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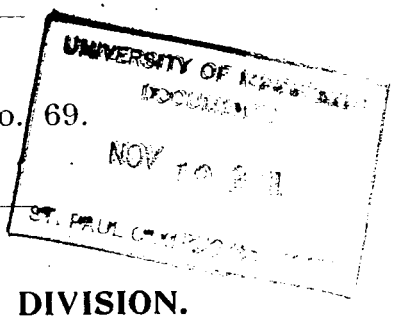

BULLETIN No. 69.

ENTOMOLOGICAL DIVISION.

DECEMBER, 1900.

BUGS

INJURIOUS TO OUR CULTIVATED PLANTS.

ST. ANTHONY PARK, RAMSEY CO., MINNESOTA.

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BUGS

(*Hemiptera*)

INJURIOUS TO OUR CULTIVATED PLANTS.

OTTO LUGGER.

The destructive species of Butterflies, Moths, and Beetles found in Minnesota have been described in previous reports, and especially have those been mentioned which are injurious to fruit-producing plants. In every case a description and an illustration of the culprits was given, as well as the best remedies to counteract their injuries or to prevent entirely losses caused by them. In this report "Bugs" will be considered in the same manner, and to make the report of greater value to farmers and students, the insects belonging to the order of Bugs (*Hemiptera*) will be arranged in such a manner as to indicate their classification as usually adopted. To do this more thoroughly a few only moderately injurious as well as some beneficial species have been included, for it is wise that the fruit-grower and farmer should not only know his enemies, but also his friends, as this knowledge will enable him to combat the former and to protect the latter.

ORDER OF BUGS, PLANT-LICE, BARK-LICE ETC.

(*Hemiptera*).

The perfect, adult, or winged members of this order of insects possess four wings; in one sub-order, (Heteroptera), the first pair of wings are thickened at the base and have thinner extremities, which overlap on the back (Fig. 1); in another sub-order, (Homoptera), the first pair of wings are of the same thickness throughout, and usually slope at the sides of the body (Fig. 2). The mouth-parts are formed for sucking, (Fig. 3), and the metamorphosis is incomplete (Fig. 4).

The *Hemiptera* comprise the insects which are properly called *bugs*. This term, as commonly used, is applied to anything that creeps or crawls, but the entomologist always refers to a member of the order of *Hemiptera* when he speaks or writes of a bug. In the order are included such insects as *true lice, bark-lice* or *scale insects, plant-lice, tree-* or *leaf-hoppers, stink-bugs, chinch-bugs, bed-bugs, electric-light bugs,* and others. Many of these insects are very destructive, and annually cause heavy losses to the fruit-grower and to the farmer. Others are

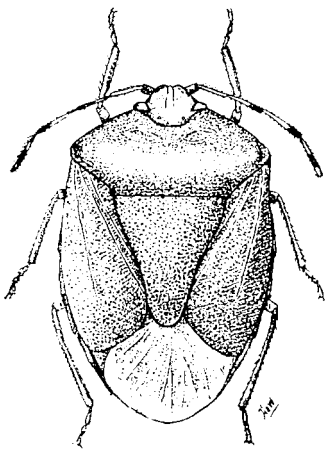


FIG. 1.—A heteropterous insect (*Nezara pennsylvanica* De Geer), with crossed wings. Original.

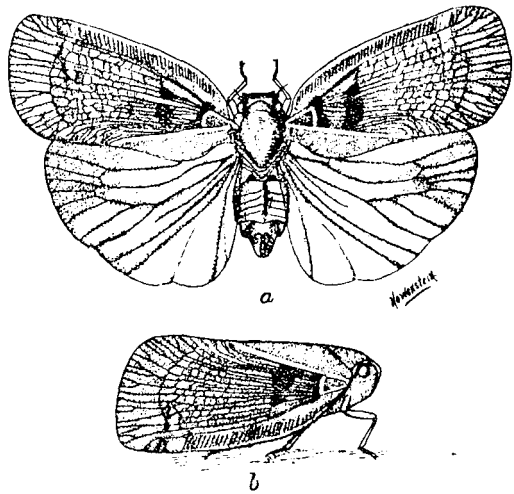


FIG. 2.—A homopterous insect (*Ormenis pruinosa* Say); *a*, with wings expanded; *b*, with folded wings. Original.

beneficial, as they destroy numerous injurious insects, while still others, as the cochineal and lac insects, produce useful materials.

The name *Hemiptera,* which has been selected for this order, has been derived from two Greek words: *hemi,* half; and *pteron,* wing. It was suggested by the form of the first pair of wings in the true bugs, where the basal half is thickened, resembling the wing-covers of beetles, and where the abrupt terminal half is quite different, being delicate and wing-like. The second pair of wings is thin and membranous; they are used for flight, and are folded beneath the first pair of wings when at rest. The

upper pair of wings are frequently called wing-covers, or *hemelytra,* a name suggested by their structure.

The *wing-covers* furnish characters of importance in classification, and for this reason special names are given to the different parts. The thicker basal portion is composed of two pieces joined together at the sides; one of these, called the *clavus, (cl.)*, is narrower, and is the part next to the scutellum when the wings are closed, Fig 5; the broader piece is the *corium (co.)*. In some families a triangular piece of the terminal part of the corium is separated as a distinct piece, which is called the *cuneus, (cu.)*; in other cases a narrow piece on the costal margin of the corium is separated, which has received the name *embolium, (e.)*. The softer terminal portion of the wing-cover is called the *mem-*

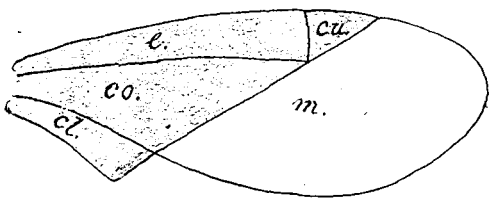


FIG. 5.—Venation of an upper wing of a heteropterous insect. Original.

brane, (m.). All wings are strengthened by veins, which have also received special names not necessary to mention in this report.

There are a number of degraded forms of bugs, degenerated because leading a parasitic life. In these cases, as in the true lice and in the bed-bugs, the wings are not developed, nor would they be of much use to the insects. In fact they would be decidedly harmful in the case of the bed-bugs, who in sparsely populated regions, after leaving one host, would not be likely to be able to find another one. But in cities wings would be a great improvement for bed-bugs, though a step in the wrong direction as far as man is concerned! In some species of aquatic bugs we find adult individuals entirely unwinged, half winged, and with fully developed hemelytra and wings.

The mouth-parts (Fig. 3) of all bugs are formed for piercing and sucking. They appear as a slender jointed beak, starting at the base of a shorter pointed upper lip or *labrum*. But this beak or *rostrum*, usually composed of four joints, never more, is simply a horny, jointed, and tapering sheath, enclosing the true and real mouth-parts. If we dissect the beak, or rather remove

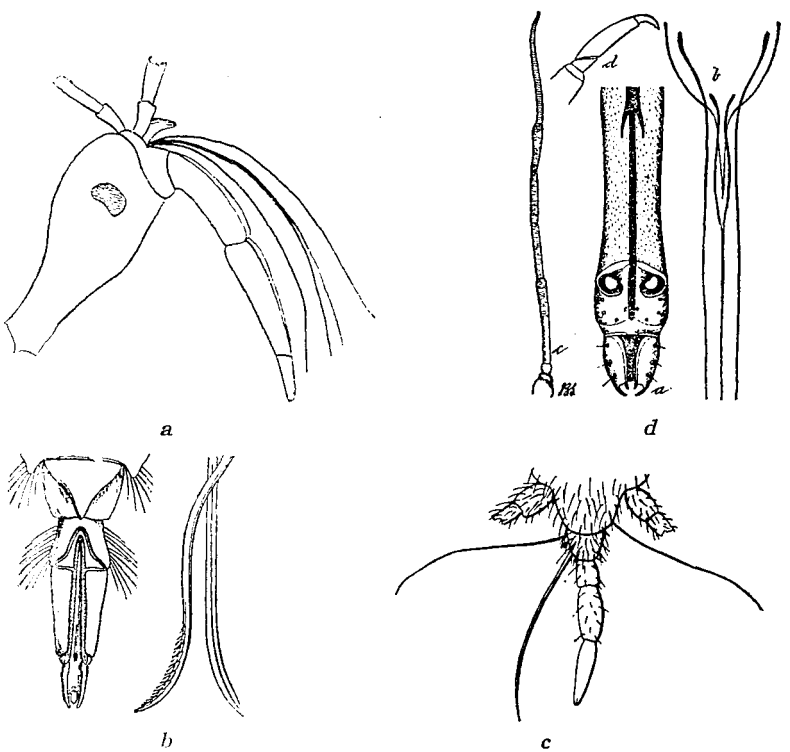


FIG. 3.—Mouth-parts; *a*, of *Reduvius*, from side, after Smith; *b*, of *Notonecta*, after Miall; *c*, of *Bed-bug*, original; *d*, of *Aphis*, after Smith.

it entirely, we can detect four bristles, two of which represent the mandibles, and two the maxillæ. Maxillary palpi are wanting. The four bristles are adapted for piercing the tissues of plants, or the skin of animals. Sometimes the beak is very long and slender, or it is short and thick. The length of the beak depends upon the food-habits of the bug, whether it has to probe deep into the plants, or finds liquid food near the surface.

By means of contractile muscles the liquid nourishment is imbibed. We find, as a general rule, that bugs living upon the sap of plants have a long and slender beak, while those imbibing blood have a stout and shorter one. The *sternum* is so modified that it coincides with the form and use of the beak, since it has to support the movements of the head and its organs.

The Hemiptera are either aerial, terrestrial, riparian, or aquatic. Some live high up in trees, others on the lower limbs and trunks; still others are found among the roots and rubbish on the ground. Many hide among the foliage of plants, among

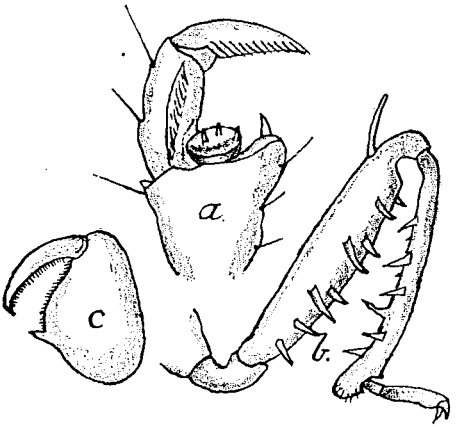


FIG. 6.—Different legs; *a*, grasping claw of *Hog-louse*; *b*, grasping front leg of a *Soldier-bug*. *c*, ditto of *Phymata*. Original.

grasses and herbage, while others skim over the surface of placid waters, or swim below it, coming to the surface only to breathe. A few are found even remote from land, upon the quiet waters of tropical and sub-tropical oceans. But in all cases their legs are adapted to their mode of locomotion.

Some are fitted for leaping, others for running and creeping, and still others for grasping tightly to the objects upon which they rest. Those that creep about in search of living prey are often furnished with curved or hooked fore-legs, suitable for seizing and holding creatures when in motion, such as caterpillars and other larvæ (Fig. 6). The anterior femora of

many kinds which move about on branches and leaves of trees are set with numerous sharp thorns, sometimes in opposing rows; with them they transfix and hold their victims. In the tropics there are many forms in which the hind legs are not alone simply flattened, but are flattened to such an extent as to be transformed into veritable sails.

"The head is either somewhat flat above and extended forwards nearly in the plane of the thorax, with the eyes seated in or next the base; or it is spindle-shaped, long conical, or cylindrical, freely movable, with the eyes placed considerably in advance of the base. In most riparian forms the eyes stand out prominently from the corners of the broad forehead. The aquatic species have the eyes either deep-seated in the basal angles, or projecting like beads on the sides of the vertex. In the Corisæ the head overlaps the front of the thorax like a cap, and is there attached by a slender neck, as in Diptera and dragonflies. Strongly in contrast to all these we find in the principal Homoptera a head either transverse or vertical, deep-seated, immobile, and prolonged downwards and backwards. In such exceptional groups as the Fulgoridæ, the front of the head is either drawn out into a large inflated protuberance, is curved forwards in a long, tapering horn, or it is shaped like an Indian war club. Two, or at most three, ocelli are generally present; but they are absent in certain groups.

"The thorax constitutes a large portion of the mass of the body, and its first principal division is generally free, as in the Coleoptera. All three sections of this part of the body, the prothorax, mesothorax, and metathorax are well distinguished, and are only fused together in such low forms as Aleurodes, Aphidæ, Coccidæ, and the lice.

"To these three pieces the legs are attached, not far out on the sides, as in Orthoptera and Pseudoneuroptera, but beneath, and generally near the middle line. They are fitted for running, jumping, grasping, or swimming; and are often provided with curious balancing plates, curved thorns, waved lamellæ, or rows of spines. The coxæ are also built upon two principal patterns; the one being more or less conical and rotatory, the other more elongated, fixed, and only capable of motion in the direction of

the longitudinal axis of the body. The tarsi have generally three or two joints, rarely only one. Generally there are four wings present, but the posterior pair does not appear in the males of the Coccidæ. The hemelytra and lower wings are developed from the sides of the meso- and metathorax; and in the Homoptera they are generally attached lower down than in the Heteroptera.

"A system of tracheal vessels conveys air to all parts of the body, and communicates with the outer surface by means of openings called stigmata. These openings are provided with a lid or contractile fold, which can be tightly closed to prevent suffocation. In a few of the aquatic forms, *Belostoma, Zaitha,* etc., they are apparently closed, but in reality have slit-like or valvular orifices which serve to strain the air and perhaps to admit only the oxygen that it contains. An air-chamber generally rests beneath each stigmata, and is connected with the others by tracheal tubes running throughout the length of the body on both sides. The stigmata amount in all to ten on each side; a pair is placed on the underside of each of the three divisions of the thorax, generally on or near the transverse sutures; six pairs are set beneath, on the sides of the abdomen, and a pair is placed above next to the suture which separates the thorax from the abdomen. In *Fulgora* and its near allies the latter are very large, but are covered with a whitish fibrous secretion in the living insect. In the higher Heteroptera the abdominal orifices are capped by a little prominence resembling a bead, while in *Notonecta, Corixa,* and some *Cicadas* they are concealed by fur, hairy filaments, or scales. *Ranatra* and *Nepa* possess the usual number of stigmata, but have in extension a pair of long respiratory tubes at the end of the body through which they appear to receive most of the air required.

"A variety of fluids and other substances are secreted by the Hemiptera. Some of these are for the protection of the body or the eggs, as in the Coccidæ; others, perhaps, for defence, as the annoying spray emitted by most of the Heteroptera. In many of the latter a most offensive bug-odor is characteristic of the fluid secreted by glands situated generally in each side of the body behind the mesosterum. Each of these glands com-

municates exteriorly with an orifice placed behind or near the middle coxa, called the osteole, which generally issues in some kind of an open channel styled the osteolar canal, and this is surrounded by a more or less rugged and granulated space, the evaporating surface. The secretion is an ethereal oil variously combined, speedily dissipated in the atmosphere, and often having an odor similar to that of pears and other fruit. In some species of Coreidæ it is decidedly aromatic, and in a few it has a spicy smell very much like that of cinnamon.

"These organs appear to be absent from the Homoptera; but most Cicadas secrete a powdery substance, scales, or hairy patches from the under side of the body, while the Fulgoridæ become covered beneath and on the end of the abdomen with a cottony or fibrous white substance. Some of the Coccidæ secrete wax or lac, and others various kinds of valuable dyes. The functions of nutrition are performed by a well-defined system of organs, of various forms, and often of remarkable complexity. Behind the mouth a short, distinct throat receives the fluid from two pairs of ducts connected with the salivary glands. From this the stomach is continued by an intestine-like tube, swollen in two or more places, until it reaches the vent. The first stomach, or gizzard, is a large, straight, frequently constricted glandular sac, narrowed behind into a long flexed or convoluted canal (duodenum), also glandular, and dilated posteriorly into the chylific stomach; this is often continued backwards as a slender intestine (ilium), emptying into a colon-like expansion that terminates with the corespondingly wide rectum. Both of the intestinal parts of this organism are sometimes reduced to mere peduncles of the three pouched dilatations.

"Most of the eggs of the higher Heteroptera are ornamented with bands, or other patterns of color, and many of them are fluted, beaded, ribbed, etc. They are also capped by a toothed and movable lid, provided with a ligamentous spring to aid the emergence of the larva. (Some eggs are shown in the illustrations showing the various stages of these insects.) The number of eggs laid by a single female varies also, not only with the species, but in the individuals. Some have been known to lay as few as twenty-five eggs, while the female Cicada sometimes deposits more than five hundred.

"Although these insects are not so numerous in species as the Coleoptera, Diptera, or Hymenoptera, they far outnumber the Orthoptera and Neuroptera, and possibly also the Lepidoptera. A large proportion of them have sober colors, agreeing well with bark, earth, rock, or other surface upon which they rest, and multitudes are easily overlooked because of their close resemblance to buds, processes, scales, and other objects that surround them; it is these peculiarities which have caused them to be difficult to recognize and have retarded their acquisition. But with the spread of more exact knowledge of their habits, a new impulse has been given to the study of the species, so that every expedition to unexplored regions returns with a quota of previously unknown forms.

FIG. 4.—Stages of growth of a true bug. Original.

"Their metamorphosis (Fig. 4) is incomplete, excepting only the males of the Coccidæ and a few forms closely related to them. After leaving the egg they generally change the outer skin four times, at intervals of a few days each, to become adults. Growth is thereby permitted, the wing-pads and body become one size larger, and there is only a slight difference to be noticed between the young and the perfect insect. Nothing like the caterpillar stage appears in the newly hatched creature, and there is no such differentiation as marks the larva, pupa, and imago of Coleoptera and the higher orders. The next stage to the adult is commonly called pupa, or nymph, but not because it is in any true sense equivalent to the pupa of other insects."—Uhler.

There are few great groups of insects that display such a wide range and diversity of structure and consequent habits as the Hemiptera, and for this reason it is rather difficult to give a classification. By some authors the order Hemiptera is

divided into two orders of equal rank, but whether much is gained by this operation is doubtful. It seems best to divide it into three well marked groups or sub-orders. Prof. Comstock, who has given much thought to this group of insects, places the *Heteroptera* first, because they resemble the ancient Hemiptera—the first to appear on the earth—more closely than the members of the two other sub-orders. He places the true lice next. These are very much lower in structure than the Heteroptera, but their simplicity of structure is the result of degradation due to parasitic habits, hence represents a later development. They are probably descendants of some ancient form resembling some of the existing Heteroptera. We see in the bed-bug, an undoubted species of Heteroptera, a similar downward tendency due to its parasitic mode of life. The Homoptera, including no doubt also some very primitive forms, show the widest divergence from the hemipterous type.

The three sub-orders can be separated by the following table:

BUGS.

(Hemiptera.)

A. Wingless Hemiptera, parasitic upon man and other mammals, with a fleshy, unjointed beak.....	PARASITA.
AA. Hemiptera with or without wings, but with a jointed beak	
B. First pair of wings thickened at the base, with thinner extremities which overlap on the back; beak arising from the front part of the head.....	HETEROPTERA.
BB. Wings of the same thickness throughout, and usually sloping at the sides of the body; beak arising from the hinder part of the lower side of the head.....	HOMOPTERA.

SUB-ORDER PARASITA.

(True Lice).

Since the sub-order *Parasita* has already been fully described in the Second Annual Report, it is only necessary to repeat the essential features. It includes certain parasites of man and mammals commonly known as lice. They are wingless insects, with

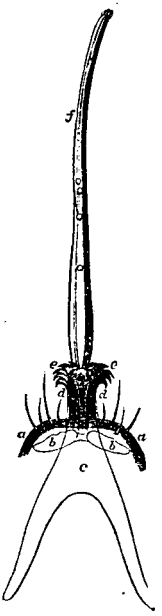


FIG. 7.—Mouth parts of body-louse; *a*, *a*, summit of head with bristles; *b*, *b*, the chitinous band; *c*, hind part of lower lip; *d*, *d*, protruding part of lower lip (*haustellum*); *e*, *e*, hooks turned outwards; *f*, inner tube of suction, with two pairs of jaws shown as lines on the outside, and a few drops of blood in the interior. Greatly enlarged. After Schiœdte.

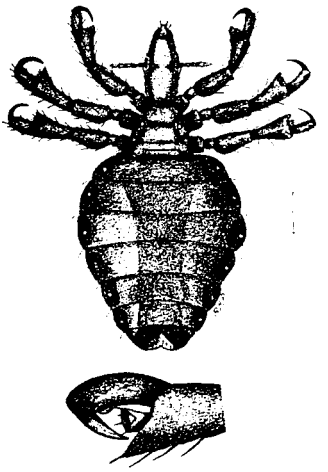


FIG. 8.—Hog-louse, and grasping claw. Original.

a fleshy and unjointed beak, Fig. 7. Only one family (Pediculidæ) occurs, which differs from the order of Mallophaga, or Bird-lice, in that it sucks the blood of its host, and does not eat its skin and feathers by means of a biting mouth.

To show the form of true lice one species is given in the illustration, Fig. 8. In the report mentioned above many remedies were given to destroy the lice on domestic animals. Strong

infusion of tobacco, an ointment made of one part sulphur and four parts lard, Scotch snuff, powdered wood ashes, and kerosene emulsion, thoroughly and repeatedly applied at intervals of three or four days, to destroy the young hatching after the first application, are all good and well tried remedies. Of course cleanliness is all important, and the stables should be kept scrupulously clean, so that they no longer deserve the name "stables," given now to rather unclean outhouses.

SUB-ORDER HETEROPTERA.

(True Bugs).

The term *Heteroptera* is composed of two Greek words, *heteros* diverse, and *pteron,* a wing. The name is well chosen, because it expresses the fact already mentioned that the upper wing is composed of two diverse parts, quite different from each other. The sub-order differs from the Homoptera in the composition and position of the wing-covers, and in the direction of the head. The wing-covers are laid flat on the back, and are composed of three well separated pieces, *corium, clavus,* and *membrane,* Fig. 5. All of these parts are modified in a great variety of ways.

The head is placed horizontally, being fastened in a hollow in the anterior portion of the prothorax; the beak is attached to or directly beneath the tip, with the exception that in the Corisidæ the head overlaps the front of the prothorax. The prothorax is a large and free segment, with a distinctly segmented *scutellum.* The head usually carries two *ocelli,* never three, which are situated on the vertex; they are absent in a few genera, and in all of the younger stages.

This sub-order is divided into two great sections, based upon modification of the *antennæ* or feelers. The following synopsis, copied from Prof. Comstock, will assist the reader. As he says, much more thorough study is still needed before a synopsis can be given which is based upon the development of these insects.

SYNOPSIS OF THE HETEROPTERA.

(True Bugs).

The Short-horned Bugs. Bugs with short antennæ, which are nearly or quite concealed beneath the head.

Bugs that live within water.

The Water-boatman, FAMILY CORISIDAE.
The Back-swimmers, FAMILY NOTONECTIDAE.
The Water-scorpions, FAMILY NEPIDAE.
The Giant Water-bugs, FAMILY BELOSTOMATIDAE.
The Creeping Water-bugs, FAMILY NAUCORIDAE.

Bugs that live near water.

The Toad-shaped Bugs, FAMILY GALGULIDAE.

The Long-horned Bugs. Bugs with antennæ at least as long as the head, and prominent, except in the Phymatidæ, where they are concealed under the sides of the prothorax.

The Semi-aquatic Bugs.

The Shore-bugs, FAMILY SALDIDAE.
The Broad-shouldered Water-striders, FAMILY VELIIDAE.
The Water-striders, FAMILY HYDROBATIDAE.
The Marsh-treaders, FAMILY LIMNOBATIDAE.

The Land-bugs.

The Land-bugs with four-jointed antennæ.

The Thread-legged Bugs, FAMILY EMESIDAE.
The Assassin-bugs, FAMILY REDUVIIDAE.
The Damsel-bugs, FAMILY NABIDAE.
The Ambush-bugs, FAMILY PHYMATIDAE.
The Flat-bugs, FAMILY ARADIDAE.
The Lace-bugs, FAMILY TINGITIDAE.
The Bed-bug and the Flower-bugs, FAMILY ACANTHIIDAE.
The Leaf-bugs, FAMILY CAPSIDAE.
The Red-bug Family, FAMILY PYRRHOCORIDAE.

The Chinch-bug Family, FAMILY LYGAEIDAE.
The Stilt-bugs, FAMILY BERYTIDAE.
The Squash-bug Family, FAMILY COREIDAE.

The Land-bugs with five-jointed antennæ.

The Stink-bug Family, FAMILY PENTATOMIDAE.
The Burrower-bugs, FAMILY CYDNIDAE.
The Negro-bugs, FAMILY CORIMELAENIDAE.
The Shield-backed Bugs, FAMILY SCUTELLERIDAE.

FAMILY CORISIDAE.

(Water-boatmen).

The family Corisidæ is the most aberrant family, being composed of insects whose mouth is flattened out, shortened, directed backward beneath, and the rostral setæ thrust through a little

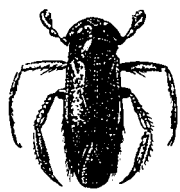


FIG. 9.—*Corisa interrupta* Say. After Uhler.

hole above the actual end of the clypeus, and not, as usual, placed at the tip. Instead of being let into the end of the prothorax, the head overlaps and fits intimately against it, and the fore-tarsi are flattened like the blade of a pen-knife, are set with bristles on the inner thin edge, similar to a comb, and end in a slender nail at the tip. "Uhler." *Corisa interrupta* Say is shown in Fig. 9. All species of Corisa are oval, gray and black, mottled, usually less than half an inch in length. These insects are truly aquatic, but leave the water occasionally; they are attracted in large numbers to the electric light, and make it decidedly unpleasant to persons forced to work near it, for the bugs have the bad habit to be disagreeably inquisitive, and to

be very restless at the same time. They are found in all our rivers and lakes, where they feed upon other insects; they deposit their eggs upon water-plants. In some regions in Mexico these eggs are so numerous that the aquatic plants are gathered, dried, and beaten, so that the eggs can be collected for food.

Few insects are more sprightly, and the aquarium acquires a new interest by the introduction of these easily obtainable creatures. They live on the bottom of puddles, ponds, and running waters, but it is especially of interest to observe their habits upon the bed of a bayed-out part of a stream, where there is no current. In such places they may be seen at home, balanced with the neatest delicacy by the tips of their intermediate feet, stationed in the midst of their young at intervals of a few inches; then, by reason of some disturbance, dashing away with rapid strokes of the posterior paddles, and arising to the surface, perchance to take in a fresh supply of the external air. There, resting horiontally for an instant, with the long middle feet extended forward, the sides and the ventral margin become glazed with an air-film which shines like translucent silver.

Water-boatmen, though very common in Minnesota, are of no economic importance.

FAMILY NOTONECTIDAE.

(Back-swimmers).

These aquatic bugs have the back shaped like the bottom of a boat, and persistently swim on their backs. The illustration, Fig. 10, shows *Notonecta undulata* Say. The eyes are large, reniform, twice sinuated on the outer side, and project slightly over the front margin of the prothorax. The beak is long, conical, acute, and composed of four joints. And they can make good use of this instrument, as those handling such insects carelessly may discover to their cost! They are only too ready to insert their poisonous beaks, and in lakes where the water has become low during our warm and dry summers, it is not always a pleasure to wade about, as the insects are only too apt to cause very severe pains followed by inflammation. Back-swimmers are

very common, but they prefer shallow lakes to deeper ones. Here they float on the surface of the water, back downward, with the tip of their abdomen projecting sufficiently to admit air into the space below their wings. Their oar-shaped hind legs are stretched outward and forward, ready for action. When disturbed they dive, carrying a bubble of air beneath their wings. Although decidedly aquatic, they are also attracted to the electric light, and are not such harmless beings as the water-boatmen. Like these they can leap from the water to take flight, but if water plants project over the surface of the water they utilize these to start from. It is very interesting to watch a

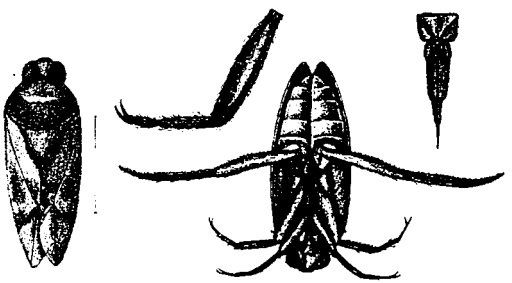


FIG. 10.—*Notonecta undulata* Say. Upper and lower side, beak and leg. Original.

pond which is drying up, and to observe the immense number of insects, not even suspected before, which are now forced to leave in search of new homes; and how they leave the water by utilizing all sorts of objects upon which to rest before unfolding their wings. Many project themselves, like flying-fishes, out of the water, instantly unfolding and using their wings.

These curious back-swimmers are no doubt decidedly injurious, as they kill large numbers of small fish, from which they suck the blood. This can be seen by keeping fish and bugs together in an aquarium; before long the latter will be the only living inhabitants.

FAMILY NEPIDAE.

(Water-scorpions).

This is another truly aquatic family of bugs, distinguished from all others by the presence of a long respiratory tube at the end of the abdomen, as shown in the illustrations, Fig. 11 and Fig. 12. This tube is really composed of two half tubes through which the air is conveyed to the interior of the abdomen. Such an apparatus enables the sluggish insect to obtain the necessary

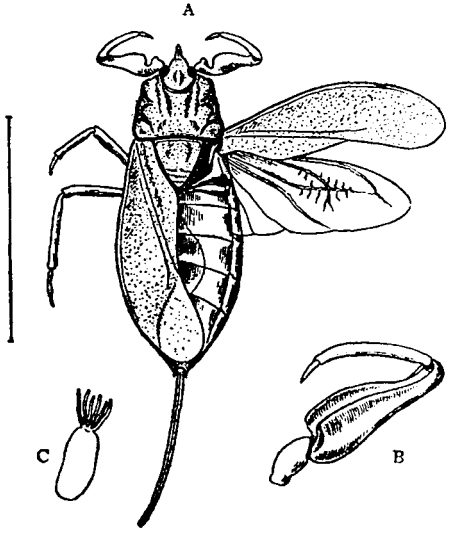


FIG. 11.—*Nepa cinerea* Linn.; *a*, adult; *b*, front leg, showing groove to receive rest of limb; *c*, egg. After Miall.

supply of air by simply projecting it above the surface of the water, while it rests among water-plants near the bottom of the pond. As the water-scorpions are carnivorous, their front legs are fitted for seizing prey, while the others are fitted for walking, not swimming. The fore-tibiæ are curved, and carry a long, slightly bent, one-jointed tarsus. Both united fit into a channel of the long and wide femora, like the blade of a pocket-knife. The head is narrow, and possesses rather prominent eyes.

There are two distinct types in this family, both of which are illustrated. In one case *(Nepa)*, the body is long-oval, flat and thin; in the other *(Ranatra)*, it is almost linear and cylindrical. The color is pale brownish, so that the carnivorous insects, well hidden among plants and under flat stones, are not readily seen. They disguise themselves still more by being covered with mud, and by remaining motionless for a long time,

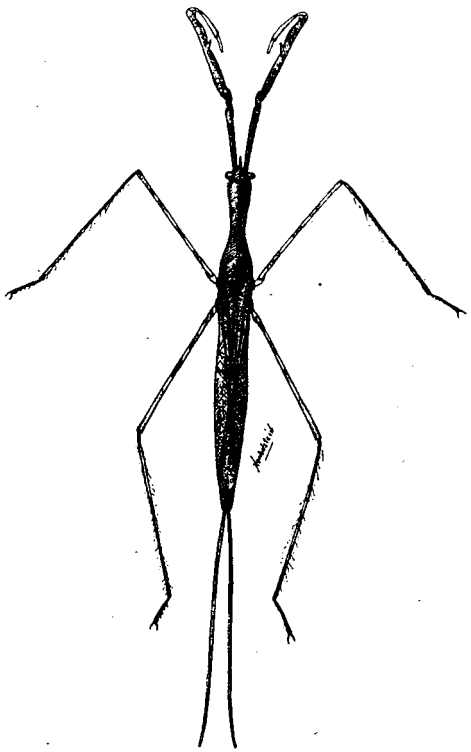


FIG. 12.—*Ranatra fusca* P. B. Original.

so that they do not look at all like animate beings, and thus are not detected by their unsuspecting victims, small insects and fish.

Prof. Uhler writes of the common *Ranatra fusca,* P. B., Fig. 12: "during the warm summer weather it may be seen at times resting at the bottom, stilted on its long legs, with the

respiratory tube projecting upwards, just a little outside the surface of the water. At such times it rests motionless for intervals of an hour or more, but at other times it searches for the eggs of pond fish, which it destroys by drawing out their contents; and it occasionally attacks the young fish of other kinds, grasping them with its curved fore-claws and sucking their blood."

FAMILY BELOSTOMATIDAE.

(Electric-light Bugs; Giant Water-bugs).

Since the introduction of the electric light in so many villages, nearly all within easy reach of rivers, creeks or lakes, these bugs have become very well known, and large numbers attracted to the light and unable to leave its dangerous allurements are killed by passing persons or vehicles. And this is a very good thing, for these rapacious creatures feed on small fish and on insects. Especially in the tropics are such giants very formidable monsters; they lurk at the muddy bottoms of shallow pools, ever ready to grasp the unwary fish in the deadly embrace of their sharp-hooked fore-legs, where it remains until all the blood has been absorbed. Some of these bugs measure four inches in length.

"The Family Belostomatidæ contains the largest Heteroptera now in existence. They are all wide and flat bodied aquatic insects of more or less ovate outline, furnished with powerful flattened swimming legs; the fore-tibiæ are curved as in the preceding family, and fitted for seizing and holding tightly the victims upon which they pounce from their hiding places in the rubbish, or among the branches of water-plants. A remarkable feature of all the genera is the presence of a pair of flattened, narrow, strap-like appendages at the end of the body, which are extensile, but not concerned with respiration, as in members of the fore-going group." (Uhler.)

We have in Minnesota three species of bugs belonging to this family. Two are very large insects, one of which is shown

in Fig. 13. It is the common *Belostoma americanum* Leidy, which varies greatly in size. It is of a pale, dirty-brown color, mottled with dark brown; the under side is also speckled with dark brown. The anterior femora are furnished with a groove for the reception of the edge of the tibiæ, which is absent in the equally large and similar *Benacus griseus* Say, which has the under side of the thorax marked by five interrupted longitudinal stripes of dark brown. Both species are as rapacious as their more southern relatives. They secrete themselves beneath stones

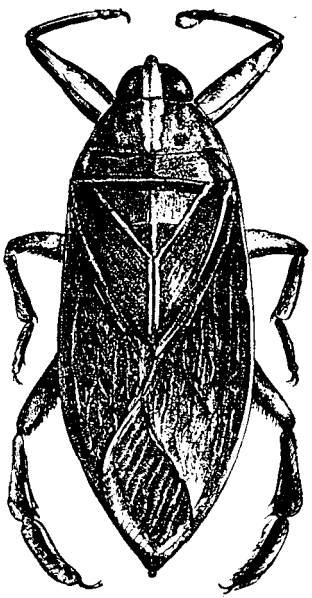


FIG. 13.—*Belostoma americanum* Leidy. After Riley.

or rubbish, even cover themselves with mud or bits of water plants, and with sudden rapidity dart upon their unsuspecting victims, grasp them in their strong fore-legs, and plunge their deadly beak deep into the flesh, after which they proceed quite leisurely to suck the blood. A large amount of poisonous saliva enters the wound, no doubt aiding to produce paralysis of the little sun-fish, minnow, frog, or insect.

It is a good thing for us that these large and poisonous insects, so common in our streets under the electric lights, are al-

most helpless when on dry land. Once upon their back they are hardly able to turn over; nor can they readily fly away from the pavement, as their long wings keep striking the stones and simply make the insect turn in circles. Their beak is so short that the bug can be handled with impunity. Still it should be borne in mind that they can inflict very painful, perhaps serious wounds.

There is another large bug found in our waters, also belonging to this family. It is shown in Fig. 14. The *Zaitha fluminea* Say measures nearly an inch in length, is of a pale clay-yellow color, an oblong ovate, with a round scar on each side of the unevenly roughened prothorax. This species, as well as all

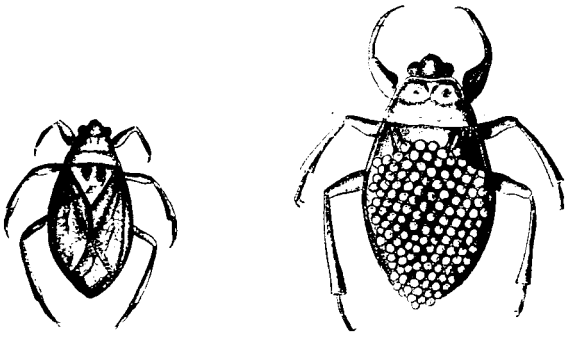


FIG. 14.—*Zaitha fluminea* Say, and *Serphus dilatatus* Say, with eggs on back. After Glover.

others belonging to the same genus, possess the peculiar and remarkable habit of carrying their eggs upon their own backs, where they hatch, and the young are shaken off to make their own living as well as they can. The eggs are fastened side by side, in an upright position, upon the back of the mother, by means of a long, protrusile, tube-like ovipositor. The bugs are also carnivorous.

FAMILY NAUCORIDAE.

Creeping Water-bugs).

These small, flat-bodied, chiefly oval insects, are very uncommon in our state, and only a single species occurs, the *Pelo-*

coris femorata Pal. Beauv., which measures a little more than one third of an inch, is greenish when living, but after death changes to a pale yellow color, with blackish or dark brown markings. Members of this family are also predaceous; they creep about submerged plants, and suddenly seize some unlucky insect that comes within reach.

To show how these insects look, a species from Arizona has been illustrated, Fig. 15.

FIG. 15.—*Ambrysus signoretii* Stal. After Uhler.

FAMILY GALGULIDAE.

(Toad-shaped Bugs).

These predaceous bugs are not strictly aquatic insects, but are found only near the muddy margins of streams, where the soil is always wet. Some even make holes in the ground in which they hide. Galgulidæ have short feelers, almost entirely concealed under the head, and have a pair of ocelli not found in the aquatic bugs described thus far. In the typical forms we find a very broad and short body, with prominent and projecting eyes, as may be seen in the only species found in Minnesota, the *Galgulus oculatus* Fab. (Fig. 16). Another species, the *Pelogonus americanus* Uhl., may exist in Minnesota, but the writer has not seen any specimens from here.

Galgulus oculatus Fab. is a queer looking bug found early in spring walking among stones on the low banks of rivers and lakes. Here it watches for small insects, and secures them by leaping suddenly upon them and clasping them between the front femora and tibiæ, after which it sucks their blood. The upper

surface of this cannibal is muddy brown, but varies according to the color of the soil upon which it is found. The whole upper surface is closely set with granules, which produce, in clean specimens, the appearance of velvet, and which are also very useful to gather a coat of protecting mud, even of green slime.

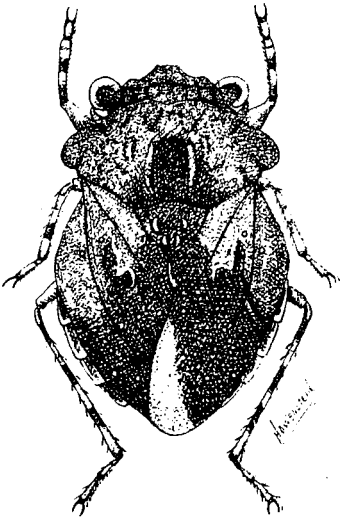


FIG. 16.—*Galgulus oculatus* Fab. Greatly enlarged. Original.

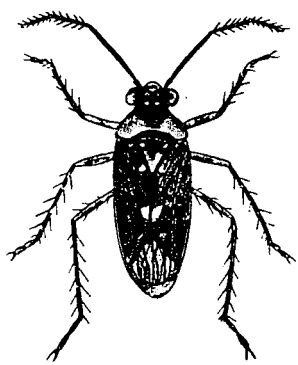
FAMILY SALDIDAE.

(Shore-bugs).

These bugs are quite different from those already mentioned, for they possess prominent feelers not concealed beneath the head. They are very numerous in our state, and there are few sandy beaches along lakes and rivers which are not frequented by these exceedingly active beings, who run and fly with equal facility, and do not hesitate at all to enter the water. Prof. Uhler, who loves these bugs beyond all others, has written a good deal about them. He says: "In the present family we have types which like Galgulus, make holes for themselves, and live for a part of the time beneath the ground. Like the members of that genus too,

a majority of them inhabit damp soils, and are often found in countless numbers on the salt or brackish marshes of our sea coasts. Their manner strongly recalls that of the tiger-beetles that inhabit the same places. When approached, or in any way disturbed, they leap from the ground, arise a few feet into the air, by means of their wings, and alight a short distance away, taking care to slip quickly into the shade of some protecting tuft of grass or clod, where the soil agrees with the color of their bodies."

The insects are small, soft, dark, with white or yellow markings; some are intensely black, polished. The head is free from



G. 17.—*Salda signoretii* Stal. After Uhler.

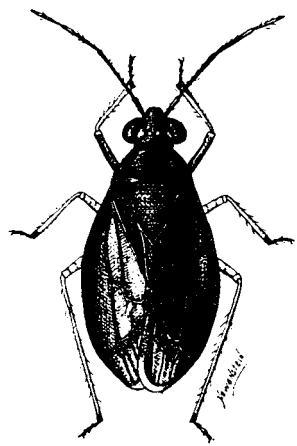


FIG. 18.—*Salda* (*coriacea* Uhler) species. Original.

the thorax, the feelers are four-jointed; the beak is very long, reaching to or beyond the middle coxæ, and is three-jointed; there are two ocelli on the crown of the head, placed close together like twin gems. The legs are long, with long spines. Some forms are very broadly oval, but the majority are long oval, with very prominent eyes.

The insects feed upon drowned flies and other insects, from which they suck the blood. In this manner they are to some extent scavengers.

Two forms have been illustrated to show the great difference in general appearance and coloration. Fig. 17 shows *Salda signoretii* Guer. and Fig. 18 an underscribed species.

FAMILY VELIIDAE.

(Broad-shouldered Water-striders).

This is a small family of bugs of very peculiar shape. Their body is usually stout, oval, and broadest across the prothorax. The beak is three-jointed; the legs long, but not so extremely so as in the next family. Insects belonging to both have the

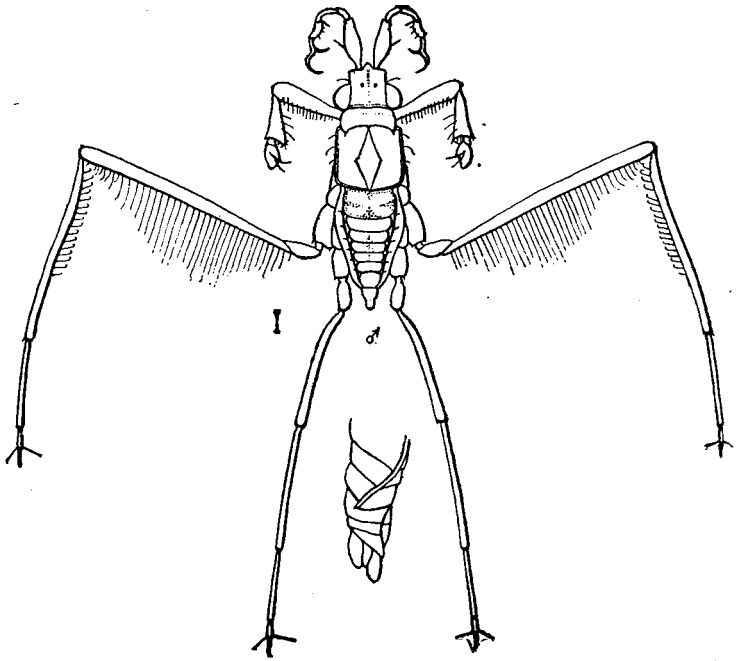


FIG. 19a.—*Rheumatobates rileyi* Berg. Normal male, enlarged, the lower figure showing abdomen from side (Heidemann, del.). After Insect Life, Div of Entomology, Dep. of Agriculture.

last segment of the tarsi bifid, and the claws are inserted before the apex. The legs are fitted for running over the water, but they can also travel with considerable ease upon the land. The head of the species belonging to the family Veliidæ is set closely into the prothorax; the round eyes project a little on each side of the head; the face is either short and convex, or produced into

a thick, blunt cone. The antennæ are four-jointed, either short and quite stout, or long and slender.

The insects are always found near the shores of water, and run over the surface in search of their food. They are well protected against getting wet by a beautiful pubescence, which rubs off rather easily.

All the insects belonging to this family are small, even minute, but few measuring more than one-third of an inch in

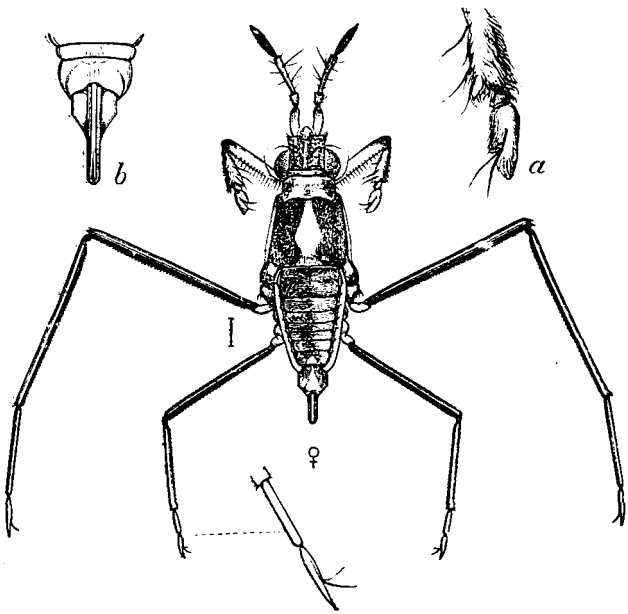


FIG. 19b.—*Rheumatobates rileyi* Berg. Female imago, with the hind tarsus enlarged; *a*, tarsus of foreleg; *b*, anal segment from below still more enlarged (Heidemann, del.). After Insect Life, Div. of Entomology, Dep. of Agriculture.

length. If inspected with a magnifying lens they are most beautiful objects. Some never become winged; others have ample organs of flight. According to Uhler they walk over the water with the greatest facility, and often use the longer middle legs like oars, with somewhat of a rowing motion. It is interesting to observe them on the quiet surface of the creeks, where they love to remain together in groups, staying together motionless for hours at a time, and then, when startled by the ap-

proach of some disturbing object, gliding away in all directions. To show at least the form of one of the most peculiar ones, the illustration, Fig. 19, of *Rheumatobates Rileyi* Berg has been reproduced.

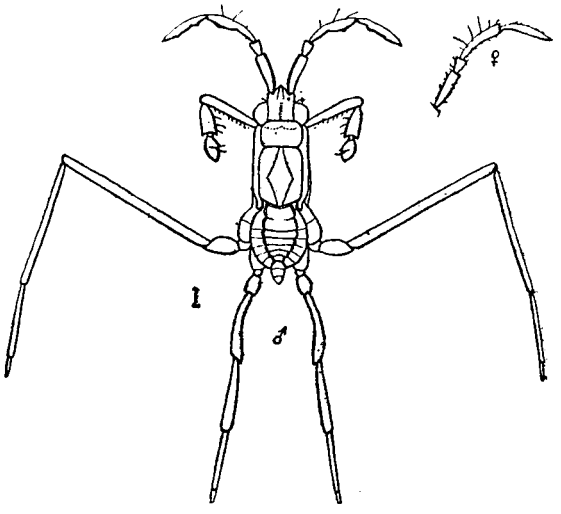


FIG. 19c.—*Rheumatobates rileyi* Berg. Male larva, enlarged, with female antenna shown at right (Heidemann, del.). After Insect Life, Div. of Entomology, Dep. of Agriculture.

FAMILY HYDROBATIDAE.

(Water-striders).

These are well known insects, familiar to all who observe things in the water. They are truly aquatic insects, although they do not dive, but live upon the surface of quiet waters, upon which they rest, or over which they skim very rapidly. Frequently they congregate in great numbers, but when disturbed they move away with amazing swiftness.

"The family Hydrobatidæ includes insects built upon an elongated pattern, with prominent round eyes, the head inserted in the thorax up to the base of the eyes, and curving forward; from it the stout rostrum bends back to pass between the forelimbs. Long antennæ, of four joints, arise from the prominences, placed some distance in front of the eyes, and the back

part of the vertex is depressed. No ocelli are conspicuous, if indeed they are present. The thorax usually widens backwards, and its thickness is increased by the prominent middle and posterior coxæ, which project beyond the sides. No scutellum is apparent, but in its place the end of the dorsal plate of the mesothorax is scale-like, narrowed, rounded, and depressed around the tip. Behind this the abdomen tapers more or less towards the last segment, which is usually armed on each side with a tooth-like process. The under side of the body is generally minutely pubescent and sericeous like satin, and this is sometimes continued along the sides of the thorax. There are

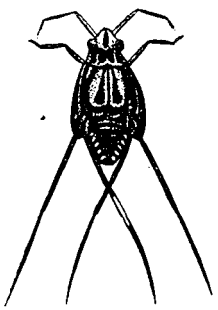


FIG. 20.—*Stephania picta* H. Schf. After Uhler.

commonly two forms of the adult belonging to the same species, the winged and the unwinged. These do not necessarily coexist. During some years only the winged forms appear, while in others, and especially if the spring and summer are cool, the individuals will all be unwinged, with perchance a single, more vigorous specimen, winged. In some parts of the Southern States three forms occur, those before cited, and another which has the wing-covers of scarcely half length, but with these organs as nicely differentiated into corium and membrane as the most completely developed." (Uhler.)

As these insects are of no economic value it is not necessary to give the different genera that compose the family. Fig. 20 and Fig. 21 show two extreme forms. Some related forms are true pelagic insects, being found on the surface of the warmer

portions of the ocean, frequently hundreds of miles from land. Here they feed on the juices of dead animals floating on the surface. The insect illustrated in Fig. 20 is very common upon the calmer portions of lakes.

The insects stow themselves away under the banks of streams, in the mud beneath leaves or rubbish, or at the bottom of water under stones and roots of trees, when the autumn begins to get cold; from thence they reappear upon the surface

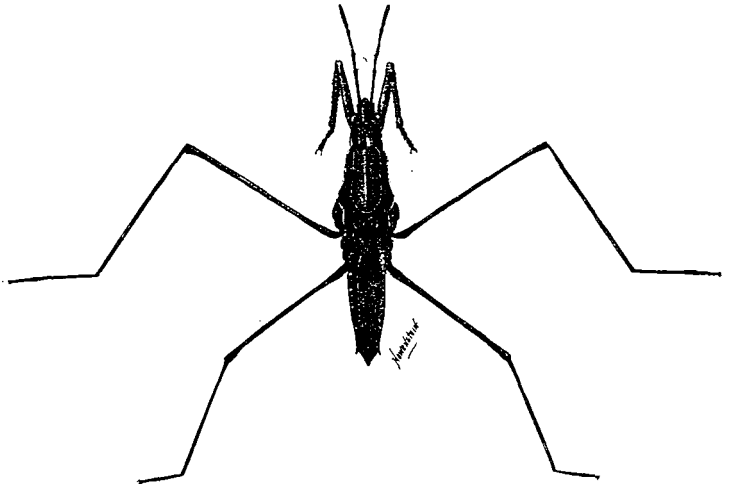


FIG. 21.—*Hygrotrechus remigis* Say. Original.

of the water as soon as the warm weather of spring returns. Soon after this the eggs are attached by a sort of glue to the leaves and stems of aquatic plants. They are whitish, translucent, long, cylindrical, more blunt at the end from which the young emerges, than at the somewhat tapering, but round, opposite extremity. If the weather continues to grow warmer, the eggs mature in about two weeks; then the larvæ push their way out, not, as in many other Heteroptera, by thrusting up the lid, but by bursting through a slit which opens a little down the side.

FAMILY LIMNOBATIDAE.

(Marsh-treaders).

Only a single species is found in the United States. It is not often seen, as it is small, dull brown, and has very quiet habits. Its body is remarkably elongated, almost linear; the long legs are suited for walking slowly over the surface of the water. The head is cylindrical, longer than the thorax; the round and projecting eyes are placed a little nearer the base than the tip of the head. All the motions of these insects are deliberate, and they creep but slowly over the surface of mud and water, in places where plants are numerous, or where they have to climb over projecting water-plants; they carry the body

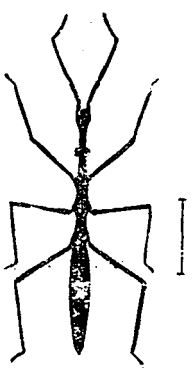


FIG. 22.—*Limnobates lineata* Say. After Comstock.

considerably elevated. "They delight to remain at rest, with perhaps a single claw hooked to some projecting object. When disturbed they move very slowly, and seem disposed to save themselves rather by concealment among rubbish and tangled growths than by active movements. The young forms are so very slender that they can only be detected with great difficulty in the places to which they resort." (Uhler.) *Limnobates lineata* Say, illustrated in Fig. 22, is less than one-half an inch in length; its legs and feelers are very slender, almost hair-like. It is fuscous, with dusky hemelytra, which have fuscous veins. Both color and markings vary greatly. It may be found by search-

ing among the duckweeds in small ponds; here it wanders about over the green algæ and other floating material.

All the bugs thus far mentioned were either strictly aquatic or were found only near water, obtaining their food from it. The next families are terrestrial or aerial, and none have their feelers concealed, but have them stand forth prominently from the sides of the head.

FAMILY EMESIDAE.

(Thread-legged Bugs).

This small family of very peculiar bugs is so closely allied to the following that some authors unite the two. They agree in having a short beak, fastened to the tip of the head; this beak,

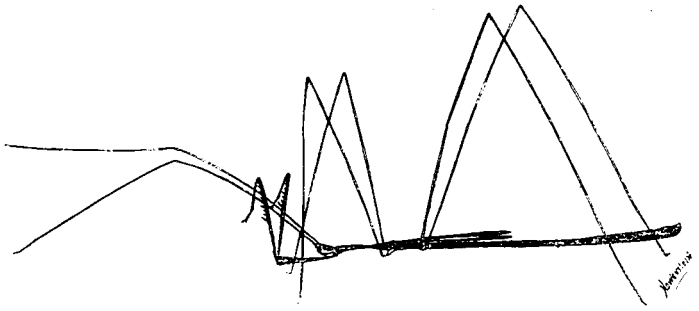


FIG. 23.—*Emesa longipes* De Geer. Original.

when not in use, rests in a groove of the prosternum. The Emesidæ have a very slender body, with long and thread-like middle and hind legs; the front legs are also very long, but are adapted for grasping, as in the Preying Mantis; the coxa of the front leg is greatly elongated, more than four times as long as thick; the femur is spined; the tibia bends back upon the femur, thus completing a grasping organ. The feelers are also very long, resembling the middle legs. Insects belonging to this family possess no ocelli; these are present in the species of the next family.

Only one species, illustrated in Fig. 23, is fairly common in Minnesota. It is the *Emesa longipes* DeGeer, a very odd-

looking object, resembling in a general way our walking-sticks, or the long-legged spiders. It is over one inch and a third in length, with wings only about one-fourth as long as the legs. The ground color is brown or fulvous, with the upper surface of the abdomen more or less reddish; a few pale stripes occur on each side of the head. The predaceous character of this insect is seen in the front legs; these are also more or less banded. When lodged in a twig or bush this peculiar being has the curious habit of swinging backwards and forwards. "The fore-legs are most formidable instruments in catching and securing the insects upon which it feeds; the long fore-coxæ project far in front of the head, and furnish a swinging joint for the spined femora, which can be thrown forward like a flail, while at the same time the sharp tibiæ are shut back against the acute spines, and the victim thus irretrievably transfixed." (Uhler.)

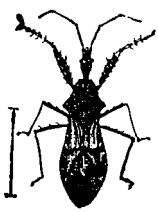


FIG. 24.—*Sinea diadema* Fab. After Riley. Div. of Entomology, Dep. of Agriculture.

FAMILY REDUVIIDAE.

(Assassin-bugs).

This is a large family of bugs representing nine sub-families and at least fifty genera. Of course it is not possible to even mention the numerous species found in our state. Generally speaking they are useful, as they are predaceous, living on the blood of other insects. But in a few cases they are not careful enough in their selection of food, and attack higher animals, not even showing respect for man. Some of the more important common species have been illustrated, so that the reader may be enabled to recognize them.

Nearly all members of this family are fairly large, and some are gayly colored. They differ from the Emesidæ by having

body and legs thicker. The front coxæ are shorter, never more than two or three times as long as broad.

Sinea diadema Fab. (Fig. 24).

This is a common insect which in the south is well known as eating or rather sucking the juices from the very destructive cotton caterpillars, hence is very beneficial wherever it occurs in large numbers. It is also very fond of the canker-worms, for which it deserves credit. Here we have also a very similar and allied species, the *Acholla multispinosa* DeG., which is most frequently found in and among the flowers of the golden rod, where it lies in ambush for all kinds of passing insects, upon which it feeds. It is by no means very particular about its food, taking with the same readiness a bad smelling bug, a caterpillar, fly, moth, and even such insects as bees and wasps. For this reason it is not a friend of bee-keepers, and near bee-hives it should be kept in check as much as possible.

Prionidus cristatus Linn. (Wheel-bug).

This is a more southern bug. It is shown in the different stages in Fig. 25, which well illustrates the life-history of such an insect. The six-sided masses of eggs, containing about 70 eggs or more, are deposited on the bark of trees, on fence rails, out-houses, and other places, and are well protected by a peculiar glossy and sticky coat of varnish. The peculiar jug-like shape of the eggs is also shown. The young insects or nymphs are blood-red, with black marks; they resemble the adults both in shape and habits, as they feed upon all other insects they are able to master, not even sparing their own brothers and sisters. "They kill their prey by inserting into it their proboscis, which ejects a most powerful poisonous liquid into the wound. The victim thus pierced dies in a very short time. They then leisurely suck out the juices and drop the empty skin. The perfect insect is of a gray color, and has a high semi-circular ridge or projection on the crest of the thorax." (Glover.) Both sexes are formidable blood-sucking insects, not at all hesitating to punish a person for sitting next to their favorite trees. The

female often measures more than an inch and a quarter in length, while the male is much smaller. But notwithstanding their formidable size and appearance they are good friends of the lovers of trees, both fruit and shade trees, as they and a few other so-called soldier-bugs are the only insects that eat such hairy caterpillars as the tussock-moth, fall-webworm, and others.

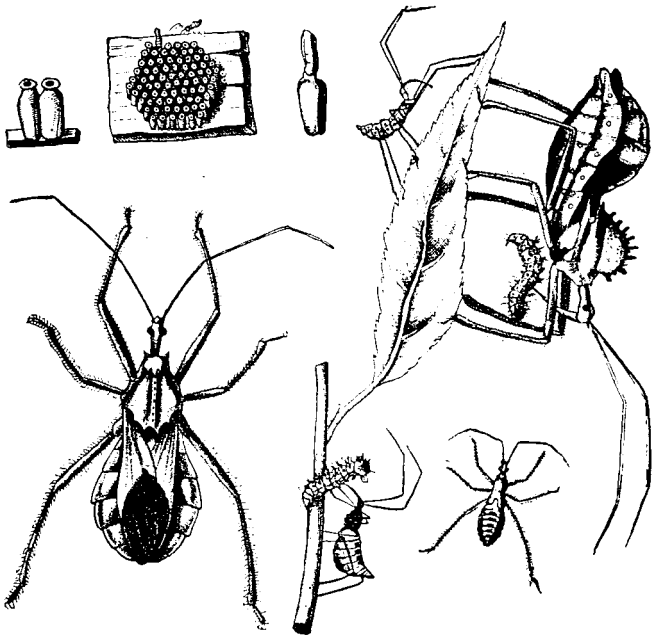


FIG. 25.—*Prionidus cristatus* Linn. Eggs, larvæ and full grown specimens. After Glover, Div. of Entomology, Dep. of Agriculture.

Milyas cinctus Fab. (Banded Soldier-bug).

This bug, illustrated in Fig. 26, is well known as a friend to farmers, as it eats all kinds of insects, including the potato-beetle. It is of a wax-yellow color, or orange-yellow, in all stages of growth, and is very conspicuous on account of the numerous black bands which cross its legs and feelers. It is frequently quite common, and can be found, singly or in pairs, upon many kinds of plants, from early in summer until late in

autumn. The eggs are glued to the bark of trees, and are covered by water-proof gum or varnish, which effectually protects them against rain. This gum, which eventually dries and hardens, does not prevent the young bugs from hatching when they push away the lid-like ends of the eggs.

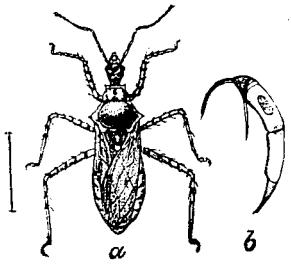


FIG. 26.—*Milyas cinctus* Fab; *a*, adult; *b*, beak. After Riley. Div. of Entomology, Dep. of Agriculture.

Apiomerus crassipes Fab.

This broad, robust, somewhat hairy bug, with a stout, thick head, large and round eyes, a deep depression back of the eyes,

FIG. 27.—*Apiomerus crassipes* Fab. Original.

and with the front bent down, is not a common insect in Minnesota. It is shown in Fig. 27. It varies considerably in color and markings, is usually black, polished on the head, thorax, abdomen, and legs; the sides of the body, with the exception of the head, are bright red, and the same color prevails more or less on the tip of the scutellum. The size of the insects is also very variable, but on an average they measure about two-thirds of an inch in length. They lay eggs on the twigs and bark of pine trees. "These hatch during the early summer, and the young may then be seen roaming over the trees in search of plant-lice and young caterpillars, which they pierce and suck to death, often holding them out on the tip of the rostrum, while keeping them from getting away by pressing down with the fore-feet." (Uhler.)

Melanolestes picipes H. Schf.

This and a very similar species belong to the sub-family Piratina, composed of narrower forms, with the head well drawn

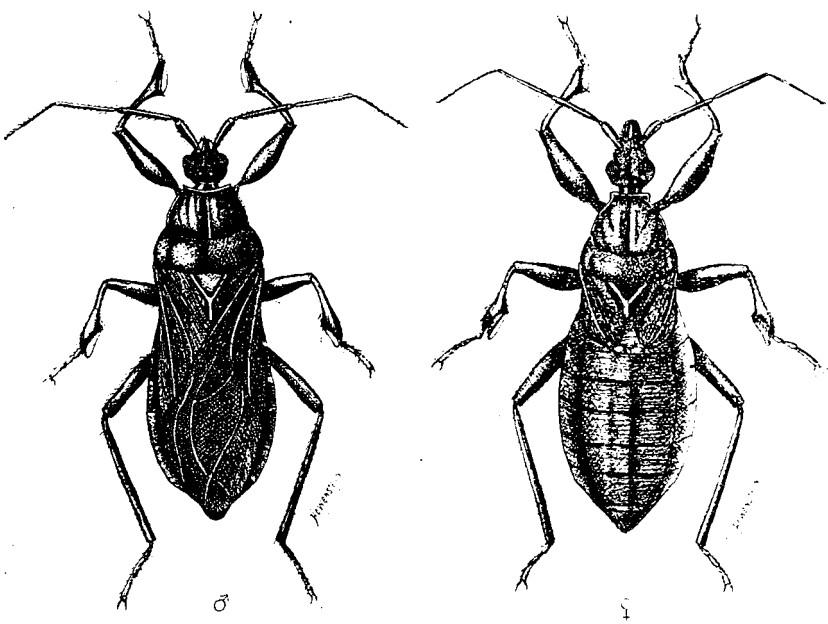


FIG. 28.—*Melanolestes picipes* H. Schf. Winged male and apterous female. Original.

out in front of the eyes; they possess stout and tapering feelers, and a transverse and impressed line behind the eyes; their prothorax is more or less bell-shaped, divided into two lobes. The femora is stout, the legs are short, with very large tibial cushions. *M. picipes* H. Schf. (Fig. 28) is black, with piceous legs and feelers. It is found hiding beneath stones and boards, but is not common in our state. It can inflict a very severe bite upon the hands of those that handle it carelessly, and as it is an active and blood-thirsty insect it had better be left undisturbed.

Conorhinus sanguisugus Lec. *(Big Bed-bug).*

This insect belongs to another sub-family, (Acanthaspidina), distinguished by a long, narrow, cylindrical head, thickest behind the eyes, with the ocelli placed at the thickened part; the feelers are rather shorter, the eyes prominent, transverse, and

FIG. 29.—*Conorhinus sanguisugus* Lec. After Riley.

placed well down against the throat. The triangular prothorax is longer than wide, bounded behind by a transverse, incomplete, impressed groove; the legs are moderately short.

This formidable insect is not found in our state, and this is a good thing for our people, as it has the bad habit of entering beds, not, like the insect described next, to kill bed-bugs, but to suck human blood. Several species occur in the southern states, and all are dangerous.

The Big Bed-bug measures about one inch in length. It is a showy species, being pitchy brown or black, marked with red patches on the sides of the prothorax; spots of the same color at the base and apex of the wing-covers, and bands at the sides of the abdomen. The rather bald surface is rough or wrinkled,

and the end of the scutellum is long and pointed. Dr. LeConte, who first described this species, says that it inflicts a most painful wound, and that he has known its bite to be followed by very serious consequences, the patient not recovering from its effects for nearly a year. He also states his belief that the accounts we have of persons being bitten by spiders are based on stings of these or allied insects.

