

SOME PEMPHIGINÆ ATTACKING SPECIES OF POPULUS IN COLORADO.

By C. P. GILLETTE.

Thecabius populimonilis Riley.

This species was described by Dr. Riley, who recorded it from Greeley, Colorado, and from southern Kansas. He described the alate female of the second generation taken during July, and said that it always occurred solitary in the galls. The description fits the examples that we have taken during the same month.

Thomas in his *Eighth Report as State Entomologist of Illinois*, page 205, copies Riley's description, but adds nothing to it.

Oestland in his *Synopsis of the Aphididæ of Minnesota*, page 24; and Packard in his *Forest Insects*, page 434, list this species.

Cowen in Bulletin 31, Colorado Experiment Station, page 116, listed this species as occurring at Fort Collins and Hotchkiss in Colorado, the latter place being on the western slope of the Continental Divide. Cowen also stated that only one louse seemed to reside in a gall.

Hunter lists this species in his *Aphididæ of North America*.

In the *Journal of Economic Entomology* for 1909, page 356, the writer recorded what seemed to be this species infesting the margins of the leaves of *Populus trichocarpa* at Portland, Oregon, and observed that there was but a single large louse in each gall, all of which were becoming winged, and that the young of these lice were migrating to the young leaves as soon as born, where they were forming new galls for themselves.

In 1910, the University of Nebraska published a manuscript on the "Aphididæ of Nebraska," which included notes on this family prepared by the lamented Thomas Albert Williams, which again copies the original description and extends the range of this species to Squaw Canon, Sioux County, Nebraska, and credits Professor Bruner with recording the species in Idaho and Utah.

Dr. Edith M. Patch, in Bulletin 213 of the Maine Experiment Station (June 1913) has extended the habitat of this insect to the cotton woods of Maine, where she has taken the galls and their inmates upon the leaves of *Populus balsamifera*.

In this Bulletin Dr. Patch has evidently overlooked the fundatrix or stem-mother and her gall, and has described an apterous second generation female instead.

The fundatrix of this species is undescribed and apparently has been unrecognized until the present year (1913).

On June 4, 1910, Mr. L. C. Bragg took a leaf of *Populus angustifolia* bearing the fundatrix gall, but its identity was not suspected until the gall (Plate I, figure 1) was discovered by the writer the past summer and associated with the production of the galls at Manitou and Colorado Springs on June 25th. At these places the galls were taken just as the second generation lice were beginning to leave the galls, which they do soon after birth, to go in search of the very young tender leaves at the tips of the twigs, upon which they locate, one in a place, along a line about midway between the midrib of the leaf and one of its margins, on the under side. The small galls on the tender new leaves were first seen, and a search for the source of the lice producing them resulted in the discovery of one of the pocket-like galls containing the fundatrix and a few of her newly born young, on a full grown leaf well down on the stem. This quickly solved the mystery as to the source of the lice that were producing the galls on the tender new leaves. In the next two hours a handful of these galls with their inmates were collected, and they were located in nearly every case by first finding the galls on the terminal leaves. At this time, most of the stem mothers had not begun to give birth to the young gall makers at Manitou.

The fundatrix gall, Plate I, figure 1, is very similar to the somewhat smaller galls of the later generations, (figures 9 and 10) averaging about 10 mm. in length, and is closed except for a narrow longitudinal slit opening below, which allows the young to escape as they are born. None of these young stay to feed with their mother in the gall.

Description of Fundatrix, Plate I, figure 2.

General color, slatey gray, due to a white powdery covering everywhere upon the surface of the body, without cottony threads, or with a few, only, about the lateral and posterior margins of the body. Beneath the powder, the body is of a dull, yellowish, olive green; head legs and antennæ blackish; body about 3.50 long by 2.25 broad; antenna (figure 3), .52; hind tibia, .45, hind femur, .55; beak very short, not attaining the second pair of coxæ; joints 3 and 5 of the antenna sub-

equal; joint 4 shortest; joints 1 and 2 and 4 about equal; 1 and 2 together about as long as joint 3; permanent sensoria only, and these are surrounded with cilia.

Described from specimens taken at Manitou and Colorado Springs, Colorado, June 25, 1913, by the writer.

Alate Fundatrigenia.

