## SILKWORMS.

[Compiled from the "Fourth Annual Report," by Charles F. Riley, State Entomologist of Missouri.]

Silk is at once the strongest and most tenacious of fibers, and makes the most beautiful, durable, and valuable of tissues. What gold is to metals, or the diamond to precious stones, that silk is to all other textile fibers.

Though we may not, at present, be able to compete, in their own markets, with the cheaper labor of parts of Europe and Asia, there is no reason why, with proper intelligence, we may not produce our own silk as cheaply as it can be brought here from those countries; and I am convinced that, should we ever be cut off by war from those countries on which we rely for our present silk supply, we can easily fall back on our own resources. Even now, there is no reason why the young people, and those unable to do harder work, in thousands of families, should not spend a few weeks each year in the pleasant work of producing cocoons.

Of the eight species which will be treated of, four, namely, *mori*, *cynthia*, *yamamai*, and *Pernyi*, are of foreign origin; and the other four, namely, *Cecropia*, *Promethea*, *Luna*, and *Polyphemus*, are native. When newly hatched, all of them, even to the mulberry species, are, in form and structure, exactly alike; and they differentiate more and more as they increase in size, until each acquires its specific characters.

All these silkworms cast their skin four times during the feeding period, and thus have five different stages of growth; the worm resting and fasting from one to three days, then gradually working off the old skin, and afterwards knocking off the head.

They all, when in the cocoon, are furnished with an acrid or bombycic fluid, with which they weaken the resisting force of their cocoons, and facilitate the exit of the moth; though those which make rounded or closed cocoons are much more amply suppl ed than those which form pointed or open ones.

All the cocoons, whether pointed or rounded, are spun in one continuous thread. In issuing, the moths of all of them rupture, more or less, the threads of the cocoon, thus rendering it valueless for reeling. Many writers assert to the contrary; but I have examined no deserted cocoon which has not shown some broken threads, and have witnessed the threads break during the emergence of the moth. Such as are naturally open are broken less than the others; but if only a half dozen threads are sundered, the cocoon is spoiled for reeling purposes. All the native cocoons are at times found drilled with large holes, and gutted by birds or squirrels; and those which fall to the ground are frequently destroyed by mice, rats, and moles.

In manufacturing silk, the cocoons are subjected to steam or to heat in order to destroy the vitality of the chrysalis, which would otherwise bore out and break the silk.

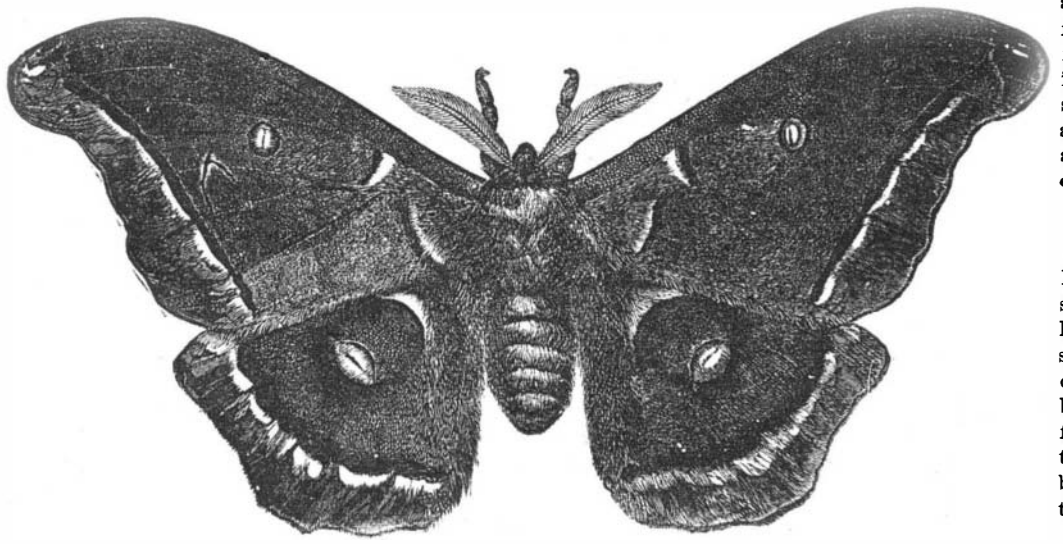
All the moths are night flyers. All the large heavy worms, when full grown and in a state of nature, hang on the under side of leaves and twigs, being too heavy to sustain themselves in an upright position. They are all of some shade of green—no matter what their color when younger—and in a measure similate the leaves of their food tree, so as to render detection difficult.

It is a little singular that the principal trees which may be used for producing the best silk, namely, the mulberry, osage orange, and ailanthus, are all three of them remarkably free from the attacks of other insects.

