

## *In Nature's Workshop.*

BY GRANT ALLEN.

### VII.—THE DAY OF THE CANKER-WORM.



T was Attila's boast, they say—I never met him personally—that where his horse's foot had once trodden, grass never grew again. Chief of the countless hordes of Huns and other barbarians scattered among the northern mosses of Europe and Asia, he swept, the Scourge of God, across the civilized but decrepit Roman empire, and left behind him one broad path of destruction in ruined towns and desolated homesteads. Centuries later, another Mongol, Timur, came forth from the same savage heart of Asia, and built his pyramid of skulls among the lonely steppes to testify to the countless thousands of human lives he had recklessly sacrificed. But these historical plagues of conquering kings, though terrible indeed in their kind, are as nothing in devastating power when compared with the destructive insect armies which from time to time burst over and obliterate whole wide areas of culture. The hosts of locusts which eat their way across the face of a continent might make Attila's boast with greater truth than the ferocious Hun himself could make it: the desolation which follows one of these terrible floods of living things is appalling to behold. And then, does not the very pettiness of the enemy render him harder to engage? Artillery is useless against myriads upon myriads of tiny foes; even railway trains have been stopped in their course in America by hordes of insects. The smaller and more numerous the adversary, the less the chance of engaging him with honour: you kill a million; and straightway ten millions take their place. France has lost more by the phylloxera which devours her vines than by the indemnity she paid to Germany for the war of 1870: and the worst of it is, the Uhlan has gone, but the phylloxera still remains encamped and intrenched in all her vineyards. That tiny fly is an enemy with which treaties and capitulations are impossible: no cession of fortresses will satisfy its greed; no promises of money down or of territory ceded will induce it to forego its conquered provinces.

I propose in this paper to trace the life-history of one or two among these famous armies of conquering insects, the Assyrian hosts or Napoleonic hordes of their kind, creatures which are produced in vast quan-

ties at once, and which suddenly appear in devastating numbers over whole areas of country. And I do not think we can do better for a beginning than by taking the case of that too familiar American pest, the so-called seventeen-year locust. American, I say, because in this, as in most other matters, America still "whips creation." When the United States go in for anything, they go in for it as a rule on the huge scale: their vast areas of forest and prairie and wheatfield allow the development of gregarious life in a way unknown to our little peninsular and mountain-severed Europe. Here we have meadow and pasture and copse and heath dividing the soil with corn or turnips: in America, wheat occupies whole square miles in a line, and so affords an easy prey to every aggressive insect. Hence it happens that such pests in the States assume the proportions of veritable armies, and that skilled entomologists have to be employed by government like policemen or soldiers in order, if possible, to check the assaults of the foe by opposing to each its own appropriate natural and hereditary antagonist.

You will hardly be surprised to hear at the outset that the seventeen-year locust is not a locust at all. "Things are not what they seem," the poet tells us; and most plants and animals are so strangely misnamed by popular natural history, that the fact of a creature being called by one name almost suffices to make one conclude it must deserve another. Locusts in Africa are very destructive beasts: a cicada in America is equally destructive: that casual resemblance of habit and practical result was enough to make the American farmer call his own local pest by the name of locust. But if you look at the portrait of the female cicada, as shown in No. 15, you will see at a glance that she does not present the slightest resemblance to the true locusts, but that, on the contrary, she is almost identical with the quaint little chirpers which keep up such a ceaseless and emulous concert in the fields and woods of Southern Europe in piping summer-time. Wherever vines grow, there you will find the South European cicada busily performing. Its continuous song is faintly pleasing to most people, especially if heard at a little distance: but it becomes disagreeable at last, from its constancy and monotony, and if heard very near it is harsh and grating.

A word or two at the outset about cicadas in general, viewed as a family, may help to put you more at home with the group as a whole: after which, we may proceed to inquire into the domestic concerns of the seventeen-year cicada herself in particular. Cicadas in the lump are large and stout-bodied insects, of the beaked class: they are very musical in their tastes, and have wings which are arranged slantwise, like the roof of a house. Their food is strictly vegetarian. Like all their kind, they are specially adapted for living by suction, draining the juices of the plants on which they fasten. For this purpose they are provided with an elaborate and highly-developed beak, intended for piercing the tissues of the food-plant. The females have also a stout and horny egg-layer or ovipositor, extremely complex in its mechanism, as I shall show hereafter; and this egg-layer is equally designed for making incisions in the tissues of plants, and laying the eggs where the young grubs, in their earliest stage, will be safest from attack and surest of rich and nutritious provender. Cicadas have always two large and very prominent eyes, set sideways at the edge of the head: but in addition to this pair, many kinds have also three secondary eyelets or ocelli, which are placed between the main eyes in the centre of the forehead: and these smaller eyes are frequently most brilliant in hue, with a gleam like a jewel's. Otherwise, the cicadas are not remarkably handsome or decorated insects; they reserve the whole of their aesthetic taste for the musical faculty.