The insect is illustrated in Fig. 29. Its normal food consists of insects in their larval and adult states, and it is well known that both the Rocky Mountain locust and the Colorado potato-beetles are killed by it.

Opsicoetus personatus Linn. *(Masked Bed-bug Hunter. Kissing-bug).*

This insect suddenly sprang into prominence about a year ago by being called the "Kissing-bug," and many wonderful accounts of it appeared in our newspapers. Perhaps some of them were founded upon facts, but the great majority of them were nothing but the inventions of the fertile brains of reporters, who vied with each other to invent the biggest stories. But the insect is bad enough! It normally enters houses, where it and its active young feed upon the bed-bugs, to which they are welcome. In its immature stages it has the body covered with a sticky substance, to which adhere all kinds of small particles found in bed-rooms, mainly dust. Even legs and feelers are so covered that they are masked, hence the name. When at rest it hides in dark corners in the room. Besides sucking blood it also feeds upon flies and other insects. Dr. LeConte, in writing of this insect, states that it is remarkable for the intense pain caused by its bite; when caught and unskillfully handled it always bites. In this case the pain is almost equal to that of the bite of a poisonous snake, and the swelling and irritation which result from it will sometimes last for a week. In very weak and irritable constitutions it may even prove fatal.

The insect, illustrated in Fig. 30, measures a little over half an inch in length; is black or very dark brown; its prothorax

is strongly constricted in the middle, rounded in front, and possesses a prominent groove in the middle line.

During the great excitement, almost panic, which we experienced here and almost everywhere in the United States on account of the "Kissing-bugs," numerous insects were received by the entomologist, and all were claimed to be the only and "Simon pure" breed! In this manner some fifty different insects were received, all distinguished by one thing: they looked strange and peculiar. But not a specimen of this bug was among them, which simply shows that it is not found in Minnesota, a fact which was known before. The insect is only found, sometimes in large numbers, in the Atlantic region and in Europe.

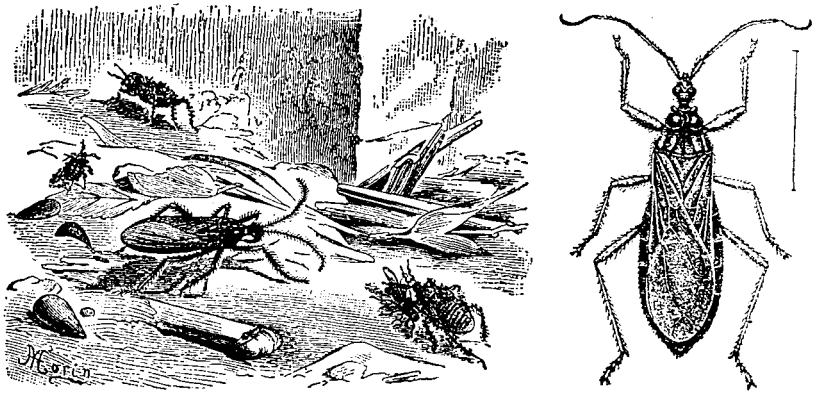


FIG. 30.—*Opsicoetus personatus* Linn. After Brehm.

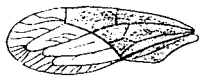
FAMILY NABIDAE.

(Damsel-bugs).

Some species of bugs belonging to this family are very common in our state. They are usually hidden among flowers and the foliage of plants, where they capture small insects; but late in autumn large numbers of them may be seen running over the wooden sidewalks in the country, no doubt hunting for

winter quarters. *Nabis fusca* Stein (Fig. 31) is a member of the sub-family Nabina, and two extreme forms of the sub-family Coriscina are shown in the illustrations Fig. 32 and Fig. 33.

Nabidæ have an oblong body, somewhat oval behind, with a thick head, long and curving down in front, and terminating in a long, slender and four-jointed beak. The front thighs are thick, spindle-shaped; the tibiæ are armed on the inside with



Upper wing of *Nabidæ*.

minute spines. The wing-covers are either longer than the abdomen, or greatly abbreviated.

Coriscus ferus Linn. is our most common member of this family. It measures about one-third of an inch in length, is pale yellow with numerous minute brown dots, and has dusky

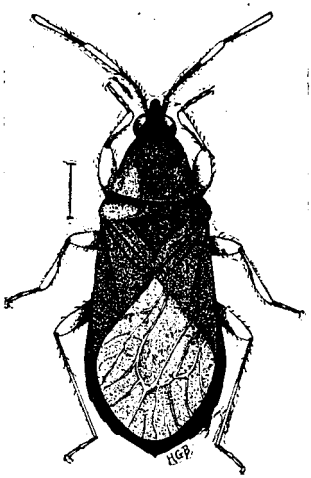


FIG. 31.—*Nabis fusca* Stein. After Bruner.

veins on the membrane. It occurs both here and in Europe, and is frequently found hiding among the flowers of the golden-rod, where it lurks to capture visiting insects. It also destroys large numbers of the grass-infesting species of leaf-hoppers.

Coriscus subcoleoptratus Kby. is very peculiar in appearance, possessing as a general rule but very short wing-covers, barely extending to the second abdominal segment. This form is wide, flat, shining, of jet-black color, bordered with yellow on the sides of the abdomen, and with yellowish legs. Prof. Uhler, in describing the winged form, says that it is much narrower behind, and that the wing-covers and abdomen are rather dusky, or piceous, than black.

All the members of this family, of which a number occur in Minnesota, are predaceous, hence beneficial.

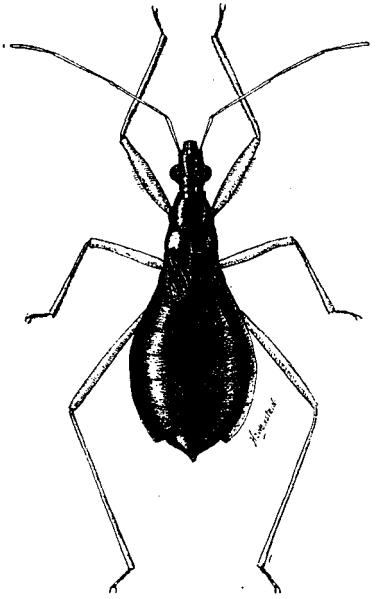


FIG. 33.—*Coriscus subcoleoptratus* Kby. Original.

FAMILY PHYMATIDAE.

(Ambush Bugs).

This is a very small family of insects, and only two species occur in Minneseota, both very similar in general appearance and habits. But few persons are familiar with these peculiar beings, who conceal themselves so well in the flowers of various plants that they are not readily detected, notwithstanding their grotesque forms.

"The body extends laterally into angular or rounded projections, suggesting the name of the typical genus (from *phyma*, a tumor). But the most striking character which distinguishes this group is the remarkable form of the front legs, which are fitted for siezing prey. The coxa is somewhat elongated; the femur is greatly thickened, so that it is half or two-thirds as broad as long; the tibia is sickle-shaped, and fits closely upon the broadened and curved end of the femur; both tibia and femur are armed with a series of closely set teeth, so that the unlucky insect that is grasped by this organ is firmly held between two saws (see Fig. 6); the apparently useless tarsus is bent back into a groove in the tibia. Another striking character is presented by the antennæ, in which the terminal segment is more or less enlarged into a knob. Under the lateral margin of the pronotum there is on each side a groove into which the antenna fits." (Comstock).

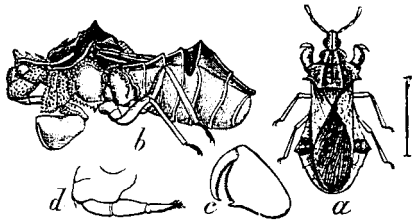


FIG. 34.—*Phymata erosa* H. Schf.: *a*, dorsal view (enlarged); *b*, side view (enlarged) *c*, front leg (enlarged); *d*, beak (enlarged). After Riley, Div. of Entomology, Dep. of Agriculture.

Phymata erosa H. Schf. and *P. wolfii* Stal. are common species; the former is illustrated in Fig. 34. It is a greenish-yellow insect, marked with a broad black band across the expanded part of the abdomen. The female is larger than the male, measuring about four-tenths of an inch in length. The insect is rather broadly notched at the tip; the ends on each side are turned up a little, and are long and triangular, but not acute. When an insect approaches its lurking place it suddenly makes a stroke with the front tibiæ, draws the insect to its beak, and there leisurely sucks the juice. It is remarkable what large insects it captures. Cabbage-butterflies, honey-bees, and even large wasps are caught and killed.

FAMILY ARADIDAE.

(Flat-bugs).

Members of this family are easily recognized by the extreme flatness of their bodies, which enables them to live under the bark of decaying trees, and to move about in such cramped situations. Nearly all are of a dark brown color, but some, and especially in their younger stages, are brown, or even reddish. As they seem to feed upon fungi they need no grasping front legs, and so we find that all their legs are of a similar form.

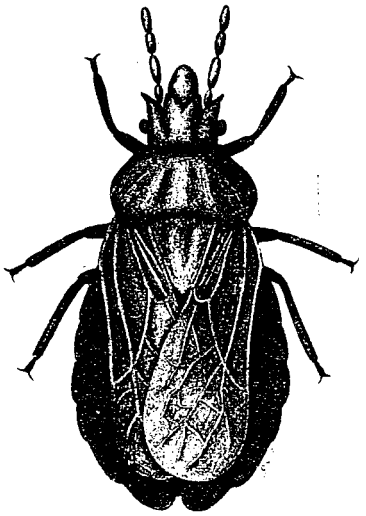


FIG. 35.—*Aradus robustus* Uhl. Original.

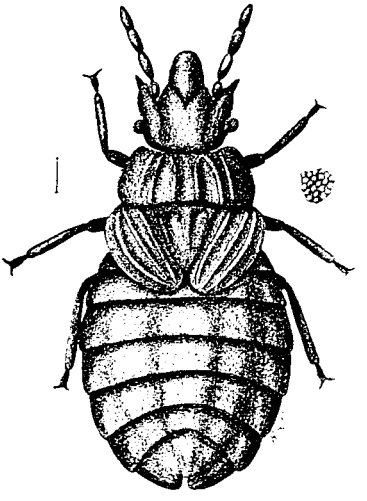


FIG. 36.—*Aradus robustus* Uhl., young stage. Original.

There are no ocelli; the feelers are four-jointed and rather broad; the beak is three-jointed, the tarsi two-jointed. The wing-covers are usually well developed, but do not in all cases cover the abdomen, which projects on all sides.

Wherever found these insects occur in large numbers, and frequently we find all stages crowded together. The eggs, glistening white in color, are deposited under the bark. It is frequently stated that bed-bugs occur in our pine-woods in a wild condition under bark, etc., and that whenever a log cabin is

erected this would soon afterwards swarm with bed-bugs. Truth and fiction are here sadly mixed! It is true that such cabins often contain a dense population of various insects parasitic upon man, but they have been brought there by the inhabitants, and did not come with the timber from the woods. In many cases, when the writer asked for proof, such insects as are shown in Figs. 35, 36 and 37 were sent to him as examples of them. They resemble bed-bugs in many ways, especially in their earlier and unwinged stages, but a trained eye can easily detect the very great difference between the two. Two species are most commonly found in and about log cabins. The one

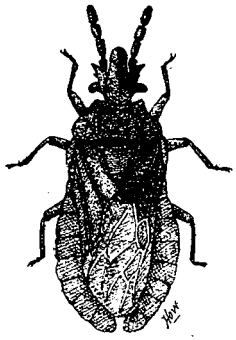


FIG. 37.—*Aradus cinnamomeus* Panz. Enlarged. Original.

illustrated, (Fig. 35, adult, and Fig. 36, larva), is black, as flat as the genuine bed-bug, and just as inactive during the day. It is *Aradus robustus* Uhler. Another species, illustrated in Fig. 37, resembles the bed-bug even more closely, being of the same color and size; this is *Aradus cinnamomeus* Panz. These insects, as well as a number of similar ones, live normally under bark of living and dead trees; they are true vegetable feeders, subsisting upon the sap of plants. Whenever logs are cut the sap contained in them, and especially that near the surface, ferments, and this attracts a large number of insects fond of this fluid. This explains why so many insects can be found near saw-mills, and chiefly upon freshly cut boards.

FAMILY TINGITIDAE.

(Lace-bugs).

Members of this family of bugs are small and feeble beings, who occur in large numbers upon the under side of the leaves of various trees and shrubs from midsummer till autumn. Here old and young crowd together, and, attached by their beaks, suck the sap. They deposit their eggs near the midribs and veins. These beautiful insects are the most easily recognized of all Heteroptera, and as they lack the unpleasant odors of the majority of other bugs, they can be handled with impunity. Their wing-covers are reticulated in the most bewildering manner, and are very gauze-like in structure; the prothorax is

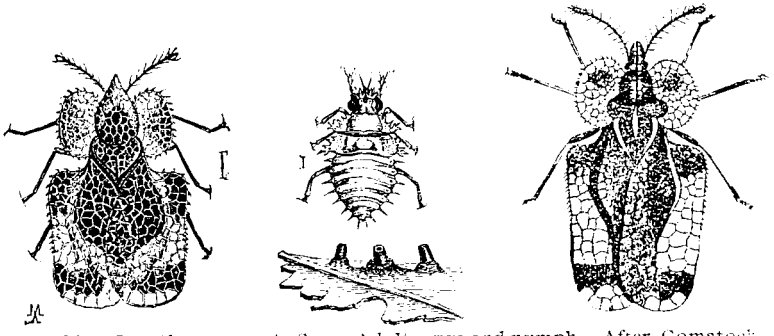


FIG. 38.—*Corythuca arcuata* Say. Adult, eggs and nymph. After Comstock, Div. of Entomology, Dep. of Agriculture. A variety, after Uhler.

greatly expanded, and beautified like the wing-covers. This beauty of structure is still more improved by black or brown bands.

Lace-bugs possess no ocelli; the beak and feelers are four-jointed; the scutellum is absent or rudimentary, but is replaced by the angular hind portion of the pronotum; the tarsi are two-jointed. The insect shown in Fig. 38, *Corythuca arcuata* Say, is common upon the under side of several kinds of oaks; *C. juglandis* is found in similar positions on the butternut; *C. gossypii* infests the cotton-plant in the South; another species occurs upon the leaves of beans.

Prof. Comstock describes the *C. arcuata* Say, which he calls the *Hawthorn Tingis,* as follows:

"This I found very abundant in Washington, puncturing the under surface of the leaves of different species of *Cratægus.* The infested leaves have a brown and sunburnt appearance. All stages were found together. The adult is represented much enlarged in Fig. 38. The eggs and immature form are also shown. The eggs are smooth, whitish, glistening, semi-transparent, and ovoid in shape. Their average length is three mm. (0.12 inch). They are deposited on their broad end, and seem to be somewhat inserted into the substance of the leaf; they are covered completely by a brown, sticky substance, which hardens soon after oviposition. It adheres so firmly to the egg, especially to the upper portion, that it is impossible to remove it without crushing the egg. At its upper end this covering of the egg is squarely truncate, giving the whole mass the appearance of a frustrum of a cone with a porous lid. From the funnel-shaped summit the young insect makes its exit. The eggs are usually laid, in groups of from ten to thirty, along both sides of some prominent leaf-vein. They bear a much greater resemblance to some forms of fungi, notably the genus Phoma, and to certain young Homopterous galls, than they do to eggs of any sort.

"The immature insect is of the same dirty brown color as the substance covering the egg, and but little darker than the withering leaf. It is of a broad, flat, oval shape, and spines seem to project from almost every portion of its body. Under the microscope it looks more like a lobe of prickly cactus than anything else I can think of.

"The cast-off skins stick to the leaf, and give it the appearance of being much more seriously infested than it really is.

"The dead leaves under the bushes during the winter have been often found to contain the living and healthy eggs of the Tingis; but the customary method of hibernation is in the adult state alone. This form can be found during the winter under the loose bark of the tree, and under sticks and stones on the ground. These insects can be destroyed by strong alkaline washes or by kerosene emulsions. But it is probable that if the leaves and rubbish underneath the trees are destroyed, either every fall or every spring, a necessity for remedies will not arise."

Piesma cinerea Say is an aberrant form, belonging to the sub-family Piesmina.

In this case the scutellum is not covered, and in long-winged specimens the tip of the membrane lacks the network of veins. The insect is illustrated in Fig. 39. It is not by any means an uncommon occurrence that farmers mistake this insect for the destructive chinch-bug, and it is frequently received as such. For this reason it is sometimes classed with other hemipterous insects as the "false or bogus chinch-bug." It is easily recognized; the prothorax is deeply pitted, so that it looks like the base of the wing-covers; the head is deeply bifid at the tip, and there is a short robust spine between the eye and antennæ on each side.

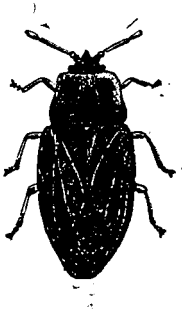


FIG. 39.—*Piesma cinerea* Say. After Riley.

The insect seems to prefer the pigweed to feed on, but it will attack other plants as well. It is exceedingly common in some years, and flies about in such large numbers as sometimes to cover the outside of buildings. It also infests vine-yards to an injurious extent, and is apt to destroy the flower-buds in early spring. It has likewise been found to injure the leaves of the sugar beet, which become dotted with whitish spots, the results of the injected poison. Here again, clean culture, the destruction of all sort of rubbish and trash by fire, to remove shelters for the winter, will check an undue increase of this and other insects.

FAMILY ACANTHIIDAE.

(Bed-bugs and Flower-bugs).

This family contains two closely allied groups, which are frequently considered as distinct families.

The sub-family Acanthiina contains but a few species of insects only too well known as bed-bugs. The one preying upon man is found over the greatest part of the world, although we have a number of villages in Minnesota where they are not found—according to the claims of their respective citizens. Lucky people!

In this subfamily "the head is broader, and the frontal narrower division is bluntly rounded, not conically produced as in the next subfamily. The antennæ have the two basal joints stout, the first being very short and much thicker than the second, while the two end joints are very slender and more pubescent; the rostrum is slender, excepting the base, and extends to the fore-coxæ." Uhler.

Acanthia lectularia Linn. *(The Common Bed-bug).*

This household pest is reddish-brown in color, and measures a little less than one-fifth of an inch in well fed specimens. The latter are often quite coarsely punctured and hairy, while their half-starved brethren have a much thinner outside integument and finer punctures, with less conspicuous pubescence. According to Uhler some specimens have the wing-pads hanging loose, as if ready to change into wing-covers, but generally they are run together in one piece in the middle line. Thus far no individuals of this insect have been met with fully winged.

A full account of these nasty insects has been given in the "Second Annual Report of the Entomologist," which is repeated.

Some persons claim that they have never seen these parasites! This means that they have either been very fortunate, or that they did not use their eyes or their nose, as bed-bugs are found wherever man has made a home for himself. It is a mooted point whence they came originally, but this, although interesting, makes but little difference at present, as they are now everywhere.

The illustration, Fig. 40, shows how this nasty insect looks. We see that, being a parasite, and no longer leading a rambling existence like other bugs, but being a sort of domesticated animal, it has lost the wings, these being no longer required, and it possesses simply rudiments of them. These are indicated in the illustration, and look like a little chitinous flap on each side behind the thorax. The adult bugs, as well as the younger ones, are well adapted to enter narrow cracks, having a very flattened shape, and in such shelters they hide during the day, being active only at night. During spring they deposit about fifty white and oval

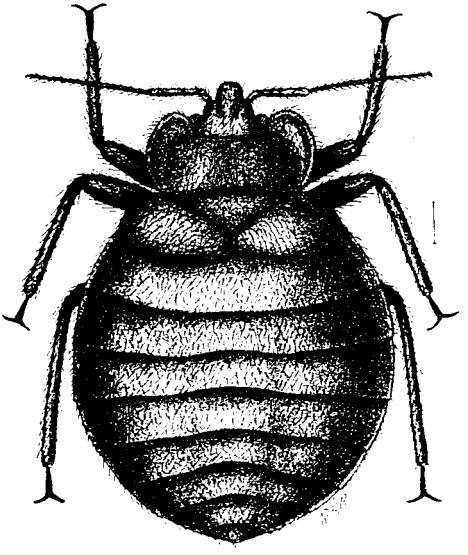


FIG. 40.—*Acanthia lectularia* Linn. Original.

eggs. 1.12 mm long, and similar to those shown in Fig. 41, in the joints of bed-steads, cracks in walls, under loose wall-paper, but especially near iron, be this an old nail in the wall or the hooks that are used to fasten the bedstead together. These eggs are very beautiful objects; they are terminated by a cap, which is removed by the escaping young bugs. These latter possess the color of innocence, being white and almost transparent; they look, in shape, very much like the old ones, and are only a little broader in comparison, and have stouter feelers. As soon as they

can attack a victim they become round and resemble a minute globule of blood. Imbibing blood whenever they have an opportunity, they quickly grow, and after moulting several times they reach their adult and sexually mature condition. The organ by means of which they obtain blood is a sucking tube or haustellum, Fig. 3. This is composed of two half-cylindrical side-pieces, analogous with the labium and labial palpi, and enclosed in this tube are four sharp and pointed lancets, the transformed mandibles and maxillary palpi.

The female deposits eggs during the warmer season four times, and about fifty at a time. In Minnesota these bugs have only one annual generation, yet judging from their numbers in certain, not first-class, hotels, not hundreds of miles distant from the "Twin Cities," they should have numerous broods every few weeks. With plenty of food and a warm temperature, they mul-

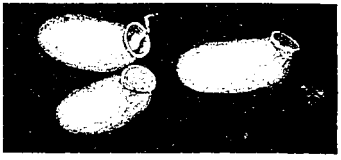


FIG. 41.—Eggs of *Acanthia hirundinis* Senyus, in nest of swallow; greatly enlarged. Original.

tiply rapidly; and if things are favorable, it requires only eleven weeks for the bug to undergo its transformation from egg to adult. Only the adult insects hibernate or are able to withstand severe cold. It is not necessary to describe them in detail, as the illustration shows well the structure of these yellowish-brown parasites. The disagreeable "bed-buggy" odor is produced in minute glands which are situated in the adult bug on the under side of the body, and in the young one on the back of the thorax. The peculiar and penetrating odor of these parasites is, to many persons, even worse than their bites. Those who have been forced to sleep in a room which had not been occupied for weeks, and in a bed alive with hungry bed-bugs, know how interesting these parasites can make it, and how active they become as soon as the light is extinguished. Like harpies they attack the would-be sleeper, and their bites produce the sensation of being stung with hot needles: soon the whole body is in a fever, and big

swellings appear wherever a bug has inserted his beak. If a light is suddenly ignited, the bugs run away as quickly as they can to their hiding-places. A glance at the ceiling of the occupied rooms will reveal many bugs, who have crawled there with the intention of falling down upon the sleeper. Though always hungry and ready to imbibe blood, bed-bugs can exist for a long time, even for a year, without any food. Prof. Leunis kept a female bed-bug in an empty paper-box for six months; when the box was opened not only the living female was found, but she was surrounded by numerous young bugs, which, like the mother, were white and transparent as glass.

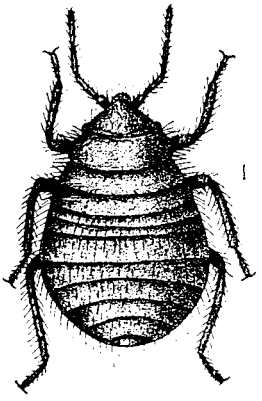


FIG. 42.—*Acanthia hirundinis* Senyns. Immature form. Original.

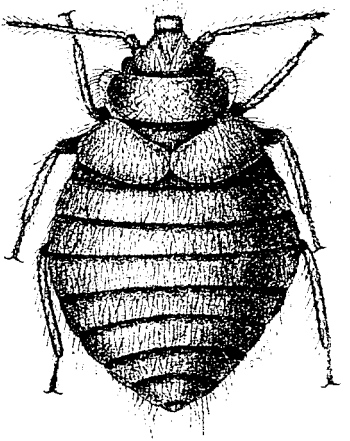


FIG. 43.—*Acanthia hirundinis* Senyns. Adult. Original.

We have a large number of remedies against this insect. Cleanliness is of course the best preventive. Yet with all care bed-bugs can and will enter houses, because they are so readily carried with trunks, etc., from infested places, and if they once find a home, they are on account of their form, which is well adapted for hiding, and their capacity for fasting, not readily driven away. The free use of benzine, or of kerosene, sprayed with a hand atomizer into all suspected cracks, will kill all insects, including the eggs, with which the fluid actually comes in contact. This spraying has to be repeated from time to time, and if carefully and thoroughly done, the bed-bugs have no chance to exist

in such beds or rooms. If we paint the cracks in a bed-stead or the wall, the ends of the slats, and all other suspected places, with one ounce corrosive sublimate dissolved in a half pint of alcohol and one-fourth pint of oil of turpentine, we have an excellent remedy. All remedies are best applied in early spring, so as to kill all the old hibernating females before they have deposited eggs.

While travelling it is well to remember that bed-bugs are active only during the night and that they abhor light. So, if forced to sleep in a bed suspected of containing such unwelcome inhabitants, it is wise to permit the lamp to burn all night.

Bugs, very similar to bed-bugs, attack chickens, pigeons, swallows and bats. Those found in the nests of swallows not infrequently reach the inside of houses against which these beneficial birds have built their clay nests. Such bugs, Figs. 42 and 43, very closely resemble the genuine bed-bugs, yet are quite different when studied in detail: they are much smaller, darker, and can not exist for any length of time away from their proper home, the nest of the swallow, where they are sometimes exceedingly numerous. The illustration shows the eggs, young, and adult of this species (*Acanthia hirundinis* Senyns).

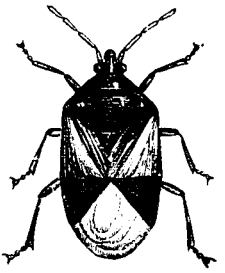
Since the above account was written, another species of true bed-bugs was found in a large school building in the western part of the state. Here these insects became very annoying during winter, and especially near the warm steam-pipes; later they invaded all the rooms. It is a strange fact that an insect, usually dormant at that time, and certainly not active during the day, should so change its habits as to become a veritable trouble in mid-winter, annoying students and teachers in broad daylight. This species is much smaller, and resembles the one found in swallow nests so closely that it may be identical with it. In dealing with such a pest it is always wise to become familiar with as many remedies as are known, and for this reason the following is quoted from Prof. Comstock:

"The means commonly employed to destroy this pest is to wet the cracks of the bedstead and other places in which it hides with corrosive sublimate dissolved in alcohol. This is sold by druggists under the name of bed-bug poison. As this substance is a virulent poison, it should be used with great care. A

safer substance to use is Pyrethrum. In case of a badly infested room it should be thoroughly cleaned; fumed with sulphur; the walls repapered, kalsomined, or whitewashed; and the woodwork repainted. In travelling where one is forced to lodge at places infested by this insect, or by fleas, protection from them can be had by sprinkling a small quantity of Pyrethrum, (Insect powder), between the sheets of the bed on retiring."

Upper wing of *Anthocorina*.

In the sub-family of Flower-bugs, (Anthocorina), we find insects whose wings are always fully developed. The species are all small, and usually so well hidden in flowers, upon trees, and under bark and rubbish, that they are not readily seen. Yet some species are very common, and being predaceous, they are of some assistance to the farmer and fruit-grower.



I

FIG. 44.—*Triphleps insidiosus* Say. After Riley.

The beak of these bugs is three-jointed; the antennæ are four-jointed; the tarsi three-jointed; and the ocelli are present.

Triphleps insidiosus Say, *(The Common Insidious Flower-bug)*, illustrated in Fig. 44, is frequently found in company with the chinch-bug, upon which it preys, and for which it is sometimes mistaken. It is otherwise beneficial because eating small insects, and it is of a very common occurrence in and among the galls formed by the grape phylloxera upon the leaves of wild and some cultivated grapes.

Besides feeding upon such insects, as well as upon the eggs of some very destructive moths, it has also been charged with injuring chrysanthemum shoots, and Osborn reports that it has actually been seen to puncture the blossoms of clover.

Two other species of bugs belonging to this family, which have proven to be very beneficial in destroying injurious insects, are given to show their forms. Fig. 45 is a western species (*Piezostethus californicus* Reut.); *Lyctocoris fitchii* Reut. (Fig. 48) is fairly common in our state, and was recently discovered in a neglected saw-mill, in which some small wood-boring beetles

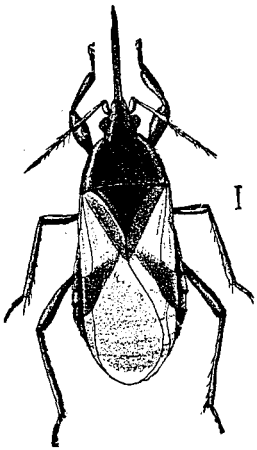


FIG. 45.—*Piezostethus californicus* Reut.

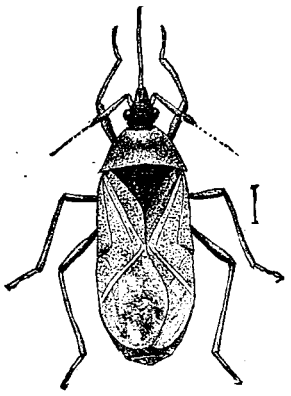


FIG. 46.—*Lyctocoris fitchii* Reut.

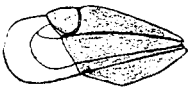
had caused great damage by destroying dry boards of hard lumber. Here our friendly bugs were at work, killing the larvæ of the destructive beetles, and could be found in almost every burrow made by them.

FAMILY CAPSIDAE.

(Leaf-bugs).

This is one of the largest families of the true bugs. Prof. Uhler writes of them: "The eye is bewildered by the excessive variety and numbers of ornamentation which are present on every hand; while the mind is delighted with their graceful

proportions and light elegance of form, as well as by the natural ease of their quick motions. Many of these insects are soft and tender, with legs and antennæ easily detached, while others are tougher, more compact, and have a crustaceous outer integument. The antennæ are either thread-shaped, taper very slender to the tip, or have the last joint a little thickened; these organs are generally long and four-jointed in all the species. They are usually of medium or small size, but include so many differences of shape, that it is impossible to draw them all into one common formula. The most readily observed character is found in the structure of the wing-covers (see illustration),



Upper wing of *Capsidæ*.

which are almost always complete, possessing clavus, corium, cuneus, and membrane; at the base of the latter are one or two cells; otherwise it is without veins. The ocelli are either wanting, or are so minute that they can not be detected without special preparation for the microscope."

Only a few of the numerous species can be described, which live chiefly upon the leaves of plants, from which they draw their liquid food; some kinds, however, are predaceous.

Lygus pratensis Linn. *(The Tarnished Plant-bug).*

This insect is a very destructive one, and injuriously affects a large number of cultivated plants, among them the strawberry and sugar-beets; elsewhere the pear and other fruit-trees are attacked. Prof. Saunders, in his excellent book, "Insects Injurious to Fruit," describes it as follows:

"It passes the winter in the perfect state, taking shelter among rubbish, or in other convenient hiding-places, and early in May, as soon as vegetation starts, it begins its depredations. Concealing itself within the young leaves of the expanding buds of the pear, it punctures them about their base and along the edges, extracting their juice with its beak. The puncture of

the insect seems to have a poisonous effect, and the result is to disfigure and to sometimes entirely destroy the young leaves, causing them to blacken and wither.

"These insects are also partial to the unopened buds, piercing them from the outside, and sucking them nearly dry, when they also become withered and blackened. Sometimes a whole branch will be thus affected, being first stunted, then withering, and finally dying. Early in the morning these plant-bugs are in a sluggish condition, and may be found buried in the expanding leaves; but as the day advances and the temperature rises, they become active, and when approached dodge

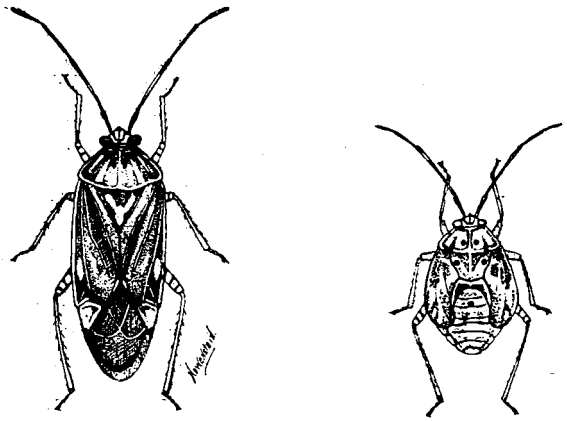


FIG. 47.—*Lygus pratensis* Linn., and young. Original.

quickly about from place to place, drop to the ground, or else take wing and fly away. In common with most true bugs, they have when handled a disagreeable odor. In the course of two or three weeks they disappear, or cease to be sufficiently injurious to attract attention.

"While they seem particularly partial to the pear, they attack also the young leaves of the quince, apple, plum, cherry, and strawberry, as well as those of many herbaceous plants."

The mature bug (Fig. 47) is about one-fifth of an inch long, and exceedingly variable in color and markings, ranging from a dull brown to a greenish or yellowish-brown. In a typical specimen the head is yellowish, with three narrow red-

dish stripes; the beak is about one-third the length of the body, and is folded upon the breast when not in use. The prothorax has a yellow margin and several longitudinal yellowish lines; behind the prothorax, upon the scutellum, is a yellow V-shaped mark; the wings are dusky brown, with a pale cuneus and black point at the apex; the legs are dull yellow. The immature insects are greenish; if a little older they possess a pair of round black dots on the back of the thorax, another pair on the scutellum, and a single dot on the abdomen.

Since these insects hibernate among rubbish of all kinds, clean culture is very important. By clean culture is understood the removal of all litter from fence corners, so as to take away the shelters in which the insect winters. When they appear in spring the plants upon which they are should be shaken early in the morning, while the bugs are still in a torpid condition, making them fall upon a sheet underneath, and then destroying them. As soon as it becomes warm the insects are exceedingly active, and so swift in all their motions that they can not be captured.

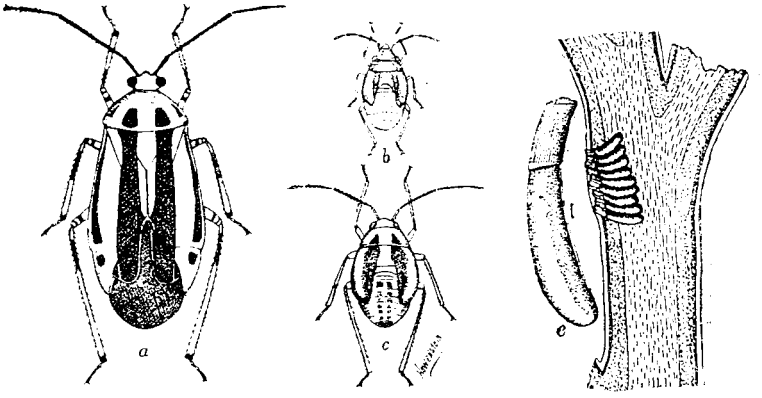


FIG.—*Pœcilocapsus lineatus* Fab; *a*, adult; *b*, *c*, immature. Original. Eggs after Slingerland.

Pœcilocapsus lineatus Fab. *(The Four-lined Leaf-bug).*

This is a bright yellow insect with the head, forepart of the prothorax, and the entire underside of the body of a shining orange-red. There are four longitudinal black stripes,

which extend over the prothorax and the greater part of the wing-covers, as shown in Fig. 48; there is also a black dot on the cuneus; two dusky bands occur on the femora; and traces of the same color are seen beneath the knees. It measures somewhat more than one-fourth of an inch in length. This bug is becoming very numerous in Minnesota, and is getting decidedly injurious to the currant-bushes. It punctures the young and tender leaves on both their upper and lower surface, thus causing small brown spots not much larger than pin-heads, but these are frequently so numerous and placed so closely together that the leaves wither completely. Sometimes the leaves become twisted, and in this way form most excellent hiding places for the culprit. The bugs are very active, and upon approaching them they either drop to the ground or fly away. Beginning to feed in May and June, they continue for a month or two, often doing great injury by disfiguring the bushes and retarding their growth.

Prof. Slingerland has given us a full account of the life-history of this insect in one of the excellent bulletins of the Entomological Division of the Cornell University Agricultural Experiment Station. He found that the eggs are deposited in slits cut lengthwise into the stems of the plants (see illustration), extending through the bark, wood, and nearly half way through the pith. The female is enabled to do so by a peculiar ovipositor, which, when not in use, is hidden in a groove.

The Four-lined Leaf-bug is not easy to control. Prof. Slingerland advises the use of insecticides and mechanical means. As an insecticide he recommends the common kerosene emulsion, made as follows:

"To make the emulsion dissolve one-half pound hard or soft soap in one gallon boiling water. While this solution is still very hot add two gallons of kerosene and quickly begin to agitate the whole mass through a syringe or force-pump, drawing the liquid into the pump, and forcing it back into the dish. Continue this for five minutes, or until the whole mass assumes a creamy color, and a consistency which will adhere to the sides of the vessel, and not glide off like oil. It may now be readily diluted with cold rain water, or the whole mass may be allowed to cool when it has a semi-solid form, not unlike loppered milk.

This standard emulsion, if covered and placed in a cool, dark place, will keep for a long time. In making a dilution from this cold emulsion, it is necessary to dissolve the amount required in three or four parts of boiling water, after which cold rain water may be added in the required quantities.

"The kerosene emulsion, diluted with five parts of water, should be applied to the young insects as soon as they appear in May.

"Since the insect winters in the egg state, which are securely placed near the tips of the new growth, burning of the garden rubbish in the fall will not affect the pest in the least, but pruning and burning the infested twigs will prove a practical and effective means to reduce their numbers.

"Probably the best method for general practice, especially against the adults on herbaceous plants, will be to capture the bugs by jarring them into a dish partly filled with kerosene and water. On currants, gooseberries, sage, and other shrubs, one should not wait until the adults appear, but should capture the nymphs in May.

"Thus there are three practical methods by which this pest can be controlled: kerosene emulsion for nymphs; destruction of the eggs by pruning; and the capture of the nymphs and adults by jarring into receptacles, where they are destroyed. Circumstances will largely determine which method will prove the most practicable in specific cases."

Besides all kinds of cultivated and wild currants a large number of other plants are more or less injured by this pest. Prof. Slingerland has given a list of about fifty different plants upon which the bug occurs, showing a surprisingly wide range of food plants. In this list we find radish, clover, pea, gooseberry, squash, cucumber, parsnip, lettuce, potato, rose, and many other cultivated plants. This fact makes it so much more difficult to control the insect; if driven away from one kind it can simply fly to another one to escape, and for this very reason growers of currants and gooseberries should be very vigilant to destroy the insect pest before it becomes numerous.

Some insects belonging to the Capsidæ are remarkable for mimicking ants. Prof. Osborn, who is making a specialty of the Hemiptera, describes a handsome little Capsid, which pre-

sents an interesting case of dimorphism, and also of mimicry. The illustration, Fig. 49, shows the sexes of *Sericophanus ocellatus* Reut. He writes:

"The significance to be attached to the peculiar dimorphism and mimicry presented in this and other species opens a question of too far reaching importance to be discussed here. That they resemble ants is certain, that they may by this resemblance gain some advantage is possible, but whether the abortion of the wings and elytra is merely the result of such mimicry, or connected with advantages of an entirely different nature, we

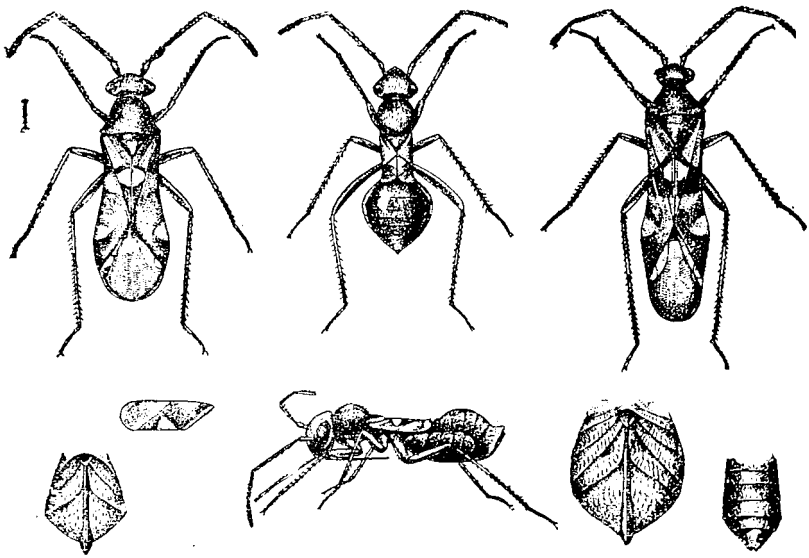


FIG. 49.—*Sericophanus ocellatus* Reut. After Osborn.

are not prepared to guess. I have used the term mimicry in a general way to cover this feature of resemblance, but I would dissent from the use of this term in such a loose manner if a better one were available. Such resemblance seems to me not of necessity mimicry in its proper sense, or protective resemblance, but merely the assumption of a similar form by different animals when adapting themselves to similar environments. The question really broadens into a discussion of all the factors of adaptive evolution, and while attractive, is too large to attack in such a paper as this."

Halticus uhleri Girard. *(The Garden Flea-hopper).*

To show how various are the bugs belonging to the Family Capsidæ the above insect has been selected. It is an old offender, but had not received much attention until recently, when its habits were described by Mr. Chittenden in one of the important bulletins of the Division of Entomology, Department of Agriculture. These bulletins, prepared under the direction of

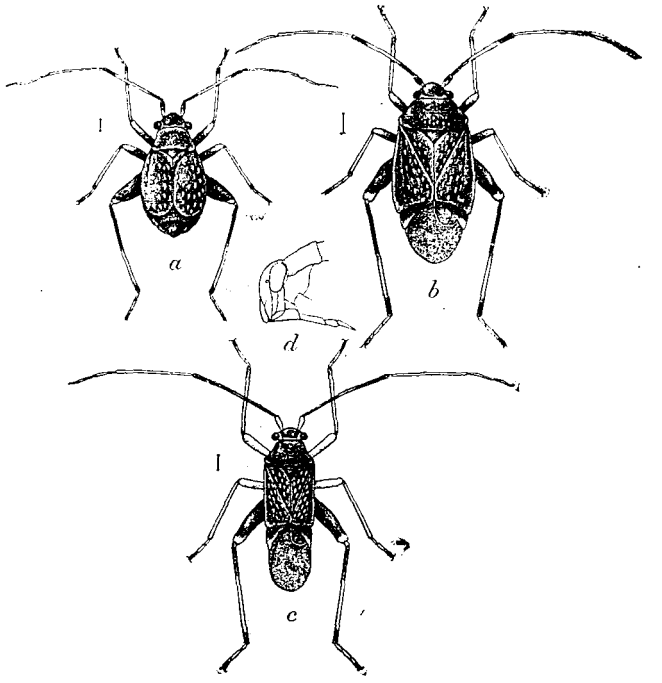


FIG. 50.—*Halticus uhleri* Giard; *a*, brachypterous female; *b*, full-winged female; *c*, male; *d*, head of male in outline. All much enlarged. After Chittenden, Div. of Entomology, Dep. of Agriculture.

the Entomologist, Dr. L. O. Howard, ought to be in the hands of every fruit-grower, gardener, and farmer.

The flea-hopper is a very peculiar insect, as can be seen in the illustration, Fig. 50. It appears in several forms. The color of all is shining black, with pale yellow portions in the feelers and legs, as shown in the picture. The wing-covers are

marked with rather sparse scale-like tufts of yellow hair, which are readily detached, so that older specimens are smooth.

The insects have been found but once in our state, injuring the sugar beets, but they may be much more common than is supposed, as they are difficult to capture, being able to jump many times their own length. They hop from the leaves of the infested plants like genuine flea-beetles. They are found upon many wild plants, but occur also in injurious numbers upon late potatoes, tomatoes, egg-plants, beans, peas, clover, and even grass.

Prof. Popenoe was the first to give an account of their injury to beans in Kansas during the season of 1890: "Living in great numbers on the under side of the leaves of the garden bean, puncturing the tissues, and sucking the sap, and by these punctures causing the death of the tissues in small, irregular patches that appear upon the upper surface of the leaf as white spots. These two species are so nearly alike, so far as habits are concerned, that they may be noticed together. They operate mostly near the ground and upon weak, low-growing sorts. They sometimes do appreciable injury to the plant. The insects of both species are able to jump many times their own length, and when disturbed they hop from the leaves like flea-beetles. They have also been observed to feed upon red clover in the manner and with the effect described above."

Mr. Chittenden thinks that the most feasible method of treatment would be the use of kerosene in some of its forms. A spray of kerosene emulsion, as strong as the plant will bear without injury, would doubtless be effective in the destruction of the bugs in all stages, or they might be jarred from the plants upon which they are feeding onto sheets saturated with kerosene, or into pans of water on which a thin scum of kerosene is floating. For the mechanical method of treatment it would be preferable to go over the infested plants early in the morning or late in the day just before dark, when the insects are less active than in the bright sunlight.

Agalliastes associatus Uhler. *(False Flea-hopper).*

This minute insect, illustrated in Fig. 51, Plate III, is easily mistaken for the insect just described. It is also very active and

black, but possesses no white spots on the wings. During July some fields of sugar beets were swarming with them, but they disappeared soon afterwards without causing any apparent injury.

Another smaller and dark bug, belonging with the one just mentioned to the sub-family Plagiognatharia, was also found in the same fields, but caused no injury. It is called *Plagiognathus obscurus* Uhler.

Hyaliodes vitripennis Say. *(The Glassy-winged Bug).*

This is really a beautiful insect, sometimes found in large numbers in early autumn upon the wild and cultivated grape-vines, and the black and red oaks, where it feeds on tender insects. It can be recognized by the neck-like proportions of the prothorax. See Fig. 52. The eyes project prominently from the sides like beads, and the front is bluntly rounded. The base

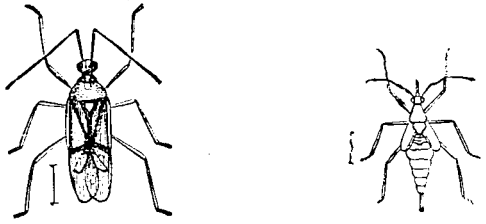


FIG. 52.—*Hyaliodes vitripennis* Say. After Riley.

of the prothorax is broadly convex, the wing-covers are flat and broadly elliptical, with the costal edge strongly carinate. The insect is yellowish-white, with the basal joint of the feelers, back part of the prothorax, and a band across the apical end of the almost transparent wing-covers red, sometimes black; the prothorax is coarsely punctured, and the forward lobe, the last two joints of the feelers, the tip or more of the second joint, and the base of the scutellum, are black. It is a small but active being, measuring about two-thirds of an inch in length.

Wherever the leaves of the wild grape are covered with the peculiar leaf-galls of the Phylloxera, an insect described later, we can be certain to find the bug in large numbers, actively engaged in sucking the lice. For this purpose the young bugs

even enter the inside of the galls, and are thus surrounded by an abundance of food. By killing large numbers of such injurious insects, as well as the injurious leaf-hoppers found on grass, this little bug becomes our friend.

Oncognathus binotatus Fab. *(The Timothy-grass Bug).*

This rather showy bug has been found from time to time sucking the juice of the timothy plant. The insects sometimes crowd in large numbers upon the head of this plant, and can cause some injury. In Europe they are sometimes quite de-

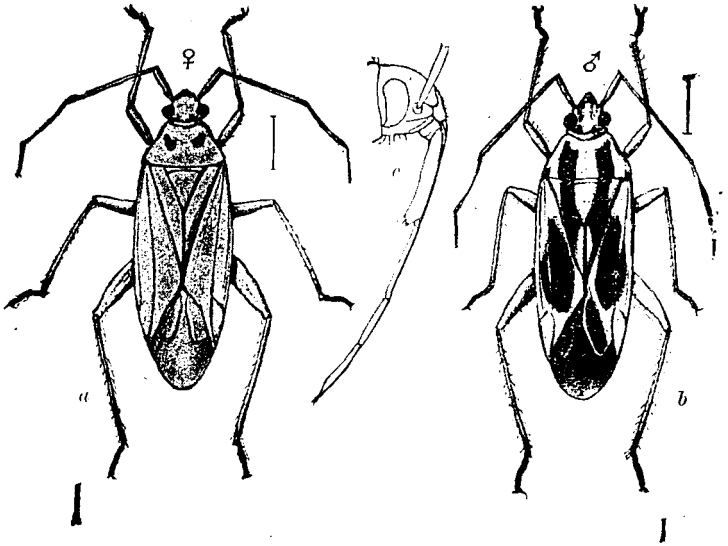


FIG. 53a.—*Oncognathus binotatus* Fab.: *a*, female; *b*, male, enlarged; *c*, head from side, still more enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

structive, preventing the seeds of the infested plants from maturing. Although possessing ample wings, they do not like to fly, but try to escape by hiding, which they do very quickly. The insect, which is shown in Fig. 53, has the sexes differently marked.

As the insect, in all stages, is also frequently found during July along the edges of wheat and oat-fields, it may in future perhaps become a more destructive being than it is at present.

Calocoris rapidus Say, which is very commonly seen upon the heads of such composite flowers as golden rods, thistles, and others, is illustrated in Fig. 54. This insect, well named *rapidus* on account of its rapid motions, belongs to another sub-family, Phytocoraria of the Capsidæ, for which reason it has been illustrated. Usually it is neither injurious nor beneficial, but at times causes considerable injury to the sugar beets. Another European species is illustrated in Fig. 55.

Another sub-family, Loparia, contains some of the brightest colored species of true bugs, in which red, orange, and black colors predominate. Some of the bugs belonging here are very common and are found in large numbers upon the bushes of wild blackberries and gooseberries during the month of July.

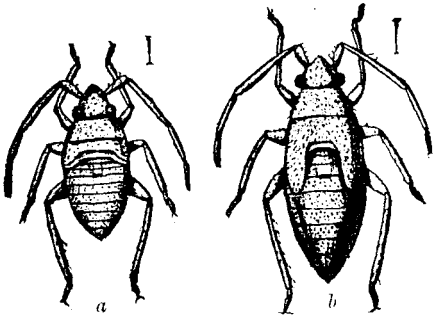


FIG. 53b.—*Oncognathus binotatus* Fab.: *a*, larva; *b*, nymph, enlarged. After Insect Life, Div. of Entomology, Dep of Agriculture.

Lopidea media Say, illustrated in Fig. 56, is very abundant; it is a rather brightly colored bug, being yellowish-red marked with black. Though plant-feeding insects, they have developed a taste for human blood. While camping for a few days upon an island largely covered with wild gooseberries, it was frequently observed upon these plants, where it seemed to feed, like all its near relatives, upon the sap. But soon after the persons living in the camp were bitten very frequently by these bugs, and their bite caused considerable pain and swelling of the bitten part. The bugs would imbibe blood until barely able to fly. But as if to prove their love for human blood they even invaded the tents, and large numbers had to be killed to prevent them from biting.

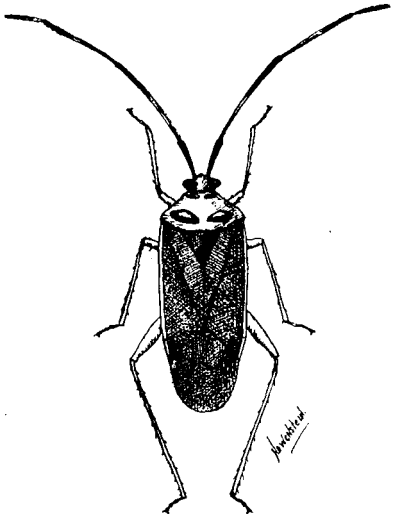


FIG. 54.—*Calocoris rapidus* Say. Original.

FIG. 55.—*Calocoris species.* After Brehm.

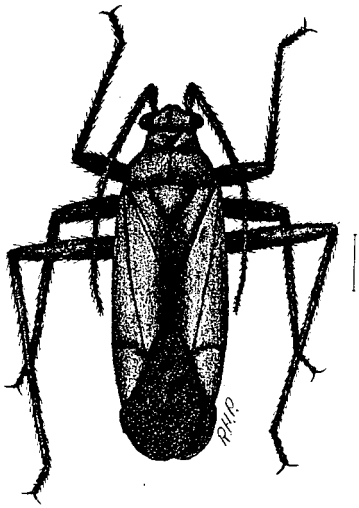


FIG. 56.—*Lopidea media* Say. Original.

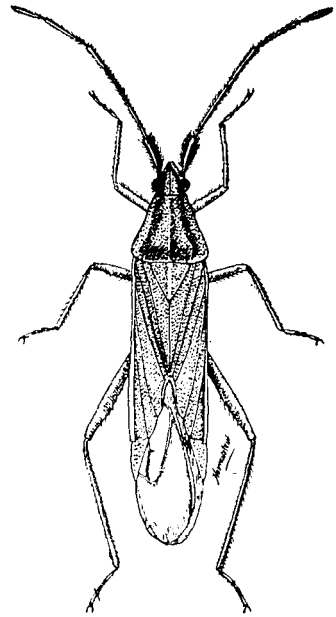


FIG. 57.—*Miris affinis* Reut. Original.

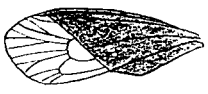
Miris affinis Reut., a member of another sub-family, (Miraria), is illustrated (Fig. 57) to show the form of such insects. It is sometimes decidedly common upon the heads of wheat, barley, rye, and timothy, and is there for no good purpose. If it should become more numerous it will doubtless cause injury to these plants, as the abstraction of sap from kernels just forming, and the introduction of poison, can be of no benefit.

FAMILY PYRRHOCORIDAE.

(Red Bugs).

There is considerable difference between the members of the last family and the one now described. Bugs belonging to the latter are stouter and much more heavily built; they are generally large insects marked with strongly contrasting colors, among which red and black are conspicuous. The venation of the membrane of the wing-covers also gives a distinguishing character. There are two large cells at the base of the membrane, from which branching veins arise, as shown in the illustration in the text.

Largus succinctus Linn. This large bug, shown in Fig. 58, is not a common insect in our state, but it has been repeat-



Upper wing of *Pyrrhocoridæ*.

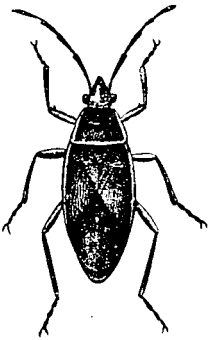


FIG. 58.—*Largus succinctus* Linn. After Uhler.

edly captured in the southern part of it. It is brownish-black, broad, ovate, with an opaque upper surface; the under side is coated with a fine bluish pubescence. The prothorax is margined behind and on each side with orange or red, and the same colored margin extends along the costal margins of the wing-covers; the trochanters and the bases of the femora are marked with the same color, which varies greatly in intensity in the different specimens. The males are usually much narrower than the females, who measure a little more than one-half an inch in length. The younger stages of this insect look quite different from the adult ones, being of a brilliant steel-blue color, with

reddish legs and a bright red spot at the base of the abdomen. The insects seem to feed mainly upon other insects, and they have been found to be very useful in California by eating the destructive cottony cushion scale, at one time threatening to destroy entirely the orange groves of that state.

Dysdercus suturellus H. Schf. *(The Cotton-stainer),* illustrated in Fig. 59, is a southern insect which does much injury by piercing the stems and bolls of the cotton-plant and sucking the juices, but causes even more damage by staining the cotton

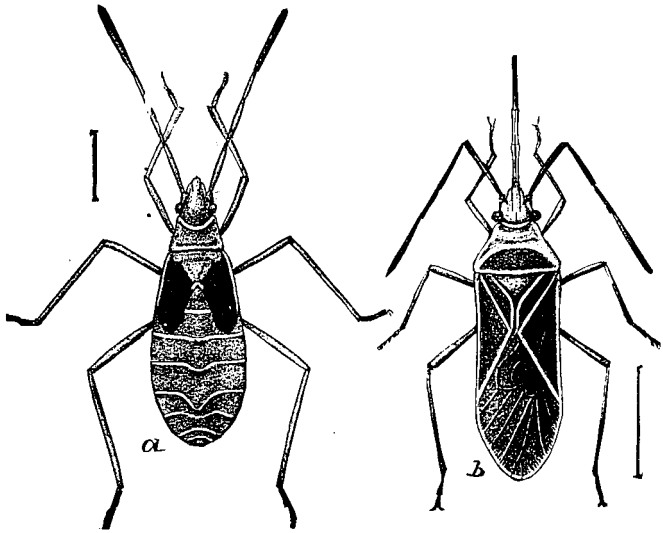


FIG. 59a.—*Dysdercus suturellus* H. Schf.: *a*, fourth stage, or pupa; *b*, adult—both enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

in the opening bolls. In Florida these bugs puncture the rind of oranges, which causes them to decay, so that the fruit drops. The insect is oblong-oval in form, of a red color; wing-covers, an arc at the base of the prothorax, and the scutellum, are pale brown. The costal margin of the wing-covers, a narrow line bordering the base of the membrane, extending diagonally across the clavus, are pale yellow.

Prof. Comstock writes that these insects can be trapped by laying chips of sugar-cane around the cotton fields. In orange groves heaps of cotton seeds as well as pieces of sugar-cane will be found useful, as the insects will collect in these places and can be scalded to death.

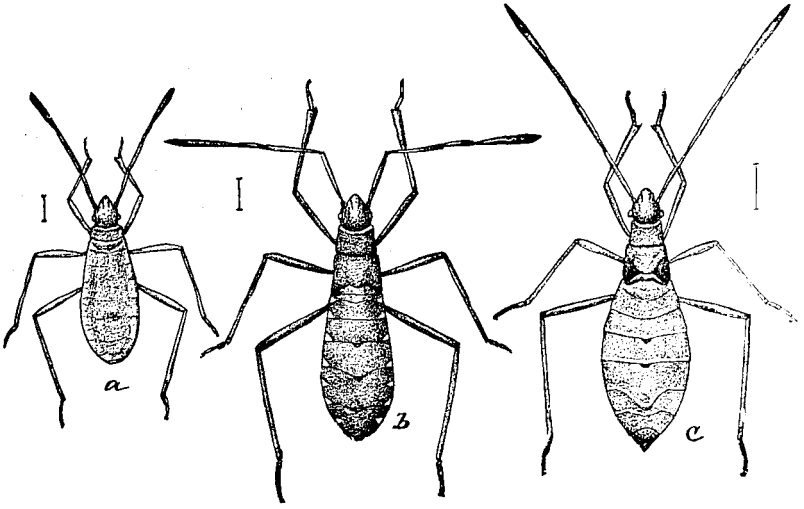


FIG. 59b.—*Dysdercus suturellus* H. Schf.? *a*, first stage; *b*, second; *c*, third. All enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

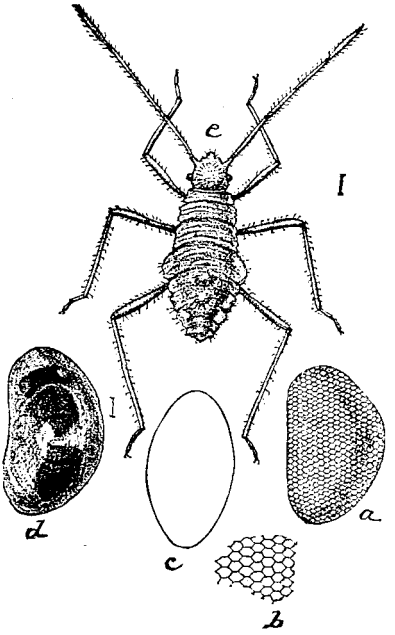


FIG. 59c.—*a*, egg taken for that of *Dysdercus suturellus* H. Schf., by Comstock, enlarged; *e*, dorsal view of same egg; *d*, with contained parasite; *c*, larva from same. All enlarged. After Insect Life, Div. of Entomology, Dept. of Agriculture.

FAMILY LYGAEIDAE.

(Chinch-bug Family).

This is another family of true bugs, divided into nine sub-families, which differ from each other chiefly in details of the parts of the prothorax. It includes species closely resembling the members of the preceding family in size, form, and strongly contrasting colors, yet the great majority are smaller and less gaudily colored and marked; but all differ from that family by the possession of distinct ocelli. The membrane of the wing-covers (see illustration in text) possesses four or five simple veins which arise from its base; the antennæ are inserted below an ideal line extending from the eye to the base of the beak, and the vertex is not constricted in front of the ocelli.

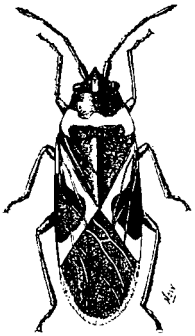
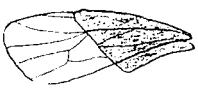


FIG. 61.—*Lygæus turcicus* Fab. Original.



Upper wing of *Lygæidæ*.

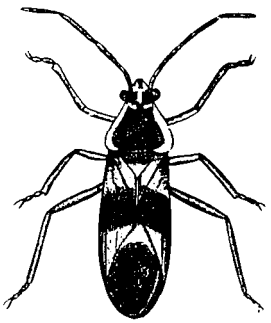


FIG. 60.—*Oncopeltus fasciatus* Dall. After Uhler.

As there are nearly fifty genera of such insects in the United States alone, many of which occur in our own state, it is of course impossible to describe them all, and only a few of the more important ones will be considered in these pages. In the sub-family Lygæina occur a number of large, chiefly red insects, banded with black across the wing-covers.

Oncopeltus fasciatus Dallas *(The Milk-weed Bug)* is very common upon the larger kinds of milkweeds (Asclepias). Like the other members of this sub-family it has the nearly conical head set well back in the prothorax, so that the eyes are directly in contact with the same. This bug has the legs, feelers, beak,

sides and middle line of the head, disk of the prothorax, scutellum, most of the breast, dots along the sides of the abdomen, its tip, and two spots on each side of the middle of the venter, black. A broad, black, transverse band is found across the middle of the wing-covers, and the membrane is also of the same color. It is a very showy insect, but is of no economic importance as it is only found upon the plants already named. The insect is illustrated in Fig. 60.

Lygæus turcicus Fab., illustrated in Fig. 61, is also very common in our state, as is the similar *L. reclivatus* Say. The former species, smaller than the milkweed bug, has a bluish-black triangular area surrounding the scutellum, and a large spot of the same color on each wing-cover, as well as on each

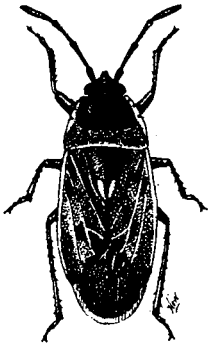


FIG. 62.—*Trapezonotus nebulosus* Fab. Original.

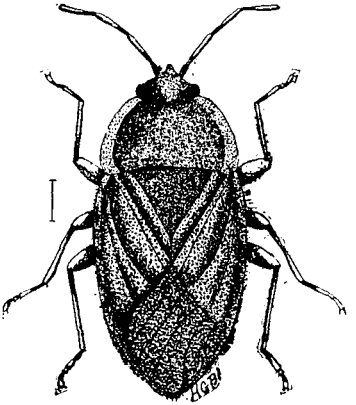


FIG. 63.—*Emblethis arenarius* Linn. After Bruner.

side of the head. Both species are frequently found early in spring running over the wooden sidewalks, very likely because these are warmer and drier than the ground. They are found again late in fall, searching for quarters in which to pass the winter.

In the sub-family Myodochina occur a number of species which are frequently mistaken for the true chinch-bugs. Some of them occur in such vast numbers late in autumn as to cover whole fields, thus alarming the farmers. This is especially true of two kinds, the *Trapezonotus nebulosus* Fab., illustrated in Fig. 62, and the *Emblethis arenarius* Linn. (Fig. 63), which

are rather beneficial, as they are strictly weed-feeders, preferring as food such plants as purslane, chenopodians and amarantus. A superficial comparison of these bugs with the true chinch-bug illustrated elsewhere will show that the insects are quite different, not alone as adults, but also in their earlier stages. Both, however, possess the characteristic chinch-bug odor, hence the mistake.

Myodocha serripes Oliv., shown in Fig. 64, also belongs to this sub-family. It can be recognized by its long and narrow shape, with the head attached to a long and slender neck, which ends in a bell-shaped prothorax. The femora of the front legs

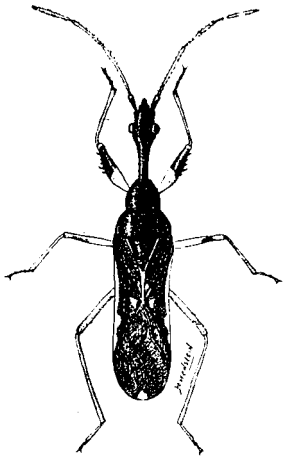


FIG. 64.—*Myodocha serripes* Oliv. Original.