This seems undoubtedly to be the form originally described by Dr. Riley, and is distinguished by the sensoria of the antenna in his drawing. Riley shows three transverse sensoria on joints 4 and 5, and this is the common number in the examples we have had for study, while in the later and smaller winged sexupara there are usually no sensoria on joint 5 but the permanent one. On joint 3 (figure 4) there are from six to nine, usually seven or eight, sensoria present and there are three to four, usually three, on joint 4; two to four on joint 5, but usually three; none but the permanent sensorium on joint 6; and a well developed spine near the base of joint 3. Our examples differ from those described by Riley by being somewhat larger, as indicated by the alar expanse, which, in our examples, varies little from 9 mm.; and in the length of the body, which, in our examples, measures from 2.75 to 3.00.

The Apterous Fundatrigenia.

What I take to be this form are light cinnamon brown in color with head and tarsi black and with more or less darkened antennæ and legs. Length, 3.00; width, 1.90; antenna, .60; hind femora, .55; tibia, .45; beak very short, not reaching the second pair of coxæ; joints 1 and 2, and 4 and 5 of the antenna (figure 6), sub-equal; joint 6 longest; joint 3 nearly as long as joint 6 without the spur; joints 4 and 5, swollen and somewhat bead-like in appearance; permanent sensoria with cilia about their margins.

Described from specimens taken in the foothills near Fort Collins from July 19th to August 14th, and at Manitou August 9th.

On August 9th, I spent the day at Manitou studying this louse. The mature galls that were occupied were found inhabited in each case by one apterous female, probably a *fundatrigenia*; a few, 6 to 10, growing larvæ and pupæ, and a small number of first instar lice; some of the last were migrating to terminal leaves and forming new galls just as the young from the stem-mothers did earlier in the season. The partly grown lice that were staying with the gall-mothers seemed all to be developing into winged individuals. All that were half grown or more gave plain evidence of this, and in one gall I found a winged adult with the apterous mother and numerous pupæ and young lice. The alate louse was a sexupara and is like the many mounted specimens that we have of this form taken in former years and again this year, late in the season.

After about the 10th of August, these alate sexupara have been common in the galls at Boulder, Fort Collins and Manitou, being still common in the galls at the last named place as late as September 20th, when there were still many larvæ and pupæ.

It is difficult to account for all the gall-mothers being apterous in August and September, when we thought that all we had noticed early in the season were winged or pupæ and solitary in the galls. Probably the explanation is that the late part of the second generation, the young from the stem mother, were apterous and remained to give birth to the two forms that occur in the galls from about the last of July on through the summer. These apterous gall mothers are certainly the parents of the alate forms (sexupara) that develop with them in the galls during August and September. The young larvæ were still producing galls at Manitou, August 9th and I found very young galls as late as September 20th at Manitou this year. .

Late Apterous Form.

Described from specimens taken at Boulder, August 31, 1913, by L. C. Bragg, and at Manitou, September 20 by the writer.

Upon some of the sprigs brought from Boulder young lice were still locating on tender new leaves at the tips of the twigs for the formation of new galls, though on most of the twigs terminal buds had formed. Most of these galls contained a single apterous female that was readily distinguished from the other lice in the gall by its being more orange yellow in color. I found from eight to fifteen lice in each gall, staying with their apterous mothers. The former were in many instances, adult, and always winged when fully grown, and were also all sexupara. These gall mothers were still giving birth to a few of the dark colored young that migrate from the parental gall to form new galls on the tender leaves.

The adult apterous females in these galls were different from those found at Manitou and Boulder earlier in the year, by being much smaller and by having five jointed antennæ (figure 7) instead of six in all of the many specimens examined, the fourth joint being short and bead-like, and the entire antenna very much resembling the antenna of the fundatrix. The earlier form also showed a tendency to combine joints 3 and 4 and become 5-jointed. Length of body, 1.80; antenna, .38; joint 3 as long as joint 5 with the spur; otherwise like the earlier form.

Sexupara.

This form is rather markedly different from the *Fundatrigenia* by being distinctly smaller by having fewer sensoria on the antennæ (figure 5) and by having several lice living together in a gall along with the apterous mother just described.

Length of body, 1.75 to 2.00; wing, 2.60; antenna (figure 5), .60; sensoria:—joint 3, from 4 to 7, but nearly always 5; joint 3, 2 to 4, but nearly always 3; joints 5 and 6 with permanent sensoria only; joint 3, slightly longer than 6, but not as long as joint 6 with the spur included; joints 4 and 5 about equal, permanent sensoria ciliated; sensoria on short transverse lobes or ridges which do not extend nearly around the antennal joints; spur on joint 3 rather weak.

Sexuales.