As a rule, indeed, you will find that birds and insects specialize their allurements in one or other of these two directions—song or colour; the two are seldom found together. Very brilliantly plumaged birds, like the peacock, the birds of paradise, the humming-birds, and the parrots, do not often possess beautiful voices: and, *per contra*, very sweet-voiced birds, like the lark, the nightingale, the thrush, and the linnet, are not usually remarkable for the hues of their feathers. It seems almost as though nature economized in the matter of display: where she attracts by song, she does not think it necessary to attract by colour; where plumage suffices to charm the eyes of delighted mates, she does not trouble to add music also. So pretty a girl, she says, can do without accomplish-

ments: so accomplished a girl has no need for beauty. Now, the cicadas are, almost without exception, musical. But their song is produced exclusively by the male insects, who are provided for the purpose with a curious resonant, drum-like instrument. It consists of a cavity with a stretched membrane, whose vibration, controlled by muscles, sets up the familiar chirping or stridulating noise so well known to all who have lived in Italy. In warm sunshine these insect vocalists keep up a continuous concert of sweet sounds, intended no doubt to attract the females. Resonators in the body increase the volume of the note, and make it carry further; we had one cicada in our house in Jamaica which sang so loud that we always knew it as the prima donna. We were wrong in the gender, I admit: we ought rather to have said the first tenor; for the females have no song: a fact much commented upon by the malicious Greek poet—doubtless a married man, tied to a loquacious Athenian lady:—

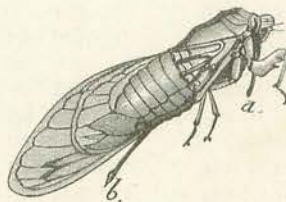
Happy the cicadas' lives  
Since they all have voiceless wives.

You can thus tell a male cicada from a female at once, because the large horny plate which covers the stridulating apparatus in the nobler sex is wanting or at least rudimentary in the ladies of the species.

But I am too long delaying the introduction of our particular subject, the seventeen-year cicada, who is really the hero of this present drama. The name is an odd one, but it is strictly true. The cicadas of this kind appear in each district once only in every seventeen years—"And that is once too many," said an aggrieved Kentucky farmer. The fact is, all cicadas remain for a long time underground in the grub condition before emerging in the upper air as perfect insects; and this particular sort takes no less than

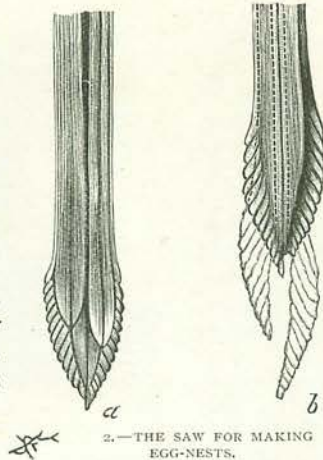
seventeen years to mature, though there is in certain States a thirteen-year variety or local species. No. 1 of my illustrations shows you a specimen with the wings on one side removed, so as to exhibit the chief offending organs—the mouth or beak (a) and the saw-like egg-layer (b). In the breeding season, the males appear for a short

time only, sing, pair, and then die at once, it being probable, indeed, that they cannot or do not eat in the adult or perfect condition. But the females make up for this little defect in their partners' economy by eating



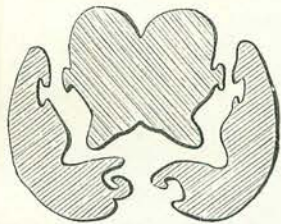
1.—THE SEVENTEEN-YEAR CICADA.

voraciously, and laying some four or five hundred eggs apiece in the buds or twigs of trees: after which they, too, proceed to die, having also fulfilled their place in nature. For the winged state in insects is usually little more than a device for mating and egg-laying: it may be aptly compared to the flowering stage in plants, since the flower exists only for the sake of being fertilized, and fades as soon as the seeds begin to set; its sole use is to attract the impregnating insects, as the sole use of the butterfly is to mate and lay eggs for future generations.



2.—THE SAW FOR MAKING EGG-NESTS.

puncture drilled by the ovipositor. At *b*, the surface of the twig has been deftly removed, so as to show the arrangement of the eggs in the egg-basket thus cunningly excavated. At *c*, you have a side-view of the eggs lying in their basket; and at *d*, you have the cavity exposed after the eggs are removed, so as to let you see the sculpture left by the ovipositor. I think you will agree that a neater or more perfect nest could hardly be devised than this thus carved out of a living twig by the minute instruments



3.—SECTION OF THE SAW, SHOWING HOW THE PARTS FIT TOGETHER LIKE A PUZZLE.

