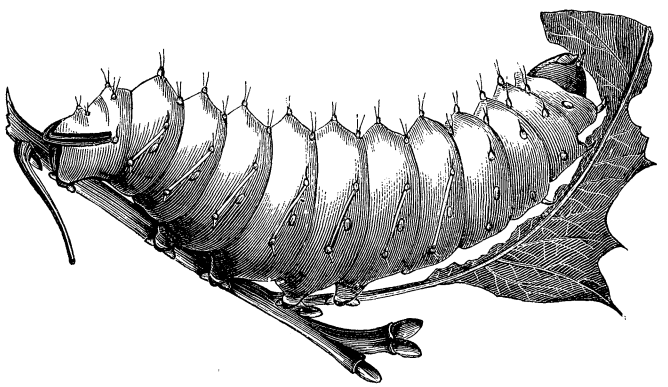
istence of creatures of the form of Lælaps, Iguanodon, and Hadrosaurus, would amply account for the well known foot-tracks of the Triassic Red Sandstone of the Connecticut Valley. The arguments adduced to prove that these were made by birds are equally applicable to their indicating the presence of Dinosaurians; and as the latter have been found very much more nearly approximated in time —as *Scelidosaurus* in the Jurassic formation—the latter hypothesis is altogether the more probable of the two in the estimation of the writer.

THE AMERICAN SILK WORM.

BY L. TROUVELOT.



The insect fauna of North America contains several gigantic species of moths belonging to the Lepidopterous family Bombycidæ. This family has long been known to spin when in the larval, or caterpillar state, a cocoon which produces a large amount of silk, with a fibre of the most delicate texture, of great strength and of the most

beautiful lustre. Every one is familiar with the beautiful and delicate fabric made from the fibres spun by that crawling repulsive creature, the silk worm.

Our country alone has eight or ten species of silk worms. Two of these, Callosamia Promethea and C. angulifera, feed on the lilac and wild cherry. They spin a small elongate cocoon of so very dense texture and so strongly gummed, that I have failed in all my attempts to reel the silk from the cocoon. These cocoons resemble very much those of Samia Cynthia, or the Ailanthus Silk Worm, recently introduced into Europe from China, but the cocoon is of a looser texture. Platysamia Euryale, P. Columbia and P. Cecropia feed upon many different species of plants; they make a large cocoon, within which is another cocoon, or inner layer, of an oval form; but as the larva in spinning the cocoon, leaves one end open for the exit of the moth, this prevents the reeling of a continuous thread. The silk, though quite strong, has not much brilliancy, and the worm is too delicate to be raised in large numbers.

The caterpillar of Tropæa Luna, the magnificent green moth with the long tail-like expansion of the hind wings, feeds upon the oak, sycamore and other trees, and spins an oval cocoon, which however is so frail and thin, and the fibre so weak, that it is impossible to reel it.

Practically, however, the larva of Telea Polyphemus is the only species that deserves attention. The cocoons of Platysamia Cecropia may be rendered of some commercial value, as the silk can be carded, but the chief objection as stated above, is the difficulty of raising the larva. The Polyphemus worm spins a strong, dense, oval cocoon, which is closed at each end, while the silk has a very strong and glossy fibre.

For over six years I have been engaged in raising the Polyphemus worm, and here present the following imperfect sketch of the progress made from year to year in propagating and domesticating these insects from the wild stock.

In 1860, after having tested the qualities of the cocoons of the different species of American silk worms, I endeavored to accumulate a large number of the cocoons of the Polyphemus moth, for the future propagation of this species. At first the undertaking seemed very simple; but who will ever know the difficulties, the hardships and discouragements which I encountered. This worm having never been cultivated, of course its habits were entirely unknown, though all success in my undertaking depended very much upon that knowledge. However I was not discouraged by the difficulties of the task. The first year I found only two caterpillars. The chance of their being each a male and female was very small, and it was another question whether the two sexes would come out of the cocoon at about the same time for the fecundation of the eggs. So success was very doubtful. Spring came, and with it one of the perfect insects; it was a male, one, two, three days elapsed, my poor male was half dead, the wings half broken, the other cocoon was not giving any signs of an early appearance; imagine my anxiety; it was a year lost. The male died on the sixth day. The other moth came out more than a fortnight after; it was a male also. During the summer of 1861, I found a dozen worms, knowing then a little about their habits. In the spring of 1862, I was fortunate enough to have a pair of these insects that came out of the cocoon at the proper time, and I obtained from their union three hundred fecundated eggs. The pair which gave me these eggs