The alate sexupara begins giving birth to the sexual forms soon after leaving the galls. Those that escaped from the galls collected August 31st, had given birth to many males and oviparous females in the breeding cage September 1st. The females are greenish in color and measure about .90 in length; the males are pale yellow in color and measure about .60 in length; neither have beaks with which to take food; about 4 to 5 of each are born from one female.

The fact that this species is on the cotton woods from the time of formation of the stem mother gall early in the summer until the developement of the sexupara, it seems strongly probable that this species has no alternate host plant. The sexuales must be deposited upon the cottonwood or the stem mother could hardly be upon the leaves of these trees early in the spring.

SUMMARY OF LIFE HISTORY.

From all the data that we have been able to gather to the present time it seems probable that the life history of this species is about as follows:

The fundatrix hatches upon the cottonwood in the spring from eggs deposited upon these trees the previous fall. These stem mothers locate between the midrib and the margin of one of the early developing leaves and produce almond shaped galls similar to those that are produced on the terminal leaves, by their descendants, later in the season. From this stem-mother gall, the young escape almost as soon as born and locate on the tender new leaves, as did their mother, between the margin and midrib, each louse being solitary and producing an almond shaped gall. Apparently the lice of this second generation all become winged at first, it is certain that many do, and leave the galls, while a portion, especially of the later lice that are born, remain apterous, stay in the galls, and give birth to a third generation. These young, like the young from the stem mother, also migrate to the new leaves to continue the production of galls, each of which harbors but one louse at first, but a portion of the young of this brood remain with the mother in the gall

and become winged sexupara, of which ten to twelve may be found in a single gall with the parent. These winged sexupara begin to emerge in the vicinity of Fort Collins about the first week of August and continue to emerge till the last of September and soon give birth to the sexual forms.

The apterous females (*fundatrigenia* or *virgogenia*), occur in leaf galls, at least from about July 17th to September 20th, a portion of their young also staying in the galls with them and becoming sexupara, and a portion migrating as soon as born to form new galls, as late as September 1st. If this interpretation is correct, the alate fundatrigenia in this species seems only to distribute the species from one tree to another, but we have no observations that fully confirms this hypothesis. *The Galls.* (Figures 1, 9, and 10.)

Throughout the summer the galls are started upon the very tenderest young leaves only, by first instar lice which locate on the ventral surface of the leaves. There may be from one to a large number of these galls on the leaves, the entire surface of the leaf being included in gall development very often when the lice are abundant. The galls are paler green than the remaining portions of the leaves; are long oval in general form; commonly 6 to 8 mm. in length, but may be as long as 10 mm., and always upon the upper or dorsal surface of the leaf.

While it is common to find these galls abundant upon the narrow leaved cottonwood, *Populus angustifolia*, in Colorado, we have never taken one of these galls on any of the several varieties of broadleaved cottonwoods which are more common. It is entirely possible, therefore, that the specimens recorded in this paper from other states may belong to a distinct species. The galls sent from California by Professor E. Bethel, George P. Weldon, and A. C. Maxson; from Maine by Doctor Edith M. Patch; from Michigan by Professor R. L. Pettit, and those taken by the writer at Portland, Oregon, were all from broad leaved cottonwoods. On the broad leaved cottonwoods, the galls are usually placed near the leaf margin so that the long diameter of the gall is parallel with the leaf margin.*

*Since writing the above paper Mr. George M. List has collected additional material of this species for me at Manitou, on October 18th. Some of the galls taken on this date still contain the virgogenia and alate sexupara as described above and many sexual males and females. Probably it is only the belated sexupara that deposit their sexual young in the galls. This completes the round of development on the cottonwood except for the egg stage, which doubtless occurs on this tree, also.

The specimens of this species in the collection have been taken as follows.

FUNDATRIX.

Manitou, Colo.,	6-25-13	<i>Populus angustifolia</i>	C. P. Gillette
Colorado Springs, Colo.	6-25-13	" "	C. P. Gillette

FUNDATRIGENIA

Horsetooth Mountain	8-8-09	<i>Populus angustifolia</i>	M. A. Palmer
Spreckles, Cal.	7-27-13	" <i>fremontei</i> (?)	A. C. Maxson
Fort Collins, Colo.	8-11-12	" <i>angustifolia</i>	L. C. Bragg
Fort Collins, Colo.	8-11-13	" "	" " "
Vanderbilt, Mich		" <i>candicans</i>	R. L. Pettit
Boulder, Colo.	8-14-12	" "	L. C. Bragg
Sacramento, Cal.	8-1-13	" <i>fremontei</i>	E. Bethel
Horsetooth Mountain	7-19-09	" <i>angustifolia</i>	M. A. Palmer
Boulder, Colo.	8-25-12	" "	L. C. Bragg
Manitou, Colo.	8-9-13	" "	C. P. Gillette
Boulder, Colo.	8-31-13	" "	L. C. Bragg
Manitou, Colo.	10-18-13	" "	G. M. List

SEXUPARA.

