

vented a process of producing oxygen cheaply for industrial purposes, and applied it in the manufacture of illuminating gas. At the time of his death he was engaged in introducing his system of gas making for the Municipal Gaslight Company of this city. During his residence here he has patented improved processes in mining and metallurgy; and in connection with M. Rossi, he developed last year the binary absorption system of ice making, illustrated in this paper February 21.

THE ARMY WORM.

This dreaded foe to grass and small grains has lately been doing very considerable damage along parts of the sea coast from Virginia to Long Island, and may be expected to appear in the New England States as the season advances. Accounts of its ravages are more particularly numerous in Delaware and on Long Island. The *Herald* of the 3d inst. has a long account of its injuries to rye.

This is one of the insects that, on account of wide-spread injuries at irregular intervals, and of its not being noticed by farmers during the intervening years, attracts more than usual attention, and, notwithstanding it had been written about by economic entomologists for many years, and especially since 1861, when we had a wide-spread visitation of it, yet its full natural history was first made known some four years ago by Prof. Riley, who published a complete account of it in his Eighth and Ninth Reports on the Insects of Missouri.

Various caterpillars that, from excessive multiplication, occasionally move from field to field in large bodies, have been popularly called army worms, but the term belongs to this insect *par excellence*. Up to the year 1861 very little but that was inaccurate and confusing had been written about this insect, though it is referred to in Flint's Second Report on the Agriculture of Massachusetts, as occurring in millions as long ago as 1743. 1861 and 1873 were noted years of wide-spread injury.

WHERE THE EGGS ARE LAID.

The favorite place to which the female consigns her eggs is along the inner base of the terminal blades of grasses, where such blades are yet double, and on both the green and dry blades. In fact the dry blades are preferred, and occasionally the eggs are thrust in between the sheath and stalk. The female, says Prof. Riley, having once commenced to lay, is extremely active and busy, especially during warm nights, and but two or three days are required to empty the ovaries, which have a uniform development. A string of fifteen or twenty eggs is placed in position in two or three minutes, and by the end of ten more, the moth will choose another leaf and supply it with another string. The moth perishes within a day after having exhausted her supply of eggs. The egg is glistening white when first laid, and only becomes tarnished or faintly dull yellowish toward maturity.



Chrysalis of Army Worm.

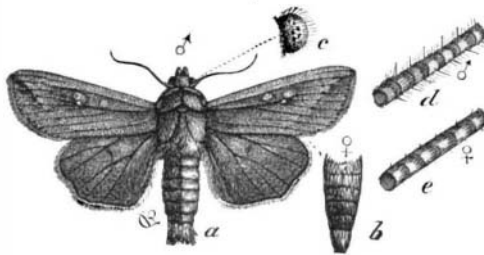
HABITS OF THE WORM.

As Prof. Riley well observes, the fact cannot be too strongly impressed on the mind, that the traveling of the worms in large armies is abnormal. During the latter part of April and throughout the month of May, in this part of the country, the worms may almost always be found by diligent search in moist grass land that was not cut or grazed too closely the previous autumn. At these times they have essentially the habits of ordinary cut-worms, and are seldom noticed unless so abundant as to cut the grass entirely down and be obliged to travel to fresh pastures. Indeed, one may pass daily through a grass plat where they abound, and never suspect their presence until the plat suddenly begins to look bare in patches.

The reasons why they so easily escape detection in this their normal condition is that, when less than half an inch long, the worms are scarcely recognizable as army worms, the characteristic dark, sinuous lines on the head being at this time obsolete, and the general color being pale green. The color is very variable at any stage of growth, and in some individuals the brown predominates while they are yet quite small; but up to the last moult the green generally prevails and the longitudinal dark lines are less conspicuous. The broad stigmatal line is the most persistent, being distinguished when the insect is one quarter inch long. The worms in this their normal condition feed mostly at night, and hide during the day at the base of the grass or under any other shelter at hand. If they venture to mount a plant and feed during the day—which they often do in cloudy weather—they drop at the least disturbance, and curl up in a spiral so as to simulate very closely a small shell of the *Helix* form. The worm loves cool, moist places, and is more often found around the margins of creeks and ponds than elsewhere. Last year, when the rains were so copious as to fill creeks and bottom lands and float numbers of the worms away, I saw many a one cling tenaciously to grass blades and continue feeding as though little concerned, even when partly immersed.