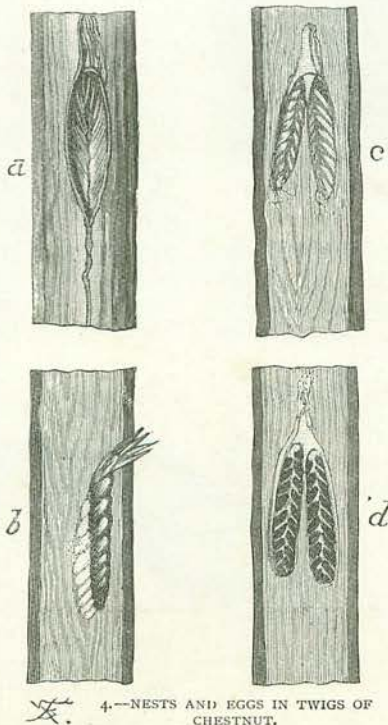
at the disposal of a petty two-inch-long insect. But the ovipositor or egg-layer, seen at *b* in No. 1, is a most remarkable organ, whose minute structure you can further observe in No. 2, where I have had it much enlarged

at the disposal of a petty two-inch-long insect.

The eggs soon hatch out in their snug little nest in the twig: but the larvæ do not continue to live there permanently. In a very short time they drop to the ground, burrow their way into the soil by means of their strong-toothed thighs, and fasten on to the roots of trees and plants, where they earn their livelihood by perpetual suction. Caterpillars and other above-ground larvæ, exposed to stress of weather and with the perpetual terror of winter before their eyes, usually live

and feed for one summer only: they turn into pupæ during the course of that summer, or at best assume the chrysalis form in late autumn, hibernating as well as they can in the dormant condition, and coming out as perfect insects with the succeeding springtide. But the cicada tribe pass their larval period for the most part underground, where they are tolerably protected from the inclemency of the weather, for frost never strikes deep; therefore, they need be in no hurry to grow old apace: they can take their own time for arriving at maturity. And they do take it: they eat their way slowly and laboriously through life: one variety of the periodical cicada matures in seventeen years, the other in thirteen.

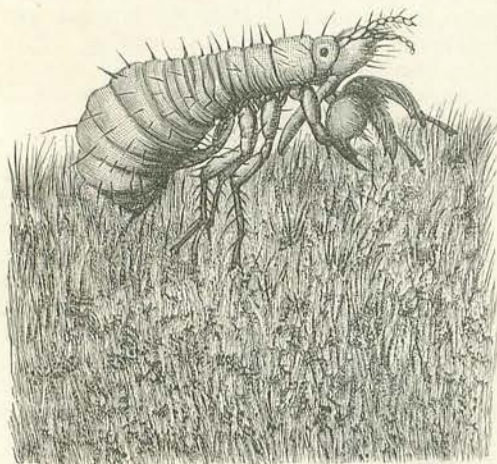
for you. In *a*, this wonderful cutting instrument is seen from above, and in *b*, from beneath, the dotted lines being intended to indicate the up-and-down motion of the saw-like blades or cutters. These cutters are fitted together by grooves into the fixed holder or axis almost like a puzzle, so as to move up and down truly: and the cross-section in No. 3 enables you to appreciate the exquisite way in which the parts fit into one another, with that extraordinary accuracy only to be found in the works of nature. No. 4, again, shows you how the mechanism acts as a whole. It exhibits a series of views of the twig of a tree operated upon by the seventeen-year cicada. At *a*, you have a recent



4.—NESTS AND EGGS IN TWIGS OF CHESTNUT.

Meanwhile, the larva lives by suction on roots and underground stems or tubers, doing much unobtrusive damage to vegetation in a quiet way, and eating what he can get with constant vigilance. Of course, he is often eaten in turn, in accordance with the usual law of nature: for myriads of the larvæ are devoured by birds, by frogs, and even by pigs, which grub them up with their snouts from the soil where they have buried themselves; but myriads more survive, and turn out in the end as fully-winged cicadas, to the no small disgust of the American agricultural interest.