Manitou, Colo.	8-9-13	<i>Populus angustifolia</i>	C. P. Gillette
Manitou, Colo.	10-20-08	" "	" " "
Big Thompson Canon	9-18-10	" "	" " "
Boulder, Colo.	8-31-13	" "	L. C. Bragg
Manitou, Colo.	10-18-13	" "	George M. List

SEXUALES.

Manitou, Colo.	10-18-13	<i>Populus angustifolia</i>	George M. List.
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Cornaphis, New Genus.

The genus is closely related to *Asiphum* Koch. The wax plates are absent in the fundatrix but are present in the apterous fundatrigenia; the antenna of fundatrix, 5-jointed; of fundatrigenia, 6-jointed; permanent sensoria ciliated. In the type specimens the cubitus is simple, and the fundatrix, fundatrigenia and sexupara all develop in a gall together.

Cornaphis populi, New Species.

Producing galls on leaves of *Populus angustifolia*, which are merely a thickened and extended portion of the margin of the leaf which folds upon the upper surface producing a moon shaped, pod-like gall of a paler green color than the surrounding foliage, and often streaked with red. Galls usually measure from 15 to 18 mm. in length, and are about one-third as thick as the extreme length (figures 11 and 12).

I have never seen more than one of these galls on a single leaf, apparently each gall develops three generations of lice within it, the fundatrix and the fundatrigenia which are apterous, and the sexupara which is alate.

On July 15, 1913, the alate form was just beginning to acquire wings about Laramie, Wyoming. At this time, the fundatrix was still in the galls in a vigorous and active condition.

Description of Fundatrix, Figure 13.

The general color is a slatey gray, the body being covered everywhere with a fine, white powder; the head, four spots in a transverse row on the pro-thorax, the antennæ and legs, including coxæ, black; beak attaining third coxæ; joint 2 of the antenna (figure 15) about three-fourths as long as joint 3; entire antenna, .40 long; apparently no gland plates on any part of the body; permanent sensoria surrounded with ciliary fringe; length of body 2.75. On the vertex, between the insertions of the antennæ, is a slight tubercle, which is not very prominent in the fundatrix.

Fundatrigenia, Figure 14.

Apparently the young of the Fundatrix are all apterous, and their offspring, the third generation, all alate sexupara. The other possibility would be for the stem mother to give birth to two sets of offspring, the earlier ones being apterous individuals which later give birth to the sexupara, and the later ones developing into sexupara directly, which does not seem at all probable.

The adult apterous fundatrigenia is of a light straw yellow color and more or less covered with white powder, but there seem to be no tufts or patches of the waxy secretion upon the body; head including a prominent frontal spine, eyes and tarsi blackish; dorsum of head, usually four patches on the pronotum in a transverse line, legs and antennæ dusky brown; beak attaining third coxæ; antennæ (figure 16) 6-jointed; third joint longest but barely exceeding joint six with the spur; joint 4 shortest, being about half as long as 3; length of body 2.50; antenna, .62. This form lives in the gall with the stem female and other descendants of the year.

Described from specimens taken at Laramie, Wyoming, July 15, 1913.

Sexupara.

General color, pale greenish yellow, with dusky head, antennæ and tarsi; thorax a little darker than the abdomen, length 2 to 2.25; length of wing 2.75; length of antennæ (figure 17) .90; median ocellus on a rather prominent tubercle, cauda broadly oval; joints of antenna about as follows: third joint longest, a little shorter than 4 and 5 together; joint 4 a little shorter than 5; joint 6 without spur equal to joint 5; sensoria very indistinct; about 3 to 5 broadly oval sensoria on the distal one-third of joint 3, one near the distal end of joint 4, and also the permanent sensoria on joints 5 and 6; cilia about permanent sensoria rather weak, but always present. The examples studied seem each to be able to give birth to about twelve of the sexuales.



Gillette, C. P. 1913. "Some Pemphiginae attacking species of Populus in Colorado." *Annals of the Entomological Society of America* 6, 485–493.
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