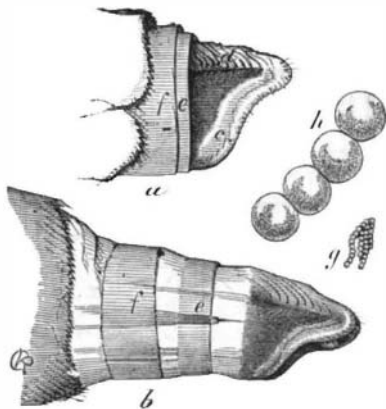
It is only when hunger impels them that they march forth from the fields where they were born, though after they

have once begun the wandering habit they often pass through fields without eating everything to the ground. Invariably when the older individuals are attracting attention by congregating and traveling in armies, others may be found of all sizes in the more normal and quiet condition in grass that is yet sufficiently rank; they may indeed be found some time after the first worms have changed into moths; and the mower with his scythe often startles the moths in



ARMY WORM MOTH.—a, male moth; b, abdomen of female, natural size; c, eye; d, base of male antenna; e, base of female antenna, enlarged. numbers during the latter part of June, while yet the worms are clinging to the grass that he is cutting, or hiding in the stubble that he leaves.

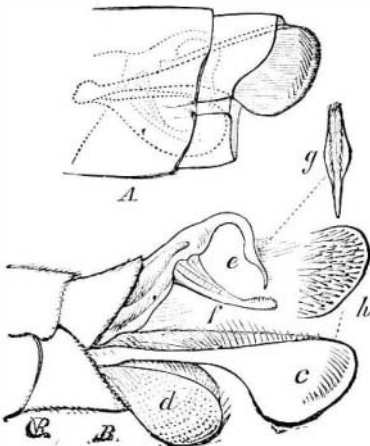
When traveling the worm "will scarcely turn aside for anything but water, and even shallow water courses will not always check its progress; for the advance columns will often continue to rush headlong into the water until they have sufficiently choked it up with their dead and dying bodies, to enable the rear guard to cross safely over. I have noticed that after crossing a bare field or bare road, where they were subjected to the sun's rays, they would congregate in immense numbers under the first shade they reached. In one instance I recollect their collecting and covering the ground five or six deep all along the shady side of a fence for about a mile, while scarcely one was seen to cross on the sunny side of the same fence."



ARMY WORM MOTH.—a, end of abdomen denuded and showing ovipositor at rest; b, same with ovipositor fully extended; c, f, retractile sub-joints; h, eggs, all enlarged; g, eggs, natural size.

Though when hard pushed the worms will fall upon and devour each other, and will even feed upon some kind of vegetable, yet their attacks are mostly confined to the grasses and cereals, and their most natural food plants are the rank swamp grasses.

While in the more Northern States there is but one annual generation, there are at least two farther South. The insect hibernates in the perfect moth state, and is very frequently captured during mild weather of winter, especially in the Southern States. There is good reason to believe that it may exceptionally hibernate underground as a chrysalis.



GENITALIA OF MALE ARMY WORM MOTH.—A, end of body, denuded of hairs, showing the upper clasp protruding, and the natural position of the hidden organs by dotted lines; B, the organs extended.

The worm has numerous natural enemies, which pursue it remorselessly whenever it becomes unusually numerous, so that it very rarely, if ever, appears in destructive numbers for two years in succession.

REMEDIES.

Experience has well established the fact that burning over a meadow, or prairie, or field of stoppel, either in winter or spring, effectually prevents the worms from originating in such meadow or field. Such burning destroys the previous year's stalks and blades, and, as a consequence of what we have already stated, the nidi which the female moth prefers. Burning as a preventive, however, loses much of its practical importance unless it is pursued annually, because of the irregularity in the appearance of the worm and the difficulty of anticipating its coming. Judicious ditching, i. e., a ditch with the side toward the field to be protected perpendicular or sloping under, will protect a field from

invasion from some other infested region when the worms are marching. When they are collected in the ditch they may be destroyed either by covering them up with earth that is pressed upon them, by burning straw over them, or by pouring a little coal oil in the ditch. A simple plow furrow, six or eight inches deep, and kept friable by dragging brush in it, has also been known to head them off.

