third joint somewhat thinnest towards its base, and sparsely annulated.

EGGS and LARVÆ white.

PUPA.—Orange; eyes brown, ocellar spots red, antennæ and legs dusky; wing pads whitish, sometimes pale dusky or with the external margin or the tip dusky. Surface of body densely granulate. Antennæ slender, the third joint at least three times the length of the two basal joints combined.

MIGRATORY FEMALE.—Length of body 0.8-1mm. Expanse of wings 2.6–2.8mm. Slender. Color orange, the prothorax darkest, the end of the abdomen palest. Head, mesothorax, scutellum and sternum blackish or brownish, the head often orange with a dusky tinge, and blackish anteriorly. Antennæ and legs dusky. The prothorax is marked with two more or less distinct, large, transverse dusky spots or bands, one near the anterior margin and the other beyond the middle, with three small blackish punctures, arranged in an oblique, curved row each side of the posterior band. The sides are also broadly dusky. Surface of body distinctly and quite densely granulate. Antennæ slender and rather longer than the head, with joint 1 scarcely longer than wide and somewhat stoutest at base, with its apex truncate; joint 2 slightly longer than wide, thinnest at base and rounded at apex; both joints but sparsely annulated, joint 3 rather more than three times the length of the others combined, very slender and with about thirty closely placed, sharp and scaly annulations.

It approaches *Ph. devastatrix* n. sp., though the third antennal joint is still more slender, with the lower sensorial membrane placed higher up and the upper one longer, the former a little

above the basal one-fourth, is rather small and but little projecting, while the latter is about as long as the basal section below the indentation; the differences in the galls will, however, readily separate the two. *Ph. devastatrix* forms a stem- or bud-gall approaching that of *perniciosa*, whilst this forms a leaf-gall approaching that of *c.-septum*. It comes also very near *c.-intermedia*, to which it appears to be most closely related, though the galls have no resemblance to each other.

PHYLLOXERA PICTA Pergande, n. sp.

Pl. II., fig. 10; Pl. IX., fig. 48; Pl. X., figs. 61–63.

The galls of this species resemble very much those of *c.-septum*, though ordinarily smaller, much more flattened, and to all appearances entirely destitute of a dividing membrane. The insects are also smaller and paler and exhibit some characters which tend to separate it from that species.

The transverse diameter of the gall varies between 3–6^{mm}. and the vertical diameter between 2–3^{mm}. It is quite flat on both sides, though somewhat more elevated and more convex on the upper, with a more or less distinctly depressed ring surrounding the base of the nipple. Both sides of the gall are provided with a short, conical nipple, each closed till maturity, and furnished inside and generally also at the tip with fine pale hairs. The lower nipple always remains closed, while the upper opens in a round or oval mouth, split into several very short, recurved bracts covered with fine pubescence. The walls of this gall are very thin and semi-transparent so that the insects can be seen moving about if held towards the light. The color is variable. Some are quite dark-green with a faint purplish shade and with the nipple and a ring around its base dark red. Others are of the color of the leaf or slightly paler, with a faint purplish ring surrounding them, the nipple and the depression surrounding its base pale buff or pale clay-yellow. Another variety is more or less pink, its margin yellowish or concolorous with the leaf. Still others are pale greenish-yellow with a faint purple ring surrounding the still darker nipple, besides many other variations. The under side is uniformly paler than the leaf and the nipple yellowish.

It occurs on *Hicoria tomentosa* and matures by the end of May or early June.

To separate this gall from many of the forms of *Ph. intermedia* is often very difficult, especially after they have burst open, when they resemble each other quite closely, though a comparison of the winged forms of both will show them to be unmistakably good species.

STEM-MOTHER.— Length 0.5^{mm}. Almost globular, pale-yellow, the oldest ones darker and with a faintly dusky tinge. Legs and antennæ pale-dusky and rather stout. Eyes purplish-black. Antennæ short and rather stout; the third joint somewhat clavate, slightly curved, quite pointed beyond the minute thumb and but sparsely annulate. The surface of the whole body is closely covered with large, round tubercles.

PUPA.— Varying from nearly white to various shades of yellow. Antennæ and legs faintly dusky; the wingpads whitish with a dusky external margin. Eyes and ocellar spots reddish. The whole surface of the body is distinctly and densely granulate. Antennæ slender; the third joint of about uniform thickness and with scarcely a trace of annulation.

MIGRATORY FEMALE.— Length of body 0.8–1.3^{mm}. Expanse of wings 2–2.6^{mm}. Color pale orange. Head, mesothorax, scutellum and sternal plate varying from dusky, to almost black. Antennæ and legs faintly dusky. Ocelli clear, margined at inner side with black. Form rather slender, the abdomen often considerably elongated. Head and prothorax finely rugose, the sculpturing much finer than in *c.-septum*. Abdomen indistinctly granulate. Antennæ slender and very similar in shape to those of *c.-septum;* joint 2 somewhat longer than the first, thinnest at base, rounded at apex and divided by 3-4 apparently scaly annulations; joint 3 of almost uniform thickness, slightly constricted just above the lower sensorial membrane, its basal section being about the length of joint 2, and sharply and coarsely annulate; the upper sensorial membrane attains almost one-half the length of the joint, whereas the lower one is inconspicuous, small and round. The whole appearance of this joint, in the main, is very similar to that of *c.-septum*. Wings delicate and pale dusky, the veins slightly darker though often almost

obsolete. Stigma distinct. The stigmal vein straight and normal in its course, exhibiting no tendency to connect with the discoidal vein.

PHYLLOXERA INTERMEDIA Pergande, n. sp.

Pl. II, figs. 11–14; Pl. X., figs. 64–65.

The gall of this species appears to be intermediate between *Ph. c.-septum* and *Ph. picta*. Its inner construction resembles that of *c.-septum* on account of the presence of a rudiment of the central membrane, though its general form, especially in the larger specimens, is more like that of *picta*, from which, however, it differs in the much thicker walls and the absence of a nipple on the upper side.

The transverse diameter of this gall varies between 3 and 6$^{mm.}$ and its vertical diameter between 2 and 3$^{mm.}$. The shape above is regularly convex in the larger galls and slightly conical in the smaller ones, and without a trace of a nipple or opening before maturity. On the under side it projects but slightly and is provided with a minute, but closed nipple, the insect issuing from the upper surface which splits in a more or less jagged, round or oval opening, the bracts of which curve more or less outward. In some few cases the nipple on the under side also opens sufficiently to allow the insects to emerge from both sides. The color of the galls above is reddish or yellowish, generally surrounded by a paler ring, and beneath paler than the leaf. It occurs on *Hicoria alba* in company with the other two, and matures from the end of May to the middle of June.

MIGRATORY FEMALE.— Length of body 08.–1.3$^{mm.}$. Expanse 1.6–2.4$^{mm.}$ Color pale orange, palest toward the end of the body, the prothorax darkest. Head, antennæ and legs dusky, the metathorax and scutellum darker, the sternal plate black. The prothorax is more or less distinctly marked, mediodorsally, with a small, transverse, dusky spot and bordered each side with a dusky shade. Antennæ rather more slender than in the other two species, about as long as the tibiæ and apparently composed of four joints, the third joint in most of the specimens being distinctly and sharply divided just above the lower sensorial membrane. The annulations are rather shallow and in some specimens difficult to detect. There is, however, more or less

variation in the length and prominence of the third joint, which is often much shorter than represented in the figure; or it may be longer in one antenna and shorter in the other, resembling in the latter respect more *Ph. picta*. Wings delicate, faintly dusky or almost colorless and rather short; stigma dusky, with a yellowish tinge or sometimes almost colorless; veins very delicate, especially the discoidal and stigmal veins, both of which are often difficult to discern; the stigmal vein in some specimens connects with the stigma in both wings, in others either in the right or left wing only; whereas in others one or both veins curve away from the stigma to connect with the third discoidal vein, resembling in this respect *c.-septum*, from which it differs, however, in its smaller and paler wings and venation, the paler and almost smooth body and the more slender antennæ.

SECTION II.

PHYLLOXERA FOVEOLA Pergande, n. sp.

Plate III., figs. 15, 16.

The gall of this beautiful species is evidently closely related to and may possibly be identical with *Ph. foveata* Shimer (Trans. Am. Ent. Soc., II., p. 393), but considering the number of closely allied species in which the galls resemble each other more or less closely, and the fact that the inmates of his galls were winged and plentiful by the 20th of June at Mt. Carroll, Ill., whereas the galls of *foveola* are nearly deserted by the 1st of June, near Washington, induce me to consider the two forms as specifically different.

I have found this gall during the latter part of May upon *Hicoria glabra* in the vicinity of a small creek between Arlington, Va., and the Potomac River. Most of the galls contained, as early as May 23rd, numbers of the winged form. These galls grew either singly or as many as forty upon a single leaf when they become at times confluent, each retaining, however, its character and individual cell intact. On some of the trees they were much more numerous, completely covering some of the leaves. The diameter of the galls ranges more or less between 3-5$^{mm.}$ horizontally and between 1-3$^{mm.}$ vertically. They are as a rule very

convex and more prominent above than beneath, with a rather deep dimple or depression at the centre, which depression occasionally reaches as far down as to the opposite side of the gall; its basal circumference forms either a depressed or elevated ring. Beneath they are but slightly convex, often sunken below the plane of the leaf, with the centre depressed and bearing a very short, somewhat conical nipple, which is tightly closed and densely covered on the inside with a pale pubescence in the younger galls, whereas in the older or mature galls the nipple splits into 4-8, or rarely more, short and rather flat recurved bracts, which leave a round or slightly oval orifice between them.

In the largest and perfectly developed galls the upper side is either of a delicate pale red with the dimple darker and its basal circumference yellowish-green; or entirely yellowish-green with only the dimple of a beautiful pink color. Beneath they are uniformly yellowish-green, often with a faint reddish tinge, especially toward the nipple. On the other trees, most densely covered by them, they were less beautiful, with less red and a shallower dimple. The walls are very thin and paper-like and readily collapse when old. All galls are perfectly smooth on both sides.

STEM-MOTHER.—One of the smallest so far observed. Length 0.4–0.6$^{mm.}$ Broadly ovoid, pointed posteriorly. Color yellow or pale orange. Antennæ and legs dusky, eyes black. Antennæ very short, the third joint being scarcely longer than the two basal joints combined, and rather thin; joint 1 much the stoutest, about as long as wide, and truncated at apex; joint 2 longer than wide, stoutest and rounded at apex; joint 3 slender, somewhat curved, with 8-10 irregular and coarse annulations; the thumb short but distinctly projecting; two to three fine hairs surrounding the tip. Front of head straight or slightly concave. Granulation of body extremely fine and quite dense.

EGG.—White, with a faint yellowish tinge, regularly ovoid, highly polished and quite profusely reticulate.

LARVA.—White; legs and antennæ pale dusky; eyes red. Six prominent conical tubercles along the front edge of head, each furnished with a fine hair. Surface of body finely granulate. Antennæ longer than usual, the third joint stoutest at middle,

tapering towards both ends and, apparently, with twelve shallow annulations, the thumb small and at some distance from the apex of the joint. Rostrum extremely long, reaching about one-half its length beyond the abdomen.

PUPA.— The younger pupæ are whitish and the larger pale orange, the wingpads and mesothorax whitish, the former often with a blackish external margin, and the latter with the two median lobes faintly dusky or greenish. The head darkest and the end of the body palest. Surface of body quite densely and coarsely granulate. Eyes brown, ocellar spots red. Antennæ rather long and stout.

MIGRATORY FEMALE.— Length of body quite uniformly 1.2$^{mm.}$; expanse of wings about 2.8$^{mm.}$. Form slender, much more so than in most species. Color orange, varying in depth, the prothorax darkest. Head black; in the younger ones dusky with only the front edge black. Eyes brown, ocelli clear, bordered with black at inner edge. Antennæ blackish. Legs dusky with a yellow tinge, and rather slender. Mesothorax, scutellum and sternal plate black or dark brown. There is a poorly defined, more or less dusky band or shade across the prothorax, two ill-defined dusky spots near anterior margin, with more or less distinctly dusky anterior angles, and sometimes a blackish subdorsal spot each side in the dusky median band. Front of head straight or slightly concave. Antennæ slender, the first joint about as long as wide, slightly stoutest at base, truncate at tip, with but feeble indications of annulation. The second is slightly longer than wide, thinnest at base, rounded at apex, and rather coarsely scaly or annulated. The third is about three times the length of the two basal joints combined; it is slender and of almost equal diameter throughout, with the upper sensorial membrane about one-half the length of the joint; the lower one is minute, often apparently wanting, and close to the base of the joint, resembling in this respect those of *Ph. c.-avellana*. The lower part of the joint, as far as the upper sensorium, is rather coarsely annulated, and the upper part scaly. Wings long and narrow and faintly dusky. Stigma and costal cell dusky with the stigma not well separated from the cell. Subcosta and veins blackish, the latter bordered with a dusky

shade; the two branches are much farther apart than is usual, on account of the stigmal vein, which is far removed to the apex of the stigma. The bases of both branches are often completely obliterated and without a connection with either the discoidal or the stigma.

PHYLLOXERA PILOSULA Pergande, n. sp.

Pl. III., fig. 17; Pl. IX., fig. 49.

The galls of this species are very unique and readily distinguished from any others so far observed. They occur usually on solitary trees of *Hicoria glabra* along the Potomac near Washington. They are usually quite abundant though rather sparsely distributed, there being but one, or rarely more than 3-6, upon a leaf and seldom so close together as to become confluent.

When first found, May 23rd, they were already fully developed, but contained, besides the stem-mother, only eggs and larvæ. Ten days later most of the insects had already acquired wings.

The transverse diameter of the gall varies between 3-6$^{mm.}$, and their height to the tip of the nipple 2-3$^{mm.}$. They are quite flat above, even with the surface of the leaf or but slightly projecting above it. In the latter case they are usually surrounded by a somewhat depressed ring and have a slight inclination to one side. There is always a more or less distinct shallow depression at the middle, which is usually quite densely covered with rather long, faintly yellowish, soft and glistening hairs. On the under side they resemble somewhat those of the variety *Ph. c.-symmetrica*, though they are more evenly convex and provided with a rather long and slender nipple, which is split into five to six, or rarely more, slender filaments, which usually lean to one side. This nipple, as well as the surface of the gall, is quite densely covered with long, glistening and faintly yellowish hairs similar to those on the upper surface. This pilosity of the gall is quite in contrast with the otherwise perfect smoothness of the leaves above and beneath. The upper side of the galls is of a paler green than the leaf itself, with a slight tinge of yellow, whilst on the underside the color merges gradually from pale green at its circumference to almost white at the nipple. The walls are quite

solid and rather stout at the base. The galls are almost perfectly white on the inside and semi-transparent.

STEM-MOTHER.— Length about 0.8mm. Shape broadly oval, the last two or three segments quite slender. Color pale dull yellowish, with a faintly dusky tinge. Head, antennæ and legs dusky. Eyes brown. Surface of body apparently without granulation. There are two small blackish median punctures on the head, between the eyes; six stiff hairs along its front edge, a transverse row of four such hairs back of the anterior margin, one each side of the black punctures, and one close to the inner edge of the eyes. Two similar hairs, arising from lateral tubercles of each of the thoracic segments and one each side, also on tubercles, on the abdominal segments. The dorsum is marked with six rows of pale dusky tubercles, each bearing a hair, with two deep subdorsal punctures each side of the prothorax, and two similar punctures each side in the following three sutures. Antennæ rather short; the first joint very much swollen and almost globular. The second slightly longer than wide, rounded and somewhat stoutest at apex. The third not much longer than the two basal joints together, of equal diameter througout and quite scaly. Legs rather longer than usual, the tarsi very stout, conical, with the knobs of the terminal hairs larger than usual.

The stem-mother of this species is more active than that of any of the other observed species.

EGGS.— Pure white, ovoid, highly polished and with a faint trace of hexagonal reticulations.

LARVA and youngest pupæ white, the older ones pale orange; mesothorax and wing-cases white. Eyes and ocelli red. Antennæ and legs white. Surface of body densely and quite coarsely granulate.

MIGRATORY FEMALE.—Length of body about 1.2mm. Expanse of wings 2.8–3mm. Color orange, the prothorax darkest. Head blackish, its anterior margin darker. Eyes brown, ocelli clear, bordered with black at inner margin. Antennæ and legs pale dusky. Mesothorax, scutellum and sternal plate black. The prothorax is marked at its anterior margin with a median, somewhat elongated, triangular, pale dusky spot and a short trans-

verse subdorsal line each side of it; a short, oblique or curved line subdorsally each side, often broken into two or three spots, and a slightly dusky, median shade at posterior margin. Surface of body sparsely and finely tubercled. Antennæ short, scarcely as long as the head is wide posteriorly; joint 1 stoutest, about as long as wide and of about equal thickness. The second but faintly longer than wide, rounded and a little stoutest at apex. Both joints are distinctly scaly and annulated. The third joint is of about equal thickness throughout, with the upper sensorial membrane very long, occupying two-thirds or more of the joint, the lower one being entirely wanting. The upper two-thirds of the joint, or more, is quite coarsely scaly and the lower part divided by about ten annulations; the apex is blunt and provided with one hair at tip and two others a little below it. Legs rather slender, the tibiæ annulated and the terminal pair of capitate hairs longer than usual, and the knob more distinct. The body ends, above, in a stout and prominent conical anal projection which is not uncommon in other Aphididæ, but is not ordinarily conspicuous in Phylloxeridæ. The vulva is also very prominent, expanding trumpet-fashion, and with its external surface closely and beautifully striated. Wings large, pale, though with a dusky hue and with their surface densely scaly; stigma, subcosta and veins dusky, the latter shaded. Venation normal, though the stigmal branch reaches seldom to the stigma, but fades away some distance before it.

The winged form approaches quite closely that of *Ph. foveola*, more particularly in the antennæ, the third joint of which in that species is also quite uniform in diameter. The absence of the lower antennal sensorium, the more slender form, and the differences in the stem-mother and the gall, all serve to separate the two forms.

PHYLLOXERA DEPLANATA Pergande, n. sp.

Pl. III., figs. 18-20; Pl. IV., figs. 21-23; Pl. X., figs. 66-70.

The galls of this species and their architects were carefully studied in 1883 on some small trees of *Hicoria tomentosa* growing on a hilly slope, bordering the Potomac River, opposite Georgetown, D. C. An interesting fact connected with the species was

the absence of the winged or migratory generation, in which respect it agrees with *Ph. c.-semen* Walsh and *Ph. caryæ-venæ* Fitch. That *Ph. deplanata* is distinct from this last is made patent by a comparison of the galls and stem-mother; while it would also seem to be distinct from *Ph. c.-semen*, its western representative. The galls of *Ph. c.-semen* are the smallest known, measuring not more than 0.6–2$^{mm.}$ horizontally, being more or less subglobular and provided with a round orifice, surrounded by a fringe of 5-8 or more, rather broad bracts; whereas the galls of this species have a transverse diameter of 1-5$^{mm.}$, are but slightly convex above and more prominent beneath; the orifice is oval and without any bracts, but closely fringed with fine hairs. Its walls are rather thin and flexible, while those of *Ph. c.-semen* are thick and hard. In how far the insects of these two galls differ is not at present known, but there is little doubt that future more careful study of Walsh's species will reveal sufficient differences.

The leaves of some of the smaller trees are often literally covered with the galls of *deplanata* which then produce a sickly, yellowish and crumpled appearance thereof. By the end of June the galls are deserted, brown and dry, or else have completely decayed, leaving innumerable holes in the affected leaves, seriously affecting the health of the tree. When but a few days old (first week in May) these galls resemble minute yellow specks.

The transverse diameter of the mature galls varies from 1-5$^{mm.}$; height about 1$^{mm.}$; walls rather thin above and beneath and semi-transparent. Upper surface projecting but little above the plane of the leaf, convex, usually with a shallow fovea; frequently not central and occasionally with a slight central elevation. Under side more strongly convex, sometimes almost conical, the nipple usually more or less flattened and generally leaning to one side, as if pressed down when young; with the orifice usually oval, though sometimes more or less rounded, and which before maturity is perfectly closed and densely fringed with short pale hairs. Color above either reddish with the depression yellowish, or almost entirely greenish-yellow; below purplish or dull greenish-yellow. Many of the galls are conjoint, *i. e.*, contain from 2-6 or more

stem-mothers together with large numbers of eggs and sexual individuals, the cavity being completely crowded.

STEM-MOTHER.— Length of body 0.4–05$^{mm.}$ and almost as broad. Color, varying shades of orange. Antennæ, legs and rostrum faintly dusky, almost colorless. Eyes dark-purple or black and each composed of three simple ocelli. The whole body is densely covered with distinct, minute, conical tubercles. Head about twice as broad as long, almost semi-circular, slightly flattened between the antennæ and furnished each side just in front of the eyes with a peculiar, rather prominent, more or less conical, fleshy, colorless and apparently retractile, protuberance. Antennæ quite slender, the first joint of almost equal thickness; the second shorter than the first, thinnest at base, truncate at tip. Joint 3 long and slender and somewhat stoutest beyond the middle, with eighteen or more sharp annulations more or less well defined. Legs quite stout, the tibiæ distinctly clavate. Anus bluntly rounded and apparently furnished with four hairs around its edge.

EGGS.— Length 0.1–02$^{mm.}$ Ovoid, polished and pale yellow, the more recently laid, whitish. The smaller produce males.

SEXUAL FORM, ♂ ♀.— Length of the female 0.4$^{mm.}$, the male being about one-sixth smaller. Color pale yellow, head, antennæ, legs and a rather indistinct band across all segments pale dusky. Eyes dark purple or purplish-red, composed of three large ocelli arranged in a triangle. Surface of whole body covered with very minute conical tubercles and with four dorsal and one lateral row of larger warts on the thorax and abdomen and quite a number on the head, each bearing a slender hair, which, in the female, is simple, but capitate and stouter in the male. A minute conical rudiment of the rostrum in both sexes, not fitted for sucking. A somewhat prominent round tubercle on each side of the pro- and metathorax. The antennæ are quite slender; the first joint stoutest; joint 2 longer than wide. Annulation of third joint rather indistinct and irregular. The thumb-like organ near the tip is quite prominent and has been observed to be distinctly movable. The tips of the thumb and of the joint are furnished with several exceedingly fine hairs, the terminal one, as well as that at the tip of the thumb, in the male, being capitate. Legs

rather short. The body of the male, besides being smaller, is almost of equal diameter throughout, while the female is broader and elongate-ovoid.

Both sexes are very active and run briskly about after leaving the galls, particularly the males.

During May of 1902 I happened again to observe the galls of this species to be quite numerous on the leaves of *Hicoria* (*Carya*) *microcarpa* and found on examination that each of the galls contained from one to five or more of the stem-mothers, their eggs and the sexes, and, to my surprise, found also a number of pupæ and winged migrants in some of them; which proves that the habitually apterous species evolves from time to time a migratory form, to preserve the species against extermination.

The migrant is orange; the head, antennæ, thoracic lobes, sternal plate and legs dusky to black; the wings are dusky. The antenaæ are evidently four-jointed, the fourth joint is distinctly petiolated, with the petiole being divided by three to eight or more sharp annulations; the sensorium of joints three or four being very much elongated.

PHYLLOXERA DEPRESSA Shimer.

Dacytlosphæra depressum Shimer. Trans. Am. Ent. Soc., 2, pp. 389–390.

Phylloxera depressa Riley. Seventh Rep. Nox. and Ben. Ins. of Mo., p. 118.

Phylloxera depressa Thomas. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 164.

Not having had an opportunity of seeing this gall, I am unable to form an opinion as to its specific value and reproduce, therefore, the description as given by Shimer:

"These galls were found to be exceedingly numerous on some trees [*Carya alba*]. On June 20th they were smooth, slightly rounded above, pale yellowish-green; beneath somewhat whiter, and having in the centre a nipple-like projection; opening round, surrounded with a burr-like fringe composed of many filaments, the cavity like an inverted cone, the wall above being quite thin and translucent, so that the inmates may be seen moving about. This apparently very flat gall was placed as much below as above

the plane of the leaf. Diameter .15–.25 inch [3.8–6.2mm.]; vertical thickness .125 inch [3mm.].

"Winged imago.—Yellow; head, antennæ, legs and a band around the thorax, black; antennæ 3-jointed; otherwise as in specimens from gall No. 1 [*Ph. hemisphericum* Shimer]. Length of body .04 [1mm.]; to tip of wing .06 inch [1.5mm.]."

PHYLLOXERA FOVEATA Shimer.

Dactylosphæra forcatum Shimer. Trans. Am. Ent. Soc., 2, p. 393.

Phylloxera forcata Riley. Seventh Rep. Nox. and Ben. Ins. of Mo., p. 118.

Phylloxera forcata Thomas. Eighth Rep. Nox. and Ben. Ins. Ills., p. 164.

This appears to be nearest related to *Ph. foveola* n. sp. and *Ph. intermedia* n. sp., though as no opportunity has offered to further study *foveatum* at Washington, Shimer's original description is reproduced:

"On the same leaves [of *Carya amara*] containing the small galls, Nos. 7 [*Ph. minimum* Shimer] and 8 [*Ph. c.-semen* Walsh], I observed a number of larger ones with a dimpled depression above (which may be caused by the collapse of the thin paper-like centre), an opening beneath by a rounded, downy orifice, and having a diameter of .06–.33 inch [1.5mm.] and a vertical depth of .12–.16 inch [3–4mm.]; all contained the female and her eggs, and some larvæ.

"Winged imago.—Abdomen and prothorax pale orange, with a dark band or ring around the mesothorax; wings carried flat on the back in repose, hyaline, veins small, stigma very faint, smoky; antennæ 3-jointed, the last joint long, subcylindrical and on a very long pedicle; abdomen quite pointed. Length to tip of wings .06 [1.5mm.]; of antennæ .005 inch [0.1mm.].

"Mother insect.—Pale yellow, palest posteriorly. Length .04 [1mm.]; width .2 inch [0.05mm.].

"On June 20th the winged imagos were very plenty, but no eggs could be found."

[As printed in Trans. of the Am. Ent. Soc., Vol. II., p. 393, the name of this species reads *Dactylosphæra forcatum* and not *forcatum*, as used by Riley, Thomas, and others. The word as used in the Transactions is evidently a misprint which originally read *foveatum*, with reference to the dimpled depressions on the upper side of the leaf. The corrected spelling is used in the index to the volume. I deem it, therefore, proper to correct those errors.]—THEO. P.

PHYLLOXERA MINIMUM Shimer.

Dactylosphœra minimum Shimer. Trans. Am. Ent. Soc., 2, pp. 391–2.