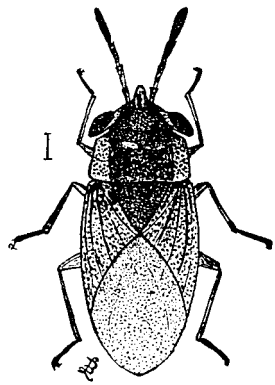


FIG. 65.—*Geocorus bullatus* Say. After Bruner.

are swollen in the middle, and are armed with a number of teeth of unequal length on the under side. The insect is black, with the margin, sutures, veins, and some spots on the wing-covers, the tip of the scutellum, and the legs, pale yellow. It is about one-third of an inch in length, and is quite common in some places, but chiefly among stones and rubbish of all kinds, where it finds suitable shelters in which to pass the winter. "It is rendered very comical by the swinging of the long antennæ with their thickened apical joint, while running over the ground among stones and rubbish of its favorite haunts. Meadows and rich soils in thin woods furnish it with needed shelter, and there it

may be found throughout the entire year, half concealed by bits of twigs and dead leaves, or stowed away beneath the loose fragments of rock which lie scattered over the ground." (Uhler.)

In the sub-family Geocorina we find a few insects very remarkable on account of their large and projecting eyes, for which reason they are frequently called "Big-eyes." One species (*G. bullatus* Say) is illustrated in Fig. 65. These bugs are sometimes exceedingly numerous and not unfrequently cause alarm by their presence, as farmers are apt to conclude that they are the injurious chinch-bugs. Yet they are perfectly harmless, feeding upon many kinds of low-growing weeds. They possess another point in their favor, as they have been seen to actually eat the farmer's great enemy, the chinch-bug.

The sub-family Blissina contains the dreaded chinch-bug, an insect only too well known as one of the greatest enemies of the grain-growing farmer. Much has been written about this insect, and a number of bulletins were issued by the writer, which can still be obtained by writing for them to the office of the Experiment Station of the University of Minnesota at St. Anthony Park. It would require too much space to quote all that has been written about this pest. Prof. Comstock, in his Introduction to Entomology, gives the following short account, which may suffice for the present:

Blissus leucopterus Say. *(The Chinch-bug).*

"This well-known pest of grain-fields is a small bug, which when fully grown measures a little less than 4 mm. (0.16 in.) in length. It is blackish in color, with conspicuous snowy white wing-covers. There is on the costal margin of each wing-cover, near the middle of its length, a black spot; from each of these spots there extends toward the head a somewhat Y-shaped dusky line. The body is clothed with numerous microscopic hairs. In Fig. 66, Plate I, this insect is represented natural size and enlarged. The species is dimorphic, there being a short-winged form.

"There are two generations of the chinch-bug each year. The insects winter in the adult state, hiding beneath rubbish of any kind; they even penetrate forests and creep under leaves, and into crevices under bark. In early spring they emerge from their winter quarters and pair; soon after the females begin to

lay their eggs; this they do leisurely, the process being carried on for two or three weeks. The eggs are yellowish; about 500 are laid by a single insect; they are deposited in fields of grain, beneath the ground upon the roots, or on the stem near the surface. The eggs hatch in about two weeks after being laid. The newly-hatched bugs are red; they feed at first on the roots of the plants which they infest, sucking the juices; afterwards they attack the stalks. The bugs become full-grown in from forty to fifty days. Before the females of this brood deposit their eggs they leave their original quarters and migrate in search of a more abundant supply of food. About this time the wheat becomes dry and hard; and the migration appears to be a very general one. Although the insects sometimes go in different directions, as a general rule the masses take one direction, which is towards the nearest field of corn, oats, or some other cereal or grass that is still in the succulent state. At this time many of the bugs have not reached the adult stage; and even in the case of the fully winged individuals the migration is usually on foot. In their new quarters the bugs lay the eggs for the second or fall brood.

"Satisfactory means for preventing the ravages of this insect are yet to be discovered. Something can be done by burning in autumn all rubbish about fields, in fence-corners, and in other places where the bugs have congregated to pass the winter. The marching of the spring broods into new fields has been stopped by means of ditches, as is done with the army worm. Some farmers have accomplished the same purpose by making a line of gas-tar on the ground; the bugs will not pass such a line, but it is necessary to replace it frequently. In some cases kerosene emulsion can be used to advantage."

To this may be added that possibly the chinch-bug may only be single brooded in some localities, and that it is frequently almost annihilated by a number of diseases, one of which is shown in Fig. 67.

In the small sub-family Nysiina we have a few well-known species, some of which are sometimes almost as abundant as the genuine chinch-bug, and for that reason have received the name of "Bogus Chinch-bug" or "False Chinch-bug."

Nysius angustatus Uhler, *(The False Chinch-bug)* is a very general feeder, and sometimes decidedly injurious, as it is found

damaging the grape-vine, strawberry, young apple grafts, potatoes, turnips, radishes, beets, cabbages, lettuce and other plants. Strawberry plants are especially apt to be injured. Generally speaking, however, this bug seems to prefer cruciferous plants and to avoid grasses and cereals. Potato-leaves infested by these insects show little rusty and circular specks or holes wherever the beak has been inserted. No doubt this insect, like the chinch-bug, injects a small quantity of poison while inserting the sucking organs, and this poison is powerful enough to darken the surrounding area. If the bugs are at all numerous they soon

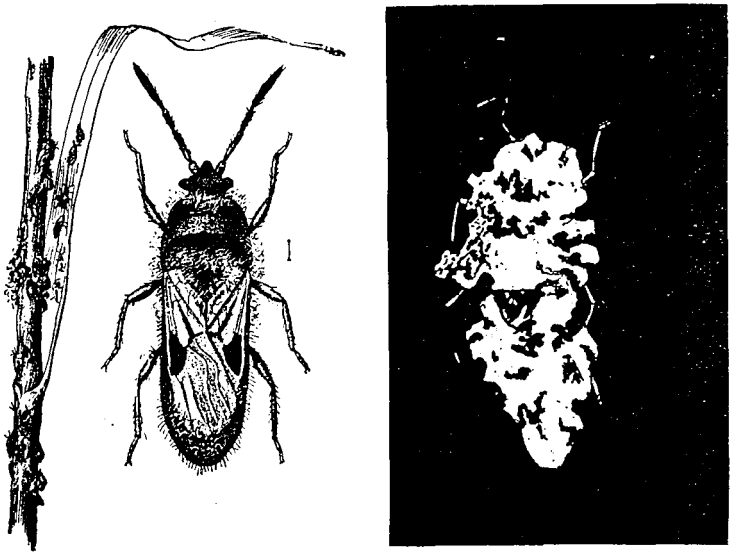
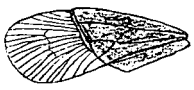


FIG. 67.—Diseased Chinch-bugs. Original. Greatly enlarged, and natural size on stems of wheat.

cause the invaded plants to wilt and die. The adult insect is shown in Fig. 68, *c;* it is an active being, taking alarm very readily, and arises in swarms when disturbed. The young wingless bugs are much paler than the mature insects, and are marked with more or less distinct longitudinal dark lines on the head and thorax. The so-called pupa, Fig. 68, *b,* has the front part of the body marked with more distinct red and brown lines, with the abdomen paler, and with longitudinal mottlings of a pinkish color.

Wet weather, as with the true chinch-bugs, is unfavorable to their development and increase, and even in early morning after a cold night with some dew, they are quite sluggish, and do not attempt to escape by flight, but rather hide in wilted leaves. Wherever purslane grows this insect is common, and this spreading weed, covering the ground rather closely, makes excellent hiding and hibernating quarters. Clean cultivation best prevents the injuries of the bug. The burning of all trash found among the plants to be protected will also greatly lessen their numbers, and these two methods are about the only practical remedies. Prof. Forbes finds that Pyrethrum, (Persian Insect-powder), and kerosene-emulsion, are perfectly satisfactory against this insect as well as against the Tarnished Flower-bug already described.



Upper wing of *Coreidæ*.
(Page 77.)

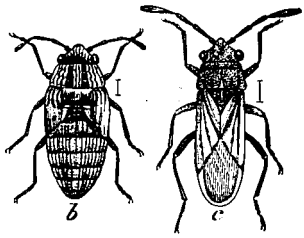


FIG. 68.—*Nysius angustatus* Uhler.
After Riley.

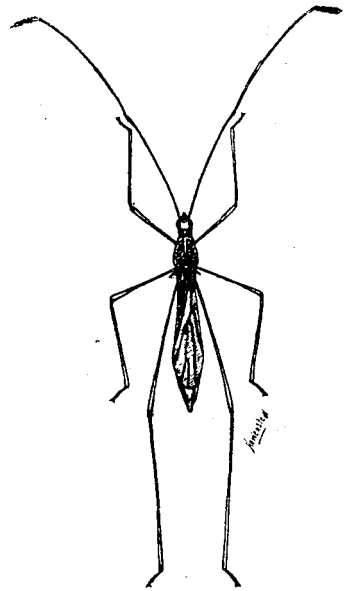


FIG. 69.—*Jalysus spinosus* Say.
Original.

FAMILY BERYTIDAE.

(Stilted Bugs).

This family contains but a few species of bugs, which are very striking in appearance, being extremely attenuated in all their proportions. They have a long and narrow body, with

very long and extremely slender feelers and legs. A transverse incision occurs in the vertex in front of the ocelli. The four-jointed feelers are elbowed at the base of the second joint, and the tip of the terminal joint is enlarged. The beak is also four-jointed; the membrane of the wing-covers is furnished with a very few veins. Their colors are chiefly sober tawny or pale yellow, with markings of black and white. To show the general appearance of these crane-fly like beings, the illustration of *Jalysus spinosus* Say has been prepared, Fig. 69. In this species the vertex is not furnished with a prominent spinous process, but possesses a distinct carina; there is a small spine on the scutellum, and one on each side of the thorax in front of the coxa.

The insect measures about one-third of an inch in length, is rather sluggish, and occurs in the undergrowth of oak woods.

FAMILY COREIDAE.

(Squash-bug Family).

This is one of the most extensive families of true bugs, and is divided into many sub-families. It is characterized as follows: "The antennæ are inserted above an ideal line extending from the eye to the base of the rostrum, and are four-jointed; the vertex is not transversly impressed; the ocelli are present; the rostrum is four-jointed; the scutellum is small or of medium size; the wing-covers are usually complete and composed of clavus, corium and membrane; the membrane is furnished with many veins, which spring from a transverse basal vein, and are usually forked; the tarsi are three-jointed." (Comstock).

The family contains both vegetable feeders and carnivorous forms; in some cases the same species will feed upon both plants and insects. Only a few of the more common species will be described and illustrated.

The sub-family Leptocorisina forms a sort of connecting link with the bugs just described and the following ones. Here the body, feelers and legs are also long, but not so slender as in the Berytidæ. The head has two protracted lobes with a gutter between them, or these are separated. The best known member of this sub-family is the box-elder bug, *(Leptocoris trivittatus*

Say), illustrated on Plate II. Fig. 70. It was described in a former report which is now entirely out of print, and as there is a constant demand for information about this insect, the article is repeated.

Leptocorisa trivittata Say. *(The Box elder Bug).*

There are few insects that have created such a sensation, such a fear, as the above bug during the last four years in Minnesota. Early in September, and all through October and the early part of November, the letter carrier never failed to bring his daily ration of letters asking for information in regard to it. Packages of all kinds arrived at the office of the entomologist and almost invariably contained specimens of this brightly colored insect. Some writers feared that these bugs might be an improved breed, an enlarged edition of the chinch-bugs; others complained by stating that bed-bugs were bad enough, and that they did not care for an addition of domestic insects so much larger than those cultivated before. This fall such inquiries were so numerous that it was deemed best to publish articles about this insect in most of the daily papers and thus to allay to some extent all exaggerated fears. The insect is not as bad as its long scientific name would indicate; in fact such long names are only of a threatening aspect to people who have not studied any branch of natural history. It is frequently asserted that the smallest animals have the longest names; this is not so, however, as some larger ones are distinguished by names that are long in proportion to their size. Scientific names are a necessity, though they may appear an evil to some persons.

The Box elder Bug has indeed so suddenly increased in numbers in our state that most people claim that they were only recently introduced. This is not the case, however, as they are old settlers, older than any member of the "Early Settlers' Association." But they have not forced themselves upon the attention of our citizens until during the last few years. Their rapid increase, or rather the reason that they are at present noticed so much more frequently, is owing to the fact that the box elder is now grown more commonly along our streets in cities and towns than formerly. Being a very hardy tree, one of the best adapted for villages in the open prairies, they are there most

usually selected for shade-trees. They form also a large proportion of the trees utilized for wind-breaks and timber claims. Considering this rapid increase in their numbers it is no wonder at all that insects which utilize this tree as food should also increase very rapidly. This has been the case, and where a few years ago the Box elder Bug was an unknown insect it is now found in large and increasing numbers. Still this great increase would not be noticed, or only by a few more observing persons, if this insect did not possess the peculiar habit of crowding together late in autumn, preliminary to searching for suitable quarters to hibernate. As soon as the foliage of the box elder becomes dry and discolored, or, in other words, as soon as the leaves of the tree no longer offer liquid sap to the insects, these desert such useless sources of food, and descend to the limbs and trunks of the trees. Here they gather in large numbers, perhaps to hold indignation meetings about the shortness of summer and food supplies! At all events they crowd together, old and young, as if waiting for better times. Whenever the sun shines and warms one side of the trunk, or the sidewalk below the tree, there these bugs are sure to congregate. Later, and when the leaves commence to drop, all bugs have reached their full size, all are winged. But they do not use their wings, and are very sensible not to do so, because they assuredly would be blown about the adjoining prairies and would perish. They now search for winter quarters. If the sidewalk under the box elder trees, their old homes, should be a wooden one, most of the bugs will find shelter under it. If no such shelters are found, however, the insects enter barns and stables, and are not slow to even enter houses, much to the disgust of the ladies of the household. The bugs are decidedly stupid, at least they cannot be scared away, but have to be forcibly ejected. This habit of crowding into dwellings has been the cause of many complaints.

The life-history of this box elder bug is told in a few words: here in Minnesota it infests only the box elder, not having as yet been found injurious to other trees. The bugs, being sucking insects, insert the organs of suction, which are enclosed in their beaks, into the tissue of the leaves, always choosing their under side. Here they live in plenty, undergoing all their changes from a young larva to the adult insect, until the supply

of liquid food flows more and more slowly, when they are forced to leave, as has already been mentioned. Frequently eggs are found early in the spring upon all sorts of things stored away in our out-houses. This should not cause such a fear as was expressed in a letter, in which the writer asked whether the insects resulting from such eggs would injure his new self-binder, as that machine had been covered with eggs. Most of the young bugs hatching from eggs deposited in such situations will die before reaching a suitable tree. To kill these bugs is not an easy matter, as they cannot be poisoned like insects with a biting or a chewing mouth. To kill them at all would require a powerful spraying machine, by means of which the entire tree could be thoroughly sprayed. Such a machine is not found in the possession of people having only a dozen or so of shade-trees in front of their houses, nor could we expect this. But as the cities and villages are interested in good and healthy shade-trees in their streets and parks, the authorities should buy sufficient good spraying outfits, and should engage men to use them frequently and intelligently, not alone against the box elder bug, however, but against all insects infesting our shade trees. During the warmer parts of the season most of the shade-trees are in a decidedly bad condition, owing to all sorts of insects, but chiefly to leaf-lice of various kinds. A forcible spraying, even with pure water alone, would be a wonderful blessing to such dusty and bug-infested trees, while repeated spraying with kerosene-emulsion would soon transform the neglected and unsightly trees into things of joy and beauty. Under the head of leaf-lice and elsewhere formulas are given for kerosene-emulsion. Farmers possessing wind-breaks should all possess spraying machines.

The box elder bugs have one peculiar habit that we can utilize to keep them from becoming too numerous. They crowd together during the autumn, and are very slow and apparently stupid during the colder parts of the day. As they gather together in large numbers, such meetings could be enlivened by the owners of the trees injured by these insects by pouring some boiling hot water over their enemies. This would dispose of many. Other meetings could be broken up by sweeping the bugs into tin pans or directly into the fire. The free use of kerosene-

oil upon the bugs upon sidewalks or other places is also a good way of reducing their numbers; of course the oil should in no case be thrown upon the trunks of trees for that would be apt to kill them. In fact the bugs should be killed whenever and wherever seen, since otherwise they will increase still more, and to the great injury of the box elder.

The illustration on Plate II shows this insect in its different stages; the adult, shown both enlarged and in natural size, is a bright-colored insect. All the parts shown black in the illustration are of that color in the insect, while the light colored parts are a bright red. In other words this bright color forms three broad lines over the black thorax, whence the latin name *trivit-*

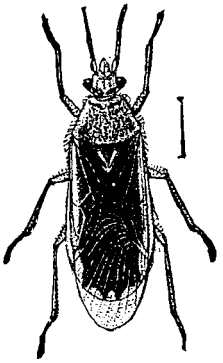


FIG. 72.—*Corizus hyalinus* Fab. After Riley. Div. of Entomology, Dep. of Agriculture.

FIG. 73.—*Harmostes reflexulus* Stal. Enlarged and natural size. After Glover.

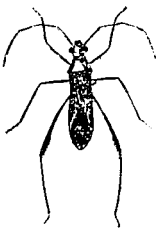


FIG. 74.—*Alydus 5-spinosus* Say. After Glover.

tatus, or three-banded. The harder parts of the wings are edged with red, and all the veins are of the same but more dingy color. The earlier stages of this insect are distinguished by the same color, which, being even brighter red than in the adult insect, enables us to readily detect it.

The sub-family Rhopalina contains a number of very common bugs, two of which are shown. They are of little economic importance, although *Corizus hyalinus* Fab. (Fig. 72) is known as an enemy to the cottony cushion-scale; it is similar to our *C. lateralis* Say. Related species, as *Harmostes reflexulus* Stal. (Fig. 73) are also common. The latter belongs to another division of the Coreidæ, but is closely allied to the one under discussion.

The sub-family *Alydina* also contains some very common bugs. They are of a moderately narrow form, with a sub-conical head contracted behind the eyes, the last joint of the feelers thickened, and the hind pair of femora enlarged towards the tip, and armed beneath with unequal spines.

Alydus eurinus Say, is very common, and is found late in autumn and early in spring running over wooden sidewalks. It is of a rather uniform dark brown dotted with minute darker specks; others equally abundant, are *A. 5-spinosus* Say, shown in Fig. 74, which is much lighter in color, with reddish legs; *A. pluto* Uhler is black. All have similar habits, and none are injurious, feeding mainly on animal food.

The sub-family Anisoscelaria contains moderately and even very large bugs, some of which are decidedly injurious.

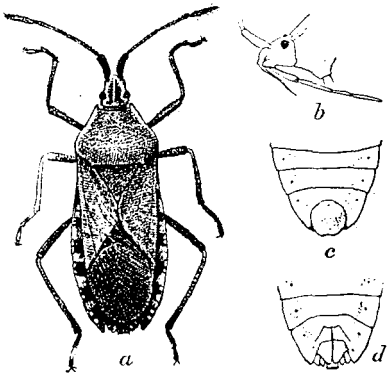


FIG. 75.—*Anasa tristis* DeG.: *a*, mature female; *b*, side view of head, showing beak; *c*, abdominal segments of male; *d*, same of female;—*a*, twice natural size; *b*. *c*. *d*, slightly more enlarged. After Chittenden, Div. of Entomology, Dep of Agriculture.

Anasa tristis De Geer. *(The Squash-bug).*

This is only too well known as one of the most annoying of the many pests of the kitchen gardens, and wherever members of the cucumber family of plants are grown upon a large scale for the market, this insect is apt to cause much trouble. At present it is not common in Minnesota, but seems to be on the increase, hence it is wise to be prepared for it.

In bulletin 19 of the Division of Entomology, Department of Agriculture, Mr. Chittenden has written a full and illustrated account of this insect, which is shown in all stages in Fig. 75.

The adult insect is dirty dark brown above and mottled yellowish beneath. Those especially interested in the life-history of the insect should consult the above bulletin. The eggs, shown in another illustration, are beautiful objects; they are of a polished dark coppery or bronzy brown color.

The insect has a number of enemies; but they are not sufficient to keep it in check. In fact it is a difficult being to combat, as it is unusually resistant to all insecticides, particularly the adult. Mr. Chittenden advises the following methods:

"Protection of young plants with coverings; repellents such as land plaster or gypsum saturated with kerosene or turpentine;

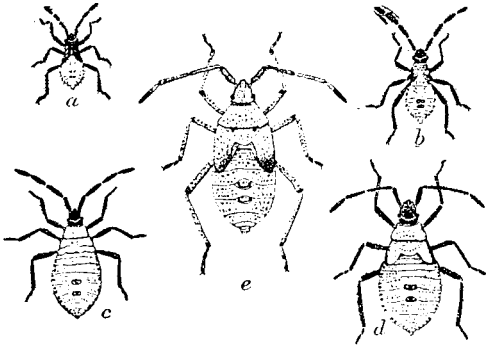


FIG. 75.—Nymphs of *Anasa tristis* DeG.: *a*, newly hatched; *b*, second stage; *c*, third stage; *d*, fourth stage; *e*, fifth stage—all about twice natural size. After Chittenden, Div. of Entomology, Dep. of Agriculture.

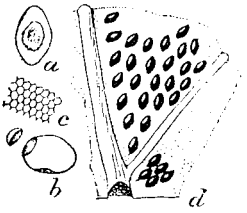


FIG. 75.—Egg of *Anasa tristis* DeG.: *a*, from below, showing point of attachment; *b*, from side, showing place of escape of nymph; *c*, sculpture of egg; *d*, egg cluster; *a*, *b*, about five times enlarged; *d*, one-fourth enlarged; *c*, greatly enlarged. After Chittenden, Div. of Entomology, Dep. of Agriculture.

planting an excess of seed to distribute attack; stimulating the growth of the plants by manure or other fertilizers, and lastly, clean cultural practice. If the precaution be observed of gathering the vines as soon as the crop is harvested and burning them, many bugs in their different stages will be destroyed and the crop of insects reduced for the ensuing year.

"Other methods in general use against this species are hand-picking early in the season and the trapping of the bugs by means of boards, pieces of bark, or similar material, placed about on the ground in the garden. (Under such material the insects will find shelter during the winter).

"Protection to cucurbits, other than squash and perhaps pumpkin, can be secured by growing these plants with the others to serve as trap crops. Attack will thus be centered upon a few plants, when the insects can be more readily controlled by the measures already mentioned."

Anasa armigera Say *(The Horned Squash-bug)* is also found in our state. It is shown in Fig. 76. Being very similar in general appearance it has frequently been received by the entomologist as the squash-bug. The insect has similar food habits, and the same remedies apply to both.

Catorhintha mendica Stal., illustrated in Fig. 77, is also quite common in our state and is frequently mistaken for its more de-

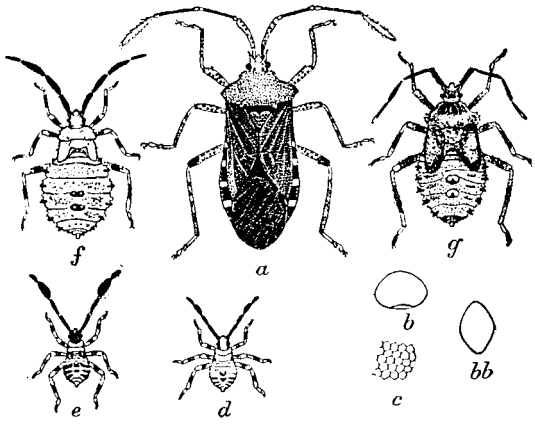


FIG. 76.—*Anasa armigera* Say.: *a*, mature form; *b*, egg in profile, from side; *bb*, same from above; *c*, sculpture; *d*, newly hatched nymph; *e*, nymph after first molt; *f*, nymph fourth stage; *g*, nymph fifth stage.—*a*, twice natural size; *d*, *e*, *f*, *g*, nearly the same; *b*, *bb*, more enlarged; *c*, greatly magnified. After Chittenden, Div. of Entomology, Dep. of Agriculture.

structive relative. But it is not found at all upon any of the cucurbits, being found only upon *Oxybaphus nyctagineus,* a wild plant very common near the sandy shores of our numerous lakes.

Leptoglossus oppositus Say. *(The Northern Leaf-footed Plant-bug).*

This is another insect destructive to melon vines, but is very uncommon in our state, only a single specimen having been seen. It is a large and interesting insect, with remarkable leaf-like expansion along the shanks of the hind legs. The insect is shown

in Fig. 78. Although stated to possess carnivorous habits, it is not slow to attack fruit-trees as well, where it punctures the fruit, sucking the juice, so that it withers, bearing scars and marks of injury. Another much more southern species, the *L. phyllopus* Linn., is a well known enemy to the orange and other tropical fruits, but is also found upon the cucurbits. It is shown in Fig. 79.

The sub-family Mictina embraces the largest and the brightest insects of the family. One species, the *Euthoctha galeator* Fab. is sometimes found in our state. It is brownish-gray; the membrane is nearly black; and each projecting segment of the

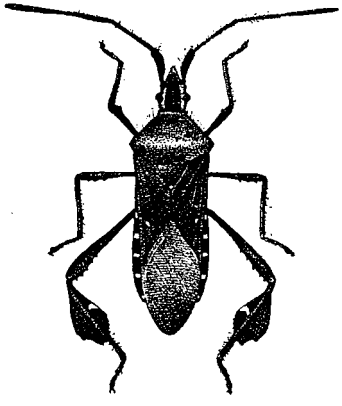


FIG. 78. — *Leptoglossus oppositus* Say. Twice natural size. After Chittenden, Div. of Entomology, Dept. of Agriculture.

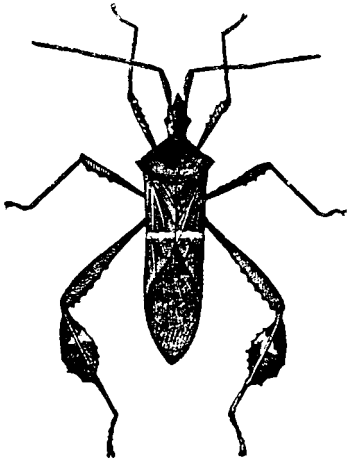


FIG. 79.—*Leptoglossus phyllopus* Linn. Twice natural size. After Hubbard, Div. of Entomology, Dep. of Agriculture.

abdomen is marked with a white line, plainly visible from above. It can be recognized from related species by the greatly swollen thighs and slender tibiæ. The insect seems to be a general feeder, and has been repeatedly found in fields planted with sugar beets. The eggs, fastened in irregular clusters to leaves and stems, are of a peculiar golden color, and oval in shape. This bug, illustrated in Fig. 80, is frequently found on blackberries and raspberries, but seems to cause no damage.

Another sub-family, Acanthocephalina, embraces some of our larger forms of true bugs.

Metapodius femoratus Fab. *(The Cherry Bug).*

This insect is stated to injure the fruit of the cherry by puncturing it with its beak, and sucking its juices, showing its good taste by preferring the sweeter varieties. It is sometimes very common in our state, though cherries are almost unknown as a Minnesota fruit. In the South it has been observed to destroy the cotton worm. The insect, illustrated in two stages in Fig. 82, can be recognized by the dark brown color and rough upper surface, with a blade-like process projecting from the forehead, and by the thick, curved, knobby hind femora armed with coarse, curved teeth, and the plate-like expansion along the hind shanks.

FIG. 77.—*Catorhintha guttula* Fab. After Glover.

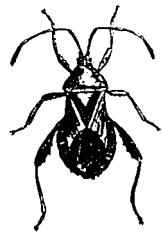


FIG. 80.—*Euthoctha galeator* Fab. After Glover.

FAMILY PENTATOMIDAE.

(Stink-bug Family).

Prof. Comstock writes very feelingly, showing that his remarks were based upon experience, that "this is a family the taste and odor of which most of us know to our sorrow. We learn the flavor in one experience, and conclude that once is enough for a life-time. To those who live in cities it may always remain a mystery why one berry looking just like another should taste and smell so differently; but all bare-footed boys and sun-bonneted girls from the country who have picked the wild strawberries on the hill-sides or scratched their hands and faces in raspberry patches, know well the angular green or brown bugs that leave a loathsome trail behind them; and they will tell you, too, that the bugs are worse than their trail, for it is a lucky youngster that has not taken one of these insects into his mouth, by mistake, with a handful of berries.

"It should not be concluded, however, that only members of this family possess this disagreeable odor; for most of the heteroptera protect themselves by rendering their bodies unpalatable in this way. Doubtless birds soon learn this fact, and leave such bugs alone. But it is to members of this family that the expressive name given above is commonly applied. The nauseous odor is caused by a fluid which is excreted through two openings, one on each side of the lower side of the body near the middle coxæ."

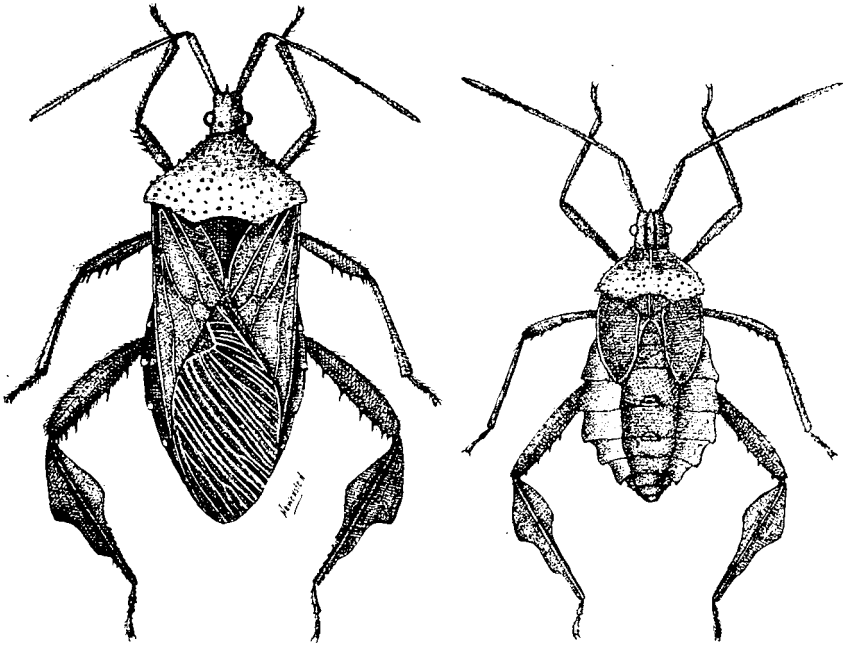


FIG. 82.—*Metapodius femoratus* Fab. Adult and immature. Original.

The insects forming this large family possess five-jointed feelers; their body is short, broad, and rather thick. A large scutellum is always present; it is more or less flattened and triangular in outline, tapering to almost a point posteriorly. The lateral borders of the scutellum have a groove into which the wing-covers fit when not in use. In most members of this family head and prothorax together form a triangle; the tibiæ are either unarmed or furnished with very fine short spines. Some members of the Pentatomidæ are predaceous, others are vegetable

feeders, and still others feed both upon animal and vegetable food.

In the northern part of our state we very commonly find a rather prettily marked bug illustrated in Fig 83. *Acanthosoma cruciata* Say, an insect belonging to the pine regions. It is of no economic importance.

Nezara pennsylvanica DeG. *(The large green Tree Bug).*

This bug, illustrated in Fig. 84, is from six to seven tenths of an inch long, flattened in form, of a grass-green color, margined with a light yellow line, which is interrupted at each point of the abdomen with a small black spot. The feelers are black, with yellowish on the basal and terminal joints.

This is not a common bug in our state, and is much more frequently detected by the odor than by the eye. During September it occurs on grape-vines and other plants. If fruits are eaten that have come in contact with this insect we are very apt to detect it and to refuse to eat the contaminated berries.

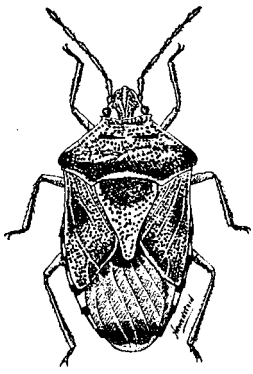


FIG. 83.—*Acanthosoma cruciata* Say. Original.

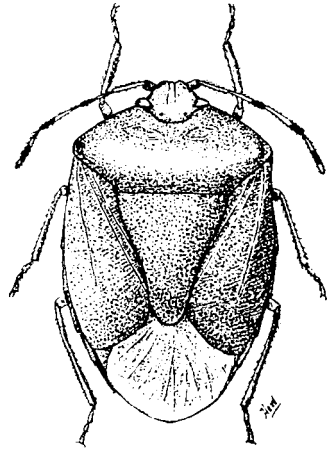


FIG. 84.—*Nezara pennsylvanica* DeG. Original.

Murgantia histrionica Hahn. *(The Harlequin Cabbage-bug).*

This is a very fine looking bug, and instead of smelling as badly as the one just mentioned, some people claim that they like its odor. Of course there is no quarreling about taste! But notwithstanding this it is a very bad insect, and our market gardeners are to be congratulated that it is as yet not found in our state, as it plays havoc with the cabbages and other cruciferous plants, even attacking the cucurbitæ. It seems, however, as

if it were gradually coming northward. Much has been published about this insect. Prof. Comstock writes as follows:

"Among the species of the Pentatomidæ that feed upon cultivated plants, the Harlequin Cabbage-bug, or 'Calico-back' as it is called in some sections, is the most important pest. It is a very common insect in the Southern States. It occurs from New Jersey southward and westward. I have specimens from Colorado and Arizona. It feeds upon cabbages, turnips, and other cruciferous plants; it is also found sometimes on plants not closely related to the cabbage. The adult bug measures about ten mm. (0.4 in.) in length. It is polished blue-black, banded, striped, and margined above with yellow and orange spots; and

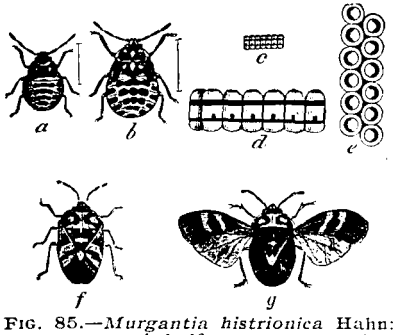


FIG. 85.—*Murgantia histrionica* Hahn: *a*, young; *b*, half grown; *c*, egg cluster; *d*, from side; *e*, same from above, *f*, adult, wings closed; *g*, same, wings open; *c*, *f*, *g*, natural size; *a*, *b*, slightly enlarged; *d*, *e*, considerably enlarged. After Riley, Div. of Entomology, Dept of Agriculture.

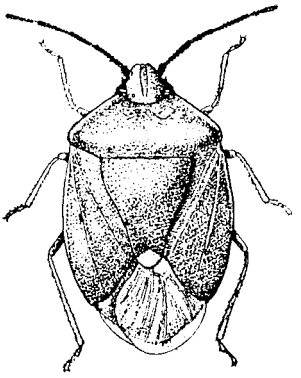


FIG. 86.—*Lioderma ligata* Stal. Original.

the head has generally two white spots on the front. The relative proportions of the black and the light colors vary greatly in the different specimens. This bug winters in the adult state; in early spring it emerges and lays its eggs on the young plants. The eggs are usually attached to the lower surface of the leaves in two parallel rows of about six each. The young larva is of a uniform pale-green color, marked with black; with the successive moults the various orange markings appear. In the immature stages the antennæ are only four-jointed. This insect develops very rapidly; the eggs hatch on the third day after they are laid; and it is said that the bugs will pass through all their moults and be ready for reproduction in two weeks. There

is a series of generations extending through the entire summer. This is an exceedingly difficult species to contend against. Much can be done by trapping the bugs that have hibernated by placing turnip or cabbage leaves in the garden in early spring."

The above insect, illustrated in Fig. 85 is a member of the sub-family Pentatomina, to which belong many showy looking bugs. Prior to the late civil war it was confined to the states south of Virginia, but since that time it has spread as far north as New Jersey, and west into Missouri. Its native home appears to have been Guatemala, whence it spread into Mexico, Texas and north.

FIG. 88.—*Euschistus variolarius* P. Beauv. After Riley.

Lioderma ligata Stal. *(The Bound Tree Bug).*

This is also a large green bug closely resembling the *Nezara* already described; it is, however, more broadly edged all around, except upon its head, with pale red, and has a pale red spot on the middle of its back. The feelers are also green, excepting the last three segments which are black. It measures a little more than half an inch in length, and seems to be a rather general feeder, occurring most abundantly upon berries and upon the hazel. Fig. 86 shows this insect.

A very similar bug *(L. uhleri* Stal.), originally from Mexico, has recently appeared in South Dakota, where it causes great injury to a great variety of plants. This shows that even southern insects may find a congenial home with us, in which they can multiply so rapidly as to become a pest. For this reason it is always wise to kill insects infesting cultivated plants as soon as they are discovered, and not to wait until it is too late. This is especially true in this case, as these insects are not readily killed by any of the remedies now known.

Proxys punctulatus Pal. Beauv. occurs in the South, where it feeds largely upon the cotton worms.

The genus *Euschistus* contains a number of species which are very common in our state. They are found running about early in spring and late in autumn, and may be found in all stages during the summer. The one illustrated (Fig. 88) is *Euschistus variolarius* Pal. Beauv., which may be called the *Brown Stink-bug*, although it varies greatly in color, from yellow to light brown. It is sometimes injurious. In one case a large colony of these bugs was discovered upon asparagus plants, sucking the sap and killing the plants; again they were found in large numbers upon the heads of wheat, where they did no good, judging from the wilted appearance of the infested plants.

Cosmopepla carnifex Fab. is another very common insect, sometimes covering wild plants. It is a pretty insect, as may

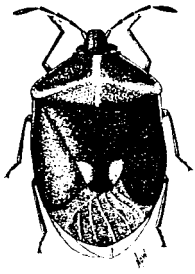


FIG. 89.—*Cosmopepla carnifex* Fab. Original.

FIG. 90.—*Oebalus pugnax* Fab. After Ent. Commission, Dep. of Agriculture.

be seen in the illustration, Fig. 89, measuring about three-tenths of an inch in length, of a shining black color, and a densely punctuated body. Red or orange colors ornament the lateral margin of the body, including the prothorax, basal half of the wing-covers, meta-thorax, and abdomen. The disk of the pronotum is crossed by a transverse and a longitudinal line of the same color, as is shown in the illustration. Two bright red or orange spots are found near the tip of the scutellum. Usually it is of no economic importance, but it has recently been found in large and injurious numbers upon such plants as the raspberry and blackberry.

Oebalus pugnax Fab., illustrated in Fig. 90, is a friend to the cotton grower in the South, as it there destroys the larvæ of the cotton moth. But here it has very different habits, and it

is a good thing that it is not very common. Some years ago a large field of wheat was almost covered with these bugs in all stages, all intent upon sucking the sap from the growing plants. Of course their presence boded no good, as was shown by the greatly lessened yield of the infested field. In the following year not a single insect of this kind could be detected. This shows how unexpectedly insects, usually very uncommon in one locality, may suddenly so increase in numbers through some favorable conditions as to become injurious.

In the sub-family Halydina, which contains chiefly broad, moderately flat, gray and brown bugs, with slender feelers and

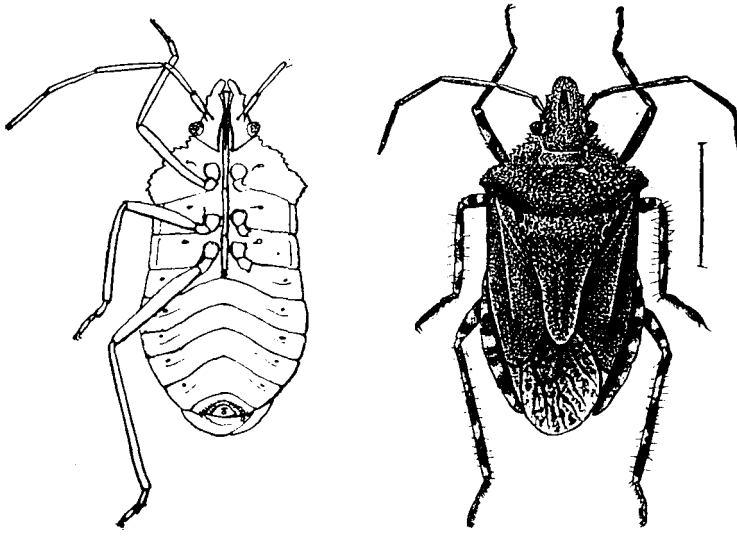


FIG. 91.—*Brochymena annulata* Fab.: Adult; under surface shown at left—enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

beaks, prominent shoulders and uneven surface, with very branching veins to the membrane, we possess a number of species which have of late become decidedly numerous. Late in autumn numbers of them may be seen sunning themselves while resting upon the bark of trees, with which their color and shape blend so well that they can hardly be distinguished, notwithstanding that the insects are rather large. Again we find them during winter under loose bark of trees, or in early spring slowly walking about upon the dry and warmer fence-posts. They well deserve to be classed with the stink-bugs!

Brochymena annulata Fab. *(The Angular Gray Tree Bug).*

This insect has a square head with the front rather short, and a deep notch on each side. The surface is unevenly dotted with black; the membrane is also distinctly marbled with black; the side-margins of the prothorax are moderately toothed; the shoulders are oblique, feebly curved, and knobbed. The insect, according to Prof. Uhler, is notwithstanding its long and slender rostrum a great enemy to caterpillars and other insects; it searches for them upon the leaves and twigs of a great variety of trees in cities and in the thin woods in the adjacent country. But it has also other habits not so useful, and its presence upon young apple trees in nurseries and orchards is not desired, as here it is frequently seen engaged in sucking the sap from the tender ends of still green twigs. It is shown in Fig. 91.

Similar to the species of Euschistus already mentioned are the insects in the genus *Podisus;* they belong, however, to a different sub-family, the Asopina.

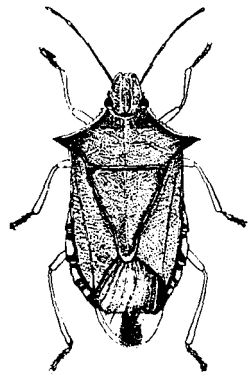


FIG. 92.—***Podisus spinosus*** Dall.
Original.

Podisus spinosus Dall. *(The Spined Tree Bug).*

This bug, illustrated in Fig. 92, is a well known insect, frequently mentioned in entomological literature as destroying the potato-beetles, currant-worms and other well known pests. All insects belonging to this genus are very similar in general appearance, but the one under discussion has the angles of the prothorax prolonged into spines. It measures about four-tenths

of an inch in length, is of a tawny yellowish-gray color, more or less thickly dotted with brown. The wing-covers are frequently red at their tips, and the true glossy wings have a brown spot at their extremities. The under side is whitish, with a row of black dots along the middle of the abdomen, and another on each side.

The insect is very common during autumn, being found in large numbers on different trees and shrubs; it is no doubt a very useful one. It has a stout and long beak, which gives it a great advantage in holding and piercing other insects, and it must also possess a wonderful strength in this flexible organ, since it is able to lift with it an insect twice its weight and hold it straight forward while sucking it dry.

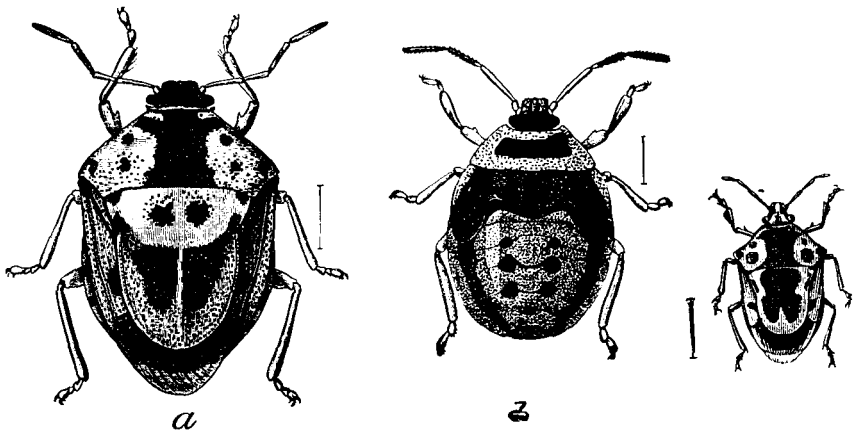


FIG. 93.—*Stiretrus anchorago* Fab. After Riley. Div. of Entomology, Dept. of Agriculture. Var. *fimbriata* Say.

To the sub-family Asopina belong a number of very beautiful bugs, one of which is shown in the illustration, Fig. 93. *Stiretrus anchorago* Fab., in one of its varieties, *(fimbriata* Say), is not a common insect in our state, but is found from time to time. "The insect is of a glossy steel-blue color, with orange marks on the front and sides of the pronotum, also a band at the base, and a narrow margin at the end of the scutellum, besides the margins of the venter, large spots on its disk, and some spots on the sternum, all of the same color. Here the scutellum

is nearly as long as the abdomen, and more than one-half its width, while the rostrum is very stout, and the fore-thighs flattened into plates." (Uhler).

FAMILY CYDNIDAE.

(Burrower-bugs).

These bugs have an oval, rounded or elliptical body, more convex than in the preceding family. The large scutellum, less than half as long as the abdomen, is either broad and bluntly rounded, or triangular, with the apex pressed down; the lateral margins are also furnished with a groove for the reception of

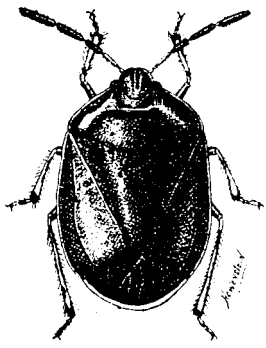


FIG. 94.—*Canthophorus cinctus* P. B. Original.

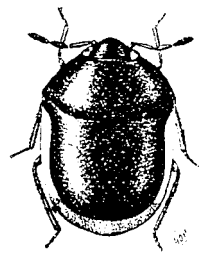


FIG. 95.—*Corimelæna pulicaria* Germ. Very greatly enlarged. Original.

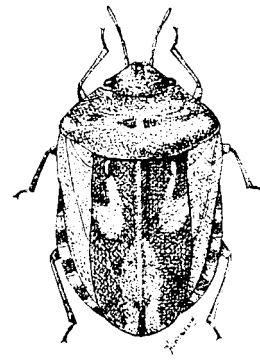


FIG. 96.—*Eurygaster alternatus* Say. Original.

the wing-covers when at rest. The front legs are more or less flattened and fitted for digging. All species are dark, mostly dark brown or black. They are found burrowing in sandy places, or under sticks and stones, sometimes near the roots of plants, especially grasses, where they obtain their food, probably by sucking sap. Very little is known about their habits.

To show how these bugs look, some of whom are found in our state, the illustration, Fig. 94, of *Canthophorus cinctus* Pal. Beauv., has been prepared.

FAMILY CORIMELAENIDAE.

(Negro-bugs).

This family contains a number of mostly black, hemispherical and beetle-like bugs; some have a bluish or greenish tinge, and all belong to a single genus. The scutellum is very large, very convex, covering nearly the entire abdomen; it also possesses short grooves on each side for the reception of the edge of the wing-covers.

Corimelæna pulicaria Germ. *(The Flea-like Negro-bug).*

As the illustration, Fig. 95, shows, it is black, polished, with a whitish stripe along each side. Its pointed beak is hidden. It sometimes occurs in large numbers upon various fruit-bearing plants, but seems to be partial to the blackberry and raspberry, and is by no means a stranger to the strawberry. Very large numbers sometimes occur upon the potato vines, where they cause wilting of the leaves. It is a disgusting little pest, and its presence may be discovered by the nauseous buggy odor of the fruit. The insect is so small, however, that it is often taken into the mouth unnoticed until its disgusting flavor reveals its presence. Of course such an accident is apt to spoil the appetite for even the finest plate of fruit, and the disappointed lover of it is apt to use strong language about bugs in general and the negro-bug in particular.

FAMILY SCUTELLERIDAE.

(Shield-backed Bugs).

The insects, belonging to this family resemble the Negro-bugs in many ways. They are turtle-shaped, with a large scutellum covering nearly the entire upper surface of the abdomen, but they possess no grooves to receive the edges of the wing-covers when at rest. In the few species occurring in Minnesota the feelers are five-jointed. The insects are too uncommon to be of any economic importance, but to show their shape *Eurygaster alternatus* Say has been illustrated in Fig. 95.

SUB-ORDER HOMOPTERA.

(Cicadas; Tree-hoppers; Plant-lice; Scale-insects; and others).

Prof. Uhler, our authority in this order of insects, writes that "this grand division of the order contains the greatest number of large species, and the widest range of diversity in the forms of all stages. Comparatively few are destitute of wings, except in one sex of the lowest group; but some have these organs short and unfinished, and it is but very rarely that we meet with one of this kind fully winged. This division is also remarkable for the blunt face and backward pressed elements of the head and breast, thus carrying the rostrum far underneath. Both kinds of eyes are generally present; the compound ones being generally large and prominent, while the single ones, *ocelli,* are like little convex gems, placed between the larger eyes on the vertex or front; but occasionally, as in Fulgoridæ, on the sides of the cheeks between the latter and the antennæ. There are usually two ocelli, although in Cicadidæ and most Psyllidæ they are three in number and are placed in front, forming a triangle. The antennæ are usually situated in the hollow between the eyes and are composed of a few expanded joints at the base, with a tapering, slender, bristle-shaped termination.

"Exceptions occur in Psyllidæ, Aphididæ, and Coccidæ, where these organs are commonly filiform and somewhat thickened at the tip.

"There are two principal types of legs in this division, although these are variously modified for particular modes of life, the one being adapted for crawling, the other for leaping. The former have short legs, generally stout; the latter have the hind legs long, often curved and set with rows of stiff spines."

The Homoptera have the upper wings of the same thickness throughout, (Fig. 2), and, when at rest, usually sloping like a roof over the sides of the body. There is no neck; this is so closely pressed to the thorax that usually the front coxæ articulate with the cheeks, so that in many forms the beak seems to arise from between the legs.

Homoptera form a well marked group, so well defined that some entomologists consider it a distinct order; yet the families in it show very great variations in structure and modes of growth. The name *Homoptera* is derived from two Greek words: *homos,* same; and *pteron,* a wing.

All Homoptera are plant-feeders, piercing the tissues of plants by means of lancets, and sucking the sap from the cells beneath. For this reason they are of more or less importance to the agriculturist, and, as a matter of fact, some of our most destructive insects belong to this order. They are most difficult to combat, and stomach poisons, such as are applied to biting insects, are of no avail, hence contact poisons have to be resorted to.

Prof. Comstock gives the following classification:

A. Beak apparently arising from the sternum, or absent; tarsi one or two-jointed; antennæ usually prominent and filiform, sometimes wanting.

B. Tarsi one-jointed; adult male without any beak and with only two wings: female wingless, with body either scale-like or gall-like in form, or grub-like and clothed with wax. The waxy covering may be in the form of powder, of large tufts or plates, of a continuous layer, or of a thin scale beneath which the insect lives..... COCCIDAE.

BB. Tarsi usually two-jointed; wings, when present, four in number.

C. Wings opaque, whitish; wings and body covered with a whitish powder..... ALEYRODIDAE.

CC. Wings transparent.

D. Legs long and slender, not fitted for leaping; antennæ three- to seven-jointed..... APHIDIDAE.

DD. Hind legs fitted for leaping; antennæ nine- or ten-jointed.... PSYLLIDAE.

AA. Beak evidently arising from the mentum; tarsi three-jointed; antennæ minute, setiform.

B. With three ocelli, and the males with musical organs. Usually large insects, with all the wings entirely membranous..... CICADIDAE.

BB. Ocelli only two in number, or wanting; males without musical organs.

C. Antennæ inserted on the side of the cheeks beneath the eyes.... FULGORIDAE.

CC. Antennæ inserted in front of and between the eyes.

D. Prothorax prolonged into a horn or point above the abdomen..... MEMBRACIDAE.

DD. Prothorax not prolonged above the abdomen.

E. Hind tibiæ armed with one or two stout teeth, and the tip crowned with short, stout spines..... CERCOPIDAE.

EE. Hind tibiæ having a double row of spines below.... JASSIDAE.

Other authors have divided these insects in a much larger number of families, but in a report of this kind it is not necessary to do so.

FAMILY CICADIDAE.

(Cicadas; Dog-day or Harvest-flies).

All the members of the large order of Hemiptera thus far considered were mute, but the Cicadidæ have been famed in classic lands for their wondrous songs, which, by the way, shows that classic music was not well understood by the old Greeks. But not all classical writers were equally admirers of the song of these noisy insects, as Xenarchos says: "Happy is the cicada, since its wife has no voice." But Xenarchos, notwithstanding his well sounding name, may have been an old and confirmed bachelor! Nearly all our species of Cicadas are large, and may be recognized by their heavy sub-conical bodies, wide, blunt head,

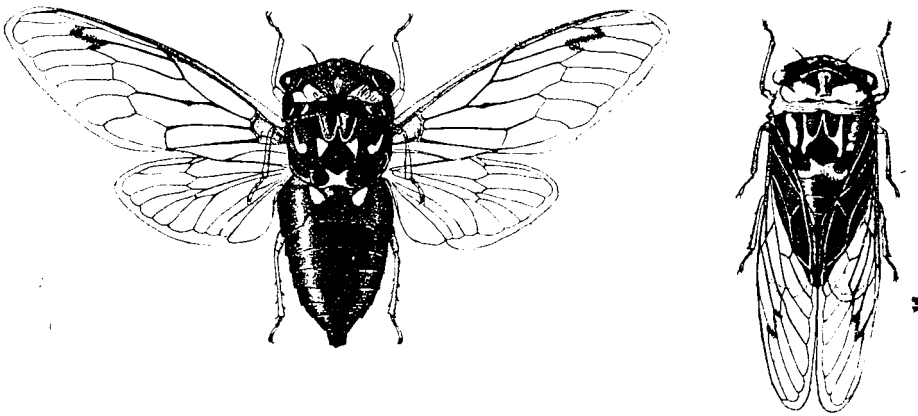


FIG. 98.—*Cicada tibicen* Linn. Male and female. Original.

with prominent eyes on the outer angles, bristle-shaped feelers, placed in a socket beneath a projection of the vertex, and three bead-like ocelli arranged in a triangle. Figs. 97 and 98 show the shape of these insects very well. The wing-covers, nearly elliptical, and longer than the body, are parchment-like and transparent, while the hind wings are membranous and very much smaller.

But the most distinctive peculiarity, which has no parallel in any of the groups, appears in the organs of sound, only found in the males, the females not possessing them. "These consist

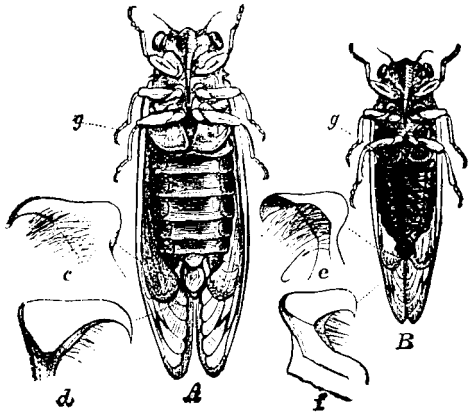


FIG. 97a.—*Tibicen septendecim* Linn.: *A*, male of typical form—natural size; *c*, *d*, genital hooks—enlarged; *g*, singing apparatus—natural size; *B*, male, of the small form (*Cassinii*)—natural size; *e*, *f*, genital hooks. After Riley, and Hagen, Div. of Entomology, Dep. of Agriculture.

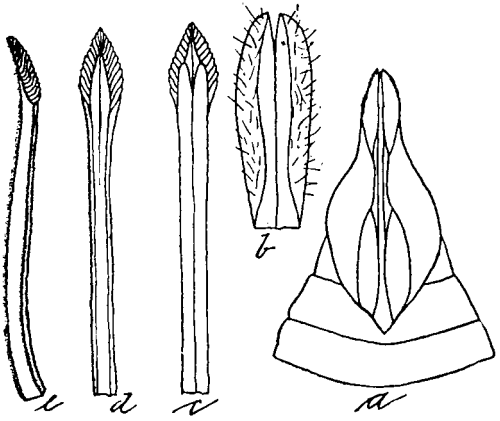


FIG. 97f.—*a*, tip of abdomen of female from beneath *b*, the sheath inclosing the top of the ovipositor; *c*, ovipositor from below; *d*, ovipositor from above; *e*, ovipositor from side—enlarged; *c*, *d*, *e*, not quite four times actual size. After Smith.

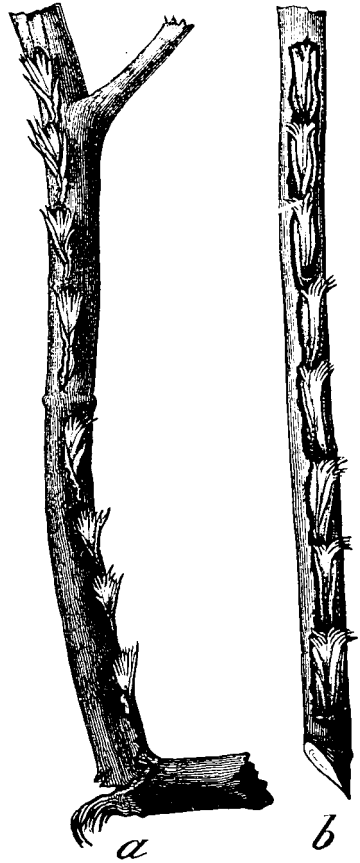


FIG. 97c.—*a*, twig showing recent punctures, from front and side, and illustrating manner of breaking; *b*, twig showing older punctures, with retraction of bark—natural size. After Riley, Div. of Entomology Dep. of Agriculture.

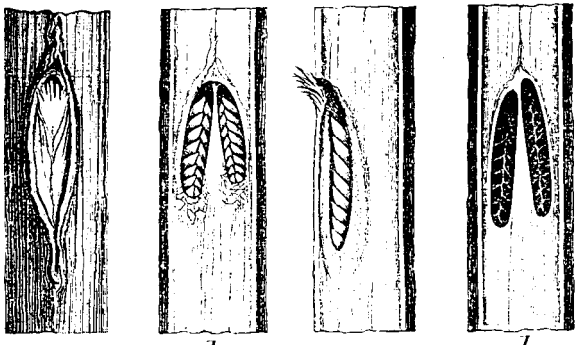


FIG. 97b.—*Cicada septendecim* Linn.: *a*, recent puncture, front view; *b*, same, surface removed to show arrangement of eggs, from above; *c*, same, side view; *d*, egg cavity exposed after eggs are removed and showing the sculpture left by the ovipositor—all enlarged. After Riley, Div. of Entomology, Dept. of Agriculture.

of two large parchment sacs, ribbed and gathered into numerous plates, furnished with powerful muscles, and situated in large cavities at the base of the abdomen. When in action the air is driven with great force against the ribbed surfaces, and vibrations are set up which produce the sound in accordance with the number and form of the fluted spaces and ribs." (Uhler.)

Each of the above cavities is covered with a thin plate which can be lifted, and which acts as a sounding-board; by lifting or lowering it the sounds are modified.

FIG. 97d. Twig showing scars from punctures after second year—natural size. After Riley, Div. of Entomology, Dept. of Agriculture.

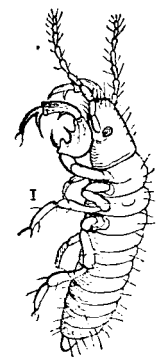


FIG. 97e.—Newly hatched larva—greatly enlarged. After Riley, Div. of Entomology, Dept. of Agriculture.

Tibicen septendecim Linn. *(The Periodical Cicada or The 17-Year Locust).*

This species is remarkable as requiring seventeen years to develop. As it is not found in Minnesota, but close to our borders in Wisconsin, it is not necessary to say much about it. Wherever it occurs it is well known owing to the great numbers in which it appears at intervals of seventeen years. This periodical appearance is due to the enormously long time required for the early stages to obtain their growth, and all the members of one generation appear as Cicadas at about the same time. The winged females deposit their eggs in slits made in the twigs of trees, as shown in Fig. 97, and small fruit-trees are some-

times injured in this manner. After about six weeks the eggs hatch, the young drop to the ground and bury themselves in the earth. Here they live by sucking the sap from the roots of plants, at least this is the expressed opinion of most entomologists. Yet the writer has so often found them in solid cells of tenaceous clay, without any traces of roots even near them, that he doubts the correctness of such a conclusion, but rather believes that they obtain their food not from the sap of living plants, but rather from the moisture in the soil alone. If this is the case it would account quite naturally for the long time required to reach the adult stage.

Several weeks before the time of issuing from the ground the yellowish-brown pupæ can be found beneath stones and other objects lying upon the ground, but when ready to change to adults they crawl to the side of a fence, out-house or tree, and grasp it tightly with their claws. The skin now splits down the back and the soft and white creature draws itself out of the stiff, old skin, remains suspended for a few hours until the moisture has evaporated from the body, and the wings have stretched to their full size. Meanwhile the distinctive colors of the insect have also gradually appeared.

The introduction of the English sparrow has had the effect of gradually killing off these insects, so that whole generations have almost disappeared. These birds are very fond of the Cicada, and kill immense numbers of them, as may be seen by the detached wings of the insects found under the trees. It is a pity that these sparrows are not equally fond of other insects!

The species is shown in various positions and ages in Fig. 97.

It is a medium sized black species, with bright red eyes, banded with red on the abdomen, and with red and orange veins at the base and costal margins of both pairs of wings. With some imagination a "W" can be seen in the veins of the upper wings, which superstitious folks declare to mean war or what not.

Cicada tibicen Linn. *(The Common Dog-day or Harvest-fly).*

This Cicada, illustrated in Fig. 98, is usually black and green in color, and more or less powdered beneath with white. Its

song is a high and sharp trill frequently heard during the hottest days in midsummer. This sound seems to fill the air around us, and it is not easy to distinguish from which tree it comes. When we at last discover the musician it is found sitting upon the trunk and larger branches of the tree, but it requires a very cautious approach to observe it, as otherwise the insect flies to another tree, almost with the swiftness of a bullet, and with a loud humming noise.

This species is found every season. According to Comstock it requires only two years for its development, and as there are two broods or generations of this species, the adults appear every year.

Other and much smaller species occur in our state, and some are entirely confined to the prairies. None are of any great economic importance in Minnesota.

A number of other species are also found in our state, even in the prairies, but as all have, as far as known, similar habits, it is not necessary to describe them.

FAMILY MEMBRACIDAE.

(Tree-hoppers).

"Nature must have been in a jolly mood when the tree-hoppers were developed, for these little creatures are most comically grotesque in appearance. In general outline they resemble beech-nuts, except that many have humps on their backs. The prothorax is prolonged backwards over the body like a roof, often quite covering it." (Comstock).

Membracidæ are the most typical Homoptera. They have three-jointed tarsi; are of every conceivable form; arched, compressed, depressed, hump-backed, spindle-shaped, pointed at both ends, inflated, hemispherical, or conical, and besides this they are furnished with an endless variety of superficial attachments. Their feelers are short, like bristles, thick at the base, and placed beneath the expanded margin of the clypeus. All are good leapers, with strong legs armed with spines on the tips of the hind tibiæ.

Tree-hoppers subsist upon the juices of many kinds of plants, but in most cases are not numerous enough to cause any real damage. When they rest upon twigs they resemble thorns;

sometimes we find them sitting in rows, young and old, but as soon as we approach them with the finger they slide around to the opposite side of the twig, and fly or leap away. They are still more protected by the patterns of their markings, which blend well with the surroundings. A few secrete honey-dew, like the true plant-lice, and their presence can be detected by the ants, who eat this sweet material.

This is a large family and only a few of the more common forms can be mentioned.

Entilia sinuata Fab. This curious being, illustrated in Fig. 99, is very common upon a variety of plants. It is somewhat partial to sun-flowers, which sometimes show the effect of their presence by looking scorched, and no wonder, as the insect is gregarious, and as many as six hundred have been counted upon a single plant. The eggs are laid in the midrib of the leaf, almost in-

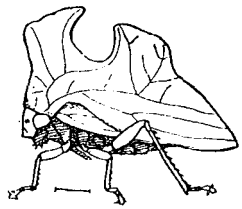


FIG. 99.—*Entilia sinuata* Fab. Adult enlarged. After insect life, Div. of Entomology, Dept. of Agriculture.

variably on the underside. They begin to hatch early in September. The young larva is pale green, thickly dotted with black, and does not resemble the adult in the least. Mrs. Rice has published an account of these curious beings in Insect Life. She says that "almost every colony was guarded by one or more ants. One colony consisted of many larvæ and perfect insects, each group guarded by medium sized ants, which were all black, except the central portion of the body, which is brown. When I raised a leaf to examine closer the ants gave battle and bit my finger. I gently drew them away, when every insect, perfect and larvæ, began to scatter with astonishing alacrity all over the plant. The ants returned and 'rounded them up' exactly as a collie does sheep, placing one ant as guard if the colony was small, more if large. When one strays away an ant at once goes after it, and with infinite patience gently drives it home

again. They constantly pat and press them with their antennæ as they do the Aphides. I have numbers of Aphides in my garden almost deserted by ants, which assiduously attended them before the Entilia hatched. When the larvæ split on the back the ants supervise the process, seeming to peel the empty larval case off. When the insect emerges one or more ants anxiously tend it, passing their antennæ over it repeatedly. I 'cut out' a newly hatched Entilia, and it at once made for the upper side of the leaf. Very few are ever found on the upper side of a leaf. An ant was detailed to bring it back, which it finally did. It then stayed with the rest. Immense numbers of *Entilia sinuata* were present about one hundred feet away, and these were tended by medium sized black ants. A very large ant-hill is in the center of this flower-garden. I believe they attract or introduce Aphides to the vicinity of their abode. These were arrant cowards, and when touched dropped some five or six feet to the ground; otherwise they conducted themselves like their black and brown relatives. Twenty minutes afterwards the Entilias were quiet and the ants on guard. When one considers the fact that *Entilia sinuata* in perfect form can both jump and fly—had one jump four feet and fly ten feet from my hand this evening—the control that the ants maintain over them is remarkable. In fact, as I told the hired man (who patiently listens to all the new 'old facts' I discover), Solomon knew what he was talking about when he said: 'Go to the ant, thou sluggard; consider her ways and be wise.' I am fully convinced both from observation and reading that ants have reasoning powers."

