

OBSERVATIONS ON *LECANIUM CORNI* BOUCHE, and
PHYSOKERMES PICEÆ Schr.*

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The following studies on the life history and habits of two of our common soft scale insects were made at Madison, Wisconsin, under the direction of Prof. J. G. Sanders. The writer is greatly indebted to Professor Sanders for invaluable assistance and to Mr. A. A. Girault for the determination of parasites.

THE EUROPEAN FRUIT *LECANIUM* (*Lecanium corni* Bouche).

Lecanium corni, probably native of Europe and one of our commonest and most widely distributed soft scales, has been the subject of much discussion in various scientific and popular journals. Sanders¹ has demonstrated that it is capable of much variation in form, size, and coloration even on the same host, and since it develops on numerous plants it is especially subject to a variety of normal environmental conditions. For instance, on hickory the ovipositing females are almost invariably white with black markings (Plate XV, fig. 2b), instead of the normal brown coloured forms (Plate XV, fig. 2a). Parasitism and disease produce abnormally developed forms, and these as well as immature individuals have been described as separate and distinct species.

History.—This insect was first reported in this country in 1851 when Fitch described it as *Lecanium tilia*². In 1859 it was found in Canada and in the United States as far west as Minnesota³, and in 1891 Crawford found it in large numbers in California⁴. Until 1908 there was much confusion regarding the identity of this species as its numerous synonyms indicate. It was found, however, that while external appearances might be extremely variable, certain microscopical characters remained constant, and Marchal⁵ and Sanders⁶ reduced to synonymy some forty so-called species, the form described by Bouche in 1844 as *Lecanium corni* having priority.

*Contributions from Entomological Department, University of Wisconsin.

1. Sanders, Jour. Ec. Ent., Vol. II, No. 6, pp. 443-445, 1909.

2. Fitch, 4th. Rep. Reg. Univ., N.Y., p. 69, 1859.

3. Fitch, 3rd Rep. Ins., N.Y., p. 50, 1859.

4. Crawford, Rep. Calif. Bd. Hort., p. 12, 1891.

5. Marchal, Ann. Soc. Ent. Fr., LXVII, p. 264, 1908.

6. Sanders, *loc. cit.*
September, 1917

Distribution and Economic Importance.—*Lecanium corni* is found throughout most of the United States and is known to occur as far north as Nova Scotia and Ontario, and south into Mexico. In spite of the wide range of its host plants and its general distribution this insect seldom becomes of economic importance, although serious outbreaks of it have been recorded. In 1891 Crawford⁷ reported its occurrence in California where it had become and still remains a serious pest of apricot and prune trees, and in 1894 Slingerland⁸ found a similar and doubtless the same species occurring in destructive abundance in the larger plum growing districts of New York.

Food Plants.—The European fruit lecanium, as already indicated, has been found on a wide variety of deciduous shrubs and trees, and it has received various popular names in different localities, according to its favorite host plant, being known in New York as the "plum scale," and in California as the "apricot scale". The following list gives an idea of the extent of its food plants.

<i>Aceraceæ</i>	<i>Acer macrophyllum</i>	
	" <i>negundo</i>	Box elder.
	" <i>saccharinum</i>	Soft maple.
	" <i>saccharum</i>	Sugar maple.
<i>Betulaceæ</i>	<i>Betula alba</i>	White birch.
	<i>Ostrya virginiana</i>	Hop hornbeam.
	<i>Corylus americana</i>	Hazelnut.
	" <i>rostrata</i>	Beaked hazelnut.
<i>Caprifoliaceæ</i>	<i>Viburnum pubescens</i>	Pursh.
<i>Celastraceæ</i>	<i>Evonymus sanguinea</i>	Evonymus.
<i>Compositæ</i>	<i>Grindelia</i> spp.....	
<i>Cornaceæ</i>	<i>Cornus alternifolia</i>	
	" <i>sanguinea</i>	
<i>Ericaceæ</i>	<i>Vaccinium corymbosum</i>	High bush blueberry.
<i>Fagaceæ</i>	<i>Castanea dentata</i>	Chestnut.
	<i>Quercus palustris</i>	Pin oak.
	"	Laurel oak.