Shimer's original description is as follows:

"Small round galls, generally very numerous in the leaves, and in some cases almost entirely covering them, a single leaf sometimes containing upwards of 250 galls; the average size larger than those of No. 8 [*Ph. foveatum* Shimer], although often quite as small, the larger ones measuring three-sixteenths of an inch [5mm.] in diameter. They were (June 25th) quite hard and smooth, and present, especially above, a bright, shining appearance; they were quite thick and plump, the vertical diameter compared with the horizontal diameter being as 2 to 3, and were much more plump and elevated above the leaf than those of No. 8 [*Ph. carya-semen* Walsh]. The portions of the leaf between the galls had in some cases turned crimson. I found from three to twenty-five inhabitants in a gall; the round opening beneath was so close as to be pretty safe against enemies, as I found none in the galls opened thus far. Larvæ and pupæ whitish, with red eyes; mother insect cinnamon color and smaller than the pupa.

"On July 5th I found winged imagos in all the galls, large and small, that were opened, the smallest galls not much exceeding .05 inch [1mm.] in diameter; when opened, the young insects eagerly ran out, and all presented the same pale, translucent appearance, with minute dark spots on the anterior part of the body, which is in contrast with the inhabitants of gall No. 8. The winged imago was first observed on June 30th.

"Winged imago.—Body, antennæ and legs, pale yellowish-white; the head and a band around the thorax, dusky; wings on the back in repose, translucent, neuration obsolete, the stigma scarcely perceptible. Length of body .025–.03 [0.6–0.8mm.]; to end of wings .045–.05 inch [1–1.1mm.]

"These insects are much smaller, paler in color and less disposed to fly than any of the other species noticed in this paper. From a gall .05 inch [1.1mm.] in diameter, I took a single winged imago with body .025 inch [0.6mm.] in length; with it there were a few eggs, but no other insect. I verified this same circumstance in several other small galls of this species, and it therefore appears

probable that the winged imago was the mother insect, developed into the winged state, although we have heretofore considered them as males."

PHYLLOXERA CARYÆ-SEMEN Walsh.

Pl. IX., figs, 50-51.

Phylloxera caryæ-semen Walsh. Proc. Ent. Soc. Phil., VI., p. 283.

Daktylosphæra caryæ-semen Walsh. First Ann. Rep. Nox. Ins. of Ills., p. 231.

Daktylosphæra caryæ-semen Shimer. Trans. Am. Ent. Soc., 2, p. 392.

Phylloxera caryæ-semen Riley. Seventh Rep. Nox. and Ben. Ins. of Mo., p. 117.

Phylloxera caryæ-semen Thomas. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 163.

This is evidently closely related to *Ph. deplanata*. The galls of *c.-semen* are, however, much smaller, more strongly convex, projecting above, and of much finer and harder texture. They also greatly resemble smaller specimens of *Ph. minima* notwithstanding the striking difference in the life-history of the two species, viz.: the production of a winged, migratory form in *Ph. minima* and the absence of such in *Ph. c.-semen*.

Walsh (Proc. Ent. Soc. Phil., 6, pp. 283 and 284) was led from the apterous nature of the species to consider it Coccidous rather than Aphidian, and in discussing the relative generic value of winged and apterous gall-making species, remarks that "*Carya* possesses at least two Coccidous galls, namely, *caryæ-venæ* Fitch, which I find exclusively on the Shell-bark Hickory in August, and which is described by Fitch as Aphidian, and doubtingly referred to the genus *Pemphigus*, and *caryæ semen* Walsh MS., a gall of the size and shape of a cabbage seed, which I find in prodigious numbers on the leaflets of the Pig-nut Hickory in July." And further on, in a foot note, he says: "That these two galls are Coccidous, not Aphidian, may be inferred from the fact that the tarsi of the mother-lice are 1-jointed, not 2-jointed. And besides,

Dr. Fitch himself describes the mother-lice of *caryævenæ* as laying eggs, and the same remark applies to those of *Caryæ semen*; whereas all true gall-making Aphidians that are known to me are viviparous so long as they live in the gall. Moreover, all gall-making Aphidians that are known to me remain in the gall till they have reached maturity and most of them acquired wings; whereas in these two galls the young larvæ, almost as soon as they have hatched out, stray away to found new galls, leaving the mother-lice behind them to lay from time to time fresh eggs."

With our present knowledge of the Phylloxerinæ we know that Walsh erred in forming this opinion. The tarsi of both species mentioned are (like those of all other known species of Phylloxera) plainly 2-jointed, he having simply overlooked the small basal joint; while the economy of the species producing winged females shows that they all originate from eggs, numerously deposited by the stem-mother on the walls of the gall. Maintaining this erroneous position regarding the Coccidous character of *c.-semen*, he refers it later (First Ann. Rep. Nox. Ins. of Ills., p. 23) to Shimer's genus *Dactylosphæra*, to include all those species which produce, or are supposed to produce, nothing but apterous individuals and proposed for all others, producing a winged generation, the name of *Xerophylla* (Proc. Ent. Soc. Phil., VI., p. 283, and 1st Rep. Nox. Ins. of Ills., p. 23). In the latter publication, after much discussion, he gives a short description of the gall and its architects on page 23, as follows:

"Gall *Caryæ-semen*, n. sp. made by *Dactylosphæra caryæ-semen*, new species. On the general surface of the leaflets of the Pignut Hickory (*Carya glabra*) in prodigious abundance, a subglobular, smooth, seed-like, hollow, sessile gall, 0.06–0.10 inch in its widest diameter, subhemispherical above, rather flatter below, with a nipple-like opening in the middle. Walls of the gall rather stout, fleshy and not woody. The external color is greenish-yellow above and pale green below, with the open central nipple whitish. There are frequently as many as 100 of these galls on a single leaflet. Inside may often be found as many as three or four mother bark-lice, similarly shaped and of the same yellow color as those of the *vitifoliæ* gall, but on the average rather smaller and accompanied, in the same manner, by eggs or very

young larvæ, or both. As with the mother bark-lice of the galls *vitifoliæ* Fitch, *caryæ-venæ* Fitch and *caryæ-fallax* Walsh MS., the antennæ of this mother bark-louse are three-jointed, joints 1 and 2 short and subequal, and joint 3 longer than 1 and 2 put together. The young larvæ are about 0.01 inch long and of the usual shape. Almost as soon as hatched—as is also the case with the larvæ of all the allied galls—these larvæ stray away to found new galls. The galls themselves are very abundant about July 24th, but by the 12th of August they were almost all empty and gaping open below.''

Dr. Shimer, referring to the same species (Proc. of the Acad. of Nat. Sci. of Phil., Vol. 19, 1867, p. 3), confounds it with his *Dak. globosum*, which forms a similar though much larger gall on the same leaves and produces a winged generation. Speaking of the young of the smaller galls he says ''the young larva usually leaves the gall as soon as hatched and proceeds, as does the 'grape-leaf louse' (*D.? vitifoliæ*), to construct a new gall.''

The following notes, made in the West some years ago, will amplify the somewhat brief description of the gall by Walsh:

Description of Gall.—Transeverse diameter 0.3–2$^{mm.}$ or slightly larger. Vertical diameter 0.2–0.5$^{mm.}$. Hemispherical and more prominent above than beneath and frequently depressed at the centre, the depression often running out to one side. More or less projecting beneath, with a tendency to become somewhat conical, terminating in a short nipple, with a round or slightly oval orifice, surrounded by 4–10 or more rather stout and profusely pubescent recurved bracts, completely closed when young. Upper surface smooth, yellowish-green to brownish-yellow. Rather tough and leathery and slightly semi-transparent at the centre if held toward the light.

This gall is usually extremely abundant on infected trees, often to such an extent that every leaf is completely covered. I have counted on some of the smaller leaflets over 300 of these galls, many of which, to the number of 2–5 or more, were confluent.

This appears to be an exclusive western species and has been found at Kirkwood and elsewhere in the Mississippi Valley, upon *Hicoria glabra*, maturing during the latter half of July and early August.

PHYLLOXERA CARYÆ-FALLAX Riley.

Pl. IX., figs. 52-53; Pl. XI., figs. 71-74.

Phylloxera caryae-fallax Riley. Seventh Rep. Nox. and Ben. Ins. of Mo., p. 118.

Phylloxera caryæ-fallax Thomas. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 164.

Considerable doubt has existed until lately in my mind as to the identity of the species briefly referred to under this name by Walsh in his "First Ann. Rep. of the Nox. Ins. of Ills.," p. 23, and that described by Riley under the same name in the "Seventh Ann. Rep. on the Nox. and Ben. Insects of Mo.," p. 118. Walsh states that he never found a winged insect either in this gall or in those of *c.-semen* and *c.-foliæ*, though he has opened and examined hundreds of them. My observations regarding this peculiar gall, extending as far back as 1872, run counter to those of Walsh, for I have found this particular gall swarming with the winged female.

To account for this apparent discrepancy in independent observations, it may be stated that my own observations were made from early May until June, and that these made by Mr. Walsh were from the 17th until the end of June, or at a time when the winged form had already forsaken the galls. What, then, were the numerous larvæ (?) with which he found the galls swarming, and what was their office? They could not well form new galls, as the season for that purpose was already too far advanced!

The explanation will doubtless be found in the following facts:

If the galls be opened early in May, or before the nipple has opened, they will be found filled with winged insects, pupæ, numerous eggs, and what appear to be larvæ. These supposed larvae, however, upon careful examination, are not larvæ hatched from eggs deposited by the stem-mother, but the true sexual individuals, both males and females, produced from eggs deposited freely by the winged females. In this species, therefore, the sexed individuals are (in part at least) produced within the original gall, though winged females subsequently perform the true function of migrants and leave the galls to carry their sexed young elsewhere.

The gall of this species is one of the most common and numerous on the leaves of *Hicoria* (*Carya*) *alba*, and probably some other species of the genus in the states of Missouri and Illinois, extending at least as far south as Tennessee and probably throughout most of the states bordering the Mississippi. It seems to be exclusively a western species, and is at times so extremely abundant as to cover completely every leaf upon a tree, the leaves becoming much dwarfed and distorted. On some small leaflets, about 2 inches long by ¾ inch wide, more than 300 of these galls were counted.

The fully grown galls vary in height and diameter at base from 1–5 mm. Those more densely crowded are narrower at base and higher in proportion. They are conical or tooth-like above and frequently lean over to one side. The under side is more or less prominently convex and more or less prolonged at the centre, with the nipple often, also, inclining to one side. The orifice is either round or oval, closely fringed with pale hairs, and tightly drawn together till maturity. The walls are rather tough and leathery. The color of the galls when younger is greenish-yellow to reddish, becoming gradually brown or black, and brittle after the insects have left.

STEM-MOTHER.— Length about 0.6mm. Body almost globular. Color, orange; legs and antennæ dusky. Eyes, dark purple. Surface of body quite densely covered with rather coarse, somewhat conical granules, though less dense than in the stem-mother of *Ph. deplanata*, the granules interspersed with a few stiff hairs, most numerous about the anal segment, and some of them capitate. Antennæ rather stout, the third joint about as long as the tibiæ and somewhat clavate, with about 18–20 rather coarse and apparently scaly annulations, and provided at tip with two short hairs. Legs ratber long and stout.

MIGRATORY FEMALE.— Length of body 0.6–0.8mm. Expanse of wings 2.3–2.8mm. Color, orange yellow. Head and thorax blackish, the head often paler. Eyes purplish; the two inner ocelli red, the frontal one colorless, all bordered with black at inner side. Antennæ and legs faintly dusky. Wings pale brownish; stigma and veins darker; the veins shaded with dusky. Venation normal, stigmal vein and cubital branch almost parallel,

Head and prothorax rugose, the latter but finely so. Surface of body covered quite densely with minute, somewhat conical, granules. Antennæ rather slender and quite peculiar; apparently 4-jointed. Joint 1 about as long as wide or but slightly longer, truncate at tip and faintly scaly; joint 2 more slender, distinctly longer than wide, a trifle thinnest at base, rounded at apex and quite coarsely scaly; joint 3 appears to be composed of two joints, the basal section abruptly truncated just above the lower sensorium, and tapering gradually to the base, coarsely scaly and divided by 6–8 quite distinct annulations; the terminal section is about two-thirds the length of the whole joint, its sensorial membrane much elongated and about one-half the length of the entire joint; its diameter quite uniform, though the part below the sensorium is somewhat thinner and divided by five or more coarse and somewhat scaly annulations; the remainder of the joint is coarsely scaly, with two or three short annulations at the apex, resembling minute joints.

This antennal structure comes quite near to that of *Ph. picta*, the third joint of the antennae of which is more or less distinctly divided into two sections.

SEXUAL INDIVIDUALS, ♂ ♀.—Length about 0.4$^{mm.}$, the female being somewhat the larger. Color orange. Eyes blackish. Antennæ and legs pale dusky. Surface of body quite smooth, apparently without granulations, and provided with four rows of rather stout, capitate hairs, which are somewhat longer and stouter in the females. Antennæ stout, the third joint longer than the tibiæ, clavate, with 10–12 more or less well-defined annulations. From the apical fourth of the third joint rises a long, stout, capitate bristle; two short, fine hairs at the tip, and another a little lower down on inner side. Legs very stout, more so than usual. Rostrum rudimentary, not fitted for sucking.

GROUP II.

Galls more or less fleshy, not transparent, usually more protuberant beneath than above; conical, globular, or pedunculate; opening always beneath.

13. Large; convex on both sides, more prominent beneath; circumference above button-like, with a more or less sharply defined edge; either above or sunken beneath the surface of the leaf; nipple short, surrounded by short bracts. Opening round... *Ph. rimosalis* n. sp.

14. Subglobose; about equally prominent above and beneath; without a nipple; opening in a transverse slit ..... *Ph. c.-scissa* Riley.
15. Subglobose, somewhat more prominent above than beneath; without a nipple; the orifice an elongate slit..... *Ph. c.-globuli* Walsh.
16. Subglobose; about equally prominent on both sides; conical beneath, ending in a short nipple, splitting into several stout bracts .. .. *Ph. conica* Shimer.
17. Flat above, either flush with, or sunken below the surface. Globular or pyriform beneath and more or less constricted at base; with or without a distinct nipple, which, when present, splits into several bracts..... .....*Ph. c.-avellana* Riley
18. Size medium; quite flat above, usually with a more or less distinct median depression; prominent and conical beneath; not constricted at base. Nipple distinct, surrounded by short bracts. *Ph. symmetrica* n. sp.
19. Large, more or less irregular; convex above; more prominent and conical beneath, splitting at maturity into several very long bracts. *Ph. notabilis* n. sp.
20. Large; globular; projecting about equally on both sides; the nipple short, with four to five short, stout, pubescent bracts surrounding the orifice, curving outwards when old..... *Ph. c.-globosa* Shimer.
21. Large; pedunculate and more or less elongated; suspended from the under surface by a slender petiole, quite sticky when fresh; split at the apex into several long filaments ..... *Ph. c.-gummosa* Riley.

PHYLLOXERA RIMOSALIS Pergande, n. sp.

Pl. IV., fig. 24; Pl. IX., fig. 54.

A very large and conspicuous gall, growing always upon the leaves of *Hicoria tomentosa*, bearing a great resemblance to the gall of *Ph. c.-scissa*, from which it differs in the round, not elongated, orifice and in some other characters.

It is not uncommon along the Potomac near Washington and affects more generally the terminal leaves of the more succulent young shoots. It matures somewhat later than most of the other galls, the first winged females occuring the latter part of May. It grows generally singly, though occasionally 2–4 may occur on the same leaf, in which case they tend to become more or less confluent, so as to form a large, flat mass; each retaining, however, its cell independently. It forms upon any part of the leaf, often very close to the edge, and may extend across two or

even three of the transverse veins, (when the upper surface becomes somewhat uneven) but never, as far as observed, across the midrib. The horizontal diameter ranges between 3–11$^{mm.}$ (those growing singly being usually much the largest) and between 1.6–3.4$^{mm.}$ in height. The form is quite flat or but slightly convex above, with the circumference usually sharply defined and sunken below the plane of the leaf, which forms around it a somewhat elevated and quite sharp edge or rim. The disk may be raised button-like above the plane of the leaf. Sometimes the upper surface is slightly uneven or concave; or there may be a slightly convex, central elevation, with a dimpled depression on one side of it. Beneath it is much more prominent and convex, resembling somewhat that of *c.-septum*, except that its nipple is extremely short and conical, with the orifice round and completely closed in the younger ones, with indications that it will split when mature into 5–8 short bracts, which are closely covered at the tip and inner side with minute, white, silken hairs. The surface above is perfectly smooth, whilst the under side is sparsely beset with short, pale yellowish, radiating hairs and yellow papillæ which characterize the under side of the leaves.

It is seen to be slightly transparent, if held between the light, especially around its margin. Its walls are rather thick and hard, especially at the base. The color above and beneath is of a somewhat paler green than the surrounding surface of the leaf, occasionally faintly tinted with red at the centre and polished above.

Each gall contains, by the middle of May, besides the single stem-mother, large numbers of eggs, larvæ and young pupæ, covering closely its inner walls, each with the end of the body directed toward the centre, as if they were standing on their heads. Some individuals acquire wings by about the 20th, while the majority do not reach this condition till the end of the month or the first week in June.

STEM-MOTHER.—Length when fully developed about 1$^{mm.}$; greatest diameter about 0.5$^{mm.}$ Elongate-pyriform, the older, or those which are nearly empty of eggs, are more or less broadly ovoid, 0.6–0.8$^{mm.}$ in length and 0.4–0.7$^{mm.}$ in diameter. Color

pale yellow in the younger and faintly brownish-yellow in the older. Eyes dark purple. Antennæ and legs dusky or blackish. There are usually two, more or less distinct (in some quite large, in others entirely lacking) black, double impressions on the head, somewhat in front of the eyes; several small black spots on the prothorax (often indistinct or wanting), two of which are near the anterior margin, and a group of three subdorsal spots each side, posteriorly; there is also a subdorsal spot in each of the first three abdominal sutures. Surface of body almost smooth, the sculpturing being almost invisible. Front of head more or less concave, with a short hair each side of the concavity. Antennæ short, the first joint stoutest and almost globular, the second longer than wide and of almost uniform diameter; the third slender, slightly stoutest towards the end and quite coarsely annulate.

EGGS.—White, or with a faintly yellow tinge, highly polished and with a distinct hexagonal sculpture.

LARVÆ and younger PUPÆ white or with but the faintest yellow tinge; eyes red; antennæ and legs very faintly dusky. The whole body densely covered with very minute points. The younger pupæ are marked with dusky spots very much as in the stem-mother. Wing-sheaths faintly dusky.

PUPA, mature.—Color orange, the mesothorax, wing-pads and two or three terminal abdominal segments whitish, the mesothorax often with a somewhat greenish tinge. Eyes and spots indicating the ocelli, red. Antennæ and legs pale dusky. There are two small dusky spots behind the ocelli, and a subdorsal curved row of six blackish punctures on each side of the prothorax, the posterior three of which are arranged in a triangular group, similar to those of the stem-mother. Antennæ stout and with but faint indication of sculpture. Entire surface of body densely and quite coarsely granulate.

MIGRATORY FEMALE.—Length of body about 1$^{mm.}$. Expanse of wings 2.3–2.5$^{mm.}$ Color pale orange, palest toward the end of the body. Front of head, as far as the posterior edge of the eyes, the two middle lobes of the the mesothorax and the sternal plate, blackish, all other parts dusky or brownish, with a yellowish tinge. Posterior half of head pale orange. Eyes brown;

ocelli yellowish, broadly bordered at inner side with dark brown. Two small dusky spots behind ocelli. Anterior angles of prothorax pale dusky, and two small, dusky, transversely linear spots, usually more or less indistinct, on the middle of the prothorax. Wings faintly dusky, the stigma, subcosta and discoidal vein darkest, the two branches very faint, though normal in their course. Surface of wings quite profusely granulate or scaly. Antennæ dusky, short, scarcely as long as the head is broad, the two basal joints almost equal in length, the first slightly longest and stoutest, narrowest at base, truncate at tip; the second almost as long as wide, rounded and stoutest at tip; both joints quite distinctly scaly; joint three is rather robust, diminishing but slightly and gently toward the base, connecting with the second joint by a very short though well separated petiole. There is no basal constriction and, apparently, only the upper sensorium present, which is rather stout and somewhat oval; surface quite coarsely scaly with the lower third sharply annulate; from 3–4 distinct, short bristles surround the apex, the two terminal ones stoutest.

PHYLLOXERA CARYÆ-SCISSA Riley.

Pl. IV., fig. 25; Pl. IX., figs. 55, 56.

Phylloxera caryæ-scissa Riley. Am. Ent. Vol. III., n. Ser. Vol. I., p. 230.

This gall, as already indicated, bears a close resemblance to that of *hemispherica* but it will be unsafe to consider them identical until further careful study is made of the latter species.

The first galls of *caryae-scissa* were received in 1880 from Mr. W. H. Ashmead, of Jacksonville, Fla., found growing upon *Hicoria alba*. Since then the same species has been occasionally observed in the vicinity of Washington, always growing upon the leaves of *Hicoria tomentosa*. It is a rather rare species, and occurs for the most part singly.

In general appearance it closely resembles that of *Ph. rimosalis*, for which it might readily be mistaken, but the upper surface of *c.-scissa* is never flattened, as in *rimosalis*, while the orifice is never round or nipple-like, but always a transeverse slit. All the different forms of insects, from the stem-mother to the winged

female of *c.-scissa*, are also larger and darker, with the antennæ much longer and more slender, particularly in the winged form.

The transverse diameter of this gall ranges from 8–14$^{mm.}$ and and the height from 2–5$^{mm.}$ or more. It is about equally convex on both sides, though sometimes more prominent either above or beneath, and often with a slight, central, nipple-like projection above. The surface on both sides is more or less distinctly covered with short, fine, yellowish hairs when upon *Hicoria tomentosa;* while upon *H. alba* it is smooth above and but slightly hairy beneath. The gall is always situated between two of the transverse veins, with the slit either parallel with them or slightly oblique. When young, this slit is slightly closed and not easily seen, but forms regular, shallow lips, densely pubescent, when older. Color above and beneath pale greenish or dirty yellowish-green.

The winged female may be found from the middle of May to the middle of June.

STEM-MOTHER.—Length 1–2$^{mm.}$; diameter across the thorax 0.8$^{mm.}$. Shape broadly ovoid. Color pale yellow; antennæ and legs faintly dusky; eyes purplish-brown. There are two deep black punctures on the front of the head and two smaller and somewhat oval spots at its posterior edge. A somewhat angulated, dusky, subdorsal spot each side on the prothorax; a larger, transverse spot each side in the first suture, and a smaller one each side in the two following thoracic sutures; also, a lateral row of three spots: the first is placed in the last thoracic suture and the others in the sutures of the first two abdominal segments. Granulation of body extremely minute and sparse. Antennæ and legs slender. First joint of antennæ stoutest; joint two considerably longer than wide and of almost uniform diameter, rounded at tip; joint three very slender, of almost uniform diameter, slightly stoutest at the apical one-third and quite coarsely but rather sparsely annulate.

Eggs white, regularly ovoid, highly polished and apparently without sculpturing.

LARVA and youngest pupæ white or faintly yellowish, the eyes red; the legs and antennæ slender; the whole body densely covered with distinct granules.

PUPA, mature.—Orange, the wing-pads and two or three last abdominal segments whitish, wing-pads becoming dusky externally with age. Antennæ and legs shaded. Eyes small, brown. Ocelli barely indicated by obscure brownish spots, between which are noticed two small, pale brownish piliferous spots. A subdorsal spot each side of prothorax. Entire surface of body densely granulated. Antennæ very slender, the third joint about three times as long as the two basal joints combined.

MIGRATORY FEMALE.—Length of body 1–1.2$^{mm.}$ Expanse of wings 3.4$^{mm.}$. Color orange. Head, mesothorax, scutellum and sternal plate blackish. Eyes dark brown or purple, almost black. Ocelli clear, colorless, broadly bordered at inner side with brown. Wings pale fuscous, the costal cell and stigma brownish; the stigma either not separated or scarcely separated from the costal cell. Venation blackish, normal, bordered with a dusky shade, especially the cubital vein. Surface densely covered with minute scale-like points. Anterior angles of prothorax broadly dusky; two small, more or less confluent, discal spots, a transverse spot at anterior margin and an elongated subdorsal spot each side, usually remaining quite pale. Surface of body quite densely granulated, the granulation less prominent than in the pupæ. Antennæ long and slender; joint 1 longer than wide, stoutest toward the base, curved outward toward apex; joint 2 shorter than one, a little longer than wide, narrowest at base, the apex nearly straight; joint 3 almost four times as long as the two basal joints combined; indented above its basal one-third, beyond which it becomes quite slender; both the anterior and posterior sensoria very indistinctly defined, the upper rather more than one-half the length of the upper section above the indentation; the whole surface quite densely scaly.

PHYLLOXERA CARYÆ–GLOBULI Walsh.

Phylloxera caryæ-globuli Walsh. Proc. Ent. Soc. Phila., Vol. I., p. 309.

Phylloxera caryæ-globuli Walsh. Proc. Ent. Soc. Phila., Vol. VI., p. 275.

Dactylosphæra hemisphericum Shimer. Trans. Am. Ent. Soc., II., p. 386.

Phylloxera caryæ-globuli Riley. Seventh Ann. Rep. Nox. and Ben. Ins. of Mo., p. 117.

Phylloxera caryæ-globuli Thomas. Eighth Ann. Rep. Nox. and Ben. Ins. of Ill., p. 164.

The galls of this species, as far as can be learned from the descriptions of Walsh and Shimer agree quite well with those of *c.-scissa* and I simply repeat here the original descriptions. That by Walsh is rather insufficient, somewhat scattered and mixed with other matter, from which it has been sifted.

Phylloxera caryæ-globuli Walsh. Proc. Ent. Soc., I., p. 309, and VI., p. 275.

"Galls spherical, generally located between the veins that branch from the midrib of the leaflets of the Shag-bark Hickory, and when ripe opens below by a simple, longitudinal slit. Never exceeding one-half or one-third the extreme diameter of *caryæ-caulis*.

"MIGRATORY FEMALE. —Length to tip of wings .07–.08 inch. Three specimens. The antennæ are scarcely longer than the head and I am unable to distinguish the joints. The stigma is about three times as long as wide, straight posteriorly, slightly hunched anteriorly and acute at both ends. Abdomen blackish [doubtless from dead and dry specimens, as no phylloxeræ have the abdomen black in life]; the whole costa pale brown, the stigma with a yellow tinge; the third or stigmal vein is not abortive at its origin and the second or middle vein not parallel with the third, but each of the two is slightly convex toward the other."

Dactylosphæra hemisphericum Shimer. Trans. Am. Ent. Soc., II., p. 386.

Galls on the Shell-bark Hickory (*C. alba*).