Ceresa bubalus Fab. *(The Buffalo Tree-hopper).*

This species as well as two others closely resembling it, i. e. *C. diceros* Say and *C. taurina* Fitch, are very common in Minnesota, and are sometimes decidedly injurious, not so much because they abstract the sap from our fruit trees, but because they make slits in their twigs in which they lay their eggs.

The Buffalo Tree-hopper (Fig. 100) is about one-third of an inch long, of a light grass-green color, with whitish dots and a pale yellowish streak along each side. On the front there is a sharp process or joint jutting out horizontally on each side, re-

minding one of the horns of a bull or buffalo, hence the above name. The body is three-sided in form, and is furnished with a sharp pointed beak, with which it punctures the bark and sucks the sap from the trees.

It is common on apple and many other trees from July until late in autumn. The eggs are laid in slits on the bark, as shown in the excellent illustration kindly loaned by the Division of Entomology, Department of Agriculture.

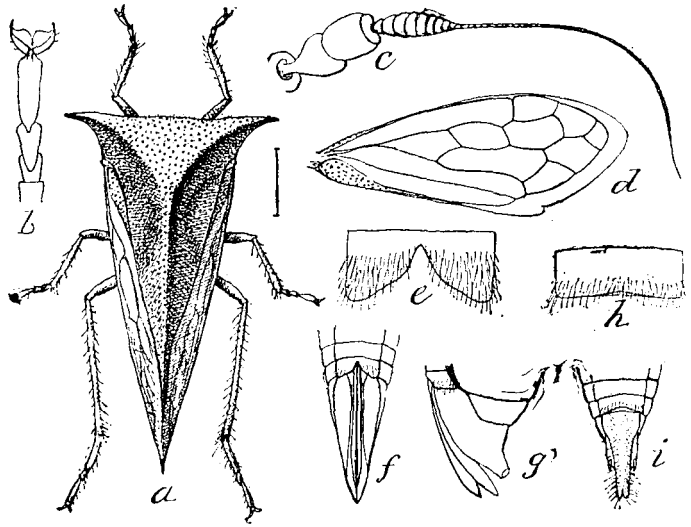


FIG. 100.—*Ceresa bubalus* Fab. *a*, female; *b*, enlargement of anterior foot of same; *c*, do. of antenna; *d*, do. of wing; *e*, last ventral segment of female; *f*, ventral view of tip of abdomen of female, showing terminal segments and ovipositor; *g*, do. lateral view; *h*, penultimate ventral segment of male; *i*, ventral view of tip of abdomen of male—all enlarged. After Marlatt, Div. of Entomology, Dep. of Agriculture.

The young, which hatch in spring, are very different from the adult insects, being furnished with a pair of long spines on each segment. They hatch from eggs deposited during the previous season. Mr. Marlatt describes their habits and life-history in Insect Life:

"The adult insect chooses as a nidus for its eggs the twigs, preferably those of two or three years' growth, of various trees, particularly the apple, willow, cottonwood, maple, etc.; confines itself in general to the upper surface of the twigs, and works more abundantly on the south side of the tree than on the north,

although in this respect the prevailing winds and other conditions influence the insect. The eggs are deposited quite as readily in the new growth of old trees as in young trees, but the damage is much more noticeable in the latter case. The eggs are placed in small compound groups arranged in two nearly parallel or slightly curved slits extending in the direction of the twig about three-sixteenths of an inch in length, and separated by one-eighth inch or less of bark. Facing either toward or away from the trunk, the female makes with its ovipositor a slightly curved slit through the outer bark, cutting in a direction posterior to the insect, so that the ovipositor, which is at first ex-

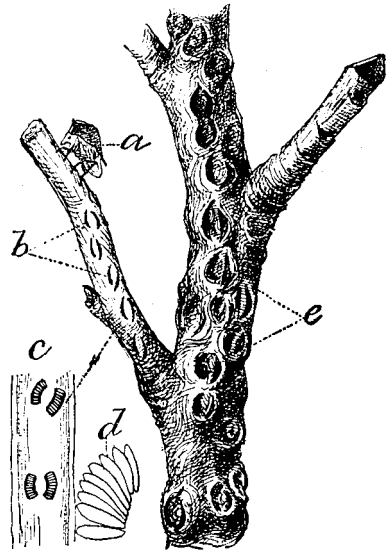


FIG. 100a.—*Ceresa bubalus* Fab. Twig of apple showing: *a*, female at work; *b*, recent egg punctures; *c*, bark reversed with egg in position, slightly enlarged; *d*, single row of eggs, still more enlarged; *e*, wounds of two or three years standing on older limbs (adopted from Marlatt). After Insect Life, Division of Entomology, Dep. of Agriculture.

tended nearly at right angles to the body, at the completion of the slit, lies almost against the abdomen. The eggs are inserted very obliquely through the bark and nearly at right angles to the twig, immediately after the completion of the preliminary incision, beginning at the end of the slit last made, and are thrust well down into the cambium layer between the bark and the wood. A period of from one-half to two minutes is required for the insertion of each egg, after which the ovipositor is partially with-

drawn, moved a little forward, and re-inserted, about twenty minutes being required for the cutting of the slit and filling it with eggs, which, in each slit, vary in numbers from six to twelve. As soon as the first slit is completed a second one is made parallel to and slightly curving toward the first, without change of position of the insect. The ovipositor, however, is thrust in at a very considerable angle from that assumed in the first case, so that it crosses beneath the bark the cut first made, and the narrow intervening bark between the two incisions is cut entirely loose. This has a very important bearing on the subsequent condition of the wounds made by the insect in oviposition. The object is doubtless to cause a certain cessation of growth between the two rows of eggs, to prevent their being crushed and choked out by the rapid growth of the twig, and it is due to this peculiarity that the injury to the young limbs later assumes so serious a nature. A single incision made by the insect to contain its eggs would heal over and cause little after damage, but with the combination of two incisions and the killing of the intervening bark, causing it to adhere to the wood, a large scar is produced, which, with each subsequent year's growth, enlarges and ultimately assumes an oval form, the dead bark of the center breaking out.

"After a few years, limbs which have been thickly worked on by the insect become very scabby and rough, are easily broken off by the wind, and are very liable to attack by wood-boring insects. After completing the two complementary slits and filling them with eggs, the female rests a considerable time before again beginning operations. The number of eggs deposited by a single female exceeds 100, and possibly 200. Rather late in the fall a female which had just finished a pair of slits which contained some 20 eggs, was found to still contain 40 eggs in her ovaries. The adults first appear the middle of July, and become most numerous during August and September. They begin oviposition about the middle of August, or even earlier, and continue this work until they are killed by the frosts of early winter. In Kansas I have found them busily ovipositing as late as the 24th of October. The eggs remain unchanged or dormant in the twig until the following spring, hatching in May or early in June.

"The eggs of the buffalo tree-hopper are subject to the attacks of at least two minute egg-parasites."

Ceresa diceros Say. *(The Two-horned Tree-hopper).*

This is also very common and resembles the above species in size and form, but it is of a pale, dirty yellow color, spotted with brown; the lateral and caudal aspect of each horn is brown; the caudal tip of the prothorax, and a large spot midway between the tip and horns are also brown. The whole insect is densely covered with fine hairs. It has habits similar to those of the one already mentioned.

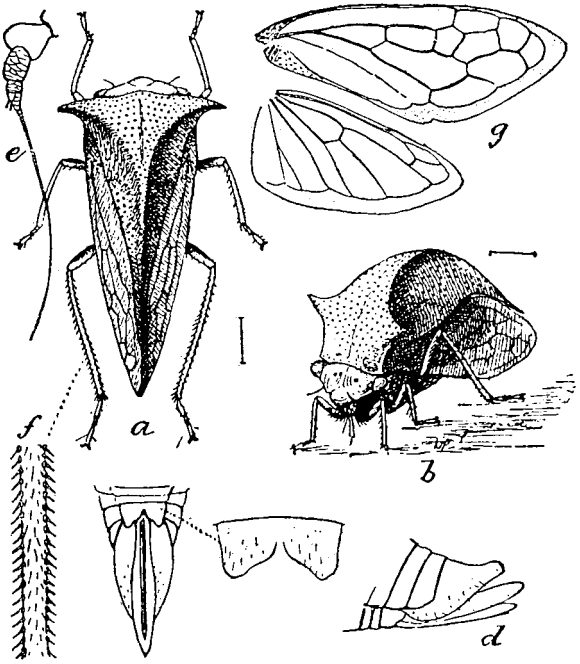


FIG. 101.—*Ceresa taurina* Fitch.—*a*, adult female, dorsal view; *b*, one-half lateral view of same; *c*, ventral view of tip of female abdomen with last ventral arc still more enlarged at side; *d*, lateral view of same; *e*, antenna; *f*, portion of hind tibia—all enlarged. After Marlatt, Div. of Entomology, Dep. of Agricul.

The closely allied Tree-hopper, *(Ceresa taurina* Fitch), is also fairly common in our state, and is shown in Fig. 101, as are also the egg-slits, larva and nymph.

Remedies against these three insects as well as against those described later are difficult to apply, for these tree-hoppers are

rather general feeders and are—in the adult stage—too active and quick of flight. But it is possible and equally necessary to have orchards and nurseries in such a clean condition that no foreign vegetation can be found, which will of course starve out the intruders. But the best and only certain remedy besides cleanliness is in autumn or winter to cut off all twigs showing the presence of such eggs. The larvæ can also be greatly reduced in numbers by repeated applications of kerosene and soap emulsion, or by the use of strong tobacco extracts.

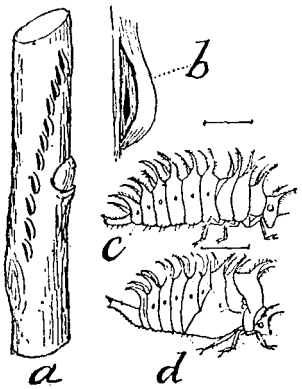


FIG. 101a.—*a*, twig showing rows of egg slits, natural size; *b*, one egg slit enlarged, showing egg; *c*, larva; *d*, nymph—last two enlarged. After Riley. Div. of Entomology, Dep. of Agriculture.

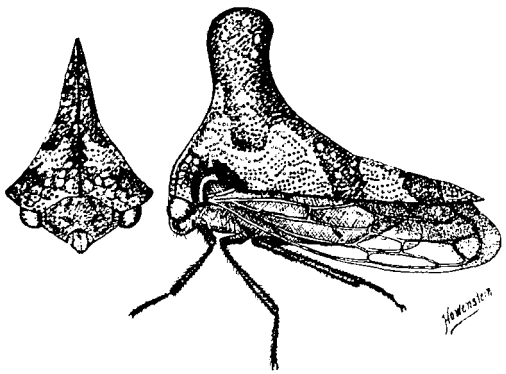


FIG. 102.—*Thelia cratægi* Fitch. Front and side view. Original.

Thelia cratægi Fitch. (The Thorn-bush Tree-hopper).

This insect has habits similar to those of the Buffalo Tree-hopper and during July and August is quite common on apple trees and the thorn bushes, where it may be seen resting upon the small limbs, sucking the sap. But it is a wide awake insect which upon approach is apt to leap away with a sudden spring and is then lost to view.

As the illustration Fig. 102 shows, it is a very peculiar looking object, with a three-sided body, black, varied with chestnut brown, with a large white spot on each side, which, extending forwards, forms a band across the front. Another white band extends across the hind part of the back; the protuberance on the front part of the body is large and peculiar, giving to the

insect an odd appearance. The whole insect measures about one-third of an inch in length.

A number of other species of tree-hoppers belonging to the genus Thelia are found in our orchards. All are similar in habits and size. *T. univittata* Harr., one of the more common kinds, is chestnut-brown in color, tawny-white in front, with a white stripe along the back, extending from the protuberance to the tip. It is sometimes found in fairly large numbers during July and August on the grape vines.

The genus *Telamona* also furnishes a number of peculiar tree-hoppers common in Minnesota. Most of them are found upon oaks and other forest trees, where they rest singly on the limbs and branches, with the heads directed away from the trunk. As long as young these insects keep together in small groups.

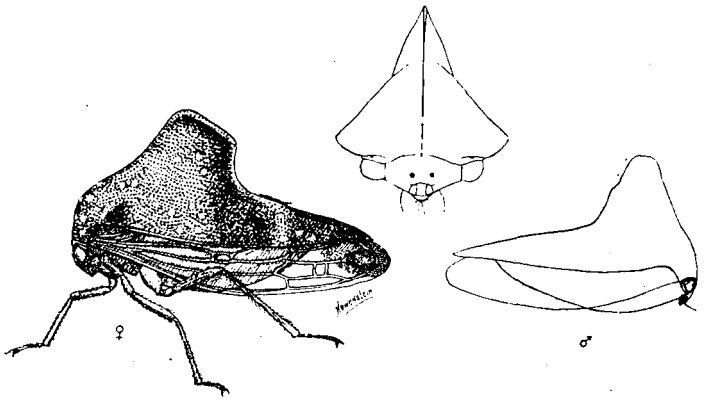


FIG. 103.—*Telamona monticola* Fab. **Original.**

Telamona monticola Fab. *(querci* Fitch) sometimes swarms upon the branches of the Virginia creeper during June and helps to destroy this vine by draining its sap, as well as by puncturing its bark to deposit its eggs. It is shown in Fig. 103.

Archasia galeata Fitch, (Fig. 104), is an entirely different looking insect, very much arched, and of an apple-green color. It is common in midsummer on young oaks and hickories.

Acutalis dorsalis Fitch. *(The Black-backed Tree-hopper).*

This is a small, shining, triangular insect, with a smooth and rounded back, of a greenish-white color, with a large black

spot on its back, from the anterior corners of which a black line runs towards each eye. The upper margin of the head, and the breast, are also black. The insect is small, the female not measuring more than one-fifth of an inch in length, while the male is still smaller.

This insect is frequently found in large numbers on the grape-vine, and may cause some damage. It is illustrated in Fig. 105.

Enchenopa binotata Say. *(The Two-spotted Tree-hopper).*

This is still another strange form, which occurs upon a variety of trees, shrubs, and herbaceous plants, but prefers the Water-ash, *(Ptelea trifoliata)*. It sometimes punctures the tender stems of the grape, and causes them to wilt and turn brown. It is an odd-looking brown insect with a remarkable prolonga-

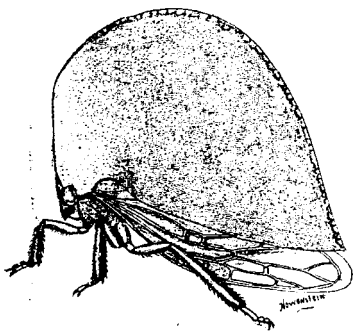


FIG. 104.—*Archasia galeata* Fitch. Original.

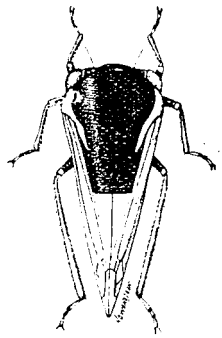


FIG. 105.—*Acutalis dorsalis* Fitch. Original.

tion in front, like the beak of a bird; two yellowish spots on the edge of the back give it the above name. Being gregarious, both adult and immature forms are clustered together, usually in long rows on the branches of their food plants. If disturbed they all slip to the opposite side, and readily perform this manouevre a number of times, apparently not willing to escape by flight or by leaps. Wherever they occur ants are certain to attend to them, for the selfish purpose of obtaining the honey-dew perpared by their "cattle." This species deposit eggs in frothy masses, which are white and waxy and remain on the plants for

a long time. Adult insects and egg-masses, natural size and enlarged, are shown in Fig. 106.

A similar species, the *E. curvata,* also brownish, but unspotted, has even a longer horn, and when the wings are spread we have the minute picture of a flying goose.

Other members, equally peculiar in shape, abound everywhere in the wooded portions of our state, but are of no economic importance. Prof. Comstock, in speaking of such insects, writes that if a young entomologist wishes to laugh, let him look at the face of a tree-hopper through a lens; their eyes always have a keen droll look, and the line that separates the head from the prothorax gives them the appearance of wearing glasses. In some cases the prothorax is elevated above the head, so that it looks like a peaked night-cap; in others it is shaped like a Tam-O-Shanter; and sometimes it has horns, one on each side. He gives a drawing of four such insects sitting side by side upon a blade of grass. They also forcibly remind us of a party of little Brownies, dressed in queer costumes, and frolicking in some leafy bower.

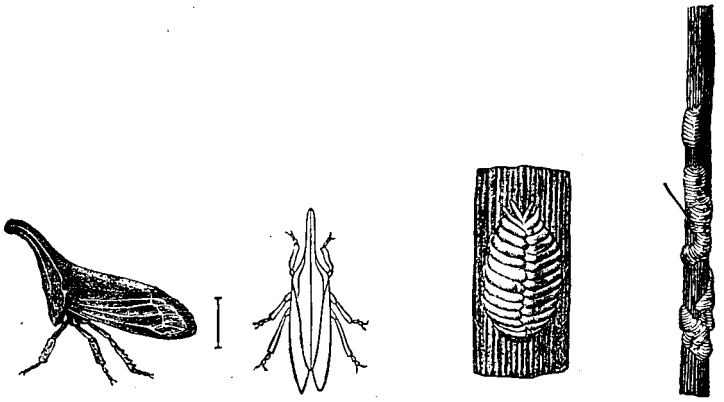


FIG. 106.—*Enchenopa binotata* Say. Showing the adult, enlarged; egg-mass nat. size; and one egg-mass, greatly enlarged. After Lintner.

FAMILY FULGORIDAE.

(Lantern-flies, etc.).

Nearly every book on Natural History describes the great Lantern Fly of Brazil, or the Candle-fly of China, described by Linnaeus from the supposed fact that the species were luminous.

The family contains a wonderful variety of forms, some of which have been mistaken for butterflies and moths, others for neuropterous insects, which some closely imitate.

The most useful characteristic by which to recognize these insects is by their compressed, vertical, often carinated face, and by the bristle-shaped feelers, which are inserted into a button-shaped base on the side of the cheeks beneath the round eyes; below the latter appears a small ocellus.

None of these insects have attracted the attention of our farmers, although all are vegetable feeders; in the tropics some cause great injury to crops. All our species are small in comparison with some of their exotic relatives, some of which spread more than six inches across their expanded wings.

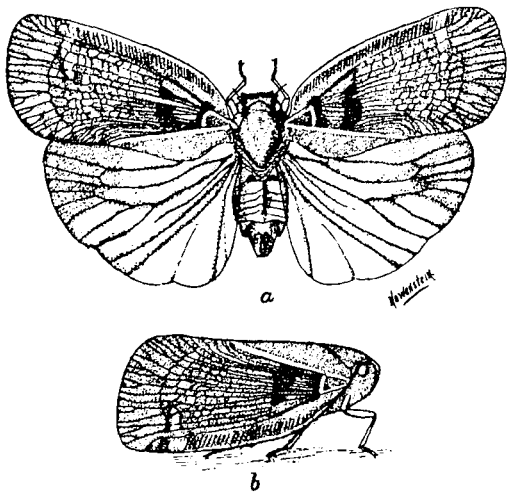


FIG. 107.—*Ormenis pruinosa* Say. Original.

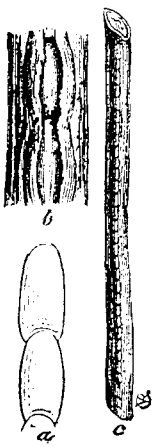


FIG. 108.—*Ormenis pruinosa* Say. *a*, eggs. much enlarged; *b*, eggs in bark; *c*, twig with eggs.

Ormenis pruinosa Say. *(The Mealy Flata).*

In this genus the broad wing-covers are a little wider at the tip and cut off squarely; they are closely applied to each other in a vertical position. The insects vary greatly in length, from one-third to nearly one-half an inch from the front to the end of the wing-covers. Their flight is feeble, and they flutter about like small moths, which they greatly resemble when their wings are spread out, as shown in Fig. 107. The one illustrated is of a slate, dark gray, or even blackish color, made bluish by a

fine powder covering most of the surface. "When fresh the head, face, under side of the body and legs are yellow, the costal margin is white, and the wings are smoke-brown. When rubbed the wing-covers are seen to be blackish, becoming translucent towards the tip, and having a pale spot on the pterostigmal areole, and a larger spot next to the basal angle of the corium, the latter marked with three or four roundish, black spots; the suture bounding the clavus is also a pale yellow or whitish color." (Uhler).

The female cuts a continuous slit with her ovipositor into the skin of various plants (Fig. 108), into which regular series of long, oval, yellow eggs are deposited, which hatch, towards May, into little tree-hoppers, which soon commence to pump up the sap. They soon afterwards secrete a white and mealy substance, which completely covers them.

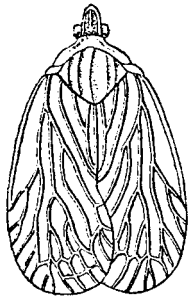


FIG. 109.—*Helicoptera* species. After Uhler.

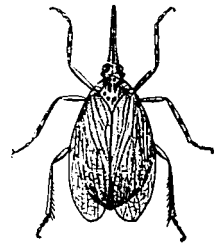


FIG. 110.—*Scolops sulcipes* Say. After Uhler.

The insects attack the succulent shoots of the gooseberry and sometimes the leaves; they also occur on the grape, but are of little economic importance.

The genus *Helicoptera* also occurs in our state, but it is only found in the pine regions. In this case the shape is that of a fan, the head, which is narrow, produced and triangular, forming the handle. It is shown in Fig. 109. According to Uhler, "wherever a solitary pine-tree can find place to thrust its root into the hard soil, there the Helicoptera settles, and brings up its numerous progeny."

Another very common and decidedly peculiar insect belongs to this family.

Scolops sulcipes Say. *(The Candle-head).*

It lives on grass and various other plants growing in low ground, and is also frequently seen along the edges of wood; in the prairies it occurs in large numbers on grass growing near wet places. The illustration, Fig. 110, shows its peculiar shape. It is oval, dull straw colored, with a long, slender, up-curved, candle-shaped projection starting from the front of the head. The eyes are brown; the veins of the wing-covers are margined and spotted with the same color.

Another quite different form is shown in Fig. 111. It is a gayly marked species, either lemon-yellow or cream-colored, with a broad stripe on the side of the face and wavy red forked lines on the wing-covers. Looking at the head from the side it looks like a plough-share, with the little brown eyes standing out like beads.

This species, *(Otiocerus coqueberti* Kby.), occurs upon the leaves of the grape-vine, oaks and hickory, and is found during July, August, and September.

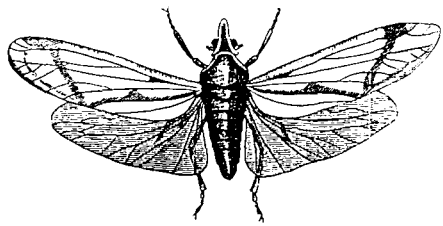


FIG. 111.—*Otiocerus coqueberti* Kby. After Uhler.

Many other peculiar and equally interesting forms occur in our state, but as none of them cause any particular injury to our crops, those mentioned above will be sufficient to give a general idea of the family. Fig. 112 (Plate III) is a very beautiful insect, hence the name *Liburnia ornata* Stal. It is found sometimes in numbers on the foliage of the sugar beet.

FAMILY CERCOPIDAE.

(Spittle-insects or Frog-hoppers).

"In the great family Cercopidæ we observe forms quite unlike any that have been previously noticed, and some which mark an important advance in the direction of the Heteroptera by the

large size of the prothorax and increased freedom of the fore-legs. This extensive piece is no longer a mere cap or scale as in most of the Fulgoridæ, nor yet a lid, case, or bubble-like expansion as in the Membracidæ, but is an important regional portion, exercising various important functions. Here the front of the head is generally prominent, in the form of a ridge, which is crossed each side by a series of more or less distinct grooves. There are two conspicuous ocelli placed on the vertex, far back. The prothorax is six-sided or trapezoidal, cut square off in front, and the triangular scutellum is of medium size. There is generally a

FIG. 113.—Spittle insects. After Brehm.

marked difference between the apical area and the other parts of the wing-covers, the former being membranous and sometimes transparent, while the remainder is thick and leathery, or crustaceous.

"The legs are generally stout, the hind pair being longer than the others, having the shanks armed exteriorly with one or two stout teeth, and the tip crowned with short, stout spines." (Uhler).

They agree, like the following family, with the Membracidæ in having the antennæ inserted in front of and between the eyes,

but they differ from them by the absence of prolongations of the prothorax, and from the Jassidæ, a family to be described later, in the character of the spines on the hind tibiæ.

Best known are the spittle-insects. During the early part of the summer we frequently observe peculiar masses of white froth upon various shrubs and herbs (Fig. 113). Uneducated people are afraid of these unpleasant looking objects, but when pressed for an explanation, or reason for such fears, they are unable to give any. The negroes in some of the Southern States claim that the smaller horse flies of the forest are produced from such accumulations of froth. If we investigate this froth we find in it a young insect, sometimes several. During hot days this continuous bath of froth must be quite gratifying to the insects inside, and is at the same time a good protection. It is produced by expelling from their beaks the juices drawn from the plants.

"It is asserted that these insects undergo all their transformations within this mass, that when one is about to molt for the last time, a clear space is formed about its body; the superficial part of the foam dries, so as to form a vaulted roof to a closed chamber within which the change of skin is made. The adult insects wander about on herbage and trees." (Comstock).

Aphrophora 4-notata Say. *(The Four-spotted Spittle-insect).*

This flat insect, about three-tenths of an inch long, has brown wing-covers with a blackish spot at the tip, a second one at the middle of the outer margin and a third one at the base, with the spaces between the spots whitish. Numbers of these insects occur upon the branches of the grape-vines, where they can readily be destroyed by the hand, while still in the frothy covering as soft and wingless beings. The insect is illustrated in Fig. 114.

A. signoreti Fitch, very similar in habits and appearance, is a little larger, and of a tawny-brown color clouded with dull white, and is thickly punctuated with black spots. The wing-covers have a small white spot on their inner margin near the tip, and a larger one opposite this on the outer margin; the wings are not spotted with black, as was the case with the species described above.

A. (Lepyronia) 4-angularis Say is also similar in habits and appearance, being brownish, covered densely with microscopic hairs, and black beneath. Here the wing-covers are marked with two oblique darker brown bands, which run together near the middle forming a sort of cross.

In the allied genus *Clastoptera* we have a number of insects that are quite different in shape, possessing a blunt head and a plump and short body, sometimes nearly hemispherical. All are small, seldom measuring more than one to two-tenths of an inch in length.

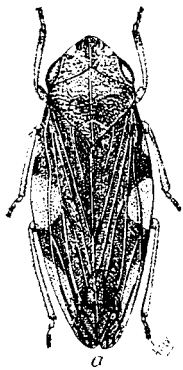


FIG. 114—*Aphrophora 4-notata* Say; *a*, from above; *b*, from side. Original.

FIG. 115—*Clastoptera protenus* Fisch. After Uhler.

a

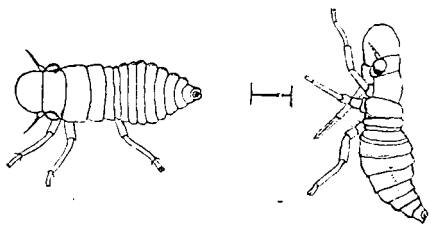


FIG. 116—*Clastoptera pini* Fitch—Larva; *a*, side view. After Div. of Entomology, Dep. of Agriculture.

Clastoptera proteus Fitch. *(The Cranberry Spittle-insect).*

In its younger stages it is found in the early part of June in little masses of froth upon the growing shoots of the cranberry vines; it also occurs upon the blueberry bushes in swampy places. The adult insects, which vary greatly in coloration and markings, hence the name *proteus,* jump with the agility of fleas. A very distinct example is deep black, highly polished, marked with two yellow bands on the vertex and one on the thorax, with two oblique stripes on the base of the wing-covers; and a cross-bar near the tip. At the base of the pale brown membrane and also

near the tip, a black dot is frequently found. One form is shown in Fig. 115 with expanded wings. It is so protean in coloration that we may find the same insect plain black, red, or even nearly uniform yellow.

Another species produces little accumulations of bubbly fluid in a bunch of pine needles, where it has resorted to for food. If we investigate we find the insect a small, shining, broad-oval tree-hopper, black in color, with a pale yellow head marked with a black band at the front margin. The thorax is sculptured with fine transverse lines, and with a pale yellow band anteriorly; the wing-covers possess a band with hyaline margin on the outer side, interrupted with black near the middle; a shining black dot occurs near the tip; underside and legs are pale yellow. The larva is shown in Fig. 116. It is *C. pini* Fitch.

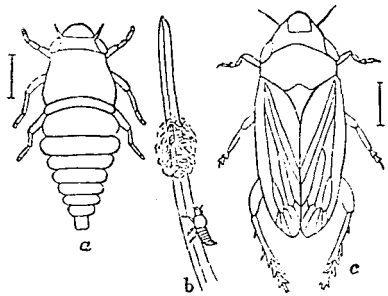


FIG. 117—*Ptyelus lineatus* Linn. After Lintner.

Several other species occur, but are not often numerous enough to cause serious damage.

Ptyelus lineatus Linn. *(The Lined Spittle-hopper).*

This is a common species in low and damp meadows, and in some cases, when exceptionally numerous, is apt to cause considerable anxiety to farmers. The insect, of which an outline is given in Fig. 117, produces a large mass of frothy material fastened to stems and blades of grass, inside of which the immature stages may be found. The adult is found late in June, and may be recognized by a narrow brown double streak on the head and prothorax, and by a slender line of the same color near the costal margin of the wing-covers; the margin itself is white.

Although common enough, it has never been reported as injurious.

A number of genera such as *Bythoscopus, Pediopsis, Idocerus,* and *Agallia* are illustrated on Plates IV-VIII; most of them are grass-destroying insects, but some of them occur upon our fruit-producing plants. These insects form the sub-family *Bythoscopida* of some authors.

FAMILY JASSIDAE.

(Leaf-hoppers).

Prof. Comstock in his "Introduction" writes of this family as follows:

"This, the highest family of the Homoptera, is a very extensive one. And it is also of considerable economic importance; for it includes a number of species that are very injurious to vegetation. The body is more slender than in the preceding family; with which this agrees in the insertion of the antennæ in front of and between the eyes, and in the absence of a prolongation of the prothorax above the abdomen. But the most salient character which distinguishes the Jassidæ is the structure of the hind tibiæ. These are nearly or quite as long as the abdomen, curved, and armed with a row of spines on each margin. The form of the body is 'commonly long and slender, often spindle-shaped, with a large transverse prothorax not much wider than the head. The front is generally an oblique, cross-ribbed, inflated prominence, with the cheeks touching the anterior coxæ, but rarely, if ever, restraining their movement. They have a rather large triangular scutellum; the wing-covers curve over the sides of the abdomen, appear as tapering towards the tip, and the membrane is distinguished from the more leathery corium.'" (Uhler).

Very few persons are aware of the amount of annual losses which leaf-hoppers cause to our cultivated and wild grasses, yet it is simply enormous. When we walk over the grasses covering our lawns, meadows and the prairies and roadsides, we can see myriads of little insects jumping and flying away as soon as disturbed, to settle again a moment later. Nearly all these small and active beings are sap-sucking leaf-hoppers, as shown

in the plates (Plates IV-VIII). They are so numerous at times that every blade of grass harbors one or more, all engaged in drawing on the vitality of the plant by pumping up the sap. Prof. Osborn, formerly of Ames, Iowa, who has studied the history of these insects very closely, in several of his papers describes the astonishing number of such insects, and it is almost a wonder that any grass can survive their attacks. Nearly one-fourth, if not one-half of all the grass growing annually is destroyed by leaf-hoppers; this is a rather startling statement, but frequently only too true and borne out by facts. He has described these insects and their work so well that nothing better can be done than by quoting his words:

"Following up the work indicated in the last bulletin we report some experiments with the hopper-dozer for leaf-hoppers. The larvæ of some species of the leaf-hoppers, notably *Deltocephalus debilis* and *D. inimicus,* appeared in great numbers upon the college campus about the eleventh of May. About two weeks later a frame six feet long and about two and one-half feet high was mounted upon runners so that it made an angle of about sixty-five degrees with the horizontal, and was covered with heavy paper which was then coated with coal tar. The runners were about one and one-fourth inches high so that the lower edge of the frame would scrape the grass when it was pushed forward by means of two handles so fastened that the operator could walk behind. This machine was somewhat unsatisfactory. The insects would be caught upon the lower part of the dozer and be brushed off on the grass together with the tar, which not only prevented our knowing the results we were getting, but injured the grass to a slight extent for feeding purposes. It was also noticed that many of the insects upon rising in front of it would swerve from its path too quickly to be caught by its motion. However, many of the insects were destroyed, and an unexpected result was the multitude of mites *(Bryobia pratensis)* captured, probably being thrown upon the dozer by the backward spring of the plants upon which they were feeding, from beneath a wire fastened two or three inches before the dozer for the purpose of scaring up the leaf-hoppers. Another form of the dozer was next tried. A piece of sheet iron, eight and one-half feet long and two feet wide was coated on the upper side with coal

tar and, lying flat on the lawn, was dragged along by means of three cords, one fastened at each end, and one in the center. The advantage of this form of machine over the preceding was at once apparent. It was more easily operated, no tar was wasted, and the insects upon springing into the air were almost certain to fall upon it in their descent. Two plats of blue grass upon the college lawn, having as nearly as possible the same natural advantages, were selected for experiment. May 29th one of these plats, which for convenience we will call plat I, was run over with the dozer, letting it at each round of the plat run over about half its width on the track of the preceding round, so that the entire plat was run over twice with the dozer. This plat, a triangle, was bordered by a grape patch on one side, and by roadways about twelve feet wide on the other sides, so that the migration of the leaf-hoppers into it from adjacent parts was in some degree prevented. The second plat, directly adjoining, was left untouched, and in this the insects pursued their work. The difference in growth and vigor of grass on the two plats was very noticeable in a short time, though no advantage of one over the other could be detected at the beginning of the experiment. This difference was more marked during an extended dry period than at any other time, thus indicating that the grass upon the untreated plat was materially sapped by the insects. Any possible natural advantage which plat I may have had over plat II we think insufficient for all the difference noticed. In order to ascertain the comparative numbers of insects at work in the plats, on the ninth of June, the dozer was dragged three rods on plat I. By actual count three hundred leaf-hoppers were taken. On plat II, in moving the dozer the same distance, 1,564 leaf-hoppers were taken; that is, more than five times as many as upon the plat which had been treated ten days previously. Upon the same day we attempted to clear plat I the second time with the dozer, but were compelled to stop by the interference of the grass pollen which soon covered the tar and enabled the insects to leap from the dozer back into the grass again. Hence, the dozer must be used before the grass blossoms, if grass is allowed to go to seed. On the twentieth day of June we again tried the dozer, the insects at this time for the most part being well developed and able to fly. Two men operated the dozer,

each holding a string fastened at the end and one fastened at the center, four strings in all. The advantage in having two men is that when alarmed by approaching foot-steps on either side, they will move centerward and be caught by the dozer, whereas when one man draws it and walks in front of the center they fly outward from his path on both sides and thus tend to escape.

"In moving fifty-five feet with the dozer the number of leaf-hoppers taken was estimated by counting the insects on three sections of the dozer, each six inches long and extending the entire width of the dozer. The counts were 183, 319, and 226, respectively, which averages 243 for each section, or 4,131 on the whole pan. At this rate about 376,000 insects would be caught per acre.

"Another test was made at the same time, dragging the dozer over 66 feet of lawn. This time five sections of six inches each were counted off and averaged instead of three, which resulted in giving 2,805 insects on the dozer, or 213,089 would be taken on an acre.

"Their wings at this time were so developed that many would fly entirely over the pan. At this stage the dozer should be of greater dimensions than ours, or used at hours of the day when hoppers are less active. The difference in numbers on the ground run over with the dozer and that not cleared was not very noticeable and there can be no doubt that over one million leaf-hoppers can, and often do, live on an acre of ground.

"The dozer will be found most effective while the insects are still immature and are unable to fly readily.

"Other insects captured at the same time, and worth noting, were several of the *Elateridæ* or click beetles, the parent forms of the destructive wire-worms, some tineids, sod web-worm moths, and numerous Capsidæ.

"July 2nd the hay upon plats I and II was cut and the product of the two equal triangles carefully surveyed with a surveyor's chain, and each containing 39-100 of an acre, was weighed and compared. The hay from the triangle on plat I weighed 338 pounds, or yielded at the rate of 876 pounds per acre. The hay from the triangle on plat II weighed 252 pounds, or yielded at the rate of 646 pounds per acre. The difference in

weight from the triangle on plat I and the triangle on plat II was eighty-six pounds, or at the rate of 221 pounds per acre, 34% in favor of the treated plat.

"Our experiments seem to us to strengthen our previous opinion that by using this simple form of the hopper-dozer the yield of hay or pasture land may be increased from one-fourth to one-third at a cost not exceeding ten cents per acre, even if all help employed is hired. We would recommend the use of the simple flat dozer and advise that it be used in the spring just as soon as young hoppers appear, and then if either these or young grasshoppers appear numerous at time of hay cutting, that the treatment be repeated."

These insects have but few enemies, and, what is worse, they are becoming less and less in numbers. As Bruner feelingly remarks; "every insect has its natural enemies, either vertebrate or invertebrate. These natural enemies when left to themselves usually keep the insects that do the damage within certain limits, these limits being below the point of danger. When various unnatural conditions arise these enemies for some cause or other are not able to destroy the insects upon which they feed, and as a result these latter increase beyond the normal, when injury to the vegetation follows. Chief among these natural enemies of grass insects in particular may be mentioned the various kinds of birds that naturally make their homes upon our prairies and on the bottom lands along our streams. Before civilized man came into the country and began his nefarious warfare on the birds, there were seldom any reports of excessive increase among the grass-feeding insects. But when civilization pushed westward and encroached upon our broad prairies, these birds fell before the firelocks of civilized man. The insects being deprived of their natural checks to increase began multiplying, and in time became much more numerous than formerly, and the result was the devouring of grasses in much greater quantity than formerly. As the birds decreased, the insects naturally increased, and the gap has been growing wider and wider with each successive year.

"The natural enemies of grass insects belonging to the bird class are first, prairie chickens, the sharp-tailed grouse, quail, meadow-larks, Bartramian sand-pipers, various other sand-pipers,

golden plover, the grasshopper-sparrow, black-birds, and a number of other prairie-frequenting birds, all of which have suffered more or less from what has been termed civilized conditions; and secondly, domesticated birds, as turkeys, hens, ducks, etc. Until we can make up our minds to cease slaughtering these friends of ours, the destruction of our grasses will continue more and more year after year until even these, like our cultivated crops, will be so much under the influence of insect pests as to render the production of feed for stock uncertain. Why not, then, wake up and at once begin redeeming our lost grounds by assisting nature to gain its former equilibrium?"

Remedies. As far as known there is no better remedy against the grass-destroying leaf-hoppers than hopper-dozers similar to the ones used against grasshoppers or locusts. This cheap machine has been repeatedly described and illustrated in previ-

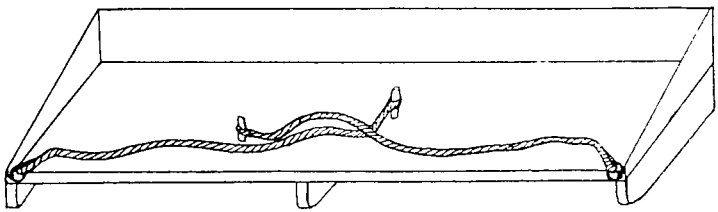


FIG. 118—Hopper-dozer. After Smith.

ous reports, and is again shown in Fig. 118. The pans are partly filled with water, upon which floats a small quantity of kerosene-oil, just sufficient to form a thick film. The insects coming in contact with this oil will perish. Of course it is necessary to modify the hopper-dozers in such a way as is required by local conditions, but the ingenuity of our farmer will soon overcome any defects in the old hopper-dozers, so as to fit them for the smaller insects to be captured.

Different writers have divided the Jassidæ into two sub-families; others have proposed as many as seven. The two sub-families can be distinguished as follows:

A. Ocelli placed on the front rim of the vertex close to the eyes, or on the front, but never on the disk of the vertex..... I. *Jassina.*

AA. Ocelli placed upon the vertex.....II. *Tettigonina.*

SUB-FAMILY JASSINA.

Only a few of the more destructive species of *Jassina,* besides those shown in the illustrations on plates IV-VIII can be given. *Hecalus lineatus* Uhl., illustrated on one of the plates, is a common grass infesting leaf-hopper, but occurs also in the cranberry swamps. It is pale green, with four orange lines on the vertex, which are continued back upon the prothorax and scutellum. The wing-covers are opaque, with orange veins; the recurved costal margin is either white or pale yellow.

Several species of the genus *Athysanus,* which feed upon the sap of grasses, are shown in the plates, as well as others belonging to the genus *Phlepsius;* they are shown as adults as well as in the immature stages.

Tamnotettix clittelarius Say. *(The Saddled Leaf-hopper).*

The above species, as may be seen in the illustration, Fig. 119, is very peculiarly marked; it is dark brown or black, with a sulphur-yellow spot like a saddle upon the middle of its back; in front of this is a band of pale yellow; head and underside are also of this color. It is occasionally found in large numbers upon plum trees, where it punctures the stem of the fruit, sucking the fluids, and thus injuring them. It is, however, not common enough to cause much injury.

Cicadula exitiosa Uhler. *(The Destructive Leaf-hopper).*

This insect was described in the Agricultural Report of 1879, where it was stated that in that year it caused much damage to winter grain in some Southern States, but as it occurs in our state as well, it will be well to repeat the description given, so that it may be recognized.

"It is a small, active, brownish insect, which measures with its wings folded about 5mm. (0.2 inch) in length. Its general form is well indicated by the enlarged figure, Fig. 120. It is very quick, a good flyer, and a great jumper. It injures grass or grain by piercing the midrib of the leaf and sucking the juices from it. Upon the plantation where I studied this insect, there was observable a most exact line between the eaten and the uneaten portions of the wheat field. Instead of spreading themselves over the field indiscriminately, or half eating a patch here and there, the leaf-hoppers ate the wheat down to the ground

as they progressed. They are very shy, however, and fly away on the least disturbance. Judging from the known habits of allied species, the eggs are doubtless laid in the stems of grasses close to the ground. The young hoppers when hatched are almost precisely of the same appearance as the old ones, except that they lack wings. The time occupied in attaining full growth probably does not exceed a month, so that there are several

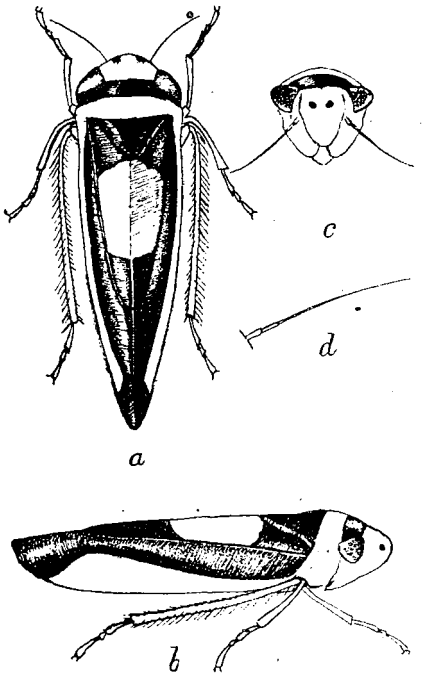


FIG. 119—*Tamnotettix clittelarius* Say; *a*, from above; *b*, from side; *c*, front of head; *d*, antenna. Original.

FIG. 121—*Cicadula 4-lineata* Forbes. Original.

broods a year. These insects are readily attracted by light; and probably many of them could be destroyed by trap-lanterns, or by building bonfires at night. It is possible, also, that many could be destroyed by spraying with some of the alkaline or other washes. In those cases where the line of injury is a well marked one, only a small part of the field would need to be sprayed." (Comstock).

This species is polished pale yellow, banded with black on the upper surface of the abdominal segments. The brighter yellow face is crossed each side by a series of curved brown lines; the outer cheeks are marked with two long and brown spots, and the front with a black dot on each side near the reddish ocelli. The scutellum is bright yellow, with a brown line on the base of each side, and four small irregular spots behind the middle. The illustration gives a better idea of this insect than a mere description.

Cicadula 4-lineata Forbes. *(The Celery Leaf-hopper).*

During the early part of July a small tree-hopper resembling that found on the grape vine, but very much larger, was doing considerable damage to the celery plants in the vicinity of the Twin Cities. As the injury did not seem to be very wide-spread and as the insect is probably to be controlled by the same remedies as is the grape-vine hopper, it was not thought best to carry on very extensive experiments with it until the success of the ex-

FIG. 120—*Cicadula exitiosa* Uhler. After Comstock Div. of Entomology, Dep. of Agriculture.

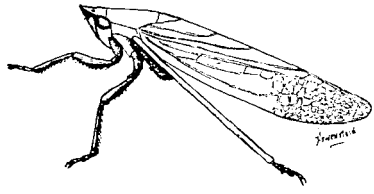


FIG. 123—*Gypona octolineata* Say. Original.

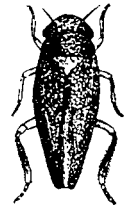


FIG. 127—*Phlepsius (Aulacizes) irroratus* Say. After Uhler.

periments on the latter insect could be determined. Raupenleim was tried as a repellant, but the result was not satisfactory. Probably the best remedy is a spray with the tobacco-extract described in the article on the grape-vine tree-hopper; this, while it would injure the sale of the celery if applied late in the season, would probably prove very effectual earlier, and before the plants are too far advanced. The culprit, which is a rather handsome insect, is illustrated in Fig. 121. It is of a bright green color, marked with a few black spots upon the head, the underside of which is illustrated to show the sharp and pointed beak which is inserted into the tissue of the plant to abstract the sap.

Plants infested by many sucking insects of this kind wilted and died; it seemed as if a poison was injected by the insect while imbibing the fluid food.

In the genus *Empoasca* we find a number of species which frequent fruit-trees, and for no good purpose.

Empoasa albopicta Forbes. *(The Green Apple Leaf-hopper).*

These insects were exceedingly numerous early in the summer of 1900 upon the currant and gooseberry bushes, and caused great injury to the leaves, upon the lower surface of which they live, sucking the sap. They cause the leaves to become spotted with white, in many cases to such an extent that the foliage became dry and dropped, thus forcing the plant to do extra work by producing a new set of leaves. They do not, like the plant-lice, cause the leaves to curl. Fig. 122 (Plate III) shows this insect; it is also shown upon the leaves of currants on Plate III, Fig. 123.

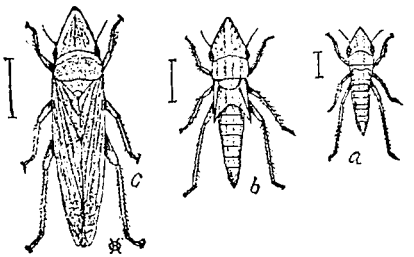


FIG. 126—*Diedrocephala mollipes* Say. After Osborn.

A number of insecticides were used; fresh insect powder, (pyrethrum), gave the best results, and all the insects reached by it were killed.

Other and very similar species occur upon the foliage of apples and other fruit trees. *Empoasca mali* LeB. is sometimes very troublesome to the foliage of the apple. It is the same as *albopicta* Forbs.

Typhlocyba rosæ Linn. *(The Rose Leaf-hopper).*

This is a very common pest, and sometimes occurs in large numbers upon the rose. "Swarms of these insects may be found, in various stages of growth, on the leaves of the rose-bush, through the greater part of the summer, and even in winter, upon

housed plants. Their numerous cast skins may be seen adhering to the lower sides of the leaves. They pair and lay their eggs about the middle of June, and they probably live through the winter in the perfect state, concealed under fallen leaves and rubbish on the ground." (Harris). The same insect is also found on the apple.

Typhlocyba vitis Harr. *et al.* *(The Grape-vine Leaf-hoppers).*

This destructive leaf-hopper, infesting both grape-vine and Virginia creeper, frequently but wrongly called "Thrips," has been described and illustrated in a former report, now out of print. The account given there is repeated.

For a number of years the above insects have been more numerous than usual and have caused considerable annoyance and losses, and as they still seem to be on the increase, it was considered important to discover methods and means to prevent their increasing injuries. Not only have our grape-vines suffered greatly, but the beautiful Virginia creepers, so often utilized to adorn houses in and about the cities, have also been more or less injured by these leaf-hoppers. A glance at Fig. 124, Plate IX, reveals how a grape-vine leaf is disfigured by the numerous insects seen resting on its under side; here are also shown other white objects, the characteristic empty pupal skins. A leaf infested with these insects has a mottled appearance, and in course of time becomes yellow, brown, and eventually drops off. The larger illustrations show a larva, pupa, and two different adults.

Early in the season the vine-yards in the vicinity of Lake Minnetonka were reported to be suffering again from these insects, and a number of experiments were made by the assistant entomologist to discover remedies.

As most persons growing grape-vines know from sad experience how these insects look, it is not necessary to describe them in detail; the illustrations show their general appearance much better than words could express it. Four different species were found, all about the same size and shape, only varying in markings. The most common ones were the two species illustrated, of which one is *Typhlocyba vulneata* Fitch, and the other one *T. comes* Say. The former is a reddish-brown insect marked

with white lines and dots, and also with two prominent black lines at the margins of the upper wings; the latter is of a translucent white color, prettily marked with red lines and prominent black spots at the tip of wings and two black lines at the margin. The younger stages of both are very pale, but the insects in that stage are almost as active as the adult ones, though lacking, of course, the wings. They will dodge about in a most amusing way, and as they, like the adult ones, jump readily, they are not easily captured. Like all insects belonging to this order they are active and take food as soon as born, not passing through an inactive pupal stage like beetles and moths. They take their food by suction, hence the application of such stomach poisons as Paris green or London purple is of no avail, though it will kill, by contact, some of the still very tender and younger specimens, or even adult ones while they are just shedding their skins and are still very soft and unable to clean themselves. The only remedies that promise success are insecticides which kill by contact, as kerosene-emulsions, tobacco-extracts, insect powders, and others. The former, to be of any use at all, should be applied very early in the morning, when the insects are less active than later in the day. A number of different insecticides were tried at a time, when the leaves, even at that early date, May 20, showed already considerable injury, being somewhat withered and curled, and appearing scorched and very unhealthy.

The following experiments were made: On May 20th a mixture of kerosene and water was applied with a knapsack sprayer having a special arrangement for mixing the two liquids without previously making an emulsion. This liquid was used in the proportion of one part of kerosene to 15 parts of water, and the vines were thoroughly moistened with it. During the spraying the leaf-hoppers rose in swarms, and many fell to the ground, but the greater part of these recovered and flew away to return in the course of half an hour. A few were rendered inactive and appeared paralyzed for a time, but very many of these recovered in less than half an hour. The mixture seemed to produce no permanent effect upon the insects, simply because the integument of these minute beings is very smooth. To remove the offensive fluid the insects used their spiny hind legs very diligently and with success.

A solution of tobacco-soap in the proportion of two ounces of the soap to one gallon of water, and another one of one-half pound of whale-oil soap to the same amount of water was applied, Mr. Reel, the owner of the vine-yard, reported on June 10th that neither had been of much use, and that even a few hours after the application but very little difference could be detected between plants treated and not treated.

On July 3d another experiment was made with a tobacco extract sold as "Scabcura Sheep-dip." This mixture was applied with a knapsack sprayer in two different strengths; one row of vines was thoroughly sprayed using two ounces of the extract to one pailful of water, and another row was sprayed using four ounces of the extract. The effect was immediate, and at the end of two hours but very few of the pests could be seen on the plants. On Aug. 25th Mr. Reel reported as follows: "I am pleased to be able to report that the grape-vines experimented upon show a much better foliage than the adjacent rows, although the hoppers appear on them to some extent; the foliage is not so badly browned. I am satisfied that by spraying in the spring, while the leaves are not too thick, it might drive them away. The stronger solution is by far the most effective one." The action of this extract is almost wholly that of a repellant, and but few if any of the insects are killed. At the same time another test was made of the effectiveness of the kerosene and water spray against the leaf-hoppers which were at this season largely immature; three strengths were used, viz. 1:10, 1:15, 1:20 of water, and besides spraying several rows of vines, leaves which were covered with insects were picked off and sprayed separately. It was found that when 1:20 was used it killed very few; 1:15 killed many of them; while 1:10 killed the great majority, but the difficulty of reaching all the leaves and spraying the whole vine was very great, as the foliage was at this time fully developed and very dense, and the insect invariably hides on its underside.

The above report shows that an extract made of tobacco and sold under the name "Scabcura Sheep-dip" proved of considerable value, and that if applied early in the season we possess in it the means of protecting our grapes.

Prevention is always better than cure, and much can be done to prevent the undue increase of these insects. They winter in all kinds of rubbish found in and about the vine-yards and adjoining woods and fields. All such rubbish should be collected and burned after the first frosts have driven the insects into their winter quarters. By doing so many are killed by the fire, and still more are exposed to the inclemency of the winter and perish. This burning should be general, as the insects migrate to some distance to find suitable quarters for the winter; hence the rubbish or dead leaves in neighboring woods should also be burned. The neighbors should unite in this work because if one person in the midst of many vine-yards should neglect to do his duty, he can harbor enough of these insects to endanger all his neighbors' vines. If mulching is used, this material will offer, as long as still fairly fresh, most excellent hiding places for these leaf-hoppers; and especial care should be taken to prevent them from utilizing such places for hibernation. This can be done in various ways, depending upon conditions; but every one recognizing this danger will doubtless find means to lessen or overcome the same.

A number of other methods have been used with more or less good results. By attracting the winged insects with a light many can be destroyed; hence a brightly burning torch is slowly carried at night along the rows of vines, which are at the same time disturbed to alarm the leaf-hoppers. Another plan is to carry a shield covered with a sticky substance between the vines during the hottest part of the day, and thus catch the insects that have been driven off the plants by beating these lightly with a stick.

SUB-FAMILY TETTIGONINA.

(Leaf-hoppers).

Members of this family are mostly small or medium sized insects with long and narrow bodies, although some resemble the short-bodied frog-hoppers described before. Many of them have an expanded face, with a prominent ridge in front.

The exceptional genus *Gypona,* possessing plump proportions instead of a long and narrow body, occurs in a number of species in Minnesota. As a type the pea-green *G. octolineata*

Say may be mentioned, which measures nearly half an inch in length. It is marked on the head by eight yellow lines, which continue back upon the prothorax. The head is broad, shovel-shaped, and a little peaked at the very tip. It is found upon a number of low plants, but likes the blackberry very well, as shown by the large numbers visiting that plant. (Fig. 125½).

The genus *Diedrocephala* contain a very large number of species, which are usually grass-green, pale-green, spindle-shaped insects, well representing the typical form of this sub-family; all possess a long deltoid head, as seen from above. The common *D. mollipes* Say (Fig. 126) has the abdomen, legs and body beneath pale yellowish, the lines across the front and at the vertex are black, the wing-covers are edged with yellow, and the veins of the wing-covers are blue; those of the cells of the membrane are green. It measures about one-third of an inch in length, and is very common upon grass, mints, and low plants near creeks.

The genus *Tettigonia* is also well represented in our state, and some very beautiful insects belong to it.

On the willow and other plants in damp places we find another interesting species, the *Aulacizes irrorata* Fab., illustrated in Fig. 127. It is of a pale yellowish color, fresh and alive an ivory white, clouded with pale brown. It measures rather more than one-fourth of an inch, and is sometimes very common from July until the end of October.

Oncometopia undata Fab. *(The Waved Proconia).*

This cylindrical insect measures nearly half an inch in length, and is more blunt than the species mentioned in the preceding two genera; it is also much wider across the eyes than it is across the thorax. Its body, head, fore part of thorax, scutellum, and legs are bright yellow, with circular lines of black on the head, thorax, and scutellum. The under side of the abdomen is banded, and the breast and legs are speckled with black. The wing-covers are bluish purple, when fresh, and coated with whitish powder. (Uhler). In some specimens an oval white patch is seen on the sides, as shown in the illustration, Fig. 128, which gives a view of the insect from above, from the side, and of one of the under wings.

The insect is said to lay its eggs in single rows in the wood of canes, in some cases preferring, greatly to the sorrow of the fruit-grower, the canes of the grape-vines, in which case the insect becomes a great pest. Besides attacking the leaves it punctures the stems of the bunches of grapes with its beak, causing the stems to wither and the bunches to drop. Sometimes it pumps out the sap so vigorously from the succulent branches that the drops fall in quick succession from its body. It is also found in large numbers in willow trees, and the united work of many insects causes a light shower of sap to fall to the ground. In this way they transform the common willow trees into veritable "weeping" willows.

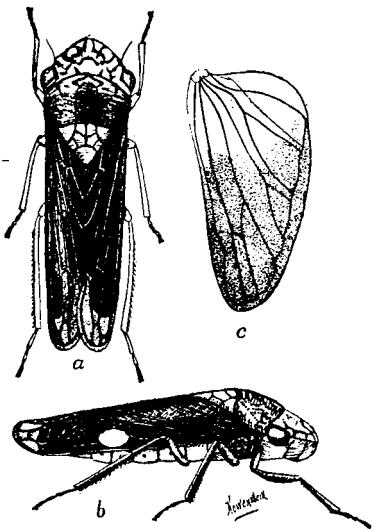


FIG. 128—*Oncometopia* (*Proconia*) *undata* Fab. *a*, from above; *b*, from side; *c*, under wing. Original.

FAMILY PSYLLIDAE.

(Jumping Plant-lice).

This is a family of rather small insects, few of which occur in Minnesota, none measuring more than one-sixth of an inch in length. When they are examined with a magnifying lens they are seen to resemble minute cicadas. They differ from the true plant-lice, or Aphides, by a firmer texture of the body, stouter limbs,

of which the posterior ones are fitted for jumping. Their peculiar feelers, which are armed at the tip with one or two bristles, are nine- to ten-jointed; their tarsi are two-jointed. Their thighs are thick, and the posterior shanks are armed with stout spurs at their tips to aid in leaping. The short and three-jointed beak

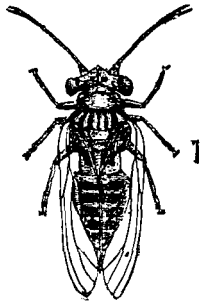


FIG. 129a—*Psylla pyricola* Forster: adult, enlarged (after Slingerland); Div. of Entomology, Dep. Agriculture.

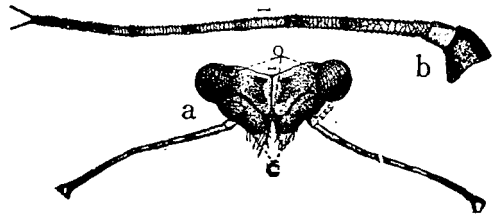


FIG. 129b—*a*, head of adult, front view; *c*, cones of clypeus; *o*, ocelli; *b*, antenna of adult, all enlarged (after Slingerland), Div. of Entomology Dep. of Agriculture.

FIG. 129d—Egg, enlarged (after Slingerland). Div. of Entomology, Dep. of Agriculture.

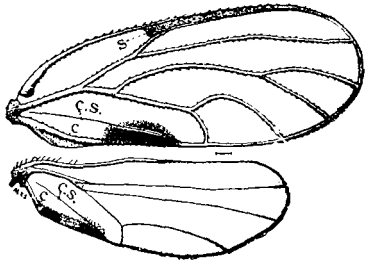


FIG. 129c—Venation of wings. *s*, stigma; *c*, clavus, *c*, *s*, claval suture—enlarged (after Slingerland). Div. of Entomology, Dep. of Agriculture.

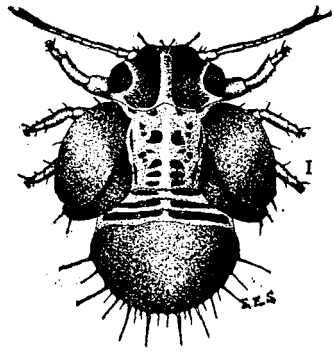


FIG. 129e—Full grown nymph, dorsal view—enlarged (after Slingerland) Div. of Entomology, Dep. of Agriculture.

is placed almost between the fore-coxæ, where it fits into a groove. Both sexes possess wings in their adult forms. The ample and frequently transparent wing-covers are thicker than the wings, and possess stout curving veins, which enclose a few areoles at the tip. They possess a flat and transverse forehead with three ocelli.

Psyllidæ are strictly vegetarian in their food habits. Most of them, like the plant-lice, feed upon the sap of plants, where they can cause serious damage if at all numerous; others form peculiar galls.

To show the form of these peculiar beings two species are illustrated.

Psylla pyricola Forster. *(The Pear-tree Psylla).*

This jumping plant-louse has caused very severe losses upon pear growers in various parts of the Eastern States; in extreme cases it has destroyed extensive pear orchards by sucking the

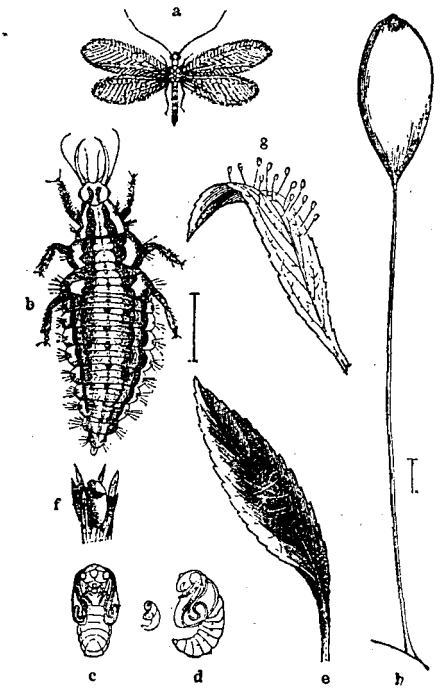


FIG. 130—*Chrysopa* species. After Brehm.

sap from the smaller limbs and twigs, and in many other cases it seriously interferes with the successful cultivation of this fruit. As pears are not grown to any great extent in our state it is not necessary to describe the insect in detail, and it is sufficient to state that the adult and winged insect has a striking resemblance

to a cicada. Its general color is crimson with broad black bands across the abdomen. The end of the abdomen of the female resembles a bird's beak, that of the male ends in a large trough-shaped segment from which three narrow copulating organs project upwards.

The insect, illustrated in Fig. 129, passes the winter as a winged being under loose bark of the infested tree. Early in spring the sexes mate and soon the females commence to deposit their peculiar eggs, which are elongated pear-shaped, smooth, shining light orange-yellow in color, and are attached to the bark of the tree with a short stalk, while a long and thread like process projects from the smaller end. As soon as hatched the strange-looking young nymph seeks the axils of the leaf petioles and later the stems of the growing fruit.

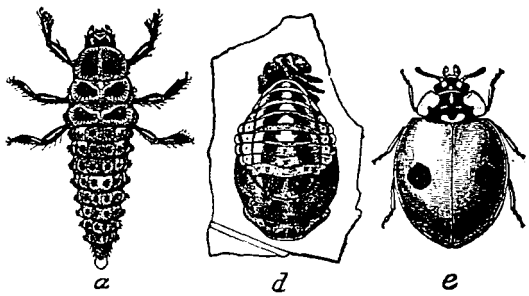


FIG. 131—*Adalia bipunctata* Linn. After Div. of Entomology Dep. of Agriculture.

In the state of New York this insect has at least four annual generations. Like the true plant-lice they secrete a large amount of honey-dew, at least in their younger stages.

A number of other insects feed upon them. Some of them are shown in the following illustration. Fig. 130 represents the common lace-winged fly, *(Chrysopsa oculata)*; others closely related to it eat large numbers of the pear-tree psylla. The different kinds of lady bugs, but especially the one shown *(Adalia bipunctata)*, (Fig. 131), also assist us materially not alone in keeping in check this jumping plant-louse, but all the other true plant-lice.

The Psylla can be destroyed in the same way as the true plant-lice. The best methods to do so will be given later.

A number of other species of Psylla are sometimes injurious.

Psylla rubi W. & R. *(The Blackberry Flea-louse).*

This small jumping plant-louse, about one-eighth of an inch in length, is reported as common on blackberry leaves. Here it curls the leaves, which should be gathered and burnt, as otherwise they offer safe harbors for their larvæ, which can be found hiding in them during the greater part of the summer.