We conclude with the following summary of the natural history of this worm, given by Prof. Riley in an essay which obtained the Walker prize of the Boston Society of Natural History in 1877:

"The insect is with us every year. In ordinary seasons, when it is not excessively numerous, it is seldom noticed: First, because the moths are low, swift fliers, and nocturnal in habit; second, because the worms, when young, have protective coloring, and, when mature, hide during the day at the base of meadows. In years of great abundance the worms are generally unnoticed during early life, and attract attention only when, from crowding too much on each other, or from having exhausted the food supply in the fields in which they hatched, they are forced, from necessity, to migrate to fresh pastures in great bodies. The earliest attain full growth and commence to travel in armies, to devastate our fields, and to attract attention, about the time that winter wheat is in the milk—this period being two months later in Maine than in Southern Missouri; and they soon afterwards descend into the ground, and thus suddenly disappear, to issue again two or three weeks later as moths. In the latitude of St. Louis the bulk of these moths lay eggs, from which are produced a second generation of worms, which become moths again late in July or early in August. Exceptionally a third generation of worms may be produced from these. Further North there is but one generation annually. The moths hibernate, and oviposit soon after vegetation starts in spring. The chrysalides may also hibernate, and probably do so to a large extent in the more Northern States. The eggs are inserted between the sheath and stalk, or secreted in the folds of a blade; and mature and perennial grasses are preferred for this purpose. The worms abound in wet springs preceded by one or more very dry years. They are preyed upon by numerous enemies, which so effectually check their increase, whenever they unusually abound, that the second brood, when it occurs, is seldom noticed; and two great army worm years have never followed each other, and are not likely to do so. They may be prevented from invading a field by judicious ditching; and the burning over of a field, in winter or early spring, effectually prevents their hatching in such a field."

The Army Worm.

One notable feature of the present invasion is the origin of the swarms along the shores of the Sound and the ocean. For seven or eight years they have prevailed sparingly on the southeastern side of Long Island and probably elsewhere. For some favorable cause they have multiplied amazingly during the recent dry weather, and now they threaten to overrun not only all of Long Island, but also the shore counties of New Jersey and Connecticut. The invasion began about the first of June, on the farm of J. N. Plumb, near Islip, L. I., where a large area of young corn, rye, and wheat was soon destroyed. The corn was eaten off close to the ground. In the grain fields the worms crawled up the stalks and ate off the green leaves one by one, beginning at the outer end of the leaf on the under side and eating back to the stalk. Then the head was attacked, the worm nipping off the tip of each kernel and sucking out the juice. Grass, oats, clover, garden crops, and all succulent vegetation are taken as they come, the country ravaged being left brown and bare. A reporter on Long Island says: What was fresh green grass a week ago seems to the eye to have been burned by a drought. The ground is as brown as burnt sienna. The pedestrian walks on the roadside and feels the insects crush under his boots. When the sun's rays strike the worms they are, as if at a signal, at once on foot in brown masses that cover the ground. They cross the whitish road, and its dust is hidden. A carriage passes, and the wheels become as thickly incrustated with the slaughtered insects as they are with mud after a soaking rain has softened the roads. The worms crawl upon the fences and pass on exploring expeditions.

The movement of the worms in one corner of Mr. Johnson's field could distinctly be heard by leaning on the fence near by. The worms were in some rank blue grass. The column began at the fence, and almost in a straight line stretched out into the field. The march was rapid, and the grass was cut to the ground, which was covered already with multitudes pressing on behind. The sound was like the rustling of grass in a wind, only it was more continuous.

Many devices have been tried to stop the march of the pests. Some small grain fields have been in a measure protected by drawing back and forth across the grain long ropes to brush or jar the worms from the leaves and heads. Fire and boiling water have been resorted to with slight success. Ditches have been dug or plowed around threatened fields, but unless they are very deep, or the worms are constantly raked out or burned out with fire, they are soon filled up with worms, and the rest of the army goes on to complete the work of destruction.

Thus far on Long Island, the worms have ravaged a belt about two miles wide all along both shores, and are rapidly marching inland. They have just begun their march in Connecticut, while in New Jersey the coast line is suffering as severely as the Long Island shores.