No. 5 is a portrait of the larva, "aged eighteen months," if I may plagiarize the familiar phrase so often used in another department of this Magazine with reference to the photographs of more illustrious



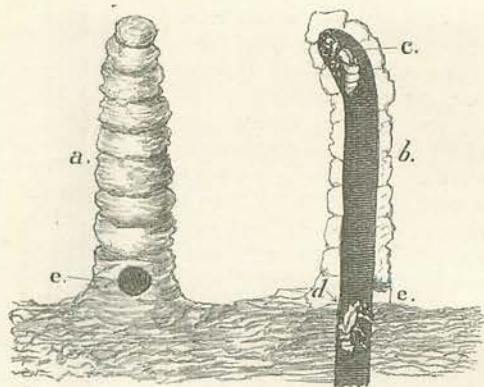
5.—THE LARVA OF THE CICADA, AGED EIGHTEEN MONTHS.

celebrities. You will see at once that our undeveloped cicada is already a creature capable of doing a fair amount of serious damage to trees or crops; and when you consider that he has still fifteen years to grow, you can understand that he inspires a just fear in the bosom of the farmer who has most to deal with him. Admirably adapted both for sucking and nipping, as this picture shows, he can do as much harm as any insect of his size known to science, with the solitary exception, perhaps, of that famous winged fiend, the true African locust.

At the end of his long



7.—THE PUPA COMES OUT.



6.—THE GALLERIES FOR THE PUPÆ.

and tedious minority, the cicada larva begins at last to think of assuming the *toga virilis* of his race, and prepares to put on the robe of the pupa. But his pupa stage is not like that of the butterfly, an inert and mummy-like chrysalis existence: in common with the great group of beaked insects to which he belongs, the cicada only undergoes what is technically known as an "imperfect metamorphosis." The pupa in these cases does not become dormant: it is merely a sort of active hobbledehoy, which walks and behaves like the larva or the perfect insect: it represents an intermediate form between the grub and the winged cicada—an intermediate form quite as capable of taking care of itself as the perfect animal. For seventeen years vast hordes of larvæ live unseen underground in the same district: at the end of that time, all with one accord begin to change into pupæ, and construct for themselves strange galleries of emergence, so that the soil in certain places seems honey-combed with their tunnels. Two of these galleries are seen in No. 6, one in front view, and the other laid open as a section. Here *c* is the door or orifice of the gallery,

and *c* is a pupa waiting to undergo transformation; while *d* is a brother insect just ready to metamorphose. Whole acres together are often covered and pierced with these strange tubes or shells, as thick as blades of grass in an English meadow.

No. 7 shows the next stage in the process of emergence. Here, the active pupa has walked up from the ground, and is just preparing to enter upon a new phase of life as a free winged insect, frequenting the open

sunlight. It moves cautiously and slowly, a little dazzled and stunned, like a man brought up for many years in a mine, and then suddenly turned loose in the crowded and garish streets of some great city. No wonder the creatures feel like so many insect Kaspar Hausers, and move gingerly about on the branches which support them. The pupa crawls out upon a twig, and finds its skin has strangely hardened.

seen sideways, and have grown a little larger, but they are still rather thick or fleshy in texture, softly plastic, and wholly unfit for the act of flying.

The three next illustrations show the process of passing into the flying stage. In No. 12, the newly-emerged cicada has cast itself quite free from the clogging garment of its pupal condition, and is balancing itself on a leaf preparatory to inflating and drying its wings. In No. 13, it has poised itself firmly, and is beginning to swell. In No. 14, the wings have been fully inflated, like a

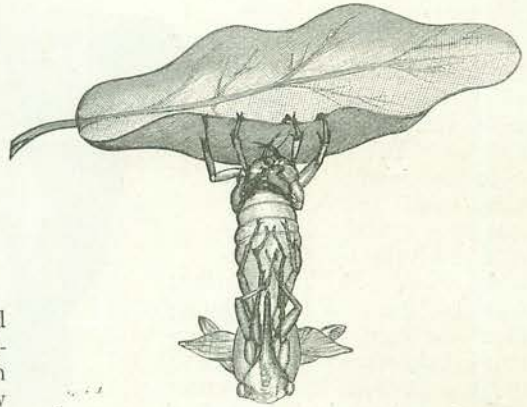


8.—AND THE CICADA COMES OUT OF IT.



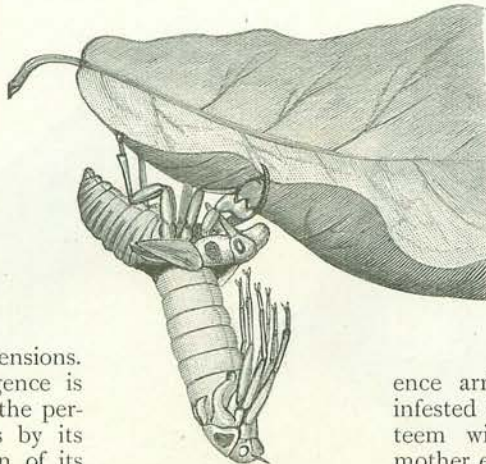
9.—BODY FREE!