P. tripunctata is a wax-colored species with three brown curved streaks, and three darker spots near the posterior margin

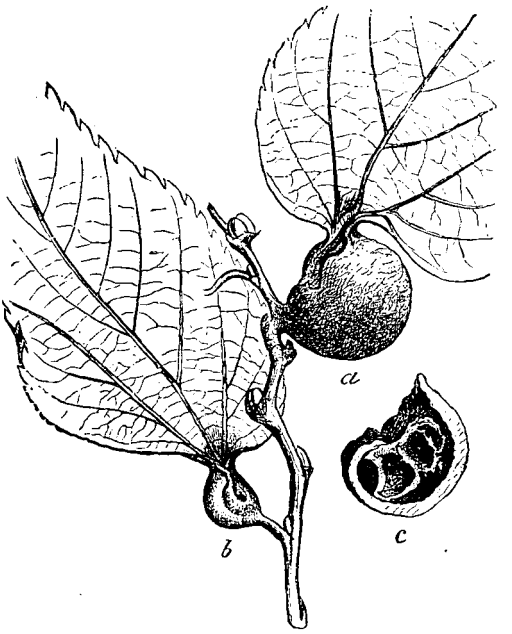


FIG. 132a—*Pachy-psylla venusta* O. S. *a*, gall fully formed; *b*, same forming; *c*, section of same, natural size. After Riley, Div. of Entomology, Dep. of Agriculture.

of the wing-covers. It thrives upon the leaves of the blackberry, which it causes to wrinkle and purse, while it is equally common among the needles of pine-trees. (Uhler).

A number of gall-forming jumping plant-lice occur upon the hackberry tree, a tree of very graceful appearance, very hardy, and one that should be more frequently planted for shade and ornament in our state, where it is native. Some of the little gall-makers are beautifully marked.

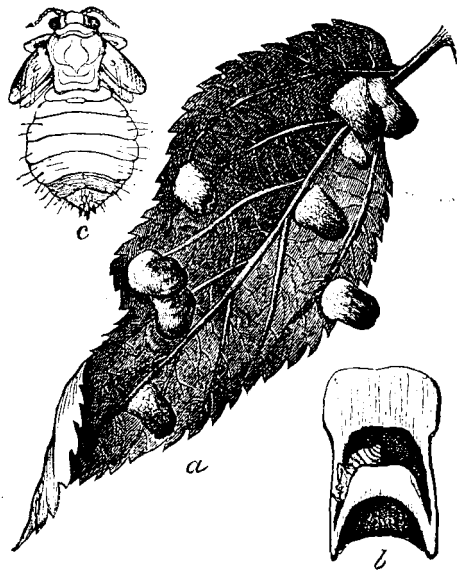


FIG. 132b—*Pachypsylla c. mamma*, Ril.: *a*, leaf with galls from under side—natural size; *b*, section of gall showing cup-like depression, and insect in cavity; *c*, pupa, enlarged. After Riley.

Pachypsylla venusta O. S. *(The Hackberry Gall Psylla).*

This is one of the hackberry inhabiting species, and is much larger than all others, expanding nearly half an inch across the expanded wing-covers, which are grayish, marked with brown, with a double oblique row of squarish dark brown spots along the posterior margin of the wing-covers. The gall produced by arresting the flow of sap in the petiole of the hackberry leaf sometimes reaches the size of a large filbert nut. When ripe in autumn it is very hard and coarse. The structure of the gall, and that of another one *(P. c. mamma* Ril.*)*, as well as the gall-maker, are shown in Fig. 132. These insects are of no economic importance.

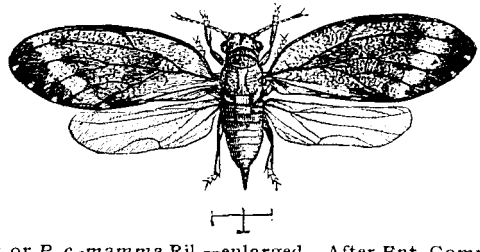


FIG. 132c—Adult or *P. c.-mamma* Ril.—enlarged. After Ent. Commission, Div. of Entomology, Dep. of Agriculture.

FAMILY APHIDIDAE.

(Plant Lice).

Every lover of plants, whether he grows only a few geraniums in his window, or possesses a garden in which to grow his vegetables, whether he grows plants of all kinds for the market, or is a farmer who cultivates very extensive fields for crops, must often have noticed plant-lice upon the leaves, stems, or even on the roots of the plants he is growing. Here these small, soft-bodied insects, with long legs and feelers, are seen in crowds, steadily engaged in pumping the sap through their thread-like beaks. Plant lice are not the friends of the farmer, gardener, or horticulturist, and to obtain some results from their labor the latter have in some cases to continuously fight the intruders.

There are a great many species of plant lice, the largest measuring less than one quarter of an inch, while the great majority are very much smaller. Up to very recent times these insects have not received the attention of the entomologist as much as they deserve, and the life-history of very many species is still shrouded in mystery, and no wonder, for they have a most peculiar life-history, quite different from that of all other insects.

Of late such men as Comstock, Howard, Smith, Webster, Forbes, Oestlund, Pergande and a host of others have tried to solve the numerous riddles their various forms, curious habits, and strange development have presented, and gradually we commence to understand this family very much better than in the past.

Prof. Comstock, in "An Introduction to Entomology," has given such a comprehensive and thorough account of these insects that it is quoted in full.

"The body is usually more or less pear-shaped. The winged forms have two pairs of delicate, transparent wings. These are furnished with a few simple veins; but the venation is more extended than in either of the two following families. The first pair of wings is larger than the other; and the two wings of each side are usually connected by a compound hooklet. The

beak is two-jointed, and varies greatly in length; sometimes it is longer than the body. The compound eyes are prominent; and ocelli are also usually present. The antennæ are from three- to seven-jointed. On the dorsal aspect of the sixth abdominal segment there is, in many species, a pair of tubes, through which a sweet, transparent fluid is excreted. In some genera these organs are merely perforated tubercles; while in still other genera they are wanting. The fluid which is excreted through the

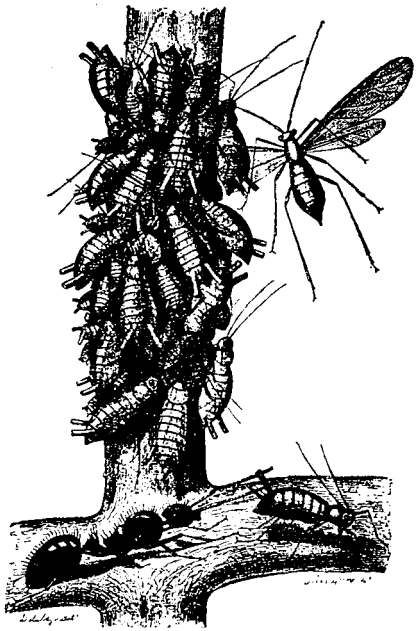


FIG. 133—Ants milking plant-lice. After Figuier.

abdominal tubercles is the substance known as honey-dew. It is sometimes produced in such quantities that it forms a glistening coating on the leaves of the branches below the plant-lice, and stone-walks beneath shade-trees are often densely spotted with it. This honey-dew is fed upon by bees, wasps, and ants (Fig. 133). The bees and wasps take the food where they find it, paying little, if any, attention to its source. But the ants recognize in the plant-lice useful auxiliaries, and often care for them as man cares for his herds.

"In addition to honey-dew, many Aphids excrete a white substance. This may be in the form of a powder, scattered over the surface of the body, or it may be in large flocculent or downy masses; every gradation between these forms exists.

"The plant-lice are remarkable for their peculiar mode of development. The various species differ greatly in the details of their transformations; but the following generalizations can be made: .

"At some period eggs are produced by impregnated females. This ordinarily occurs in the autumn; in which case the eggs do not hatch till the following spring. From the fact that these eggs are fertilized, they are frequently referred to as true eggs, in contradistinction to pseudova, described later. These true eggs are also known as winter eggs.

"From the winter eggs there hatch in the spring a generation of Aphids in which there is no distinction of sex. All are females; and each has the power of reproducing without the intervention of a male. Such reproduction is termed *agamic reproduction,* or reproduction by budding. And this term is also applied to the individuals that reproduce in this way. Usually, the agamic generation produced by the winter eggs is wingless. The agamic female which hatches from a winter egg, being the starting point from which arise the generations that intervene between this egg and the production of other true eggs, is termed the *stem-mother.*

"The offspring of the stem-mothers are wingless, or winged, or both, and are agamic. In many cases they are born alive. This can be seen by examining almost any colony of plant-lice during the summer time. While an agamic mother is unconcernedly feeding or walking about, it may be giving birth to a young louse; the latter can be seen with the unaided eye, but better with a lens, emerging from the caudal end of its mother, tail first, and kicking vigorously, even before its head has been delivered. In other cases, the agamic form produces egg-like bodies, which are termed *pseudova,* to distinguish them from the fertilized or true eggs. And, in still other cases, they produce living young, which are enveloped in a pellicle, from which they emerge in the course of a few minutes; such an enveloping pellicle with its enclosed young is also termed a pseudovum.

"The number of agamic generations that may follow without the intervention of sexual forms varies with different species, and, in some cases at least, varies in the same species, depending upon temperature and other conditions. Thus Kyber, in the early part of this century, succeeded, by keeping the insects in a warm room, in raising a series of agamic generations of two species of Aphids, which extended through four years without the intervention of sexual forms.

"As already indicated, the agamic generations are of two forms, wingless and winged. Each of these has a peculiar function in the economy of the species. The wingless generations, which are usually the more numerous, by their great fecundity provide for the enormous and rapid multiplication of individuals, which is so characteristic of these insects. But this great increase of individuals would be disastrous to the species, by the destruction of the infested plants and the consequent starving of the insects, were it not supplemented by other powers. We find, therefore, interspersed among these wingless sedentary generations, generations which are winged and migrating. Thus the spread of the species is provided for.

"Generally on the setting in of cold weather, or in some cases on the failure of nourishment, the weather being still warm, there is produced a generation including individuals of both sexes. The males may be either winged or wingless; but, so far as is known, the females that pair with the males are always wingless. These females, after becoming impregnated, produce the winter eggs; thus is completed the cycle of changes through which the species passes. In many cases, at least, the individuals of the agamic generation that immediately precedes the sexual one produce but few pseudova; from these pseudova the sexual individuals emerge, not as larvæ, but as fully developed individuals, ready to pair and reproduce; in fact in the cases referred to, the sexual individuals have the mouth-parts in a rudimentary state, and take no nourishment. In many species the impregnated female produces a single egg, which is nearly as large as the insect herself; frequently this egg is not laid, but remains throughout the winter in the dry skin of the dead parent.

"Agamic Aphids may hibernate, and may coexist with the sexual generation of the same species.

"From the above generalizations it will be seen that a single species of plant-louse may present three distinct forms; first, a sedentary, agamic, wingless form, furnished with mouth-parts; second, a migrating, agamic form, which is winged and furnished with mouth-parts; third, a sexual form, of which the females are wingless, while the males my be either winged or wingless; in certain cases, at least, the sexual forms are mouthless.

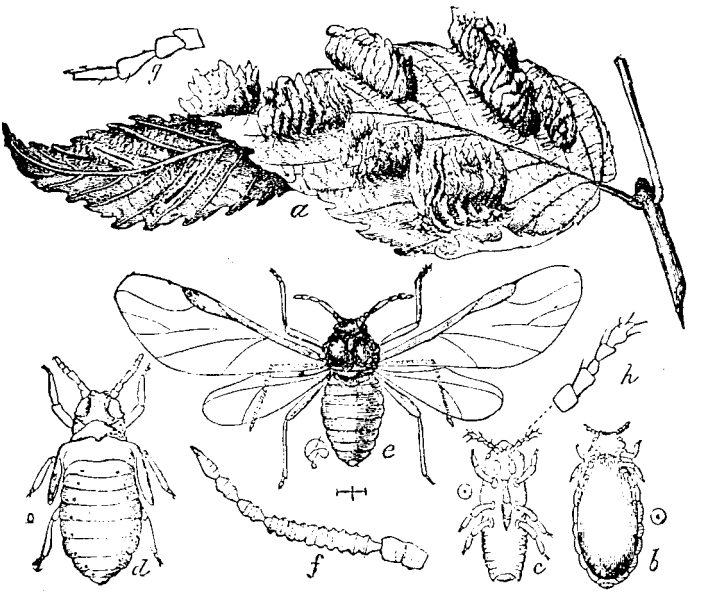


FIG. 135—Cockscomb gall on elm (*Colopha ulmicola:*) *a*, leaf showing galls from above and beneath—natural size; *b*, impregnated egg surrounded by skin of true female; *c*, newly-born young of second generation, ventral view; *h*, its antenna; *d*, pupa of same, dorsal view; *e*, winged female; *f*, her antenna; *g*, antenna of stem-mother—all enlarged. After Riley and Monell in U. S. Geol. and Geogr. Survey.

"There is unfortunately a generalization in most of the text-books on entomology, that is incorrect. It is that the winged generation is produced only on the approach of cold weather, and that this generation is the sexual one.

"Plant lice are often very destructive to vegetation; they appear, however, to be more liable to attack unhealthy plants than those that are in good condition. The best method of destroying these pests is by spraying with a strong solution of soap, or with kerosene-emulsion. As plant-lice draw their nourishment from

below the surface of the plants they infest, they are not injured by the application of poisons to the plants."

The presence of plant-lice is made manifest in various ways. Sometimes the plant is sapped of its vitality and dies, or is impoverished simply by loss of its sap. At other times an abnormal growth is produced in the leaf or stem on which the louse feeds. In the case of the currant-louse (Fig. 134, plate IX), as well

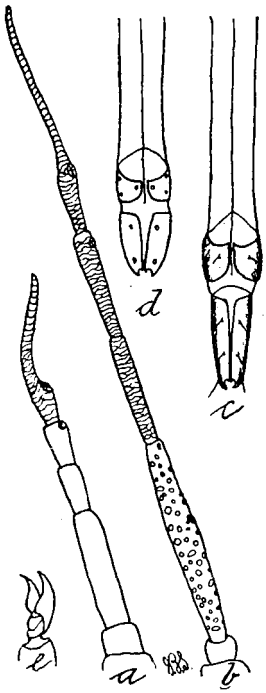


FIG. 137a—Antenna of wingless forms of cabbage lice; *b*, antenna of winged forms; *c*, beak of young lice; *d*, beak of winged form; *e*, claw. After Smith.

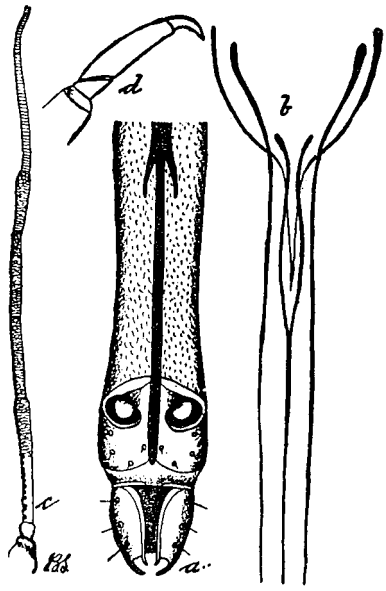


FIG. 137—Beak of plant louse; *a*, proboscis of wheat-louse; *b*, lancets contained in it, *c*, antenna showing the sensory pits; *d*, tarsus. After Smith.

as in that of the plum-louse, the twisted and bladder-like leaves present a shelter in which the young lice can be raised in safety. At other times again the abnormal growth extends to the formation of a hollow gall, in which the family of lice live very much as in a small house. Our cottonwood trees produce a familiar example in the form of large terminal galls; such galls are always open to allow for the exit of their inmates. Fig. 135 shows a

common gall on the elm, called the Cockscomb Gall, from its fancied resemblance to the comb of a fowl. At other times plant-lice work on the roots of plants, as in the case of our lettuce root-louse, and the grape-phylloxera. In the latter case large knobs and gall-like swellings are produced by the sucking lice, and here they may be found. The lice, if infesting European

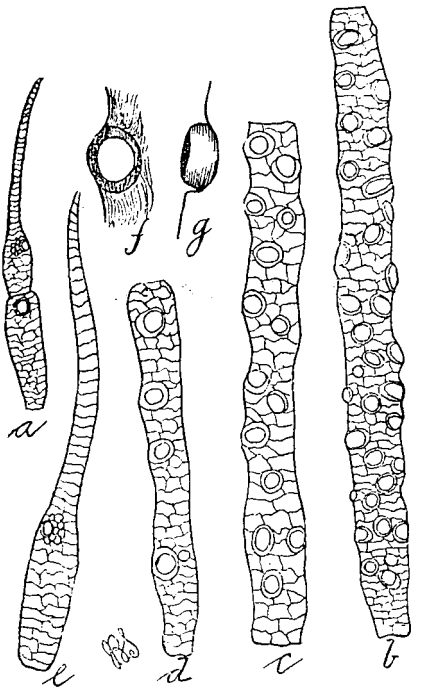


FIG. 138—Sensory pits of peach louse; *a*, antenna of young lice; *b*, first long joint of winged form; *c*, second long joint; *d*, third long joint; *e*, whip joint; *f*, sensory pit of antenna, from top; *g*, same from side. After Smidt.

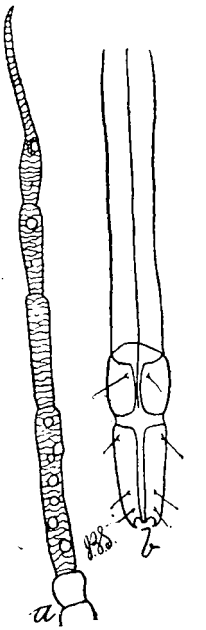


FIG. 138a—*a*, Antenna of melon plant louse showing sensory pits; *b*, beak of same. After Smidt.

grape-vines, usually cause the death of the vine. This same insect, which produces galls on the roots of the vines, can also produce small galls on the under side of the leaf. These leaf-galls are hollow and serve as houses for the lice. The woolly louse of the apples is a species which is becoming more and more important and destructive with the development of our apple-orchards. They collect in clusters, which become very con-

spicuous, because the louse is covered with a white woolly matter. In consequence of their work the bark ceases to grow wherever such clusters occur. This species has also a root-inhabiting form, which, like the phylloxera, causes gall-like growths on the smaller roots. This makes this pest a very difficult one to combat.

Fig. 136, Plate X, shows a plant-louse in the act of sucking; it will be seen that the beak does not enter into the tissue at all, but that the four lancets laid together to form a single long tube is the only organ that is used to obtain the liquid sap of the

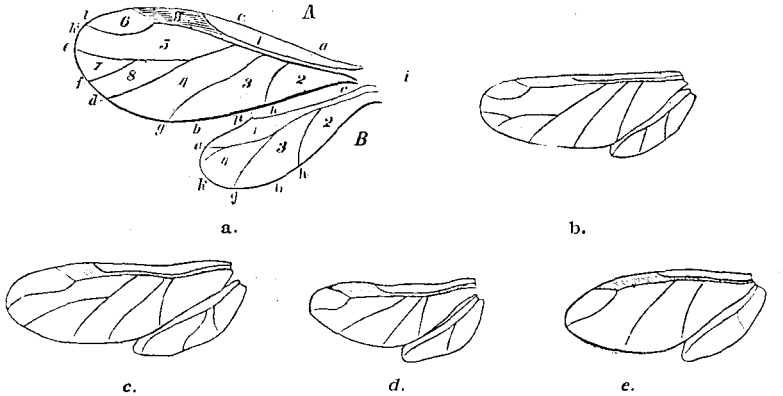


Fig. 139a—Venation of wings of plant lice: A, upper wing of *Sipphonophora;* B, lower wing of same; *a*, sub-costal vein or cubitus; *b*, posterior margin; *c*, costa or costal vein; *d*, third discoidal or cubital vein; *e*, first fork or first furcal vein; *f*, second fork or second furcal vein; *g*, second discoidal vein; *h*, first discoidal vein; *i*, the base or point of insertion; *k*, apex or apical margin; *l*, sigmatic or fourth vein; *p*, hooklet; 1, costal cell; 2, basal cell; 3, first discoidal cell; 4, second discoidal cell; 5, infra-marginal cell; 6, margina, cell; 7, second cubital cell; 8, first cubital cell; 9, stigma; b, wing of *Aphis*, *l*, of *Schizoneura; d*, of *Tetraneura; e*, of *Chermes*. After Thomas.

plants. The structure of the beak of a plant-louse is also shown, in Fig. 137, greatly enlarged. It also shows the very peculiar feelers, covered with an immense number of sense-organs (Fig. 138). The arrangements and distribution of these organs are of great importance in classification.

The Aphididæ comprise four sub-families; the following table for separating these sub-families is published by Dr. Thomas, in the "Eighth report of the State Entomologist of Illinois." It is necessary here to give the names applied to the veins of the wings, as some of them are used in this table (see Fig. 139). The principal vein of the front wing, that which extends

from near the base to the tip of the wing, is the subcostal or submarginal one. The distal end of this vein becomes widened, and extends to the margin of the wing; this part of it is the stigma (st). From the stigma, a curved vein extends to the tip of the wing; this is the stigmatic or fourth vein. From the submarginal vein there branch two or three veins (in addition to the stigmatic vein), which extend across the disk of the wing; these are the first, second, and third discoidal veins. The third discoidal vein is sometimes forked. The veins of the hind wing, so far as they are present, are named in a similar manner.

A. Winged form known; species not subterranean, except in a few cases where there are dimorphic forms.
  B. Front wings with three discoidal veins; antennæ of the winged individuals, and generally of the apterous individuals, six- or seven-jointed.
    C. Front wings with the third discoidal vein twice forked; posterior wings with two discoidal veins; honey-tubes various..... 4. APHIDINA.
    CC. Third discoidal vein with one fork or simple; posterior wings with one or two oblique veins; honey-tubes tuberculiform or wanting.....3. PEMPHIGINA.
  BB. Front wings with but two discoidal veins, the third being absent; antennæ never more than five-jointed, sometimes but three-jointed.....2. CHERMESINA.
AA. Permanently apterous; at least no winged form has been observed: chiefly subterranean, residing on the roots of plants.... 1. RHIZOBIINA.

SUB-FAMILY RHIZOBIINA.

(Root-lice).

This is a sub-family of plant lice in which no winged forms have thus far been found. They may be simply degraded wingless generations of higher developed forms with wings. Their

feelers are short, five- or six-jointed; the beak is variable in length; the eyes are very small and inconspicuous, or are entirely lacking; the legs are short and stout; the tarsi possess two claws, which are sometimes folded so as to appear single, or there is only one claw, as in the genus Rhizobius. There are no honey-tubes, yet the insects are always accompanied by ants. These lice have commonly a depressed form, tinted with pale brown or yellow colors; they are found upon the roots of plants, where they can become very destructive.

Rhizobius lactucæ Fitch. *(The Lettuce Earth-louse).*

This eastern species sometimes occurs in destructive numbers on the roots of the lettuce, both on wild and cultivated kinds. It measures less than one-tenth of an inch in length, is oval, of a dull white color, with dusky legs and feelers. The whole body seems to be dusted with a white powder.

Roots of grasses like those of Poa and Eleusine, and the roots of other herbaceous plants, harbor such insects, even some evergreens do not escape.

The genus Tychea, which belongs to this sub-family, is found in Minnesota, and Prof. Oestlund has described one species occurring on the roots of a common weed, the Ambrosia trifida. The genus possesses five-jointed feelers, of which the third joint is the longest.

Tychea phaseoli Passerini. *(The Bean Root-louse).*

Prof. Garman has described this insect as being quite destructive to cultivated beans in the gardens near Lexington, Ky. It was so numerous, clustering on the root-stalks, that it was difficult to get a stand of plants. It is illustrated in Fig. 140, is almost globose in shape, and has the body clothed everywhere with short, erect pubescence. Living specimens are white, owing to a coat of waxy material, but if this coat is removed it is seen that the real color is pale yellow, nor is this waxy material found in the young lice, which have a glossy honey-yellow color; the tips of the feelers and the tip of the beak, as well as much of the legs, are dusky.

Plants infested by such root-lice have an irregular growth and dwarfed appearance. Whenever they occur we find little

hills of loose earth near the plants, due to the presence of small brown ants, who take good care of their "cattle," even carrying them away when the plants are taken up.

Prof. Garman recommends the use of ground-up tobacco stems, to be scattered liberally along the furrows in which the beans are planted. Since the tobacco is at the same time a good fertilizer, its use makes the plants more vigorous, so that they can withstand their underground enemies much better than plants not so well fed.

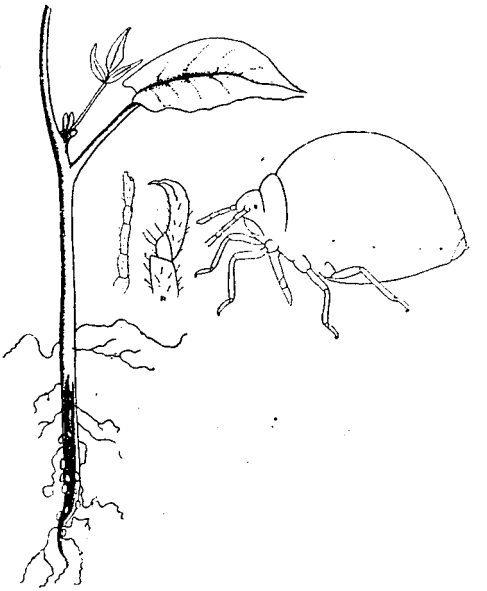


FIG. 140—*Tychea phascoli* Passeiini, *A*, antenna; *B*, tarsus, greatly enlarged. After Garman.

SUB-FAMILY CHERMESINA.

These lice have short, five-jointed or three-jointed feelers; their beak is short, never very long, and is even wanting in the perfect sexes. The eyes are nearly always large and prominent; the fore-wings have only two discoidal veins; the hind-wings have a single oblique vein, sometimes very obscure or even absent. The legs are short, the tarsi have two claws, and the honey-tubes are wanting.

The sub-family includes two genera frequently considered as types of distinct families.

In the genus Chermes the feelers are five-jointed, in Phylloxera three-jointed. The species of the genus Chermes are almost without exception confined to coniferous trees. Their body is usually covered with a white flocculent matter.

Chermes pinicorticis Fitch. *(The Pine Louse).*

This insect has been repeatedly observed on the ornamental and shade pines near our cities, and especially on the Scotch pine, and is responsible for much of the "sun scald" or "blight" stated

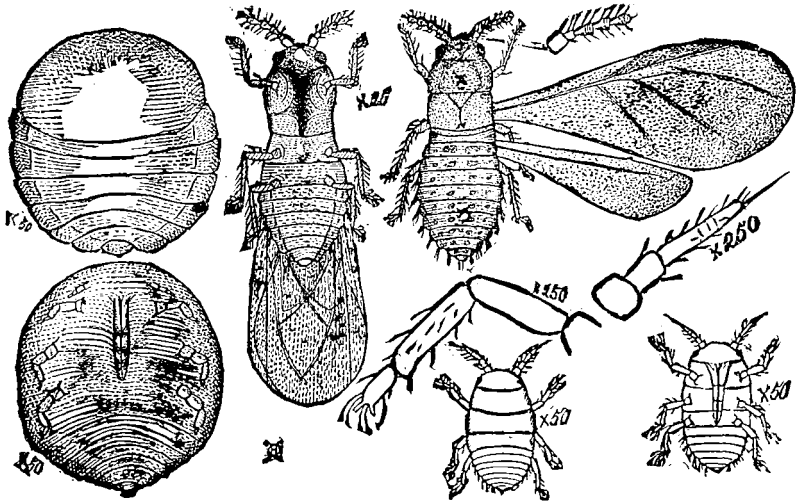


FIG. 141—*Chermes pinicorticis* Fitch: apterous female, upper and underside, enlarged 50 diameters; winged form, upper and underside, enlarged 25 diameters; young larvæ, upper and underside, enlarged 50 diameters; antennæ and legs of young larvæ, enlarged 250 diameters. After Osborn.

to destroy these trees. The excellent illustration, Fig. 141, first published by Prof. Osborn, who studied this insect at Ames, Iowa, gives a good idea of its different stages. The larvæ, (lower right hand corner), when first hatched are oval in shape, flattened, yellowish, or light brown. "The antennæ are three-jointed; the first joint is short and thick; the second is slightly longer, and not so thick; the third is three times as long as the first, and half as thick, set with a few stiff hairs at the apex, one being two-thirds the length of the joint; also a few lateral hairs. Near the end of this joint are a few transverse marks or ridges, extending part way round.

"As these larvæ grow they become darker in color, assuming a deep red-brown, and finally almost black appearance, while the woolly substance develops thickly on the abdominal segments, and also somewhat on the meso- and meta-thorax, entirely hiding the insect, which thus appears like a ball of white down." The pupæ are similar in appearance to the larvæ, only a little larger and are provided with wing-pads. These, when they transform, disclose the winged form, which Prof. Osborn describes as follows:

"The winged form is when it first issues from the pupa, light reddish in color, the wings are very white, expanding rapidly, and becoming transparent, while the body gradually becomes darker till nearly black. The antennæ are five-jointed, short; the tarsi are one-jointed with rudimentary first joint and with two ungues (claws). The wings are four, folding rooflike over the body; the anterior ones being furnished with a strong sub-costal vein which is branched at one-third the distance from the base, the lower branch running parallel for some distance, then turning obliquely towards the posterior margin; also from this branch two oblique discoidal veins run to the posterior margin. The stigma is indistinct. The posterior wings have a subcostal vein with no branch veins.

"The eggs seem to be laid, chiefly at least, by the apterous females, which are shown in the illustration at the left. She can be described as having the legs and antennæ comparatively small; the latter three-jointed, and the tarsi one-jointed and terminated as in the larva. During egg-laying her body is elongate pyriform, but afterwards and in the winter it is contracted to a flattened or globular form.

"This insect continues to breed throughout the spring, summer, and into early fall. The winged individuals do not appear to have been clearly determined as to sex, or definitely placed in the economy of the species. Each and every form is provided with secretory glands, from which emanate the waxy filaments that cover their bodies. They are most abundant during the season when the trees are making their new growths, and at that time are very active as larvæ and winged individuals. But few of the apterous females appear to be present when the winged ones are at their height, but appear more plentifully later.

Remedies and Enemies. The insect has its natural enemies in common with most of our other plant-lice; but on account of the scattered nature of our pines in the region infested, these enemies do not keep it in check. We must, therefore, adopt other methods of warfare if we would get rid of it and save our trees. The kerosene emulsion is the best thing that we know of for this purpose."

Some species of the genus Chermes produce very peculiar swellings at the ends of the twigs of the spruce, which somewhat resemble the cones of the same trees. Such swellings are sometimes found on trees sold in our markets as Christmas trees. A similar one, very common in Europe, is shown in Fig. 142. Our species, *(C. abieticolens* Thos.) looks very much like it.

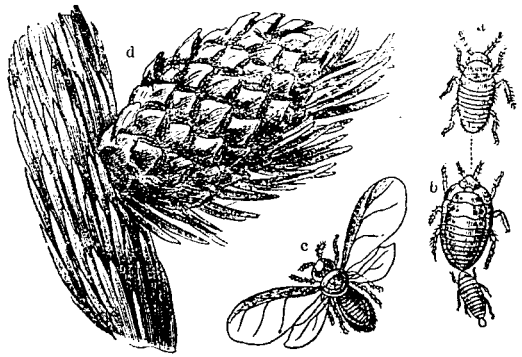


FIG. 142—Gall-like swelling produced by *Chermes*. After Brehm.

Another species, the *Larch Chermes, (C. laricifoliæ* Fitch), is shining black, about one-tenth of an inch long, with a dark green abdomen, whitish or pale legs, hyaline wings, with pale brown veins, and a large, opaque, pale-green stigma. It occurs on the leaves of the American larch or tamarack.

The genus Phylloxera is only too common in at least one species, and few of our cultivated grape-vines are entirely free of the root-inhabiting form, while the leaves of some of our wild species are covered year after year with numerous galls produced by another form of the same species.

Phylloxera vastatrix Planch. *(The Grape-vine Phylloxera).*

A most excellent account of this insect was given by Mr. Marlatt in one of the Farmer's Bulletins issued by the Department of Agriculture, and it is here repeated as well as the illustrations (Fig. 143):

"This insect has always existed on our wild vines, yet it was not until it had been introduced abroad and began to ravage the vine-yards of the Old World that particular attention was drawn to it as a vine pest, or that anything definite was known

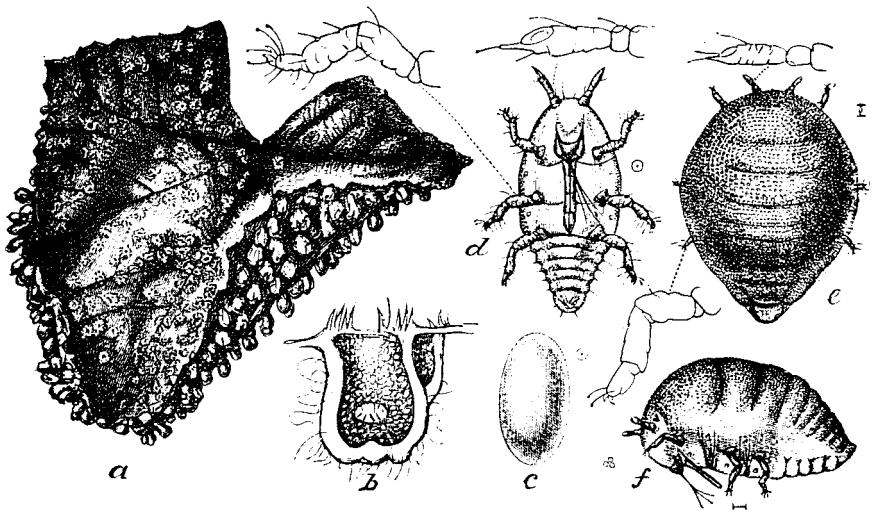


FIG. 143a—*Pylloxera vastatrix* Plach.: *a*, leaf with galls; *b*, section of galls showing mother louse at center with young clustered about; *c*, egg; *d*, larva; *e*, adult female; *f*, same from side—a, natural size, rest much enlarged. After Marlatt, Div. of Entomology, Dep. of Agriculture.

of its habits. It appears in two destructive forms on the vine, the one forming little irregular spherical galls projecting from the underside of the leaves, and the other subsisting on the roots and causing analogous enlargements or swellings. The leaf form is the noticeable one and is very common on our wild and cultivated vines. The root form is rarely seen, but is the cause of the real injury done by this insect to the vine, and while hidden and usually unrecognized, its work is so disastrous to varieties especially liable to attack that death in a few years is almost sure to result. It first produces enlargements or little galls on the rootlets. As it extends to the larger roots these become

swollen and broken, and finally the outer portion decomposes and rots, and the roots ultimately die. With the multiplication of the root lice and their extension to all parts of the root system, the vine stops growing, the leaves become sickly and yellowish, and in the last stages the phylloxera disappears altogether from the decomposed and rotting roots, and the cause of death is obscure to one not familiar with the insect. Many cases of death ascribed to drought, overbearing, winterkilling, etc., are undoubtedly due to the presence of the root louse.

"The abundance of galls on the leaves is not an indication of the presence of the rootlouse in any numbers, but, in fact, the reverse of this is usually true; while on the other hand the

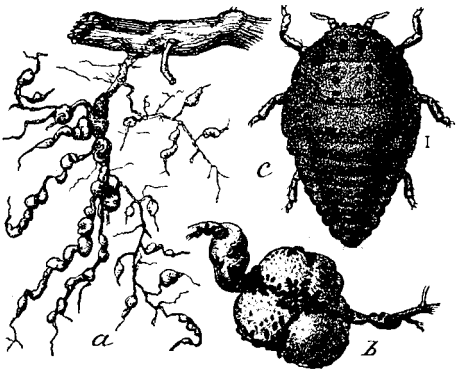


FIG. 143b—*a*, root galls; *b*, enlargement of same showing disposition of lice; *c*, root-gall louse—much enlarged. After Marlatt, Div. of Entomology, Dep. of Agriculture.

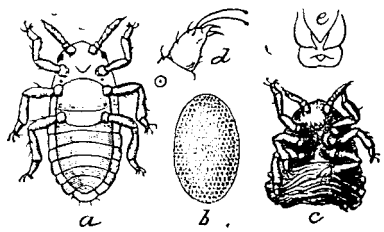


FIG. 144a—*a*, sexed stage, larviform female, the dark-colored area indicating the single egg; *b*, egg; *c*, shriveled female after oviposition; *d*, foot of same; *e*, rudimentary and functionless mouth-parts. After Marlatt, Div. of Entomology, Dep. of Agriculture.

destructive abundance of the lice on the roots is often, if not usually, accompanied by little, if any appearance of the leaf form. This is particularly noticeable with the European grapes, which are very susceptible to phylloxera and rapidly succumb to it, yet rarely show leaf galls. American grapes, on the contrary, are generally very resistant to the root form, and yet are especially subject to the leaf-gall insect. Certain varieties, as the Clinton, which are most resistant to the former, are especially subject to the latter.

"*Distribution.* The phylloxera was carried to France about 1859, on rooted American vines, and has since spread through

the principal vine districts of southern Europe, extending also into Algeria and through southern Russia into the adjoining countries of Asia. It has also been carried to New Zealand and South Africa. In this country it was at first known only in the region east of the Rocky Mountains, but was soon after found in California, where, however, it is confined practically to the vine districts of the Napa and Sonoma valleys.

"*Life History and Habits.* The life cycle of the phylloxera is a complicated one. It occurs in four forms in the following order: The leaf-gall form *(gallicola)*, the root or destructive form *(radicicola)*, the winged or colonizing form, and the sexual form. The leaf-gall insect produces from 500 to 600 eggs for

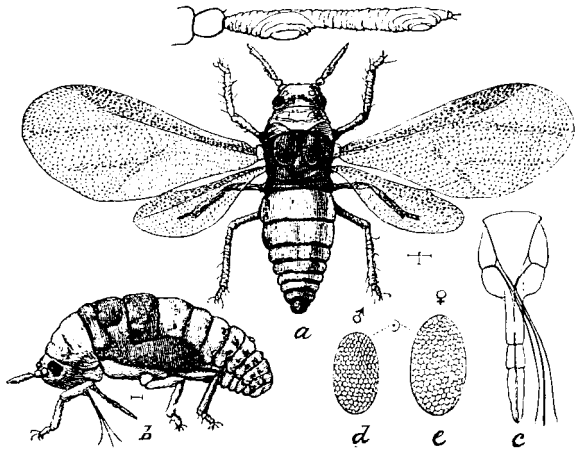


FIG. 143c—*a*, migrating stage, winged adult: *b*, pupa of same, lateral view; *c*, mouth parts with thread-like sucking setæ removed from sheath; *d* and *e*, eggs showing characteristic sculpturing—all enlarged. After Marlatt, Div. of Entomology, Dep. of Agriculture.

each individual, the root-inhabiting insect not much above 100 eggs, the winged insect from 3 to 8, and the last sexed insect but 1 egg. This last is the winter egg and may be taken as a starting point of the life cycle. It is laid in the fall on old wood, and hatches, the spring following, into a louse, which goes at once to a young leaf, in the upper surface of which it plants its beak. The sucking and irritation soon cause a depression to form about the young louse, which grows into a gall projecting on the lower side of the leaf. In about fifteen days

the louse becomes a plump, orange-yellow, full-grown, wingless female, and fills its gall with small yellow eggs, dying soon after. The eggs hatch in about eight days into young females again, like the parent, and migrate to all parts of the vine to form new galls. Six or seven generations of these wingless females follow one another throughout the summer, frequently completely studding the leaves with galls. With the approach of cold weather the young pass down the vines to the roots, where they remain dormant until spring. The root is then attacked, and a series of subterranean generations of wingless females is developed. The root form differs but slightly from the inhabitant of the leaf galls, and the swellings or excrescences on the roots are analogous to those on the leaves.

"During late summer and fall of the second year some of the root lice give rise to winged females which escape through cracks in the soil, on warm, bright days and fly to neighboring vines. These winged lice lay their eggs within a day or two in groups of two or four in cracks in the bark or beneath loose bark on the old wood of the vine and die soon after. The eggs are of two sizes, the smaller and fewer in number yielding males in nine or ten days, and the larger the females of the only sexed generation developed in the whole life round of the insect. In this last and sexed stage the mouthparts of both sexes are rudimentary, and no food at all is taken. The insect is very minute, and resembles the newly hatched louse of either the gall or the root form. The single egg of the larva-like female after fertilization rapidly increases in size until it fills the entire body of the mother, and is laid within three or four days, bringing us back to the winter egg, or starting point.

"This two-year life-round is not necessary to the existence of the species, and the root form may and generally does go on in successive broods year after year, as in the case with European vines, on the leaves of which galls rarely occur. Under exceptional circumstances all of the different stages may be passed through in a single year. The young from leaf-galls may also be easily colonized on the roots, and it is probable that the passage of the young from the leaves to the roots may take place at any time during the summer. The reverse of this process, or the migration of the young directly from the roots to the leaves, has never been observed.

"The complicated details noted above were only obtained after years of painstaking research, conducted by the late Prof. Riley in this country and many careful investigators in France.

"*Means of Dispersion.* The distribution of phylloxera is, first, by means of the winged females; second, by the escape, usually in late summer, of the young root lice through cracks in the soil and their migration to neighboring plants; third, by the carrying of the young leaf-gall lice by winds or other agencies, such as birds or insects, to distant plants; fourth, by the shipping of infested rooted plants or cuttings with winter eggs. By the last means the phylloxera has gained a world-wide distribution; the others account for local increase.

"*Remedies and Preventives.* The enormous loss occasioned by this insect when it reached the wine districts of the Old World led to the most strenuous efforts to discover methods of control. Of the hundreds of measures devised few have been at all satisfactory in results. The more important ones are the use of bisulphide of carbon and submersion to destroy the root lice; and, as preventive measures, the use of resistant American stocks on which to graft varieties subject to phylloxera and the planting of vineyards in soil of almost pure sand.

"*Bisulphide of Carbon.*—The use of this liquid insecticide is practicable only in soil of such consistency as to hold the vapor until it acts on the root lice and yet friable enough to afford it enough penetration. It will not answer in compact clay soils, in very light sandy ones, or in soils liable to crack excessively. The liquid is commonly introduced in the soil by hand injectors at any season except that of blooming or of ripening of the fruit. Sometimes sulphuring plows are used, or the liquid is mixed with water and the soil about the vines thoroughly drenched. The great volatility of the bisulphide enables it to penetrate to the minutest roots, and the lice quickly perish. Four or five injections of one-fourth ounce each may be made to the square yard over the entire surface of the vine yard, inserting the implement from 8 to 12 inches and not approaching within one foot of the base of the vine. The opening in the soil must be promptly closed with the foot. A large number of small doses is preferable to a few large ones. This treatment will ordinarily have to be repeated every year or two, and is therefore expensive

and unsatisfactory and not to be recommended except where other means are not available.

"*Submersion.*—Next to the use of resistant stocks, by far the best means against the phylloxera is in inundating vineyards at certain seasons of the year and for definite periods, being applicable wherever irrigation is practiced or water may be applied without too great expense. Submerging as a means against insects is a very ancient practice in southern Russia and Greece, but was first used against phylloxera in 1868 in France, and is now practiced wherever feasible. The best results are obtained in soils which water will penetrate rather slowly. In loose and sandy soils submersion is impracticable. For this treatment vineyards are commonly divided into rectangular plats by embankments of earth, the latter protected from erosion by planting to some forage crop. As now practiced, the vines are inundated shortly after the fruit is gathered, when growth of the vines has ceased, but the phylloxera is still in full activity and much more readily destroyed than during the dormant winter season. The earlier the application the shorter the period required. During September from 8 to 15 days will suffice, and in October 18 to 20 days, while if delayed until November a period of 40 to 60 days will be needed. Copious irrigation at any time during the summer, if it can be continued for forty-eight hours, will give very considerable relief from phylloxera.

"*Planting in sand.*—It was early observed that vines in very sandy soil were little subject to phylloxera injury, probably owing to the fact that the sand does not crack and allow the insects to escape and spread, being more thoroughly wetted with rains and subterranean moisture, and the insect is drowned out, as in submergence. The resistance is proportionate to the percentage of sand in the soil. In France vineyards are very successfully established on the sandy shores of the Mediterranean and in the alluvial sands of the valley of the Rhone and other streams.

"*American stocks.*—The use of American vines, either direct for the production of fruit or as stocks on which to graft susceptible European and American varieties, has practically supplanted all other measures against phylloxera in most of the infested vineyards of the world. The immunity to root attack of American vines seems to be due to the thicker and denser bark

covering of the roots and to greater natural vigor. All our vines are not equally resistant, and no vines are wholly immune, while several of our cultivated varieties, as the Delaware, are almost as defenseless as European vines. Of the many wild American vines, those of chief importance as sources of stock are the Aestivalis, Riparia, and Labrusca. Of these, Aestivalis and its cultivated varieties rank first in resistant qualities. The varieties of this species commonly grown and used for stocks are Herbemont and Cunningham. These are also very valuable on account of the superior quality of their own fruit.

"The wild varieties of Riparia are quite resistant to the root louse, although the most subject of all vines to the attacks of the leaf-gall lice. Of the cultivated varieties the Clinton, the Taylor, Solonis, etc., are very commonly used as stocks. The fox grapes, derived from *Vitis labrusca,* while more resistant than European grapes, are much inferior to the other American species mentioned in this respect. Isabella and Catawba, for example, are very subject to root lice; the Concord, while not often seriously injured, is still rather subject to attack and therefore not so valuable as a source of resistant stocks. There are many hybrids of these and other American species, which are used either direct for their fruit or as stocks. Conditions of climate and soil will determine the particular variety to be employed, and these points can only be settled by experimental tests for new localities."

Other species of phylloxera are found in galls on the leaves of various plants, but chiefly those of the hickory, while a few occur on the oak and chestnut, and even in the deserted and empty galls found so often on the cottonwood.

SUB-FAMILY PEMPHIGINA.

(Gall-making Plant-lice).

The insects forming this sub-family are distinguished by having three discoidal veins on their front wings; the third discoidal vein has only one fork or is simple; the honey-tubes are either wanting or are tuberculiform.

The lice belonging here live mostly above ground, although there are also some root-inhabiting forms; some are remarkable

for the abnormal vegetable growths or galls they produce and in which they live; others are peculiar on account of the form and the abundance of their excretions. The species form two sections, the Pemphigini and the Schizoneurini.

In the Pemphigini the rather short feelers are six-jointed, rarely five-jointed, the third joint being longest; the eyes are large, though sometimes absent in the apterous forms enclosed in the galls. The species are very similar in form, but the galls they make are of such peculiar shape and so constant in form and position on the various parts of the woody plants on which they occur that we can distinguish the different species by the galls. We have three genera in our state, which can be recognized as follows:

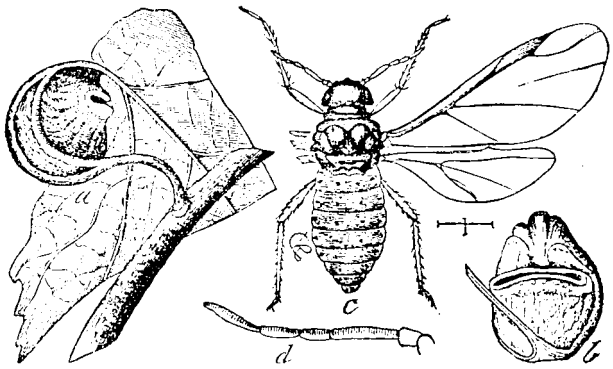


FIG. 144—*Pemphigus populi-transversus Ril.*—After Riley and Monell in Bull. U. S. Geol. and Geog. Survey.

A. Hind wings with two discoidal veins..... PEMPHIGUS.
AA. Hind wings with only one discoidal vein.
B. Antennæ 6-jointed.....TETRANEURA.
BB. Antennæ 5-jointed..... HORMAPHIS.

The genus *Hormaphis* is represented in Minnesota by *H. papyraceæ* Oest., which according to Prof. Oestlund is found on the under side of the leaves of the paper birch, corrugating them between the veins, forming long folds in which the lice are packed as closely as it is possible for them to be, and at the same time be able to reach the leaf with the beak. Being also abundantly covered with a flocculent substance, especially the apterous form, they undoubtedly find a good protection between the plications of the leaf.

The genus *Pemphigus* is represented in our state by a number of species, all producing peculiar galls. To give an idea of these insects the figures 144 to 146 are given.

P. populi-transversus Ril. *(The Poplar Gall-louse)* makes a globular swelling on the petiole near the base of the leaf of the cottonwood (Fig. 144). The gall is formed by the folding or twisting of the petiole in such a manner that the edges come together and form a broad opening or mouth.

P. vagabundus Walsh. *(The Vagabund Gall-louse)* causes irregular galls on the ends of twigs of poplars (Fig. 145). Such galls are not alone very unsightly, but they cause considerable in-

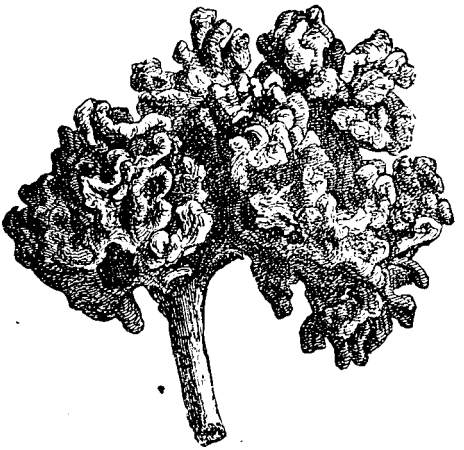


FIG. 145—*Pemphigus vagabundus* Walsh. After Riley.

jury to the tree, as the twigs stop growing at the ends. Such galls, green when young, but black later in the season, are very common, and the only remedy we have to prevent the increase of the insects is to remove the galls while still green and to burn them. If we wait until they turn brown or black, which takes place in August, we simply remove the cradle of the lice, but not the lice themselves, as they have already left to spend the rest of their existence elsewhere. But where, is still an open question!

P. *fraxinifolii* Riley *(The Ash-tree Plant-louse)* is another louse, which curls the terminal leaves of the ash, forming a sort of gall. Where such lice abound the trees are greatly disfigured.

The lice are covered with a large amount of flocculent matter, and they also exude an abundant supply of honey-dew.

P. rhois Fitch *(The Sumach Gall-louse)* makes a smooth, thin-walled gall on the under side of the leaf of the sumach, usually near the base of the leaf (Fig. 146). These remarkable galls, sometimes rather appetizing by resembling a small and brilliantly colored apple, are crowded with insects.

P. rubi Thos. has been found on the under side of the common raspberry along the mid-vein.

While printing this report a copy of one of Prof. Forbes' excellent bulletins was received, in which he describes the insects infesting the sugar beet in Illinois. Among other insects injurious to that plant he describes also a plant-louse destructive to the above plant.

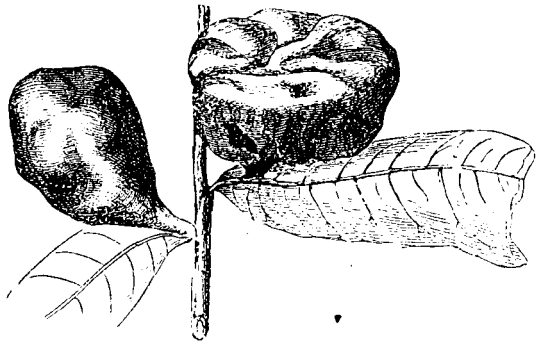


FIG. 146—*Pemphigus rhois* Fitch. After Riley.

Pemphigus betæ Doane. *(The Beet Aphis).*

This insect, but recently discovered by Mr. Doane of the Washington State Agricultural Experiment Station, at Pullman, Wash., offers an extraordinary example of the injury to vegetation which may be caused by root-lice. Mr. Doane writes, that "when it was found a field of two or three acres of beets was generally infested, a strip of twenty-five to a hundred yards being so badly injured that the beets were nearly all soft and spongy, and the plants much smaller than the average." The same insect also infests such weeds as the wild yarrow and a common knot-weed, as well as other plants and grasses. It occurs in two forms, winged and wingless, as shown in Fig. 147, of which

the latter is most abundant. These are small pale yellow or whitish, covered at the posterior part with a mass of flocculent matter; their form is mostly pear-shaped, and they measure an eighth of an inch in length when full grown.

The smaller rootlets of the beet are attacked first, and they are soon destroyed, the leaves in consequence wilt, and the whole beet becomes spongy. If we find any wilting leaves in our fields of sugar beets we had better investigate at once to discover whether this louse is present or not. It is of course always inadvisable to plant beets as a first crop on new land, nor should our farmers grow these plants, or any other root crop, year after year, in the same field. Here, again, proper and systematic rotation is all important.

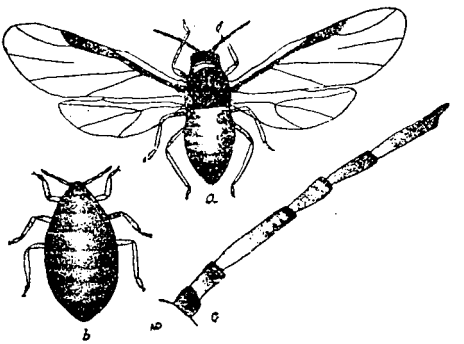


FIG. 147—*Pemphigus betæ* Doane.—*a*, winged female; *b*, wingless female; *c*, antenna of winged female. After Doane.

Other lice, not discussed in this report, also infest the sugar beet.

In the section Schizoneurini we have genera in which the third discoidal vein of the front wings is forked; the short feelers are six-jointed, annulated, and with transverse sensoria, or when not annulated with circular sensoria. The honey-tubes are rudimentary or wanting.

The species either secrete a flocculent matter, or they are simply covered with a fine powder. Some form galls, but the majority simply curl the leaves and are protected by them and the flocculent exudation. A few species living underground also belong here. Some naturalists consider the Schizoneurini entitled

to the rank of a sub-family, and they may be correct, although the habits and development are similar in both sections.

We have two genera in Minnesota. In Colepha the hind wings have only one discoidal vein; in Schizoneura they have two.

Lice belonging to the genus Colepha are very common in some parts of the state, and seem to be spreading very rapidly, infesting the elms and causing considerable damage to these fine trees. According to Oestlund the oviparous female produces but one large egg in the fall.

Colopha ulmicola Fitch. *(The Elm-leaf Cockscomb Gall).*

This gall, looking very much like a cock's comb, occurs most commonly on young elm trees, arising abruptly on the upper surface of the leaves. It is usually an inch long and a quarter of an inch high, compressed, with the sides wrinkled perpendicularly, and its summit irregularly gashed and toothed. It is of a paler green color than the leaf, but is more or less red on the side exposed to the sun. The gall opens on the under side of the leaf by a long slit-like orifice; inside it is wrinkled perpendicularly into deep plates. The gall is always found between two of the branching parallel veins, and those between which it grows are usually drawn closer together than the rest. The galls are always crowded with lice and white flocculent material, and as they become old and are deserted by their inhabitants, they become darker and darker, thus greatly disfiguring the trees.

The illustration, Fig. 135, shows the galls as well as the various stages of the insect.

The genus Schizoneura is well represented in Minnesota, and contains some very destructive insects, most of which are covered with woolly or flocculent matter. Some species infest leaves without curling them, others are found on twigs and leaves covered with woolly material, and not a few lead a subterranean existence on the roots of grasses or trees.

Only a few of the more destructive species are given.

Schizoneura americana Riley. *(The White-elm Schizoneura).*

This louse is found on the under side of the leaves of the elm, *(Ulmus americana)*, which it causes to curl, forming a sort

of gall. If at all numerous they can greatly deform the ends of the twigs, where all the leaves are curled, forming a mass of sickly, yellowish leaves. All the lice are covered with a whitish powder, and exude an abundance of liquid, which is very attractive to ants; and these active insects are not slow to discover and to utilize such a store of food. If we carefully examine the cracks and crevices of an elm badly infested with such lice the previous summer, we shall very likely be able to detect the impregnated eggs of this species. The minute, dull-yellowish, ovoid eggs are more or less effectually covered with the

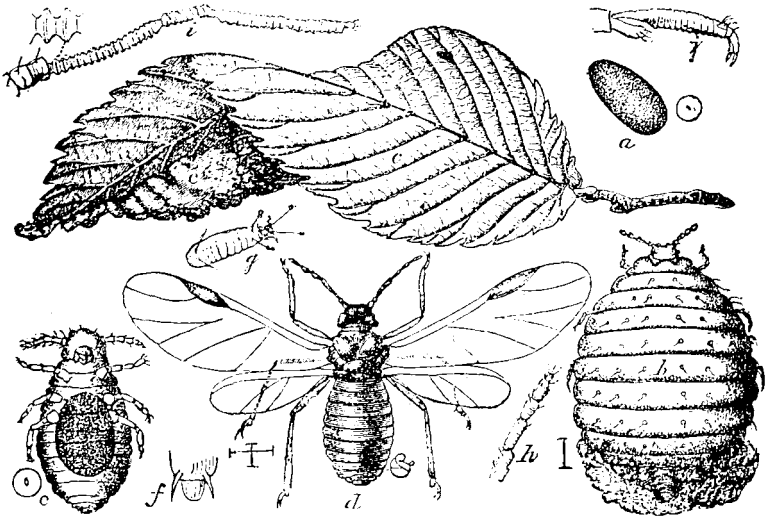


FIG. 148—*Schizoneura americana* Riley.—*c*, *c*, leaf showing curl, natural size; *a*, winter egg; *b*, stem-mother; *d*, winged female; *i*, her antenna; *j*, her tarsus; *e*, true female, ventral view, showing solitary egg; *g*, her tarsus from beneath; *f*, annus and genital points of male; *h*, antenna of fourth generation, all enlarged. After Riley and Monell, U. S. Geol. and Geog. Survey.

parent's dry skin, which still faintly shows the rings of the living female. As soon as the young louse hatches in spring it crawls to the more terminal twigs, and settles upon the under side of the first tender leaflet it meets with. This stem mother very soon causes the leaf to swell and curl, by the irritations and punctures of its beak. Persons whose elm trees are thus affected year after year should watch for the first signs of such deformed leaves and should remove and burn them, thus effectively destroying the later numerous generations of such nasty visitors.

This insect is shown in various stages in Fig. 148.

Another species occurring on the under side of twigs of hawthorn was described by Prof. Oestlund as *Sch. cratægi.* He says that it is found during September in an almost continuous row on the under side of every twig, and that it is very conspicuous from the flocculent covering of the apterous form.

Sch. corni Fab. occurs during September and October in great numbers on the underside of the leaves of the dogwood.

Sch. panicola Thomas is found on the roots of some grasses, as *Panicum glabrum, Setaria glauca* and others.

In the northern part of the state we find another very peculiar species on the under side of the branches of the alder, which always attracts the attention of observing persons.

Schizoneura tessellata Fitch. *(The Alder-blight).*

Wherever these insects are at all numerous they form large patches of a snow-white down. By removing this delicate covering we find wingless individuals of a dull bluish black; the back of the segments are marked with strongly impressed lines, and are covered with white down in square, checker-like spots. The louse is fairly large, measuring 0.16 of an inch in length. They secrete an abundant supply of honey-dew, which of course attracts ants. It is so abundant that the foliage beneath the lice is coated with it; upon it black fungi grow. Another curious fungus grows in large spongy masses immediately beneath the cluster of plant-lice, being evidently fed by the honey-dew that falls upon it.

Nothwithstanding the protecting covering or white down, many of these lice are eaten by the larvæ of a fly, even the caterpillar of a butterfly finds it to its taste.

Other species of this interesting genus might be mentioned, but all of them are of less importance than the following species, which can become very injurious to our apple trees; and buyers of young trees from nurseries should keep their eyes open, so that they do not introduce it into their orchard. This warning is important, as the entomologist knows positively that such dangerous insects have been shipped from nurseries to their customers, and once introduced it is not easy to eradicate them, as will be seen by reading their peculiar life-history.

Schizoneura lanigera Hausmann. *(The Woolly-louse of the Apple).*

This is one of the best known pests of the fruit-grower, not alone in this country, but in Europe as well. Throughout the summer until very late in the autumn we can find in infested orchards small bluish-white flocculent or cottony patches produced by a cluster of lice, on the lower part of the trunks, but everywhere on young trees. Such clusters are found most abundantly on the water-sprouts, which of course are never permitted to grow in orchards well taken care of. Younger trees suffer most severely, as in this case the bark becomes deeply pitted, in some cases even deep and large cavities are formed.

"The bark apparently ceases to grow at the point of attack, but swells into a large ridge about the cluster of lice, leaving them in a sheltered pit. The lice also frequently congregate in the axils of leaves and the forks of branches." (Comstock).

As long as the lice are thus plainly visible, they can be controlled, but like the Grape-vine Phylloxera already described, this louse possesses a root form which is much more injurious and is very much more difficult to reach. On the roots it produces gall-like swellings, in the cracks of which it lives in clustered masses. Even the deeper and more fibrous roots are invaded. The injury to the infested trees is due both to the sucking up of the sap and to the poisoning of the plants as shown by the abnormal growths following the injury. In cases of badly infested trees it will hardly ever pay to try to save them and to try to get rid of the lice, and it is better and cheaper to dig the trees up and to burn them, and to devote the ground to another use for some time. Of course another species of tree can be safely planted in the place of the one removed, but not a different variety of apple.

Mr. Marlatt, in one of the excellent bulletins of the Division of Entomology of the Department of Agriculture, has issued a circular in regard to this pest in which he says that:

"The damage is particularly serious in the case of nursery stock and young trees, and is less often important after the tree has once become well established and of some size. Where this insect is abundant all the roots of a young tree to the depth

of a foot or so become clubbed and knotted by the growth of hard fibrous enlargements, with the result in a year or two of the dying of the rootlets and their ultimate decomposition with attendant disappearance of the galls and also of the lice, so that after this stage is reached, the cause of the injury is often obscure. On the trunks the presence of the lice sometimes results in the roughening of the bark or a granulated condition which is particularly noticeable about the collar and at the forks of branches or on the fresh growth around the scars caused by pruning, which latter is a favorite location. On the water shoots, they collect particularly in the axils of the leaves, often eventually causing them to fall; and on the tender greener side of the stems. The damage above ground, though commonly insignificant, is useful as an indication of the probable existence of the lice on the roots. A badly attacked tree assumes a sickly appearance, and does not make satisfactory growth; the leaves become dull and yellowish, and even if not killed outright is so weakened that it becomes especially subject to the attacks of borers and other insect enemies. Injuries from the woolly aphis are almost altogether confined to the apple, even the wild crab not being so liable to attack, or at least injury by it. There is however some difference exhibited by different varieties of apple in immunity, and particularly is the Northern Spy proof against it, and it is possible that, as in the case of the grape phylloxera, by employing root stock from seedlings of the more resistant varieties or from wild crabs, considerable protection would result. The character of the soil also exerts some influence,—that is, loose dry soils are favorable and wet compact ones are unfavorable to the aphis."

The illustration, Fig. 149, will give a good idea of the insect and its work. On Plate XI another picture of this dangerous pest is given.

As far as remedies are concerned it is easy enough to control the lice on the bark, where they are readily seen, and where they can be reached and exterminated by any of the washes recommended for plant-lice, such as kerosene emulsion, a strong soap wash, resin wash, etc., which will be described later. All of these washes should be applied with sufficient force and thoroughness to penetrate the protecting cottony cover, and for this purpose it is best to apply them warm.

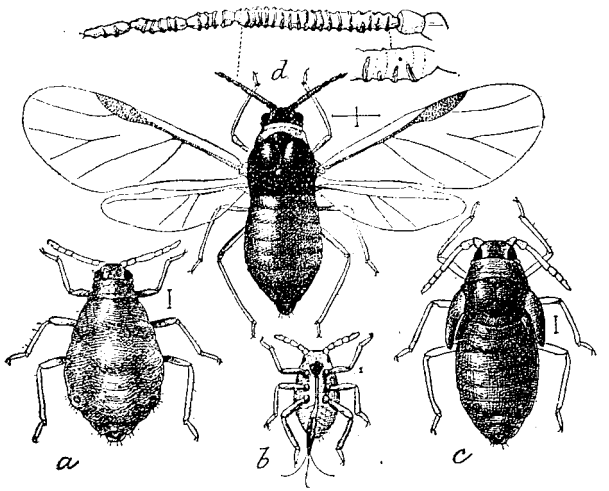


FIG. 149.—Woolly aphis (*Schizoneura lanigera* Hausm.)—*a*, agamic female; *b*, larval louse; *c*, pupa; *d*, winged female with antenna enlarged above; all greatly enlarged and with waxy excretion removed. After Marlatt, Division of Entomology, Dept. of Agriculture.

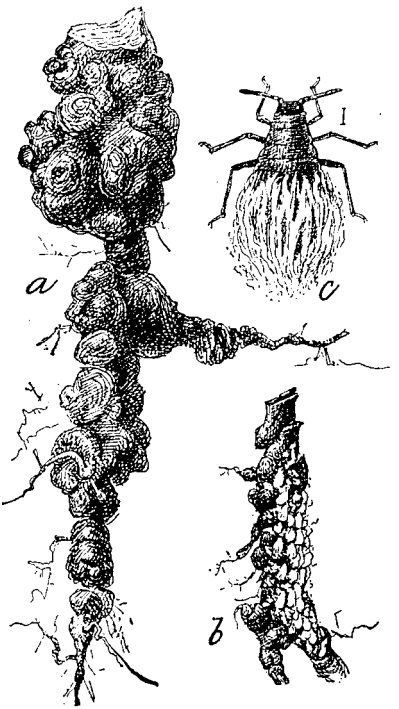


FIG. 149a.—Woolly aphis.—*a*, root of young tree illustrating deformation; *b*, section of root with aphides clustered over it; *c*, root louse, female; *a* and *b*, natural size; *c*, much enlarged. After Marlatt, Division of Entomolony, Dep. of Agriculture.