"GALL NO. 1.—This is a large subhemispherical gall, situated in the parenchyma of the leaf, generally projecting above the plane of the latter. Structure somewhat thick, tough and dense, the average thickness of the walls being about .05 inch. Color pale whitish-green, much paler than the leaf, the upper surface frequently tinged with red and often quite purple-red. Size: diameter in the plain of the leaf, one-fourth to one-half inch; vertical diameter one-half.

"These galls open beneath with a slit, the length of which is about one-third of the diameter of the gall; its direction is usually in, or somewhat oblique to, that of the veins of the leaf, and when oblique, more nearly parallel with the longitudal axis of the leaf. The lips of these slits are pinched so tightly together as to project out, and their margins are either smooth or slightly hairy. Sometimes a leaf contains but a single gall, others two or more. The galls may be scattered irregularly on the leaf, or placed in one or two rows along and near the midrib, and one or two dozen may be found in a single row, placed so closely together as to be contiguous.

"Upon opening one of these galls, I found the mother insect and her eggs, the latter in great abundance, one hundred or more studded all over the concave surface; but very few eggs had then (June 7th) hatched. But on opening one of the largest galls, which seemed to be in a much more advanced state, I found the mother insect in the midst of a very numerous brood of newly-hatched larvæ, and also many eggs still unhatched; the new-born larvæ were pale greeenish-white, while those more advanced were of a deeper color and of all shades approaching to orange; many were already in the pupa state, having short wing-cases. The mother insect moved in a stately manner among her numerous offspring, apparently proud of her queenly position.

"On June 18th the galls were in prime condition for examining the inhabitants; many were opening at the slit beneath and the winged imagos escaping in great numbers. The following is a description of the species:

Dactylosphæra hemisphericum, n. sp.? Walsh., Proc. Ent. Soc., I., 309.

"Winged Imago.— Light orange yellow, head, antennæ, legs, and a band around middle of thorax blackish; abdomen pointed; wings delicate, hyaline; antennæ (viewed with a single lens) apparently 3-jointed. Length of body .04; to tip of wing .06 inch.

"*Microscopic view.*— Antennæ 5-joined, the first two, as usual, short and thick; third longer; fourth slender, shorter than third; fifth clavate, longer than third and fourth and about as thick as the third; these joints do not appear so evident in all specimens, as sometimes only four are discernable, and sometimes the microscope separates the antennæ on one side into four joints, and that on the other into five. Promuscus slightly hairy, 3-jointed, the middle joint shortest and thickest, and the third

longest. Legs slightly hairy; femora very thick above, slender in the middle, being not half the upper diameter, then swelling out and clavate toward the lower end; feet with one joint, two claws and two digituli; which have clavate ends.

"Mother Insect.— Pale greenish-yellow, orange-yellow about the head; antennæ, proboscis and legs black; abdomen pointed, very versatile.

"*Microscopic view.*— A few very short, fine, black hairs scattered over the body; three spiracles are seen along each side; surrounding the femur there is an inverted conical or bell-shaped cup, bordered with black, within which the limb has room to work freely, and outwardly a frænum or skin attaches the side of this cup to the body, its lower margin black and about as large as the diameter of the cup. Proboscis projecting downwards between the fore legs. Eyes black. Tarsi with one joint, two claws, two long globe-ended digituli, and several hair-like spines. Antennæ 3-jointed, first two joints short and thick, subglobular, the last long and clavate.

"Pupa.— Pale orange, wing-pads lighter; eyes brown; ocelli red; feet plainly showing two digituli."

Of the winged imago thousands were observed, each cell containing from thirty to forty specimens. On June 18th I found no eggs, only a few larvæ and many pupæ.

I am rather suspicious that this *may* be the *Phylloxera caryæglobuli* of Walsh; but he says (*ibid.*) that the gall of his species is "spherical" and also that the size of the insect is ".07 to .08 inch in length" and that the abdomen is blackish. But unless described from living specimens, the color is of no value, as they all turn black after death.

PHYLLOXERA CONICA Shimer.

Pl. V., figs. 26-29; Pl. XI., figs. 75-78.

Dactylosphæra conicum Shimer. Trans. Ann. Ent. Soc., 2, p. 390.

Phylloxera c.-conica Riley. Seventh Ann. Rep. Nox. and Ben. Ins. of Mo., p. 118.

Phylloxera c.-conica Thomas. Eighth Rep. Nox. and Ben. Ins. of Ill., p. 1.

It is rather strange that Shimer failed to mention the color of this gall, notwithstanding it is one of the handsomest of this group. There can scarcely be any doubt, however, that the gall

here considered is identical with that described by him under the above name.

The first notes upon the species were made in 1872 when it was found in Missouri on the leaves of the Bitter-nut Hickory, (*Hicoria amara*). This is one of the most widespread and common of the Hickory galls in the Mississippi Valley, and was frequently sent by correspondents for identification. The galls begin to form the latter part of May and are then almost globular, though somewhat more prominent above than beneath, with a scarcely noticeable nipple on the under side, densely covered with yellowish pubescence. Their color is a deep purplish-brown, contrasting prettily with the light green color of the young leaves; their surface above and beneath is more or less roughened or granulated, and the appearance reminding one strongly of the galls of *Cecidomya q.-pilulæ* of the oak.

By the first week in June the galls are fully grown, but only contain the stem-mother, her eggs and larvæ. By the middle of the month the winged female prevails, with but few pupæ and still fewer larvæ, while in many cases the galls have opened and migration has actively begun.

The transverse diameter of the matured gall varies from $3–7^{mm.}$ and their vertical diameter from $2–5^{mm.}$ Many of them are almost globular, and, as a rule, more prominent above than beneath. Occasionally, however, they are more prominent beneath. In the majority, especially the larger galls, the under side is considerably sunken beneath the surface of the leaf and much less conical and usually much paler than when younger. The color above is a dull, dark purplish brown, sometimes, however, with only a brownish shade, or entirely of a dull greenish-yellow. The surface above, and sometimes slightly beneath, is densely and quite coarsely rugose and more or less distinctly pubescent, especially beneath, and covered with a more or less noticeable sticky or viscid excretion. The orifice is more densely pubescent than the rest of the gall, and splits, when mature, into 4–8 short bracts. The walls of the galls are rather stout, leathery and flexible. At full growth the inside is almost pure white, but by the time the insects are ready to leave, the color is brown all through. Generally these galls grow singly, though there

are often as many as ten, of which several may be confluent, on the same leaf.

STEM-MOTHER.— The fully grown stem-mother measures between 0.8–1$^{mm.}$ in length, the younger broadly pyriform, the older perfectly globular. Color pale yellow with a slight dusky tinge. Antennæ and legs blackish. Eyes small, black, scarcely seen from above. Surface of body closely covered with minute points. No piliferous warts noticeable. Antennæ rather long and stout; joint 1 about as long as broad and of nearly uniform diameter; joint 2 longer than broad; joint 3 about thrice as long as the two basal joints together, of nearly uniform diameter, or slightly thinnest at about the middle and divided by about eighteen rather coarse, more or less distinct annulations. The thumb is minute though quite distinct.

EGGS.— Perfectly white, highly polished and with distinct, large, hexagonal sculpturing.

LARVA.— White, the larger ones faintly yellowish, the eyes red. In the larger individuals may be noticed a group of prominent granules, just at the anterior angles of the mesothorax. Surface of body very minutely granulate. There are four small round warts along the front edge of the head, each bearing a fine hair, and one just opposite the eyes. Similar, though rather sparsely distributed warts, are noticed all over the body, but on account of their pale color they are not easily seen. The pupæ are of the same pale color as the larger larvæ.

MIGRATORY FEMALE.— Rather slender. Length of body 0.8–1.2$^{mm.}$. Expanse of wings 2.2–2.6$^{mm.}$. Color pale yellow, the prothorax and posterior half of the head darker. Anterior half of head, mesothorax, scutellum and sternal plate brownish or blackish. Eyes dark brown. Ocelli yellowish, bordered narrowly with black at inner side. Antennæ and legs pale dusky. Insertion of antennæ white. A small dusky subdorsal spot each side of the prothorax. Wings large, pale fuscous, the veins and stigma darker, the surface quite densely scaly. Surface of body densely but minutely granulated. Antennæ about as long as the head is wide posteriorly: joint 1 about as long as wide or slightly longer and slightly narrowest at base; joint 2 also about as long as wide, almost globular and with distinct, sharp, scaly annula-

tions; terminal half of joint 3 of nearly uniform diameter, tapering slightly from the upper sensorium to the base; upper sensorial membrane about one-half the length of the joint; the lower one wanting. The whole surface is densely scaly and sharply annulated, especially the lower half.

PHYLLOXERA CARYÆ-AVELLANA Riley.

Pl. V., figs. 30, 31; Pl. VI., figs. 32-36; Pl. XI., figs. 79-81.

Phylloxera caryæ-avellana Riley. Am. Ent., Vol. III., n. ser., Vol. I., p. 230.

Not uncommon on the leaves of *Hicoria tomentosa* along the Potomac near Washington.

Judging from the appearance of the galls, as regards size, shape and color, one might be led to conclude that we had to deal with two or more distinct species. A careful study and comparison, however, of the architects in their different stages, shows but one species. The more typical, larger and more brilliantly colored galls are the product of those stem-mothers which first settled, at a time when the development of the young leaves was most rapid and the circulation of the sap most vigorous.

By the 20th of May many of the galls already contain pupæ or even winged females, while others contain only eggs and larvæ. By the middle of June most of the galls are already empty and by the end of the month have become dry and shrivelled.

The transverse diameter varies from 5–10$^{mm.}$ and the height is about the same. Flat or but slightly convex above and either flush with or somewhat sunken beneath the surface of the leaf; sub-conical or more or less globular beneath, constricted at base and resembling somewhat in shape a diminutive filbert. The surface beneath is quite densely pubescent and with similar minute yellow papillæ as those which cover the under side of the leaves, and causing a certain stickiness. The orifice, at the top of the gall, is, before maturity, closely drawn together and densely covered on the inside with white wooly hairs, opening at maturity into several short and stout bracts. Walls very thick and succulent. The color above is either greenish, yellow-green or of a more or less intense, beautiful crimson or pink; and beneath pale greenish, or even almost white.

STEM-MOTHER.— The stem-mother varies from 0.8–1.3mm. in length, and is about half as wide. Shape broadly-ovoid, pointed posteriorly, almost globular in the older specimens. Color pale yellow, with a faint dusky tinge, slightly orange or dull greenish-yellow in the older specimens. Antennæ and legs black. Eyes dark red or black or purplish-black and rather small, with two deep, blackish, median punctures a little in front of them. On the head an oblique, blackish depression each side anteriorly, a larger subdorsal depression each side on the prothorax, and a blackish, subdorsal spot in the three following sutures, all of which spots, with the exception of those on the head, become more or less completely obliterated in older specimens. There are, in addition, four rather prominent warts along the front edge of the head, one each side behind the antennæ, one each side at inner edge of eyes, one each side of the two punctures and two at the posterior margin. Two similar warts each side of the thoracic and one each side of the abdominal segments. Beside these warts there are two transverse rows of four warts across each of the thoracic and one row of four across the abdominal segments, each bearing a short, stiff hair. Surface of body densely covered with minute sharp points. Front of head more or less concave. Antennæ rather short, but little more than one-half the length of the posterior margin of the head: joint 1 very stout and but little longer than wide; joint 2 more slender, longer than wide, stoutest and almost straight at apex; joint 3 slender, of nearly uniform diameter, somewhat curved and quite coarsely annulated, its tip truncate, surmounted by a stout hair and two smaller ones a little below the tip; thumb small and insignificant. Legs and tarsi rather stout, the terminal pair of the tarsal bristles (or *digituli*) with the knob much larger and more conspicuous than usual.

EGG and LARVA white or faintly yellowish; the sculpturing of the eggs extremely delicate and sub-obsolete. Surface of the body of the larva densely covered with minute granulations; eyes red, antennæ and legs whitish.

PUPÆ pale orange, the younger specimens whitish or pale yellow, with the external edge of the wing-pads often blackish.

Eyes red, ocellar spots reddish. Antennæ and legs dusky. Surface of the whole body densely granulated.

MIGRATORY FEMALE.— Length of body 0.9–1.2$^{mm.}$. Expanse of wings 2.2–2.8$^{mm.}$ Color orange, the prothorax somewhat the darkest. Head, mesothorax, scutellum and sternal plate, black. Antennæ and legs dusky; eyes brown or dark purple. The prothorax is often faintly dusky and is often marked medio-dorsally with three more or less distinct, minute spots, of which the two smaller, anterior ones, are more or less oval, and the larger posterior one linear. Antennæ about as long as the tibiæ: joints 1 and 2 about equal in length and but faintly annulated; joint 3 much the largest and almost three times the length of the other two combined, almost uniform in diameter throughout its whole length, quite straight, with a short pedicel at base and terminating in a distinct nipple which shows at least two well-marked annulations and is provided with three extremely fine hairs; the whole joint is but faintly annulate, the annulations more numerous and more distinct at its basal fourth, the sensoria subobsolete, particularly the basal one, the terminal one very slender and about one-half as long as the joint. Wings ample, faintly dusky, the veins and stigma darker, the subcosta yellowish at base; of the veins the discoidal vein is darkest, and all are bordered with a faint dusky shade. The discoidal vein arises somewhat nearer to the stigma than to the base of the wing and branches near its middle; the stigmal vein is but slightly curved and starts from about the middle of the stigma. Legs rather short.

PHYLLOXERA SYMMETRICA n. sp., Pergande.

This species, as far as its gall is concerned, appears to be closely related to, if not identical with, *Ph. conifera* Shimer (Trans. Am. Ent. Soc., Vol. II., 1868, p. 397), but as his description, both of the gall and its architect, is rather vague, brief and general in characterization, so much so as to apply equally as well to many others, it is deemed more expedient to describe it as new.

This gall has been noticed on young trees of *Hicoria* (*Carya*) *tomentosa* and some other species, in the neighborhood of Wash-

ington, for quite a number of years and appears to be slowly but gradually increasing.

Judging from the appearance of the galls alone, one is tempted to divide them into two or perhaps three distinct species, with regard to shape, size and color. A careful study, however, and comparison of the migratory forms of their architects, have conclusively convinced me that the different forms of these galls are nothing else but varieties of one species, depending, as it appears, on the earlier or later settling of the young lice, and the therewith connected more or less advanced stage of development of the young leaves. There can be no doubt that the larger and more brilliantly colored galls are the product of such of the young lice of this species which hatched in advance of the bulk of the same brood, just at the time when the development of the leaves was most rapid and the circulation of the sap most vigorous. To enable the future student, therefore, to recognize these different forms more readily, it is deemed expedient to figure each form of gall and to give each of them a variety name. All these forms are usually, at least in this locality, met with at about the same time and upon the same trees, though the two largest or more brilliantly colored galls are much scarcer than those of the typical form. As a rule, there is generally but a single gall on a leaflet, though occasionally two, or even as many as five or six, and in one instance even as many as twelve were observed upon a single leaflet, all crowded together near the base of the leaf, and more or less confluent. If there be more than one on a leaf, it will be observed that generally most of them are dwarfed, whilst but one or two have attained their full size.

At what date the young stem-mother settles down has not been ascertained, though it must be at the time when the young leaves begin to unfold, at about the middle or latter part of April, for it was observed that by the 20th of May many contained already pupæ, and a few even some winged insects, whilst others contained only eggs and larvæ. By the 15th or 20th of June most of the galls are empty and by the end of the month all inmates have left and the galls become dry and shrivelled.

PHYLLOXERA SYMMETRICA n. sp., Pergande.

TYPICAL FORM.

This gall forms always on the under side of the leaf; it is quite flat on the upper side, or slightly convex, occasionally somewhat depressed at the middle, circular, with its margin generally more or less deeply sunken below the plane of the leaf and generally concolorous with the upper side, or of a somewhat darker shade. On the under side, however, it is quite prominent and regularly conical in shape, with an opening at the tip, which, however, is tightly closed till the time arrives for the migrants to leave. At this time the apex commences to split into 4–8, more or less slender, backward-curved bracts or filaments, surrounding a more or less circular opening. The color of the lower side of the galls is either that of the leaf or somewhat paler, though rather darkest towards the apex, and their surface covered rather sparsely with the peculiar hairs and pellets of resin so characteristic of the under side of the leaves, becoming more dense towards the apex. The walls of this gall are rather stout and of a dense and firm texture, increasing in thickness toward the base. The transverse diameter above ranges between 2–5$^{mm.}$ and the vertical diameter from 3–4$^{mm.}$. After the insects have left, the galls gradually dry up, become brown, lose their shape and disappear at last almost completely.

In this connection it will be interesting to record here what appears to be a second crop of galls of probably the same species, though it is quite possible that later observations may prove this to be distinct.

On the 29th of July, 1883, while examining a solitary young hickory tree near the fair-ground, in the District of Columbia, standing at a distance of between 20–50 feet from the nearest trees of its own kind, it was observed that considerable numbers of young galls had formed on the uppermost and youngest leaves, which, to all appearance, could scarcely be older than, perhaps, two or at most three weeks. A further examination of the older leaves proved that they had been infested quite profusely by galls of the species under consideration, all of which were empty and more or less dried up, though a few were still on the upper

side; no galls of any other species could be detected on any of the leaves. Notwithstanding this fact, it is still possible that these new galls were the product of some other species, the winged form of which may have migrated there from some distance. These newly formed galls were smaller and also quite different in appearance. Their upper surface is also scarcely elevated above the plane of the leaf, with the centre quite distinctly depressed. This depression is reddish or pink and is generally encircled by a pale yellowish-green ring, the under side is more prominent, though by no means conical, and somewhat paler than above. All contained, besides the females, numerous eggs and also a few larvæ. The female is yellow with the eyes black, the larva pale yellow with reddish eyes; the eggs are colorless, the more mature ones faintly yellowish.

Var. A. PHYLLOXERA VASCULOSA Pergande.

This variety is more striking in appearance and much larger than the more common or typical form. It grows also on the under side of the leaves, but is rather scarce, there being not more than from one to perhaps twelve or a few more upon a tree. Its upper surface is very much like that of the typical form, though it is often considerably sunken below the plane of the leaf and is of very much the same color. The galls proper, on the under side, are very much of the shape of a vase or urn. They are more or less constricted at base, the sides rounded and of a pear- or more or less globular form. The opening at tip, which is closed while the galls are immature, opens at maturity into bracts, similar to those of the typical form, whereby a more or less distinct neck is produced. The color of the galls is pale green, or sometimes almost white or pale yellowish, the surface being quite pubescent. Their diameter across the widest part ranges generally between 5–8$^{mm.}$, and their vertical diameter between 4–10$^{mm.}$.

Var. B. PHYLLOXERA PURPUREA Pergande.

This form or variety is in shape between the typical form and var. A. It is of about the same size or somewhat larger than the first. Its base is constricted and the remaining part beyond it

quite conical, with the opening completely closed. The upper side is quite flat, somewhat sunken beneath the plane of the leaf and often most beautifully red, yellowish or paler than the leaf. On the lower side the galls are either pale green or whitish and the surface covered more or less densely with pale pubescence.

STEM-MOTHER.— Length about 0.8mm.. Shape oval or pyriform, broadest across the mesothorax, tapering gradually towards the end; slightly indented or constricted beyond the head. Head small, about twice as broad as long, almost half-circular in outline. Eyes very small and blackish. Antennæ and legs pale dusky. The head as well as the body is sparsely beset with medium-sized, rather stout, stiff, spine-like bristles, some of which are placed in rows. A double row of these spines fringe the whole body and are divided as follows: Eight pairs fringe the head, two pairs each side of the pro- and meso-thorax, three pairs each side of the meta-thorax and one pair each side of the abdominal segments. Color yellow.

MIGRATORY FEMALE.— Length of body 0.9–1.2mm.. Expanse of wings 2.2–2.8mm.. Color of both the adult and pupæ, orange. Head, mesothorax, scutellum and sternal plate black, antennæ and legs dusky; eyes brown or dark purple. The prothorax is often faintly dusky and is often marked medio-dorsally with three more or less distinct, minute spots, of which the two smaller, anterior ones, are more or less oval, and the larger, posterior one, linear. Antennæ distinctly three-jointed and about as long as the tibiæ. The two basal joints are shortest, about equal in length and but faintly annulated; the third is much the longest and almost three times the length of the two basal joints combined; it is almost uniform in diameter throughout its whole length, quite straight, with a short pedicel at base and a distinct nipple at tip showing at least two well-marked annulations and provided with three extremely fine hairs at tip. The whole joint is but faintly annulated, the annulations being more numerous and more distinct at its basal fourth. The usual two sensoria are almost obsolete, at least the lower one, which could scarcely be detected, whilst the upper one is very slender and about half as long as the joint. Wings ample, faintly dusky, the veins and stigma darker, the subcosta yellowish at base. Of

the veins the discoidal vein is darkest, and all are bordered with a slight dusky shade. The discoidal vein arises slightly nearer the stigma than the base of the wing and its branch near its middle. The stigmal vein is but slightly curved and arises at about the middle of the stigma. Legs rather short. The tarsi provided with the usual pair of knobbed hairs at the tip of the under side of the first joint and at the upper side of tip of the second joint.

The pupæ are orange, their meso-thorax, wing-pads and three last abdominal segments whitish; eyes and ocelli light cherry brown; antennæ and legs pale dusky. Larvæ and youngest pupæ almost colorless.

PHYLLOXERA NOTABILIS n. sp., Pergande.

Pl. XII., figs. 82–90.

A few galls belonging to this species, growing along the midrib of the leaves of the Pecan, *Hicoria olivæformis*, were received July 3, 1877, from Mr. J. Monell, St. Louis, Mo., which bear a general resemblance to those of *Ph. caryæcaulis* when growing upon the leaves, though more convex above and more conical beneath, where they split into a number of rather long and slender pubescent bracts or filaments. The color of these galls, which had partly become quite dry, appears to have been somewhat reddish above and green or yellowish beneath. Their shape was more or less oval above and compressed laterally beneath, caused evidently by the drying of the substance. Their largest transverse diameter was 5 to 10 mm. and the vertical diameter 3 to 8 mm.

Apparently the same species of galls on leaves of Pecan was received June 1, 1891, from Mr. L. Biedeger, Idlewild, Tex., but, unfortunately, all were empty when received, the contents of most having been destroyed by some Tortricid larva.

The same kind of galls were found during August of 1891 to be very numerous on the leaves of young trees of a variety called

the "Meier Pecan," imported two years prior from Bluffton, Mo., to the Department of Agriculture at Washington, D. C. Numerous additional galls were also received from I. H. Evans, from Austin, Texas.

The fresh galls, as found at Washington, are yellowish-green or slightly reddish, circular and bladder-like, from 2 to 10$^{mm.}$ in diameter at the circumference, and from 2 to 7$^{mm.}$ vertically; they are convex on both sides and situated either near the midrib or between the transverse veins, and generally more prominent on the upper side with a more or less distinct fovea or dimple about the middle. There is a more or less central nipple or a transverse slit on the under side, from which four to eight or more depressed lines radiate towards the base, along which the gall gradually splits into slender bracts in order to facilitate the escape of the inhabitants. Both sides of the galls are pubescent, though the under side is covered most densely with short, yellowish hairs.

The great majority of these galls contained, besides the stem-mother, numerous eggs and pupæ in various stages of development, numbers of the true sexes, many of which were also observed running about on the outside of the galls, and but one or a few of the winged migrants. This leaves no doubt that most of the sexes were the progeny of the pupæ, whereas the few migrants were destined to perpetuate their species on distant trees.

STEM-MOTHER.— Length 0.6$^{mm.}$. Pyriform, broadest across the thorax, tapering posteriorly and more slightly so towards the head. The head is rounded in front and somewhat notched about the middle. The entire insect is densely covered with acute tubercles, intermixed with a few short hairs. The antennæ are short and about one-fourth the length of the body; third joint slightly clavate and sharply serrate; the sensorial thumb is small and bordered at one side with three circular pores. Color yellowish, eyes purple, legs blackish.

PUPA.— Length about 0.8$^{mm.}$. Color pale orange or lemon yellow, eyes dark brown, ocelli dark red; antennæ, legs, wing-

pads, rostrum and two impressions on the head dusky. They are broadest about the wing-pads, tapering gradually towards the end of the body and covered densely with minute, acute points. Head convex in front and slightly emarginate or notched at the middle. Antennæ slender, almost one-third the length of the body, the third joint thinnest at about its basal third and quite densely serrate or scaly; the upper sensorium is short, elongated and accompanied at one side by two to four circular pores, while the tip is furnished with two or three small hairs. Wing-pads curved outward. Legs and digituli normal.

The eggs produced by the pupæ are pale-yellow, highly polished and apparently without any sculpturing. Those producing the males are about one-third smaller than the female eggs.

MIGRATORY FEMALE.—Length of body 0.6 to 0.8$^{mm.}$ Expanse of wings 2 to 2.4$^{mm.}$. Color yellow to orange; the head, thoracic lobes, scutellum and sternal plate blackish, with some dusky markings on the prothorax. Antennæ and legs yellow, shaded with dusky. Eyes and ocelli black or dark-purplish. Head and thorax faintly sculptured. The antennæ are rather long and slender and almost half the length of the body; the basal joint is about as long as wide and the second slightly longer than wide, narrowest at base and rounded at the apex; both are faintly sculptured. The so-called third joint is distinctly and sharply divided into two separate parts or independent joints; the lower or smaller section, which I designate as the third antennal joint, is sharply truncate at the apex, smooth, cylindrical, slightly curved and usually slightly stoutest near the apex, from which point it suddenly tapers to a short, conical petiole, with two or more sharp annulations. The sensorium of this joint is rather broad, abnormally long and reaches from the apex to the petiole. The terminal or fourth joint is almost twice the length of the third; it is slightly curved and faintly tapering, its base rounded and prolonged in a short, cylindrical petiole, composed of from three to six very fine and sharp annulations; its sensorium is also abnormally long and reaches from near the apex to the rounded base. The sensorial nipple

is minute, near the apex of the joint, and bordered at one side by about four circular pores.

The wings are rather long and broad and of a brownish shade, with the veins and stigma still darker or dusky; both the branch of the discoidal and the stigmal vein are obliterated at base.

The antennal characters of this species are more remarkable than those thus far observed in any of the other Phylloxerini.

SEXUAL GENERATION.— Both sexes are yellow, though the male is somewhat paler and smaller. The eyes are reddish-brown to black; the head, antennæ, legs and pronotum dusky, the rest of the thorax and interrupted band across the abdominal segments still darker.

The sexual female is about 0.4$^{mm.}$ in length and slightly over 0.1$^{mm.}$ in diameter about the middle. It is elongated and contains but one egg. The third antennal joint is clavate and quite sharply serrate; the sensorial nipple is small and placed near the apex, bordered at one side by one to three circular pores. The body is provided with rows of small hairs.

The male is about one-third smaller and more tapering posteriorly and the genital armature elongate conical. The antennæ are identical with those of the female, except that there is a rather long bristle about the terminal third of joint three. The hairs of the body are also much longer and slightly dilated or capitate at the apex.