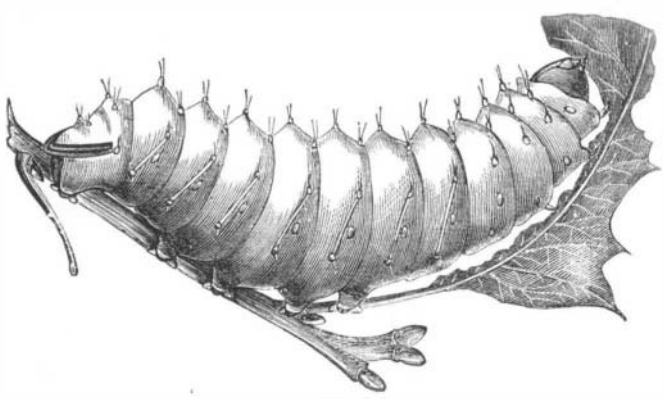
By judicious breeding and selection, I believe that the native worms may be improved in their silk-producing qualities, and that the foreign ones may be acclimatized and better adapted to our conditions.

THE POLYPHEMUS SILKWORM—*Attacus* [*Telea*] *Polyphemus*, LINN.—(*Lepidoptera, Bombycidæ.*)

This insect has been styled, with much justice, "the American silkworm" by Mr. L. Trouvelot, of Medford, Mass. That gentleman made a series of very interesting experiments in rearing the worm in large quantities in the open air, and in 1865 he had not less than a million feeding upon bushes covered with a net. An interesting account of these experiments, but more especially of the natural history of the species, may be found in the first three numbers of that excellent periodical, the *American Naturalist*.



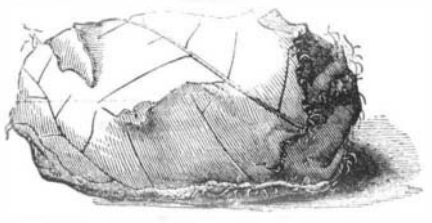
POLYPHEMUS MOTH, MALE.



THE POLYPHEMUS SILKWORM.

The eggs of *Polyphemus* are deposited singly, or in twos or threes, on the under side of a leaf or upon a twig. They are whitish, inclining to flesh color on the top and bottom, and encircled on the sides by a characteristic broad band of amber brown, which is the natural coloring of the egg shell and distinct from the brown fluid which is secreted with them and fastens them to whatever object they are consigned. This brown band has a narrow pale spot at the two smaller ends. The moths issue with us the latter part of April or in May, and the female commences depositing very soon afterwards. The eggs hatch in about ten days after deposition.

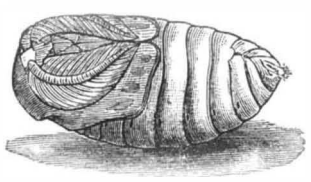
The worm feeds on oak, walnut, hickory, basswood (*Pilia*), elm, maple, hazel, apple, rose, quince, thorn, plum, choke cherry, sycamore, poplar, birch, honey locust, blueberry, and willow, on the first nine of which I have found it myself. When full grown, it is a most delicate and beautiful object, being of a clear apple green color, with oblique yellow lateral lines, and tubercles tinseled with orange, gold, and silver. The head, spiracles, legs, and ends of prolegs are of a buff yellow, the front edge of the first joint sulphur yellow, and the edges of the anal shield purple.



COCOON OF THE POLYPHEMUS SILKWORM.

The cocoon is formed of strong silk which, when unwound, has a glossy fiber. It is oval and closed at both ends, dense and generally fastened to a leaf or leaves, with which it falls to the ground, though sometimes it is fastened to twigs and therefore remains exposed, during the winter, to its enemies. The exit of the moth has been well described by Mr. Trouvelot:

"The moth is provided with two glands opening into the mouth, which secrete, during the last few days of the pupa state, a fluid which is a dissolvent for the gum so firmly uniting the fibers of the cocoon. This liquid is composed in great part of the bombycic acid. When the insect has accomplished the work of transformation which is going on under the pupa skin, it manifests a great activity, and soon the chrysalis covering bursts open longitudinally upon the thorax; the head and legs are soon disengaged, and the acid fluid flows from the mouth, wetting the inside of the cocoon. The process of exclusion from the cocoon lasts for as much as half an hour."



CHRYSALIS COVERING OF THE POLYPHEMUS SILKWORM.