The root lice are much more difficult to reach, but the remedies applied against the phylloxera will also be more or less effective against them. Some are the use of bisulphide of carbon, submersion in water, strong soap or tobacco washes applied to the soil above the crown, and soot and ashes.

Like most other plant-lice this species has a very complicated life-history, some details of which are still unknown.

"The common forms both on the root and above ground are wingless lice, not exceeding one-tenth of an inch in length, of a reddish-brown color, and abundantly covered, especially in the aerial form, with a flocculent waxy excretion. These are so-called agamic females, and reproduce themselves by giving birth, as observed by many entomologists, to living young indefinitely, perhaps for years, without the intervention of other forms. The newly born larvæ have none of the white excretion, which, however, soon appears as a minute down when they begin to feed. These lice are also peculiar in lacking the honey-tubes common to most aphides, but exude the honeydew from the tip of the body. In October or November, or earlier in the South, among the wingless ones, numbers of winged individuals appear, which are also all females, and are the parents, as shown by the observations, partly unpublished, of Messrs. Howard and Pergande, of a true sexed generation of minute, wingless, larviform lice, the females of which, as in the case of the grape root-louse, give birth to a single "winter egg." This egg is attached within a crevice of the bark, and, probably, following the analogy of the phylloxera, hatches in the spring into a female aphid which originates a new aerial colony.

"The winged females appear somewhat abundantly in autumn, and are one of the means of the dispersal of the insect. They are very minute, clear-winged, gnat-like objects, greenish-brown, almost black in color, with the body covered with more or less of the cottony excretion.

"The aerial colonies are probably killed out every winter in the colder northern districts, but in the warmer latitudes the partly grown individuals, at least, survive protected in crevices or under bits of bark, and remain more or less active during winter and renew the colonies the following spring. This has been shown to be true in the District of Columbia, and also in

the interior regions of the same latitude in spite of the much colder winters. The root form survives the winter usually in an immature condition, viz, larvæ in various stages of development, and both in latitudes where the aerial forms are killed by the severity of the winter and elsewhere it seems probable that there is a regular upward migration in spring and early summer from the roots, the aerial colonies appearing first near the crown and at a later period on the higher parts of the tree. At any time during summer and fall there may be migrations to the roots, and throughout the year the subterranean colonies are maintained.

"The spread of the insect is accomplished in part by the viviparous females, which appear in late summer, but quite as commonly perhaps by the transporting of young or partly grown individuals from tree to tree or to distant orchards by means of birds or insects to which they have attached themselves. Its wide distribution is usually dependent on the traffic in nursery stock."

"The most generally recommended measure hitherto is the use of hot water, and this, while being both simple and inexpensive, is thoroughly effective, as has been demonstrated by practical experience. Water at nearly the boiling point may be applied about the base of young trees without the slightest danger of injury to the trees, and should be used in sufficient quantity to thoroughly wet the soil to a depth of several inches, as the lice may penetrate nearly a foot below the surface. To facilitate the wetting of the roots and the extermination of the lice, as much of the surface soil as possible should be first removed.

"Some recent very successful experiments conducted by Mr. J. M. Stedman have demonstrated the very satisfactory protective as well as remedial value of finely ground tobacco dust. The desirability of excluding the aphis altogether from nursery stock is at once apparent, and this Mr. Stedman has shown to be possible by placing tobacco dust freely in the trenches in which the seedlings or grafts are planted and in the orchard excavations for young trees. Nursery stock may be continuously protected by laying each spring a line of the dust in a small furrow on either side of the row, and as close as possible to the tree, covering loosely with earth. For large trees, both for protection

and the destruction of existing aphides, from 2 to 5 pounds of the dust should be distributed from the crown outward to a distance of 2 feet, first removing the surface soil to a depth of from 4 to 6 inches. The tobacco kills the aphides by leaching through the soil, and acts as a bar for a year or so to reinfestation. The dust is a waste product of tobacco factories, and costs about one cent per pound, and possesses the additional value of being worth fully its cost as a fertilizer.

"The use of bisulphide of carbon for the woolly aphis is the same as for the grape root-louse. It should be applied in two or three holes about the tree to a depth of 6 to 12 inches and not closer than one and one-half feet to the crown. An ounce of the chemical should be introduced into each hole, which should be immediately closed. The bisulphide evaporates and penetrates throughout the soil, and readily and promptly kills the aphides. It does not, however, furnish any protection from future attacks, and is attended with danger to the tree unless the precautions named are carefully observed. That it is highly inflammable should also be constantly borne in mind. If it is to be used at all extensively, an automatic injecting device should be secured, such as the McGowan injector. The chemical costs ten cents per pound in 50-pound cans of the manufacturer, E. R. Taylor, Cleveland, Ohio.

"Badly infested nursery stock should be destroyed, since it would be worth little even with the aphides removed. Slightly infested stock can easily be freed of the aphides at the time of its removal from the nursery rows. The soil should be dislodged and the roots pruned, and in batches of a dozen or so the roots and lower portions of the trunk should be immersed for a few seconds in water kept at a temperature of 130° to 150° F. A strong soap solution similarly heated or a fifteen times diluted kerosene emulsion will give somewhat greater penetration and be more effective, although the water alone at the temperature named should destroy the lice. This treatment is so simple and inexpensive that it should always be insisted upon by the purchaser if there be any indication of the presence of this insect, and stock exhibiting much damage should be refused altogether.

"After planting, if the trees be kept in vigorous condition by careful cultivation and, if necessary, proper fertilizing, damage

from the lice is much less apt to occur, and the principal danger period, namely, the first two or three years after planting in the orchard, will pass in safety. The value, as a means of protection, of thorough cultivation and good care of young orchards can not be too strongly insisted upon. Vigorous growing trees have a decided power of resistance or are able to sustain with comparatively little damage the presence of the root-lice, while ill-cultivated and neglected orchards are especially liable to injury."

The Woolly-louse of the Apple has, like most other plant-lice, a large number of enemies; these will be described later.

SUB-FAMILY APHIDINA.

(Typical Plant-lice).

This is a very large sub-family, frequently divided into a number of sub-families, but for purposes of this report it is not necessary to do so. Most of the species live above ground, on the surface of leaves or twigs of all kinds, and none produce true galls. They include such genera in which the third discoidal vein of the front wings is twice forked; the hind wings have two discoidal veins; the honey-tubes are usually well developed, and are sometimes tuberculiform or are obsolete.

The genus *Lachnus,* to which the largest of our species of Aphididæ belong, have the six-jointed feelers about half as long as the body; the very long beak reaches to or beyond the third pair of coxæ, and is sometimes even much longer. The honey-tubes are short, not longer than broad, often tuberculiform, or are even wanting.

Lachnus dentatus Le Baron. *(The Toothed Willow Plant-louse).*

"This species is found in October and November in colonies on the under side of the branches of the gray willow; and occasionally, but apparently accidentally, on trunks of small nursery apple trees. The winged individuals measure about one-sixth of an inch to the tip of the abdomen, the wings expand about half an inch. Black, abdomen dark, and ash color, with six transverse rows of black dots. Antennæ as long as the head and thorax. Front wings with a very long stigma, the third vein with two forks, as usual in this genus. Honey-tubes reduced to

mere tubercles. Thighs dark honey yellow, broadly tipped with black; tibiæ dusky reddish at the base. The dots on the abdomen are very distinct in the full grown individuals, the intermediate rows have six dots in a row. Just behind the middle of the abdomen, and occupying the place of the two middle dots in the fourth row, is usually a somewhat conspicuous black, conical protuberance. When crushed a louse stains the fingers red." (Le Baron).

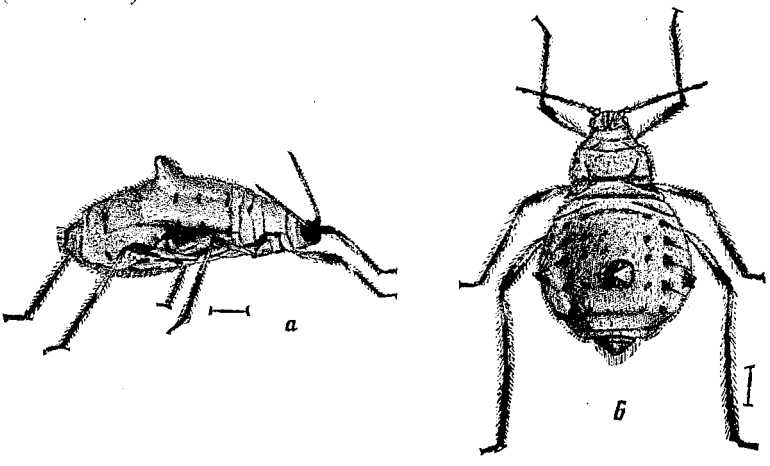


Fig. 1.

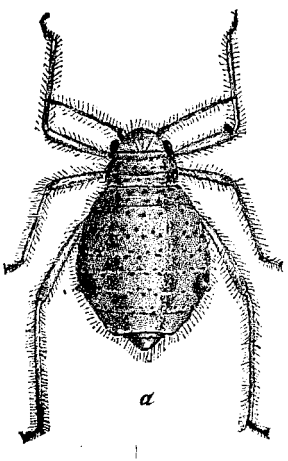


Fig. 2.

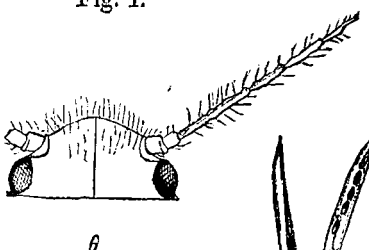
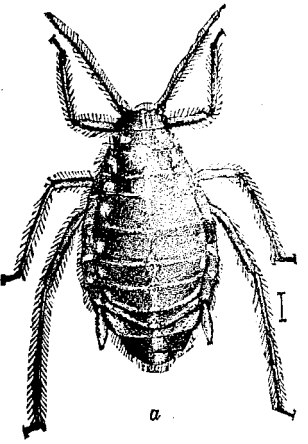


Fig. 3.

FIG. 150—*Lachnus dentatus* Le B.—Fig. 1—*a*, apterous viviparous female, side-view; *b*, dorsal view of same enlarged. Fig. 2—*a*, oviparous female of *L. pini* Linn; *b*, head and antenna of same, enlarged. Fig. 3—Eggs of *L. pini*. After Webster.



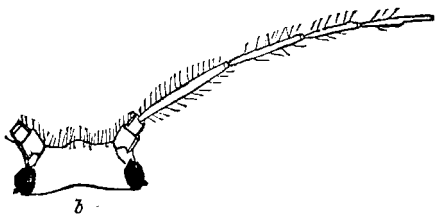


Fig. 1.

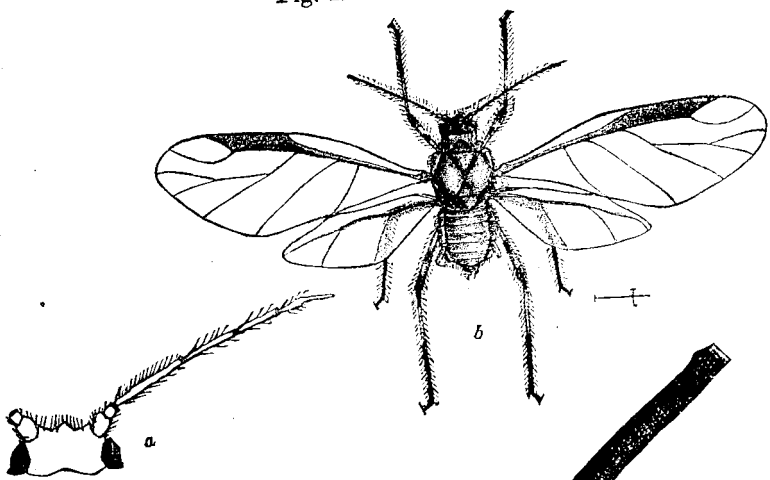


Fig. 2.

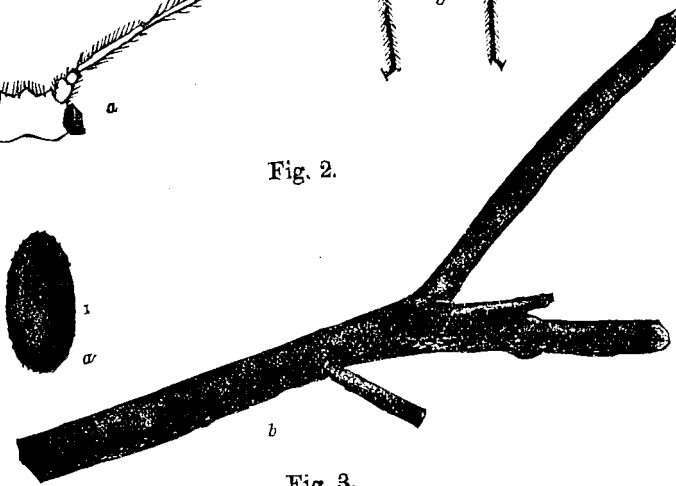


Fig. 3.

FIG. 151—*Melanoxanthus salicis* Linn. Fig. 1, *a*, oviparous female; 1, *b*, head and antenna of same; Fig. 2, *a*, winged male; 2, *b*, head and antenna of same; Fig. 3, *a*, egg, enlarged; 3, *b*, oviparous females and eggs on branch of willow, natural size. After Webster.

Prof. Webster has described and illustrated the apterous viviparous female. To give an idea how the insect looks it is illustrated in Fig. 150. In the same illustration is also shown the *L. pini* Linn. *(The Scotch Pine Plant-louse).*

A number of other species occur on the willow, hickory, white pine, tamarack, spruce, oak and other trees.

The genus *Melanoxanthus* contains species of lice which have the venation and feelers of *Lachnus,* but are different in general form and habits. The honey-tubes are short and stout, but always longer than broad, being broadest in the middle.

Melanoxanthus salicti Harr. *(The Willow-grove Plant-louse.)*

This plant-louse is found upon a great variety of willow trees in the eastern states, and at times becomes exceedingly abundant; it also occurs upon the maple and poplar. It is shown in Fig. 151.

A related species, *(M. bicolor* Oestl.), was described from Minnesota by Prof. Oestlund upon the willow. It is a more elongated brownish insect, without a grayish white median line; the honey-tubes are paler, the wings clearer, and with more slender discoidal veins.

The genus *Chaitophorus* is somewhat similar to the one just described. The insects belonging to it have an elongated body; their antennæ are mostly a little longer than half the length of the body, hairy, and the last joint is always as long or longer than the sixth joint. The beak is short; the wings frequently have smoky bands and spots; the hairy legs are moderately long. The abdomen is usually tuberculate with long and slender hairs, which are never knobbed; the honey-tubes are short and thick, seldom longer than they are thick at the base.

A number of species occur in our state, and some of them are decidedly injurious. The one described may serve as a type.

Chaitophorus negundinis Thom. *(The Box elder Plant-louse).*

This louse (Fig. 152) is green, the color of the tender twigs and leaves from which it abstracts the sap. "Early in spring, even before the tender leaves have made their appearance, the eggs that were deposited the previous fall hatch, and the little

fellows gather about the opening buds, where they wait patiently, and perhaps shiveringly, too, so as to be ready to attack the first green growth that appears. These little lice that come from the eggs are of the form known as agamous females; that is, the females that produce young without the intervention directly of the opposite sex. These females are also viviparous, that is to say, their offspring are produced alive, which latter are also of a like nature. Just when the first winged specimens of this louse are to be found we do not know, nor are we prepared to

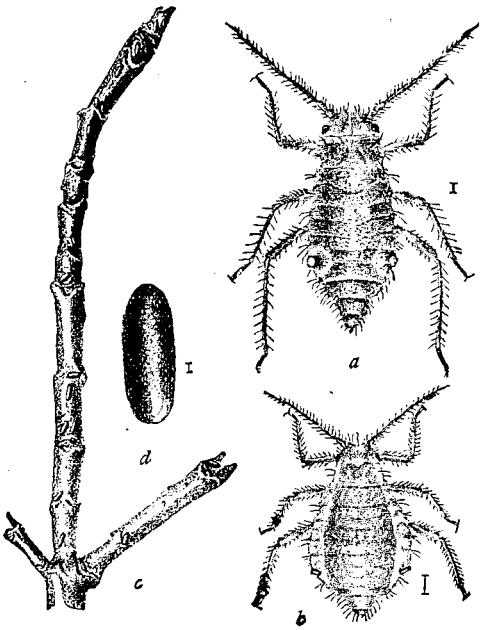


FIG. 152.—*Chaitophorus negundinis* Thom.: *a*, apterous male; *b*, oviparous female; *d*, egg; all greatly enlarged; *c*, eggs on twigs, natural size. After Insect Life, Div. of Entomology, Dep. of Agriculture.

give an outline history of their special mission in the cycle of this insect's annual existence, further than, perhaps, to state that they are for the spreading of the species from one locality to another. The winged specimens, like the wingless agamous form, are also viviparous. In the fall of the year, after the first frosts, and when most of the leaves have fallen, the true female, which is a wingless form, lays eggs. These eggs are usually thrust into crevices of the bark, and between the buds and twigs. By

means of these eggs the insect is carried through the winter, and the continuance of the species is insured for the following year.

"As above stated, the insect begins its work just as soon as, or before the leaves appear in spring, with the viviparous agamous female, or stem mother. She becomes full grown in a few days, and begins the process of reproduction by 'budding' internally and expelling small lice of her kind, which in turn, after maturity, repeat the operation. The successive generations continue without interruption during spring and summer, some of them being furnished with wings, which enable them to migrate from place to place. In this manner new localities become infested, damp weather favoring and very dry weather retarding their excessive increase." (Bruner).

These lice are sometimes exceedingly numerous, and the large amount of honey-dew which frequently covers all the leaves of the box elder, is a very unpleasant sight, and at the same time injurious to the tree. Many ants may be seen constantly at work feeding upon this sweet liquid. Some of the different kinds of ants, not satisfied with "milking their cows," even make the lice captives, carrying them down into their nests, where they feed them so as to be able to milk them at their leisure.

The lice have many enemies, but they are not sufficient in numbers to entirely check their increase on the box elder, about the only tree that seems to thrive in our prairie villages, possibly, or rather, because it requires the least attention.

Strong soap-suds sprayed upon the parts infested will kill most of the lice, but this has to be repeated from time to time. Kerosene emulsion is a much more certain remedy.

The genus *Callipterus* has the smooth feelers about as long as the body, or even longer, eyes pale or bright red in color; beak very short, rarely reaching the second pair of coxæ; honey-tubes short, sometimes almost on a level with the abdomen. The wings are deflexed in repose, frequently clouded with bands and spots; front-wings with the stigma short and much curved, often subhyaline.

A number of species occur in our state; they occur on the red and burr oak, milkweeds, elm, birch, walnut, hickory and other trees and plants, but as none of them are of any economic importance, they have not been illustrated. They seem to be

rather sporadic in their habits. If closely inspected some of them are really beautiful objects, with an elongate, slender, more or less depressed body, and of a very pale and delicate color.

The old genus *Aphis* has been subdivided into many genera, which it is not necessary to describe in this report. A considerable number of very destructive insects belong to this genus, and only a few of the more important ones can be discussed. Those interested in such matters, and especially in the classification of the Aphididæ, should consult the "Synopsis of the Aphididæ of Minnesota" by O. W. Oestlund, published as bulletin No. 4 of the Geological and Natural History Survey of Minnesota. It was published in 1887, hence is somewhat out of date, and it is to be hoped that the author will soon give us a new edition of this important and necessary work.

Aphis cerasifoliæ Fitch. *(The Choke-cherry Aphis).*

This is a very common louse, occurring in large numbers on the leaves of *Prunus virginiana*, where it sometimes becomes very conspicuous by the deformed leaves on the tip of the branch infested by it. The apterous form is thickly covered with a white powder, and a large amount of honey-dew is produced, which is frequently found in fine liquid drops among the colony of lice. The young lice are pea-green, with white feelers, honey-tubes and legs. As they grow older a darker green stripe appears along the middle of the back. The winged insect is black, with a pale green abdomen marked with three dark green dots on each side forward of the honey-tubes, and above these a row of impressed deep green dots extending backwards past the nectaries, with a deep green stripe upon the middle of the back, which does not reach to the tip.

Plate XII, Fig. 153, shows a closely related European species, the *Aphis cerasi* Fab.

Aphis crataegifoliæ Fitch. *(The Thorn-leaf Aphis).*

This species is black; abdomen, with a row of blackish dots along each side; veins of the fore-wings whitish, black at their tips; tibiæ or shanks, except at their tips and base of the shanks, green; honey-tubes equalling nearly half the distance to the tip of the abdomen. Length 0.15 of an inch. (Fitch).

Prof. Oestlund during May found these lice on *Cractægus tomentosa,* where they caused the leaves to curl very much, and turning dark brown or red in color they became very conspicuous.

Aphis maidis Fitch. *(The Corn Plant-louse).*

"This species is found on all parts of corn, and becomes very destructive in some years, especially if it attaches itself in large numbers to the stem which bears the ear, since this is a very vital spot as far as the yield is concerned. This species, according to the observation of Forbes, winters in the wingless, agamic form, in the earth of fields previously infested. In the spring it appears to be strictly dependent upon a species of ant, which mines along the principal roots of the corn, collects the plant-lice, and conveys them into these burrows, and there watches and protects them. In a short time after the lice have been transferred to the roots of the corn, they mature a winged generation by means of which adjacent fields may be stocked. These facts indicate the inadvisability of planting corn on a field that was infested by this insect the previous year." (Comstock).

Aphis maidi-radicis Forbes. *(The Corn Root-louse).*

This root louse, illustrated in Fig. 154, "is a small, soft-bodied, greenish-white insect, and will be found adhering to the roots of the corn plant, the head attached to the roots by the beak, which is inserted in the tissue in order to pump out its food. The antennæ are composed of seven joints and are rather long, reaching to beyond the thorax. The number of joints in the antennæ and the length will readily separate this species from the other form which is found upon the corn roots. Almost always this root-louse will be found accompanied by ants, and they are quite dependent upon the ants to place them upon suitable roots upon which they can feed, and especially for care over winter. It is evident that since they are confined year after year to the soil, that rotation of the crop will be useful in avoiding their injuries; but it will be most effectual if the corn crop is followed by some crop distinctly different, so that it would fail to furnish any sustenance for the lice. It hardly seems probable that the species has become very much distributed in this state, but it would be wise to examine the roots of the corn which

show a tendency to turn yellow or to wither, and ascertain what kind of injury it may be suffering from. It would often happen that the determination of the kind of insect affecting the roots would determine the best method of cultivation for the next season." (Osborn).

Aphis brassicæ Linn. *(The Cabbage Plant-louse).*

This plant-louse (Fig. 155) occurs in such immense numbers on the cabbage and related plants that it is the most destructive species of plant-louse infesting the vegetable garden. It is sometimes equally numerous on the wild mustard, and it would not be considered a bad habit if it concentrated all its energies to subduing that weed. There are few seasons in which

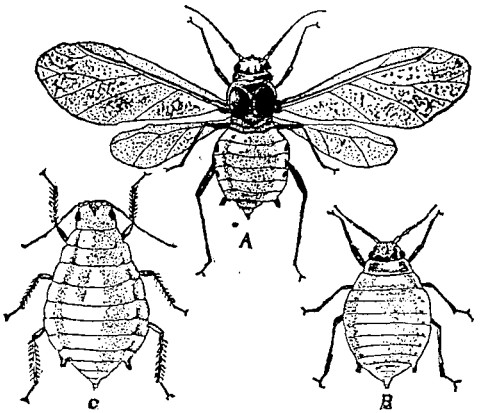


FIG. 154½.—*Aphis maidi-radicis* Forbes: *a*, winged viviparons female; *b*, apterous viviparous female; *c*, apterous oviparous female. After Forbes.

it does not appear in immense numbers, and in this case the plants become so weak that they fail to grow. Turnips and radishes also suffer severely, but to a less extent. The damage is especially severe on young plants just set out. The insect remains on the plants till frost.

"The wingless viviparous female is rather a long oval in form, of a greenish-gray color, with a series of black spots on each side of the back, becoming larger in size toward the tip. This coloration is usually obscured by the whitish, mealy or waxy secretion which covers the body of these insects. The antennæ are green, with black tips, and the eyes and legs are black. See Fig. 137, *a*.

"The winged viviparous female is yellowish-green, with the eyes black, the lobes of the thorax, the honey-tubes and the legs, brown. The general appearance of this form is shown in the figure, which also brings out well the differences between this species and the grain louse. This is most noticeable in the size of the honey-tubes as compared with other species, those of the cabbage louse being much smaller and different in shape.

"In the structure of the antennæ there is also a great difference, for whereas in the grain louse, described later, there are but a few sensory pits on the first long joint, in the present species they are very numerous all around the segment; those of the

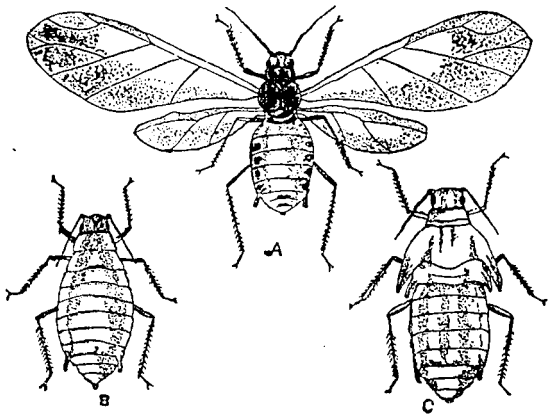


FIG. 154.—*Aphis maidis* Fitch; *a*, winged viviparous female; *b*, wingless viviparous female; *c*, pupa. After Forbes.

third and fourth joints being about the same. On the wingless forms there is only one large sensory pit on the third long joint, and the usual little group on the whip joint.

"Not only in antennal structure, but even in the structure of the beak itself, this species differs from the grain louse. The terminal joint is longer; the second simple, without the peculiar flap figured in the other species. The beak is also longer, and more slender, in contrast with the antennæ, which are shorter and stouter.

"This insect has been known in our country since 1791, and is as common in Europe as it is in the United States; indeed, it is probable that the species has come to us from Europe.

"Unlike the grain louse, we can here do very much more with insecticides, and indeed with care, can keep the insects completely in check. One of the best of the remedies is the whale-oil soap of commerce. The kerosene emulsion is equally effective, and for penetrating power is even better. In all experiments made for me this season the result was uniform and the effect satisfactory. It will be enough to state that the fish-oil soap was perfectly effective at the rate of one pound of soap to eight gallons of water. Another very satisfactory remedy was found in ground tobacco. This was used with excellent result, put on early, while the plants were wet, and dusted on thoroughly. It has the great advantage of being a fertilizer as well as an insecticide, and one of my correspondents who made the experiment,

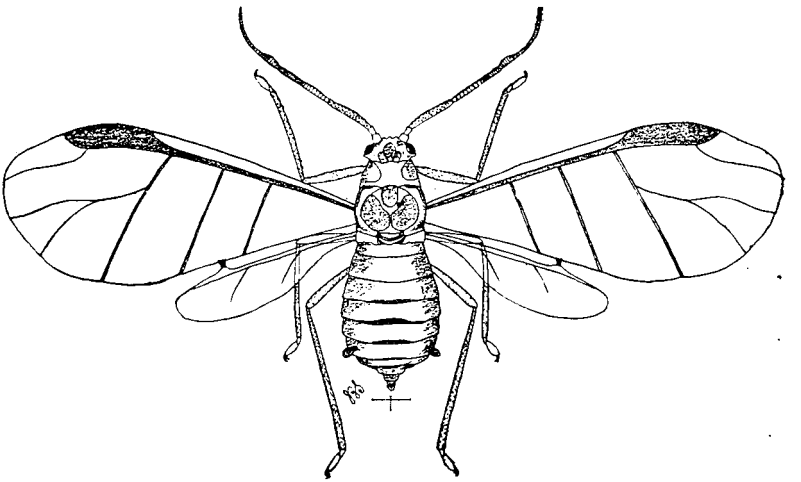


FIG. 155—*Aphis brassicæ* Linn.—Winged, viviparous female. After Smith.

writes May 18th: 'I have no cabbage lice at present. I first commenced with the tobacco mixture, and after two or three applications that row has done fine; they are now as large around as a truck basket.' Regarding the whale-oil soap the same correspondent writes: 'The whale-oil soap was put on another lot; the first application did not kill all of the lice, so the next day we put it on again as you directed, which has killed them all, and the cabbage is doing nicely. This is a sure remedy. I let some others have of it with the same result.' We are therefore not without a remedy for this pest; but many complain that the

difficulty is in the application. The lice get under the leaves or curl them, and the spray does not reach them. The remedy is to use the modern machinery for applying the insecticides. For spraying insecticides on cabbages, a knapsack sprayer is necessary, and to this a Cyclone or Vermoral nozzle should be attached. This nozzle, at the end of a stick of convenient length, can be passed all around and into the cabbage plant, sending a fine spray into every corner. A man can go over a large field, stopping only a few seconds at each plant and wasting no liquid. The insecticides should be applied as soon as the lice appear in any numbers." (Smith).

Aphis rubicola Oest. *(The Smallest Blackberry Aphis).*

This sometimes occurs in large numbers on the under side of the leaves of *Rubus strigosus*. According to Oestlund it should be easily recognized from our other species on account of its small size and its simple sensoria.

Aphis rumicis Linn. *(The Bean Plant-louse).*

This is a rather common dark or aerial plant-louse infesting the garden beans; in some cases it is very destructive to certain kinds, forming black rings around the flowering heads. The writer has repeatedly tried to introduce a large bean from Europe, but failed to make the plants bear although they would flower in abundance. Even after introducing the root-bacteria of this plant, which form very large gall-like swellings on the roots, he failed, simply because the lice infested the bean-plants to such an extent as to dwarf the pods. This was very peculiar, as the plant had never been grown in the state, and the question arose whence came the lice. It seems however, as if the same species occurred also on such weeds as the *Chenopodium,* and *Rumex.*

Prof. Osborn gives the life-history of this species in one of his reports, and as his conclusions are not alone very interesting, but also important, to gardeners and fruit-growers, they are quoted:

"The question naturally arises of what economic value is the life-history of an insect, especially a plant-louse; which some florists distinguish as 'Green Aphis' and Black 'Dolphin.'

"Many people have undoubtedly observed the sudden disap-

pearance and the equally sudden re-appearance at somewhat fixed intervals, of these pests. This peculiarity is usually accounted for by the condition of the weather. In England it is supposed to be caused by an east wind, and is called 'Blight.' The truth of the matter is that some of these pests have fixed habits of migrating and are not dependent on the conditions of the weather. In order that florists, horticulturists and agriculturists may better be able to take preventive measures against their rapid increase, it is well to know where to find them at all seasons of the year. At times when they are all supposed to be dead, destroyed by the weather or some other dispensation of Providence, they may be increasing in destructive numbers on some useless plant in a neglected corner.

"Though it has long been surmised by entomologists that many of the species of plant-lice migrate from one kind of plant to another, during part of the season, but few species have been proven to have this habit. The Snowball and Waahoo Louse both have this habit of migrating. The history of the Waahoo Louse is as follows The eggs which are deposited around the buds of Waahoo *(Euonymus atropurpureus)* hatch between the middle of April and the first of May. All of the brood from the egg are wingless. After moulting two or three times each individual, all being females, begin to deposit young plant-lice like themselves on the under side of the leaves, which the stem-mothers have caused to curl slightly. When full grown the second brood develop wings, and migrate to such weeds as Shepherd's Purse, Curled Dock, Pigweed, and Thistle. This migration occurs between May 20th and June 10th. They remain on these weeds throughout the summer. The number of broods produced during the summer is not known. In this locality they seem to prefer the Pigweed *(Chenopodium album)*. Feeding as they do on the flower spikes, they resemble the seeds of the weeds and are easily overlooked.

"The latter part of August another brood of winged females appear on the Pigweed. These migrate back to the Waahoo on the leaves of which a wingless brood is deposited. This wingless brood is the last of the season. About the time the latter are deposited on the Waahoo, a brood of males are deposited on the pigweed, which develop wings, migrate to the Waahoo, and pair

with the wingless females, after which the females deposit their eggs around the buds to pass the winter.

"This in brief is the life cycle of this aphis. The migration was observed in the field and proven by artificial transfers. It was surmised from the mixed up description of *Aphis rumicis,* as the louse on Shepherd's Purse and Pigweed is called, (also known by the common name of 'Black Dolphin' and 'Bean Louse'), that *Aphis euonymi,* the one on *euonymus* or Waahoo and *Aphis viburni,* the Snow Ball louse, might be related. Dr. Thomas and also Fitch quoting from Walker gives *Aphis euonymi* as a synonym of *Aphis rumicis,* but does not suggest that they migrate. During the spring of 1892 a louse was found in the flower clusters of snowball which resembled the descriptions of the Waahoo louse and Bean louse, and we partially concluded that it must be the Snowball louse because Buckton states that *Aphis viburni* infests the flower clusters. With the intention of solving this riddle and determining the life-history of the Snowball louse as already stated, transfers of *Aphis euonymi* were made from the Waahoo to the Snowball May 17th, and covered with netting. At the same time search was made for *Aphis rumicis* on such weeds as Shepherd's Purse, Pigweed, Curled Dock and Thistles, but none could be found, nor was any plant-louse found on these weeds, with the exception of a root form on Shepherd's Purse, till June 2nd. In the meantime the *Aphis euonymi* transferred to the Snowball thrived and worked principally in the flower clusters; at the same time another species supposed to be the Snowball louse could be found working on no part except the leaves.

"On May 23d and 25th winged specimens of the louse transferred from Waahoo to Snowball were transferred to Shepherd's Purse, Curled Dock and Bean; which had been plotted, covered and kept in the greenhouse for this purpose. The louse infesting leaves of Snowball was treated in the same way, but it refused to colonize on any of the plants named and died; while the Waahoo louse thrived and increased to such numbers on the Shepherd's Purse as to kill the plant. It did not do so well on the Dock in confinement, and all perished on the bean.

"Pupæ of *Aphis euonymi* were found on Pigweed about the middle of September, taken into the laboratory and confined.

When the latter developed wings they were transferred to covered branches of Waahoo. Here they deposited the last brood of wingless females. As soon as the males could be obtained they were transferred to the nets on Waahoo. By October 12th eggs were found around the buds of the covered branches.

"The following conclusions can be drawn from the work as done:

"First.—That *Aphis rumicis* and *Aphis euonymi* are one and the same.

"Second.—That this Aphis has a true migration twice a year, first from Waahoo to annual weeds from May 23d to June 10th; and second back again to Waahoo from September 15th to October 15th, to deposit their eggs around the buds.

"Third—That it can live and feed on the Snowball. In fact quite a number of colonies, being deposited by late migrations, were observed the present fall on Snowball leaves after the Waahoo leaves had fallen. This habit of also migrating to the Snowball and infesting the flower clusters, as proven by experiment, accounts for Buckton's mixed descriptions of the different forms of *Aphis viburni*, and his statement that it curls the leaves and infests the flower clusters. In fact what was supposed to be *Aphis viburni* has not been found on any place except the curled leaves. The most characteristic difference between the two species is to be seen in the larval forms; those of the Wahoo louse being an olive brown color, while those of *Aphis viburni* are greenish white.

"Fourth.—That *Aphis viburni* does not migrate to such weeds as Shepherd's Purse and Dock. Though by June 15th all had left the Snowball leaves and were not seen again until the latter part of October."

Knowing that some plant-lice migrate to weeds, which have no place in the garden anyway, these should be sprayed with a strong emulsion and then plowed. In this way the large majority of the insects would be destroyed and could not later invade useful plants.

Aphis mali Fab. *(The Apple Plant-louse).*

This is a little green louse, frequently so abundant in early spring on both leaf and fruit buds of the apple, that in seasons favorable to their development the entire tree becomes infested, though usually the injuries are confined to the terminal shoots of a few branches. The same species also occur on the crab-apple and the mountain ash. It is especially noticeable when the spring is cold and backward. Prof. Webster has studied this insect very carefully, not alone in the orchards, but also in his insectary, and has discovered some most unsuspected facts, or, as he expressed it:

"It would appear almost visionary to advocate spraying apple orchards in midwinter to protect the wheat crop, but nevertheless one of the most serious enemies of young fall wheat passes its egg stage on the twig of the apple during the winter season. I refer to the Apple Leaf-louse, *Aphis mali* Fab. Soon after the young wheat plants appear in the fall the winged viviparous females of this species flock to the fields and on these give birth to their young, who at once make their way to the roots, where they continue reproduction, sapping the life from the young plants. On very fertile soils this extraction of the sap from the root has no serious effect, but where the soil is not rich, and especially if the weather is dry, this constant drain of vitality soon begins to tell on the plants. Though they are seldom killed outright, these infested plants cease to grow, and later take on a sickly look, and not until the Aphis abandons them in autumn to return to the apple, do they show any amount of vigor, It is very seldom that the affected plants fully recover, at least in autumn, and the result must be to reduce their productiveness the following year.

"It seems that by the third week from the time the eggs begin to hatch the lice become winged, and then abandon the trees and fly to grasses and probably to some of the common weeds.

"Of the three principal species of aphides infesting our smaller cereals, this species occupies an anomalous and at the same time important position. In point of numbers it is very greatly in advance of *Toxoptera graminicum,* and, usually, of *Siphonophora avenæ*, and its effects on young wheat during the

fall is, if anything more serious than either of the others, especially if the land be poor and the weather be dry. So far as my own observations go, it is more detrimental to the wheat than to the apple. The occurrence of the eggs on the twigs of apple, during winter, and the appearance of the young on the first tender buds, and leaves in the spring, are familiar to all horticulturists. I have several times made the attempt to colonize the species on wheat plants, with individuals taken from the apple, but was never able to thoroughly succeed in this until this year, when a series of experiments was begun in the insectary which swept away any previous doubts on the subject of migration.

"Several years ago, on April 17th, all stages of *A. mali* were found on the young buds of quince—a new food plant so far as published record goes—and being unrecognizable without the winged adults, the attempt was made to carry them on artificially until these would appear. In doing this a number escaped from the breeding cage where they were kept, and took up their abode on some young wheat growing in a box on the same table. Not knowing with what generation I began investigating it on the quince, it is of course impossible to say whether, as with the Hop Aphis, it is not until the third brood is reached that adults attempt to escape to other plants, and if it was to this third brood to which the escaped individuals belonged. It will be only safe to say that they were winged and migrated. A wingless female from the quince also strayed from the cage and stationed herself on some of these wheat plants, and produced a number of young, but these all died and fell from the plants. At the same time, in a large cage out of doors, others of this species were being reared from the eggs on twigs of apple. Wheat was sown within this cage, and some of the winged adults, after leaving the young buds and leaves, went first to the muslin sides of the cage, and afterwards to the wheat plants. One of these remained for two weeks alive, on one of the plants, but I could not see that she produced young. While these transitions were certainly made between the tree and grain plants, nature apparently chose to accomplish it only by her own methods, and would brook no interference of human assistance.

"Early in March of the present year, 1893, I placed in the insectary a couple of small seedling apple trees, and to these bound twigs from the orchard, thickly stuck with eggs of this

Aphis mali. In the same bench, about twenty feet away, wheat was sown, while some corn was planted in the intervening space. A pot containing a strawberry plant infested with another species of Aphis, and which were attended by ants; *Lasius flavus,* had previously been placed on this bench. With the hatching of the *mali* a large portion of the ants abandoned their wards on the strawberry and gave their attention to the new one on the apple. The strawberry was then removed, but they still clung to their new found friends. As the population on the apple increased, the ants distributed the apterous females to plants of *Poa, Setaria,* and *Ambrosia artemisiæfolia,* but especially to the wheat; carrying them by the corn to the wheat beyond, which soon became overrun with Aphis. Later they began to colonize their wards on the corn,—but this seemed to be less desirable than either the wheat or the grass. Winged *mali* left the apple unaided, and after taking up their position on the wheat, began their labor of reproduction. On this wheat being uprooted the indefatigable ants removed them to a few wheat plants still farther away from the apple.

"The species also lives over winter in the wheat fields, at least during mild winters, and I have found females reproducing every month of the year. Here, in the west, when the young wheat comes up in September and October, the winged females appear on the plants, and give birth to their young, and these crawling downward attach themselves to the stem just below the surface of the ground, or even on the roots themselves. Here they go on reproducing when the temperature is favorable, the adults being apterous, so far as observed by me, until spring, when they ascend to the foliage, the adults being after this both winged and wingless. On the stems and roots below the surface of the ground, they are of a greenish color, tinged with reddish brown, especially posteriorly, the full grown individuals often being wholly of a dark brown. It is during autumn that they do their greatest injury to wheat by sucking the juices from the young plants, often, if on poor land and during dry weather, checking their growth and causing the foliage to turn yellow." (Webster).

The eggs of the Apple Plant-louse can be found in the cracks and crevices of the bark of the twigs, and at the base of

the buds; they are very minute, oval, shining and black, but when first laid they are of a light yellow or greenish color. Early in spring the young lice hatch, and reaching maturity in ten to twelve days, they commence to give birth to living young at the rate of two each day. The young locate as closely to the parents as they can, and also become mothers before very long. The young lice, when newly born, are almost white, but soon become of a pale, dull, yellowish-green color. The insect is shown in Fig. 156. As far as Minnesota is concerned the migration to wheat fields has not yet been observed.

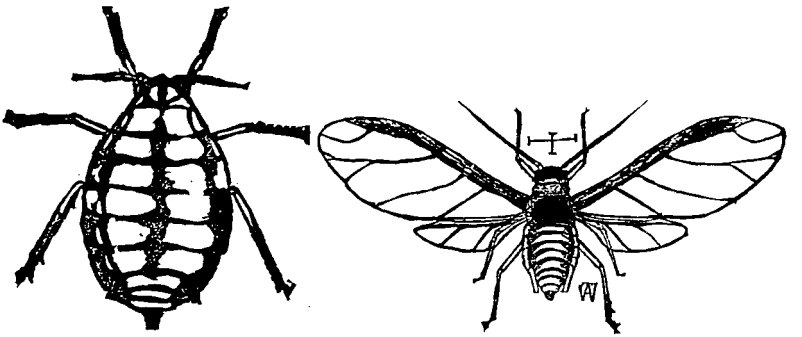


FIG. 156—*Aphis mali* Fab.; winged viviparous female, apterous viviparous female. After Bruher.

Aphis malifoliæ Fitch is perhaps only a variety of the above insect. It is, however, black.

In Fig. 156, Plate XII, is illustrated another plant-louse infesting the apple; it is *Aphis sorbi* Kaltenbach of Europe.

Aphis prunifoliæ Fitch *(pruni* Thos.). *(The Plum-tree Plant-louse).*

This insect resembles the Apple Aphis, and is sometimes rather common. It infests the underside of the plum leaves, puncturing them, and if at all numerous, curling and twisting the same. When first hatched the young lice are of a whitish green color, but as they grow older they become a deeper green, and when mature they have a shining black head and thorax, with a pale green abdomen, marked with a row of dots; the winged forms possess dusky wings.

Aphis cucumeris Forbes. *(The Melon Plant-louse).*

This insect, equally well known in the South as an enemy to the cotton plant, for which reason it was described by Glover as *A. gossypii,* causes great injury in the Eastern states, and may before long be found in our own state. It also infests the cucumber, dwarf bean, spinach, hop, pear, purslane, burdock, dandelion, plaintain, and numerous other plants, even the red clover. According to Pergande it is found almost everywhere in the United States, excepting the more northern regions, in Mexico, and in the West Indies.

Like all other plant-lice it sucks the sap, and if at all numerous the leaves are caused to curl over the insects, so that they are concealed and sheltered. Prof. Smith gives a good illustration of this plant-louse, Fig. 157, and in 1895 described its life-history as follows:

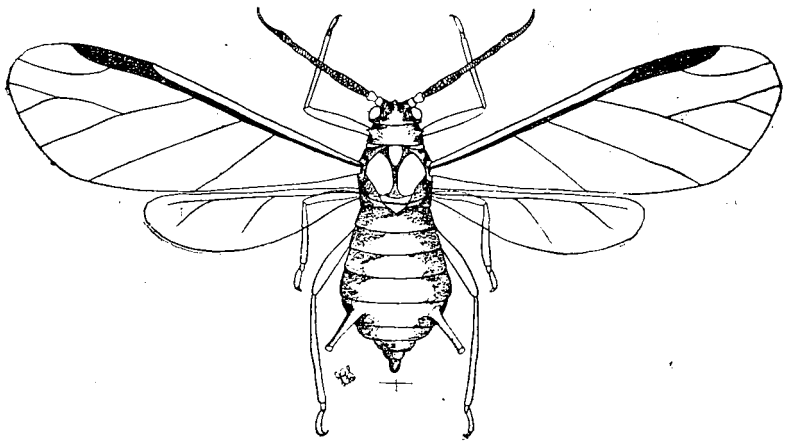


FIG. 157—*Aphis cucumeris* Forbes—Winged viviparous female. After Smith.

"Thus far neither complete males or females have been discovered, although specimens of the viviparous form have been found in almost every month of the year. Mr. Pergande reports the insect on purslane from June until the plants are killed by frost, and a winter egg was found on one of these plants late in October. On shepherd's purse it was found from September to January or later, 'even after heavy frosts, sleet and snow.' On cultivated strawberries it has been found from September to March or later, frequently very numerous on the under side of

leaves, petioles, and between the folds of young leaves. 'With them was found a winter egg in January, deposited in an angle formed of the midrib and a vein on the under side of the leaf.' On most of the plants that remain green or partially green during the winter, the ordinary viviparous form of the insect has been found throughout the season. On plants that die down completely in fall it has, of course, been found during the summer months only, and usually beginning with the month of June or July. It is probable, therefore, that the insect winters, not only in the egg state, but also in the incomplete wingless form. It is of course, certain, that a large proportion of these hibernating forms are killed off in one way or another; but under ordinary circumstances, a considerable proportion of them survive. The hardest winters for them are those in which frosts and thaws alternate frequently. In New Jersey, where the insect is troublesome to melons, it is certain that the insect winters on the common weeds of the fields along the road sides, and probably also to some extent in strawberry patches, where such are planted in the vicinity of melon fields. Among the long list of common weeds on which the insect has been found, there is no difficulty in finding a sufficient number of plants for the specimens compelled to leave the dying cucurbits in the fall. As soon as warm weather arrives in spring, the insects begin to multiply; slowly at first, more rapidly as the season advances, if the weather proves favorable. Experience has shown that in New Jersey the question of whether we will have an invasion of the insects, is settled during the month of June. If the weather during this month is favorable for the development of plant lice, i. e., warm and pleasant, without cold storms, they increase rapidly, and by the middle or towards the end of June, depending a little upon location and earliness of the season. the insects begin to crowd the plants upon which they have theretofore lived, and winged individuals are developed. These fly from their original food plants, and if melon vines are in the vicinity, they settle upon them and at once start reproduction. We may find, usually during the latter part of June or early in July, scattered here and there on the vines, a winged viviparous female, with a cluster of anywhere from four to ten or a dozen wingless young of differing sizes about her; or we may find a little cluster without the winged

female. In such cases she has departed for another leaf, or even another plant, to found another colony. In this way the melon fields become infested, and at that time of the year. Now if, during this period, we have a heavy, cold rain, and especially if it lasts more than a day, most of these migrating forms will be destroyed, and with them also a considerable portion of such young as have been deposited on the melon vines. For some reason it seems as if there were not much migration to melon fields after this time, and if no lice are found in the fields by the end of the first weeks of July, exemption will probably continue throughout the season. If circumstances favor, however, the insects multiply rapidly and spread from hill to hill, partially of their own motion, winged forms being developed and flying a short distance, and partially by the assistance of ants. These are usually found in great numbers in the fields in attendance on the Aphids, and without much doubt they carry specimens from one plant to another."

There are many other species belonging to the genus Aphis, that are found in our state, but it is not necessary to describe them here.

The genus *Myzus* has the feelers about as long as the body, and they are situated on moderately distinct frontal tubercles, which are gibbous on the inner side, as are also the first joint of the antennæ. Legs moderately long; honey-tubes cylindrical, rather long; body often more or less covered with capitate hairs.

A number of very destructive species belonging to this genus are found in Minnesota.

Myzus cerasi Fab. *(The Cherry-tree Plant-louse).*

This is a shining black louse which appears as soon as the leaves of the cultivated cherries expand, being hatched from eggs which are deposited on the branches the previous autumn. The disgusting looking lice multiply so fast that before long the underside of the young leaves is entirely crowded with them, turns yellowish, and in the case of a young tree the whole foliage looks sick and the tree suffers greatly. The species is also abundant on the sand-cherry.

In extreme cases the lice crowd together in such dense masses that they stand, two deep, on each others' backs, with just suffi-

cient space between them to enable the individuals to insert their extended beaks into the tissues of the leaf. Before long their black bodies also cover the leaf-stalks, the stems, and the still green berries. As they secrete a large amount of honey-dew, numerous flies are attracted, who keep up a constant buzz around such colonies of lice. Many lice-destroying insects are attracted, and these multiply so rapidly that they cause astonishing havoc among their defenceless victims, and if nothing happens to them they will before long clear the trees of the lice, which, however, appear a second time later in the season, when they only occupy the more terminal leaves.

The species is sometimes exceedingly numerous, hence correspondingly injurious if not combatted by beneficial insects or by the energetic owner of the trees.

Myzus ribis Linn. *(The Currant Plant-louse).*

This plant-louse (Fig. 134, Plate IX) is only too common in our state, and frequently becomes so numerous as to cause considerable damage. In some gardens it is not uncommon to see the different varieties of currants, and to a less extent the gooseberries, with every leaf distorted by them. Early in spring the stem-mothers settle, usually singly, upon the under side of a still very young leaf, sometimes not yet fully expanded, and insert their beak to obtain the liquid sap from it. This causes the leaf to distort in such a manner that a discolored, bladder-like hollow is formed, in which the louse, and later the numerous offspring, are well sheltered, and where they can not readily be reached by sprays applied to kill them. The bladder-like distortion assumes a dark red color and is readily detected. The lice themselves have a shining black head and thorax; the abdomen is pale green or yellowish green, with a large graduate patch above, the margin with a row of black dots. The pale, or but slightly dusky honey-tubes are cylindrical, sometimes widening in the middle.

According to Webster the winged lice leave the bushes early in summer, but he was unable to discover to what plant they migrated; but in September and October winged oviparous females returned to the currants and gave birth to young, who developed into oviparous females. The winged males flew in

from some other plant, presumably developing with the migrating viviparous females, who gave birth to the oviparous form.

Myzus persicæ-niger E. A. Smith. *(The Black Peach-louse).*

This plant-louse (Fig. 158) is exceedingly injurious in some of the peach-growing regions of the United States, but of course is not found in Minnesota, hence it is not necessary to describe it.

The genus *Nectarophora* also contains a number of destructive species, a few of which will be mentioned. In this genus the feelers are nearly always longer than the body and are situated on distinct and approximate frontal tubercles; the seventh joint is mostly longer than the third. The wings are large, the legs long and slender; the long honey-tubes are cylindrical.

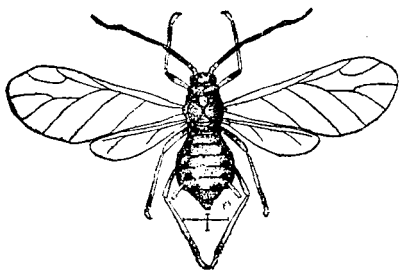


FIG. 158—*Myzus persicæ-niger* D. A. Smith—Winged viviparous female. After Smith. (See also fig. 138).

Plant-lice belonging to this genus are found on a number of wild and cultivated plants, sometimes in sufficient numbers to cause injury. The grape-vine is sometimes invaded, nor do such other plants as the rose, blackberry, strawberry, pea, lettuce, and many others escape their invasions. Only a few can be described.

Nectarophora viticola Thos. *(The Grape-inhabiting Aphis).*

"About the 25th of June they first began to appear on the ends of the Clinton grape-vines, at first working only a few inches down from the end. They spread over the twigs rather rapidly, so that in the course of two or three days they were on a dozen or more. By this time the larva of a Syrphus and a Chrysopa had found them, and were at work upon them. By July 10th the lice had spread over the vines along one side of a walk, which

is bordered on both sides by a mixture of Clintons and Concords, yet working on the Clinton only. They appeared to work mostly on those twigs that were in the shade of some neighboring trees. July 14th a further examination showed that more twigs were infested than before, some twigs were covered as far down as twelve or fifteen inches from the tip." (French).

This species is of a dusky brown or blackish color, legs greenish, marked with dusky. The winged forms have clear wings with brownish veins.

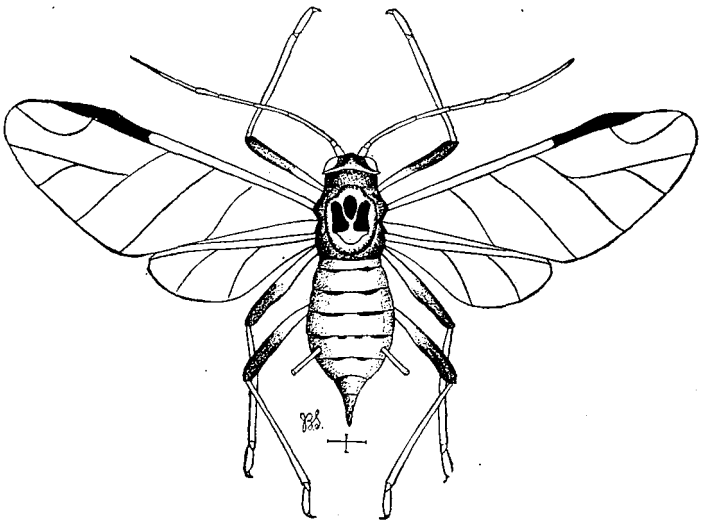


FIG. 159—*Nectarophora* (*Liphonophora*) avenæ Fab.—Winged viviparous female. After Smith. (See also fig. 137).

They have as yet not been found in our state, and with our method of covering the vines every autumn with earth to prevent freezing, it is not likely that the winter egg will survive.

Nectarophora destructor Johnson. *(The Pea Plant-louse).*

This insect, unknown before 1898, has become very destructive to late peas in some of the eastern states, and is spreading so rapidly westward, that it has already been reported from Wisconsin. It is wise therefore to be on the lookout for this new intruder. Yet this insect is an old offender, the *N. pisi* Kalt.; it was found in Minnesota many years ago on the roots of shepherd's purse.

Nectarophora (Siphonophora) avenæ Fab. *(The Wheat Plant-louse).*

Our wheat plants have a large number of enemies, and in some seasons the above plant-louse has caused great losses by sucking the sap from the leaves, stems, and young ears. Rye is also susceptible to injury. The winged insect, shown in Fig. 159, is green, varying in shade, with a large egg-shaped spot on each side of the thorax, and with a row of blackish dots on each side of the abdomen. The feelers, also shown in Fig. 137, are about as long as the body, the legs have pale-greenish thighs, and dull ochre, black-tipped shanks. Other details are also given. The wingless forms are similar in shape, but are more uniformly green in color, and the very young lice are more elongated and of a deeper green. The sensoria or pit-like sense-organs are shown in the lower half of the first long joint.

We repeatedly had invasions of such plant-lice, and they caused a decided shrinkage in our wheat crops. But happily so many parasites were at work that the lice soon disappeared for a number of seasons.

With the new light thrown upon the life-history of the Apple Plant-louse, we can well understand why entomologists were unable to discover the male of this insect, and why there was no evidence that the species ever had a true egg state.

Phorodon humili Schrank. *(The Hop Plant-louse).*

This insect, in some years very destructive in the hop growing regions of this country and of Europe, also has a very curious life-history, the essential parts of which will be given.

The insects during autumn leave the old hop-plants, and migrate to the different kinds of wild and cultivated plums, where they deposit their little glossy, black, ovoid eggs, on the terminal buds, especially in crevices where they are more or less protected (Fig. 160). From each winter-egg a stem mother hatches, Fig. 160, which is stouter, longer-legged, and has shorter honey-tubes than the latter generations. Three parthenogenetic generations are produced upon the plum, the last one being winged, Fig. 162. This winged louse, sometimes called a "migrant," instinctively flies to the hop-plant, which is entirely free from attack previous to this time. A number of parthenogenetic generations are now

produced upon the hop, until during September winged females appear. These are called "return migrants," as they return again to the plum. Each of the females produces three or more young lice which never become winged, yet are true sexual females,

FIG. 160—Winter-eggs on plum. Original.

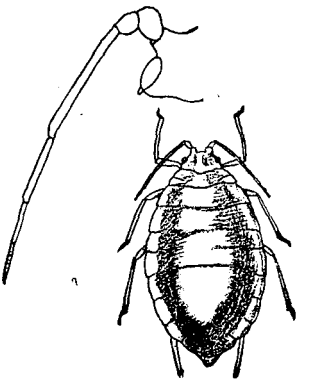


FIG. 161—*Phorodon humuli* Schrank. —Stem-mother, enlarged, head and antenna still more enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

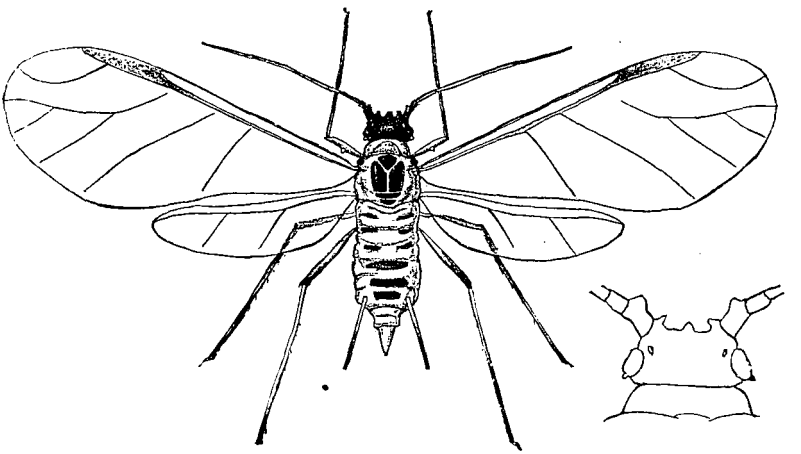


FIG. 162—*Phorodon humuli* Schrank.—First migrant from plum, third generation, enlarged; head at side still more enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

Fig. 163. Somewhat later true males appear on the hop, Fig. 164. Seeking the females on the plum, they pair very late in the season with the wingless true females, who deposit their eggs as already mentioned, Fig. 165. As many as twelve generations of the lice can be produced in a single season, and when we consider that "each parthenogenetic female is capable of producing on an average one hundred young, (the stem mother probably being more prolific), at the rate of one to six, or on an average of three per day, under favorable conditions" (Riley), we can well realize how much injury can be caused by plant-lice, for all suck the liquid sap from the plants they infest.

Hop growers, to prevent losses from these lice, should not permit any wild or cultivated plum trees to grow near their hop yards; a very simple remedy, providing they have no slovenly neighbors.

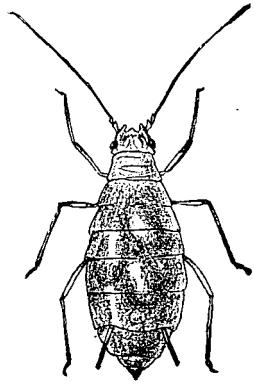


FIG. 163—*Phorodon humuli* Schrank.—True sexual female, enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

Remedies against Plant-lice.

In some cases remedies have already been suggested. It is of course impossible to lay down general rules as to the treatment of all plant-lice, since their habits differ so greatly, but there are a few points that should be known.

The earlier the plant-lice are dealt with the better is the chance to eradicate them, hence remedies should be applied as soon as the lice are noticed. If we wait they increase rapidly and the plants at the same time become weaker and less resistant.

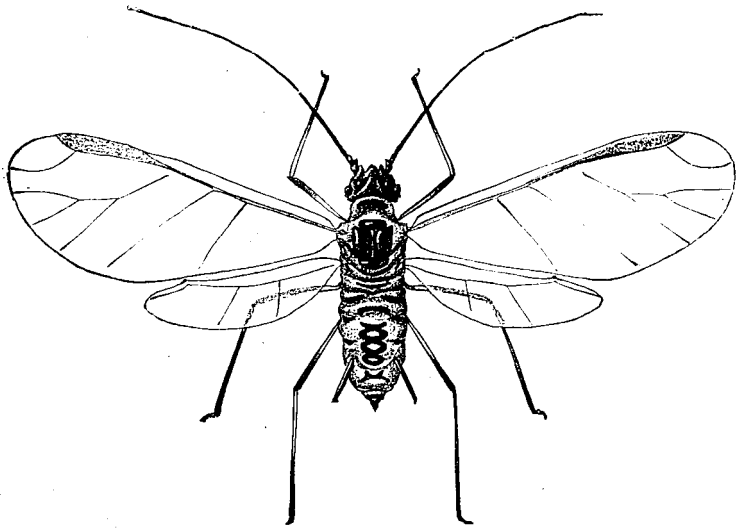
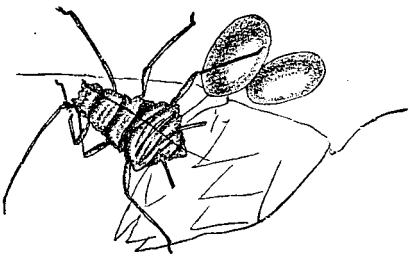


FIG. 164—*Phorodon humuli* Schrank.—Male, enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.



165—*Phorodon humuli* Schrank.—Eggs and shriveled skin of female which laid them, enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

Nothing is better than kerosene emulsion, which, when diluted about ten times with water, kills all the young lice and the adults of the common species, providing, however, that the insects are reached with the spray, which is sometimes difficult if they are hidden in curled and twisted leaves. The black and brown species are much more difficult to kill, and we have to use one part of the emulsion with six or eight parts of water.

Fish-oil soap is also a good remedy, and is effective at the rate of one pound in six gallons of water against the more tender species, and one pound in four gallons against the tougher, dark kinds. In every case a thorough application is essential, and if there is any doubt the spraying should be repeated.

Tobacco decoction, or tobacco used as a finely ground powder, also has good effect. In greenhouses tobacco is the standard remedy, and repeated application is almost certain to keep the plants free of the pest. It is usually burnt, the smoke penetrating everywhere among the foliage, killing the insects. Frequently the steam pipes are simply covered with moist tobacco stems to produce the atmosphere poisonous to the lice.

In forcing beds, the lice can be killed by placing shallow dishes of carbon bisulphide in them, which are left over night in the covered beds. The poisonous fumes of this liquid are very effective, and can also be used in greenhouses. In this case the plants, and dish, are covered with a box for two or three hours, or a fumigating box can be used, in which a number of potted plants, infested with lice, are exposed to the fumes. In every greenhouse and nursery such fumigation boxes should be found, for they are useful in many ways. As far as bisulphide of carbon is concerned, it should be handled with care, and always away from fire. The fumes do not rise, but being five times heavier than air, they sink down, hence the box should be quite tight. One dram of liquid per cubic foot of space is sufficient, and this quantity will not injure the vegetation, but will kill all the lice by the time it has evaporated.

The enemies of plant-lice will be considered later.

If we wish to eat fruit, if we wish to harvest crops of all kinds, we have to observe closely and nip the evil in the bud, i. e. destroy the destructive bugs as soon as they make their appearance.

FAMILY ALEYRODIDAE.

(Aleyrodes).

The insects are like scale insects in their immature stage, and for a long time were classed with them, but the mature insects differ so much from the Coccidæ or Scale Insects, that now they are classified as a distinct family. They are very small insects, and both sexes are winged. In the adult stage all species are similar in color, having white wings, sometimes spotted, with a yellowish or pinkish body, more or less spotted with black. The adults of both sexes have the wings and body covered with a whitish powder, which has given them the name *aleurodes,* i. e. like flour.

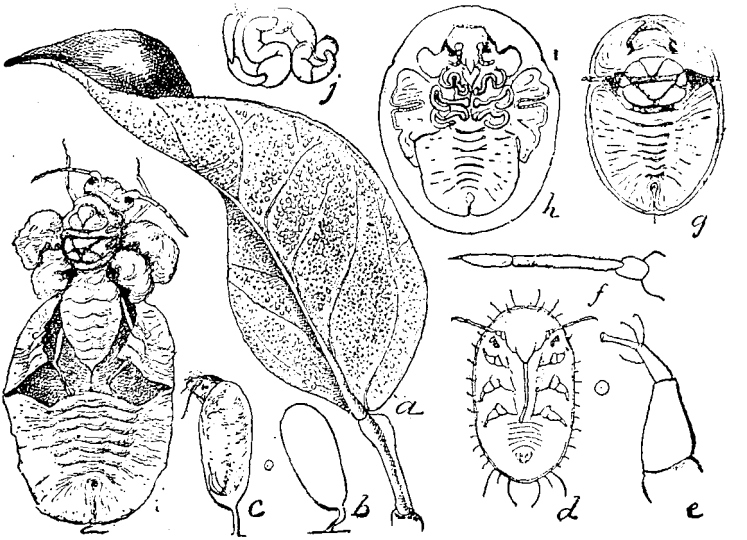


FIG. 166—*Aleyrodes citri* Ril. and Howard; *a*, orange leaf badly infested by full grown larvæ, natural size; *b*, outline of egg; *c*, young larva in the act of hatching from egg; *d*, newly hatched larva seen from below—enlarged; *e*, leg of *d*; *f*, antenna of *d*—still more enlarged; *g*, advanced pupa; *h*, adult nearly ready to emerge and seen through pupa skin; *i*, adult with wings still unfolded in the act of emerging from pupa shell—enlarged; *j*, leg of *h*—still more enlarged. After Insect Life, Div. of Entomology, Dep. of Agriculture.