PHYLLOXERA GLOBOSUM Shimer.

Pl. XIII., figs. 91, 92; Pl. XIII., figs. 93, 94, var. *coniferum*.

Dactylosphæra globosum Shimer. Proc. Acad. Nat. Sci. Phila., Vol. 19, p. 2.

Dactylosphæra globosum Shimer. Trans. Am. Ent. Soc., 2, p. 392.

Dactylosphæra coniferum Shimer. Trans. Am. Ent. Soc., 2, p. 397.

Phylloxera c.-globosum Thos. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 163.

I have had no opportunity to add anything new to what has been recorded by Shimer, and reproduce such parts of the original description (Proc. Acad. Nat. Sci. Phila., 1867, p. 2 and 3) as undoubtedly have reference to this species, substituting *migratory female* for his term *male*.

In his original description Shimer has confounded this large gall and its architects with those of the rather minute galls of *c.-semen* Walsh, found growing at the time upon the same leaves, notwithstanding that, as he himself states, none of the small galls contained the winged form, but were simply crowded with the so-called larvæ which, as has already been shown, were, without much doubt, the true sexes.

"*Gall* variable in size, often numerous in the parenchyma of the leaf, others on the veins and leaf stalks, all opening on the lower side of the leaf, with a very small orifice; smoothish, of a somewhat leathery structure, pale yellowish-green, glaucus or dark green; sub-globose or sometimes somewhat irregular, without any of the mealy sugary dust within, which is common in galls of the *Aphis* family.

"*Female* [*Stem-mother*] much resembling the 'grape leaf louse' (*D. ? vitifoliæ*), but smaller, the dull pointed promuscis blackish at the extremity; eyes of few (about five) facets.

"*Eggs* similar to those of the 'grape leaf louse.' Smaller and of a deeper yellow.

Pupa of male [Migratory female] orange-yellow, sometimes inclined to greenish; undeveloped wings pale yellow; body somewhat elongate; abdomen pointed; antennæ linear, three-jointed, 1st thick, subglobose; 2d smaller, short, thick; 3d very long, clavate, obliquely pointed, without a spine at the apex, a spine on the inner side of the first and second joints.

Male [*Migratory female.*] — Abdomen and prothorax orange-yellow; mesothorax, head and eyes, blackish; legs and antennæ dark cinereous. Wings hyaline, broad, somewhat overlapping as they lie horizontally on the back. Anterior wing, evenly rounded on the posterior margin; anterior margin rather stright, somewhat curved, convex at the middle of the stigma, apex quite broadly rounded, the wide wedge-shaped base not extending beyond the middle; stigmatic nervure nearly straight, terminating in the centre of the apex, not visible at either end. The discoidal within the middle of the wing, not visible at its outer end, somewhat con-

vex anteriorly, its branch hyaline at its extremities; stigma honey yellow, darkest on the costal margin, the apical end lanceolate; inwardly extending to the base of the wiug, all the costal space being of the same color. Posterior wing, one longitudinal vein and no discoidal. Tibiæ and tarsi with a few scattering hairs; claws palish-horn colored, with black tips. Antennæ four-jointed, sublinear, first and second short and thick, the others long, the third on a narrow pedicel, which may be a small joint, fourth clavate. Length to tip of wings .07 inch; body about .025 inch long.

The winged males [females] were numerous, but, as the weather then was very wet, they were in an extremely bad condition, their wings adhering to the walls of the galls and to their own bodies from the excessive dampness in the galls; but among the hundreds observed I saw a number of perfect specimens. Subsequently, in more pleasant weather, I examined several dark green, more perfectly globular galls, located as those observed before, with a good supply of winged specimens in perfect condition. I made careful examination and notes as before, and found that they agreed with the former precisely and compared favorably with the former dried specimens."

Shimer adds (Trans. of the Am. Ent. Soc., Vol. 2, p. 393, Gall No. 10) that this with No. 8 (*caryæ-semen*) "are the only known Hickory galls that have the character of being soft and leathery in structure. The perfect insect was found between Sept. 20th and Oct. 20th, 1866, since which time I have not seen it. I then described it as being found on what I supposed to be *Carya glabra*, but which now proved to be *C. amara*."

"This is manifestly distinct from *caryæ-globuli* Walsh, which is said to mature in June while *globosum* matures in October; and the openings of the galls are quite different in shape, that of *globosum* being round and on a nipple-like projection, while that of *caryæ-globuli* is an elongated slit."

Dactylosphæra coniferum Shimer, I consider to be but a variety of *D. globosum*.

PHYLLOXERA CARYÆ-GUMMOSA Riley.

Pl. VI., fig. 37; Pl. XIII., figs. 95-97.

Phylloxera caryæ-gummosa Riley. Seventh Rep. Nox. and Ben. Ins. of Mo., p. 118.

Phylloxera caryæ-gummosa Thomas. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 164.

Forming pedunculate, ovoid or globular galls on the under side of leaves of *Hicoria alba;* the gall white or yellowish, pubescent, and gummy or sticky; opening below in a fibrous point. The eggs are almost spherical, pale and translucent. Larva, mother-louse and pupa quite pale, the red eyes and eyelets strongly contrasting. The winged insects with difficulty distinguished from some of the other species, a difficulty made all the greater from the fact that other species get caught in the sticky surface of the gall.

STEM-MOTHER.— Length about 1$^{mm.}$; elongate pyriform, more than twice as long as broad. Front edge of head somewhat concave and furnished with four short, stiff hairs above, one at base of antennæ and one in front of the eyes; two each side of the thoracic and one each side of the abdominal segments, and from six to eight around the end of the body. Entire surface densely and very finely granulate, with a few more prominent warts on the thoracic segments, each bearing a stout hair. There are also some minute hairs, sparsely set, along the posterior margins of the abdominal segments. Antennæ as usual, with the third joint about twice the length of the two basal joints combined, and of almost uniform diameter throughout. Thumb very short. Surface indistinctly scaly and annulated.

GROUP III.

21. *Forming elongate folds along the veins beneath, with corresponding ridges or carinæ above* ..... *Ph. caryævenæ* Fitch.

There is but one species in our fauna representing this group.

PHYLLOXERA CARYÆVENÆ Fitch.

Pl. VI., figs 38-39; Pl. XIII., figs. 98-105.

Pemphigus? caryævenæ Fitch. Third Rep. Nox. and Ben. Ins. of N. Y., Section 164, p. 126.

Phylloxera caryævenæ Riley. Eighth Rep. Nox. and Ben. Ins. of Mo., p. 117.

Phylloxera caryævenæ Thomas. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 162.

The galls of this species are readily separated from those of any

of the other species found upon Hicoria. They resemble more closely those of certain of the *Cecidomyidæ* occurring on different species of oaks and other plants.

They always form, either along the main rib or more frquently along the transverse veins, shorter or longer folds or plaits projecting more or less evenly from both sides, though usually more prominent above, where they form elongate ridges or carinæ, which are often transversed by 3-5, or more, short, elevated branches, about equal in length to the diameter of the gall. The opening or slit is always on the underside and, while fresh, is tightly closed except at the outer end, and covered by a delicate white or greenish pubescence which also more or less completely covers the entire surface beneath. The color is generally yellowish-green, though very frequently also brownish or purplish. Two or more are often confluent, so that their length varies from 6–14$^{mm.}$ or more, and their diameter from 2–3$^{mm.}$.

The gall begins to form early in May. It occurs not only upon *Hicoria tomentosa* but upon several other species of Hicoria and is widely distributed over the eastern half of the United States, having been observed from New York to Florida, and west as far as Illinois and Missouri.

No winged migratory female has yet been observed, but the most remarkable fact is that I have been unable to discover in any of the many galls examined from 1880 to 1890 a sexual form, though examinations were made during different months. The only occupants thus far found in these galls were the true stem-mothers (of which 1–3 have been observed in the same gall), their eggs and the wingless sexuparæ in different stages of development.

By the middle of August, when the majority of the galls had become dry and empty, but a few remained still green and contained the still living, though much shrunken, stem-mother, a small number of eggs and a few larvæ, but no migrants or sexual individuals.

On July 19, 1890, when many of the galls still contained their usual inhabitants, extended and careful search was made to discover the whereabouts of the larvæ after leaving the galls. Small colonies, absolutely identical with those found within the

galls, were finally discovered snugly hid away either in deep cracks of the bark or at the bottom of deep and more or less completely closed depressions, which are found on the trunk and stouter twigs and which are caused by the decay and dropping out of small branchlets. Here the insects live upon the juices from the tender bark which forms at the bottom of the cavities. These colonies usually consist of the stem-mother, a number of fully grown apterous females and larvæ (both the direct progeny of the stem-mother) and *eggs of three different sizes*. The smallest, and most numerous of these eggs, correspond exactly in size and general appearance with those deposited by the stem-mother in the galls, while the others are about twice as large but yet of two sizes, the larger ones of a regularly ovoid shape, the smaller more conoidal in outline. The former produce, after a few days, the true sexual female, and the latter the male, which pair, when the female brings forth her single impregnated or winter egg which doubtless hibernates within the cavity.

In some of the depressions no stem-mother is found, but only the other forms here described and a few of the winter eggs.

STEM-MOTHER.— Length of body 0.8–1.2$^{mm.}$. Shape broadly ovoid, or almost globular. General color pale yellowish, growing gradually darker while increasing in age. Antennæ, legs and rostrum pale dusky. Eyes, blood-red, composed of three ocelli each side, arranged triangularly on a conical prominence. Antennæ with the first joint stoutest and about as long as wide; the second somewhat more elongate, stoutest at anterior end; both together somewhat shorter that the third; joint 3 slender and tapering slightly toward both ends and divided by 5–8 more or less distinct serrations; the thumb minute and movable; tip blunt and provided with three fine and short hairs. Surface of body covered with minute granulations, and ornamented in addition with six rows of small and somewhat conical, and slightly dusky tubercles; five similar tubercles each side of the head provided with a minute hair. Head short, almost twice as broad as long and more or less distinctly separated from the body.

EGG FROM STEM-MOTHER.— Length 0.2$^{mm.}$, and about 0.1$^{mm.}$ in diameter. Ovoid, highly polished and apparently without a trace of sculpture. White, or with but the faintest yellow tinge.

APTEROUS SEXUPARA.— Length of body about 0.6mm. Shape elongate-ovoid. Color whitish, pale yellow or greenish-yellow, with the members and warts dusky. Eyes dark purplish-red. Surface of body densely covered with minute points. The dorsal warts are normally placed, though faint, those on the thorax round, with the intermediate one each side on pro- and meso-thorax obsolete, leaving on each of these joints but two transverse rows of four each, while the single row on metathorax has six. On the abdomen the two medial rows are transversely elongate. In some specimens these warts are very distinct and readily observed, while in others they become more or less obsolete, and on the abdomen they are more or less confluent towards tip. Antennæ short and very similar to those of the stem-mother; the third joint scarcely longer than the two basal joints combined, somewhat curved, thinnest at base, with but few and indistinct annulations; the thumb rather stout and close to the tip of the joint. When young the rostrum projects beyond the end of body.

SEXUAL FEMALE.— Length of body slightly less than 0.2mm. Shape broadly ovoid, with the last two segments much narrower than the rest of the body. Mouth rudimentary, broad and rounded at tip. Color yellow; eyes purple; antennæ and legs faintly dusky. The antennæ are extremely short, the third joint but slightly the longest, and the second slightly shorter than the first. Joint 1 stoutest, of uniform diameter, truncate anteriorly; joint 2 but slightly narrowing at base; joint 3 also narrowest at base, bluntly rounded at tip and provided with a slender hair, its surface faintly annulate; the thumb minute, though distinct and placed close to the apex.

MALE.—The male is about one-fourth smaller, and narrower than the female. Antennæ, legs and genital armature rather stout. Color pale yellow; eyes brown.

WINTER-EGG.—Length slightly less than 0.2mm. Shape ovoid, sometimes faintly curved, somewhat flattened, dark, dull, grayish-yellow or green, ornamented with rather coarse and deep, more or less irregular, transversely oval pits.

During the summer of 1902 another effort was made by me to discover, if possible, the winged migrant of this species, though

without avail. Unfortunately nearly all the trees on which the galls used to be plentiful had been cut down, leaving but a few small shrubs in that particular locality, with still fewer galls on some of the leaves. These galls were also extremely scarce on trees in the woods some distance to the north, in all of which the usual apterous forms and some eggs were present, though not a single one of the winged migrants. That this form, after a shorter or longer interval must exist, seems quite plain, while otherwise the species is doomed to become extinct, since the migration of some of the apterous forms from tree to tree, especially if such trees should grow at some distance from each other, must naturally be rather slow and uncertain. I take it, therefore, for granted that the spread of this species depends, as in other species, on a winged migrant, which sooner or later will be found.

Group IV.

Twig or Petiole Galls.

This group comprises a series of more or less closely related galls, growing principally on the youngest twigs and petioles. Some of them resemble each other so closely that it is frequently difficult to separate them, particularly after they have become dry, though the insects producing them often differ markedly.

For convenience these galls may be divided into three sections.

I. *Galls more or less globular. Orifice completely closed when young; splittiug into 3–6 or more irregular bracts when mature and leaving an irregular opening.*

22. Globular or oval; often more or less conical; spiny or smooth according to the tree on which they grow, and more or less confluent. Size varying from 5–25$^{mm.}$ ..... *Ph. caryœcaulis* Fitch.

23. Globular; covered densely with long and fleshy filaments. Size 5–15$^{mm.}$ ..... *Ph. spinuloides* Pergande, n. s.

24. Size medium; growing in larger or smaller clusters, and apparently deformations of the flower and leaf-buds. Splitting when mature into four or more broad bracts. Surface smooth. Size 3–15$^{mm.}$ ..... *Ph. devastatrix* Pergande, n. s.

25. Size medium; smooth; growing in clusters; usually with a short, stout, nipple-like projection on one side. Diameter 5–10$^{mm.}$ ..... *Ph. georgiana* Pergande, n. s.

26. Large, oval, smooth; growing upon the petioles. A slight central depression, covered with short hairs. Length about 20mm., diameter about 10mm. ..... *Ph. subelliptica* Shimer.

II. *Galls more or less globular or irregular, terminating in a tooth-like nipple.*

27. Growing on tender twigs, petioles or ribs of leaves, often confluent. Smooth. Diameter 2–8mm. ..... *Ph. perniciosa* Pergande, n. s.

III. *Galls more or less reniform. Opening when mature in a transverse slit.*

28. Growing on the petiole or midrib of the leaves, the transverse slit dividing the gall in two halves. ..... *Ph. c.-ren* Riley.

PHYLLOXERA CARYÆCAULIS Fitch.

Pl. VII., fig. 40; Pl. XIV., fig. 106; *caryæcaulis;*
Pl. VII., figs. 41–42; Pl. XIV., fig. 107; var. *magna;*
Pl. VIII., figs. 43–44; Pl. XIV., figs. 108–114; var. *spinosa,*
Pl. XVI., figs. 124–127; var. *spinosa.*

Pemphigus caryæcaulis Fitch. Third Rep. Nox. and Ben. Ins. of N. Y., p. 126 and 163.

Dactylosphæra caryæ-magnum Shimer. Trans. Am. Ent. Soc., 2, p. 391.

Dactylosphæra spinosum Shimer. Trans. Am. Ent. Soc., 2, p. 397.

Phylloxera caryæcaulis Riley. Seventh Rep. Nox. and Ben. Ins. of Mo., p. 117.

Phylloxera caryæcaulis Thos. Eighth Rep. Nox. and Ben. Ins. of Ills., p. 160.

Up to the present time these three forms of galls have been considered as quite distinct species on account of their dissimilarity, two of them being smooth and the other more or less profusely covered with fleshy spines. But a careful study of the architects of these forms forces the conclusion that they are identical, there being no tangible characters by which to separate them. The spiny form of gall always grows upon trees with pubescent leaves, such as *Hicoria tomentosa*, while the smooth forms are always found upon trees with smooth leaves, such as *Hicoria glabra*, *amara* and probably other species.

The typical form, growing upon the young and succulent limbs, petioles or the midrib of the leaflets of *Hicoria-glabra*, occurs over the eastern half of the United States.

The size of the galls varies from 5–25$^{mm.}$ in diameter. Those growing singly often attain immense proportions, but when numerous or crowded they are reduced in size and often confluent, so as to form an elongated mass. Before maturity of the inhabitants the gall is closed, but as soon as any of the inmates have acquired wings, it cracks transversely into 3–6 or more broad and more or less irregular bracts so as to allow the mature migrants to escape, and to leave room and food for the younger individuals. The color is pale yellowish-green, more or less tinted with red or crimson. The walls of the galls are rather thick and succulent when young, becoming more tough and leathery when older and hard, brown or black when empty and dry.

STEM-MOTHER.— Length when fully grown 0.8–1.8$^{mm.}$ and about 0.6–1.2$^{mm.}$ in diameter; often almost globular. The color varies, according to age, from greenish-yellow to brownish-yellow, with a faint dusky shade. Eyes dark purple; antennæ and legs blackish. Two transverse, more or less distinct frontal foveæ, dusky. The whole surface of the body is quite densely covered with extremely minute, sharp points, most dense, and arranged in rows, on the abdominal segments. Antennæ rather short, the third joint of about uniform diameter, scarcely twice the length of the two basal joints combined and divided by about 8–13 more or less distinct and coarse annulations; the thumb small, though quite distinct and apparently movable.

EGG.— Elongate-ovoid, colorless or faintly greenish, polished and translucent.

LARVA.— Either colorless or faintly yellowish, or yellowish-green, with the eyes red. Surface of body profusely covered with minute tubercles, each provided with a short hair.

PUPA.— The youngest pupæ are pale greenish-yellow and the older ones pale orange, with the antennæ, legs and external edge of wing-cases dusky. Eyes and ocellar spots reddish.

MIGRATORY FEMALE.— Length of body 1.2–1.8$^{mm.}$. Expanse of wings 3.4–3.8$^{mm.}$. Color paler or darker orange; the prothorax darkest, marked more or less distinctly with either two transverse spots or a continuous line near anterior margin, a transvere, medio-dorsal, more or less curved spot, often divided at middle, a

smaller round spot usually occurring each side of it, and broad anterior angles, all dusky. Anal part marked with two generally quite distinct, oval, orange spots which turn brown or black in specimens mounted for some time in balsam. Eyes brown, ocelli clear. Head black, its posterior portion usually yellow. Prothorax finely but rather densely rugose. Antennæ, mesothorax and sternum black. Legs and wings dusky. Wings large, broad; the subcosta, stigma and veins darker, the latter with a brownish shading on each side. Course of veins normal, the stigmal vein straight, connecting near the base of the stigma. Antennæ rather slender, the first joint stoutest and somewhat longer than wide, not, or but faintly, annulate; the second slightly shorter, narrowest at base, rounded at apex, divided by five or six scaly annulations; the third slender, its upper half scaly and the lower half annulate and more or less distinctly scaly; basal portion of the joint considerably constricted above the basal sensorium; anterior sensorium about one-half the length of the joint, the basal one small and round.

Ph. spinosa Shimer is evidently but a variety and more numerous than the typical form in localities where the pubescent-leaved species of Hickory prevail. It is often considerably larger than the typical form and is always more or less covered with short, fleshy spines. It closely resembles, also, *c.-spinuloida*, which, however, is still more densely covered with longer and more slender spines. The more striking differences are, however, noticeable in the migratory females, which in *caryœcaulis* have shorter and broader wings, different antennal characters, comparatively longer legs and the two oval orange or blackish spots at the end of the body.

Ph. c.-magna Shimer (Trans. Am. Ent. Soc., 2, p. 391) may also be considered as a variety of *caryœcaulis*. The form is found in Missouri growing on the petioles and bases of the leaflets of *Hicoria amara*. Some of the specimens also closely resemble those of *subelliptica* Shimer, which probably belongs to it, but of which I have not yet succeeded in obtaining the migratory form. On account of some slight differences in the gall, which are no doubt due to the specific differences of the infested trees, *c.-magna* may perhaps be allowed to remain under a variety name, though the

architects in their different stages, as far as examined, show no differences by which to separate them from the typical *caryœcaulis*. The galls of this variety vary from 4–20mm. in size, the normal being about 10mm.. They occur on the under side of the petiole and the base and often the midrib of the leaves, and, when in the latter position, they generally project somewhat on the upper side. The shape varies from globular to sub-conical, or broadly ovoid. The surface is quite densely covered with a minute pubescence which gives it a slightly velvety appearance. The orifice beneath is rather small and transverse and tightly drawn together before maturity. Color greenish-white to yellowish-green beneath and beautifully crimson on the upper side. Usually single, though occasionally two or more may become confluent, with their cells, however, well separated.

PHYLLOXERA SPINULOIDA Pergande, n. sp.

Pl. XVII., figs. 128 130.

The galls of this species, as already remarked, are very similar and closely related to those of *spinosa*, for which, without comparison of the migratory females, they might easily be mistaken. They are, as a rule, more regularly globular, or but slightly conical, covered with numerous irregular, more or less radiating, low ridges, which are rather plentifully provided with irregular, long, fuzzy, fleshy spines or filaments. They grow generally upon the petiole of the leaves, which they often almost completely encircle, causing, at the point of junction with the petiole, a curve or bend. They also occur on the midrib of the leaves. When mature each gall bursts at the apex in a more or less irregular opening. The diameter of those examined varied from 5–15mm.. The color appears to be quite uniformly greenish-yellow, or brownish-yellow on one side.

MIGRATORY FEMALE.— Length of body 0.6–1.8mm. Expanse of wings 3.6–3.8mm.. Color orange. Head, antennæ and legs dusky. Meso- and metathorax and sternal plate purplish-black. Eyes black. Ocelli clear and with a blackish border at the inner side. Prothorax marked with three pale dusky spots, of which the two smaller are placed in front. Antennæ slender, scaly, the two basal joints nearly equal in length; joint 2 almost globular,

with five or six scalloped or scaly annulations; joint 3 variable, even in the same specimen. In some specimens that portion between the anterior and posterior sensoria is almost one-half longer than usual, while in others a smaller but very distinct projecting intermediate sensorium may be observed just below the anterior sensorium. Wings large, distinctly dusky or brownish; veins and stigma darker; all veins bordered with a dusky shade. Stigmal vein straight, connecting with the stigma near its base.

Found at Georgiana, Fla., on Hickory (species not determined). The migratory females leave the galls from about the middle to the end of March.

PHYLLOXERA DEVASTATRIX Pergande, n. sp.

Pl. XVII., figs. 131–135.

The galls of this species resemble very closely the smaller galls of *caryœcaulis* and also those of *perniciosa*. From both of these, however, the species differs markedly in the antennæ of the winged form, which are much more slender than in either of the other two, with scarcely a constriction above the lower sensorium and with the anterior sensorium much shorter.

Its principal points of attack, as in the other species of this group, are the tender twigs, petioles and the midrib of the young leaves; but the leaf-buds and flower-buds are also often involved so as to prevent the setting of the fruit.

It appears to be an exclusively western or southwestern species, infesting the Pecan-hickory (*Hicoria olivæformis*) during May and early June. This gall was first received in 1887 from Mr. M. E. Winster of Staunton, Adams County, Miss., and again in 1889 from Mr. H. M. Johnson of Marston, La., with the statement that it was greatly damaging the trees. It is either globular or more or less irregular in shape, especially where much crowded. Before opening it is often provided with a short more or less distinct nipple, most prominent in the younger galls, and becoming almost obsolete in the more mature form, when its position is indicated by a more or less densely pubescent spot. It splits transversely into four or more broad bracts, similar to those of *caryœcaulis*. The size varies frem 3–15^{mm}. Surface smooth, green or yellow-

ish-green, and often beautifully red on one side while young, turning brown or black and soon drying up after the architects have left.

MIGRATORY FEMALE.—Length of body about 1.2$^{mm.}$. Expanse of wings 3.4–3.6$^{mm.}$ or more. Color paler or darker yellow, the head, mesothorax and sternum black or brown, the antennæ and legs dusky, the eyes brown or black. Antennæ long and slender; joint 1 longer than wide and of uniform diameter; joint 2 more slender than usual, of almost uniform diameter, rounded at tip, with more or less distinct scaly annulations; joint 3 long and slender, its anterior sensorium only about one-fourth the length of the joint; the lower one very small, often almost obsolete; greater part of the joint, at least as far as to the anterior sensorium, distinctly and quite coarsely annulate, the rest being scaly. This joint is often quite irregular in shape, the more common form as represented in the figure. Head and thorax finely rugose; the abdomen quite densely and finely striate, the striæ closely lined with minute sharp points. Legs rather long and robust. Wings large, rather broad, pale dusky or brownish; stigma and discoidal vein darker; the discoidal branch and the stigmal vein sometimes almost obsolete; all more or less shaded. Sometimes the stigmal vein passes the stigma and connects with the discoidal vein near its base. The hind wings are also large and rather broad and their subcostal vein sometimes almost completely obliterated.

PHYLLOXERA GEORGIANA Pergande, n. sp.

Plate XV., figs. 115–117.

The galls of this species closely resemble those of *Ph. devastatrix*, being of the same shape, size and color; but the winged form is quite different and may readily be distinguished by its much paler wings and venation and particularly by the shorter antennæ and much larger sensorial membranes of the third joint.

The galls grow either singly or in close clusters upon the tender twigs and petioles and often recall in appearance the galls of *Cynips q.-ficus*. Those growing in clusters are more or less irregular in shape, whereas those growing singly are quite globular

and frequently provided with a short nipple. Their size varies from three-sixteenths to one-half inch in diameter; color either uniformly greenish-yellow, sometimes reddish on one side or around the base, or entirely dark red.

STEM-MOTHER.—Length 1–1.6$^{mm.}$ Color orange. Antennæ and legs blackish. Pyriform, broadest across the mesothorax. Surface of body closely covered with minute sharp points and the anal end furnished with 6–8 rather stout bristles. Eyes small, projecting, composed of 3–5 or perhaps more simple, colorless, eyelets. Antennæ rather long and slender, the first joint stoutest, wider than long, of uniform diameter, truncate at tip, with a slender bristle near the apex; joint 2 rather more slender, longer than wide, most slender at base, rounded at anterior end and also furnished with a bristle; joint 3 about thrice the length of the other two combined and divided by about eighteen rather coarse and more or less irregular annulations, the last bearing a short bristle; terminal sensorium very small and oval.

MIGRATORY FEMALE.—Length of body 0.8–1$^{mm.}$ Expanse of wings 3–3.6$^{mm.}$ Color orange. Head, meso- and metathoracic parts and sternal plate blackish. Eyes black, antennæ and legs dusky. Head and prothorax rugose, the rugæ of the head somewhat the coarsest. Antennæ rather stout, joint 1 about as long as wide, indistinctly scaly or annulate; joint 2 slightly longer than wide but slightly narrower at base, rounded at apex and distinctly scaly; joint 3 sharply annulate at about its basal half, the anterior portion scaly; anterior sensorium about one-half the length of the joint, though sometimes either somewhat longer or shorter; the basal sensorium rather large and subcircular. Wings large and broad, very pale or but faintly dusky, the veins somewhat darker and with fuscous shades; stigma yellowish.