7. Crawford, *loc. cit.*

8. Slingerland, Cornell Exp. Sta. Bull. 83, 1894.

<i>Hamamelidaceæ</i>	<i>Liquidambar styraciflua</i>	Sweet gum.
<i>Juglandaceæ</i>	<i>Hicoria alba</i>	Shag-bark hickory.
	<i>Juglans cinerea</i>	Butternut.
	<i>" nigra</i>	Black walnut.
<i>Lauraceæ</i>	<i>Sassafras sassafras</i>	Sassafras.
<i>Leguminosæ</i>	<i>Cercis canadensis</i>	Red bud.
	<i>Gymnocladus dioica</i>	Kentucky coffee tree.
	<i>Gleditsia triacanthos</i>	Honey locust.
	<i>Robinia pseudacacia</i>	False acacia.
<i>Magnoliaceæ</i>	<i>Magnolia</i> spp.....	Magnolia.
<i>Oleaceæ</i>	<i>Fraxinus americana</i>	White ash.
	<i>Amelanchier canadensis</i>	Shad bush.
<i>Rosaceæ</i>	<i>Prunus armenieaca</i>	Apricot.
	<i>" cerasus</i>	Cherry.
	<i>" domestica</i>	Plum.
	<i>" " galatensis</i>	Prune.
	<i>Pyrus communis</i>	Pear.
	<i>" malus</i>	Apple.
	<i>Rosa</i> spp.....	Rose.
	<i>Rubus</i> spp.....	Cultivated blackberry.
	<i>Rubus</i> spp.....	" raspberry.
<i>Salicaceæ</i>	<i>Populus</i> spp.....	Poplar.
	<i>Salix</i> spp.....	Willow.
<i>Saxifragaceæ</i>	<i>Ribes</i> spp.....	Currant.
	<i>" "</i>	Gooseberry.
<i>Solanaceæ</i>	<i>Solanum dulcamara</i>	Climbing bittersweet.
<i>Tiliaceæ</i>	<i>Tilia americana</i>	Linden.
<i>Urticaceæ</i>	<i>Celtis occidentalis</i>	Hackberry.
	<i>Maclura pomifera</i>	Osage orange.
	<i>Morus rubra</i>	Red mulberry.
	<i>Ulmus americana</i>	American elm.
<i>Vitaceæ</i>	<i>Vitis</i> spp.....	Grape.

Life History.—*Lecanium corni* passes the winter in the second instar, the larvæ being found attached to the bark, generally preferring the underside of the branch and appearing as small, brown, flattened, oval bodies closely appressed to the surface. The appendages are withdrawn beneath the scale over which a thin, transparent, waxy covering is secreted.

Growth in spring is coincident with the beginning of sap flow, the insects seldom migrating, and within a week moulting for the second time. (Plate XV, fig. 5). Following this the male larva undergoes a series of transformations quite distinct from those of the female.