were the originators of the large number which I have cultivated since. Of these three hundred worms, I lost a great many, not knowing their wants, but I succeeded in obtaining twenty cocoons in the autumn. It was only in 1865 that I became expert in cultivating them, and in that year not less than a million could be seen feeding in the open air upon bushes covered with a net; five acres of woodland were swarming with caterpillar life.

Natural History of Telea Polyphemus. Early in summer, the chrysalis of Polyphemus which has been for eight or nine months imprisoned in its cocoon, begins to awaken from its long torpor, and signs of life are manifested by the rapid motion of its abdomen. In the latitude of Boston, the earliest date at which I have seen a perfect insect is the twentieth of May. From this time until the middle of July, the moths continue to come out of the cocoons. The cocoon being perfectly closed, and a hard gummy, resinous substance uniting its silken fibres firmly together, it is quite hard for the insect to open it, as it has no teeth, nor instrument of any kind to cut through it, and the hooked feet are far too feeble to tear such a dense structure.

But the moth must have some means of exit from the cocoon. In fact they are 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 fibres of the cocoon. This liquid is composed in great part of 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 its mouth, wetting

the inside of the cocoon. The process of exclusion from the cocoon lasts for as much as half an hour. The insect seems to be instinctively aware that some time is required to dissolve the gum, as it does not make any attempt to open the fibres, and seems to wait with patience this event. When the liquid has fully penetrated the cocoon, the pupa contracts its body, and pressing the hinder end, which is furnished with little hooks, against the inside of the cocoon, forcibly extends its body; at the same time the head pushes hard upon the fibres and a little swelling is observed on the outside. These contractions and extensions of the body are repeated many times, and more fluid is added to soften the gum, until under these efforts the cocoon swells, and finally the fibres separate, and out comes the head of the moth. In an instant the legs are thrust out, and then the whole body appears; not a fibre has been broken, they have only been separated.

To observe these phenomena, I had cut open with a razor, a small portion of a cocoon in which was a living chrysalis nearly ready to transform. The opening made was covered with a piece of mica, of the same shape as the aperture, and fixed to the cocoon with mastic so as to make it solid and air-tight; through the transparent mica, I could see the movements of the chrysalis perfectly well.

When the insect is out of the cocoon, it immediately seeks for a suitable place to attach its claws, so that the wings may hang down, and by their own weight aid the action of the fluids in developing and unfolding the very short and small pad-like wings. Every part of the insect on leaving the cocoon, is perfect and with the form and size of maturity, except the pad-like wings and swollen and elongated abdomen, which still gives the insect a

worm-like appearance; the abdomen contains the fluids which flow to the wings.

When the still immature moth has found a suitable place, it remains quiet for a few minutes, and then the wings are seen to grow very rapidly by the afflux of the fluids from the abdomen, In about twenty minutes the wings attain their full size, but they are still like a piece of wet cloth, without consistency and firmness, and as yet entirely unfit for flight, but after one or two hours they become sufficiently stiff, assuming the beautiful form characteristic of the species. If, while the wings are growing, they are prevented from spreading by some agency, they will be deformed forever. Sometimes when the wings are developing, the afflux of liquid is so great, that some parts of the wing swell up considerably, and if one of these swellings be opened with a pin and the sac emptied a singular phenomenon will result; the wing which has lost so much of its fluids will be smaller than the others, and sometimes it will retain the normal form of the wing, only being smaller, while the wound can be detected only on very close observation. I have in my cabinet a perfect specimen of such an insect; naturalists would regard it as a monstrosity.