PHYLLOXERA SUBELLIPTICA Shimer.

Plate XV., figs. 118–119.

Dactylosphæra subellipticum Shimer. Trans. Am. Ent. Soc., 2, p. 389.

Of this species I am familiar with the gall only and reproduce, therefore, Shimer's description as published in the Tansactions of

the American Entomological Society of Philadelphia, Vol. 2, 1868, page 389 :

"On June 7th I observed, placed in the common petiole of the leaf, large, elongate, subelipsoidal, nut-like galls, of a deep leaf-green color, mottled with paler green, and somewhat nodulated ; some were irregular, being on the side of the stem ; but most of them are quite regular in form and completely surrounding the stem ; in these latter the leaves are very much dwarfed. The opening is on the middle of the side, slightly elongate, bnt at this date so close as to be scarcely apparent. These galls contain capacious cavities, in which were found vast colonies of larvæ, and an abundance of eggs. Transverse diameter five-eighths inch ; conjugate diameter three-eighths inch.

"By June 20th these galls had considerably changed in appearance, being contorted into different shapes ; they had began to crack open, having transverse fissures on their outer surface. The first one opened contained many hundred winged imagos, all dead, and in the midst of them was a large syrphidian larva. I found only one gall that contained perfect living imagos, the inhabitants of all the other galls that were examined having been destroyed by various enemies."

"*Dactylosphæra subellipticum* n. sp.

"*Winged Imago.*—[*Winged female*].—Large and robust, blackish, with abdomen light yellow ; antennæ and legs blackish ; wings hyaline. Length of body .06–.07 ; to tip of wings .08–.09 inch.

"*Mother Insect.*—[*Stem-mother*].— Rugose, greenish-yellow ; antennæ and legs black ; otherwise like that from gall No. 1 [*Dactylosphæra hemisphericum*]. Length .06 ; breadth .04 ; thickness .03 inch.

"The winged imago of this species is the largest yet observed, and the eggs are more nearly globular than those found in other species of galls.'

This may possibly be but a variety of *Ph. caryœcaulis* Fitch, but not having had an opportunity to study its architects I prefer, for the present, to leave it as a distinct species.

PHYLLOXERA PERNICIOSA Pergande, n. sp.

Pl. VIII., fig. 45 ; Pl. XV., figs. 120–123.
Pl. XVIII., figs. 136–140.

This is one of our most destructive species, occurring in the District of Columbia, Maryland, Virginia and Pennsylvania, where it takes the place of *Ph. caryœcaulis* and *Ph. magna*, having the same habit and there proving as disastrous to the foliage of *Hicoria tomentosa* as those prove in the North and Northwest to the other species of *Hicoria*. It attacks, as do those species, the

tender twigs and petioles and the different parts of the leaves at times in such immense numbers as to completely deform and cause them to dry up and drop to the ground, literally, at times, defoliating the tree. My attention was first called to this particular species in May, 1883, when, passing through a strip of woods bordering the Potomac River in Virginia, I observed that the air was swarming with the migratory form. The insects were settling not only on the leaves of the different species of *Hicoria*, but on all other kinds of trees and shrubs and even on weeds, on all of which they were actively engaged in depositing their eggs; but they all originated from a tall slender tree of *Hicoria tomentosa*, every leaf, petiole and young twig of which was affected by the galls.

By May 27th the eggs were found upon the leaves of all sorts of vegetation, generally on the under side, along the midrib and the larger veins, and particularly in the angles where the veins ramify. Yet many were deposited indiscriminately on all parts of the leaves.

By June 1st every leaf upon the gall-covered tree was beset with hundreds of eggs, while numbers of winged females were still actively engaged in ovipositing.

On June 4th these were still numerous, but the earlier deposited eggs were already hatching. A careful study of the insects from these eggs proved them to be true males and females, the males about 50% more numerous than the females. The male is quite active, running briskly about, while the female is more sluggish and inclined to be stationary. She is about twice the size of the male and contains a single large egg. By this time large numbers of the leaves affected were dropping, and the ground for some distance around the tree became covered with them. No winter eggs had, up to this time, been noticed and but few of the sexed individuals were seen upon the branches and upon the trunks.

On June 8th the sexes were still numerous and active, the males still outnumbering the females. They could not be found on or under the bark of the tree anywhere within easy reach, though they were abundant under the old and rotten leaves lying

on the ground, and a considerable number could be found on the stumps of old *Hicoria* and other trees and in the cracks of the soil.

On June 12th the first winter eggs were discovered, most of them upon twigs that had been infested with galls. They were most numerous in old galls, in the cracks around and about them and in the old bark, often as many a fifty packed closely together intermixed with the dead and empty skins of the females. They were also found in the depressions caused by the shed leaves of the previous year, as also at the base of the new growth, especially where surrounded by a fringe of hairs, under and between which the eggs were thrust; also in the angles formed by the petioles and upon the twigs, in the old, dead and rather hairy or fuzzy buds, and, in fact, in any crack or perforation upon the tree. Some were even found between old leaves on the surface of the ground and under the loose bark of a piece of old grape-vine lying beneath the tree; in the sheltered places afforded by an old oak stump near by, as well as under the loose bark of a Dogwood (*Cornus florida*).

On June 19th a more careful examination of the trees showed that the eggs became more numerous as one ascended the tree. At a distance of about thirty feet from the ground they were extremely abundant, being closely packed under the loose bark of dead twigs, in crevices and under and between lichens growing upon the trunk.

None of the eggs had hatched on July 18th though large numbers had been destroyed by various natural enemies, especially by different mites belonging to the genera *Tyroglyphus*, *Rhizoglyphus*, *Hypopus*, *Scirus*, *Nothrus*, and *Oribata*. An examination July 30th showed that none of the eggs had yet hatched.

November 20th they were still unhatched but sound.

February 6th, 1884, they were again examined and found to be in good condition.

On March 15th none had yet hatched.

On April 1st, notwithstanding the devastations of the mites before mentioned, and other destructive agents, a number of sound eggs remained. At this time they were somewhat more yellowish than in the previous autumn, rather more swollen and smoother,

though the sculpture was still visible; the eyes of the embryo were now easily seen through the shell, and by the 12th of April or coincident with the first bursting of the buds, these eggs began to hatch in large numbers, the young stem-mothers running briskly in search of a suitable position to settle down and to found the colonies.

By the 15th of April most of the eggs had hatched. By the 28th of April most of the young stem-mothers had settled either on the young petiole or mid-rib, on the cross-rib, or on the more fleshy parts of the young leaves, where small depressions or cavities had been formed.

By May 8th it was noticed that the galls had been formed on almost all parts of the leaves or on the petioles or on the more tender twigs. The more perfect specimens were growing singly, resembling a blunt tooth or thorn, those on the leaves projecting about evenly on both sides though ordinarily more prominently on the under side. The stem-mother had already by this time acquired full growth and began depositing numerous eggs, covering almost the whole inner surface of the gall, the eggs placed on end and side by side reminding one in miniature of the regular crystallizations in the cavities of some geode. By the 18th of May the galls contained, besides the eggs, both larvæ and pupæ in different stages of development. By the 25th the winged insects had formed and were leaving the galls in large numbers and settling, as at the same time the previous year, on all kinds of vegetation in the neighborhood of the tree on which they had developed.

To sum up the life-history of this species, the winter or impregnated eggs are deposited early in June in all sorts of sheltered positions, especially on the upper portions of the tree; they hatch early in April of the following year, remaining dormant some ten months. The stem-mother attains maturity and begins ovipositing in about twenty days after hatching, while the winged migratory females (sexuparæ) mature and begin to leave their galls in about twenty days after the first eggs are laid. The first sexual individuals appear about ten days subsequently and some ten days further elapse before the true female, after pairing, begins to consign her single egg to its winter quarters.

Hence there are but three annual generations produced, viz., the apterous and parthenogenetic stem-mother, the migratory or winged sexuparæ and the apterous sexed individuals; and all the direct issue from the stem-mother become sexuparæ. This, as already stated, may be looked upon as the normal mode of the development of the majority of the gall-producing species on Hickory. Yet there are exceptions, and our *Hicoria* species present some of the varying biologic features already known in other species of the sub-family and have, in addition, others which are peculiar.

STEM-MOTHER.—Recently hatched. Length 0.3$^{mm.}$. Color yellow. Eyes reddish-brown with a clear, colorless ocellus at their middle. Antennæ, legs and rostrum dusky, the last joint of the rostrum yellow. Body elongate-ovoid. Antennæ stout, the terminal joint with apparently five annulations and with a thumb, externally, near tip. Tarsi with strong claws and digituli. The rostrum stout, reaching a little beyond the posterior margin of the metasternum.

MATURE STEM-MOTHER.—Length 0.8–1$^{mm.}$; diameter across mesothorax 0.6$^{mm.}$. Shape broadly pyriform, broadest across the mesothorax. Color grayish-green or yellow, with the sutures slightly darker. Antennæ and legs blackish. Surface of the body densely covered with minute, pointed granules. Front of head somewhat concave, lined with four short and rather stiff bristles. Antennæ short, joint 3 about twice the length of the others combined, of uniform thickness, slightly curved and quite coarsely scaly; the thumb short, very distinct, inserted just below tip. Legs and rostrum stout, the latter reaching to middle coxæ. The eggs deposited by the stem-mother are quite transparent, highly polished, without any sculpturing, and faintly yellowish or greenish.

PUPA.—Length about 1$^{mm.}$, diameter across mesothorax 0.4$^{mm.}$. Color orange, lemon-yellow or yellowish-green, the thoracic segments darkest. Antennæ, legs, rostrum and wing-pads more or less dusky. Eyes and ocellar spots red. Dorsal surface closely and curiously sculptured, being covered with minute, slightly dusky warts, which terminate either in one or often in as many as five or six small scale-like points, these again often provided

at apex with minute teeth. Antennæ very stout, the third joint somewhat narrowed towards tip and somewhat scaly. Legs stout.

MIGRATORY FEMALE.—Closely related to both *Ph. c.-spinuloides* and to *Ph. spinosa*, from the first of which it differs principally in the structure of the antennæ, and from the latter in the absence of the two dark, oval spots at the end of the abdomen.

Length of body 0.8–1.6$^{mm.}$; expanse of wings 2.6–3.4$^{mm.}$. Color yellow; head, meso- and metathorax and sternal plate dull blackish. Sides of prothorax and three spots on its disc dusky, the posterior one transverse and largest. Eyes red, ocelli colorless, bordered at their inner side with black. Antennæ and legs dusky, the legs palest. Antennæ rather slender and very variable in shape. Joint 1 stoutest, about as long as 2 and faintly scaly; joint 2 about as long as wide or but slightly longer, rounded at anterior end, its surface distinctly scaly; joint 3 rather slender, its basal section subject to the greatest variation, being either extremely slender and scarcely half the usual diameter, or curved and bent in different directions, in which respect it is unlike anything observed in this genus before. There is also considerable variation in the sensorial membranes, the basal one being often almost completely obliterated, whereas the terminal one shows more or less a tendency to divide into several independent parts. In this respect it resembles *Ph. c.-spinuloides*. The whole surface of this joint is always more or less distinctly scaly. Surface of head and prothorax finely rugose, the rugæ rather shallow. Wings rather large, pale fuscous; the stigma and veins darker; the stigma with a more or less yellowish tinge. Venation normal and bordered with a dusky shade.

SEXUAL EGGS.—The sexual eggs are of two different sizes. Those producing the males measure 0.3$^{mm.}$, and those producing the females 0.4$^{mm.}$ in length. All are regularly ovoid, highly polished, faintly facetted and granulate and of a pale lemon-yellow color.

MALE AND FEMALE.—Length of male about 0.2$^{mm.}$; of female 0.4$^{mm.}$. Color of both sexes greenish-yellow, though the male is usually somewhat the darker. Eyes brownish, antennæ and legs pale dusky. Mouthparts wanting.

WINTER EGG.—The length of the winter-egg is about 0.2$^{mm.}$.

Rather stout, ovoid, slightly curved and curiously sculptured, so as to recall four-leaved rosettes. Color rather dull greenish-gray, rendering detection very difficult.

PHYLLOXERA CARYÆ-REN Riley.

Plate XVIII., fig. 142.

Phylloxera caryæ-ren Riley. Seventh Rep. Nox. and Ben. Ins. of Mo., p. 118.

Phylloxera caryæ-ren Thomas. Eighth Rep. Nox. and Ben. Ins. of Ill., p. 164.

Since the description of this gall nothing new has been added regarding its earlier stages and development; nor have I had the opportunity of studying its architects.

The galls usually grow, like those of the preceding species, in clusters, though occasionally singly, upon the main petiole, the leaf-stems or the midrib of the leaves of *Hicoria glabra*, usually along the underside. Frequently, however, they are so closely crowded together as to completely encircle the petioles, never becoming confluent, however. They are always placed transversely with the axis of the petiole, more or less distinctly reniform and divided along their entire transverse length in two equal halves or lids, the edges of which are incurved and pressed closely together while young, but spread open for some distance when mature to allow the insects to escape. The size varies from 2–15$^{mm.}$ and the outer surface is densely pubescent and of a pale green coler, with the interior smooth and yellowish-brown. The walls are rather thick and hard and similar in composition to the husks of the nuts.

ADDITIONAL SPECIES OF PHYLLOXERA INHABITING VARIOUS OTHER TREES.

PHYLLOXERA CASTANEÆ Hald.

Plate XVIII., figs. 143–150.

Chermes castaneæ Hald. Am. Journ. of Sci. and Arts, 2nd Ser., Vol. IX., 1850, p. 108.

Phylloxera ? *castaneæ* Fitch. Third Rep. Nox. and Ben. Ins. of N. Y., 200, p. 154, 1859.

Haldeman's original description is as follows:

"*Chermes castaneæ.* — Flavous, thorax, pectus, and eyes black; wings translucent, inner half of the stigma scarcely discolored; 1st and 3rd transverse nervure normal; 2nd arising from the middle of the 1st and terminating in the normal position; posterior wings without nervures; feet and antennæ pale fuscous. The wingless individuals are entirely flavous, with the eyes rufous. Inhabits both sides of the leaf of the chestnut, forming lines along the midrib, and causing the leaf to curl. Pennsylvania in August and September."

Since the discovery of this species by Haldeman, in 1850, all trace of it appears to have been lost, at least so far as published records indicate. In July, 1883, I found it in large numbers on terminal, or younger leaves of a low shrub of *Castanea vesca* near Laurel, Md., on which it produced a distorted, twisted and sickly appearance of the leaves, the insects being closely crowded along the midrib on the under side of the leaves in different stages of development, including the winged sexuparæ.

Among the pupæ of this species were observed two quite distinct forms, one of them resembling somewhat those of *Ph. rileyi*, for which they might readily be mistaken, though the antennal differences of the winged females are pronounced. In *Ph. rileyi* these organs have a prominent constriction or indentation near the base of the third joint, similar to that of many of the Hickory species, whereas in *Ph. castaneæ* this joint is of almost uniform diameter throughout, without a constriction.

The principal differences between these two forms of pupæ will be observed in the tubercles. In one form, even in the smallest specimens, these tubercles are extremely long and slender, especially those surrounding the entire body, while in the other form all tubercles are much reduced in size, and almost obsolete, in some specimens, on the abdomen.

That one of the forms of this species here treated of is identical with the one described by Haldeman there can be scarcely any doubt whatever, notwithstanding his statement that the posterior wings are without a nervure. He simply refers to the discoidal veins, which are always wanting in the genus, though there is a distinct subcostal vein which he overlooked.

I append herewith a more detailed description of the different forms observed.

APTEROUS FEMALE.— Length about 1$^{mm.}$. Color pale yellow. Eyes red. Antennæ and legs finely dusky. Body elongated, having four short and stout capital tubercles, two of them frontal and the other two just behind them; surface indistinctly rugose and densely granulated. Antennæ with the third joint slender, narrowest at base, divided by about 15–18 rather shallow and somewhat scaly annulations; its tip truncate and provided with apparently two fine hairs; thumb minute, though distinct.

EGG.—Length about 0.2$^{mm.}$. Color white or faintly greenish, transparent and polished. Shell very delicate but faintly pitted. Shape ovoid, slightly flattened and securely glued on the flat side to the leaf.

PUPA (with long tubercles).— Length of body of the largest observed about 0.7$^{mm.}$. Color pale yellow or pale orange. Surface of body quite coarsely rugose. Antennæ and legs faintly dusky. Eyes red, scarcely indicated above, more distinct beneath; their place above mostly occupied by a large, much elongated, somewhat tapering tubercle. Four similar tubercles of same size fringe the front margin of the head, and two still more slender tubercles rise from the middle of the head. The prothorax is furnished across its anterior and posterior margins with a row of four shorter and on its lateral margins with two longer tubercles. There is a transverse row of four similar tubercles on the meso- and metathorax; two longer, lateral ones on the meso- and one each side on the metathorax. The abdomen is furnished, medio-dorsally, with two rows of six smaller tubercles, which gradually become longer towards the end of the body, while each segment, except the last, bears a single lateral tubercle, growing gradually shorter toward the end of the body. The last segment is surrounded by four small, rounded tubercles, each bearing at tip a short spine. All tubercles appear to be slightly annulated. Antennæ long and rather stout, without annulation, with a fine, slightly capitate hair at tip, and another a little below it; thumb small, though quite distinct.

PUPA (with short tubercles).— This is the most common form. It is of about the same size, or slightly larger than the other, and

of about the same color, though the older ones are often quite orange, with the external edge of the wing-pads dusky. Eyes and ocelli red. Except a very slender, cylindrical one each side of the head, between the eyes and ocelli, all tubercles are greatly reduced in size and become quite obsolete on the abdomen in some specimens. There are no lateral tubercles, except one each side at the posterior angle of the head, one each side near posterior angle of the prothorax, and two each side on the mesothorax. Surface of body still more coarsely rugose and covered with minute, sharp points.

WINGED MIGRANT.— Length of body 0.6–0.9^{mm}. Expanse of wings 2–2.8^{mm}. Color of body yellow or orange; the prothorax generally somewhat the darkest; head of color of prothorax, with a slight dusky tinge; eyes in the younger specimens red and in the older ones dark purple; ocelli yellowish, bordered along the inner edge with red in the younger specimens and with brown in the older ones; antennæ and legs dusky; the prothorax is marked each side, anteriorly, with a sub-dorsal group of two or three more or less distinct and more or less confluent, depressed dusky spots, and with two transversely ovoid, medio-dorsal, pale dusky spots near the posterior margin; mesothorax and sternum blackish. Head and prothorax delicately rugose. Granulation of abdomen minute. Antennæ rather slender; the basal joint stoutest and longer than the second, both stoutest apically and with but faint traces of annulation; joint 3 slender and of almost uniform diameter, its sensorium rather more than two-thirds the length of the joint; annulation almost obliterated, more distinct at the basal one-third; tip furnished with three very fine, apparently capitate, hairs. Wings delicate, almost colorless. In some specimens the venation of front wings and greater part of stigma is very pale, while in others the costa, stigma, costal cell and discoidal vein are dusky, the remaining two veins delicate, often almost colorless; the stigmal vein rarely touches the stigma, but continues in a curved, very delicate, colorless line which connects it with the discoidal vein. Subcosta of posterior wings distinct, parallel with the costa and running almost to the apex of the wing.

This species has been found to infest both the upper and under side of the leaves, especially along the midrib, of *Castanea vesca*

and *pumila*, and also to some extent on the twigs of shrubs growing in the District of Columbia and in Maryland. The infested leaves frequently become very much distorted, when the ribs or veins turn brown or yellowish-brown, on account of which many of the leaves as well as numbers of the twigs dry up.

It seems rather remarkable that the majority of the immature stages of the insect, inhabiting the under side of the leaves, are of a pale yellow or almost white coloring, bearing small protuberances, whereas the majority of those on the upper side, as a rule, are bright orange and provided with long and slender tubercles. It appears, also, that one or the other form inhabits certain shrubs quite exclusively, while again both forms may occur on the leaves of others; which possibly may indicate two closely related species.

On examining the females of the two forms mentioned above I find that all those belonging to the pale form are provided with very short protuberances, which, on the abdomen, become quite rudimentary, whereas those belonging to the orange form bear long protuberances, similar to those of the pupæ. I consider, therefore, the pale or yellow form as the species described by Haldeman. Future studies, from the earlier stages to the migrant and sexes of the two forms, may reveal the presence of two related species upon *Castanea*, which may justify the adoption by me of the name of *Phylloxera spinifera* for the orange or spiny form.

PHYLLOXERA RILEYI Riley. (Licht. Mss.)

Pl. XIX., figs. 151–154.

STEM-MOTHER.— Length about 0.6$^{mm.}$; diameter across the thorax about 0.3$^{mm.}$. Color dark greenish-yellow to dark brown, the protuberances almost black, the eyes dark purple or black, antennæ and legs dusky. The antennæ are long and slender and almost one-third the length of the body; the third joint is extremely slender, very slightly clavate with numerous sharply defined serrations; the sensorium small and elongated oval. The fleshy protuberances of the body are abnormally long, especially the dorsal ones, which gradually diminish in length towards the end of the body, and wanting on the last two segments; those

along the front of the head are smallest and almost ovoid, while the lateral protuberances grow gradually longer; all are covered with sharp projections or teeth, while the tip is either rounded or furnished with some short projections. The surface of the body is densely corrugated.

PUPA.— Length 0.6$^{mm.}$. Color yellow; eyes brown; antennæ and legs dusky; the tubercles paler and the tip of the wing-pads black. Antennæ short, about one-fourth the length of the body, the third joint cylindrical and smooth. The fleshy tubercles or protuberances are very much shorter than those of the stem-mother, especially those of the abdomen which are very small and wart-like; the surface of the body is densely covered with minute points.

WINGED MIGRANTS.— Length of body 0.6$^{mm.}$; expanse of wings about 2$^{mm.}$ Color orange, the prothorax darkest and the abdomen palest towards the end. The prothorax is marked each side with a large, more or less triangular dusky spot, two transverse dusky stripes between them, accompanied in front by two small dots and a similar dot each side of the posterior stripe. Head dusky, eyes brown. Antennæ, thoracic lobes, sternal plate and legs black. Wings faintly dusky, veins and stigma darker, the subcosta almost black, the veins bordered by a slightly darker shade. Front of head arcuate; eyes large; abdomen much elongated and tapering. Antennæ rather short, or slightly more than one-third the length of the body; the lower sensorium of the third joint is circular or broadly oval and the upper one elongated and about one-half the length of the section above the lower sensorium; the whole joint is quite densely and sharply serrate.

Dr. C. V. Riley, in an article accompanied by figures, published in the Sixth Report on the Noxious and Beneficial Insects of Missouri, for 1874, pp. 64 and 65, and in his description of the species, p. 86, No. 25, as well as in a second article on the same in the Seventh Report for 1875, pp. 118 to 121, applied to it the name of *Phylloxera rileyi* Licht., of which specimens had previously been sent by Dr. Riley to Mr. Lichtenstein, who decided it to be a new species, to which he gave the name of *Ph. rileyi*, a name used by him, without a description, in

his observations on the economy of *Ph. vastatrix*, *quercus* and *balbianii*, in Comptes Rendus des Séances de L'Academie des Sciences, for 1875, p. 1223, and mentioned by him in the Stettiner Ent. Zeitung, p. 359, 1875. According to the above it seems to be justifiable to assume that the species was worked up in conjunction by both gentlemen, but that the species should be credited to Riley.

While consulting Dr. Riley's description of the apterous female or stem-mother of this species, p. 86, I have come to the conclusion that the description of his supposed female corresponds exactly with fig. 19, representing a female larva, specimens of which are still preserved in the original collection, whereas the mature female was described in the Seventh Report, p. 120, under the designation of "Black form with very long tubercles (c)" — where the following language is used by him: "With the body dark brown and the tubercles almost black; the dorsal ones, especially in middle of body, very long — half the diameter of body — slender, gradually tapering to tip, the lateral ones and some of the dorsal ones, less tapering and half as long. Antennæ with the third joint quite long and slender." Of this form two specimens have been preserved.

Thus far this species has been recorded as having been found only on the white oak (*Q. alba*) and the post-oak (*Q. obtusiloba*) in the vicinity of Kirkwood, Mo., on the leaves of which it produces white or yellowish circular spots; the insect, in various stages of development, often in immense numbers, is, as a rule, found on the under side of the leaves, whereas the earliest forms, as well as the sexes, frequent the branches, on which the winter eggs are deposited. The earliest migrants are usually observed during July and the latest in October. Whether the earliest migrants produce a sexual generation or not has thus far not been demonstrated, though it seems to be quite certain, since hibernating larvæ, which apparently hatched from the earliest eggs, as well as eggs, appear to have been found on the twigs.

PHYLLOXERA QUERCETI Pergande, n. sp.

Pl. XX., figs. 155–158.

APTEROUS FEMALE. — Length about $0.5^{mm.}$; shape pyriform, broadest about the middle of the thorax, rounded in front and

gradually tapering posteriorly. Antennæ slender, about one-third the length of the body, the third joint slightly clavate and distinctly serrate; the thumb or nipple is small and near the apex of the joint, which bears two or three short hairs. There are, apparently, six rows of very much elongated, tapering, fleshy projections which are more or less notched or toothed, bearing three or four acute lobes at the tip, on the head and thoracic segments; and four rows of similar projections on the anterior six segments of the abdomen, those of the first three segments growing gradually shorter, while those of the following three segments are very much reduced and tubercle-like; the remaining two segments bear no tubercles; on the last segment are but four small bristles. The color varies somewhat from yellow to orange and that of the eyes from dark purple to black.

The eggs deposited by the stem-mother are about $0.2^{mm.}$ in length and rather less in diameter; they are oval, highly polished and pale yellow, growing gradually darker by age, when a distinct sculpturing of obliquely arranged rows of hexagonal depressions makes its appearance.

The young larvæ hatched from these eggs are pale yellow, the eyes red and the antennæ, legs and warts slightly dusky. The warts are rather prominent, conical, and bear a short but stout and more or less cylindrical spine at the apex.

PUPA.— Length about $0.6^{mm.}$. Color yellow to orange; eyes dark purplish-brown. The fleshy projections are still longer than those of the females and more sharply toothed or serrate, the tip is more distinctly rounded and surrounded by three or four triangular teeth, while the whole surface of the body is densely covered with acute tubercles. The antennæ are about one-fourth of the length of the body, the third joint is smooth and slightly fusiform. In other respects it resembles the stem-mother.