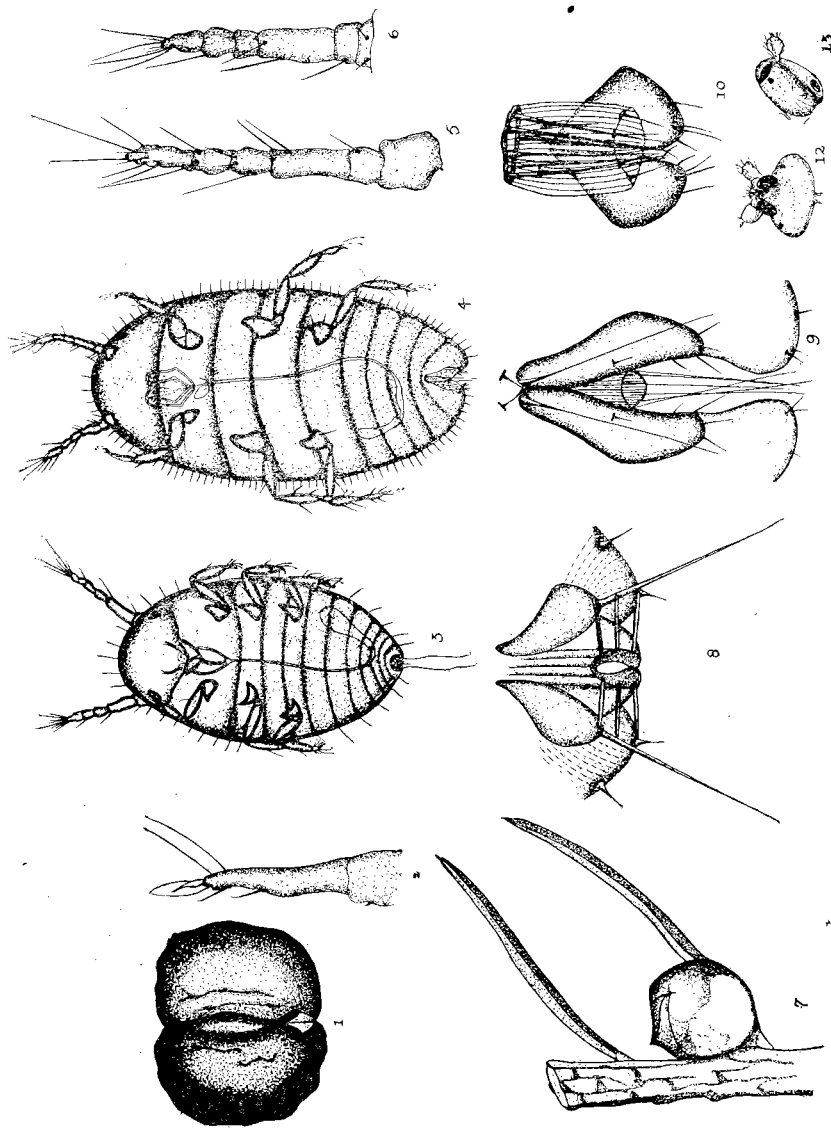
Male.—With the second moult the male enters a quiescent period known as the propupal stage during which no food is taken, and which is characterized externally by the beginning of a wax secretion over the scale or puparium which becomes separate from the insect. All larval appendages are cast off and are replaced by the developing legs and wings of the adult. This period is transitional, seldom extending more than two days.

The true pupa, which is flesh-coloured, may be easily seen beneath the opaque puparium, being distinguished only by the further development of its appendages and by the distinct segmentation of the body. Externally the secretion of wax has continued and the male scales differ from those of the females in their smaller size, more elongate shape, and wire-glassy appearance.

In from three to seven days the final moult of the male takes place within the puparium and is indicated by the wings and developing caudal filaments which often protrude beyond the scale. (Plate XV, fig. 6.) In a few hours after the last transformation the mature insect backs out from the puparium and is ready for flight. It is very delicate and lives but a few hours.

The emergence of the male generally covers a period of four weeks, the date of earliest emergence depending largely on the host species. The first males were bred out from scales collected on linden. They issued from the middle of April till the middle of May. On hickory and bittersweet males did not begin to emerge until the first of May and continued to mature until the middle of June. On elm and white ash they did not begin to issue until late in May, and the last individuals appeared late in June.

Female.—Following the second moult the female increases rapidly in size. Owing to the continued growth the protective wax covering is split and appears as irregular plates on the dorsum. These finally disappear and when mature the female is smooth, broadly oval, and slightly convex, with darker markings plainly visible on the lighter specimens. The comparative size with that of the male is indicated on Plate XV, fig. 1. Several stiff iridescent strands of wax project from the margin of the scale which may function as a secondary sexual character. Shortly after impregnation a chestnut or brown colour prevails, the surface becomes



PHYSOKERMES PICEÆ (Figs. 1-9), AND *LECANIUM CORNI* (Figs. 10-13).

pitted and as growth continues, the body is arched upwards becoming quite convex.

In the latitude of Southern Wisconsin development continues with great rapidity during May and early June, the ovisac becoming distended with eggs. Within three weeks the females stop feeding and a week later oviposition commences. Scattered individuals begin egg laying by May 25 but the majority not until June 11. The eggs are deposited beneath the scale in a cavity or brood chamber formed by the shrinking ovisac, and this process continues until the venter becomes fused with the dorsum. At the end of egg laying the parent insect remains as a mere shell, which acts as a barrier against various egg predators and parasites.

The number of eggs laid by a single female varies considerably and over two thousand have been counted⁹. Small individuals may contain only a few hundred, but the average number is considerably over a thousand.