After a while, it pauses, as in No. 8, and feels the hardened shell on its back gradually breaking. The winged cicada, which has formed itself within the pupa's skin, now begins to worm its way out with hereditary caution. In No. 9 you see it freeing itself from its mummy-case, a pale and ghost-like creature, as yet very timid and uncertain of the future. In No. 10, with one long pull, it has got its legs and wings free, but its tail still remains enclosed in the cast-off shell or pupal skin. The wings, you will observe, are at this stage very small, and quite inconspicuous: we shall see hereafter how they plim themselves out in the open air to the adult dimensions. In No. 11, the emergence is almost complete, and the perfect insect only hangs by its tail to the cast-off skin of its own pupa. The wings are here



11.—HOLDING ON BY HER TAIL.

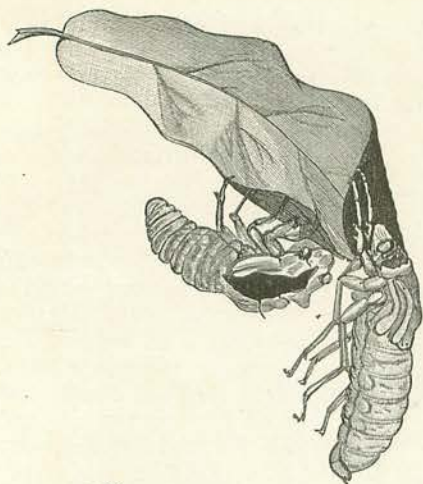
Dunlop tyre, and are now hardened and ready for action. In this stage, the cicada



10.—WINGS AND LEGS ALL OUT!

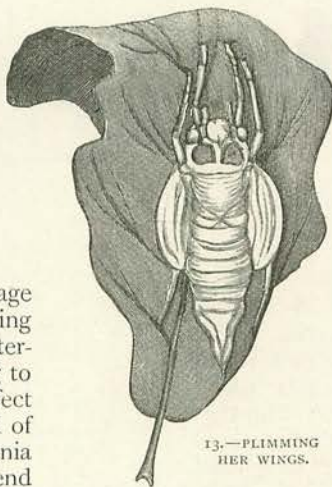
assumes a beautiful glossy and satiny appearance, though it still looks a trifle pallid and ghost-like. The illustrations show you in each case only a single cicada: the American farmer has good ground for knowing that, like other misfortunes, they never come singly. When the moment for emergence arrives, the ground in an infested district seems simply to teem with masses of cicadas: mother earth brings them forth: they pour out in their millions,

they pour out in their millions,



12.—CICADA JUST EMERGED, WITH  
EMPTY PUPA-CASE.

and devour everything on which they can lay their beaks with ruthless destructiveness. In a few days trees and shrubs are laid bare, crops are destroyed, and the year's labour is rendered vain by the victorious insects. The damage done by them as larvæ during their seventeen years of subterranean existence is as nothing to the damage done by the perfect insects during their short spell of adult activity. In Pennsylvania they have been known to bend

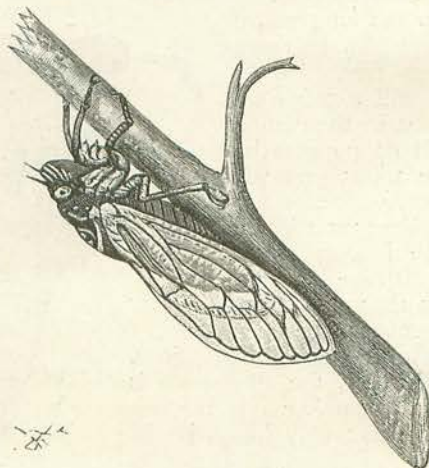


13.—PLIMMING  
HER WINGS.

and seated lengthwise on a twig of chestnut. But she is not composing an epic: in reality, she has pierced the tissues of the shoot with her auger-like egg-layer, and is now engaged in laying her eggs safe out of harm's way



14.—WINGS FULLY EXPANDED.



15.—LAYING EGGS.

and break down the limbs of trees by their weight: the forests ring with the shrill sound of their music.

For now comes the pairing season. Early in June, on every branch around, the male cicadas sit and beat their tiny drums as a summons to their lady-loves, in emulation with one another, like nightingales or skylarks. Sometimes you may hear two particularly loud ones singing or drumming in rivalry: as soon as one leaves off for a second, the other begins, like Virgil's swains, in alternate verses. Attracted by the sound, the clustering females alight near the most favoured male, and soon select the partner that suits them. In the woods at cicada-time you may see hundreds and thousands of such little domestic dramas enacted on every side, the

boughs being alive with many myriads of eager performers, each surrounded by its own little admiring group of female listeners. All around, the branches of the neighbouring trees are covered with a drapery of rent and forsaken pupa-cases.