WINGED MIGRANT.— Length of body $0.6^{mm.}$ to $1^{mm.}$. Expanse of wings 2 to $2.4^{mm.}$ Color orange. Mesothorax and sternal plate blackish; head, antennæ and legs dusky; eyes dark purplish; wings faintly brownish, the veins and stigma darker. There is a transverse row of four dusky, roundish swellings anteriorly and two similar swellings posteriorly on the prothorax, the

head and rest of the body without a trace of tubercles. The antennæ are about one-fourth the length of the body. The third joint is as usual in this genus, the lower sensorium rather large and more or less circular, the upper one elongated and about one-half the length of the larger or terminal section, which, below the sensorium, tapers gradually towards its base; the whole joint is quite densely and sharply serrate.

This species was found in and about the vicinity of Washington on the leaves of *Quercus alba*, *macrocarpa*, *panonia* and *daimio* from May till October, the affected leaves of which are speckled all over with small yellow spots, particularly so along the midrib and the smaller veins. The insects causing the injury are found in various stages or forms on the under side of the leaves.

It resembles to a great extent *Ph. rileyi*, though the stem-mother of that species is about twice as large, and the protuberances on all parts of its body much longer, while those of the pupæ are much smaller on the head and thorax and tubercular on the abdomen. The migratory female is almost one-half smaller, with shorter antennæ and wings.

There can scarcely be any doubt that future careful investigations will disclose the fact that several additional species will be found infesting our different kinds of oak in various sections of the country, all of them having more or less the same habits. At least five species have been discovered and described in Europe, all of which were found to inhabit various parts of oak trees.

PHYLLOXERA PROLIFERA Oestl.

Phylloxera prolifera Oestl. Synopsis of the Aphidæ of Minnesota, p. 16, 1887.

Mr. Oestlund describes this species in his synopsis as follows:

"*Apterous female.*—Color very pale lemon-yellow, smooth, convex above, especially in front, tapering behind into a rather long ovipositor. Eyes as a very small black spot. Antennæ short and fine, 3-jointed: I. 0.05mm., II. 0.05mm., III. 0.10mm. Beak short and thick, about 0.10mm., the setæ very long when extended, at least as long as the body, brownish. Legs short; tarsi with two rather small claws, and with the two capitate hairs as usually in this genus."

"Found in the galls of *Pemphigus populicaulis* Fitch during the fall,

after the pemphigiens have left or become destroyed. Usually but one female, or at most a few, was to be found in the gall, together with a great number of pseudova in a pile that often would be several times the female in bulk."

This species I have failed to see.

PHYLLOXERA POPULARIA Pergande, n. sp.

Plate XXI., figs. 159, 160.

Large numbers of females and their eggs were discovered by Mr. E. A. Schwarz, December, 1878, in deserted galls of *Pemphigus transversus* Riley on *Populus monilifera* at Columbia, Texas, and during January of the following year at Bayou Sara, La., in similar galls and in cracks of a black knot, growing on the branches of the same tree, about forty feet above the ground. Additional specimens were received during July, 1891, from Alma, Mich., found in empty, though still green and succulent, galls of *Pemphigus populicaulis* Fitch. Other specimens, found in galls on Cottonwood in September, 1891, at Brookings, S. D., were received from Mr. T. A. Williams. During October of 1900 the same species was found by me at St. Louis, Mo., in galls of *Pemphigus transversus* Riley, which were still fresh and had but recently dropped.

APTEROUS FEMALE.— Length about 1.4$^{mm.}$

The young females, as found in May, are pale greenish-yellow and densely covered with minute points; antennæ and legs are pale dusky, the rostrum is black and reaches to the end of the body. The larvæ are of the color of the female, the eyes red, the rostrum dusky, extremely long and almost twice the length of the body.

Females or sexuparæ, found in October, are brownish-yellow, the eyes brown, and antennæ and legs pale dusky. Shape pyriform, the thorax stoutest and rounded; front of head more or less distinctly concave. Dorsum densely covered with minute, pointed tubercles. The rostrum reaches considerably beyond the third coxæ. Antennæ much shorter than the posterior diameter of the head; first joint much the stoutest and somewhat tapering; the second joint is much narrower, distinctly longer and clavate;

joint three is slender, about as long as the two basal joints combined, and faintly tapering; the tip is bluntly rounded and bears a few short hairs. Sensorial thumb minute, placed close to the apex of the joint. Legs normal.

SEXUAL FEMALE.—With the sexuparæ, found in galls in October, were also found numerous yellow or greenish-yellow eggs besides some sexual females, which measure about 0.2$^{mm.}$ in length. They are oval in shape and about twice as long as wide and completely filled with a single egg. Color yellow or pale greenish-yellow and sometimes dusky along each side. Antennæ short, stout, barely as long as the width of the head in front; the two basal joints are stout, about as long as broad, subequal in length and somewhat stoutest at the apex; joint three is about as long as the two basal joints combined, fusiform, with three or four shallow annulations at the terminal half. Rostrum wanting, represented by a small swelling. Legs short and stout.

On account of the food-plant and the same habit, I have hesitated to consider it different from *Ph. prolifera* Oestlund, but, since its rostrum is much longer and its body covered densely with minute points, I have concluded to consider it as different and describe it herewith as new.

In connection herewith I may mention the fact that in September of 1901 I discovered two small specimens of *Phylloxera* in the empty burrow of *Oberea* in a twig of *Populus monilifera*, from Cleveland, Ohio; whether mature or not, cannot be determined, in which the rostrum is very much longer than the body, while the dorsum is destitute of tubercles and the proportions of the antennal joints apparently different from those of the other two species. They may possibly prove distinct from either of them.

PHYLLOXERA SALICOLA Pergande, n. sp.

Plate XXI., figs. 161–168.

This and the following species (*Ph. nyssæ*) are the most remarkable so far discovered in this country, and appear to be closely related to *Ph. popularia* Pergande and *Ph. prolifera* Oestl. and *Ph. salicis* Licht., of none of which the winged or migratory form has yet been observed, though it doubtless exists. The present species

infests not alone the stems and twigs of willows but occasionally also the under side of the leaves. Those on the wood are always stationed in some crack, under the delicate loose bark, or are pushed in between the leaf-buds and the twig. All are completely covered with a white wooly secretion which hides the insect from view and recalls in appearance certain coccids of the genera *Pseudococcus* and *Dactylopius*.

PUPIFEROUS FEMALE.—Length 0.6–0.9$^{mm.}$. Shape of younger, most vigorous specimens, elongate-pyriform, and that of the old or almost empty ones quite circular. Color yellow, the older ones brownish-yellow, with head and thorax darkest. Antennæ and legs faintly dusky. Eyes brown or blackish. Rostrum very long, reaching almost to the end of the body. Antennæ rather slender; joint 2 longer and more slender than the first, both stoutest near the apex; joint 3 longer than the two basal ones combined, of uniform diameter or faintly stoutest near base and slightly curved; thumb extremely minute and placed close to apex; annulation almost imperceptible, the tip apparently provided with two minute hairs. Surface of the body covered quite densely with minute and somewhat pointed granules. In addition to the general granulation there appear to be six rows of secretary spots or warts on the abdomen, less numerous on the head and thoracic segments, all of which are detected with much difficulty. Each of these warts is again divided into four to six groups, which are composed of three to four still smaller divisions or pores. Four short hairs fringe the front of the head, two similar ones each side the thoracic and one each side of the abdominal segments.

SEXUAL EGGS.—Length of egg producing the female about 0.2$^{mm.}$; that producing the male somewhat smaller, the former regularly ovoid, the latter somewhat pointed posteriorly. Color yellow, highly polished, and without sculpturing.

MALE AND FEMALE.—Length of female scarcely 0.3$^{mm.}$, the male being about one-fourth less. Color of both pale yellow, though the male is slightly darkest. Antennæ and legs faintly dusky, darkest in the male. Eyes reddish or brown. Antennæ extremely small and very similar in both sexes; joint 1 stoutest and largest; joint 2 very short, sometimes scarcely noticeable; joint 3 scarcely

longer than the first, in the male being sometimes almost globular; the thumb is minute and placed near the apex. There are faint indications of three or four annulations, and the tip is provided with two minute hairs. Surface of body minutely granulate; besides the granulation there are, on each side of the thorax of the female, three more or less prominent lateral tubercles. Rostrum rudimentary.

With each of the pupiferous females were found from one to eight eggs, most of them sexual though occasionally a few smaller ones, which produced non-sexual larvæ, with a long and well-developed rostrum. This may possibly produce a migratory generation the following season. These larvæ are scarcely 0.2$^{mm.}$ in length, with the rostrum extending beyond the tip of the abdomen. Color yellow; eyes brown; antennæ, legs and rostrum pale dusky. Surface of body similarly granulated to that of the parent. Antennæ rather long and slender, reaching to base of first pair of legs; joint 1 shortest and stoutest, narrowest at apex; joint 2 considerably longer, more slender and stoutest near the end; joint three 3 nearly twice the length of the other two combined, very slender and of uniform diameter, with two fine hairs at tip; thumb minute, though quite distinct.

The species was found during September on some small shrubs of either *Salix discolor* or *humilis* (species not determinable without the flowers), growing in a swampy spot in the middle of a piece of woods in the District of Columbia, with no other willows within a radius of a mile or more.

PHYLLOXERA NYSSÆ Pergande, n. sp.

Plate XXI., figs. 169–174.

This species, like the preceding one, is equally remarkable on account of the white secretion which covers it completely, giving it a decided resemblance to *Pseudococcus*. It is much larger and stouter than *Ph. salicicola*, with the antennæ of the pupiferous female shorter and those of the sexes longer than in that species.

PUPIFEROUS FEMALE.—Length 1–1.3$^{mm.}$. Shape broadly ovoid; broadest across the thorax. Surface of body densely covered with extremely minute points. Color lemon-yellow. Eyes red, minute,

more distinct beneath than above. Legs short and stout. Rostrum short, reaching to the second coxæ in older specimens and to the abdomen in the younger ones; pale brown at base, with the rest pale dusky. Antennæ short and stout; joint 1 much the stoutest and truncate at tip; joint 2 somewhat longer, clavate; joint 3 a little longer than the two basal joints combined, faintly curved, its surface rather indistinctly and sparsely annulate, and bearing apparently three minute hairs at tip; thumb very small.

SEXUAL EGGS.— Yellow, apparently highly polished, and of the normal form.

MALE AND FEMALE.—Length of the male about 0.3$^{mm.}$ and of the female 0.4$^{mm.}$. Surface of body covered with minute points. Color pale yellow; eyes reddish and more prominent beneath than above. Antennæ and legs with a faintly dusky tinge, darkest in the male. Antennæ very short; the two basal joints about equal in length, the first much the stoutest. In the female the second joint appears to be a little longer than the first and slightly clavate; joint 3 is about as long as the two basal joints combined, stoutest at the apical third, with five or six faint annulations, and provided at tip with two or three minute hairs; the thumb is scarcely noticeable. Legs stout, longer in the male. Rostrum rudimentary.

This species was found by me during September in the middle of the woods in the same locality as *Ph. salicicola*, on the trunks of young trees of *Nyssa sylvatica*, in cracks and depressions of the bark, though more particularly in the cavities caused by the dropping out of small dead twigs, about five or six feet above the ground. It is difficult to discover and appears to be quite rare. None could be found, after much search, on the trunks of larger trees.

The types of the new species described in this paper, as well as those described by the late Dr. C. V. Riley, and also co-types of most of the species described by Dr. Asa Fitch, Dr. Henry Shimer, and Mr. Benjamin D. Walsh, are preserved in the collection of the U. S. Department of Agriculture.

Phylloxera vastatrix Planchon has been purposely omitted from this paper on account of the large amount of literature pertaining

to the life history of this insect, and the economic relations of the species to the cultivated and wild varieties of grape-vines.

Excellent descriptions and illustrations of it may be found in Dr. C. V. Riley's Sixth Report on the Noxious and Beneficial Insects of Missouri for 1871, pp. 30–86.

ERRATA.

Page 217, line 21, from above, read *Ph. globosa*.

Page 236, bottom line, read 393.

Page 236, line 3, from bottom, read 1867, p. 2.

Page 236, line 6, from bottom, read *globosa*.

Page 247, line 15, from above, read *spinuloides*.

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[In the reproduction of the plates the original size has been in all cases slightly reduced. This must distinctly be borne in mind when comparing the plates with the explanations.]

EXPLANATION OF PLATES.

PLATE I.

Phylloxera c.-septum (Shimer).

Fig. 1. Young galls, above and beneath—natural size.
Fig. 2. Young gall, side view—greatly enlarged.
Fig. 3. Young galls, above and beneath—farther advanced.
Fig. 4. Mature galls, above and beneath—natural size.
Fig. 5. Mature galls, above and beneath—natural size.
Fig. 6. Mature gall, vertical section—greatly enlarged.

Phylloxera perforans Pergande, var:

Fig. 7. Mature galls—natural size.
Fig. 8. Mature gall, vertical section—greatly enlarged.

PLATE 1

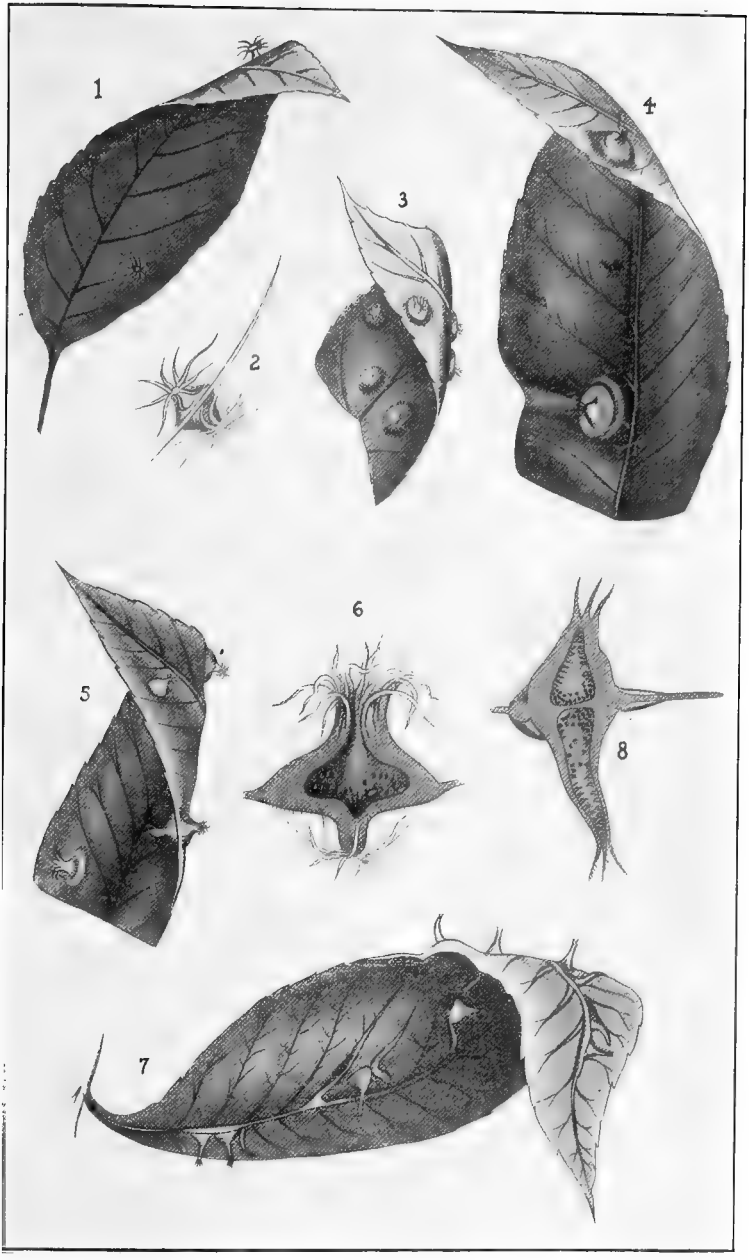

PLATE II.

Phylloxera c.-foliæ Fitch.

Fig. 9. Mature galls, above and beneath—natural size.

Phylloxera picta Pergande, n. sp.

Fig. 10. Mature galls, above and beneath—natural size.

Phylloxera intermedia Pergande, n. sp.

Fig. 11. Mature galls, above and beneath—natural size.
Fig. 12. Mature gall, vertical section—greatly enlarged.
Fig. 13. Mature galls, above and beneath—natural size.
Fig. 14. Mature gall, vertical section—greatly enlarged.

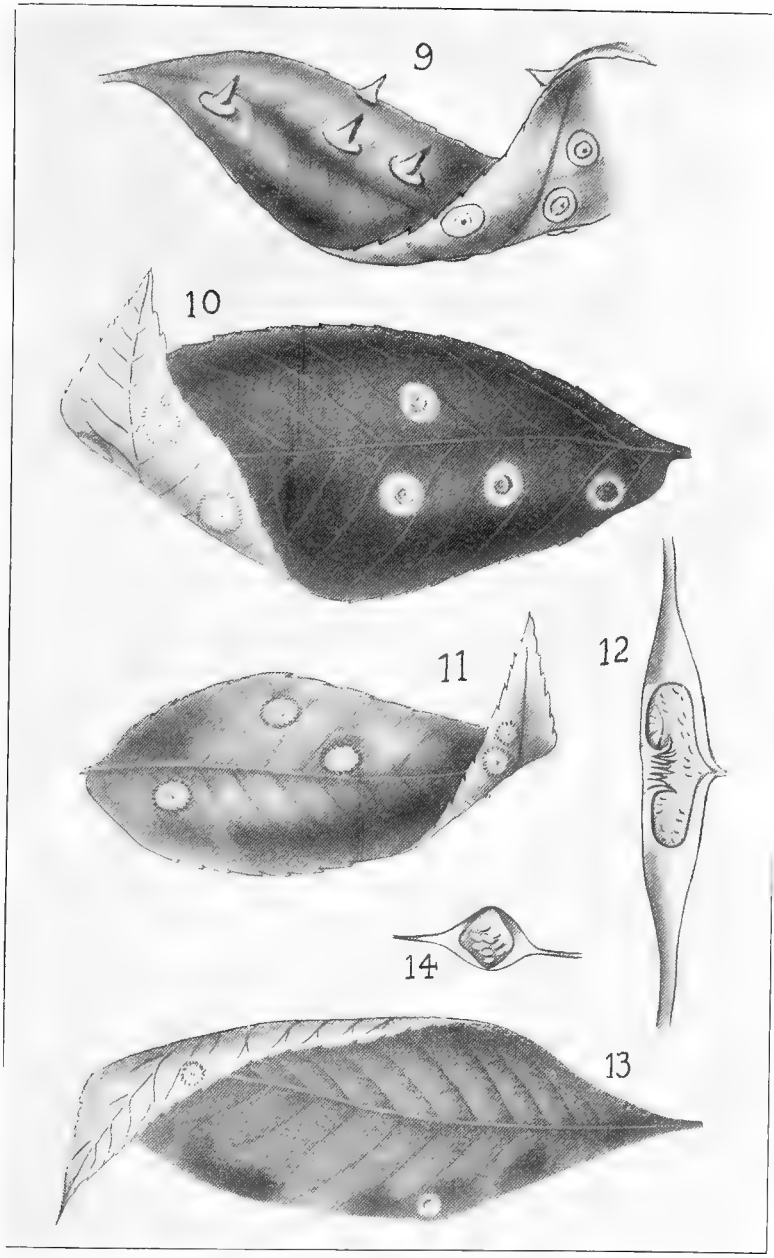
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PLATE III.

Phylloxera foveola Pergande, n. sp.

Fig. 15. Mature galls—natural size.
Fig. 16. Mature gall, vertical section—enlarged.

Phylloxera pilosula Pergande, n. sp.

Fig. 17. Mature galls, above and beneath—natural size.

Phylloxera deplanata Pergande, n. sp.

Fig. 18. Young galls, above and beneath—natural size.
Fig. 19. Young gall, from beneath—much enlarged.
Fig. 20. Young gall, from above—much enlarged.

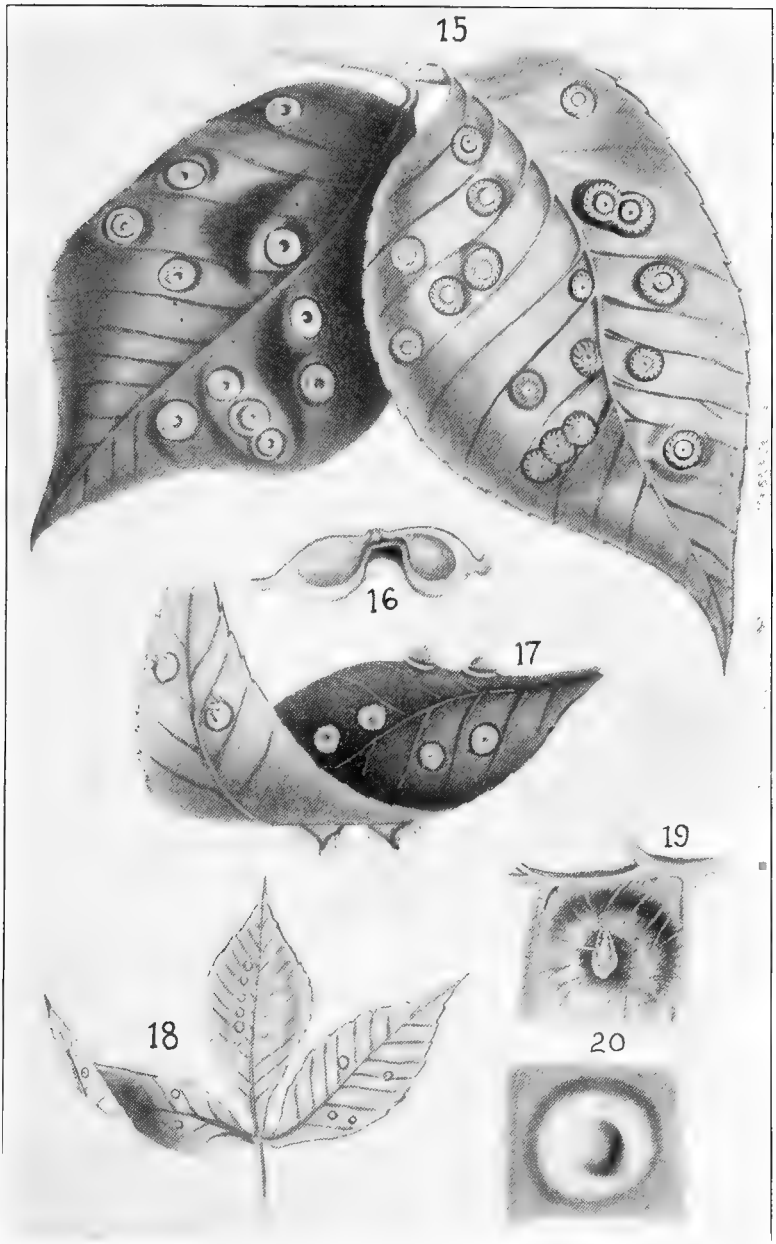
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PLATE IV.

Phylloxera deplanata Pergande, n. sp.

Fig. 21. Mature galls, above and beneath—natural size.
Fig. 22. Mature galls, above and beneath—natural size.
Fig. 23. Mature gall, vertical section—much enlarged.

Phylloxera rimosalis Pergande, n. sp.

Fig. 24. Mature galls, above and beneath—natural size.

Phylloxera c.-scissa Riley.

Fig. 25. Mature galls, above and beneath—natural size.

PLATE IV

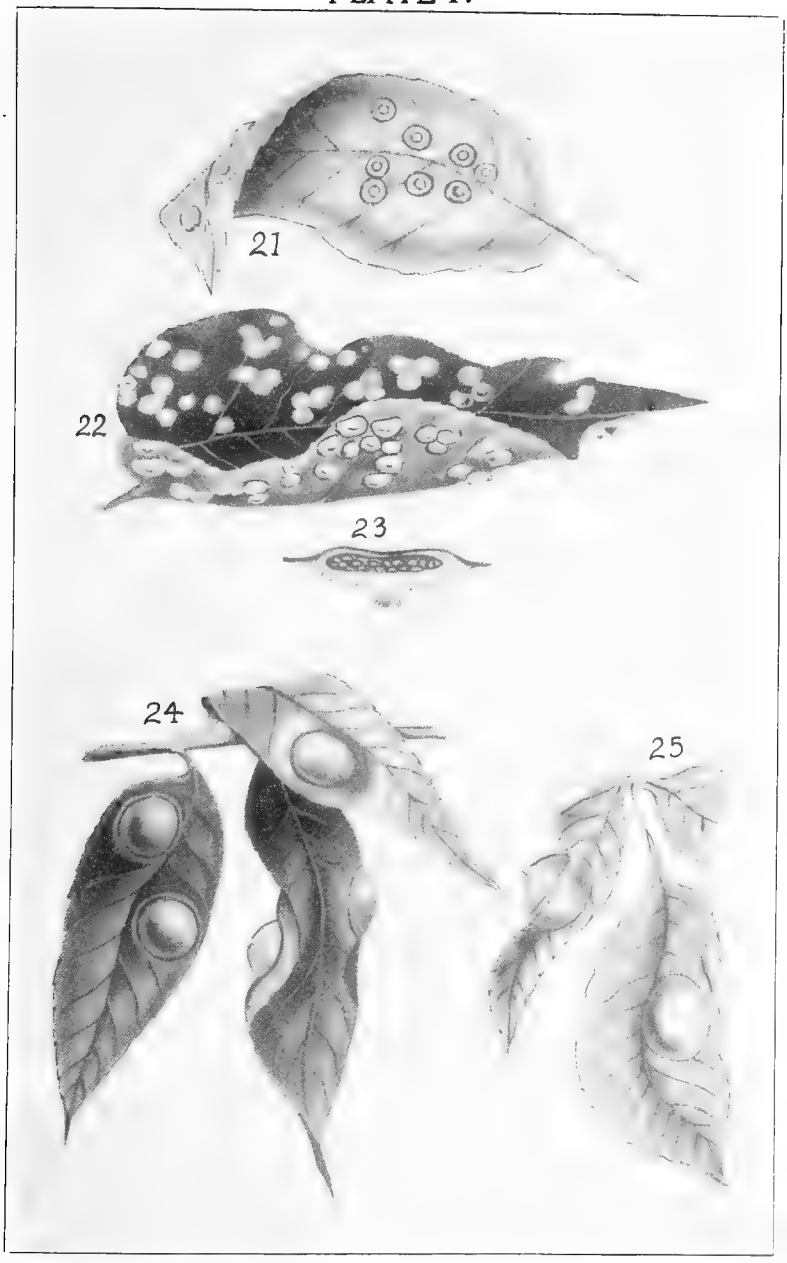

PLATE V.

Phylloxera conica (Shimer).

Fig. 26. Young galls, above and beneath—natural size.
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Fig. 28. Mature galls, above and beneath—natural size.
Fig. 29. Mature galls, variety; above and beneath—natural size.