The oviposition period terminates by the middle of June, and eggs under observation on different hosts began to hatch during the first days of July, although in one exceptional instance one female was found to contain hatching young June 12. July 5 *Lecanium corni* was found hatching on ash, linden and apple, and a few days later on bittersweet. Practically all the young had issued by July 1 in spite of the fact that the dates of oviposition extended nearly a month. The young remain under the old scale until it becomes loosened, which is usually about five days from the time the first eggs hatch. This short period of rest is not essential to the life of the insect, and when a scale is removed from hatching young they immediately migrate to the leaves. They generally settle on the underside and when numerous attach themselves along the principal veins, where they remain until autumn.

Just before the leaves fall the immature scales migrate back to the bark, having moulted once. The percentage of those successful in re-establishing themselves in this way is not known, and it is possible that many are distributed to different hosts by the scattering of the leaves.

Description.—The eggs are oval, and protected by a powdery wax deposit, measuring .246 mm. by .112 mm. They are pure

9. Lowe, V. H., Rep. N. Y. State Exp. No. 14, 1895.

white when laid, but change to cream yellow previous to hatching.

The young larvæ measure .37 mm. in length and .135 mm. in width and are pale yellow, with eight distinct abdominal segments, but with no definite body divisions. The antennæ are short, six segmented, with numerous long setæ. Two anal plate spines are conspicuous, being about one-third the length of the body. After settling the insects assume a transparent green colour and are practically invisible on the surface of the leaf.

The second stage larva is distinguished microscopically from the first by the absence of the major apical setæ which disappear at the first moult. Upon migrating to the bark the green colour is replaced by brown. In this stage two sizes become differentiated, the larger measuring about one mm. in length, and the smaller .7 mm.

The puparium is a rather elongate oval structure 1.5 mm. in length and .75 mm. in width, the white, glassy colour sharply contrasting with the bark. It is slightly convex and is adorned by two longitudinal and two transverse white lines. (Plate, XV, fig. 6.) These scales are fragile and the empty ones are easily dislodged, seldom being found later in the season.

The adult male is a small, brown, two-winged insect $1\frac{1}{4}$ mm. in length, with a wing expanse of 4 mm. and having two long, white caudal filaments. The antennæ are relatively large, eight segmented, and densely clothed with hairs. The head is provided with six ocelli, one pair being located ventrally and two dorsally. (Plate XVI, figs. 12 and 13.) The wings are clouded with a tinge of brown and no halteres are present. There are six segments in the abdomen which terminates in a large style at either side of which are secreted the two long wax filaments.

At maturity the female is a smooth, brown hemisphere, and is incapable of locomotion, the appendages having been greatly outgrown by the swollen body which is fastened to the bark by a deposit of wax. (Plate XV, fig. 3.) Microscopically the anal plates (Plate XVI, fig. 10) are conspicuous and obtusely triangular, having eight anal ring setæ, four fringe, two sub-apical, and eight apical setæ. Fully mature females still possess the appendages though in an atrophied form, and may measure from 3 by 2 mm.

to 7 by 5 mm. During oviposition and accompanying the hardening of the derm, the latter becomes perforated with minute openings known as derm pores.

Experiments in host plant transfers.—A number of experiments were undertaken in view of definitely determining whether *Lecanium corni* could be transferred from one host plant to another, and the following table represents the results obtained.

TABLE I.—TRANSFER EXPERIMENTS WITH *LECANIUM CORNI*.

Original host	Number females used	Host transferred to	Date eggs hatched	Date larvæ attached	Number larvæ attached
White ash.....	3	pear	July 7	July 16	several
"	1	apple	"	"	"
"	1	elm	"	"	"
"	1	plum	"	"	"
"	2	sour cherry	"	"	"
Climbing bitter-sweet.....	several	apple	"	July 17	"
Elm.....	"	"	"	"	"
Linden.....	"	"	"	"	"
Kentucky coffee tree.....	"	"	"	"	"
Pear.....	"	"	"	"	"
Plum.....	"	"	"	"	"
Black locust.....	"	"	"	"	"
Plum.....	"	pear	"	"	"
Linden.....	"	"	"	"	"
Elm.....	"	"	"	"	"
Linden.....	"	currant	"	"	"
Ash.....	"	plum	unsuccessful		
Bittersweet.....	"	"	"		
Linden.....	"	ash	"		
Maple.....	"	shag bark hickory	"		

It will be observed that in several instances unsuccessful attempts were made to transfer *Lecanium corni*, but this was due to either parasitism or dislodgement of the females.