The next stage in the drama of cicada life consists in the deposition of the eggs. No. 15 shows us a female cicada, apparently lost in profound thought, and seated lengthwise on a twig of chestnut. But she is not composing an epic: in reality, she has pierced the tissues of the shoot with her

among the pigeon-holes of one of those neat little nests already illustrated. It is for the sake of producing these eggs in sufficient numbers that the perfect insects—at least the females—have eaten so ravenously ever since they emerged from the pupal form: for they lay about a round five hundred apiece, and they have to devour material enough for this immense production in a week or so of rapid and greedy accumulation. You can't make eggs out of nothing, of course: and the more you have to lay, the more you must eat in order to lay them.

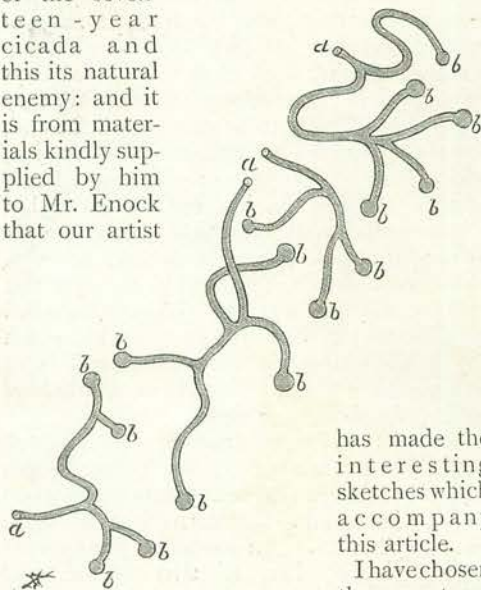
So far, we have dealt mainly with eating and drinking, marrying and giving in marriage, with a slight accompaniment of vocal and instrumental music. But the cicada's life is not always "all beer and skittles." No. 16 represents an untoward accident, to which our hero is commonly liable. A parasitic insect, by name *Megastizus*, smaller than the cicada, but stronger and heavier, seizes it bodily in his legs and carries it off to store his own nursery, exactly as evil spirits carry off wicked souls in old Italian



16.—CARRIED OFF BY AN ENEMY.

pictures. *Megastizus* is a burrower, and No. 17 shows in a lurid light one of his underground tunnels, with his own ugly larva engaged in devouring the dead cicada. These burrows themselves are singular examples of insect architecture, Ali Baba caves of tiny robbers: they are represented in ground plan in No. 18, *a, a* being in each case the door or entrance, and *b, b, b* the little round chambers stored with cicadas in which the eggs

are laid and the larvæ developed. The late Professor C. V. Riley, the official entomologist of the United States, made a special study of the seventeen-year cicada and this its natural enemy: and it is from materials kindly supplied by him to Mr. Enock that our artist



18.—THE ROBBER'S CAVES: SECTIONS OF THE ENEMY'S BURROWS.

has made the interesting sketches which accompany this article.

I have chosen the seventeen-year cicada as the first example

of these destructive hordes of gregarious insects, partly because of the curious regularity of its re-appearance in the infested districts, and partly because of its interesting musical tastes: but there are many other species equally destructive elsewhere, not the least formidable of which is the famous or infamous migratory locust of Oriental countries. The true locust is a large grasshopper-like creature, provided both with wings and with powerful jumping thighs: it is voracious in its appetite, and will devour



17.—THE ENEMY'S LARVA FEEDING ON DEAD CICADA.

almost anything, including at a pinch even its own species. The females are provided with strong and sharp egg-laying implements, and you can often watch them boring a hole with these weapons in the desert soil, and depositing their numerous eggs in the nest thus excavated. I have seen them so by hundreds on the Algerian hillsides. From the first, the young locusts resemble their parents in everything except in the presence of wings; they are most sociable in their habits, and hop about in great swarms over the arid country at the edge of the desert. By-and-by, leaving the larval form behind, they need their strong but delicate papery wings; and then begins a terrible and devastating migration. They have eaten all there is to eat in their native belt, and must needs go elsewhere. Driven from home by hunger, like the hordes of the north who attacked and overthrew the Roman Empire, the young locusts march forward in vast swarms, which sometimes extend over hundreds of miles of country together. If they succeed in finding a cultivated tract, they clear it in a few days of every living green thing: if they fail, they are almost equally to be dreaded in the end, for then they die by millions of starvation, and their rotting bodies, covering acres of land at once, fester in the sun and set up at last a pestilential malaria, which finally spreads as influenza or fever to Europe and America. From all which it may readily be seen that the prophet Joel was not exaggerating when he described the locusts as eating that which the palmerworm had left—"the land is as the garden of Eden before them, and behind them a desolate wilderness."