Phylloxera c.-avellana Riley.

Fig. 30. Young galls, above and beneath—natural size.
Fig. 31. Mature galls, above and beneath—natural size.

PLATE V

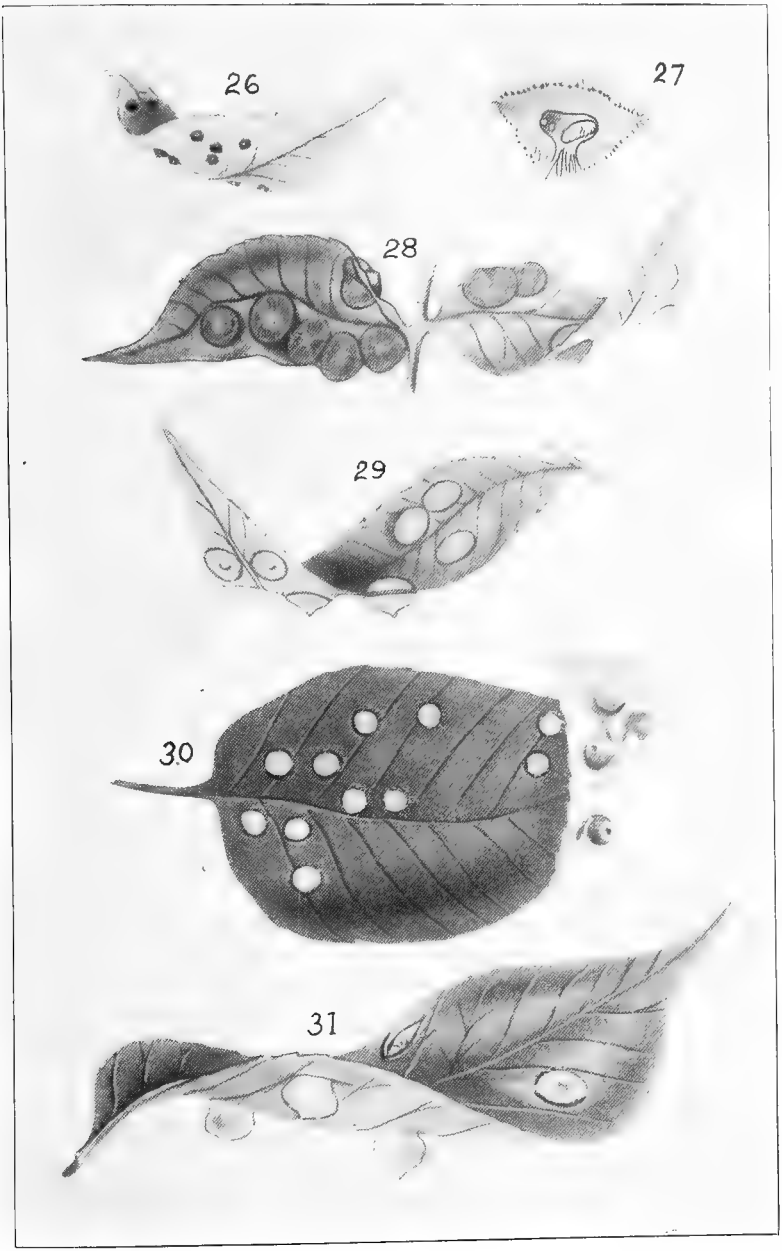

PLATE VI.

Phylloxera c.-avellana Riley.

Fig. 32. Mature galls, from beneath—natural size.
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Fig. 34. Mature galls, variety—natural size.
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Phylloxera c.-gummosa Riley.

Fig. 37. Mature gall—reduced ⅓.

Phylloxera c.-venæ Fitch.

Fig. 38. Mature galls, from above—natural size.
Fig. 39. Mature galls, from beneath—greatly enlarged.

PLATE VI

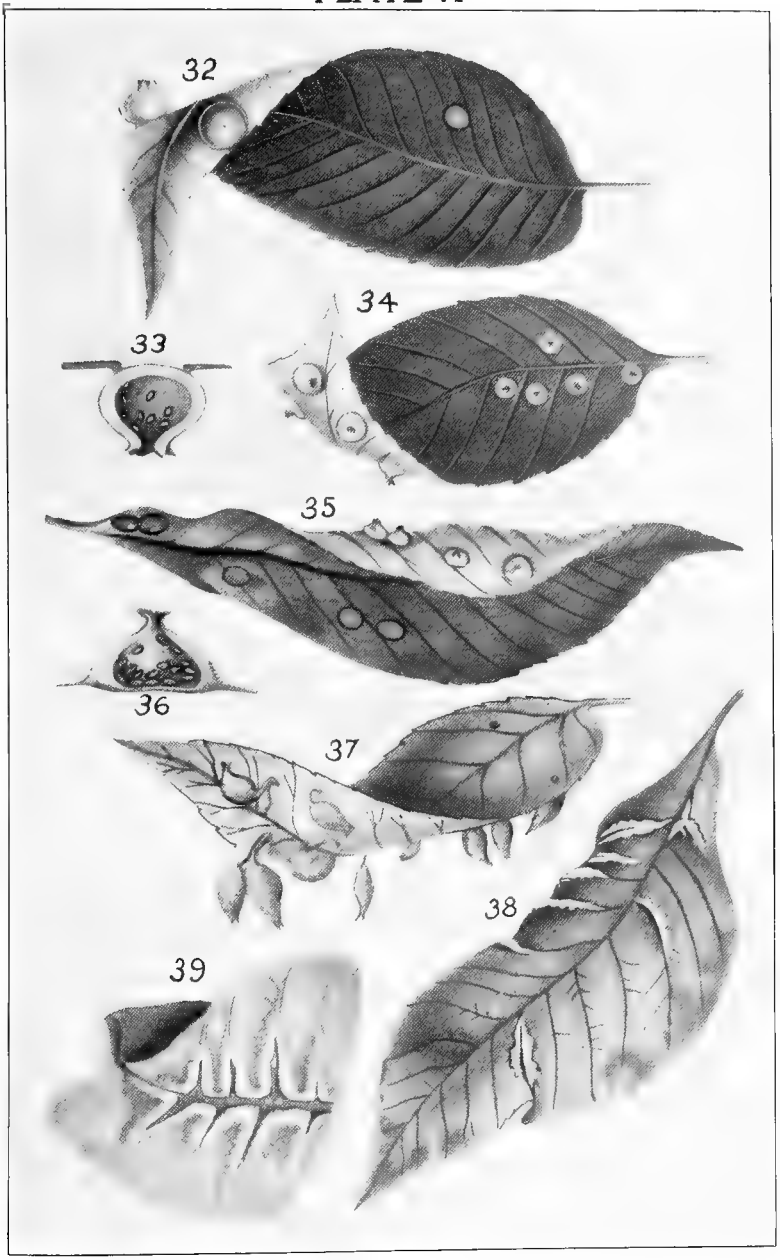

PLATE VII.

Phylloxera c.-caulis Fitch.

Fig. 40. Mature galls, typical form—natural size.

Phylloxera c.-magnum Shimer, var.:

Fig. 41. Mature galls—natural size.
Fig. 42. Mature galls—natural size.

PLATE VII

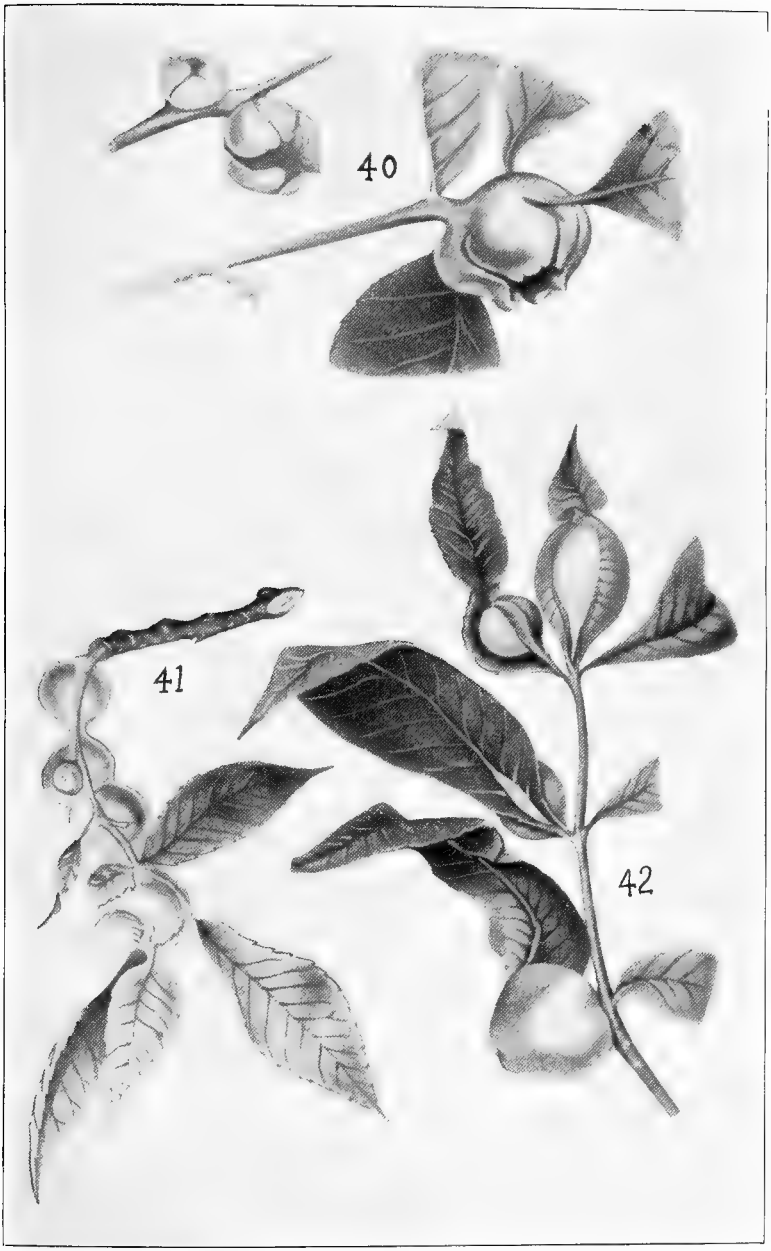

PLATE VIII.

Phylloxera spinosum Shimer, var.:

Fig. 43. Young galls—immature.
Fig. 44. Mature gall—natural size.

Phylloxera perniciosa Pergande, n. sp.

Fig. 45. Mature galls—natural size.

PLATE VIII

PLATE IX.

Phylloxera c.-septum (Shimer).

Fig. 46. Mature gall, vertical section—enlarged.

Phylloxera c-foliæ Fitch.

Fig. 47. Mature gall, vertical section—enlarged.

Phylloxera picta Pergande, n. sp.

Fig. 48. Mature gall, vertical section—enlarged.

Phylloxera pilosula Pergande, n. sp.

Fig. 49. Mature gall, vertical section—enlarged.

Phylloxera c-semen Walsh.

Fig. 50. Mature galls, above and beneath—natural size.
Fig. 51. Mature gall, vertical section—enlarged.

Phylloxera c.-fallax Walsh.

Fig. 52. Mature galls, above and beneath—natural size.
Fig. 53. Mature gall, vertical section—enlarged.

Phylloxera rimosalis Pergande, n. sp.

Fig. 54. Mature gall, vertical section—enlarged.

Phylloxera c.-scissa Riley.

Fig. 55. Mature gall, vertical section—enlarged.
Fig. 56. Mature gall, showing transverse slit—natural size.

PLATE IX

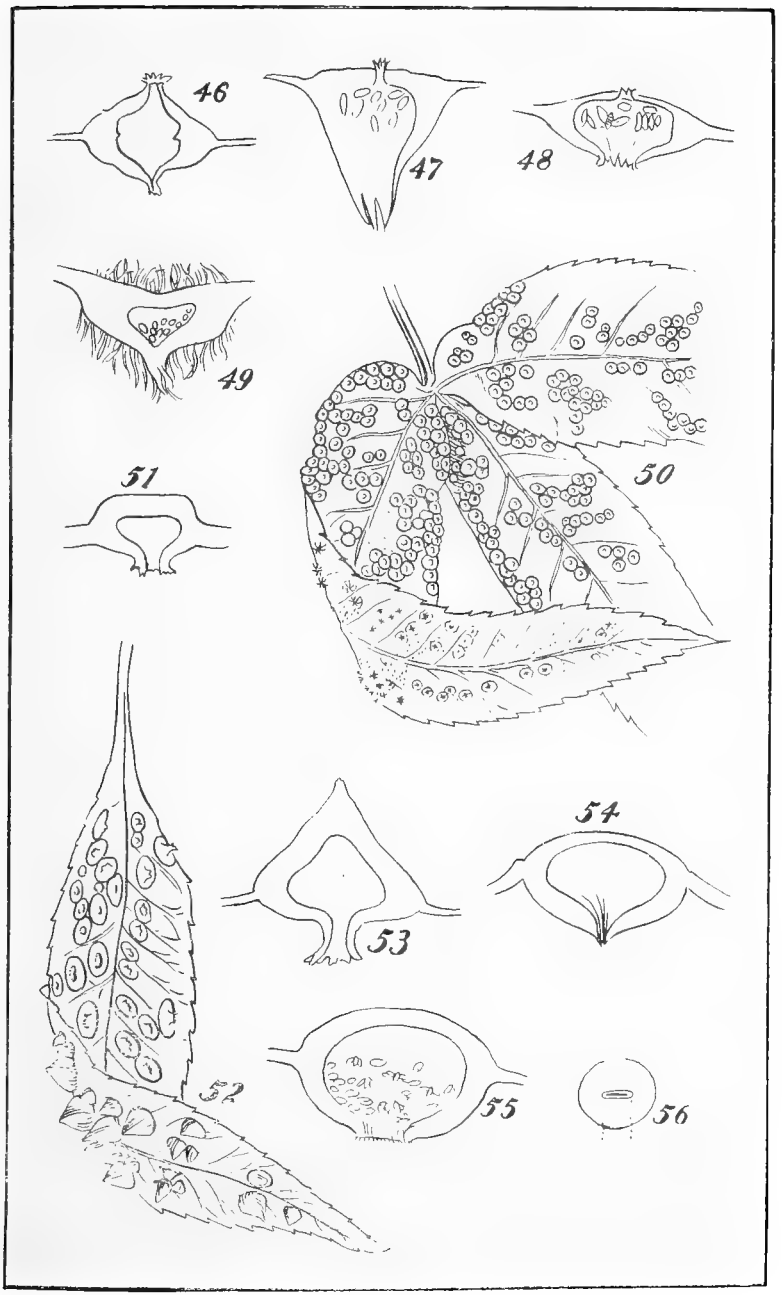

PLATE X.

Phylloxera perforans Pergande, var.:

Fig. 57. Stem-mother—enlarged 40 diameters.
Fig. 58. Antenna of stem-mother—enlarged 250 diameters.
Fig. 59. Egg of stem-mother—greatly enlarged.
Fig. 60. Antenna of migratory female—enlarged 250 diameters

Phylloxera dicta Pergande, n. sp.

Fig. 61. Stem-mother—enlarged 40 diameters.
Fig. 62. Antenna of stem-mother—enlarged 250 diameters.
Fig. 63. Antenna of migratory female—enlarged 250 diameters.

Phylloxera intermedia Pergande, n. sp.

Fig. 64. Migratory female—enlarged 40 diameters.
Fig. 65. Antenna of migratory female—enlarged 250 diameters.

Phylloxera deplanata Pergande, n. sp.

Fig. 66. Stem-mother—enlarged 40 diameters.
Fig. 67. Antenna of stem-mother—enlarged 250 diameters.
Fig. 68. Sexual Female—enlarged 80 diameters.
Fig. 69. Male—enlarged 80 diameters.
Fig. 70. Antenna of sexual female—enlarged 250 diameters.

PLATE X

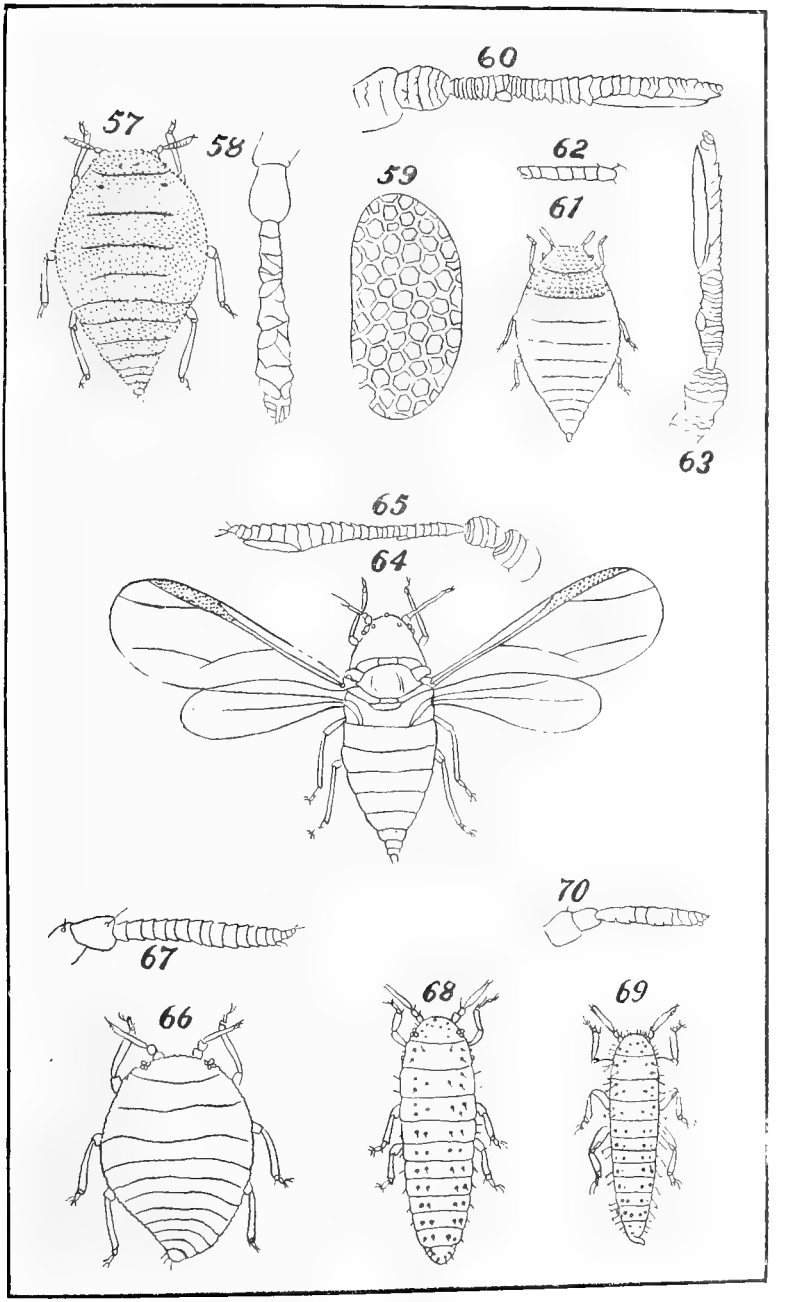

PLATE XI.

Phylloxera c.-fallax Walsh.

Fig. 71. Migratory female—enlarged 40 diameters.
Fig. 72. Antenna of migratory female—enlarged 250 diameters.
Fig. 73. Male—enlarged 40 diameters.
Fig. 74. Antenna of male—enlarged 250 diameters.

Phylloxera conicum (Shimer).

Fig. 75. Stem-mother—enlarged 40 diameters.
Fig. 76. Antenna of stem-mother—enlarged 250 diameters.
Fig. 77. Antenna of migratory female—enlarged 250 diameters.
Fig. 78. Mature gall, vertical section—much enlarged.

Phylloxera c.-avellana Riley

Fig. 79. Migratory female—enlarged 40 diameters.
Fig. 80. Antenna of migratory female—enlarged 250 diameters.
Fig. 81. Mature gall, vertical section—much enlarged.

PLATE XI

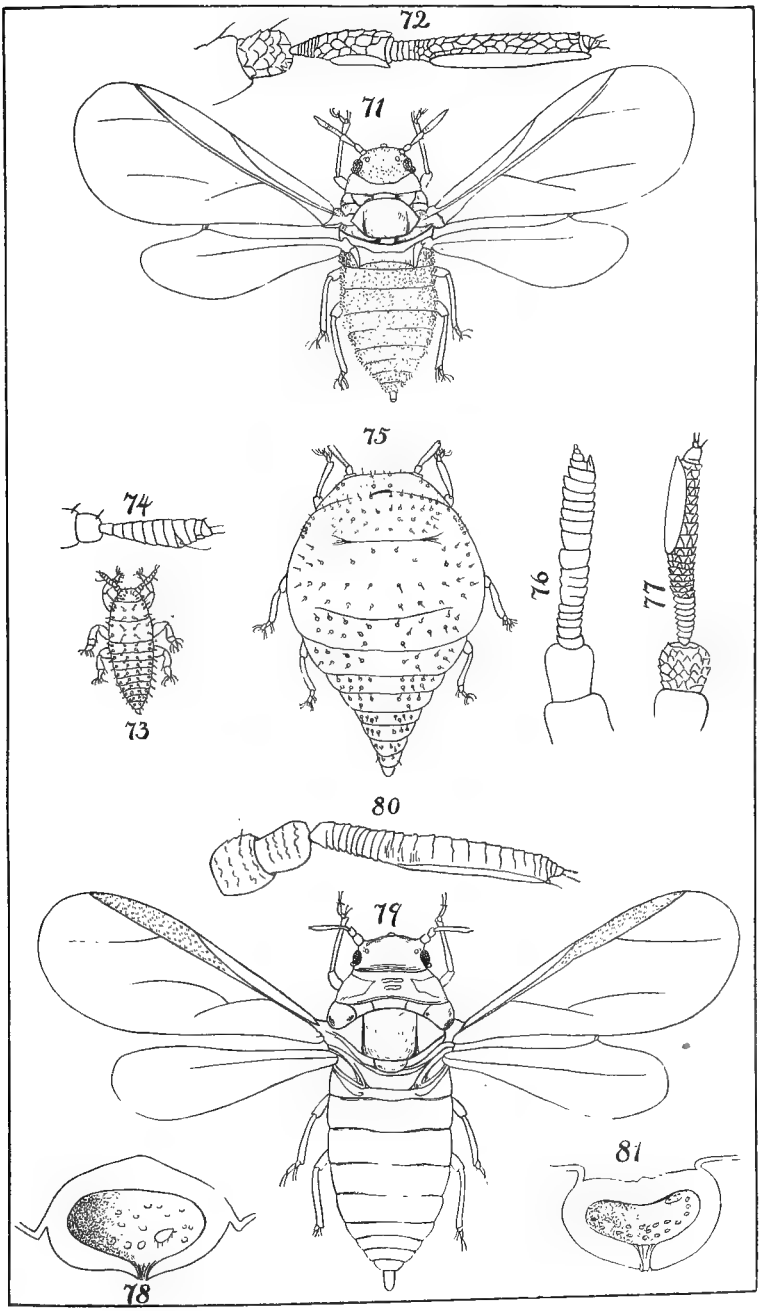

PLATE XII.

Phylloxera notabilis Pergande, n. sp.

Fig. 82. Immature galls, from beneath—natural size.
Fig. 83. Immature gall, vertical section—much enlarged.
Fig. 84. Mature galls, from above—natural size.
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Fig. 86. Stem-mother—much enlarged.
Fig. 87. Sexupar pupa—much enlarged.
Fig. 88. Antenna of sexupar pupa—much enlarged.
Fig. 89. Migratory female—much enlarged.
Fig. 90. Antenna of migratory female—much enlarged.

PLATE XII

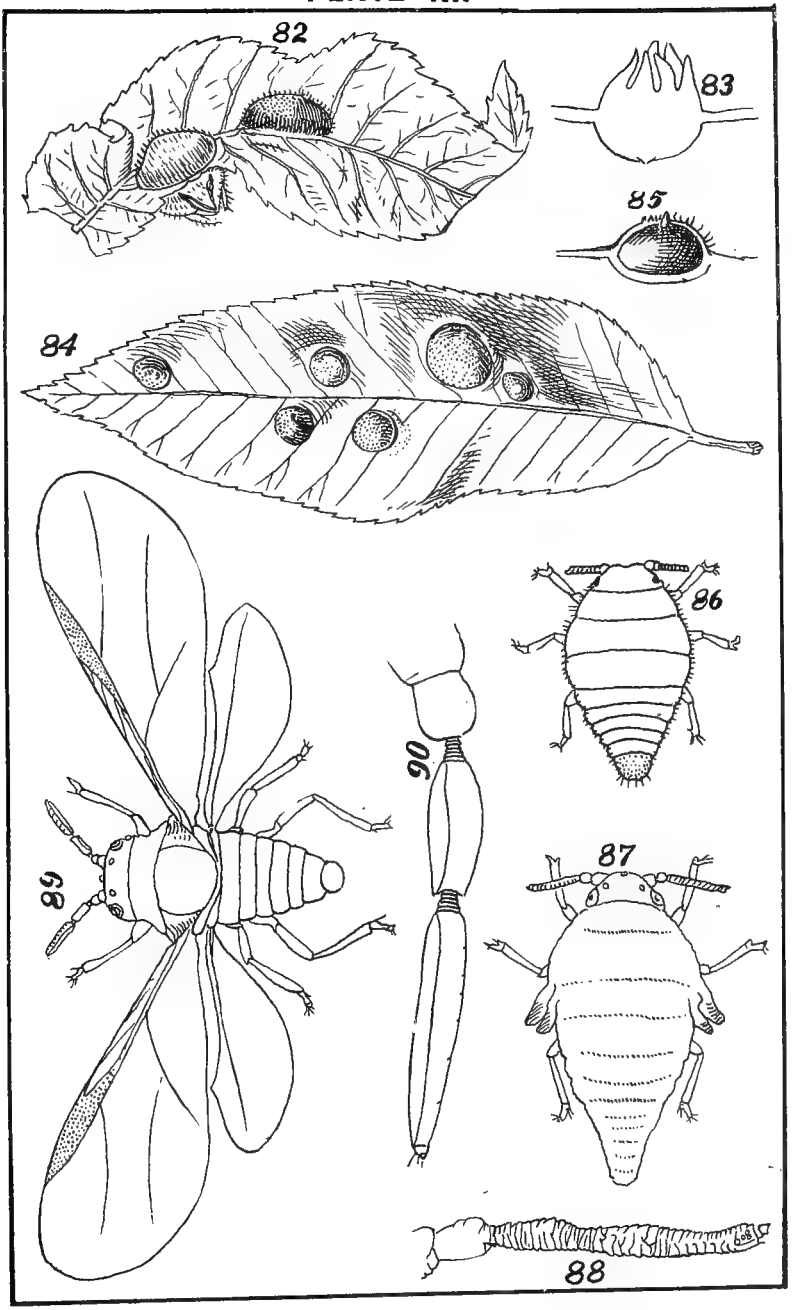


PLATE XIII.