The moth is of a dull ocher yellow, shaded more or less distinctly with innumerable black particles, and with a broad gray band along the front, or costal edge, and passing over the thorax. There is a darker, reddish brown shade across the middle of the wings, and near this shade on each wing is a transparent eye-like spot, divided by a slender opaque line, and margined by a yellow and a black ring, the last much broader on the hind than on the front wings, being there widened on the inside into a large black spot with the part adjoining the eye-spot blueish white. Near the hind margin of each wing is a dusky band (blueish on the front ones), edged with pink white behind: and near the base of the front wings is a zig zag crimson line, edged inside with white. There is a great variation in the colors of this insect, dependent in some measure no doubt, on the food of the larva. Specimens occur which have the general tint either very dark or very pale; either brown, smoky yellow, cream color, rust red, or greenish; while the large black spot on the hind wings is sometimes replaced by rust red.

The male is easily distinguished from the female by his smaller abdomen and very broad antennæ, which are, in fact, broader than represented in the annexed figure, as they have been known to spread nearly half an inch. They have actually been mistaken for a third pair of wings by inexperienced persons.

The principal difficulty in the way of reeling the cocoon of *Polyphemus* is the hard matter which binds it; but it is not an insurmountable one, and the cocoon could no doubt be improved by a proper process of continued selection. The silk is strong and lustrous.

As with some of the other species already mentioned, two broods of this insect are frequently produced each year in this latitude, though it normally appears to be single brooded in the more northern States. In the South it is always double brooded, the first moths issuing about the middle of February in Louisiana. If it is ever grown for silk, the South will be the most favorable part of the country, for it often abounds in New Orleans in such numbers, on sycamore, elm and live oak, especially the latter as to be easily gathered by bushels.

### Locomotive Boilers.

During the recent meeting of the Master Mechanic's Association, the subject of boiler construction for locomotives received earnest discussion. The merits of the plain circular boiler and the wagon top boiler were also examined. The form consists in a swell or elevation of the boiler above the fire box. On this and other features, the *Railroad Gazette* observes:

The location of the domes, too, is an element which must be taken into consideration. If there is but one, and it is located over the fire box, where the ebullition is most violent, there must necessarily be more steam room, to prevent the water being carried into the steam pipe, than would be required if the dome were over the tubes. The variation of water level due to the inclination of the track and the surging of the water will be greatest at the ends of the boiler and least in the center.

On merely theoretical grounds, therefore, it seems probable that the steam taken from a dome located in the center of the boiler would be drier than if taken from a point over the fire box, and this would seem to indicate that the evils complained of in straight top boilers are to a very great extent due to the fact of taking steam from a dome over the fire box instead of the center of the boiler. Now if we keep carefully in mind the importance of comparing the weights instead of the d mensions of boilers, and then remember that one with a straight top of a larger diameter will weigh no more than a wagon top boiler of a smaller size, we will see that, with the dome located in the center, the straight top boiler has an advantage over the other. The question thus becomes: whether steam taken from a dome located in the center of a boiler of larger diameter will be drier than if taken from one over the fire box of a boiler of smaller diameter with a wagon top. The advantage claimed for wagon top boilers of greater steam room and water capacity is gained equally well by the enlargement of the diameter of the straight boiler. The distribution of weight on the driving wheels, it must be admitted, with the present arrangement of boiler and engine is in favor of the wagon top, and locating the dome in the center increases the disadvantage in this respect of the straight boiler. It is also claimed that the wagon top gives more room, and consequently, makes the crown bars, crown sheet and braces more easy of access when they need repair or cleansing. The former advantage, we believe, could be more fully realized by a different arrangement of boiler, of which we will speak at some future time, and the latter by a different construction of crown sheet and braces. In this connection, it might not be unwise to observe that in European practice wagon top boilers are now almost unknown, and domes, or their equivalent, are almost always located on the centers of the boilers.

In considering the subject of locomotive boiler construction, we should never forget, what is now, we believe, generally admitted, that the larger the boiler, the more economically will it consume its fuel. For this there seem to be two reasons; first, the combustion is slower, and consequently more perfect, and the flames and smoke are thus in contact with the heated surface a longer time, and therefore impart more of their heat to the water; second, the water capacity of a large boiler being greater than of a small one, there is more hot water stored up for use when the maximum power of the engines must be exercised, and therefore the fire need not be forced so much as it wou'd be if it were necessary to generate all the steam consumed at such times as fast as it is used.

HOW TO DESTROY THISTLES.—While giving botanical evidence in somethistle prosecutions, Dr. Daniel Bunce, curator of the Geelong Botanical Gardens, stated that an infallible way to destroy thistles was, just before the bud began to form, to cut the root through with a spade about 2 inches below the surface; also that the practice of cutting them above the surface was an utter waste of both money and labor, as thistles thus treated invariably sprang up again with a greater number of heads than before.

ENGLAND has as many people in the almshouse as she has children in schools.