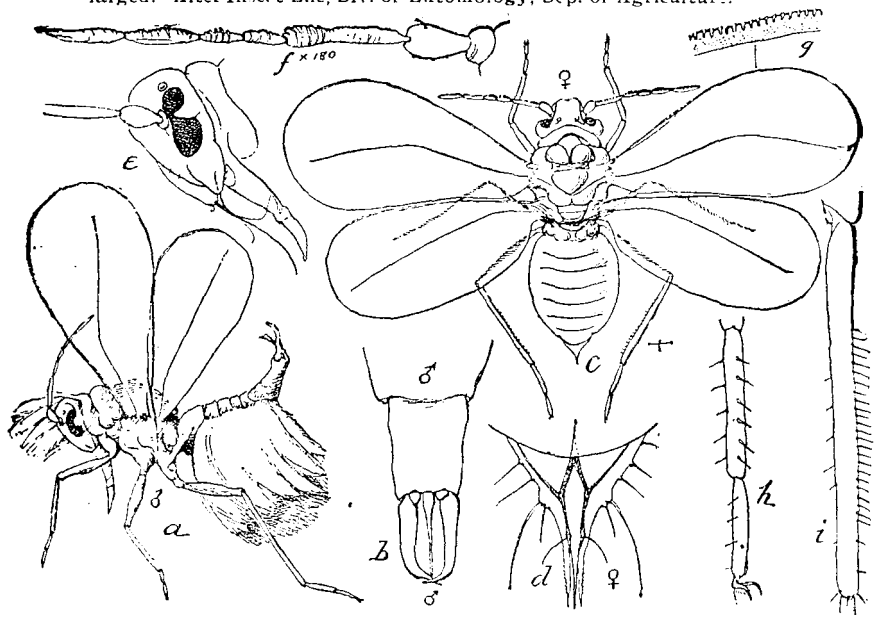


FIG. 166a—*Aleyrodes citri* Ril. and Howard: *a*, adult male seen from side and showing waxy tufts; *b*, anal segments of same seen from above; *c*, adult female seen from above, with wings spread; *d*, anal segment and ovipositor of the same; *e*, head of same from side; *f*, antenna of same; *g*, costal border of fore-wing; *h*, hind tarsus; *i*, hind tibia; *a* and *c* enlarged, *b*, *d*, *e*, *f*, *g*, *h*, *i* still more enlarged. After Insect Life; Div. of Entomology, Dep. of Agriculture.

The adult insects are very similar in the different species, but the immature scale-like forms show great differences. The most common form is very flat, nearly circular in outline, and furnished with a beautiful white fringe composed of parallel fibers which radiate from the margin of the body.

None of the species occurring in Minnesota are of any economic importance. A few occur on conservatory plants, but in the South some species can become numerous enough to cause injury to cultivated plants. The insects are readily killed by kerosene emulsion, or whale-oil soap. On conservatory plants a pyrethum extract is useful on a small scale, and at the same time is the cleanest method of killing them. To show how the insects look the illustration, Fig. 166, of *Aleyrodes citri* is given.

FAMILY COCCIDAE.

(Scale-insects, Bark-lice, Mealy-bugs).

This large family of insects includes many very destructive species, and there is scarcely one kind of fruit free from their attack. Until recently scale-insects were rather uncommon, but with the wonderful improvement in transportation, such beings, both in the form of scales and of eggs, are only too readily carried from place to place, from state to state, from continent to continent.

The family includes a number of quite different looking insects, as the True Scale-insects or Bark-lice, the Mealy-bugs, and others for which we not even have a popular name. They are a very anomalous family, and the species differ very greatly in appearance, habits, and metamorphoses from the other allied families already described. Even the sexes of the same species differ as much in the adult stage as do the members of different orders. The males, unlike all other hemiptera, undergo a complete metamorphosis, but possess only a single pair of wings. The hind wings are simply represented by a pair of club-like halteres, as is the case in the Diptera or Two-winged Flies. Each of these halteres is furnished with a hooked bristle, which fits in a pocket on the upper wing on the same side. The males possess no mouth, but have instead a second pair of eyes. The female is always without wings. and has either a scale-like or a

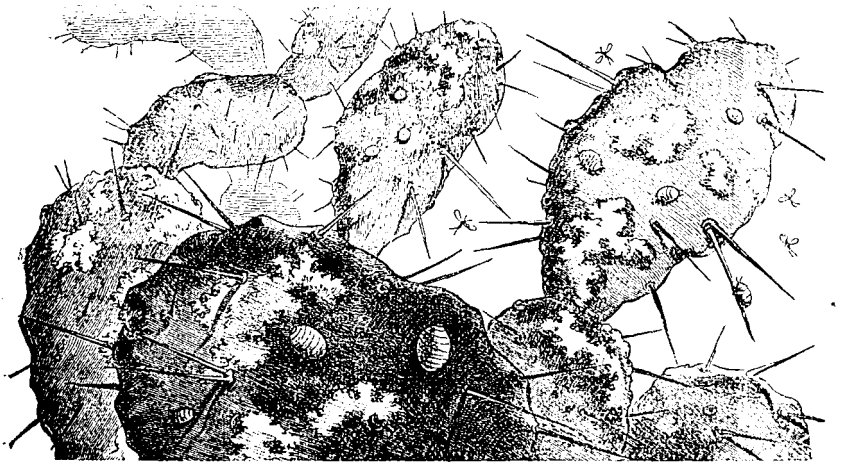


FIG. 167—Cochineal Insect. After Brehm.

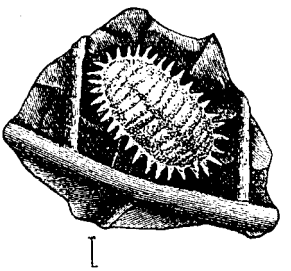


FIG. 168—*Dactylopius destructor*, female, enlarged. After Comstock, Div. of Entomology, Dep. of Agriculture.

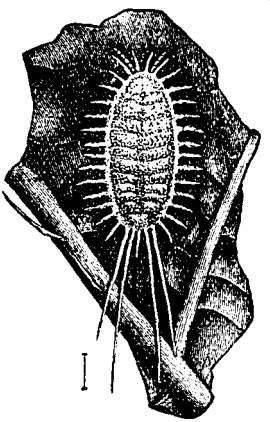


FIG. 169—*Dactylopius longifilis*, female, enlarged. After Comstock, Div. of Entomology, Dep. of Agriculture.

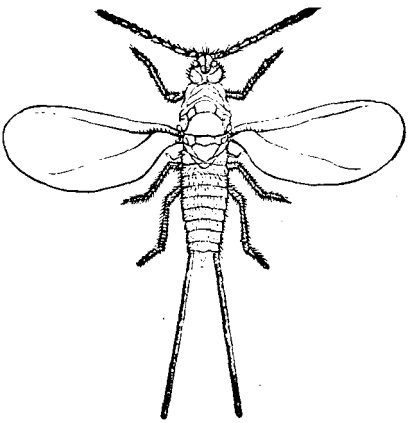


FIG. 170—*Dactylopius longifilis*, winged male, enlarged. After Comstock, Div. of Entomology, Dep. of Agriculture.

gall-like form, and is covered with larger or smaller scales of wax, which may be in the form of powder, of large tufts or plates, of a continuous layer, or of a thin scale. Beneath this protecting substance lives the insect. The illustrations of the different species described will give a better idea of these peculiar and destructive insects than mere words.

During the last years considerable attention has been paid to these insects, not alone to study their peculiar life-histories, but also to devise methods to destroy them. Prof. Comstock especially has given us most excellent descriptions.

All scale-insects are plant-feeders, and like the plant-lice obtain liquid food by means of suction. But not all are injurious, as some furnish dye-stuffs, shellac, or wax. The Cochineal insect, illustrated in Fig. 167, furnishes a beautiful color.

Prof. Comstock and others divide this family into four subfamilies, three of which are found in Minnesota:

A. Body either naked or clothed with a secretion; the clothing, however, not in the form of a scale composed in part of moulted skins.

B. Body of female usually remaining distinctly segmented, and retaining the power of motion till maturity; sometimes, however, it becomes more or less globular and fixed, but in all cases the labium is composed of several segments, and there are no anal plates. The abdomen usually ends in a pair of lobes, each furnished with one or more bristles..... COCCINA.

BB. Body of female changing much in form during development, becoming scale-like or more or less globular, with the segmentation absent or indistinctly indicated. The individuals usually become fixed to the plant upon which they live; sometimes they are enclosed in a covering of wax. In all cases the labium is composed of a single segment; the caudal opening of the alimentary canal in the adult female is covered by a pair of subtriangular plates.....LECANINA.

AA. Body of insect covered by a scale composed in part of moulted skins, and part of a secretion of the insect..... DIASPINA.

SUB-FAMILY COCCINA.

In this sub-family the females undergo the least change in form. In the majority of cases they retain the form of the young larvæ, while in some genera the body becomes a globular mass with little or no indications of segmentation. In most genera the body of the female is permanently covered with a cottony sac, but in the mealy bugs this only takes place just before they begin to deposit eggs. The caudal style of the male is short, and two long and waxy filaments are borne by the last abdominal segment, each of which is supported by one or more hair-like spinnerets at the base.

Dactylopius species. (The Mealy-bugs).

These insects are exceedingly troublesome in greenhouses and in the South to many plants growing outdoors. Two species are shown in the illustrations, Figs. 168, 169 and 170.

Dactylopius destructor Comst. *(The Destructive Mealy-bug)* is about one-twelfth of an inch wide, and one-eighth of an inch long; it has a plump body, brownish-yellow below, white with faint indication of a median line above (Fig. 168). Unlike other scale-insects it can move about slowly. The segments of the body are distinct, and the edge of the body bears 34 white filaments. The eggs are deposited in a cottony sac at the posterior end of the body, in which they remain until hatched.

Dactylopius longifilis Comst. *(The Long-threaded Mealy-bug)* is slightly larger, but narrower, so that it appears much more slender. It is also white, but differs greatly by having the four posterior filiaments very much longer, equalling or exceeding the length of the entire body (Fig. 169). Fig. 170 shows the winged male.

Both species have similar habits, and in the well-heated greenhouses we can find at the same time the insects in all stages. In greenhouses fumigated at regular intervals they are never very destructive.

Dactylopius citri Risso. *(The Common Mealy-bug).*

Everyone connected with greenhouses or conservatories is familiar with the soft-bodied little bug that has a white fringe bordering its oval body, and which takes its name from the mealy deposit with which it is covered. This little pest is one of the worst enemies of the florist and market-gardener. Although barely reaching one-eighth of an inch in length, it occurs in such numbers as to cause injuries to plants. The eggs of the mealy-bug are laid in a loose nest of sticky white fibers. The female usually remains on the nest until by its increase in size she is raised away from the plant, still clinging to it with the head depressed, and the tail elevated in the air. When the eggs hatch, a young mealy-bug emerges, which, but for its smaller size, closely resembles the adult. The young females change very little except in size; when they are about two-thirds grown, the winged males appear and copulation takes place, and soon after this eggs are laid for the next generation. Six weeks is the time ordinarily required to complete the cycle of life, or from the time the eggs hatch till those of the next generation are hatched.

The Cochineal insect *(Coccus cacti)*, illustrated in Fig. 167, is closely allied to the mealy-bugs. It is a native of Mexico, but has been introduced in other countries where it feeds upon a species of cactus. The dye is simply the dried immature female, and is famous for brilliancy and permanency.

Remedies.

Mealy-bugs are well protected by the mealy covering, and as they choose plants that will not stand very harsh treatment, they are not easily combatted. In many instances, however, as on cucumbers, they may be dislodged by a strong jet of water. In case the plant is hardy enough not to be injured, a spray or dip of kerosene-emulsion, (one part of the emulsion to from seven to ten parts of water), will effectually check the insects. If scattered and not very plentiful an alcoholic extract of pyrethrum (Persian Insect powder or Buhach), applied with a small atomizer, will prove very effective. The following was used with great success by Mr. Reid at Cornell University: alcohol,

200 cc.; buhach, 50 grams. It was allowed to stand, with occasional shaking, for seven or eight days, then filtered and diluted about one-half with water.

All these remedies have to be repeated at frequent intervals, and are consequently troublesome. No plant should be permitted to go into the greenhouse or conservatory before it is most thoroughly inspected. In this case an ounce of prevention is worth many pounds of cure.

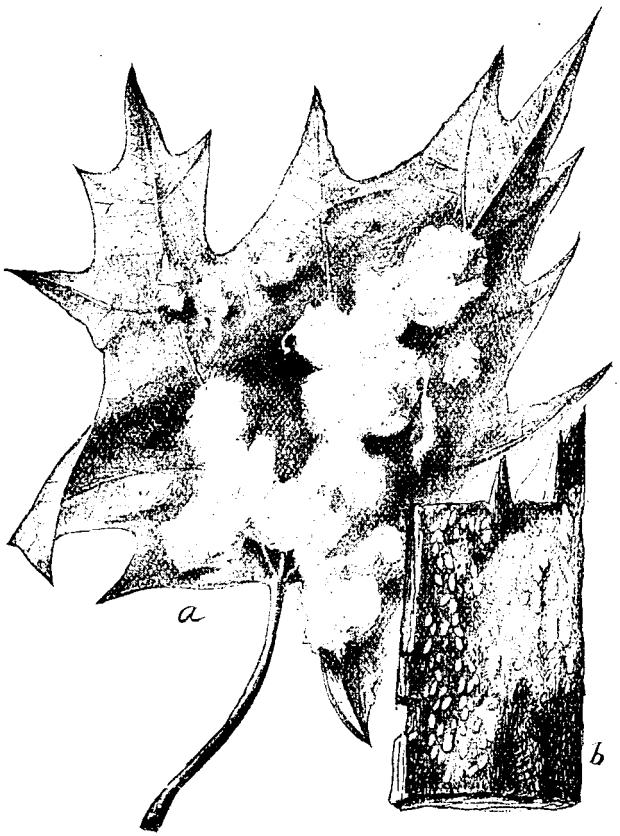


FIG. 171—*Pseudococcus aceris* Geoff.: *a*, adult females on leaf; *b*, young females and males on bark—natural size. After Howard, Div. of Entomology, Dep. of Agriculture.

Pseudococcus aceris Geoff. *(The Maple Pseudococcus).*

This insect occurs in a number of places in the United States, and as it seems to be on the increase, it is wise to look

out for it in our own state. It somewhat resembles the very common cottony scale, found in destructive numbers in many cities and villages in Minnesota, where it causes much injury to such shade trees as the box elder and maples. According to Howard, from whom the beautiful illustrations were received, Figs. 171-172, this insect occurs upon the leaves in summer, appears as an oval masss of powdery, slightly stringy, white wax about a quarter of an inch long, and a little less in width, Fig. 171, *a*. This mass contains the body of the adult female and her eggs.

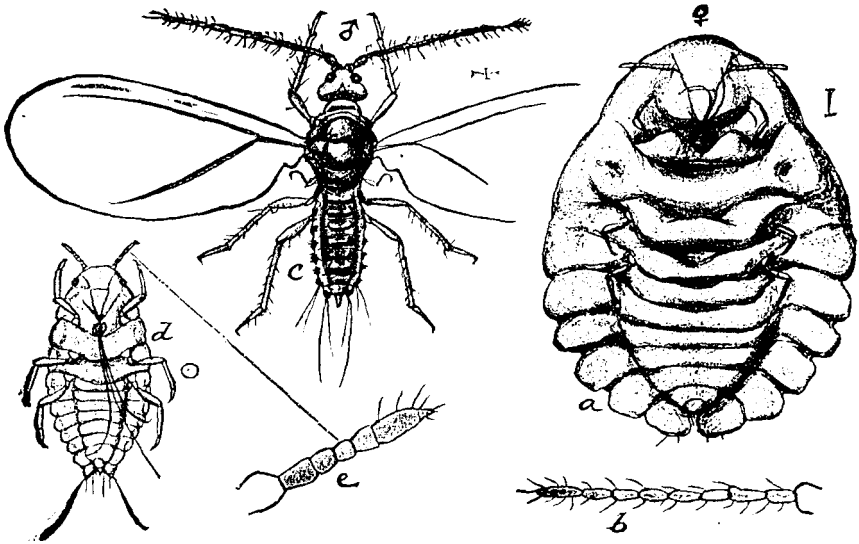


FIG. 172—*Pseudococcus aceris* Geoff.: *a*, adult female; *b*, antenna of same; *c*, adult male; *d*, young larva; *e*, antenna of same—*a*, *c*, *d* greatly enlarged; *b*, *e*, still more enlarged. After Howard, Div. of Entomology, Dep. of Agriculture.

The female occupies the anterior end of the mass, and her body constitutes about one-fourth of its bulk. She is light yellow in color; the upper surface of the body is covered with numerous spinnerets, which are more dense at the posterior extremity, and are interspersed with short spines. The male larva is reddish yellow, and the adult male, shown in Fig. 172, c, is also red. Miss Smith, who first studied this insect in the United States, at Peoria, Ill., found by practical experience that a wash composed of three gallons of water, ⅛ pound white hellebore, and one teaspoonful carbolic acid, put on with a white-wash brush during the warm days of winter and early spring, when

the insects are found hibernating on the bark, was effectual. The insects can also be removed or destroyed by a solid jet of water thrown under pressure, which will wash off and crush the very soft insects.

The genus Orthezia is remarkable on account of the calcareous secretion which covers the body in the form of long plates. As these insects occur only on various weeds, it is not necessary to enter into details. One species is shown in Fig. 173.

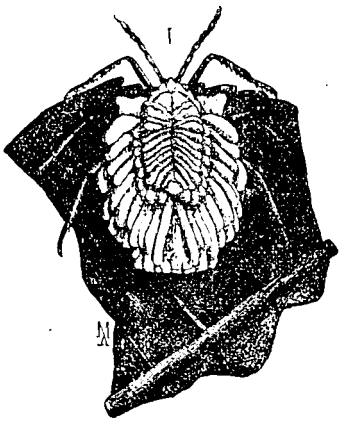


FIG. 173—*Orthezia*, enlarged. After Comstock, Div. of Entomology, Dep. of Agriculture.

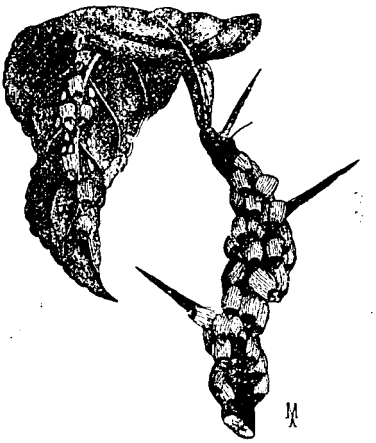


FIG. 174—*Icerya purchasi*. Female, adult and young, on orange. After Comstock, Div. of Entomology, Dep. of Agriculture.

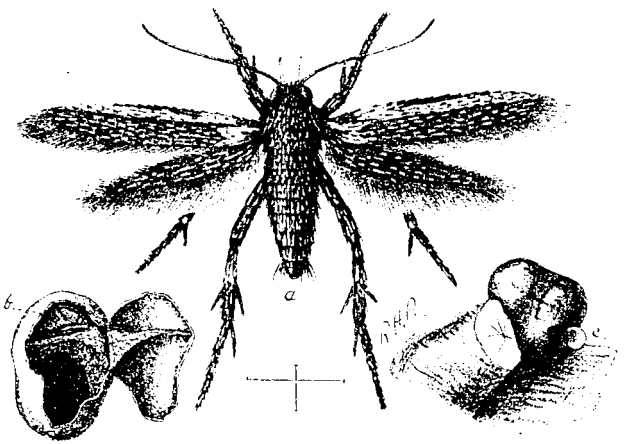


FIG. 176—Kermes-eating-moth. Original.

The celebrated *Fluted-scale* of California, *(Icerya purchasi)*, (Fig. 174), at one time the most dangerous pest infesting fruit-trees in that state, belongs to this sub-family.

The genus *Kermes* is common upon oaks, and is remarkable for the wonderful gall-like forms of the adult females, as shown in Fig. 175, Plate XV. One species is fairly common in our state, especially upon the red oaks, but is kept in check by numerous parasites, one of which is a beautiful moth, which destroys the living contents of these gall-like adult females. The moth is shown in Fig. 176.

SUB-FAMILY LECANINA.

The characteristics of this sub-family have already been given in the table, but the most distinctive character is the presence of the sub-triangular anal plate. The body is usually elliptical, or circular in outline, with a deep incision at the caudal end, leading to the anal opening. The insects are not as stationary as other scale-insects, and even some adults move from place to place. The males, even of some very common kinds, must be quite uncommon, for in some species they are still unknown.

Prof. Comstock gives the following table to separate the genera:

A. Body naked or nearly so.
  B. Female secreting a mass of cottony material in which the eggs are laid..... PULVINARIA.
  BB. Female laying her eggs beneath her body, not excreting a mass of cottony material.. LECANIUM.
AA. Body covered with a layer of wax.....CEROPLASTES.

The genus *Lecanium* occurs on all kinds of plants, both in greenhouses and in the open air; it contains numerous destructive scales frequently called by the gardener "soft-scales." These soft-scales differ greatly in their breeding habits. "Some are oviparous, an enormous number of eggs being produced, and filling the space between the scale. Some produce only a single generation in the course of the year, while others produce two or more. So there is a difference in the mode of passing the winter; this may be as an egg, as a mature, fertilized female, or as a partly grown larva." (Smith).

Only a few species can be described and illustrated. The common *Lecanium hesperidum,* a rather flat scale, elongated oval in outline, smooth and shining, is frequently found on fruit and other trees. It is illustrated in Fig. 177.

Lecanium cerasifex Fitch. *(The Cherry-tree Scale).*

This is usually an uncommon species, but is now found in destructive numbers, not alone on the cherry, but also more frequently upon the plum; though apples, pears, and other trees

FIG. 177—*Lecanium hesperidum.* After Comstock, Div. of Entomology, Dep. of Agriculture.

do not escape. In extreme cases the entire twigs are coated with scales. The shell is hemispherical in form, black, more or less mottled, with pale, dull-yellow dots. On lifting this shell we find a large amount of whitish powder, which, closely inspected, proves to be minute eggs, which hatch in spring, spreading from the scale to succulent twigs, into which they push their delicate

sucking organs to obtain the liquid sap; here they pass through their various stages of growth before the winter approaches.

Lecanium nigrofasciatum Perg. *(The Peach Lecanium).*

This insect, shown in Fig. 178, occurs further south and east on the peach, on various kinds of cultivated and wild plums, on sugar-maple, apple, and on other plants. Here in Minnesota it was once found in great abundance on a wild plum, but soon disappeared.

FIG. 178—*Lecanium nigrofasciatum* Perg. Greatly enlarged. After Div. of Entomology, Dep. of Agriculture.

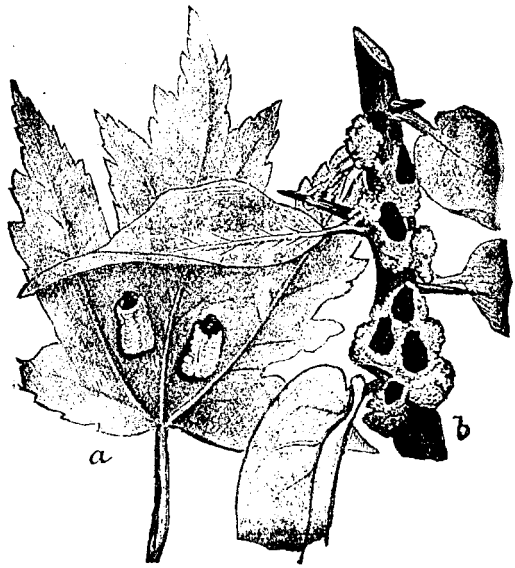


FIG. 179—*Pulvinaria innumerabilis* Rathv.: *a*, female on a leaf in late spring; *b*, same on twig. After Div. of Entomology, Dep. of Agriculture.

Lecanium ribis Fitch. *(The Currant-scale).*

This has been reported several times as being found on the bark of currant-stems early in spring. The scale is also hemispherical, brownish-yellow, and about one-third of an inch in diameter. Thus far it has caused no damage.

Many other species occur, but as all can be destroyed by the same remedy, it is not necessary to describe them in detail.

The genus Pulvinaria can be distinguished from the genus Lecanium by the fact that the adult females secrete a large mass

of a cottony substance in which the eggs are deposited, and where they are protected.

Pulvinaria innumerabilis Rathv. *(The Cottony Scale).*

This is an exceedingly common and destructive species, which sometimes occurs in such vast numbers that the under side of the twigs of box elders and maples are snow-white, being covered in spring with the white cottony substance enclosing the eggs. Wherever insects occur in such numbers the leaves have a wilted and sickly look, while the pavement below becomes coated

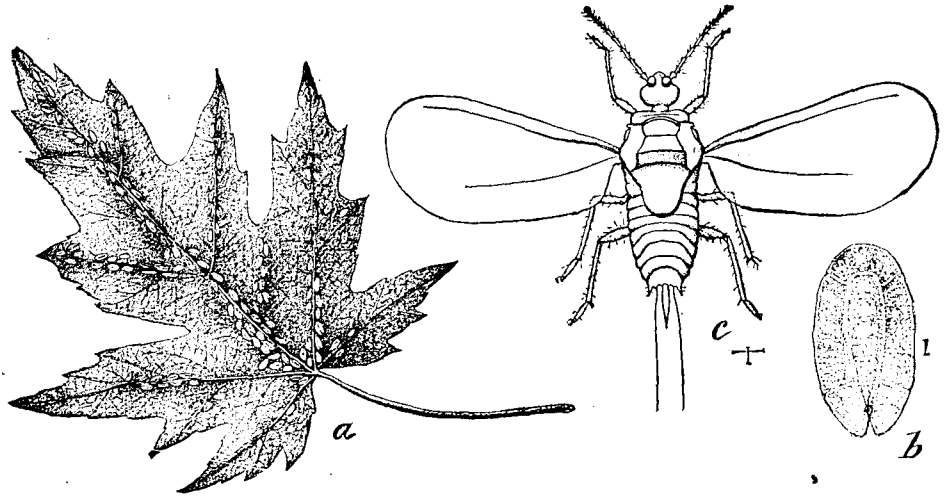


FIG. 180—*Pulvinaria innumerabilis* Rathv.: *a*, leaf covered with young scales; *b*, male scale; *c*, adult male. After Div. of Entomology, Dep. of Agriculture.

with a black and sticky substance, the honey-dew, upon which a peculiar fungus grows. Later in the season the leaves, especially on the under side, are coated with a larvæ, and they are sometimes so numerous that the writer has counted as many as 5,617 upon a single leaf. Usually, however, they do not coat the whole underside, but are chiefly confined to the vicinity of the larger ribs. The illustration, Figs. 179 and 180, gives a good of this insect in its various stages.

"The insect usually attracts attention late in May or early in June, when the gravid female excretes from beneath the scale a mass of pure white, waxy or cottony material in which the eggs are deposited.

"It is at this time more than one-quarter of an inch in length, and appears as a white, fluffy mass, with an oval, brown head, which is in reality the scale itself, though forming less than half the length of the apparent creature. The female at this time feeds ravenously, pumping sap continually in such quantity that there is a constant excretion of honey-dew, which drips to the ground below. The enormous number of eggs, from 1,000 to 2,000, are also matured and forced into the fluffy mass. They are brown, exceedingly minute, held together by the waxy fibers surrounding them, and become so numerous as to force the insect from the twig upon which it rests, until it remains at-

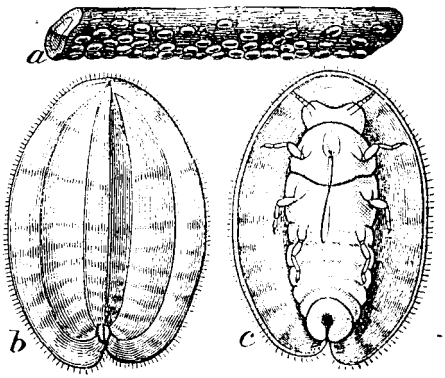


FIG. 180a—*Pulvinaria innumerabilis* Rathv.: *a*, female scales in autumn—natural size; *b*, dorsal view; c, do; ventral view—enlarged. After Fobres.

tached only by its beak and by the adhesive character of the excretion. The eggs begin to hatch about the middle of June and continue until well into July, forming a young larva which is quite deep orange in color. It is about the beginning of July that the great mass of the eggs seems to hatch, and at that time infested twigs and leaves will be literally swarming with thousands upon thousands of the little creatures. In two or three days they fix themselves along the ribs of the leaf, or, more rarely, on young twigs, and begin to feed and increase in size. The formation of the scale begins immediately ,and not until about three weeks thereafter do we have the first moult or change of the skin. The waxy secretion or scale then increases in thickness and the difference between the sexes becomes noticeable. The males grow more slender and soon cease to increase in size,

covering themselves with a thick coating of whitish wax. The pupa begins to form within the larval skin, the parts of the future adult becoming gradually distinct, and a pair of long, waxy filaments, which continue to grow during the life of the insect, is excreted from near the anus. It is the protrusion of these filaments from beneath the waxy scale which indicates the approaching appearance of the male. The posterior end of the scale is in this manner raised up, and the perfect insect backs out with its wings held close to the sides of the body.

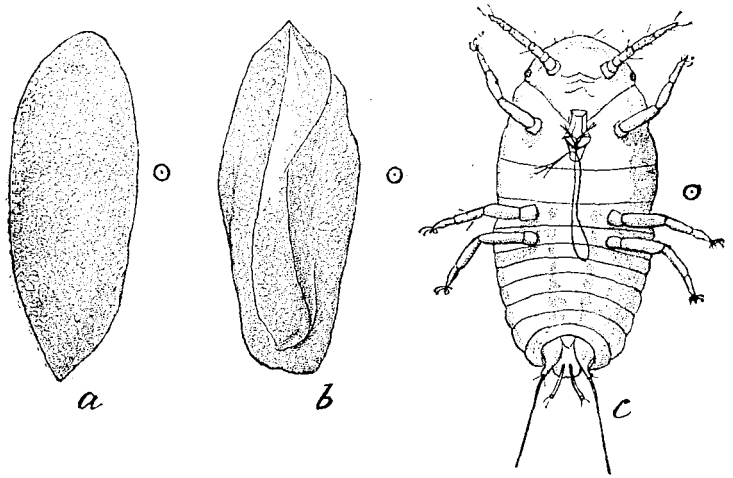


FIG. 180b—*Pulvinaria innumerabilis* Rathv.: *a*, egg before hatching; *b*, egg after hatching; *c*, newly hatched larva, ventral view—greatly enlarged, natural size indicated in circles. After Div. of Entomology, Dep. of Agriculture.

"Meanwhile the female larvæ have been undergoing but slight changes of form. They grow larger and broader across the posterior portion, but the scales remain flat, and with but a slight indication of a dorsal carina. Just before the appearance of the adult males they undergo another moult and change in color from a uniform pale yellow to a somewhat deeper yellow with deep-red markings.

"The males appear during August and the early part of September, seek the females and then die. The females gradually lose their bright-red markings, changing to a deep-brown color, becoming more convex, and the dorsal layer of wax becomes thicker and more carinated. They do not lose the power

of motion as in the Diaspini, and before the falling of the leaves they migrate to the twigs and there fix themselves, generally on the under side. They feed as long as the sap flows, then become torpid and remain in this condition until spring.

"At the opening of spring the eggs grow with great rapidity and distend the body, causing it to become convex, and soon the cottony mass first described makes its appearance." (Smith).

When at all numerous many kinds of trees and bushes are invaded, and the scales become numerous on the box elder, soft maple, hard maple, elm, poplar, apple, plum, grape-vine, and even on the pine.

Remedies.

"When this insect attacks shrubs, or vines or low trees, the infested twigs and branches may be cut off and destroyed by burning as soon as the cottony excretions are noticed on the females. Promptness is necessary here, the object being to destroy the females before the eggs begin to hatch. As, in my experience, the scales are attached toward the tips of the twigs and branches, this suggestion has a wide application even on shade trees, when the insect is not abnormally abundant.

"If cutting is not feasible for any reason, the kerosene emulsion should be resorted to. Experiments have shown that even a quite dilute mixture penetrates the cottony or waxy mass readily and will in most instances kill the adult female and all the young larvæ. It will not kill any of the eggs, however, and a second or even third application will be necessasry to destroy the young as they hatch. The kerosene emulsion for the above application may be diluted ten times. If one application only can be made the emulsion should be diluted with soap-suds, one pound of soap—preferably fish-oil—being dissolved in ten gallons of water. The application should be delayed until the larvæ begin to emerge, and should be very thorough. The object of using soap suds instead of clear water, is to mat the waxy mass containing the eggs and make it impenetrable to the larva when it escapes from the egg. By waiting until the young begin to appear the female scale will be found raised from the surface of the twig posteriorly, and the kerosene will penetrate readily. The young succumb easily, and those that

hatch soon after will find a matted, soapy mass surrounding them, which they can not penetrate.

"If the trees or plants are known to be infested they can be winter treated, i. e., cut back, burn cuttings, apply potash followed by kerosene or fish-oil soap.

"The insect is one that is usually kept in check by natural conditions, and becomes injuriously abundant at irregular intervals only. Even if no treatment is adopted the natural balance is soon restored, but not without the destruction or serious injury of considerable plant-life." (Smith).

No species of the genus Ceroplastes occur in Minnesota.

SUB-FAMILY DIASPINA.

In this sub-family the scales are composed in part of moulted skins, and partly of an excretion of the insect, but the most important character is the peculiar form of the last segment of the body, which is furnished with many openings and appendages, varying greatly in number and form, thus affording good characteristics to distinguish between otherwise very similar species (consult Fig. 185, *b*). But to use the characters we have to distinguish between the scale of the males and the females. In the scale of the fully developed female there are two moulted skins, while in that of the male there is but one.

Prof. Comstock gives the following table to separate the genera:

A. Scale of female circular with the exuviæ either central or more or less nearly marginal.

B. Scale of male but little elongated, with the exuviæ more or less central; scale usually resembling that of the female in color and texture..... ASPIDIOTUS.

BB. Scale of male elongated, with the exuviæ at one extremity.

C. Scale of male, white and carinated..... DIASPIS.

CC. Scale of male, not white and with no central carina.....PARLATORIA.

AA. Scale of female elongated, with the exuviæ at one extremity.

D. Exuviæ small.

E. Scale of male, white and carinated; last segment of female with five groups of spinnerets..... CHIONASPIS.

EE. Scale of male white, but not carinated; female with eight groups of spinnerets..... POLIASPIS.

EEE. Scale of male similar in form to that of the female..... MYTILASPIS.

DD. Exuviæ large.

F. Two moulted skins visible on the scale of the female.... PARLATORIA.

FF. Second skin covered by a secretion..... UHLERIA.

Only a few of the more important species can be given.

The genus Aspidiotus is a very large one, and contains some very injurious scale-insects.

Aspidiotus nerii Bouche. *(The Common White-scale).*

This scale is very abundant in the southern states, where it occurs on a great variety of plants. But it is by no means a stranger in our own state, where, much to the sorrow of lovers of flowers, it is sometimes found in destructive numbers on many house plants.

Aspidiotus ancylus Putn. *(The Eccentric Scale of the Elm).*

A careful examination of our silver maples and elms sometimes reveals the presence of a small gray scale, which so closely resembles the color and texture of the bark to which it is fastened, that it would be still more difficult to see it if it were not raised above the smooth surface of its resting place, Fig. 181. The largest scales are about one-sixteenth of an inch in diameter, and somewhat circular or oval, although sometimes quite irregular in outline. The scales of this species are usually found close together in groups of all sizes, from three or four to one hundred or more. It frequently happens that the scales overlap each other, and some of them are thus pushed on the backs of their fellows, so that they do not touch the bark at all. The

advantage of a long thread-like beak possessed by the scale-lice is now apparent, for with it the insect can draw its supply of food from the plant between the scales, and get underneath. The scale of the female has two small exuviæ, the smallest of which constitutes a yellow or orange dot placed eccentrically at one side of the center of the scale; from this the name "The Eccentric Scale" is derived. The scale of the male is smaller and has only one exuvia. It is often so covered with secretion as to be nearly invisible.

This species seldom occurs in sufficient numbers to cause much damage, but in case it should greatly multiply it can be checked with kerosene emulsion applied in the same manner as in the case of the others.

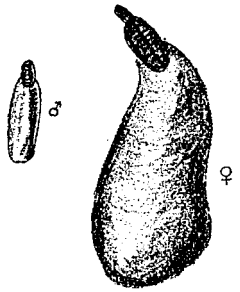


FIG. 181—*Aspidiotus ancylus* Putn.: male and female scale, enlarged. Original.

The specimens found in Minnesota differ from the typical form in lacking the spinnerets and the plate between the third and fourth spines, but as Prof. Comstock has described a variety in which the plates are lacking, it seems that it is simply a variety.

Aspidiotus rapax Comst. *(The Greedy Scale).*

This species, a bad pest infesting different kinds of fruit in California, is only found, and rarely, in our greenhouses, where it infests the *Osmanthus fragrans.*

Aspidiotus ficus Ashm. *(The Florida Red-scale).*

This, as well as some other species, occurs in Minnesota only in greenhouses, but there it is sometimes decidedly bad, and owing to the uniform and suitable temperature, it breeds constantly.

The same remedies which are applied against the next species, will keep it and all other scale insects in check. Where only small potted plants are attacked, the entire plant should be immersed in a weak solution, (1 to 14), of kerosene emulsion or whale-oil soap. A thorough spraying with the same materials, to be followed by a spray or wash of pure water, to remove the emulsion, is also effective. On a large scale fumigation with hydrogen cyanide will kill all insects.

Aspidiotus perniciosus Comst. *(The San Jose Scale).*

This most destructive species has been found but once in our state, and was promptly destroyed with the trees, and as all the neighboring trees in the infested orchard were killed since by frost, none of the insects could survive. But they can exist in Minnesota, hence we have to be on guard against their introduction from other states. A full account of this insect was given by the author in the Twenty-sixth Annual Report of the Minnesota State Horticultural Society, which is repeated:

"It seems that this scale was first noticed in 1873 at San Jose, Cal., which fact gave it the name under which it is now so well known. It spread rapidly until 1880, when Prof. Comstock discovered and collected it in Santa Clara county, and described it in the Annual Agricultural Report for that year as *Aspidiotus perniciosus.* He selected this specific name because he found it the most pernicious scale-insect found at that time; nor could a better name be proposed at this date, as it is by all means the worst insect which ever threatened our orchards. In 1892 the insect was discovered in the vicinity of Las Cruces, N. M., upon apple, pear, peach, quince and rose. In 1893 specimens were found at Charlottsville, Va. Soon afterwards it was discovered in many orchards in Florida, Maryland, New Jersey, New York and Ohio, and in many other states. In November, 1895, it was reported in twenty states, and at the present time it is doubtful whether there is a single state in the Union that is not more or less infested in some orchards, while some of them are fairly alive with it.

The following description of the insect is taken from a paper published by the Division of Entomology:

"The San Jose Scale belongs to the same group of scale

insects, the *'armored scales,'* to which the common and well-known oyster-shell bark louse of the apple belongs. It differs from this species and, in fact, from all other eastern species found upon deciduous fruit trees in that the scale is perfectly round or, at most, very slightly elongated or irregular. It is flat, pressed close to the bark, resembles the bark of the twig in color and when fully grown is about one-eighth of an inch in diameter.

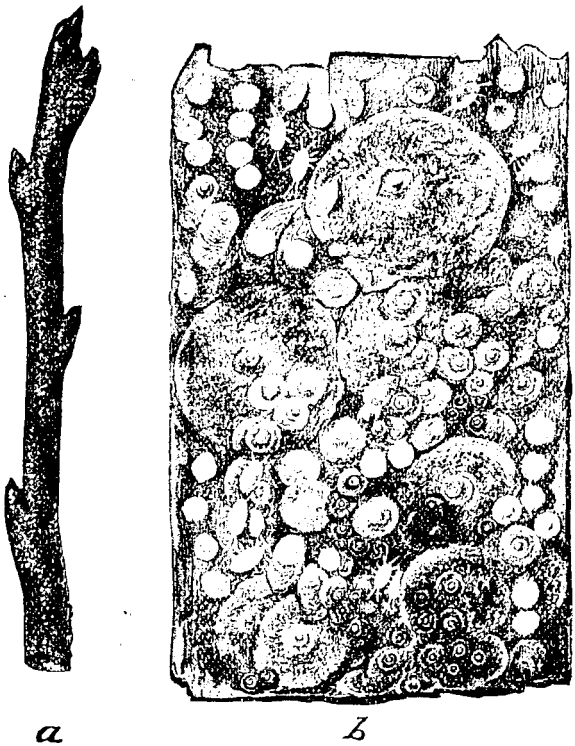


Fig. 182.—*Aspidiotus perniciosus* Comst.; *a*, infested twig, natural size; *b*, bark as it appears under a hand lens, showing scales in various stages of development, and young larvæ. From Div. of Entomology, Dep. of Agriculture.

At or near the middle of each scale is a small, round, slightly elongated black point or this point may sometimes appear yellowish. Young and full-grown scales are shown in the illustration (Fig. 182, *b*). See also Fig. 185, Plate XV.

"When occurring upon the bark of the twigs or leaves and in large numbers, the scales lie close to each other, frequently overlapping, and are at such times difficult to distinguish with-

out a magnifying glass. The general appearance which they present is a grayish, very slightly roughened scurvy deposit (Fig. 182, *a*). The natural rich reddish color of the limbs of the peach and apple is quite obscured when these trees are thickly infested, and they have then every appearance of being coated with lime or ashes. When the scales are crushed by scraping a yellowish, oily liquid will appear, resulting from the crushing of the soft, yellow insects beneath the scales, and this will at once indicate to one who is not familiar with their appearance the existence of healthy living scales on the trees.

"They are easily scraped off with the finger nail, and the bark beneath them will be seen to be darker in color. The natural color of the bark is somewhat changed, as will be seen by comparing the places from which the scales have been removed with the spots upon which the scales do not appear. The outlines of the removed scales will be noticed upon the bark, and the circumference is frequently changed in color, becoming somewhat purplish. Where the scales do not occur so thickly, they are more perceptible, and upon young, reddish twigs the contrast is quite noticeable, as the scales there appear a light gray. The younger and smaller scales are darker in color than the older and larger ones, and sometimes appear quite black, while the still younger ones are yellowish.

"During the winter the insect is to be found in the half-grown or nearly full-grown condition. The young begin to hatch and to crawl from under the female scales shortly after the trees leaf out, and from this time through the summer there is a constant succession of generations.

"The young louse is an active, crawling creature, very minute and yellowish in color (Fig. 183, *a*). The young spread out upon the new growth of the tree, settle down, and each begins to secrete a scale, as shown in Fig. 183. During its travelling stage it possesses the characters shown in the illustration. The male is an active, two-winged insect, shown in Fig. 184. The full-grown female loses her legs and antennæ, and bears a very slight resemblance to a living insect. It is shown in Fig. 185, *a*. Fig. 185, *b*, shows the spinnerets.

"The insect affects not only the young twigs and limbs, but is also found upon the leaves and upon the fruit. When abund-

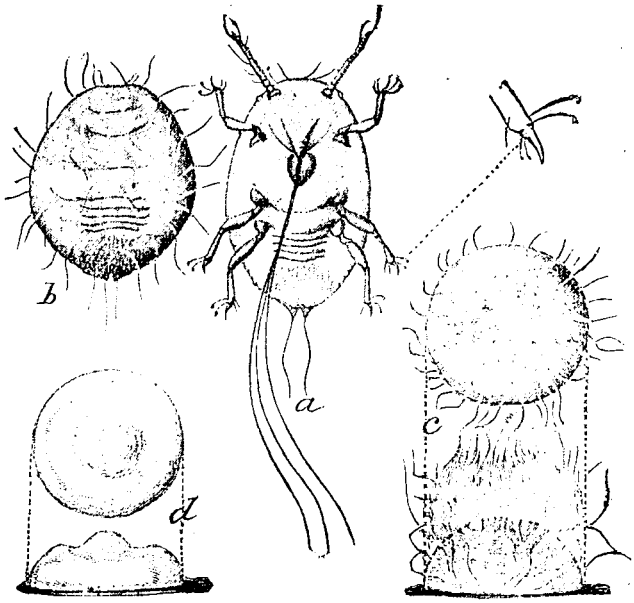


Fig. 183.—*Aspidiotus perniciosus* Comst.: Young larvæ, and development of scale; *a*, ventral view of larva, showing sucking beak with the bristles seperated; *b*, dorsal view of same, somewhat contracted, with first waxy filaments appearing; *c*, dorsal and lateral views of same still more contracted, showing further development of wax secretion; *d*, later stage of the young scale—all greatly enlarged. From Div. of Entomology, Dep. of Agriculture.

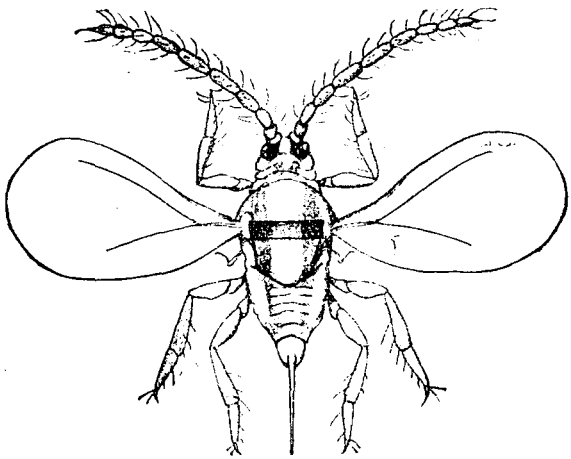
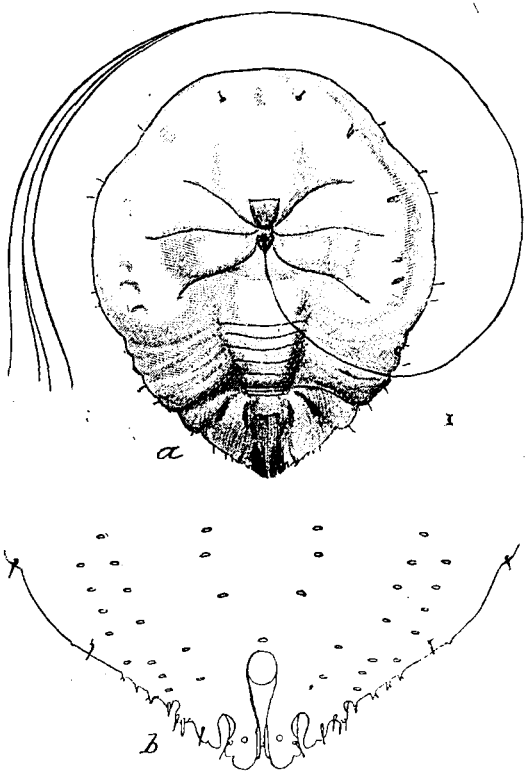


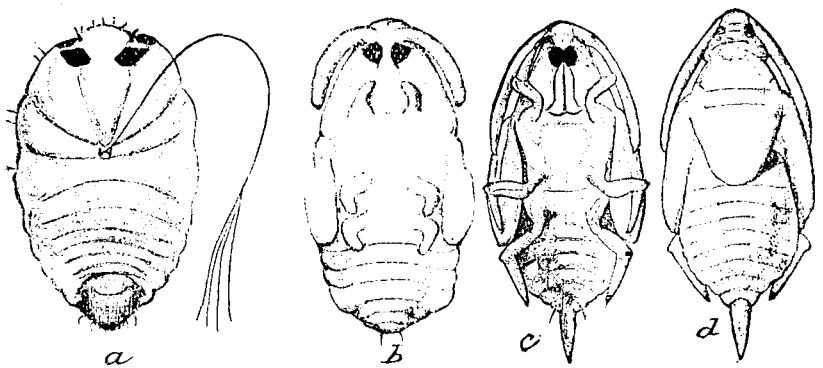
Fig. 184—*Aspidiotus perniciosus* Comst.: male—greatly enlarged. From Div. of Entomology, Dep. of Agriculture.

ant the fruit is destroyed. One of the most characteristic points in the appearance of the insect upon the fruit is the purple discoloration around the edge of each scale. So far as we know this result is confined to this one scale insect. Upon the leaves the insects have a tendency to collect along the midrib on the upper side of the leaf, in one or more quite regular rows, and also to some extent along the side ribs. The infested leaves turn brown, but do not have a tendency to fall as a result of the damage."

How the insect spreads. This scale insect can be carried on fruit sent to the market. Large numbers are thus sent long distances, and almost invariably reach their destination in good health. But as most of such fruit is eaten in the cities or away from orchards, there is not so much danger on that account, and only where peelings of fruit are thrown about in a careless and filthy manner among growing bushes and trees can the young lice find a new home. These young lice are decidedly active for a brief time, two or three days at most, and they crawl with considerable rapidity and great persistence, so that they might possibly descend from one tree and crawl for a number of yards to another; but the spread in this manner is insignificant. Where trees are close together they may pass from the branches of one to the branches of another. They rarely crawl long in one direction, however, but rather move rapidly around, irregularly and at random. Usually they do not go further than is necessary to find a good place to settle and at once begin to form a scale. This very interesting process is shown in Fig. 183. As soon as the young louse has inserted its beak into the plant, and has begun to feed, a change comes over it, and within a few hours it is entirely covered with a fine, white, waxy film. This turns to yellow and then to gray or even black, and the creature is a fixture, absolutely incapable thereafter of shifting its position under any possible circumstances. Strong winds may carry the young bodily from one tree to another, but the principal method of spread is by means of other insects which are winged, and by birds. The active young lice will soon crawl upon any small winged insect, particularly if the latter is of a dark color, and they may be carried by it to a considerable distance. They also crawl upon the feet of birds which visit the trees and may



. 185.—*Aspidiotus perniciosus* Comst.: *a*, adult female, ventral side; *b*, spinnerets of the same—greatly enlarged. After Div. of Entomology, Dep. of Agriculture.



185 a.—*Aspidiotus perniciosus* Comst.: Development of male insect; *a*, ventral view of larva after first molt; *b*, same, after second molt; *c* and *d*, ventral and dorsal views. All greatly enlarged. After Howard and Marlatt, Div. of Entomology, Dep. of Agriculture.

thus be carried for miles. They are often found upon ants, and ants, as everyone knows, are great travellers. The difficulty in moving from one place to another, and the dependence upon external agency for their distribution, will account for the fact that trees here and there in an orchard newly set out may be badly infested, while not a scale will be seen on the trees on either side. Few birds or insects visit a young orchard that is at all well kept, and the distance between the trees, especially if the land is cultivated, is altogether too great to be covered by the young lice, even did they know enough to make a bee-line for the nearest point. The result is that everything fixes upon the tree upon which it was hatched, killing it more rapidly than would otherwise be the case, but at all events confining and preventing its spread to points not before infested. This also explains why nursery stock is so evenly troubled: here the trees are grown just as closely together as is possible in rows, and there is no hindrance to crawling from one to another.

As the insects must feed for a time in the spring before attaining their full growth, it follows that only such as are fixed to a tree itself have any chance of reproducing their kind. Those that fix to the leaves fall with them, and as these dry or decay the insect dies for want of food before attaining maturity. Those on the fruit are removed when this is ripe. We have thus to consider only the wood, free of all leaves and fruit, when attempting the destruction of the insect.

All our deciduous fruit trees and many forest trees are attacked by this insect in varying ways. Smaller plants, like currants, gooseberries, raspberries, roses, etc., are also to its taste. In fact nearly all bushes and trees will support it.

Like most other insects this scale insect has a number of parasites that kill some of them. Large numbers are also eaten by such insects as the lady-bugs, and chiefly the smaller kind do not despise such a little creature. They are, all combined, but a slight check to the increase of an insect that is so prolific and has so many generations in the course of a single summer. The figures given of the number of offspring in one season are almost past belief, but they are based upon actual observation.

Remedies.—A large number of remedies have been tried, with more or less good results. As the writer has no experience

with them as regards the scale, and as so much has been written about the insect and the remedies in pamphlets that are accessible to all interested in the matter, it is not necessary to mention them at this time, especially as the insect can still be prevented to spread in our state. By all means the best, and in the end the cheapest way, is to destroy the trees that harbor such insects in large numbers. Quite recently Profs. Smith and Webster have sent out circulars in which they state that pure kerosene oil, sprayed upon the bare trees during a day with sufficient wind to evaporate this oil very rapidly, would kill the insects without injury to the trees. Perhaps it will, and it would be a sort of patriotic action on the part of some of you to sacrifice a few trees, or rather to run the risk of doing so to try the remedy. Soaking the bark of such an infested tree with oil and burning it is also recommended; I suppose on the principle that burning a house will kill all the bed-bugs!

Since the above was written Prof. Smith and others have made many very careful experiments with kerosene oils, both with crude and illuminating oils. It was found that crude petroleum, if used in winter, was a perfect remedy, providing, however, that the oil was not too heavy. It should have a specific gravity of 43° or over on the Beaume oil scale, but it is not necessary to go above 45°. Such crude oil is sold, at about 8 cents per gallon, by Mr. W. P. Cutler, 738 Bourse Building, Philadelphia, Pa.; it is not sold as crude petroleum, but as insecticide oil. Of course any crude oil, if not mixed and of the specific gravity mentioned above, will be effective; but it must be a paraffin and not an asphaltum oil. This oil does not thicken except in very cold weather, and can be used either unmixed or mixed with water if a good spraying pump is used. The light and volatile naphthas enter and kill the insects beneath the scales, and the remaining vaseline coats the whole sprayed surface, and remaining there for a long time kills all the young scale-insects that come in contact with it. It seems that the crude oil acts also as a fertilizer.

Recommendations. 1.—Every orchard that has been set out within the last six years should be thoroughly examined to ascertain whether or not the San Jose Scale is present.

2.—If the insect is found to be confined to a few trees these had better be taken out and destroyed, unless the infection is so slight that all scales can actually be removed with a stiff brush. No half way measures will suffice.

3.—No fruit grower should admit a single young fruit tree or a single cutting or a single bud from a distance into his orchard without first carefully examining it and satisfying himself absolutely that it does not carry a single specimen of this scale.

4.—Buy trees only from responsible nurserymen, best from your own state, and only when you feel quite certain that they sell plants not infested by this scale.

5.—Infested stock is most likely to come from eastern or southern states where the scale abounds.

6.—Avoid nurserymen that do not themselves grow the plants they sell. The scales that found their way into Minnesota were all bought outside the state, not from nurserymen, but from dealers in nursery stock.

7.—Have quarantine regulations established by the state."

Since the above was written the insect has spread over many regions, and is now found in very many states, but as far as known not in Minnesota. Meanwhile entomologists and fruit-growers have become more familiar with it, and numerous methods of fighting or reducing it to almost harmless numbers have been discovered. Yet it is a most dangerous pest, and we can not be too careful in keeping it out of the state. In a recent circular issued by the Division of Entomology, Department of Agriculture, Marlatt says that the San Jose scale has become a permanent factor in fruit-growing, that it is so widely disseminated, and has become so firmly established, that its extermination is now in most cases out of the question. Extermination is possible only where the scale is detected at the very outset on new or recently planted nursery stock. He gives a number of treatments, the best of which seems the kerosene treatment, consisting in spraying the trees with ordinary kerosene oil at any time during the winter.

Diaspis rosæ Bouche. *(The Rose Scale).*

This is a round or circular, pure white or very slightly yellowish-white scale, sometimes very common on neglected rose, raspberry and blackberry bushes, where it attracts the attention by forming such a striking contrast to the greenish or reddish shoots, hence is readily observed. It is most abundantly found on the stems of roses that grow close to a wall, trellis or other support, where the insects are better sheltered. As can be seen

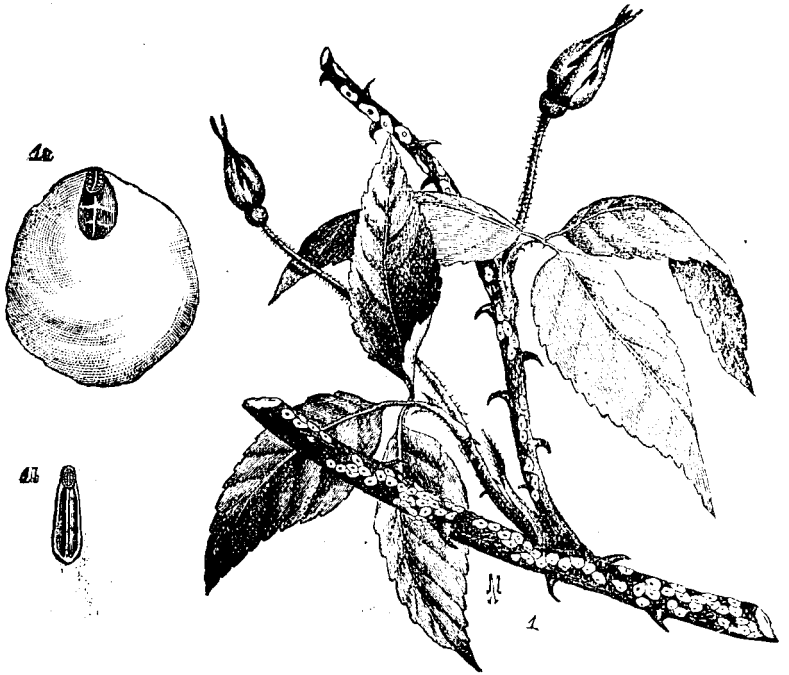


Fig. 186.—*Diaspis rosæ* Bouche; *1*, scales, actual size; *1a*, female scale; *1b*, male scale. After Comstock, Div. of Entomology, Dep. of Agriculture.

in the illustration, Fig. 186, the male scale is very small and narrow. Fig. 186, Plate XV, shows an infested twig. The life-history of the insect is very similar to that of the Scurfy-scale described later.

Diaspis cacti Comst. *(The Cactus Scale).*

One of the most conspicuous and beautiful of the greenhouse scales is the zound or white scale of the cactus. The scales possess two different forms, of which the female scale is about

one-sixteenth of an inch in diameter, circular, with a dark-brown center. The male scale is about half as large, yellowish-white, with a dark spot at one end, and a small ridge running the length of the scale. These scales are often very closely crowded, and if very numerous may cause the death of the plant.

The use of a stiff brush with soap and water, or a wash of kerosene-emulsion, are the most useful remedies.

An illustration showing this peculiar scale will be found in Fig. 187, Plate X.

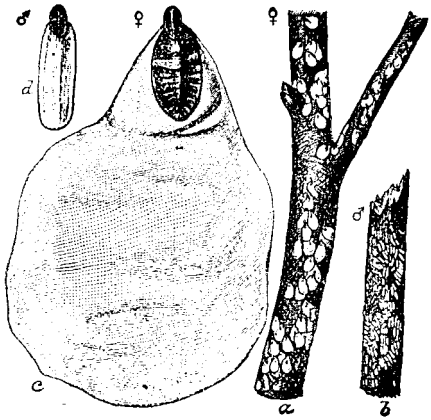


Fig. 188.—*Chionaspis furfurus* Sign.: *a*, twig infested by female scales; *b*, with male scales; *c*, female; *d*, male scale, much enlarged. After Div. of Entomology, Dep. of Agriculture.

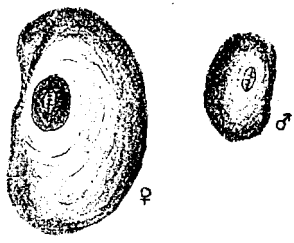


Fig. 190.—*Chionaspis americana* Johnson: Male and female scale, enlarged. Original.

Chionaspis furfurus Sign. *(The Scurfy Scale).*

This scale-insect is getting quite common in Minnesota, where it is sometimes found in large numbers on the branches of the apple tree. Fig. 188 shows both male and female scales, as well as the winged male. The female scale is oblong in form, pointed below, very flat, of a grayish-white color, and about one-tenth of an inch long. The male scale is very much smaller and narrower. The numerous eggs found during the winter under the female scale are red or reddish-brown, and hatch early in spring. Scales are shown also on Plate XIV, Fig. 188.

The same scale occurs also on the pear and the mountain ash.

Chionaspis salicis Linn. *(The Willow or Cottonwood Scale).*

The trunk and branches of our cottonwood and willow trees often present a whitened appearance, which on closer examination is seen to be due to the presence of innumerable very small, papery and snow-white scales. These scales are of two forms; the female scale is the larger one, and is usually more or less pear-shaped, with two small, oval, overlapping, cast skins at the apex; that of the male is oblong, and has three strongly marked ridges running lengthwise, while it possesses only one larval skin.

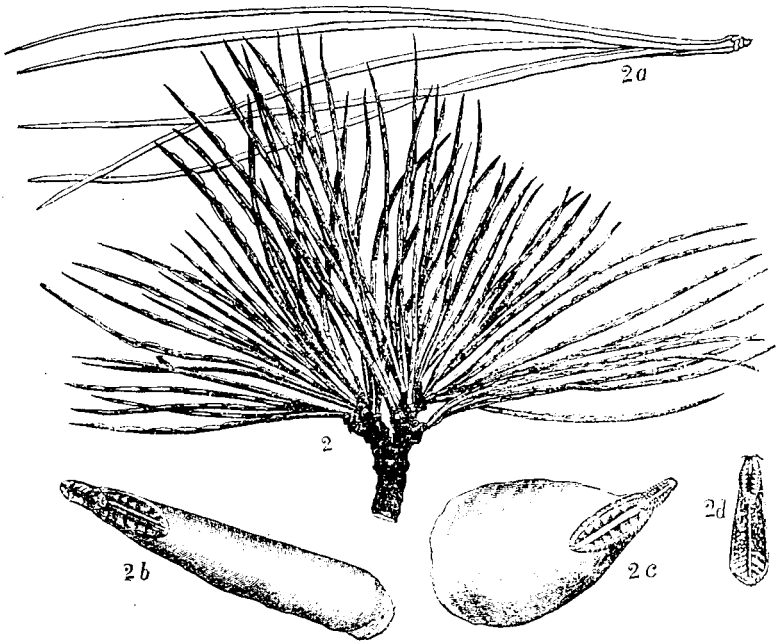


Fig. 191.—*Chionaspis pinifoliæ* Fitch: Infested leaf, male and female scale. After Comstock Div. of Entomology, Dep. of Agriculture.

The eggs are laid under the larger and pear-shaped scale, during the autumn. In depositing the eggs the body of the female gradually shrinks away until nothing is left but a mere skin at the apex of the scale. The eggs are purple in color, and very small; they hatch about the first of June into small, oval, flattened lice, which are very active, and quickly spread over the tree upon which they were born, and over such adjoining plants

of the same kind as come in contact with it. Fig. 189, Plate XV).

Chionaspis americana Johnson. *(The Elm-tree White-scale).*

Many of the fine elms in the vicinity of St. Paul and Minneapolis are infested with small white scales closely resembling those on the cottonwood, but less conspicuous, as the bark of the elm is spotted with white, and therefore better adapted to conceal them (Fig. 190). They are present on both the trunks and

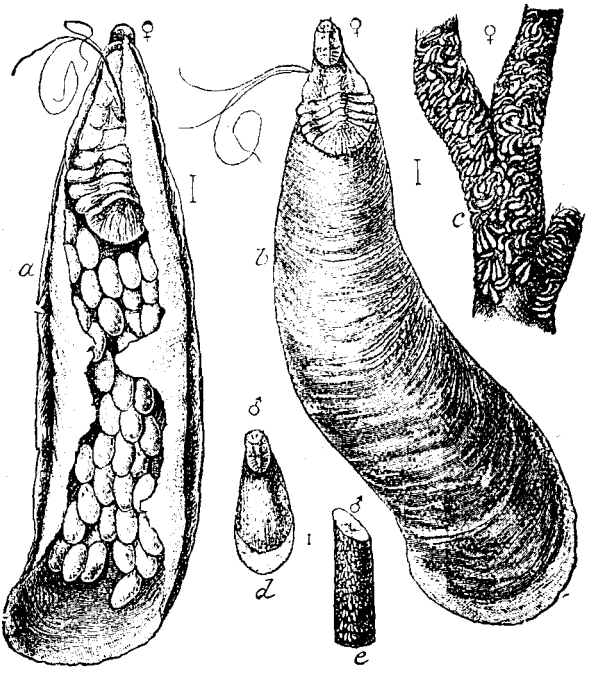


Fig. 192.—*Mytilaspis pomorum* Bouche: *a*, female scale, from beneath, filled with eggs; *b*, same from above; *c*, twig infested by female scales; *d*, male scale, and *e*, a twig infested therewith. After Div. of Entomology, Dep. of Agriculture.

twigs. The female scale is white and pear-shaped, while the male is smaller and more slender, and has a slight longitudinal ridge. This scale is not known to be destructive at present, but notice is given so that it may be recognized should it ever become so.

Chionaspis pinifoliæ Fitch. *(The White Pine-scale).*

This insect is also becoming very numerous, and in some places, especially upon pines growing in the yards as ornamental trees, they become decidedly injurious. The insect forms white scales upon the leaves of this tree, exhausting the sap, in consequence of which the foliage becomes sickly and yellow. The species is illustrated in Fig. 191.

To the genus *Mytilaspis* belong a number of very injurious scale-insects, one of which is described below.