But perhaps the method recently adopted by the British authorities for killing locusts in Cyprus affords the best commentary upon the numbers and destructiveness of these invading hordes. An ingenious land-owner in the island, Mr. Richard Mattei, had noticed that when locusts are "upon the march," about ten days after their hatching, they allow no obstacle in their course to stop them, but climb or crawl (like young eels up weirs) over every barrier that comes in their way. But he had also noticed that they could not get a foothold on a perfectly smooth surface; and he hit accordingly on a clever plan for checking their triumphant advance altogether. He induced the government to bar their progress across country by erecting screens of canvas, set up on stakes, and topped by a broad band of that unpleasantly smooth and varnished fabric known to housewives as "American cloth."

The American cloth was more than the locusts could stand: they preferred death to so vile an invention. And this is how they meet their end with becoming fortitude. At the foot of the screens, deep pits are dug and lined with zinc. The locusts advance to the screens, which are laid right across their line of march, but being unable to climb over the polished cloth they fall into the pits. Thousands upon thousands thus tumble in masses on top of one another, and crush one another to death: the smooth zinc at the side effectually prevents them from climbing out again. In one year, the locusts were thus trapped in no less than 26,000 pits: the number of the killed was roughly estimated at a number which runs into twelve figures, say some 200,000,000,000, or two hundred thousand millions. The cost of killing this gigantic host amounted only to 2s. a million, which is certainly not excessive. If we could conduct our Soudan campaigns on the same terms, I fear there would not be a native left alive in Africa at the end of a twelvemonth. The resources of civilization would have civilized Baggaras and Matebeles into non-entity—which is sooner or later the usual course of our Imperial mission.

Another curious insect of the army-forming kind is that quaint little beast, the processional caterpillar of Southern Europe, an insect on which I have made continual observations for many seasons on the Riviera. The best-known species is the processional caterpillar of the pine tree; it lives in nests like those of wasps, surrounded with a sort of cobwebby silk cover. These nests may be seen by thousands on the trees in the Esterel in early spring: they are cut down and burned in vast quantities by the foresters, but no amount of burning ever seems to diminish their numbers. When they sally forth to feed or to bury themselves before assuming the chrysalis form, they march straight across country in a long line: or, if obstacles intervene, they curve round the base of trees or the edges of rocks in graceful undulations. Every procession has a recognised leader who heads the band: the rest follow after him in long Indian file, one after another, each holding on fast to the tail of the man in front of him. This at least is the only way in which I myself have ever seen them march: I find pictures in books of the caterpillars marching two or three abreast, or even in wedge-shaped triangular order: but after years of watching, I have never myself known them to go in any other way than single file, in a long sinuous line, one by one after the acknowledged leader.



If you break the line, the whole body at first seems paralyzed for a moment: then slowly they begin to recover confidence and to meet the situation. The last man left at the end of the fore part of the train seems to pull or bite the tail of the man just in front of him, who in turn communicates with the next in front, and so on all along the line, till the news has been telegraphed right ahead to the leader. Then the leader halts, and all the rest halt behind him. Meanwhile, a similar telegraphic message has been sent post haste to the rear by the front caterpillar of the second half, or interrupted portion: he seems to halt, marking time, and so to prevent the man just behind him from moving; this last by a backward shove similarly communicates the news of a breach to the insect at his tail; and so on till both halves of the divided procession have come to a dead stand, awaiting developments. If you have only removed one caterpillar from the line to a little distance, he soon crawls back again into his place in the procession: in which case the end insects on either side of him telegraph forward and back the return of the lost member, and in a few minutes the *cortège* moves on again. But if you have hopelessly removed three or four caterpillars to a considerable distance, so that they cannot find their way back, the line waits for twenty minutes or so, to give them a fair chance, and then, probably concluding that they have been eaten by birds or lizards, gives them up as lost, closes in again slowly, and resumes its march in a saddened and dispirited fashion.