The moth remains quiet all day, and sometimes all night and the following day, if the night be cold; but if it be warm and pleasant, at dusk or about eight o'clock, a trembling of the wings is observed for a few minutes and then it takes its flight, making three or four circles in the air. The male flies only a few minutes, and then rests for two or three hours in the same place, not making any motion. It is worthy of notice that the place of rest is always the extremity of an oak leaf. Why he remains there so long I could not ascertain. The female continues to fly

about the bushes, and though a virgin, she lays eggs which are, however, of no use for the propagation of the species; she continues so doing for two or three hours, and then rests all night attached to some plant, probably waiting for her mate, who during this time has either remained motionless, or has been feeding on the sweet exudation of the oak leaf. Soon after the female moth has laid these useless eggs, the males become very active, and fly in search of their partners, whom they soon discover, especially if there be a slight breeze and the air loaded with vapors.

The moth lays her eggs on the under side of the leaves, sometimes on a twig; generally but a single egg is deposited at one place, rarely are two or three found together. I have observed that eggs are sometimes laid upon plants which the young larvæ refuse to eat, and in several instances where there was no other plant within a long distance, and consequently the young worms died; thus it seems that instinct, like reason, sometimes commits blunders, and is not so infallible a guide as has been supposed.

The incubation of the eggs lasts ten or twelve days, according to the temperature. The young worm eats its way through the shell of the egg; sometimes the young larva comes out of the egg tail foremost, as the hole in the shell is large enough to allow of the exit of the tail, but is not large enough for the head to pass through, so the worm is condemned to die in the egg. As soon as it is fairly hatched out, the larva continues for sometime eating the egg-shell, and then crawls upon a leaf, going to the end of it, where it rests for two or three hours, after which it begins to eat. The hatching-out takes place early in the morning, from five till ten o'clock; rarely after this time.

The Polyphemus worm, like all other silk worms, changes its skin five times during its larval life. The moulting takes place at regular periods, which come around about every ten days for the first four moultings, while about twenty days elapse between the fourth and fifth moulting. The worm ceases to eat for a day before moulting, and spins some silk on the vein of the under surface of a leaf; it then secures the hooks of its hind legs in the texture it has thus spun, and there remains motionless; soon after, through the transparency of the skin of the neck, can be seen a second head larger than the first, belonging to the larva within. The moulting generally takes place after four o'clock in the afternoon; a little before this time the worm holds its body erect, grasping the leaf with the two pairs of hind legs only; the skin is wrinkled and detached from the body by a fluid which circulates between it and the worm; two longitudinal white bands are seen on each side, produced by a portion of the lining of the spiracles, which at this moment have been partly detached; meanwhile the contractions of the worm are very energetic, and by it the skin is pulled off and pushed towards the posterior part; the skin thus becomes so extended that it soon tears, first under the neck, and then from the head. When this is accomplished the most difficult operation is over, and now the process of moulting goes on very rapidly. By repeated contractions the skin is folded towards the tail, like a glove when taken off, and the lining of the spiracles comes out in long white filaments. When about one-half of the body appears, the shell still remains like a cap, enclosing the jaws, then the worm as if reminded of this loose skull-cap, removes it by rubbing it on a leaf; this done, the worm finally crawls out of its skin, which is attached to the fastening made for the purpose. Once

out of its old skin, the worm makes a careful review of the operation, with its head feeling the aperture of every spiracle, as well as the tail, probably for the purpose of removing any broken fragment of skin which might have remained in these delicate organs. Not only is the outer skin cast off, but also the lining of the air tubes and intestines, together with all the chewing organs and other appendages of the head. After the moulting, the size of the larva is considerably increased, the head is large compared with the body, but eight or ten days later it will look small, as the body will have increased very much in size. This is a certain indication that the worm is about to moult. Every ten days the same operation is repeated; from the fourth moulting to the time of beginning the cocoon, the period is about sixteen days.

The worms seem entirely unable to discern objects with their simple eyes, but they can distinguish light from darkness, as a very simple experiment will show. If a worm be put in a box with two holes in it, one of them turned to the light, the other to the dark, the caterpillar will very soon come out through the hole turned to the light.—*To be continued.*

WINTER NOTES OF AN ORNITHOLOGIST.

BY J. A. ALLEN.

The winter birds of the northern and eastern States are few in number. In Massachusetts, away from the sea shore, there are ordinarily but fifty-five to sixty species, which consist mainly of permanent residents and winter visitors from more northern districts. The resident