Parasites.—The following species of Chalcidoidea were bred from *corni*, which on some trees was badly parasitized and almost exterminated—*Coccophagus lecanii* Le Baron var., *C. cinguliventris* Gir., *C. perflavus* Gir. mss., *Blastothrix longipennis* How., and several male encyrtids. Besides these parasites, *Comys bicolor* How., *Coccophagus lecanii* Fitch, *Euderus lividus* Ashm., and *Aphidius albiceps* Ashm., have been bred from this scale in Michigan.¹⁰ By far the most numerous and effective one in this region proved to be *C. lecanii*, although in California *Comys fusca* How., a species not found at Madison, and probably not occurring in Wisconsin, seems to be the chief check.

Predators.—The maggots of a small fly, *Leucopsis nigricornis* Egger, were observed feeding on the eggs. Two common coccinellid beetles *Hyperaspis binotata* Say, and *Chilocorus bivulnerus* Mulsant, are important enemies, the larvæ feeding on the eggs and young.

Disease.—The adult females are susceptible to several fungous diseases, which with favourable conditions, spread rapidly and destroy many of the insects. *Cordyceps clavulatum* Ellis is the most important of these and was first mentioned as being parasitic on *Lecanium corni* by Pettit in 1895.¹¹

THE SPRUCE SCALE, (*Physokermes piceæ* Schr.).

Physokermes piceæ Schr. is found abundantly on the Norway spruce (*Picea abies*) about the University of Wisconsin campus, and has become a serious pest of this tree. It is especially numerous on the lower branches, many of which are being killed by it, and which are rendered unsightly by a black fungus thriving on the honey-dew secreted by these insects. The heavy honey-dew secretion is also very attractive to flies, and especially honey bees.

History and Distribution.—In 1903 *Physokermes piceæ* was believed to be confined to Europe,¹² and it was not reported in this country until 1906 when it was discovered near Hartford, Connecticut. Since then it has been found in various northern localities as far west as Wisconsin. The following list of American records of its distribution was kindly furnished by Mr. E. R. Sasser, of Washington, D.C., Massachusetts.

10. Lowe, V. H., *loc. cit.*, p. 589.

11. Pettit, R. H., Cornell Exp. Sta. Bull., 97, p. 341, 1895.

12. Fernald, M. E., Mass. Exp. Sta. Bull., No. 88, p. 209, 1903.

Massachusetts				
Amherst.....	<i>Picea abies</i>	June 9, 1908.....	B. N. Gates.	
".....	" <i>menziesii</i>	" 8, 1910.....		
Malden.....	".....	May 25, 1908.....	W. T. Harris.	
Hanover.....	<i>Pinus strobus</i>	Oct. 19, 1912.....	J. W. Hinckley.	
Connecticut				
Hartford.....	<i>Picea abies</i>	June 23, 1906.....	W. H. Patton.	
New Hampshire				
Pike.....	<i>Picea rubens</i>	" 3, 1909.....	E. J. Kraus.	
New York				
Yonkers.....	<i>Picea</i> spp.....	" 15, 1912.....	W. L. Kingman.	
Pennsylvania				
West Chester.....	<i>Picea menziesii</i>	Nov. 28, 1914.....	F. Windle.	
Ontario				
Guelph.....	<i>Picea</i> spp.....	July 14, 1910.....	T. D. Jarvis.	

It is thus an introduced species from Europe, and is dependent on spruce and pine as host plants. It in fact seems to prefer the Norway Spruce *Picea abies*, being found on no other tree in Madison, Wisconsin, although in some instances the infestation was surrounded by different species of spruce.

Life History.—In winter the second stage larvæ are found clustered thickly on the undersides of the spruce needles. They remain dormant until the latter part of March, when they become active and may be observed migrating from one branch to another. This period of spring activity is of short duration and by April the majority have settled on the leaves.

By the middle of April those larvæ which are to develop into females migrate to the twigs. The male larvæ remain attached to the undersides of the needles, where they moult twice during a period of development in which the insect passes successively from a propupal to a true pupal stage beneath the first exuvia which becomes coated with wax.¹³ The adult males issue within two weeks after the twigward migration of the females and fertilization takes place by the first of May, shortly following the second moult of the females.