I have experimented in many ways with these lines of caterpillars, and have always found that if only one insect was removed, the procession soon joined together again, either with him or without him. But if several were removed at various points, so as entirely to disorganize the whole line, the insects seemed to get puzzled and at last lost heart, curling round upon one another in a helpless muddle, and trying each to effect a

junction with a leader. None but the original leader, however, seems qualified to lead: a heaven-born king or elected president, I know not which, he is absolutely necessary to the safety of the line: remove him, and not an insect will stir a leg: no other of the line dare take the place of the duly constituted hierophant. Deprived of their chief, the caterpillars seem to be thrown into an agony of terror; each tries to shuffle off upon his equally unwilling neighbour the responsibility of going first. As a rule, this chaos ends by making them all roll up into a tangled ball and refuse to move either forward or backward: there they stop till they die, or are trodden under foot or eaten by birds, too timid to proceed without their proper general. I suspect that the ordinary pictures of lines three or four deep must be derived from such broken and disorganized processions; for I have never known a healthy and perfect line

proceed in any other way than by single file order.

The last of these destructive insects with which I shall deal here is the dreaded army-worm, a terrible plague of American wheat-fields. The whole life-history of this dangerous wild beast is summed up for us in brief in No. 19, drawn also from materials supplied by Professor Riley, who worked harder at the investigation of these insect pests than any other entomologist in Europe or America. No. 1 in this illustration shows the harmless and innocent-looking eggs, quietly deposited by the mother moth on a blade of wheat as it grows. No. 2 gives us the larva just hatched, and proceeding to make a meal on the farmer's

young crop. Nos. 3, 4, 5, and 6 show it growing progressively fatter in the process, much to the detriment of the corn; while at 7 it is represented as turning into a pupa, and at 8, 9, and 10 is seen as the perfect insect. This American army-worm commits terrible ravages in the western wheatfields, and sometimes attacks whole districts at once like an invading battalion.

A totally different but still more interesting



19.—LIFE-HISTORY OF THE ARMY-WORM.

insect is known by the same name of army-worm in Southern Europe. It is the grub of a midge, and is not separately noticeable; but its numbers make it conspicuous, and its curious habits have always attracted the attention both of naturalists and of farmers. The European army-worm, however, is not in any way a menace to agriculture: it is merely noteworthy from the strangeness and weirdness of its processional habits. The adult midge is a small black fly, no bigger than a mosquito: it lays its numerous eggs among fallen and rotting leaves, which form the favourite food of its myriad larvæ. The eggs hatch out into little naked maggots, about a quarter of an inch long: the body is sticky and almost transparent, but the wee black head gives the tiny beasts a rather knowing expression, like insects of the world, quite at home in society. When the time arrives for the grubs to turn into chrysalides, thousands of families of them collect together among the fallen leaves so as to form a veritable army, which sets forth on a march across country in a serried phalanx, many feet in length, and crawling some sixty or seventy abreast in very irregular order. The line flows like a cataract over whatever comes in its way, the individual whitish grubs not being particular whether they crawl over one another or not: and as they wind in and out, around trunks of trees and gnarled roots or stems, they resemble nothing so much as a huge grey snake trailing slowly through the brush-wood. The line seethes with life: it is a living stream, composed of translucent and viscid insects, so fluid and plastic in its mode of progression that you have to look close before you can convince yourself that it is really made up of individual maggots.

At last the army reaches a suitable place for undergoing its metamorphosis. Then instinct teaches it what to do. It halts by common consent, and the various grubs roll themselves up into a huge round ball, which

seems for a time to be perfectly motionless. If you watch it long, however, you will soon begin to perceive that it is growing by degrees mysteriously smaller and smaller. Can the grubs be eating one another up, like the Kilkenny cats? It looks as though the mass were disappearing slowly into thin air: only when the ball has begun to reach its last few layers do you get an inkling of the explanation of the mystery. The larvæ have chosen a nice soft spot in the deep black mould of the wood where they can easily bury themselves to undergo transformation. Those at the bottom of the ball first burrow into the ground, and are followed one by one by the others in succession. There they all assume the form of small mummy-like pupæ: and after passing through their transformation underground, emerge at last as a vast and tangled swarm of small black midges, dancing in the sunlight with rhythmical motion. But though the European army-worm is really quite harmless, being a member of the rather innocuous or useful group of fungus-eating midges, the occasional appearance of the armies across a grassy path has always been a cause of superstitious terror to the peasants of the wild and tangled forest-lands which the creature frequents. Strange stories are told and believed about these innocent little grubs: their advent is a sign of impending war: they are the harbingers of invasion: they herald misfortune like comets and earthquakes: they even appear as portents of God's wrath before the occurrence of plague, famine, and pestilence. In New Orleans and other American towns exposed to yellow-fever, it is believed that a closely similar midge, the so-called "yellow-fever fly," accompanies the epidemics of that dreaded disease. But it is not improbable that the microbe of yellow-fever may really be spread by means of midges, so that in this respect the current belief of the New World rests perhaps upon a firmer basis than the antique superstition of the European woodlands.