Phylloxera c.-globosum Shimer.

Fig. 91. Mature galls, above and beneath—natural size.
Fig. 92. Mature gall, vertical section—much enlarged.

Phylloxera c.-coniferum Shimer.

Fig. 93. Mature galls, above and beneath—reduced ⅓.
Fig. 94. Mature gall, vertical section—enlarged.

Phylloxera c.-gummosa Riley.

Fig. 95. Mature gall, vertical section—much enlarged.
Fig. 96. Stem-mother—magnified 40 diameters.
Fig. 97. Antenna of stem-mother—magnified 250 diameters.

Phylloxera c.-venæ Fitch.

Fig. 98. Stem-mother—magnified 40 diameters.
Fig. 99. Antenna of stem-mother—enlarged 250 diameters.
Fig. 100. Winter-egg—magnified 120 diameters.
Fig. 101. Apterous sexupare, ventral view—magnified 40 diameters.
Fig. 102. Apterous sexupare, dorsal view—magnified 40 diameters.
Fig. 103. Apterous sexupare, antenna—magnified 250 diameters.
Fig. 104. Sexual female—magnified 200 diameters.
Fig. 105. Sexual female, antenna—magnified 500 diameters.

PLATE XIII

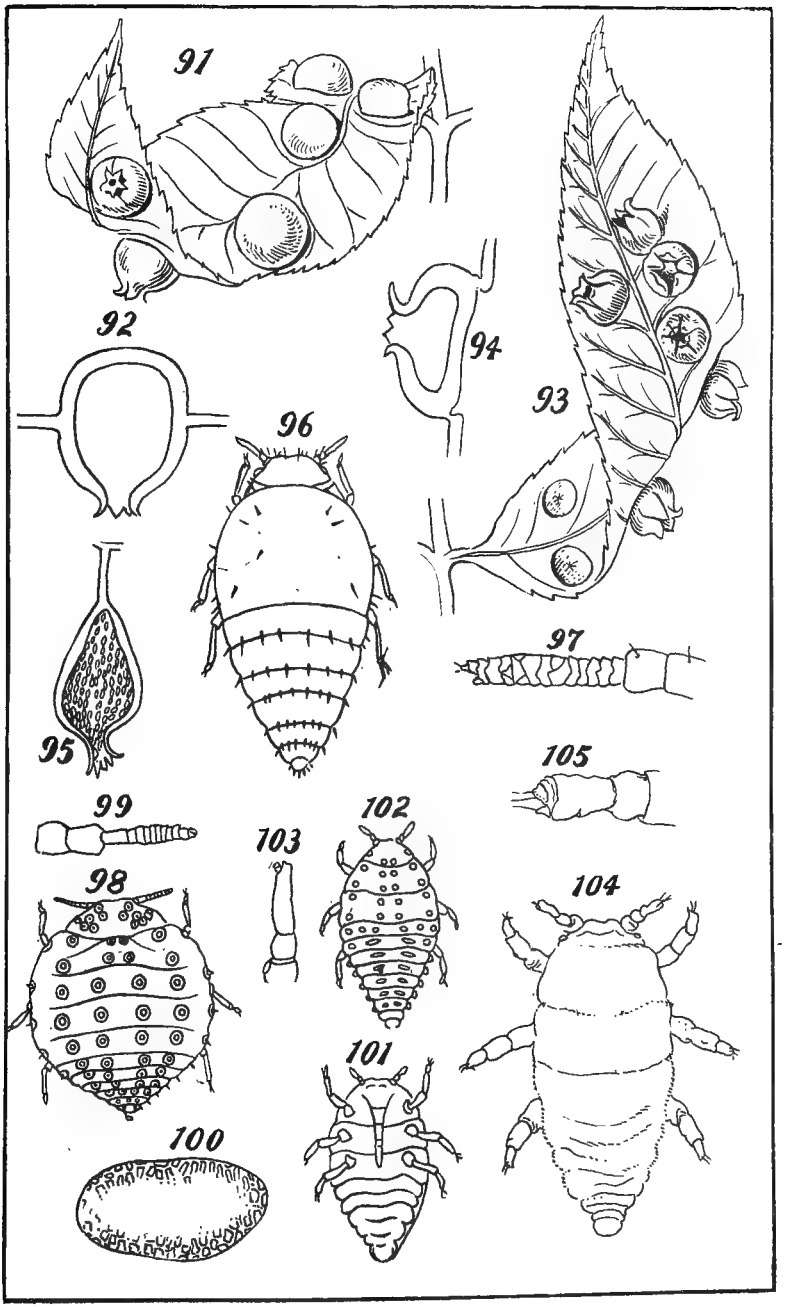


PLATE XIV.

Phylloxera c.-caulis Fitch.

Fig. 106. Old galls of various forms—natural size.

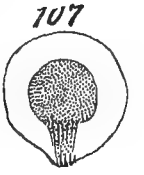
Phylloxera c.-magnum Shimer, var.:

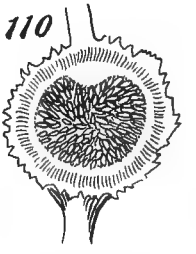
Fig. 107. Mature gall, vertical section—enlarged.

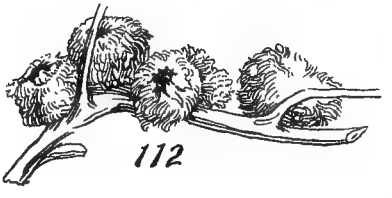
Phylloxera c.-spinosum Shimer.

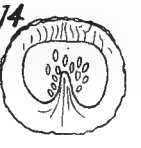
Fig. 108. Young galls—reduced ⅓.
Fig. 109. Young gall, vertical section—enlarged.
Fig. 110. Mature gall, transverse section with arrangement of pupæ—natural size.
Fig. 111. Arrangement of pupæ—much enlarged.
Fig. 112. Variety of old galls—reduced ⅓.
Fig. 113. Variety of old galls—natural size.
Fig. 114. Variety of old galls, transverse section—enlarged.

PLATE XIV









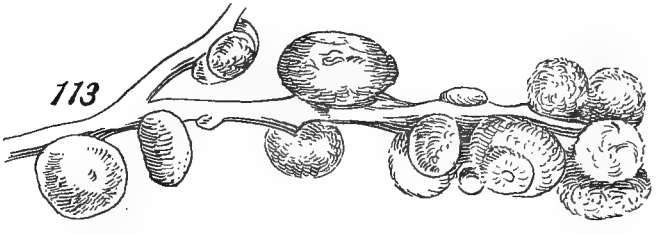


PLATE XV.

Phylloxera georgiana Pergande, n. sp.

Fig. 115. Mature galls; alcoholic—natural size.
Fig. 116. Mature gall, vertical section—much enlarged.
Fig. 117. Antenna of migratory female—magnified 250 diameters.

Phylloxera subellipticum Shimer.

Fig. 118. Immature gall—reduced ⅓.
Fig. 119. Vertical section—reduced ⅓.

Phylloxera perniciosa Pergande, n. sp.

Fig. 120. Young galls on petiole, showing interior of gall—enlarged.
Fig. 121. Young gall, vertical section—much enlarged.
Fig. 122. Mature galls—reduced ⅓.
Fig. 123. Mature gall, vertical section—much enlarged.

PLATE XV

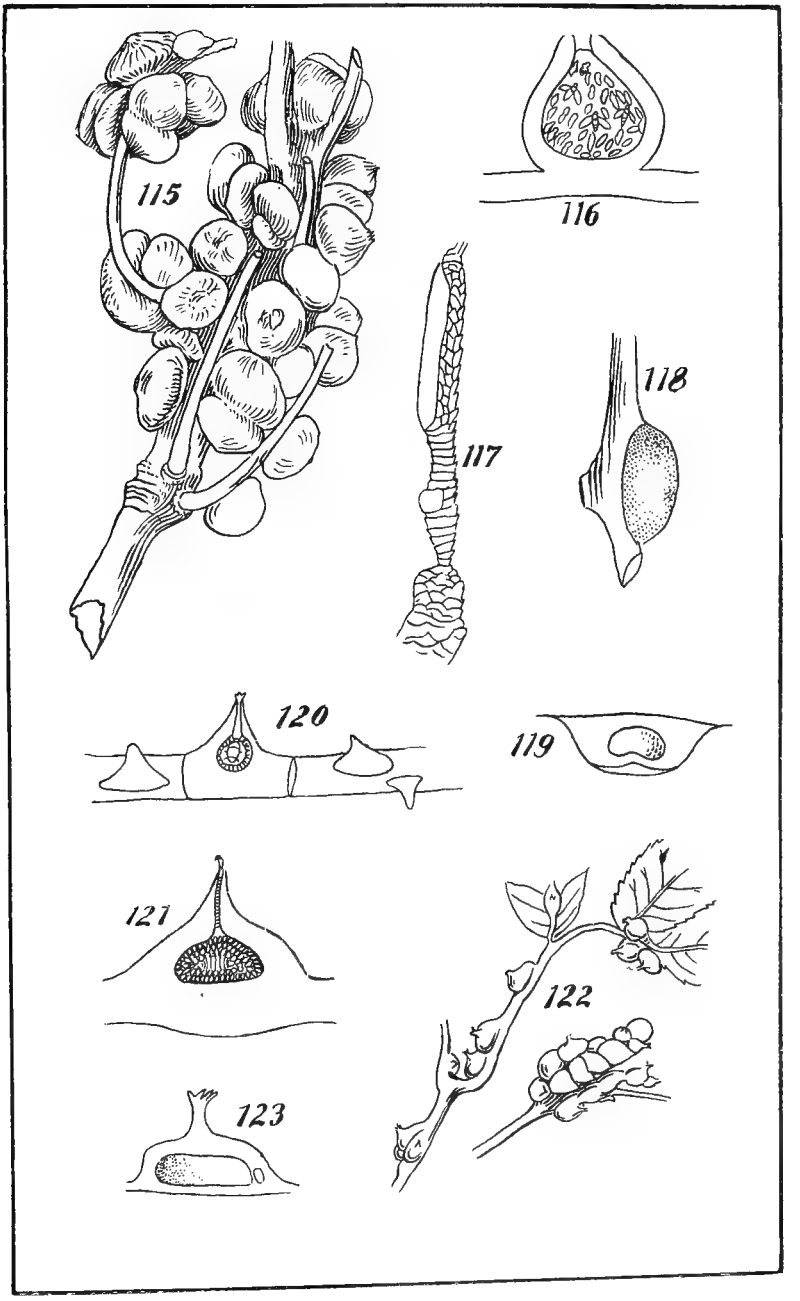


PLATE XVI.

Phylloxera spinosum Shimer

Fig. 124. Migratory female—magnified 40 diameters.
Fig. 125. Antenna of migratory female—magnified 250 diameters.
Fig. 126. Stem-mother—magnified 40 diameters.
Fig. 127. Antenna of stem-mother—magnified 250 diameters.

PLATE XVI

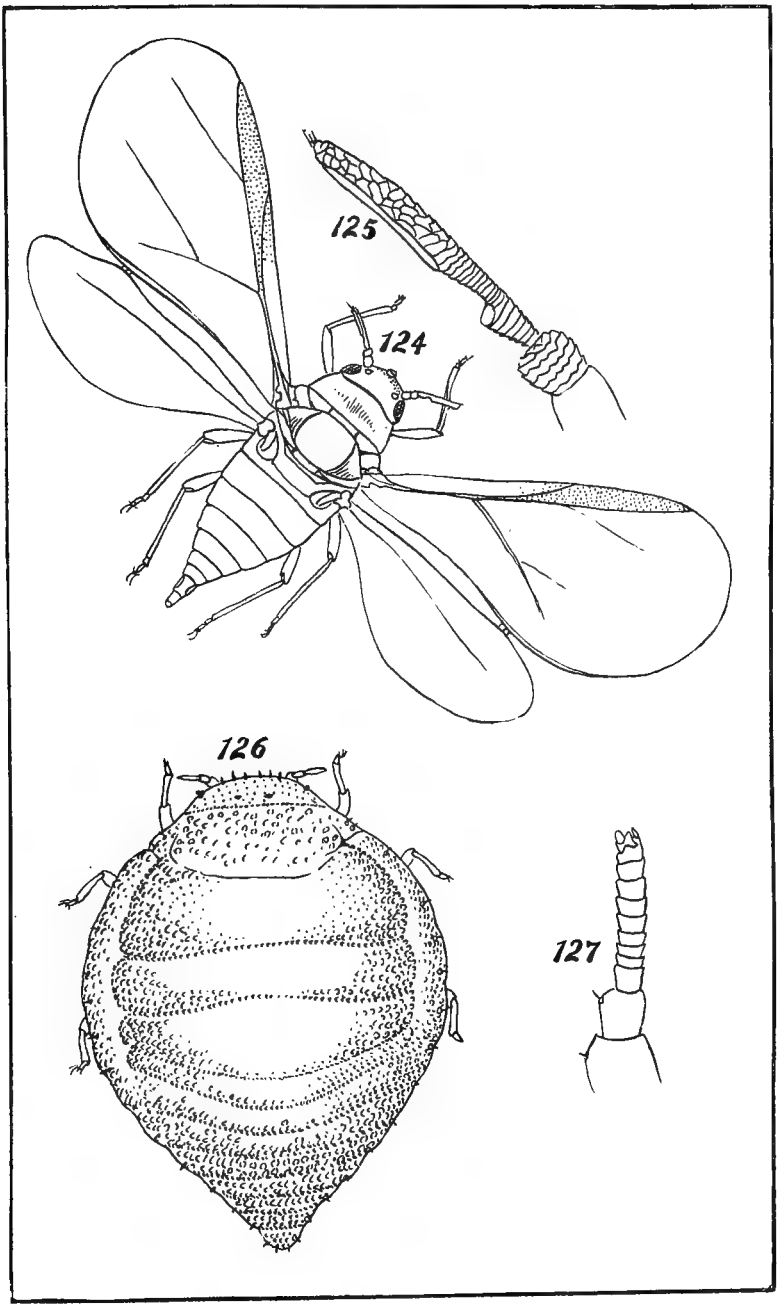


PLATE XVII.

Phylloxera spinuloida Pergande, n. sp.

Fig. 128. Mature gall – reduced ⅓.
Fig. 129. Migratory female – magnified 40 diameters.
Fig. 130. Antenna of migratory female—magnified 250 diameters.

Phylloxera devastatrix Pergande, n. sp.

Fig. 131. Young galls in various stages, showing deformation of flowers—reduced ⅓.
Fig. 132. Young galls, different stages—reduced ⅓.
Fig. 133. Mature galls—reduced ⅓.
Fig. 134. Old galls—reduced ⅓.
Fig. 135. Antenna of migratory female—magnified 250 diameters.

PLATE XVII

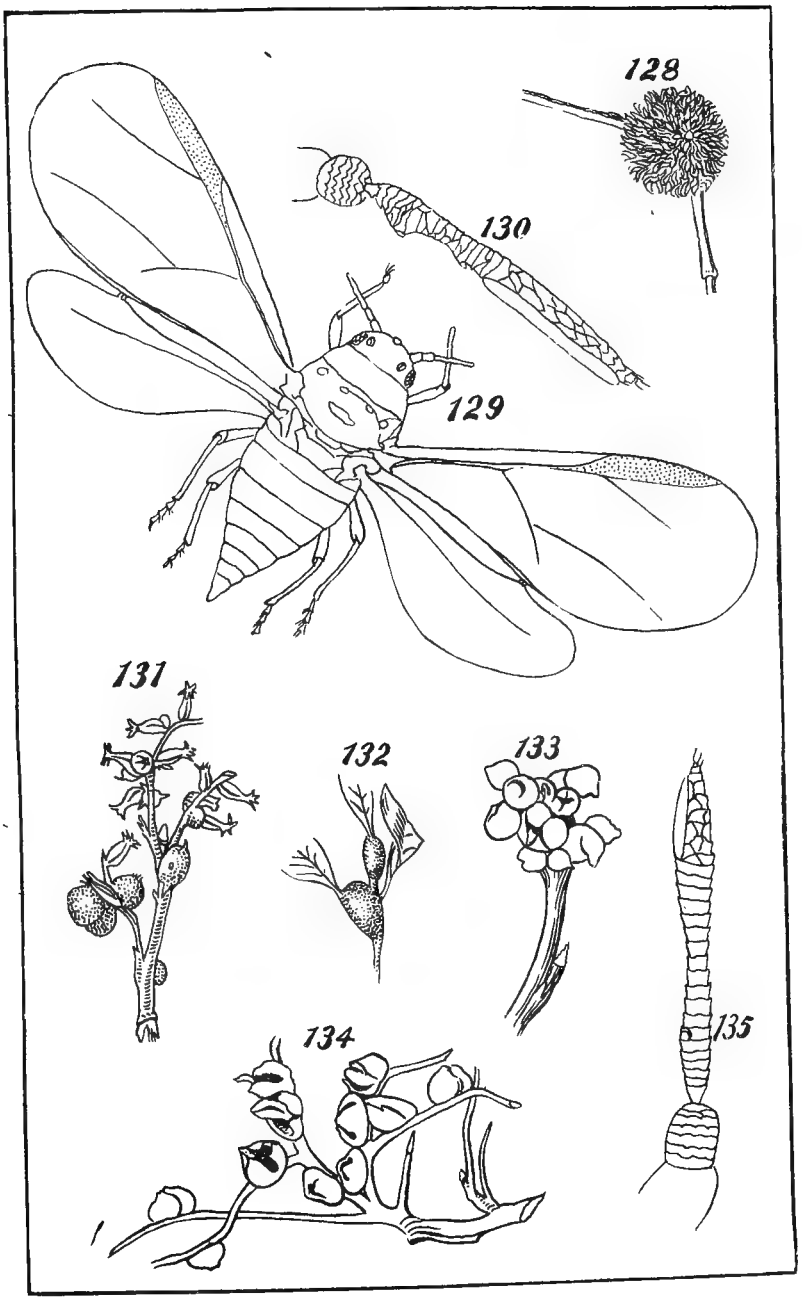


PLATE XVIII.

Phylloxera perniciosa Pergande, n. sp.

Fig. 136. Mature galls, on blossoms—reduced ⅓.
Fig. 137. Young stem-mother, after hatching—magnified 300 times.
Fig. 138. Antenna of young stem-mother—magnified about 500 times.
Fig. 139. Tibia and tarsus of same—highly magnified.
Figs. 140–141. Antennæ of migratory female, showing range of variation—magnified 250 diameters.

Phylloxera c-ren Riley.

Fig. 142. Mature galls—reduced ⅓.

Phylloxera castaneæ Haldeman.

Fig. 143. Apterous female—magnified 40 diameters.
Fig. 144. Antenna of apterous female—magnified 250 diameters.
Fig. 145. Pupa, with short tubercles—magnified 40 diameters.
Fig. 146. Antenna of same—magnified 250 diameters.
Fig. 147. Pupa, with long tubercles—magnified 40 diameters.
Fig. 148. Antenna of same—magnified 250 diameters.
Fig. 149. Migratory female—magnified 40 diameters.
Fig. 150. Antenna of migratory female—magnified 250 diameters.

PLATE XVIII

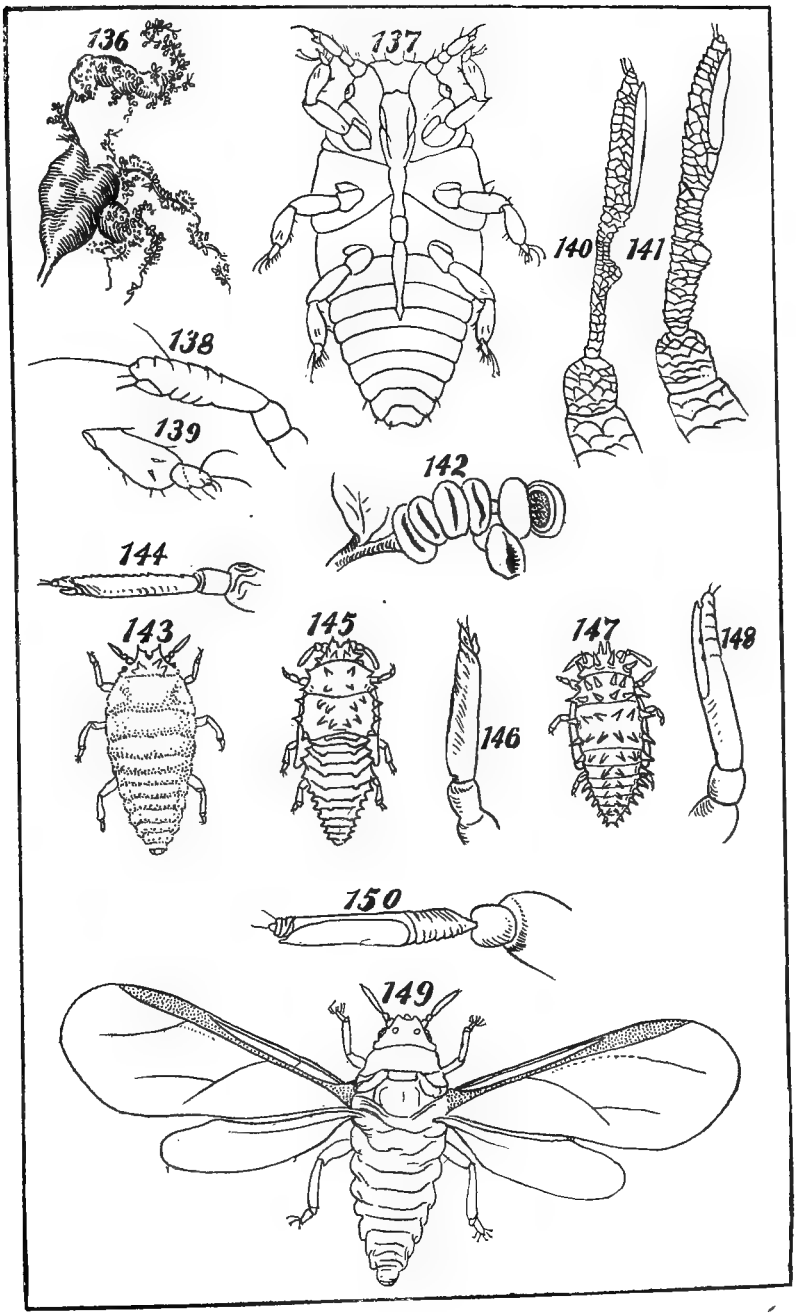
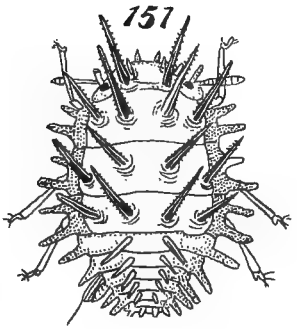


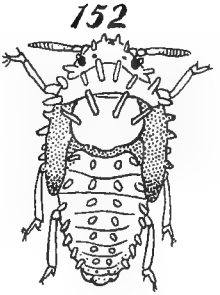
PLATE XIX.

Phylloxera rileyi Riley.

Fig. 151. Apterous female—much enlarged.
Fig. 152. Pupa—much enlarged.
Fig. 153. Migrant—much enlarged.
Fig. 154. Antenna of migrant—greatly enlarged.

PLATE XIX





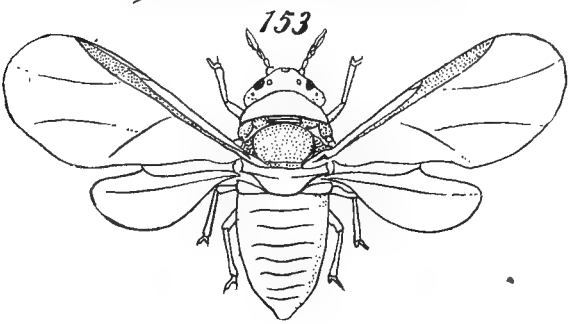
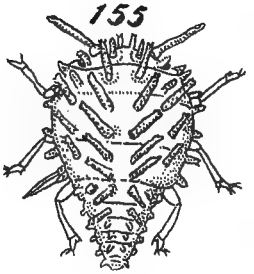


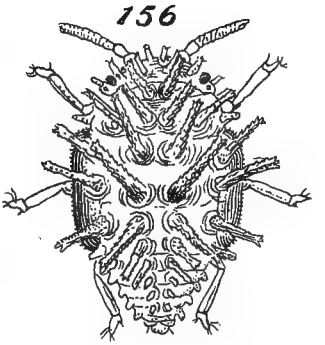
PLATE XX.

Phylloxera querceti Pergande, n. sp.

Fig. 155. Apterous female—much enlarged.
Fig. 156. Pupa—much enlarged.
Fig. 157. Protuberance of pupa—greatly enlarged.
Fig. 158. Migrant—much enlarged.

PLATE XX





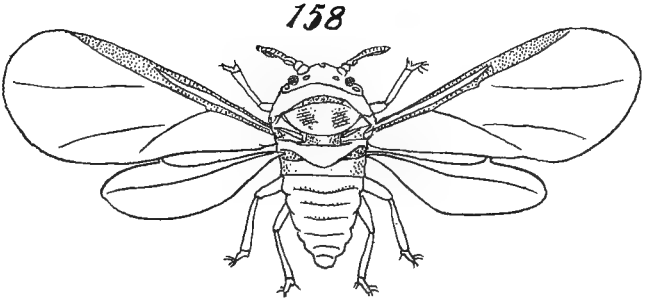


PLATE XXI.

Phylloxera populariæ Pergande, n. sp.

Fig. 159. Apterous female—magnified 40 diameters.
Fig. 160. Antenna of same—magnified 250 diameters.

Phylloxera salicicola Pergande, n. sp.

Fig. 161. Pupiferous female, dorsal view—magnified 30 diameters.
Fig. 162. Pupiferous female, ventral view—magnified 30 diameters.
Fig. 163. Sexual female, ventral view—magnified 100 diameters.
Fig. 164. Male, ventral view—magnified 100 diameters.
Fig. 165. Antenna of pupiferous female—magnified 250 diameters.
Fig. 166. Tip of antenna of pupiferous female—magnified 400 diameters.
Fig. 167. Antenna of sexes—magnified 400 diameters.
Fig. 168. Pupiferous females in position—natural size.

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Fig. 169. Pupiferous female, ventral view—magnified 50 diameters.
Fig. 170. Sexual female, ventral view—magnified 50 diameters.
Fig. 171. Male, ventral view—magnified 50 diameters.
Fig. 172. Antenna of pupiferous female—magnified 150 diameters.
Fig. 173. Antenna of sexual female—magnified 150 diameters.
Fig. 174. Antenna of male—magnified 150 diameters.

PLATE XXI