Female.—The majority of the female larvæ settle in the woody bracts at the bases of the smaller twigs. In this stage growth is at first slow, and tendril-like wax filaments are secreted around the margin of the scale. In two weeks the insects moult for the second and last time, all appendages being lost, a mere globular sac resulting. This change takes place early in May,

13. Henschel, Die Schadl. Forst. and Obst. Ins., p. 511, 1895.

practically all larvæ being in the last instar by May 3. In this month growth is rapid, the females maturing by the first of June. Specimens dissected May 29 were found to contain fully developed eggs.

Oviposition began June 9 at which time large quantities of the honey-dew persisted. As the eggs are deposited the internal structures of the female shrink until the body organs become obliterated and persist as a thin septum dividing the egg chamber into halves. During the development of the insect, the anal cleft lengthens, due to the great enlargement of the body wall, until it comes to lie dorsally. Thus at the end of oviposition the female remains as a hollow sphere, divided internally into two cells closely packed with eggs, the number of which varies from only 12 in small individuals to as many as 227, the average being about 200.

The period of incubation extends for a month and larvæ were observed hatching July 27. At this time they are entirely surrounded by the body wall of the dead female, the anal cleft being entirely closed; but within a week, the mechanical drying and shrinking of the derm causes the cleft to split apart, producing an opening through which the young can pass. The larvæ immediately migrate to the spruce needles upon which they settle, growing slowly and moulting once before autumn.

Description.—The eggs are .4 mm. by .24 mm. and are smooth, ovate and pink in colour. The hatching young (Plate XVI, fig. 3.) are small, red, lice-like insects .5 mm. in length. Microscopically the antennæ are six-segmented, (Plate XVI, fig. 6), and the anal plate is well defined, having the usual major apical setæ, (Plate XVI, fig. 8). No spiracular spines are present in this species although found in others of this genus.

There is little difference between the two larval stages except that microscopically the anal plates are further developed, (Plate XVI, fig. 9). Just preceding the second moult the larva is about 1 mm. in length, (Plate XVI, fig. 4).

The adult female is a brown sphere, averaging from 1.5 mm. to 3 mm. in diameter, (Plate XVI, fig. 3). It presents a very curious appearance when alive, capped with a large transparent viscid globule of honey dew, and clothed basally with a thin sheath of white wax, (Plate XV, fig. 4). During life the body wall is plastic

and adapts itself to the irregularities in the bark, but upon maturing it becomes heavily chitinized and extremely rigid.

The old dead female shells are generally found at the juncture of the twigs in groups of from two to as many as eight. They are of a chestnut brown colour, closely resembling buds, and are dislodged with difficulty, often remaining attached to the bark for several years. Microscopically few structures are visible, the appendages and anal plate having been lost with the second moult.

Parasites.—A parasite seems to have been introduced with the species from Europe and is effective in checking the spread of the scale. This was determined to be a new species and was recently described by Girault as *Holcencyrtus physokermis*. *Cheiloneurus albicornis* How., and several encyrtids were bred from this insect.

A NEW CANADIAN NOCTUID.

BY WM. BARNES, M.D. AND J. MCDUNNOUGH, PH.D.
DECATUR, ILL.

Xylomoia chagnoni, sp. nov.

♂.—Antennæ finely ciliate; head and thorax light ruddy brown, the collar crossed by a black line; abdomen untufted, light ochreous; primaries rather pale ruddy-brown with the maculation not well defined, the most conspicuous feature being a black dash in the sub-median fold connecting the t. a. and t. p. lines; sub-basal line very obscure, angled below costa; t. a. line better defined, faintly geminate, the inner line more or less obsolete, the outer black, with a prominent outward angle below vein 1, preceded by a slight dark shade along inner margin; orbicular and reniform very faint, rather small, the former oblique, the latter defined on its inner edge by a black lunate mark; claviform scarcely visible resting on the black streak in the fold; t. p. line faint; strongly bent out around cell, then rigidly inwardly oblique to vein 1 where it bends outward slightly to inner margin, it is followed by a few dark points on the veins; s. t. line pale, obscure, irregular, defined outwardly by two darker terminal semi-triangular patches, the

September, 1917