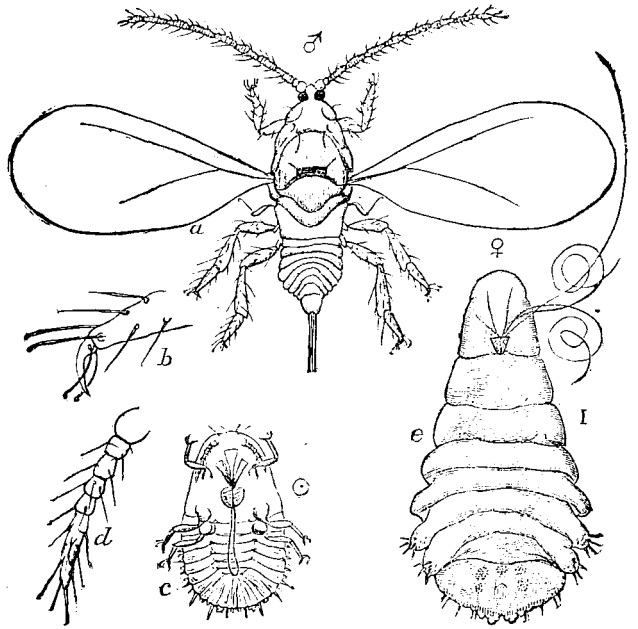


Fig. 192 a.—***Mytilaspis pomorum*** Bouche: *a*, male; *b*, its tarsus; *c*, young larva; *d*, its antenna; *e*, female—all greatly enlarged. After Div. of Entomology, Dep. of Agriculture.

Mytilaspis pomorum Bouche. *(The Oyster-shell Bark-louse of the Apple).*

This species is very destructive, and is rapidly spreading in our orchards, where it not alone injures the apple, but also a number of other trees. In one case it was found in such numbers upon the twigs of imported horse-chestnut trees, that it had caused their death. The insect well deserves the popular name it has received, since the shape of the scale resembles that of one

of the larger varieties of the oyster. The scale is about one-sixth of an inch long, of a brownish or grayish color, and so closely resembles that of the bark on which it occurs, that it is frequently overlooked when occurring in small numbers. It is a northern species, introduced from Europe nearly a hundred years ago, but it is now found almost everywhere in apple orchards, and also in some nurseries. The species is single-brooded, but further south two generations are produced. The eggs are deposited during autumn, and are found below the female scale, where they winter, in large numbers. Towards the middle of May the white eggs change to a yellowish hue before hatching, and give forth the active yellow larvæ, which, after

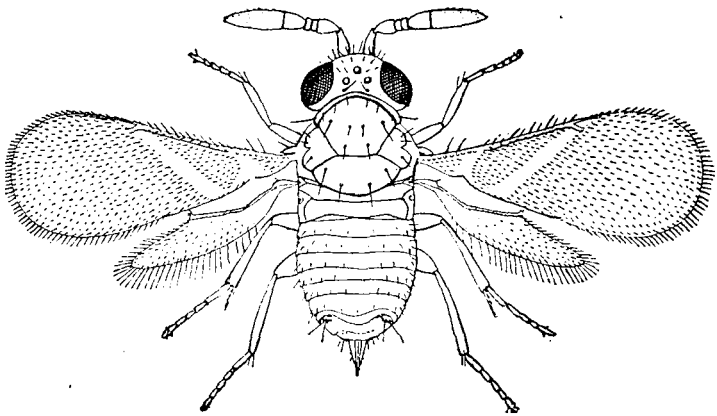


Fig. 193.—Parasite of San Jose Scale. After Div. of Entomology, Dep. of Agriculture.

running about for a short time, settle, and inserting their beaks draw nourishment from the trees. As we find from twenty to one-hundred or more eggs under each scale the branches of the apple tree soon become literally covered and crowded with scales, and they seriously impair the health and vigor of a tree thus infested. The leaves, even the young apples themselves, are also invaded and injured. The larvæ, after becoming fixed, continue to grow in the usual manner until after the midsummer. As may be seen from the illustration (Fig. 192) and on Plates XIV and XVI, the sexes are quite different. The male mature late in July or August, seek the females, and then die. A little

later the females deposit their tiny eggs, which fill all the space beneath the protecting scale.

Remedies.

A number of remedies against scale-insects have already been given, and it is only necessary to make some general remarks. It should be remembered that insects so well covered with waxy scales, cottony matter, or some powdery material, are not so easily reached by insecticides as the plant-lice. In many cases liquids will run off so quickly that they do not remain in contact with the scales long enough to do any effective work. For this reason we must apply insecticides, which remain in

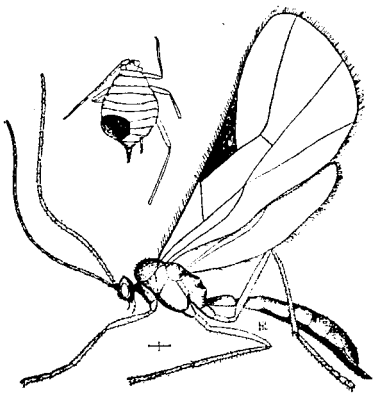


Fig. 194.—Parasite of Grain-louse. Adult and infested louse, showing hole through which the parasite escaped. After Smith.

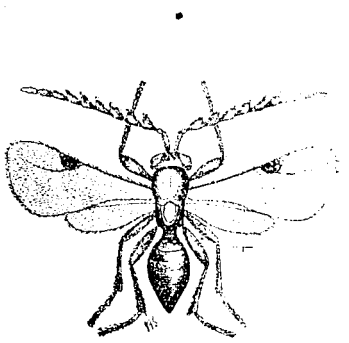


Fig. 195.—Another parasite of the Grain-louse. After Smith.

actual contact for some time, and for this reason kerosene emulsion and whale-oil soap are most excellent. When we have to deal with very smooth scales the whale- or fish-oil soap solutions are best. If possible, radical winter treatment is best. But there is a period in the life-history of all these scale-insects when the young insects are as yet not covered with a protecting substance, but are actively running about searching for a place on the infested plant upon which to fasten themselves. If during this period we apply kerosene emulsion diluted not more than five times with water or soap-suds, we can kill the majority of these still small and weak beings.

Enemies of Plant-lice and Scale-insects.

These two families of insects, notwithstanding that they can multiply so rapidly, do not have everything their own way. A large number of beneficial insects seem to make it their life-work to destroy them. Besides true parasites belonging to the order of wasps (Hymenoptera), some of which are illustrated in Figs. 193, 194, 195, which feed inside their tiny hosts, there are numerous cannibal insects which destroy immense numbers. Chief among these cannibals are the very useful lady-bugs. Some of

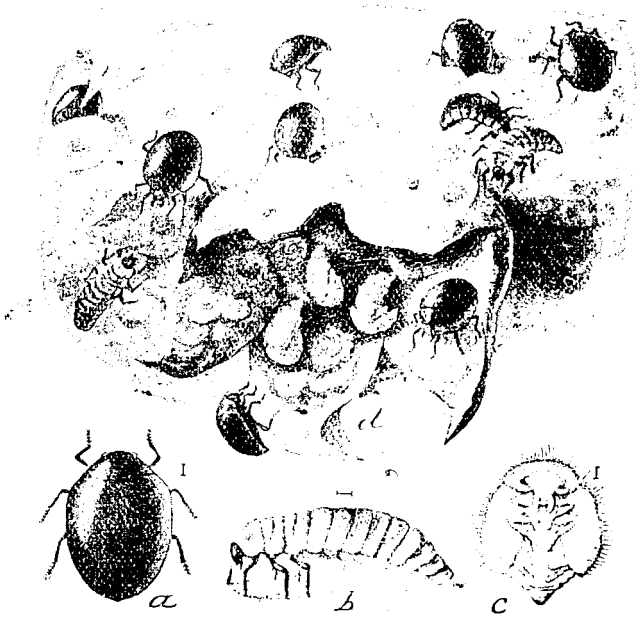


Fig. 196.—Small lady-bugs eating San Jose Scale. After Div. of Entomology, Dep. of Agriculture.

which have been illustrated in Figs. 196, 197. These beetles, both in their larval and adult stage, feed almost exclusively upon plant-lice and scale-insects, and if these injurious beings are not too numerous they are soon decimated or reduced to such an extent as to become harmless. If it is seen that lady-bugs are found in large numbers among the lice and scales upon the infested trees it is frequently best not to apply insecticides at all, otherwise we are apt to injure our friends.

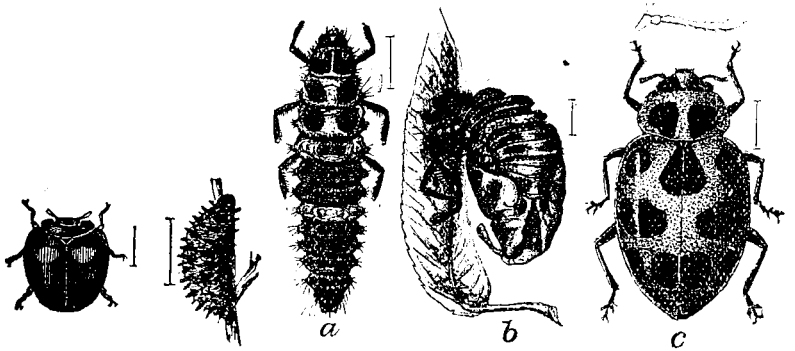


Fig. 197.—Lady-bugs. To the left the Twice-stabbed lady bug and its lava; *a*, larva, *b*, pupa; *c*, adult of another species. After Div. of Entomology, Dep. of Agriculture.

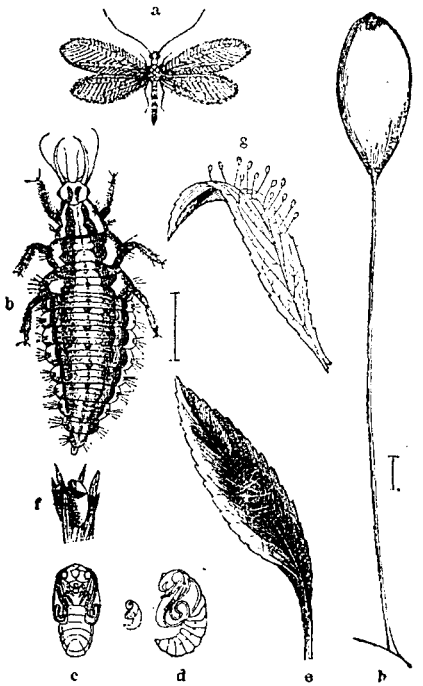


FIG. 198—*Chrysopa* species. After Brehm.

Fig. 199.—Lice-eating flies and their early stages. After Brehm.

The different kinds of lace-wings (Fig. 198) are also so fond of such food that they always congregate upon infested trees, where their larvæ, well equipped for their murderous work, make havoc, especially among the plant-lice.

Among flies we also possess a large number of very useful insects. Some of them are shown in Figs. 199, 200. In this case the larvæ are the active cannibals, eating immense numbers of the defenseless lice.

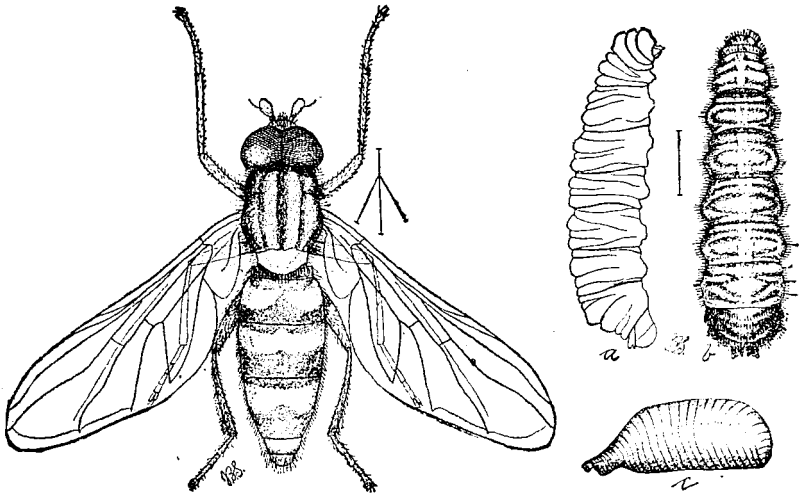


Fig. 200.—Syrphus-fly destroying grain-louse: Adult Fly; *a*, larva from side, showing the wrinkled appearance; *b*, from above; *c*, pupa. After Smith.

Many other beings, such as spiders and mites are not slow to utilize such food as plant-lice and scale insects.

Among birds we have also a large number of friends, which eat both the adult insects as well as their eggs. It is a pleasure to watch in midwinter the active tit mouse, running up or down the trunks of trees, investigating every crack in the branches as well, to discover the minute winter-eggs of lice and other insects hidden in such places. It is a pity that such useful beings do not receive the protection they so well deserve. It is a good thing for fruit-growers and farmers that these and other useful birds bring up their families so far north that boys with slings, or would-be-sportsmen with their deadly guns, can not destroy these

birds entirely. It is a crime to kill simply to show how good a person can shoot!

In some cases contagious diseases come to our assistance and carry off large numbers of such destructive insects. As all the plant-lice and most of the scale-insects produce a sweet-liquid, the honey-dew, many other insects are invited; but most of them feed only upon this sweetness, not upon the insects themselves, hence are not beneficial. In fact some, like the almost omnipresent ants even protect the plant-lice. Being always present to obtain honey-dew, the ants are of some assistance by showing us that a tree is infested and that it is time for the owner to investigate matters and to apply the remedies.

True Bugs. After Brehm.


KISSING
BUGS
IMMUNES

INDEX.

PLATE I.

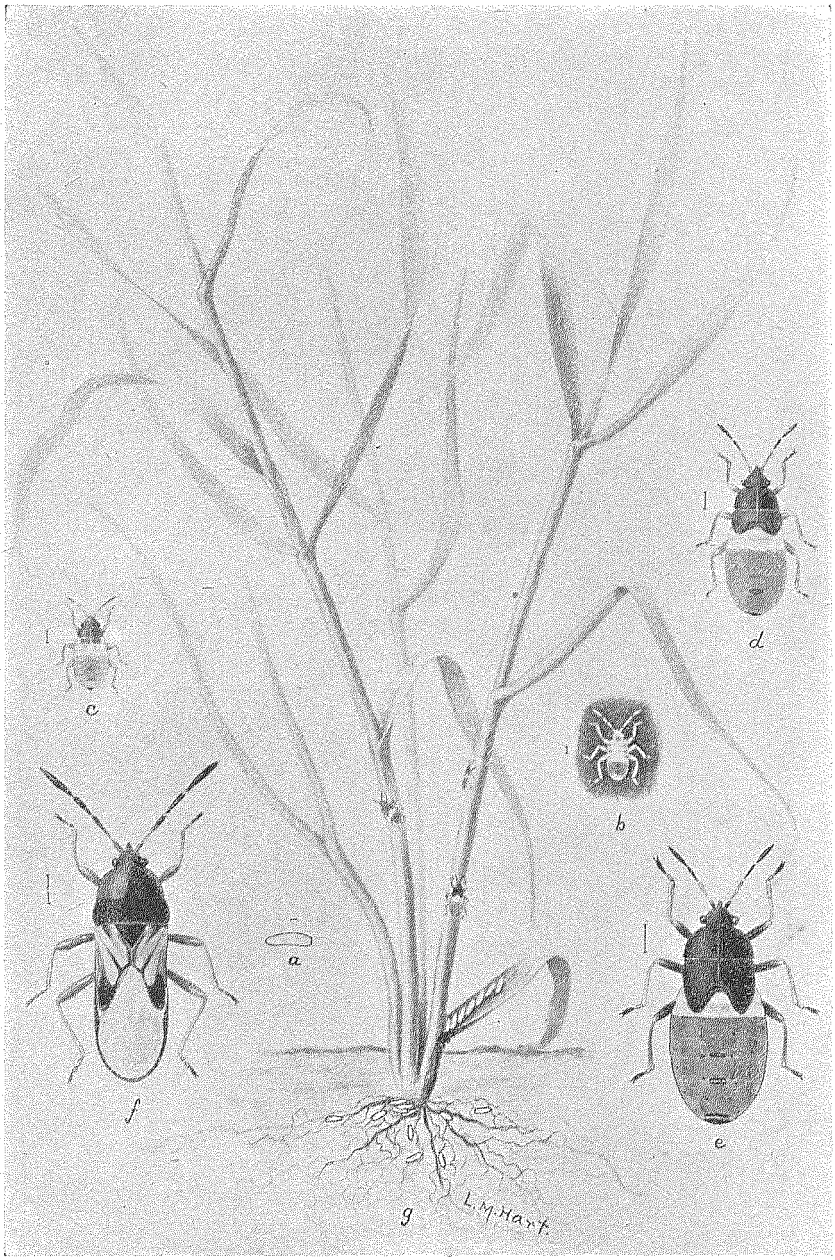


FIG. 63.—*Blissus leucopterus* Say. (Chinch-bug). All stages, enlarged and natural size; *a*, egg; *b*, *c*, *d*, *e*, young stages; *f*, adult. Original.

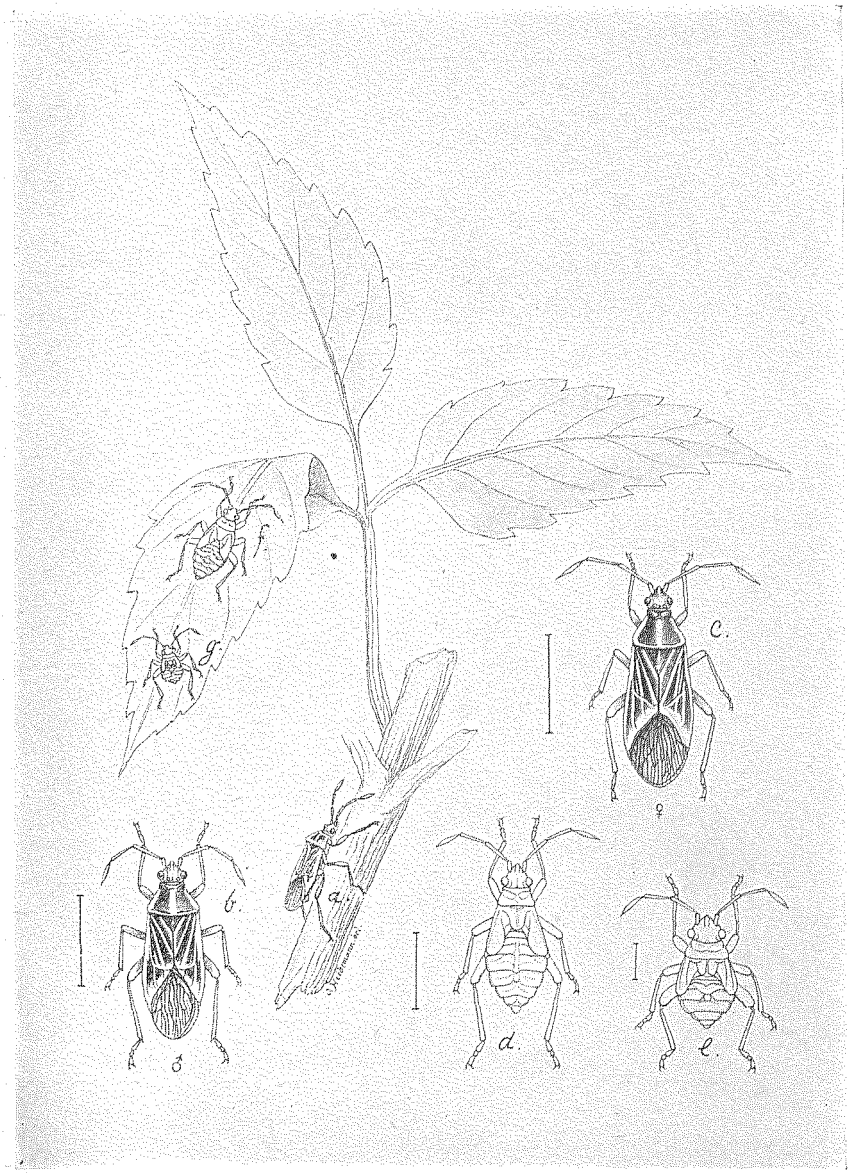


FIG. 66.—*Leptocoris trivittatus* Say. (Boxelder Bug). Enlarged and natural size; *a*, adult; *b*, male; *c*, female; *d*, *e*, *f*, *g*, young stages. Original.

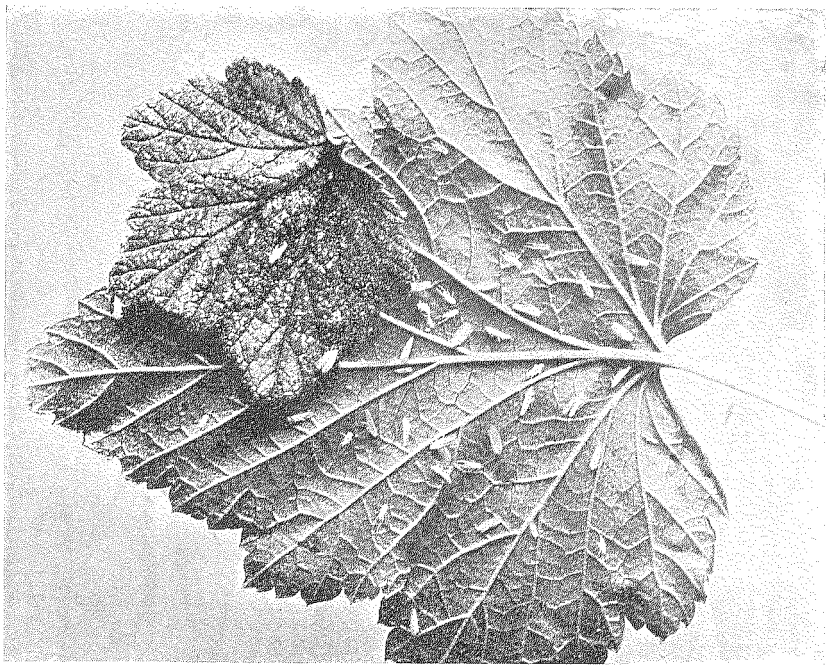


FIG. 123.—Currant leaf infested with *Empoasca albopicta*, Walsh. Original.

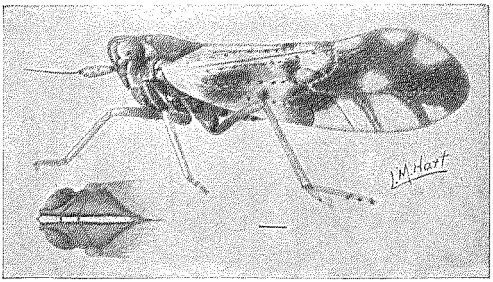


FIG. 112.—*Liburnia ornata* Stal. After Forbes.

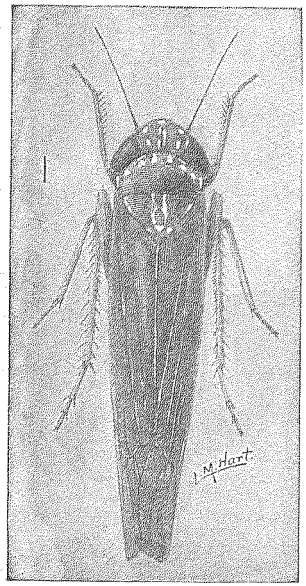


FIG. 122.—*Empoasca mali*, LeB. After Forbes.

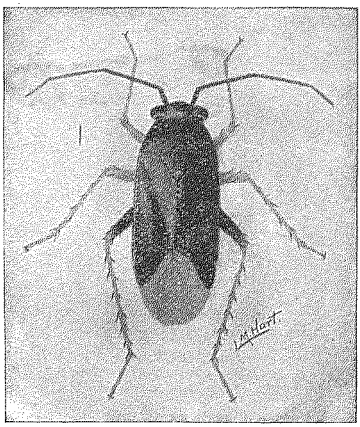


FIG. 51.—*Agalliastes associatus*, Uhl. After Forbes.

PLATE IV.

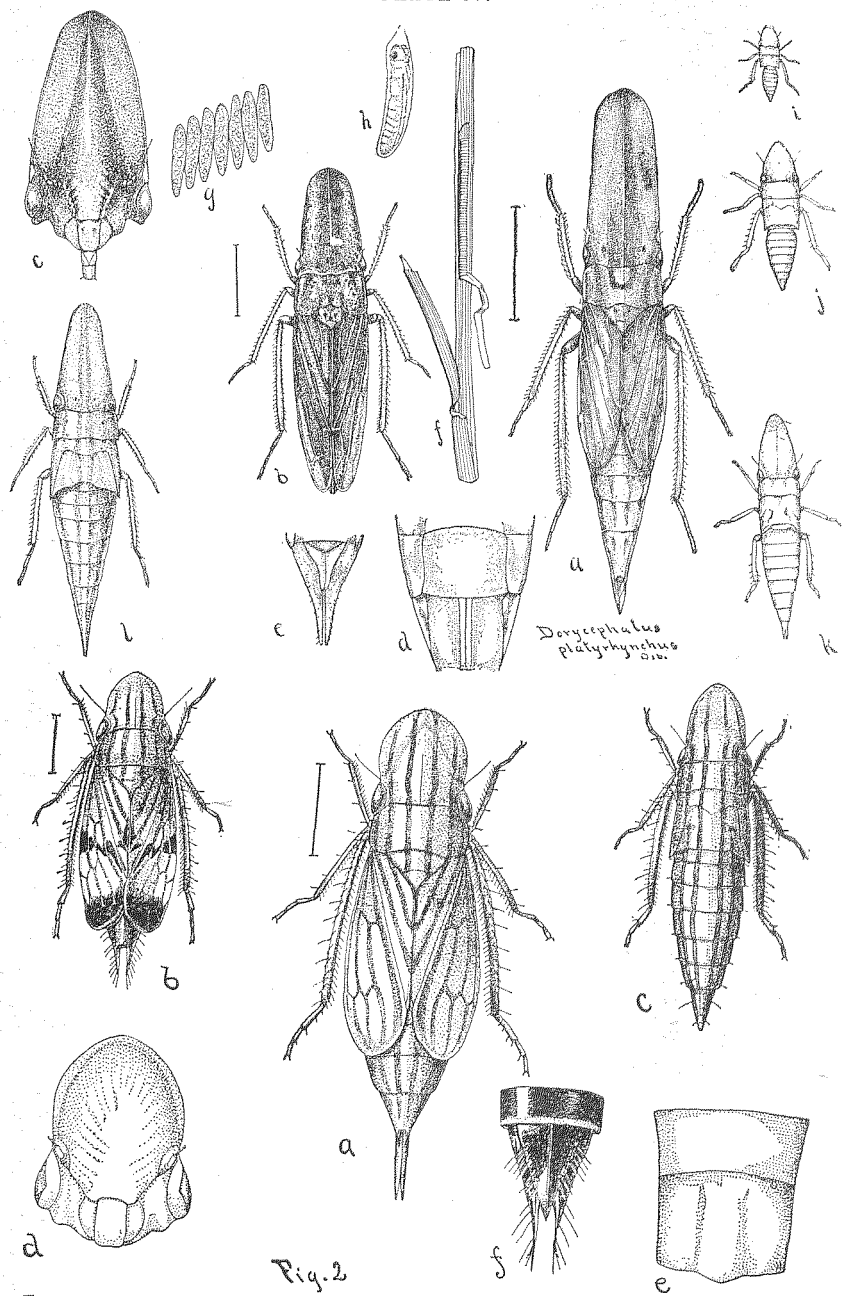


FIG. 1.—*Dorycephalus platyrhynchus* Osb.; male, female, eggs, larva and structural details. After Osborn.

FIG. 2.—*Hecalus lineatus* Uhl.; male, female and larva. After Osborn.

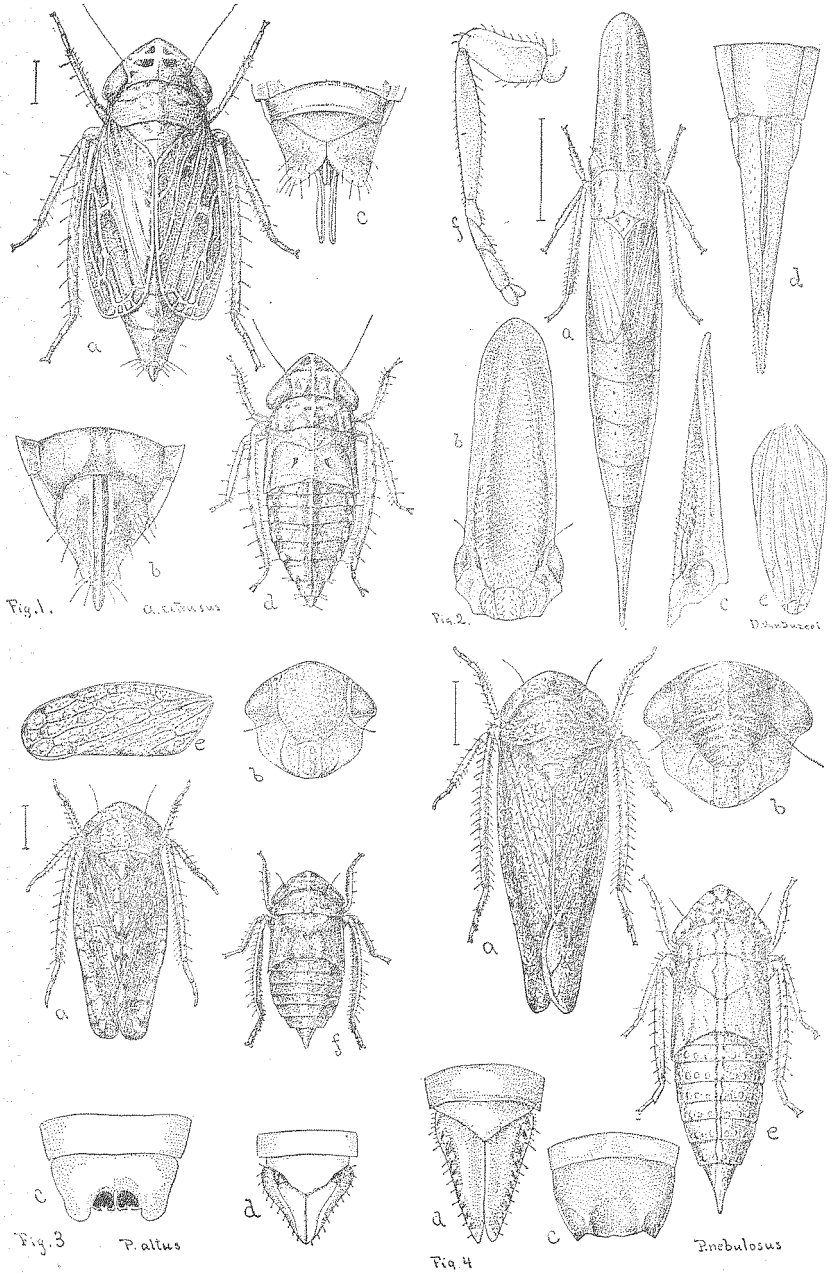


FIG. 1.—*Athysanus extrusus* Van D. After Osborn.
FIG. 2.—*Dorycephalus vanduzei* Osb. & Ball. After Osborn.
FIG. 3.—*Phlepsius altus* Osb. & Ball. After Osborn.
FIG. 4.—*Phlepsius nebulosus* Van D. After Osborn.

PLATE VI.

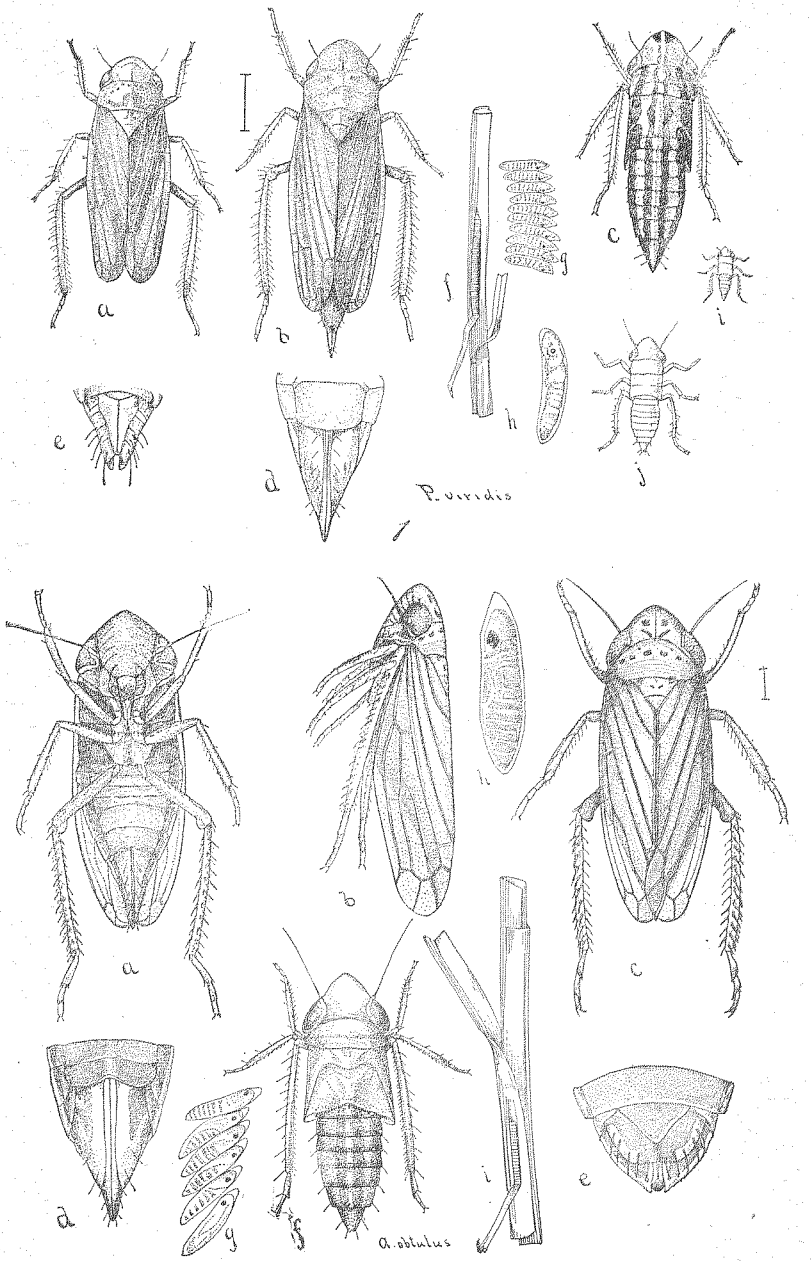


FIG. 1.—*Parabolocrates viridus* Uhl. After Osborn.
FIG. 2.—*Athysanus obtutus* Van D. After Osborn.

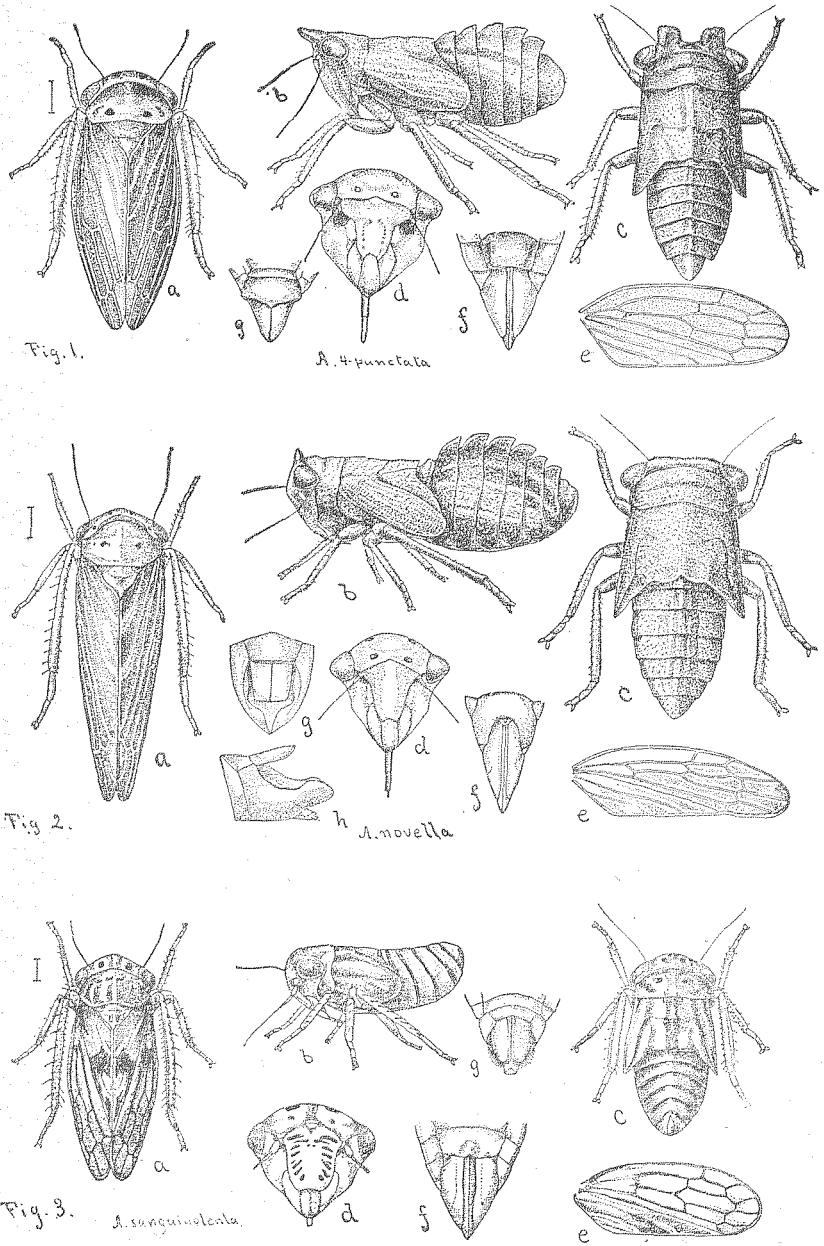


FIG. 1.—*Agallia 4-punctata.* After Osborn.
FIG. 2.—*Agallia novella.* After Osborn.
FIG. 3.—*Agallia sanguinolenta.* After Osborn.

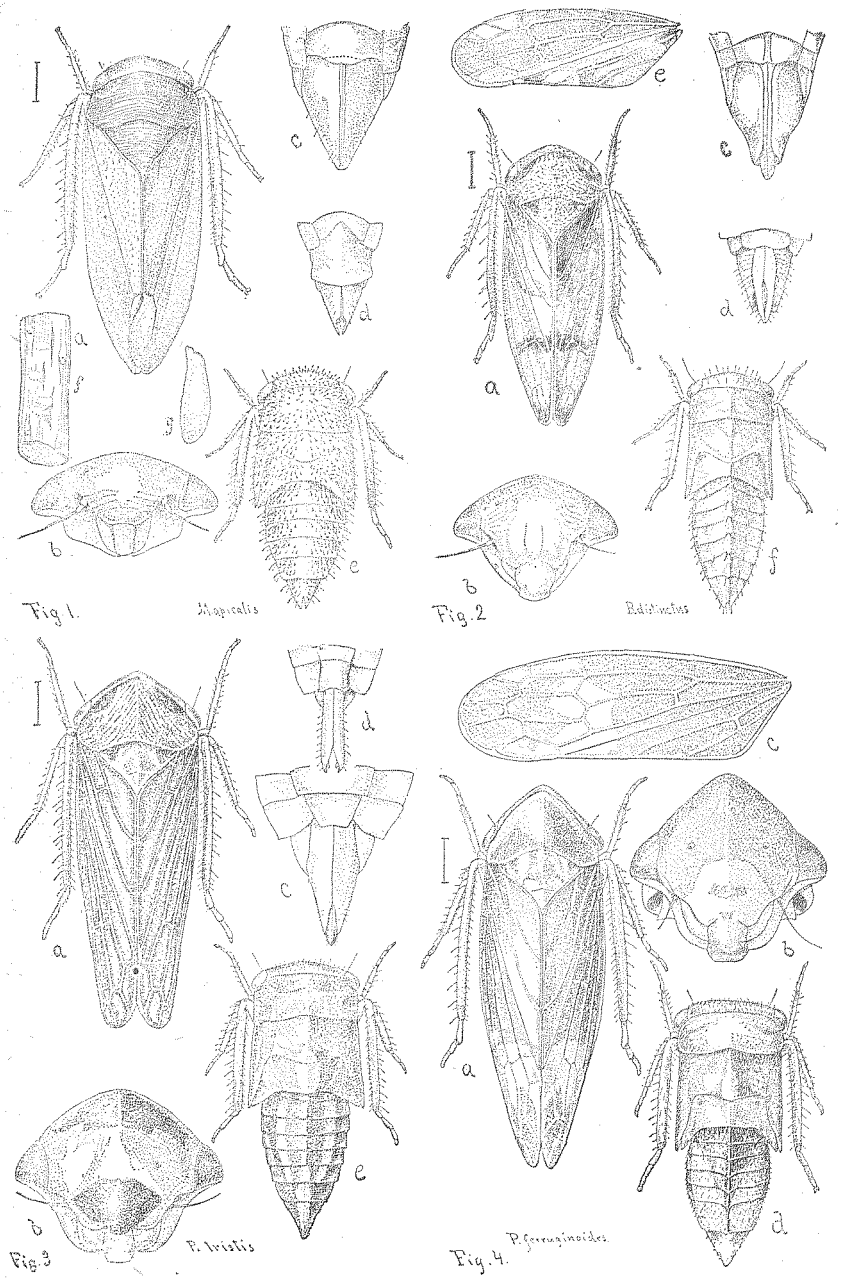


FIG. 1.—*Macropsis apicalis* Osb. & Ball. After Osborn.
FIG. 2.—*Bythoscopus distinctus* Van. D. After Osborn.
FIG. 3 —*Pediopsis tristis* Van D. After Osborn.
FIG 4.—*Pediopsis ferruginoides* Van D. After Osborn.

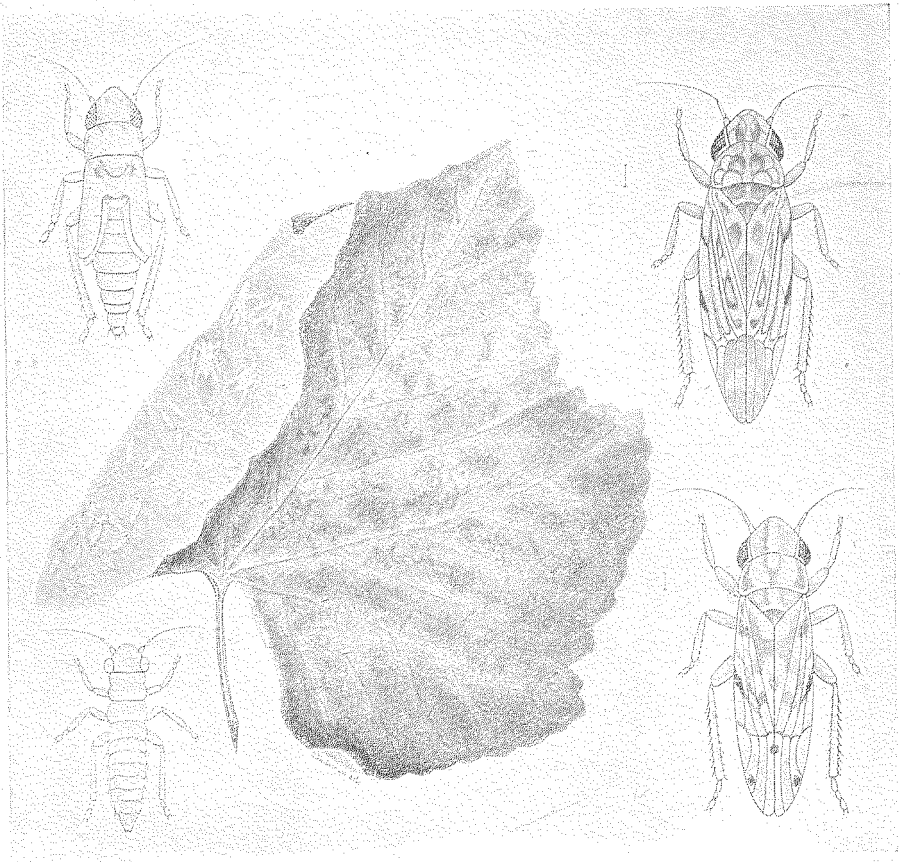


FIG. 124.—Grape vine leaf infested with *Typhlocyba* species. Original.

FIG. 134.—Currant leaves infested with plant-lice. Original.

PLATE X.

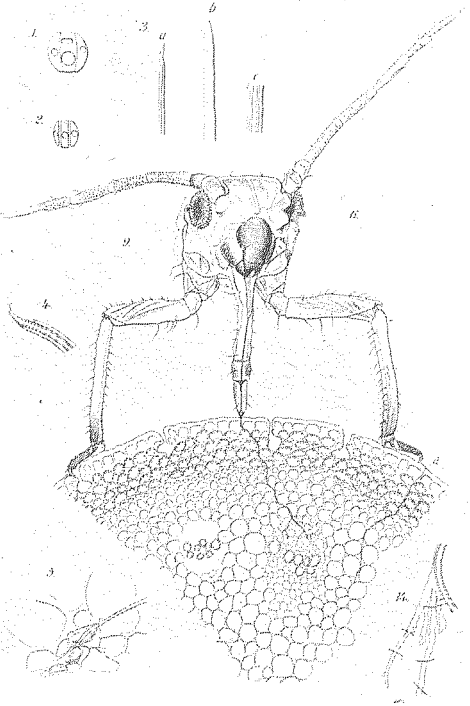


FIG 136.—Plant-louse in the act of sucking.

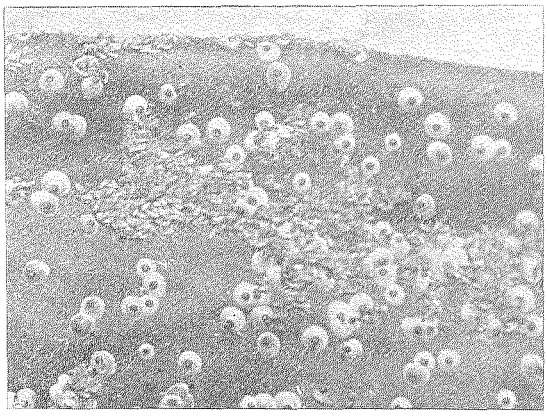


FIG. 187.—*Diaspis cacti* Comst. Original.

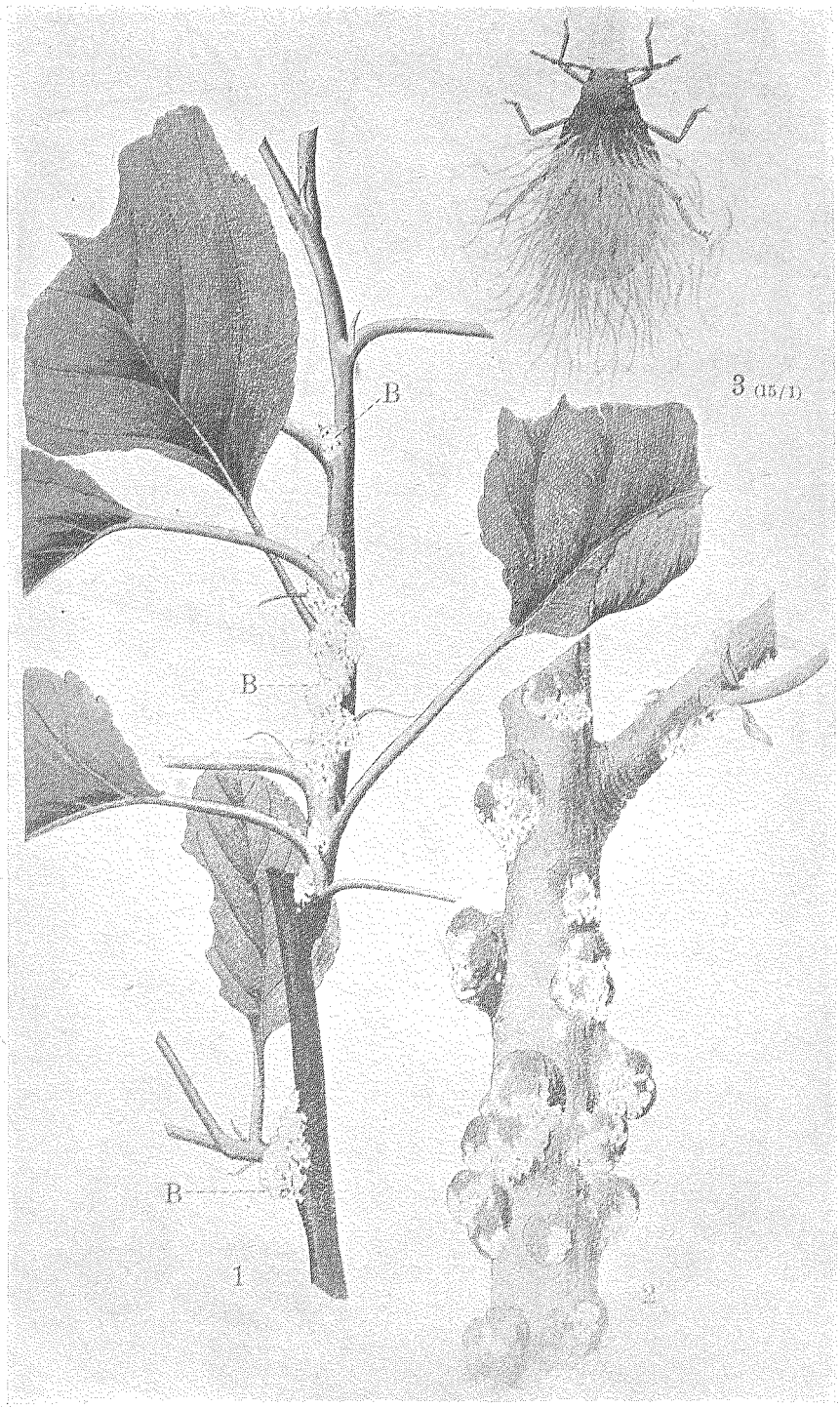


FIG. 148.—*Schizoneura lanigera* Hausm. After Kirchner and Boltshauser.

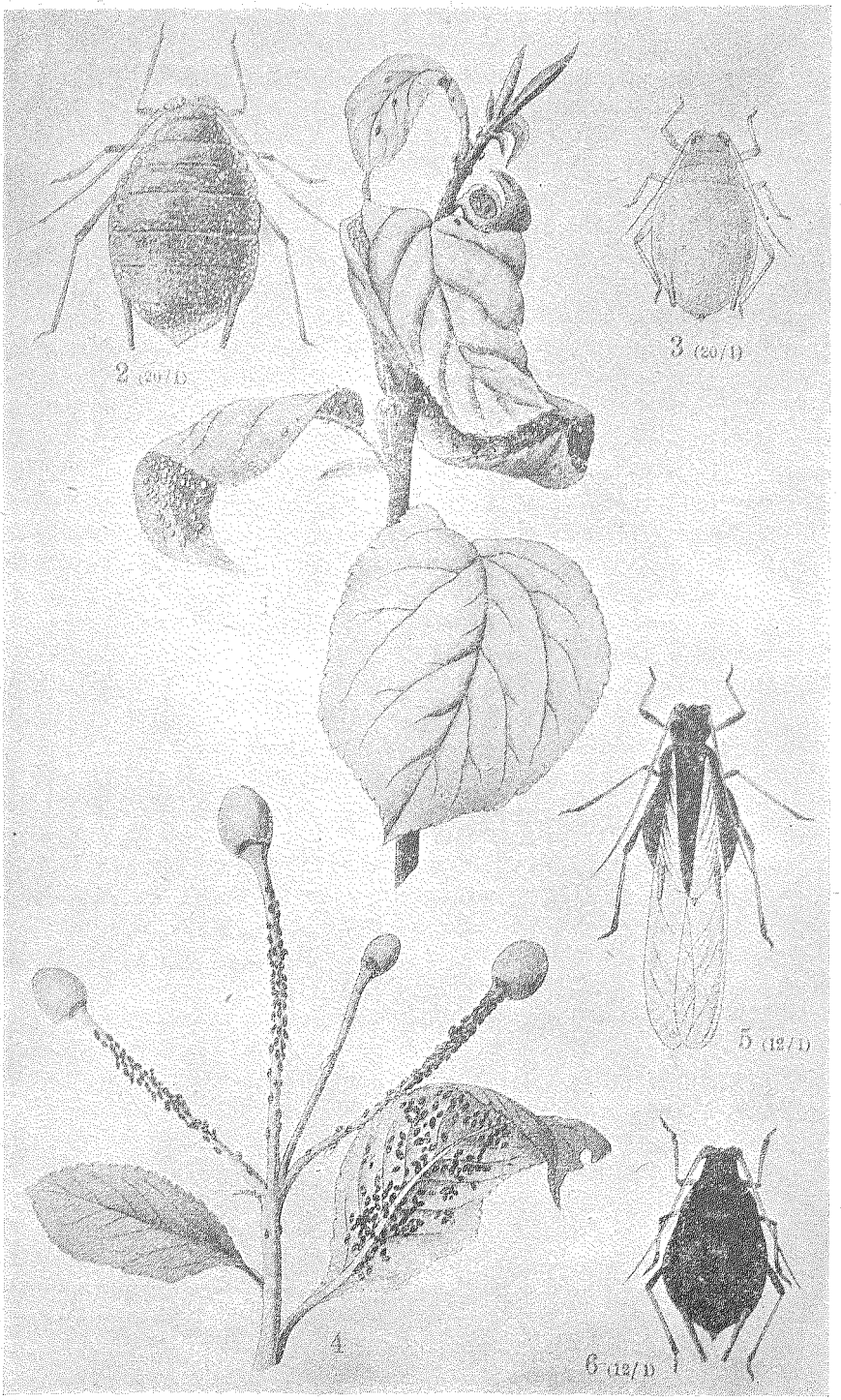


FIG. 156.—*Aphis sorbi* Kalt. (1, 2, 3.) infesting apple. *A. cerasi* Fb. (4, 5, 6,) infesting cherry. After Kirchner & Boltshauser.

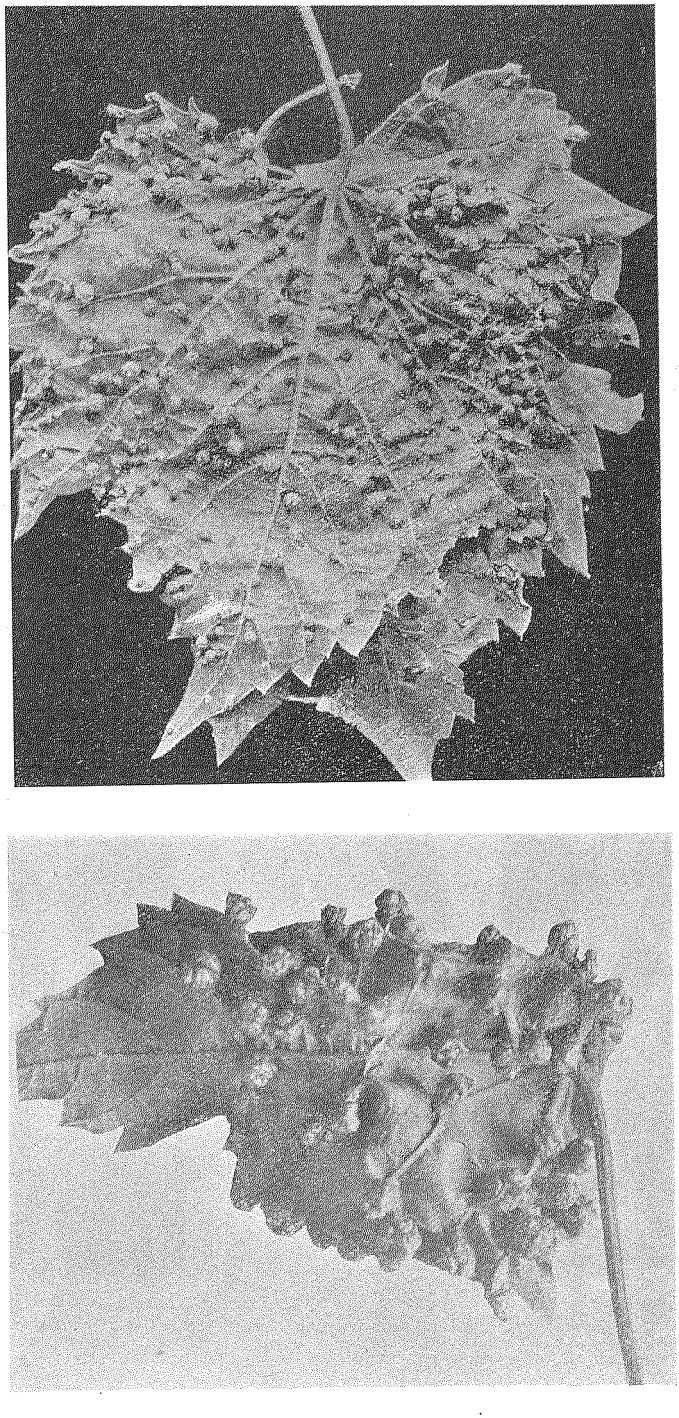
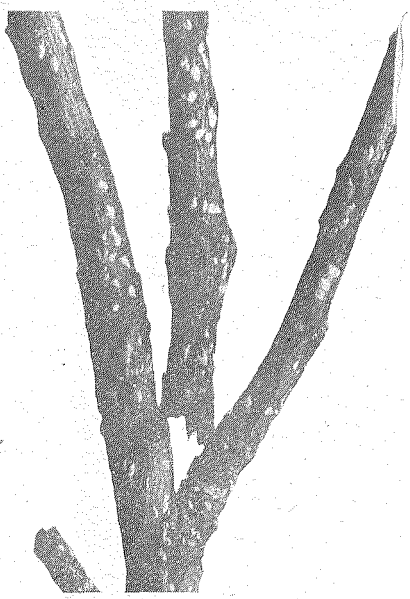
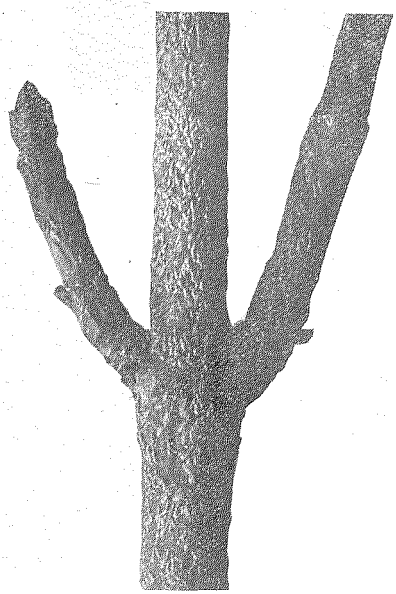


FIG. 143.—Galls made by *Phylloxera vastatrix* Planch Original.

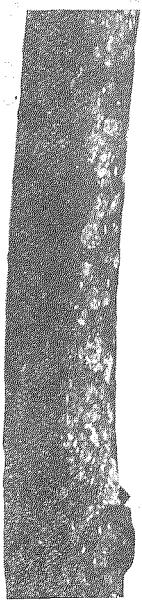


188

179.

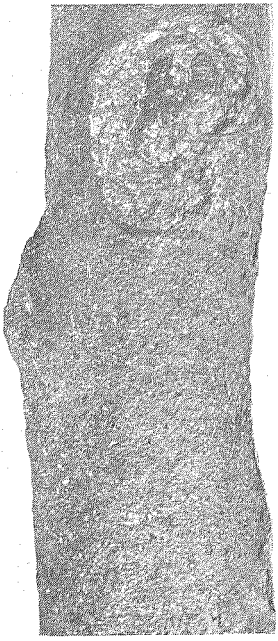


192.

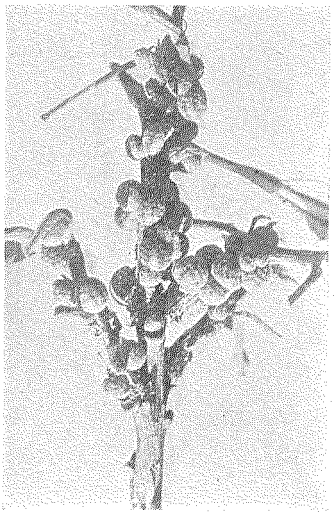


186.

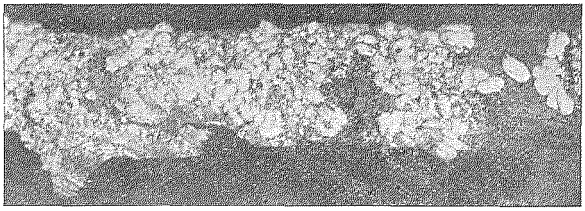
FIG. 179.—*Lecanium* scales on elm. Original. FIG. 186.—*Diaspis rosæ* on rose, Original. FIG. 188.—*Chionaspis furfurus* on apple. Original. FIG. 192.—*Mytilaspis pomorum* on horse-chestnut. Original.



185.

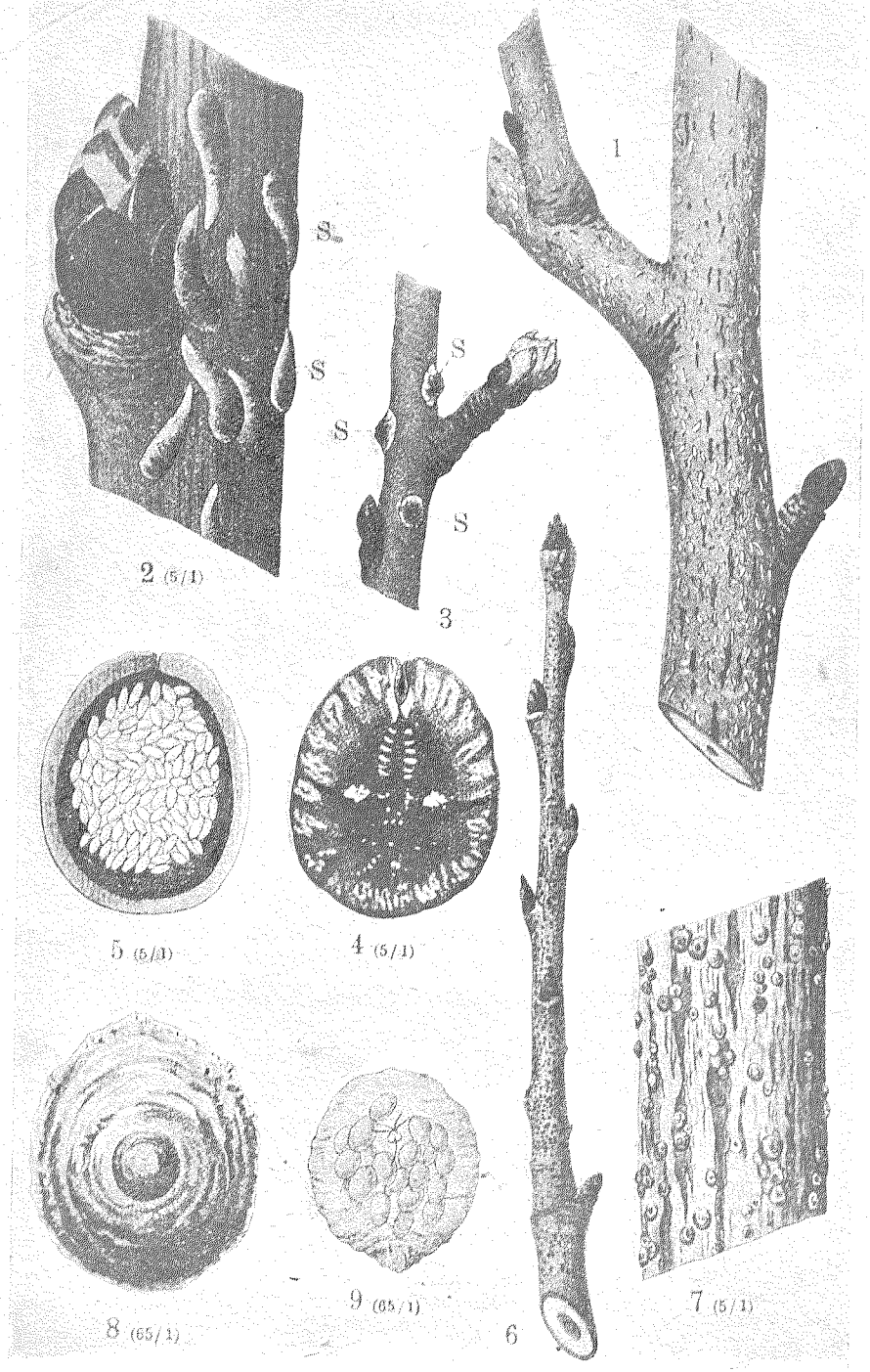


175.



189.

FIG. 175.—*Kermes* on oak. Original.
FIG. 185.—*Aspidiotus perniciosus* Comst. Original.
FIG. 189.—*Chionaspis salicis* Linn. Original.



Mytilaspis pomorum Bouche: 1, twig of apple with scales, natural size; 2, scales enlarged 5 times. *Lecanium mali* Schrank: 3, natural size; 4, enlarged 5 times from above; 5, the same showing eggs, from below. *Aspidiotes perniciosus* Comst.: 6, on twig of pear, natural size; 7, enlarged 5 times; 8, scales from above, enlarged 65 times; 9, female without scale, enlarged 65times. After Kirchner and Boltshauer.